# BassGas Offshore Operations Environment Plan 5-year Review

## Relevant Persons Identified

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| Entity ID | Type | Name | Roles and responsibilities |
|---|---|---|---|
| | | | |
| **OPGGS (E) 2023 - Commonwealth - 25(1)(a) Cth or State authority or agency (where EP activities relevant) / Relevant authorities, OPGGS(E)R 25(1)(a), (b), (c) and OPGGSR 2021 (Vic) 13F(1)(a)** | | | |
| O-00198 | Commonwealth - Agency | Australian Communications and Media Authority | Regulates broadcasting, telecommunications, online content, and radio spectrum use in Australia, promoting fair access, consumer protection, industry compliance, and respect for cultural diversity and community standards. |
| O-00202 | Commonwealth - Agency | Australian Energy Market Operator | Operates and plans Australia's electricity and gas systems, ensuring energy security, market efficiency, and a smooth transition to renewables, while engaging with communities, respecting environmental and cultural values, and supporting equitable access to energy. |
| O-03230 | Commonwealth - Agency | Australian Fisheries Management Authority | Manages Commonwealth fisheries through licensing, catch limits, and compliance, while supporting sustainability, ecosystem health, and respect for Indigenous and cultural connections to sea Country. |
| O-00208 | Commonwealth - Agency | Australian Hydrographic Office | Provides accurate nautical information to support safe navigation, maritime operations, and environmental stewardship, with a focus on safety, precision, and respect for Australia's marine heritage and sovereign waters. |
| O-00415 | Commonwealth - Agency | Civil Aviation Safety Authority | Regulates and oversees aviation safety in Australia by licensing pilots, registering aircraft, certifying airports, enforcing safety rules, and promoting safe aviation practices. |
| O-00627 | Commonwealth - Agency | Director of National Parks | Manages Australia's Commonwealth national parks, marine parks, and botanic gardens, protecting biodiversity and cultural heritage while supporting conservation, research, and collaboration with Traditional Owners and the government. |
| O-01551 | Commonwealth - Agency | National Native Title Tribunal | An independent agency that mediates Native Title claims, manages Indigenous land use agreements, maintains Native Title registers, and assists parties to reach fair and prompt agreements over land and waters. |
| O-00559 | Commonwealth - Department | Department of Agriculture, Fisheries and Forestry - Biosecurity and Marine Pests | Manage and protects Australia's biosecurity by preventing, monitoring, and responding to the introduction and spread of pests, diseases, and marine pests that threaten agriculture, fisheries, and the broader environment. |
| O-00571 | Commonwealth - Department | Department of Defence | Responsible for defending Australia and its national interests to promote security, stability, and prosperity. |
| O-00585 | Commonwealth - Department | Department of Industry, Innovation and Science | Supports Australia's economic growth, productivity, and competitiveness by fostering innovation, supporting industry development, and enhancing scientific research and technology commercialisation. |
| O-02373 | NSW - Department | Transport for NSW | Plans, delivers, manages, and regulates safe, integrated transport services, infrastructure, and policies in New South Wales. |
| O-00066 | TAS - Agency | Aboriginal Heritage Tasmania | Protects and manages Tasmanian Aboriginal cultural heritage. |
| O-00707 | TAS - Agency | Environment Protection Authority (EPA) Tasmania | An independent statutory body that regulates and enforces environmental laws to protect and improve air, water, land, noise, and sustainable development for the state's environmental quality. |

| Entity ID | Type | Name | Roles and responsibilities |
|---|---|---|---|
| O-02565 | TAS - Department | Department of Natural Resources and Environment Tasmania - Biosecurity | Manages Tasmania's parks, reserves, and wildlife by conserving natural and cultural heritage, facilitating sustainable recreation and tourism, protecting native habitats, supporting visitor education, and enforcing conservation laws and regulations. |
| O-00599 | TAS - Department | Department of Natural Resources and Environment Tasmania - Tasmania Parks and Wildlife Services | Manages Tasmania's parks, reserves, and wildlife by conserving natural and cultural heritage, facilitating sustainable recreation and tourism, protecting native habitats, supporting visitor education, and enforcing conservation laws and regulations. |
| O-00608 | TAS - Department | Department of State Growth - Mineral Resources Tasmania | Gives effect to government policy in relation to minerals and petroleum resources, and provides essential information for land management in Tasmania. |
| O-00703 | VIC - Agency | Energy and Water Ombudsman Victoria | An independent, free service that investigates and resolves customer complaints about energy and water providers to ensure fair outcomes and improve industry practices. |
| O-02718 | VIC - Agency | Environment Protection Authority (EPA) Victoria | Independently regulates, prevents pollution, protects human health, and enforces environmental laws. independently regulates, prevents pollution, protects human health, and enforces environmental laws. |
| O-00722 | VIC - Agency | Essential Services Commission Victoria | Regulates the energy, water, and transport sectors to ensure fair pricing, reliable service, consumer protection, and equitable access, while also administering the local government rate-capping system. |
| O-00923 | VIC - Agency | Heritage Victoria | Protects and manages Victoria's most significant historic sites, by regulating changes, maintaining the Victorian Heritage Register, and enforcing the Heritage Act 2017. |
| O-01691 | VIC - Agency | Parks Victoria | Responsible for managing over four million hectares of parks, reserves, and waterways, which amounts to about 18 percent of Victoria's landmass and 70 percent of its coastline. |
| O-02372 | VIC - Agency | Transport Safety Victoria - Maritime Safety Victoria | Regulates and promotes safe vessel operations, licensing, compliance, and marine incident management in Victorian waters. |
| O-02418 | VIC - Agency | Victorian Aboriginal Heritage Council | Protects Aboriginal cultural heritage through appointing Registered Aboriginal Parties, managing ancestral remains, advising government, and promoting public awareness and respect. |
| O-02423 | VIC - Agency | Victorian National Parks Association | Protects Victoria's natural environment by establishing and managing parks, promoting conservation, and engaging communities. |
| O-00575 | VIC - Department | Department of Energy, Environment and Climate Action | Integrates and leads efforts across energy, environment, water, agriculture, forestry, resources, climate action, and emergency management. |
| O-00591 | VIC - Department | Department of Jobs, Skills, Industry and Regions | Drives economic development across Victoria by supporting industries, businesses, regional and suburban development, and skills training. |
| O-00609 | VIC - Department | Department of Transport and Planning | Responsible for planning, building, operating, and maintaining Victoria's transport and planning system. |
| **OPGGS (E) 2023 - Commonwealth - 25(1)(b) Department of State Minister (responsible for offshore area) / Relevant authorities, OPGGS(E)R 25(1)(a), (b), (c) and OPGGSR 2021 (Vic) 13F(1)(a)** | | | |

| Entity ID | Type | Name | Roles and responsibilities |
|---|---|---|---|
| O-02803 | VIC - Minister | Minister for Agriculture | Manages agricultural policy, biosecurity, farmer support, and sustainable food production. |
| O-01654 | VIC - Minister | Minister for Environment | Responsible for administering state environmental laws (e.g., Environment Protection Act 2017) and overseeing pollution control measures. |
| O-01653 | VIC - Minister | Minister for Regional Development | Supports regional communities by creating jobs, delivering infrastructure, attracting investment, and enabling economic growth to share prosperity across the state. |
| **OPGGS (E) 2023 - Commonwealth - 25(1)(d) Person or organisation whose FIAs may be affected by EP activities / Relevant persons, OPGGS(E)R 25(1)(d) and OPGGSR 2021 (Vic) 13F(1)(b)** | | | |
| O-00187 | Business - Local | Atlantis Fisheries Consulting Group | Advisory firm providing services in all aspects of fisheries investment, management, research, science and trade. |
| O-02284 | Business - Local | Telstra | Provides telecommunications service across Australia. |
| O-00216 | Commercial fishing - Commonwealth Fisheries | Australian Southern Bluefin Tuna Industry Association | Represents the Australian Southern Bluefin Tuna industry, inclusive of purse seine and long line fishing, and ranching operations for Southern Bluefin Tuna. |
| O-00433 | Commercial fishing - Commonwealth Fisheries | Commonwealth Fisheries Association | Peak industry body representing the collective rights, responsibilities, and interests of commercial fishers operating in Commonwealth regulated fisheries. |
| O-02056 | Commercial fishing - Commonwealth Fisheries | Seafood Industry Australia | The national peak body representing the entire Australian seafood industry, including wild catch, aquaculture, and post-harvest sectors. |
| O-02114 | Commercial fishing - Commonwealth Fisheries | South East Trawl Fishing Industry Association | A not-for-profit organisation representing fishers, quota owners, wholesalers, and processors in the Commonwealth South East Trawl Fishery sector. |
| O-02136 | Commercial fishing - Commonwealth Fisheries | Southern Rock Lobster Limited | The national peak body representing the Australian Southern Rock Lobster industry, responsible for administering an industry-wide levy that funds research, development, and innovation to support sustainable harvests. |
| O-02139 | Commercial fishing - Commonwealth Fisheries | Southern Shark Industry Alliance (SSIA) | Represents quota owners, fishers, and processors in the Commonwealth-managed Southern Shark Fishery, focusing on sustainable harvesting of gummy and other shark species. |
| O-02390 | Commercial fishing - Commonwealth Fisheries | Tuna Australia | Represents statutory fishing right owners, holders, fish processors and sellers, and associate members of the Eastern and Western tuna and billfish fisheries of Australia. |
| O-00062 | Commercial fishing - Victorian Fisheries | Abalone Victoria Central Zone | Represents the interests of Abalone Central Zone entitlement holders on operational fishery management matters. |
| O-02058 | Commercial fishing - Victorian Fisheries | Seafood Industry Victoria | The peak body representing the Victorian seafood industry, including professional fishers, wholesalers, processors, and retailers. |
| O-02406 | Commercial fishing - Victorian Fisheries | VR Fish | Peak body representing and advocating for Victorian recreational fishers, promoting sustainable fishing, community engagement, and influencing government fisheries policies. |
| O-02034 | Commercial fishing -Tasmanian Fisheries | Scallop Fishermen's Association of Tasmania Inc | Represents and advocates for commercial scallop fishermen and processors in Tasmania. |
| O-02057 | Commercial fishing -Tasmanian Fisheries | Seafood Industry Tasmania | The peak body representing the interests of the Tasmanian seafood industry, including wild catch and aquaculture sectors. |

| Entity ID | Type | Name | Roles and responsibilities |
|---|---|---|---|
| O-02421 | Commonwealth - Agency | Victorian Fisheries Authority | Manages sustainable fishing and aquaculture, enforces regulations, issues licences, supports Indigenous fishing, and promotes economic, social, and cultural benefits. |
| O-00212 | Commonwealth - Emergency Services | Australian Maritime Safety Authority - Joint Rescue Coordination Centre | Coordinates national maritime and aviation search and rescue operations. |
| O-01234 | Community - Beach reference group | BassGas Community Reference Group | A stakeholder consultative body of local community and key stakeholders to provide advice and feedback on Beach's activities in the Bass Basin. |
| O-02780 | Education and Research Organisations - Research agency | Australian Marine Mammal Centre (AMMC) – Australian Antarctic Division | A national research center housed within the Australian Antarctic Division focused on understanding, protecting, and conserving Australian marine mammals. |
| O-02781 | Education and Research Organisations - Research agency | Australian Marine Sciences Association | Australia's peak professional body for marine scientists from all disciplines, promoting all aspects of marine science in Australia. |
| I-03936 | Indigenous - Aboriginal | Name redacted | Community member |
| O-03227 | Indigenous - Aboriginal | Bunurong Land Council Aboriginal Corporation | Traditional Owner organisation representing the Bunurong people of the south-eastern Kulin Nation in Victoria. |
| O-00410 | Indigenous - Aboriginal | Circular Head Aboriginal Corporation | Supports local Aboriginal community through health, cultural, family, and rehabilitation services in the Circular Head region of Tasmania. |
| O-00898 | Indigenous - Aboriginal | Gunaikurnai Land and Waters Aboriginal Corporation | Represents Gunakurnai people’s Native Title, cultural heritage, and land and water management interests. |
| O-02775 | Interest Groups - Enviro Group - Local | Amazon 1863 Project Inc. | Preserves the historic shipwreck through conservation, research, and community education, valuing cultural heritage and local engagement. |
| O-02747 | Interest Groups - Enviro Group - Local | Cape Woolamai Coast Action | Supports coastal conservation through revegetation, weed removal, and protecting remnant vegetation. |
| O-00783 | Interest Groups - Enviro Group - Local | Friends of the Prom | A volunteer group supporting Parks Victoria in conserving and maintaining Wilsons Promontory National Park through habitat restoration and environmental projects. |
| O-02764 | Interest Groups - Enviro Group - Local | Phillip Island Conservation Society | Works collaboratively to promote environmental protection and conservation of natural resources on Phillip Island. |
| O-02765 | Interest Groups - Enviro Group - Local | South Gippsland Conservation Society | Informs the community, conducts restoration projects, and promotes local natural resource preservation. |
| O-02763 | Interest Groups - Enviro Group - State | Bass Coast Landcare Network | Supports sustainable farming and environmental restoration through education, partnerships, and hands-on conservation work. |
| I-03935 | Interest Groups - Enviro Group - State | Name redacted | Local environmental conservationist |
| O-00756 | Marine Based Industry - Marine businesses | Fishwell Consulting | Provides expert research, monitoring, and advisory services to promote sustainable commercial, recreational, and artisanal fishing practices in Australia. |
| O-01920 | Marine Based Industry - Marine businesses | Richey Fishing Company | A third-generation family business operating in southern Australian fisheries, specialising in scallops, squid, and Australian salmon. |
| O-02364 | Marine Based Industry - Marine businesses | Top Fish Tasmania | Specialises in catching, processing, and marketing Tasmanian octopus and live seafood, supplying local and international markets. |

| Entity ID | Type | Name | Roles and responsibilities |
|---|---|---|---|
| O-00094 | Marine Based Industry -Subsea Comms Cable | Alcatel Submarine Networks | Builds and maintains undersea cable systems for global data transmission, with a focus on innovation, marine sustainability, and respecting seabed environments and cultural sensitivities. |
| O-01365 | Marine Based Industry -Subsea Comms Cable | Marinus Link | A proposed undersea and underground electricity and data interconnector linking North West Tasmania and Victoria's Latrobe Valley. |
| O-02787 | Tourism/Recreation - Marine Tourism | Island Offshore Charters | Offers fishing charters in Western Port and Bass Strait. |
| O-02508 | Tourism/Recreation - Marine Tourism | Wildlife Coast Cruises | Runs eco-certified wildlife cruises around Phillip Island and Wilsons Promontory, combining education, conservation, and immersive marine experiences. |
| O-02795 | Tourism/Recreation - Marine Tourism | Better than Working Charters | Operates fishing and cruising charters from San Remo in Western Port, Bass Strait, and around Phillip Island. |
| O-02788 | Tourism/Recreation - Peak Body | Inverloch Tourism Association | Promotes Inverloch as a destination through marketing, event support, and business networking. |
| O-00248 | VIC - Local Government | Bass Coast Shire Council | Local government authority. |
| O-00371 | VIC - Local Government | Cardinia Shire Council | Local government authority. |
| O-01509 | VIC - Local Government | Mornington Peninsula Shire Council | Local government authority. |
| O-02633 | VIC - Local Government | South Gippsland Council | Local government authority. |
| O-01637 | VIC - State | Member for Bass District | Member of the Victorian Legislative Assembly representing the Bass electorate. |
| **OPGGS (E) 2023 - Commonwealth - 25(1)(e) Any other person or Organisation that the titleholder considers relevant / Other persons, OPGGS(E)R 25(1)(e) and OPGGSR 2021 (Vic) 13F(1)(c)** | | | |
| O-02351 | Business - Local | Toll Group | Provides logistics, freight, warehousing, and supply chain management services across Australia and globally. |
| O-00447 | Business - Local | Total Marine Gippsland (Corporate Alliance Enterprises) | Operates as a comprehensive marine services company based in Lakes Entrance with primary functions including commercial welding and small fabrication services tailored for marine vessels such as fishing boats, tugs, and barges. |
| O-00111 | Business - Oil & Gas | Amplitude Energy | Explores, develops, and produces natural gas and oil for the domestic energy market, operating key assets in the Gippsland and Otway Basins |
| O-00203 | Business - Oil & Gas | Australian Energy Producers | Advocates for Australia's upstream oil, gas, and low-emission energy sector, supporting energy security, investment, and emissions reduction while promoting environmental responsibility and respectful engagement with communities and Traditional Owners. |
| O-03220 | Business - Oil & Gas | ConocoPhillips | Operator and major participant in natural gas exploration, production, and liquefied natural gas operations in Australia. |
| O-00723 | Business - Oil & Gas | Esso | Oil and gas company, operating primarily in exploration, production, refining, and distribution of petroleum products, with assets in the Bass Strait. |
| O-02651 | Commercial fishing - South Australian Fisheries | South Australia Rock Lobster Advisory Council | Promotes the interests of the South Australian Rock Lobster Industry, and supports sustainable fishery management. |
| O-02221 | Commercial fishing -Tasmanian Fisheries | TARFish | Fully independent peak body representing the interests of recreational marine fishers in Tasmania. |

| Entity ID | Type | Name | Roles and responsibilities |
|---|---|---|---|
| O-02251 | Commercial fishing -Tasmanian Fisheries | Tasmanian Rock Lobster Council Ltd | Promotes the welfare of fishery participants and advocates for legislative, management, and sustainability measures supporting the rock lobster industry and its stakeholders. |
| O-02594 | Commercial fishing -Tasmanian Fisheries | Tasmanian Seafood Industry Council | Represents fishers, marine farmers, and processors, promoting sustainable, profitable seafood industry growth. |
| O-02752 | Community - Community groups | Flinders District Historical Society | Collects, preserves, and records local history through research, exhibitions, publications, and events. |
| O-02801 | Community - Local volunteer groups | Cape Paterson Surf Life Saving Club | Provides beach patrols, lifesaving education, surf safety training, and community surf programs. |
| O-02762 | Community - Local volunteer groups | San Remo Foreshore Committee | Manages, maintains, and improves the San Remo foreshore reserve and its facilities. |
| I-03931 | Community - Member | Name redacted | Community member |
| I-03730 | Community - Member | Name redacted | Community member |
| O-02782 | Community - Recreational groups | Bass Coast Aquatic and Leisure Centre | Sports centre, includes a 25-meter indoor pool, gym, group fitness classes, toddler pools, and indoor stadium courts. |
| O-02786 | Community - Recreational groups | Bass Strait Aquatic Club | A non-profit dive club based in Rye, focused on scuba diving activities. |
| O-02800 | Community - Recreational groups | Cowes Yacht Club | Facilitates sailing events and provides sailing courses for off-the-beach boats and trailer yachts on Phillip Island. |
| O-02751 | Community - Recreational groups | Flinders Yacht Club | Offers sailing activities, training, races, social events, and venue hire for private functions in Flinders. |
| O-02789 | Community - Recreational groups | Inverloch Surf Life Saving Club | Provides volunteer beach patrols, surf safety training, emergency rescue, and community programs in Inverloch. |
| O-01541 | Community - Recreational groups | NSW Port Authority - Port of Eden | Manages the Port of Eden. |
| O-01631 | Community - Recreational groups | Ocean Racing Club of Victoria | Organises and promotes ocean yacht racing in Victoria, conducts major races, and provides ocean sailing training and safety education. |
| O-01988 | Community - Recreational groups | SCUBA Divers Federation of Victoria | A volunteer organisation that promotes diver safety and represents the interests of recreational scuba divers in Victoria. |
| O-02120 | Community - Recreational groups | South Gippsland Yacht Club | Organises sailing races and regattas, supports member participation in sailing activities, and hosts community and social events. |
| O-02804 | Community - Recreational groups | Tasmanian Commercial Divers Association | Represents commercial dive licence holders and supervisors, advocating industry interests. |
| O-02411 | Community - Recreational groups | Venus Bay Surf Life Saving Club | Provides beach patrols, water safety education, and rescue services, promoting community safety and skills development in Venus Bay, Victoria. |
| O-02753 | Community - Recreational groups | Wonthaggi Angling Club | Runs recreational fishing competitions, promotes sustainable angling, and provides a community hub for local fishers. |
| O-02527 | Community - Recreational groups | Woolamai Beach Surf Life Saving Club | Provides volunteer surf patrols, lifesaving education, junior programs, and community engagement on Phillip Island. |
| O-00299 | Education and Research Organisations - Research agency | Blue Whale Study Inc | Conducts ecological research on blue whales and their upwelling habitats in southern Australia. |

| Entity ID | Type | Name | Roles and responsibilities |
|---|---|---|---|
| O-02802 | Education and Research Organisations - University | Deakin Marine Research and Innovation Centre | Focuses on sustainable aquaculture, blue carbon, coastal ecosystems, ocean life, and marine technology research. |
| O-00963 | Education and Research Organisations - University | Institute for Marine and Antarctic Studies, University of Tasmania | Researches and educates on marine and Antarctic environments, focusing on fisheries, ecology, climate change, and ocean governance for sustainable management. |
| O-03184 | Indigenous - Aboriginal | Aboriginal Land Council of Tasmania | Focuses on returning private freehold land to Aboriginal ownership for cultural, community, and natural benefit. |
| O-00746 | Indigenous - Aboriginal | First Nations Legal & Research Services Ltd | Provides legal advice and representation to Victorian First Nations people for native title claims, recognition, and land rights negotiations. |
| O-00759 | Indigenous - Aboriginal | Flinders Island Aboriginal Association Inc | Provides health, aged care, housing, youth, cultural, and community support services for the Aboriginal community on Flinders Island. |
| O-03228 | Indigenous - Aboriginal | Tasmanian Aboriginal Centre | Advocates for community development, provides health, aged care, children's services, supports cultural preservation, land management, education, and wellbeing programs for Aboriginal people in Tasmania. |
| O-02790 | Interest Groups - Enviro Group - Local | Inverloch Historical Society Inc | Focuses on researching, preserving, and sharing Inverloch's local history. |
| O-02773 | Interest Groups - Enviro Group - Local | Phillip Island & District Historical Society | Collects, preserves, and displays historical records and artefacts related to Phillip Island and district. |
| O-02772 | Interest Groups - Enviro Group - Local | Phillip Island Nature Parks | Manages conservation, wildlife rehabilitation, research, ecotourism, and environmental education on Phillip Island. |
| O-02498 | Interest Groups - Enviro Group - Local | Westernport Swamp Landcare Group | Conserves native vegetation, indigenous fauna, waterways, and promotes sustainable land and cultural heritage management. |
| O-02754 | Interest Groups - Enviro Group - Local | Wonthaggi and District Historical Society | Conserves local heritage through museum exhibitions, archival preservation, public events, and volunteer engagement. |
| O-00964 | Interest Groups - Enviro Group - National/International | International Fund for Animal Welfare (Australia) | Rescues and protects animals, conserves wildlife habitats, combats illegal wildlife trade, supports animal welfare in emergencies, and advocates for stronger animal protection policies. |
| O-00633 | Interest Groups - Enviro Group - State | Dolphin Research Institute | Conducts scientific research on dolphins and whales, promotes marine conservation through education, community engagement, and citizen science, and advocates for the protection of marine life and habitats. |
| O-02749 | Interest Groups - Enviro Group - State | Futurefish Foundation | Supports recreational fishing through research projects, advocacy, and community programs. |
| I-03938 | Interest Groups - Progress Association | Name redacted | Community member |
| I-03856 | Landholder - Residential | Name redacted | Community member from Kilcunda |
| O-02250 | Marine Based Industry - Business | Tasmanian Divers Group | Provides scuba training, equipment sales, dive trips, and conservation activities in Tasmania. |
| O-00163 | Marine Based Industry - Desalination Plant | Aquasure | Operates and maintains the Victorian Desalination Plant. |

| Entity ID | Type | Name | Roles and responsibilities |
|---|---|---|---|
| O-02252 | Marine Based Industry - Marine businesses | Tasmanian Seafoods | Processes, markets, and exports premium wild-caught abalone, sea cucumber, and other seafood, supplying global markets with sustainably sourced Tasmanian products. |
| O-00758 | TAS - Local Government | Flinders Council | Local government authority. |
| O-02794 | Tourism/Recreation - Marine Tourism | BayPlay Adventure Tours | Provides water and land-based adventures including scuba diving, snorkeling, sea kayaking, paddleboarding, guided hikes, bike tours, and accommodation on the Mornington Peninsula. |
| O-02797 | Tourism/Recreation - Marine Tourism | Blue Water Sailing School | Provides accredited sailing courses and practical training on yachts. |
| O-02750 | Tourism/Recreation - Marine Tourism | Dive2U Mobile Adventures | Provides mobile scuba training, diving experiences, equipment rentals, and marine education programs. |
| O-02785 | Tourism/Recreation - Marine Tourism | Newhaven Fishing Charters | Operates fishing trips in Westernport and Bass Strait, providing equipment and catch cleaning services. |
| O-02779 | Tourism/Recreation - Marine Tourism | Newhaven Yacht Squadron | Provides marina berths, boat maintenance, sailing training, and hosts social and competitive boating events. |
| O-02778 | Tourism/Recreation - Marine Tourism | Ocean Adventures Phillip Island | Provides jet boat tours, snorkelling, scuba experiences, and customised water-based tourism packages. |
| O-02766 | Tourism/Recreation - Marine Tourism | S.E.A.L. Diving Services | Provides scuba diving courses, equipment hire, and organised dive trips locally and overseas. |
| O-02760 | Tourism/Recreation - Marine Tourism | T-Cat Charters | Offers fishing, scuba diving, sightseeing, and survey services in Port Phillip Bay and Westernport Bay. |
| O-02759 | Tourism/Recreation - Marine Tourism | The Reel Thing Fishing Charters | Provides fishing and diving charters in Port Phillip Bay, Melbourne, including equipment and guides. |
| O-02761 | Tourism/Recreation - Peak Body | Destination Phillip Island Regional Tourism Board | Develops, markets, and advocates for Phillip Island's tourism industry, coordinating regional growth. |

# BassGas Offshore Operations Environment Plan 5-year Review

Report on Consultation from 14 July to 28 November 2025

# Table of Contents

OPGGS (E) 2023 - Commonwealth - 25(1)(a) Cth or State authority or agency (where EP activities relevant) / Relevant authorities, OPGGS(E)R 25(1)(a), (b), (c) and OPGGSR 2021 (Vic) 13F(1)(a) ..... 7

Commonwealth - Agency ID: O-00198 Australian Communications and Media Authority ..... 7

Commonwealth - Agency ID: O-00202 Australian Energy Market Operator ..... 7

Commonwealth - Agency ID: O-03230 Australian Fisheries Management Authority ..... 7

Commonwealth - Agency ID: O-00208 Australian Hydrographic Office ..... 9

Commonwealth - Agency ID: O-00415 Civil Aviation Safety Authority ..... 9

Commonwealth - Agency ID: O-00627 Director of National Parks ..... 10

Commonwealth - Agency ID: O-01551 National Native Title Tribunal ..... 10

Commonwealth - Department ID: O-00559 Department of Agriculture, Fisheries and Forestry - Biosecurity and Marine Pests ..... 11

Commonwealth - Department ID: O-00571 Department of Defence ..... 11

Commonwealth - Department ID: O-00585 Department of Industry, Innovation and Science ..... 12

NSW - Department ID: O-02373 Transport for NSW ..... 12

TAS - Agency ID: O-00066 Aboriginal Heritage Tasmania ..... 13

TAS - Agency ID: O-00707 Environment Protection Authority (EPA) Tasmania ..... 13

TAS - Department ID: O-02565 Department of Natural Resources and Environment Tasmania - Biosecurity ..... 13

TAS - Department ID: O-00599 Department of Natural Resources and Environment Tasmania - Tasmania Parks and Wildlife Services ..... 14

TAS - Department ID: O-00608 Department of State Growth - Mineral Resources Tasmania ..... 14

VIC - Agency ID: O-00703 Energy and Water Ombudsman Victoria ..... 15

VIC - Agency ID: O-02718 Environment Protection Authority (EPA) Victoria ..... 16

VIC - Agency ID: O-00722 Essential Services Commission Victoria ..... 16

VIC - Agency ID: O-00923 Heritage Victoria ..... 17

VIC - Agency ID: O-01691 Parks Victoria ..... 17

VIC - Agency ID: O-02372 Transport Safety Victoria - Maritime Safety Victoria ..... 18

VIC - Agency ID: O-02418 Victorian Aboriginal Heritage Council ..... 18

VIC - Agency ID: O-02423 Victorian National Parks Association ..... 19

VIC - Department ID: O-00575 Department of Energy, Environment and Climate Action ..... 20

VIC - Department ID: O-00591 Department of Jobs, Skills, Industry and Regions ..... 20

VIC - Department ID: O-00609 Department of Transport and Planning ..... 21

OPGGS (E) 2023 - Commonwealth - 25(1)(b) Department of State Minister (responsible for offshore area) / Relevant authorities, OPGGS(E)R 25(1)(a), (b), (c) and OPGGSR 2021 (Vic) 13F(1)(a) ..... 22

VIC - Minister ID: O-02803 Minister for Agriculture ..... 22

VIC - Minister ID: O-01654 Minister for Environment ..... 22

VIC - Minister ID: O-01653 Minister for Regional Development ..... 23

OPGGS (E) 2023 - Commonwealth - 25(1)(d) Person or organisation whose FIAs may be affected by EP activities / Relevant persons, OPGGS(E)R 25(1)(d) and OPGGSR 2021 (Vic) 13F(1)(b) ..... 23

Business - Local ID: O-00187 Atlantis Fisheries Consulting Group ..... 23

Business - Local ID: O-02284 Telstra ..... 24

Commercial fishing - Commonwealth Fisheries ID: O-00216 Australian Southern Bluefin Tuna Industry Association ..... 26

Commercial fishing - Commonwealth Fisheries ID: O-00433 Commonwealth Fisheries Association ..... 27

Commercial fishing - Commonwealth Fisheries ID: O-02056 Seafood Industry Australia ..... 27

Commercial fishing - Commonwealth Fisheries ID: O-02114 South East Trawl Fishing Industry Association ..... 27

Commercial fishing - Commonwealth Fisheries ID: O-02136 Southern Rock Lobster Limited ..... 28

Commercial fishing - Commonwealth Fisheries ID: O-02139 Southern Shark Industry Alliance (SSIA) ..... 28

Commercial fishing - Commonwealth Fisheries ID: O-02390 Tuna Australia ..... 29

Commercial fishing - Victorian Fisheries ID: O-00062 Abalone Victoria Central Zone ..... 29

Commercial fishing - Victorian Fisheries ID: O-02058 Seafood Industry Victoria ..... 30

Commercial fishing - Victorian Fisheries ID: O-02406 VR Fish ..... 30

Commercial fishing -Tasmanian Fisheries ID: O-02034 Scallop Fishermen's Association of Tasmania Inc ..... 31

Commercial fishing -Tasmanian Fisheries ID: O-02057 Seafood Industry Tasmania ..... 31

Commonwealth - Agency ID: O-02421 Victorian Fisheries Authority ..... 31

Commonwealth - Emergency Services ID: O-00212 Australian Maritime Safety Authority - Joint Rescue Coordination Centre ..... 32

Community - Beach reference group ID: O-01234 BassGas Community Reference Group ..... 34

Education and Research Organisations - Research agency ID: O-02780 Australian Marine Mammal Centre (AMMC) – Australian Antarctic Division ..... 36

Education and Research Organisations - Research agency ID: O-02781 Australian Marine Sciences Association ..... 36

Indigenous - Aboriginal ID: I-03936 Name redacted ..... 36

Indigenous - Aboriginal ID: O-03227 Bunurong Land Council Aboriginal Corporation ..... 37

Indigenous - Aboriginal ID: O-00410 Circular Head Aboriginal Corporation ..... 39

Indigenous - Aboriginal ID: O-00898 Gunaikurnai Land and Waters Aboriginal Corporation ..... 41

Interest Groups - Enviro Group - Local ID: O-02775 Amazon 1863 Project Inc. ..... 44

Interest Groups - Enviro Group - Local ID: O-02747 Cape Woolamai Coast Action ..... 44

Interest Groups - Enviro Group - Local ID: O-00783 Friends of the Prom ..... 44

Interest Groups - Enviro Group - Local ID: O-02764 Phillip Island Conservation Society ..... 44

Interest Groups - Enviro Group - Local ID: O-02765 South Gippsland Conservation Society ..... 45

Interest Groups - Enviro Group - State ID: O-02763 Bass Coast Landcare Network ..... 45

Interest Groups - Enviro Group - State ID: I-03935 Name redacted ..... 45

Marine Based Industry - Marine businesses ID: O-00756 Fishwell Consulting ..... 46

Marine Based Industry - Marine businesses ID: O-01920 Richey Fishing Company ..... 47
Marine Based Industry - Marine businesses ID: O-02364 Top Fish Tasmania ..... 47
Marine Based Industry -Subsea Comms Cable ID: O-00094 Alcatel Submarine Networks ..... 47
Marine Based Industry -Subsea Comms Cable ID: O-01365 Marinus Link ..... 48
Tourism/Recreation - Marine Tourism ID: O-02787 Island Offshore Charters ..... 49
Tourism/Recreation - Marine Tourism ID: O-02508 Wildlife Coast Cruises ..... 49
Tourism/Recreation - Marine Tourism ID: O-02795 Better than Working Charters ..... 50
Tourism/Recreation - Peak Body ID: O-02788 Inverloch Tourism Association ..... 50
VIC - Local Government ID: O-00248 Bass Coast Shire Council ..... 51
VIC - Local Government ID: O-00371 Cardinia Shire Council ..... 51
VIC - Local Government ID: O-01509 Mornington Peninsula Shire Council ..... 51
VIC - Local Government ID: O-02633 South Gippsland Council ..... 52
VIC - State ID: O-01637 Member for Bass District ..... 54
OPGGS (E) 2023 - Commonwealth - 25(1)(e) Any other person or Organisation that the titleholder considers relevant / Other persons, OPGGS(E)R 25(1)(e) and OPGGSR 2021 (Vic) 13F(1)(c) ..... 55
Business - Local ID: O-02351 Toll Group ..... 55
Business - Local ID: O-00447 Total Marine Gippsland (Corporate Alliance Enterprises) ..... 55
Business - Oil & Gas ID: O-00111 Amplitude Energy ..... 55
Business - Oil & Gas ID: O-00203 Australian Energy Producers ..... 57
Business - Oil & Gas ID: O-03220 ConocoPhillips ..... 57
Business - Oil & Gas ID: O-00723 Esso ..... 58
Commercial fishing - South Australian Fisheries ID: O-02651 South Australia Rock Lobster Advisory Council ..... 59
Commercial fishing -Tasmanian Fisheries ID: O-02221 TARFish ..... 59
Commercial fishing -Tasmanian Fisheries ID: O-02251 Tasmanian Rock Lobster Council Ltd ..... 60
Commercial fishing -Tasmanian Fisheries ID: O-02594 Tasmanian Seafood Industry Council ..... 60
Community - Community groups ID: O-02752 Flinders District Historical Society ..... 61
Community - Local volunteer groups ID: O-02801 Cape Paterson Surf Life Saving Club ..... 61
Community - Local volunteer groups ID: O-02762 San Remo Foreshore Committee ..... 61
Community - Member ID: I-03931 Name redacted ..... 61
Community - Member ID: I-03730 Name redacted ..... 62
Community - Recreational groups ID: O-02782 Bass Coast Aquatic and Leisure Centre ..... 62
Community - Recreational groups ID: O-02786 Bass Strait Aquatic Club ..... 62
Community - Recreational groups ID: O-02800 Cowes Yacht Club ..... 62
Community - Recreational groups ID: O-02751 Flinders Yacht Club ..... 63
Community - Recreational groups ID: O-02789 Inverloch Surf Life Saving Club ..... 63
Community - Recreational groups ID: O-01541 NSW Port Authority - Port of Eden ..... 63
Community - Recreational groups ID: O-01631 Ocean Racing Club of Victoria ..... 64
Community - Recreational groups ID: O-01988 SCUBA Divers Federation of Victoria ..... 64

Community - Recreational groups ID: O-02120 South Gippsland Yacht Club ..... 65
Community - Recreational groups ID: O-02804 Tasmanian Commercial Divers Association ..... 65
Community - Recreational groups ID: O-02411 Venus Bay Surf Life Saving Club ..... 65
Community - Recreational groups ID: O-02753 Wonthaggi Angling Club ..... 66
Community - Recreational groups ID: O-02527 Woolamai Beach Surf Life Saving Club ..... 66
Education and Research Organisations - Research agency ID: O-00299 Blue Whale Study Inc ..... 66
Education and Research Organisations - University ID: O-02802 Deakin Marine Research and Innovation Centre ..... 67
Education and Research Organisations - University ID: O-00963 Institute for Marine and Antarctic Studies, University of Tasmania ..... 67
Indigenous - Aboriginal ID: O-03184 Aboriginal Land Council of Tasmania ..... 68
Indigenous - Aboriginal ID: O-00746 First Nations Legal & Research Services Ltd ..... 69
Indigenous - Aboriginal ID: O-00759 Flinders Island Aboriginal Association Inc ..... 69
Indigenous - Aboriginal ID: O-03228 Tasmanian Aboriginal Centre ..... 70
Interest Groups - Enviro Group - Local ID: O-02790 Inverloch Historical Society Inc ..... 70
Interest Groups - Enviro Group - Local ID: O-02773 Phillip Island & District Historical Society ..... 71
Interest Groups - Enviro Group - Local ID: O-02772 Phillip Island Nature Parks ..... 71
Interest Groups - Enviro Group - Local ID: O-02498 Westernport Swamp Landcare Group ..... 71
Interest Groups - Enviro Group - Local ID: O-02754 Wonthaggi and District Historical Society ..... 72
Interest Groups - Enviro Group - National/International ID: O-00964 International Fund for Animal Welfare (Australia) ..... 72
Interest Groups - Enviro Group - State ID: O-00633 Dolphin Research Institute ..... 73
Interest Groups - Enviro Group - State ID: O-02749 Futurefish Foundation ..... 73
Interest Groups - Progress Association ID: I-03938 Name redacted ..... 73
Landholder - Residential ID: I-03856 Name redacted ..... 74
Marine Based Industry - Business ID: O-02250 Tasmanian Divers Group ..... 74
Marine Based Industry - Desalination Plant ID: O-00163 Aquasure ..... 74
Marine Based Industry - Marine businesses ID: O-02252 Tasmanian Seafoods ..... 75
TAS - Local Government ID: O-00758 Flinders Council ..... 75
Tourism/Recreation - Marine Tourism ID: O-02794 BayPlay Adventure Tours ..... 76
Tourism/Recreation - Marine Tourism ID: O-02797 Blue Water Sailing School ..... 76
Tourism/Recreation - Marine Tourism ID: O-02750 Dive2U Mobile Adventures ..... 76
Tourism/Recreation - Marine Tourism ID: O-02785 Newhaven Fishing Charters ..... 76
Tourism/Recreation - Marine Tourism ID: O-02779 Newhaven Yacht Squadron ..... 76
Tourism/Recreation - Marine Tourism ID: O-02778 Ocean Adventures Phillip Island ..... 77
Tourism/Recreation - Marine Tourism ID: O-02766 S.E.A.L. Diving Services ..... 77
Tourism/Recreation - Marine Tourism ID: O-02760 T-Cat Charters ..... 77
Tourism/Recreation - Marine Tourism ID: O-02759 The Reel Thing Fishing Charters ..... 77
Tourism/Recreation - Peak Body ID: O-02761 Destination Phillip Island Regional Tourism Board ..... 78

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## OPGGS (E) 2023 - Commonwealth - 25(1)(a) Cth or State authority or agency (where EP activities relevant) / Relevant authorities, OPGGS(E)R 25(1)(a), (b), (c) and OPGGSR 2021 (Vic) 13F(1)(a)

### Commonwealth - Agency ID: O-00198 Australian Communications and Media Authority

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14204 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14279 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00162 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00329 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13854 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13991 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62673 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62805 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63208 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63341 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

### Commonwealth - Agency ID: O-00202 Australian Energy Market Operator

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14205 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00086 | 15/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00088 | 15/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00163 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00455 | 04/08/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00458 | 04/08/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-13856 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62674 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63209 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

### Commonwealth - Agency ID: O-03230 Australian Fisheries Management Authority

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14278 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14289 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14319 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14400 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00436 | 23/07/2025 | Email | Incoming | N/A | N/A | RP advised Beach should consult with Commonwealth fishing operators. | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00437 | 24/07/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP's email. Beach notes engagement with listed operators and inclusion of the Southern Bluefin Tuna Industry Association. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00165 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00312 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00324 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00328 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00378 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13872 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13928 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13930 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13931 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13932 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14090 | 26/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-14146 | 29/08/2025 | Email | Incoming | N/A | N/A | RP expressed interest in attending webinar. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-14147 | 29/08/2025 | Email | Outgoing | N/A | N/A | Webinar registration details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64534 | 09/09/2025 | Info session - online | Incoming | N/A | Project update - general | Online community information session webinar to provide attendees an overview of activities and provide opportunity for RPs to ask questions or raise concerns to Beach's Subject Matter Experts. RP did not raise any issues or concerns. | Requested consultation | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-40173 | 16/09/2025 | Email | Outgoing | Other | N/A | Summary report of themes raised during webinar distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62690 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62747 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62748 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62948 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-63225 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63283 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63284 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63480 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commonwealth - Agency ID: O-00208 Australian Hydrographic Office** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14207 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14366 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00087 | 15/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00109 | 16/07/2025 | Email | Incoming | N/A | N/A | RP has no concerns and requests update before activities begin. A fact sheet is also provided for reference. | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00119 | 21/07/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP's email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00166 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13934 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62749 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62918 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62923 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62973 | 01/10/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-63285 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63450 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63455 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64339 | 15/10/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A no objections or claims made | N/A |
| **Commonwealth - Agency ID: O-00415 Civil Aviation Safety Authority** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14234 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00178 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13858 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62677 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-63212 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commonwealth - Agency ID: O-00627 Director of National Parks** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14197 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14257 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00048 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00047 | 29/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00103 | 29/07/2025 | Email | Incoming | N/A | N/A | RP advised of updated contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00146 | 31/07/2025 | Email | Outgoing | N/A | N/A | Confirmation of contact update. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00191 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00192 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00475 | 04/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00476 | 04/08/2025 | Email | Incoming | N/A | N/A | RP advised of updated contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00477 | 05/08/2025 | Email | Outgoing | N/A | N/A | Confirmation of contact update. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00573 | 18/08/2025 | Email | Incoming | N/A | N/A | RP confirming no overlap with Australian Marine Parks and therefore requires no authorisation. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00586 | 20/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13890 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14030 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62708 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62844 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62914 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62975 | 01/10/2025 | Email | Incoming | N/A | N/A | RP advising of updated contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-62976 | 01/10/2025 | Email | Outgoing | N/A | N/A | Confirmation of contact update. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63243 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63379 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commonwealth - Agency ID: O-01551 National Native Title Tribunal** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14329 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14357 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00037 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00210 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13857 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62676 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63211 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commonwealth - Department ID: O-00559 Department of Agriculture, Fisheries and Forestry - Biosecurity and Marine Pests** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14337 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00084 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00085 | 30/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00145 | 30/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00182 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13929 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62746 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63282 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commonwealth - Department ID: O-00571 Department of Defence** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14249 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14259 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14381 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00440 | 25/07/2025 | Email | Incoming | N/A | N/A | RP advises information has been referred internally. | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00067 | 29/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00183 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13875 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62692 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-62925 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62936 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62939 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63228 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63456 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63467 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63471 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commonwealth - Department ID: O-00585 Department of Industry, Innovation and Science** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14250 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00043 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00147 | 16/07/2025 | Email | Incoming | N/A | N/A | RP advised of updated contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00148 | 23/07/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP's email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00185 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13927 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62745 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63281 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **NSW - Department ID: O-02373 Transport for NSW** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14438 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00077 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00232 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00304 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14061 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14062 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62875 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62876 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62978 | 30/09/2025 | Email | Incoming | N/A | N/A | RP advised of updated contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-62977 | 01/10/2025 | Email | Outgoing | N/A | N/A | Confirmation of contact update. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63410 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63411 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **TAS - Agency ID: O-00066 Aboriginal Heritage Tasmania** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14186 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00039 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00174 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14052 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62866 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63401 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **TAS - Agency ID: O-00707 Environment Protection Authority (EPA) Tasmania** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14263 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00195 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13877 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62695 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63229 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **TAS - Department ID: O-02565 Department of Natural Resources and Environment Tasmania - Biosecurity** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14275 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14303 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14338 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00241 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00303 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00382 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00394 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13906 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-13935 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13936 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13937 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62724 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62751 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62752 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62753 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63260 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63287 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63288 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63289 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **TAS - Department ID: O-00599 Department of Natural Resources and Environment Tasmania - Tasmania Parks and Wildlife Services** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14253 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14321 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00074 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00108 | 15/07/2025 | Email | Incoming | N/A | N/A | RP thanks Beach and seeks confirmation on the activity's occurrence in Tasmanian state waters before undertaking detailed review. | Requested further information | N/A no objections or claims made | | |
| C-00111 | 17/07/2025 | Email | Outgoing | N/A | N/A | Beach advises the activity is outside Tasmanian state waters. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00120 | 21/07/2025 | Email | Incoming | N/A | N/A | RP acknowledges Beach email. | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00075 | 29/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00186 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14058 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62872 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62922 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63407 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63454 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **TAS - Department ID: O-00608 Department of State Growth - Mineral Resources Tasmania** | | | | | | | | | | |

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14254 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14340 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00188 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00317 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00457 | 04/08/2025 | Email | Incoming | N/A | N/A | RP expressed interest in attending webinar. | Requested consultation | N/A no objections or claims made | | |
| C-00491 | 06/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13887 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13963 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14129 | 26/08/2025 | Email | Incoming | N/A | N/A | RP re-expressing interest in Webinar. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-14130 | 27/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming webinar registration. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14141 | 28/08/2025 | Email | Outgoing | N/A | N/A | Webinar registration details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64549 | 09/09/2025 | Info session - online | Incoming | N/A | Project update - general | Online community information session webinar to provide attendees an overview of activities sand provide opportunity for RPs to ask questions and raise concerns to Beach's Subject Matter Experts. RP did not raise any issues or concerns. | Requested consultation | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-40168 | 16/09/2025 | Email | Outgoing | Other | N/A | Summary report of themes raised during webinar distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62706 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62779 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63241 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63315 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Agency ID: O-00703 Energy and Water Ombudsman Victoria** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14262 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00194 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13853 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62672 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63207 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **VIC - Agency ID: O-02718 Environment Protection Authority (EPA) Victoria** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14202 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14264 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14380 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00245 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00322 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00412 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00501 | 07/08/2025 | Email | Incoming | N/A | N/A | RP enquiry on activity scope, relevant stakeholders and potential environmental impacts. | Requested further information | Relevant matter | N/A no objections or claims made | N/A |
| C-00513 | 08/08/2025 | Email | Outgoing | N/A | N/A | Beach addressed RP enquiries and resent information in introduction email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00514 | 08/08/2025 | Email | Outgoing | N/A | N/A | Beach clarifying information. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00516 | 11/08/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-13926 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13933 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14040 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14084 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62744 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62750 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62853 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62897 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62984 | 01/10/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-63280 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63286 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63388 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63431 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **VIC - Agency ID: O-00722 Essential Services Commission Victoria** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-14265 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00196 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13852 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62671 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63206 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Agency ID: O-00923 Heritage Victoria** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14243 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14285 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14327 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00204 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00390 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00418 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00432 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13841 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14017 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14018 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14067 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62660 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62832 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62833 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63195 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63367 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63368 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Agency ID: O-01691 Parks Victoria** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14367 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00217 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-00300 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13831 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14036 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62650 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62850 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63185 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63385 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Agency ID: O-02372 Transport Safety Victoria - Maritime Safety Victoria** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14320 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14439 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00231 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00323 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00364 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13839 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14021 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14022 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62658 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62836 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62837 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63193 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63371 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63372 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Agency ID: O-02418 Victorian Aboriginal Heritage Council** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14274 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14408 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14444 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-00101 | 14/07/2025 | Email | Incoming | N/A | N/A | RP advised Beach to contact the Bunurong Land Council for consultation and provided a link to their website. | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00110 | 16/07/2025 | Email | Incoming | N/A | N/A | RP encourages ongoing communication with the Bunurong Land Council and asks to remain on the contact list for future updates. | Acknowledgement of Beach email | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-00092 | 18/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00113 | 18/07/2025 | Email | Outgoing | N/A | N/A | Beach confirming consultation with the Bunurong Land Council Aboriginal Corporation. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00116 | 18/07/2025 | Email | Outgoing | N/A | N/A | Beach confirming consultation with the Bunurong Land Council Aboriginal Corporation. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00235 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00288 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00353 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00358 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13834 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14027 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14028 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62653 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62841 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62842 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62921 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63188 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63376 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63377 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63453 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Agency ID: O-02423 Victorian National Parks Association** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14410 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14446 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00237 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-00350 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13897 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13979 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62715 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62793 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63251 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63329 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Department ID: O-00575 Department of Energy, Environment and Climate Action** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-00140 | 31/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00184 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00559 | 12/08/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00560 | 12/08/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00561 | 13/08/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-14074 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14091 | 26/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-62887 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63421 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Department ID: O-00591 Department of Jobs, Skills, Industry and Regions** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14251 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00073 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00187 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00450 | 04/08/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-14032 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14089 | 26/08/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-62846 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62980 | 30/09/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

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| C-63381 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Department ID: O-00609 Department of Transport and Planning** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14255 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14288 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14301 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14314 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14350 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00059 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00189 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00190 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00385 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00407 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00415 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00481 | 05/08/2025 | Email | Incoming | N/A | N/A | RP request to resend introduction email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00498 | 07/08/2025 | Email | Outgoing | N/A | N/A | Beach resending introduction email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00502 | 07/08/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00511 | 08/08/2025 | Email | Incoming | N/A | N/A | RP expressed interest in attending webinar. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00512 | 12/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00556 | 13/08/2025 | Email | Incoming | N/A | N/A | RP sharing guidance note. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00557 | 14/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00564 | 14/08/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00565 | 15/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13905 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13998 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13999 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14000 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14001 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14076 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14142 | 28/08/2025 | Email | Outgoing | N/A | N/A | Webinar registration details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14462 | 08/09/2025 | Email | Outgoing | N/A | N/A | Beach resending requested webinar link as RP yet to register. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62723 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62812 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62814 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62815 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62816 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62889 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63259 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63348 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63349 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63350 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63351 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63422 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

## OPGGS (E) 2023 - Commonwealth - 25(1)(b) Department of State Minister (responsible for offshore area) / Relevant authorities, OPGGS(E)R 25(1)(a), (b), (c) and OPGGSR 2021 (Vic) 13F(1)(a)

### VIC - Minister ID: O-02803 Minister for Agriculture

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14352 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00063 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00281 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13988 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62803 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63338 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

### VIC - Minister ID: O-01654 Minister for Environment

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14353 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14419 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00447 | 16/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-00216 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00424 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14035 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62849 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62908 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63383 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63442 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Minister ID: O-01653 Minister for Regional Development** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14299 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00215 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13964 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62780 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62907 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63316 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63441 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **OPGGS (E) 2023 - Commonwealth - 25(1)(d) Person or organisation whose FIAs may be affected by EP activities / Relevant persons, OPGGS(E)R 25(1)(d) and OPGGSR 2021 (Vic) 13F(1)(b)** | | | | | | | | | | |
| **Business - Local ID: O-00187 Atlantis Fisheries Consulting Group** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14412 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14413 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14441 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00161 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00294 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00391 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00456 | 04/08/2025 | Email | Incoming | N/A | N/A | RP confirming if information is for member distribution. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00459 | 04/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming information to be distributed to members. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00460 | 04/08/2025 | Email | Incoming | N/A | N/A | RP asking if Beach would like to review draft communications. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-00461 | 04/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming content review prior to distribution. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00478 | 04/08/2025 | Email | Incoming | N/A | N/A | RP sharing summary draft for confirmation. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00485 | 05/08/2025 | Email | Incoming | N/A | N/A | RP checking if Beach has reviewed the draft SMS message. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00486 | 06/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming content for member distribution. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00488 | 06/08/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00489 | 06/08/2025 | Email | Incoming | N/A | N/A | RP confirming member distribution actioned. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00493 | 07/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00509 | 08/08/2025 | Email | Outgoing | N/A | N/A | Beach requesting correction to member information issued. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00515 | 08/08/2025 | Email | Incoming | N/A | N/A | RP confirming correction sent. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-13837 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14024 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62656 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63191 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Business - Local ID: O-02284 Telstra** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14231 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14247 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14351 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14387 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14436 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00034 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00036 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00230 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00285 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00332 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00361 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00392 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00396 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00517 | 11/08/2025 | Email | Incoming | N/A | N/A | RP expressed interest in attending webinar. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-00518 | 12/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00519 | 12/08/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-14589 | 20/08/2025 | Info Session | Incoming | Info sheet | N/A | RP raised concerns about subsea cable interference. Beach confirmed no new constructions would affect the cables. | Requested further information | Relevant matter | N/A | N/A |
| C-13845 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14003 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14004 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14005 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14006 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14007 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14079 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14080 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14081 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14082 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14083 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14144 | 28/08/2025 | Email | Outgoing | N/A | N/A | Webinar registration details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14463 | 08/09/2025 | Email | Outgoing | N/A | N/A | Beach resending requested webinar link as RP yet to register. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64523 | 09/09/2025 | Info session - online | Incoming | N/A | Project update - general | Online community information session webinar to provide attendees an overview of activities and provide opportunity for RPs to ask questions or raise concerns to Beach's Subject Matter Experts. RPs asked if there would be any operational changes; Beach confirmed none are planned and that operations will continue as usual. Beach also stated the environment plan is reviewed every five years. | Requested consultation | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-40174 | 16/09/2025 | Email | Outgoing | Other | N/A | Summary report of themes raised during webinar distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-40175 | 16/09/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-62668 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62818 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62819 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-62820 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62821 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62822 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62892 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62893 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62894 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62895 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62896 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62903 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63203 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63353 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63354 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63355 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63356 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63357 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63426 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63427 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63428 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63429 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63430 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63438 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Commonwealth Fisheries ID: O-00216 Australian Southern Bluefin Tuna Industry Association** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-00168 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00298 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14068 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62881 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62906 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63416 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-63440 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Commonwealth Fisheries ID: O-00433 Commonwealth Fisheries Association** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14237 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00179 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13889 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62707 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63244 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Commonwealth Fisheries ID: O-02056 Seafood Industry Australia** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14307 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14405 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00220 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00352 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13901 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13996 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62719 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62811 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63255 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63346 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Commonwealth Fisheries ID: O-02114 South East Trawl Fishing Industry Association** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14394 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14442 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00296 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00456 | 04/08/2025 | Email | Incoming | N/A | N/A | RP confirming if information is for member distribution. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00459 | 04/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming information to be distributed to members. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00460 | 04/08/2025 | Email | Incoming | N/A | N/A | RP asking if Beach would like to review draft communications. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

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| C-00461 | 04/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming content review prior to distribution. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00478 | 04/08/2025 | Email | Incoming | N/A | N/A | RP sharing summary draft for confirmation. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-13941 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62756 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62926 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63293 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63458 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Commonwealth Fisheries ID: O-02136 Southern Rock Lobster Limited** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14418 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14435 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00225 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00308 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13881 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13940 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62698 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62758 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63233 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63294 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Commonwealth Fisheries ID: O-02139 Southern Shark Industry Alliance (SSIA)** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14443 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00456 | 04/08/2025 | Email | Incoming | N/A | N/A | RP confirming if information is for member distribution. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00459 | 04/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming information to be distributed to members. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00460 | 04/08/2025 | Email | Incoming | N/A | N/A | RP asking if Beach would like to review draft communications. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00461 | 04/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming content review prior to distribution. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00478 | 04/08/2025 | Email | Incoming | N/A | N/A | RP sharing summary draft for confirmation. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-13970 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-62786 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63322 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Commonwealth Fisheries ID: O-02390 Tuna Australia** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14245 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14374 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00319 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00393 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13838 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14023 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14088 | 26/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-62657 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62838 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63006 | 07/10/2025 | Email | Incoming | Other | N/A | RP advising they have fwd information to their members. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-63007 | 07/10/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63192 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63373 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Victorian Fisheries ID: O-00062 Abalone Victoria Central Zone** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14185 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14362 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00159 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00335 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00483 | 06/08/2025 | Email | Incoming | N/A | N/A | RP reports issue receiving repeated emails from Beach. | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00484 | 06/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13888 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13966 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14148 | 01/09/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-62971 | 01/10/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63242 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Victorian Fisheries ID: O-02058 Seafood Industry Victoria** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14346 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14407 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00527 | 17/07/2025 | Email | Incoming | N/A | N/A | RP asking if information is for member distribution. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00444 | 23/07/2025 | Email | Outgoing | N/A | N/A | Beach confirmed information be distributed to members and licence holders. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00445 | 23/07/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00222 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00416 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00452 | 04/08/2025 | Email | Incoming | N/A | N/A | RP confirms contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00522 | 04/08/2025 | Email | Incoming | N/A | N/A | RP asking if information is for member distribution. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00523 | 04/08/2025 | Email | Outgoing | N/A | N/A | Beach advising information session dates are the same as first update. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00524 | 04/08/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00525 | 04/08/2025 | Email | Incoming | N/A | | RP sharing summary draft for confirmation | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00526 | 04/08/2025 | Email | Outgoing | N/A | N/A | Beach confirming content for member distribution. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00487 | 06/08/2025 | Email | Outgoing | N/A | N/A | Confirmation of contact update. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13878 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13942 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62697 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62757 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63232 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63292 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - Victorian Fisheries ID: O-02406 VR Fish** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14218 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-14449 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00233 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00399 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13866 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13972 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62683 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62787 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63218 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63323 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing -Tasmanian Fisheries ID: O-02034 Scallop Fishermen's Association of Tasmania Inc** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14311 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14404 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00341 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14002 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62817 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63352 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing -Tasmanian Fisheries ID: O-02057 Seafood Industry Tasmania** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14315 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14406 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00221 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13830 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62649 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62759 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63184 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63295 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commonwealth - Agency ID: O-02421 Victorian Fisheries Authority** | | | | | | | | | | |

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
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| C-14286 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14325 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14332 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14347 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14445 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00236 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00346 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00381 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00398 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00420 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13885 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13959 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13960 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13961 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13962 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62705 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62775 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62776 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62777 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62778 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63240 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63311 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63312 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63313 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63314 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commonwealth - Emergency Services ID: O-00212 Australian Maritime Safety Authority - Joint Rescue Coordination Centre** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14210 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14280 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14342 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14349 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14358 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14430 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00046 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00097 | 23/07/2025 | Email | Incoming | N/A | N/A | RP acknowledged Beach email and outlined maritime safety requirements for operations. | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00167 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00330 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00380 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00397 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00403 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13863 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13967 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13968 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13969 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13971 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62684 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62782 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62783 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62784 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62785 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63008 | 02/10/2025 | Email | Incoming | N/A | N/A | RP advising of notification requirements during activities. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-63042 | 09/10/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RPs email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63219 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63318 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63319 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-63320 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63321 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Beach reference group ID: O-01234 BassGas Community Reference Group** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14194 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14200 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14224 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14281 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14318 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14333 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14336 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14379 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00366 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00427 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00428 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00429 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00430 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64526 | 12/08/2025 | Email | Outgoing | Other | Update | Meeting details provided. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64527 | 12/08/2025 | Email | Outgoing | Other | Update | Meeting details provided. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64528 | 12/08/2025 | Email | Outgoing | Other | Update | Meeting details provided. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64529 | 12/08/2025 | Email | Outgoing | Other | Update | Meeting details provided. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64530 | 12/08/2025 | Email | Outgoing | Other | Update | Meeting details provided. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64531 | 12/08/2025 | Email | Outgoing | Other | Update | Meeting details provided. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64532 | 12/08/2025 | Email | Outgoing | Other | Update | Meeting details provided. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64533 | 12/08/2025 | Email | Outgoing | Other | Update | Meeting details provided. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64536 | 12/08/2025 | Phone | Outgoing | N/A | Update | Provided BassGas CRG Meeting details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64537 | 12/08/2025 | Phone | Outgoing | N/A | Update | Provided BassGas CRG Meeting details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64538 | 12/08/2025 | Phone | Outgoing | N/A | Update | Provided BassGas CRG Meeting details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64539 | 12/08/2025 | Phone | Outgoing | N/A | Update | Provided BassGas CRG Meeting details. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-64540 | 18/08/2025 | Meeting - in person | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64541 | 18/08/2025 | Meeting - in person | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64542 | 18/08/2025 | Meeting - in person | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64543 | 18/08/2025 | Meeting - in person | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64544 | 18/08/2025 | Meeting - in person | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64545 | 18/08/2025 | Meeting - in person | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64546 | 18/08/2025 | Meeting - in person | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64547 | 18/08/2025 | Meeting - in person | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64548 | 18/08/2025 | Meeting - online | Outgoing | Other | Update | BassGas Offshore Operations EP 5-year review information provided. No issues or concerns raised. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63050 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63051 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63055 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63056 | 22/08/2025 | Email | Outgoing | Other | Update | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63057 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63058 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63059 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63060 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00602 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14019 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14054 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-14055 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14056 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14057 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62834 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62868 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62869 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62870 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62871 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63369 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63403 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63404 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63405 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63406 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Education and Research Organisations - Research agency ID: O-02780 Australian Marine Mammal Centre (AMMC) – Australian Antarctic Division** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14208 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00268 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13911 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62729 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63265 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Education and Research Organisations - Research agency ID: O-02781 Australian Marine Sciences Association** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14209 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00269 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13912 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62730 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63266 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Indigenous - Aboriginal ID: I-03936 Name redacted** | | | | | | | | | | |

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14588 | 19/08/2025 | Info Session | Incoming | Info sheet | N/A | RP enquired on careers in the industry, platform location and operation timeline. Beach advised the Lang Lang gas plant will be operational until approx. 2030. | Requested further information | N/A no objections or claims made | N/A | N/A |
| **Indigenous - Aboriginal ID: O-03227 Bunurong Land Council Aboriginal Corporation** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14188 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14189 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14201 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14223 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14283 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14290 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14326 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14409 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14420 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14429 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00050 | 14/07/2025 | Email | Incoming | N/A | N/A | RP inbox no longer monitored. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00052 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00053 | 14/07/2025 | Email | Incoming | N/A | N/A | RP inbox no longer monitored. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00072 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00024 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00504 | 22/07/2025 | Email | Outgoing | N/A | N/A | Follow up on the introduction email to see if RP has any feedback or concerns. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00171 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00289 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00293 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00305 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00325 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00362 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-00387 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00413 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00434 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00503 | 08/08/2025 | Phone | Outgoing | N/A | N/A | Follow up if RP will be attending First Nations community information sessions. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00510 | 08/08/2025 | Email | Outgoing | N/A | N/A | Follow up if RP will be attending First Nations community information sessions. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00572 | 19/08/2025 | Email | Outgoing | Link to Engage beach | N/A | Beach noted no RPs attended 1st First Nations info session. Details for the next session shared and asked for confirmation that RP community were informed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13882 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13946 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13947 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13948 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13949 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13950 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13951 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14073 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62700 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62761 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62763 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62764 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62765 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62766 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62767 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62886 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62947 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62979 | 30/09/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-63235 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63298 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-63299 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63300 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63301 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63302 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63303 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63420 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63479 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Indigenous - Aboriginal ID: O-00410 Circular Head Aboriginal Corporation** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14226 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14233 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14241 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14391 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00058 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00506 | 24/07/2025 | Email | Outgoing | N/A | N/A | Follow up on the introduction email to check if RP has any feedback, questions, or concerns after reviewing the information. Beach reminded of upcoming First Nations information sessions. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00508 | 24/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00507 | 24/07/2025 | Email | Outgoing | N/A | N/A | Follow up on the introduction email to check if RP has any feedback, questions, or concerns after reviewing the information. Beach reminded of upcoming First nations information sessions. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00177 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00340 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00344 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00421 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00479 | 05/08/2025 | Email | Incoming | Letter | N/A | RP attached a formal submission in response to Beach EP. Seeking recognition as an RP under the OPGGS Regulations and outlines concerns and recommendations regarding cultural heritage, environmental risks, and inclusive emergency planning. | Raised objection or claim | Relevant matter<br>1. Beach has a list of previous relevant persons for the previous EP that was used as the basis for this EP's relevant person list. Additional relevant persons, including Circular Head Aboriginal Corporation have been identified | N/A no response received<br>See ID: C-14165 | N/A |

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| | | | | | | | | with a review of functions, interests and activities within the area.<br>2. As the activities within the EP are for existing infrastructure and activities, and there is no additional infrastructure required on the seabed.<br>3. Beach acknowledges Giant Kelp Marine Forests of South East Australia may occur within the planning area. Beach recognises the importance of Sea Country and the particular significance of Giant Kelp, to a number of First Nations groups.<br>4. Beach acknowledges concerns regarding the lack of cultural sensitivity to Tasmanian coastlines in spill response plans for the Bass Gas offshore operations. The identified broadest extent of the planning area for this activity does not reach either Tasmanian coastal waters or the coastline. | | |
| C-00552 | 13/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email and receipt of response submission. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00584 | 20/08/2025 | Phone | Outgoing | N/A | N/A | Called RP to discuss submission. Left a voicemail and requested return call. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00600 | 21/08/2025 | SMS | Incoming | N/A | N/A | Message to schedule a phone discussion. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00599 | 21/08/2025 | Phone | Incoming | N/A | N/A | Missed call to Beach. RP left a message for return call. | Acknowledgement of Beach email | N/A | N/A | N/A |
| C-00601 | 21/08/2025 | Phone | Outgoing | N/A | N/A | Beach confirmed receipt of RP submission, noted compliance with regulatory requirements and addressed concerns raised in submission. Beach advised they will respond via email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14041 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14042 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14043 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14044 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14086 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14165 | 27/08/2025 | Email | Outgoing | Info sheet | N/A | RP provided a written submission on the Bass Gas Offshore Operations EP 5-year review. Beach advised RP was identified as a relevant person based on functions, interests, and activities within the EMBA.<br>Key concerns included cultural heritage, ecological impacts, and | N/A outgoing engagement | N/A | N/A<br>1. RP included on the relevant persons list for this EP. Beach provided NOPSEMA's ALARP guidance note, Information sheet and summary of impacts and risks. | N/A |

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| | | | | | | emergency planning.<br>Beach confirmed compliance with the Underwater Cultural Heritage Act 2018 and Aboriginal Heritage Act 1975 (Tas), noting no new seabed infrastructure is proposed. The EP will assess risks to Giant Kelp Marine Forests and Sea Country values, ensuring impacts are ALARP. Spill response planning follows OPGGS regulations and includes an accepted OPEP; however, the Planning Area does not reach Tasmanian coastal waters.<br>Beach acknowledged RP's concerns about cultural inclusion and welcomed ongoing engagement, while noting capability development is outside EP scope. | | | 2. Not applicable. Should this change Beach will ensure any relevant assessments are completed, where required.<br>3. The environmental impact assessment within the EP will assess the potential impacts of the activities on the environment, including the Giant Kelp Marine Forests to ensure all possible impacts are ALARP.<br>4. As per the Regulations, Beach must have an accepted Oil Pollution Emergency Plan (OPEP) in place for each activity that will be implemented in the event of a loss of containment (LOC) or loss of well containment (LOWC). | |
| C-62855 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62856 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62857 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62858 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62899 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63390 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63391 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63392 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63393 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63433 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Indigenous - Aboriginal ID: O-00898 Gunaikurnai Land and Waters Aboriginal Corporation** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14192 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14221 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14284 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14344 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-14384 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14397 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14423 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14434 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00038 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00042 | 14/07/2025 | Email | Incoming | N/A | N/A | Individual no longer with RP. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00044 | 14/07/2025 | Email | Incoming | N/A | N/A | Individual no longer with RP. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00505 | 22/07/2025 | Email | Outgoing | N/A | N/A | Follow up on introduction email if RP has any feedback or concerns. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00203 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00320 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00348 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00363 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00377 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00410 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13879 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13952 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13953 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13954 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13955 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13956 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62702 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62768 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62769 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62770 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62771 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62772 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63237 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63304 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63305 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-63306 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63307 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63308 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63521 | 16/10/2025 | Email | Incoming | Info sheet, N/A | N/A | RP member requests a briefing in response to consultation close email from Beach. | Requested further information | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-63527 | 20/10/2025 | Phone | Outgoing | N/A | N/A | Beach called RP member to discuss request for briefing. No answer. Left message for return call. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63528 | 20/10/2025 | Phone | Incoming | N/A | N/A | RP attempted return call. No voicemail left. | N/A no response received | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-63529 | 21/10/2025 | Phone | Outgoing | N/A | N/A | Beach again called RP member to discuss request for briefing. No answer. Left message for return call. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63531 | 21/10/2025 | SMS | Incoming | N/A | N/A | RP provided a time for Beach to call. | Requested further information | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-63532 | 21/10/2025 | SMS | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63533 | 21/10/2025 | Phone | Incoming | N/A | N/A | RP member advised new to the role. Beach provided brief on EP 5-year review and regulatory consultation requirements. Beach explained revision covers current infrastructure with no new activities. RP requested a meeting for updates. RP advised of volume of information received from other proponents. RP to arrange a time for Beach briefing. | Requested further information | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-64358 | 27/10/2025 | Email | Outgoing | N/A | N/A | Follow up on RP availability for briefing meeting. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64361 | 29/10/2025 | SMS | Outgoing | N/A | N/A | Follow up on request for briefing. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64362 | 29/10/2025 | SMS | Incoming | N/A | N/A | RP pending internal confirmation for member attendance. RP noted delay in response citing volume of work. | Acknowledgement of Beach email | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-64363 | 29/10/2025 | SMS | Outgoing | N/A | N/A | Beach acknowledged RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64556 | 05/11/2025 | Email | Outgoing | N/A | N/A | Follow up on RP request for briefing meeting. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64560 | 28/11/2025 | Email | Outgoing | N/A | N/A | Beach advised multiple attempts made to schedule a meeting to discuss the environment plan (EP) 5-year revision. Beach advised they consider their obligations under the OPGGS regulations have been met and the submission of the revised EP to the regulator will proceed. Beach remains committed to keeping RP updated throughout | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | the implementation of the EP activities. | | | | |
| **Interest Groups - Enviro Group - Local ID: O-02775 Amazon 1863 Project Inc.** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14198 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00264 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13908 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62726 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63264 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - Local ID: O-02747 Cape Woolamai Coast Action** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14228 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00247 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13855 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62675 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63210 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - Local ID: O-00783 Friends of the Prom** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14273 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00202 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13832 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62651 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63186 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - Local ID: O-02764 Phillip Island Conservation Society** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14411 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00258 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00423 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13978 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-62794 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62929 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63331 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63461 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

**Interest Groups - Enviro Group - Local ID: O-02765 South Gippsland Conservation Society**

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14415 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00259 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13980 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14153 | 01/09/2025 | Email | Incoming | N/A | N/A | RP expressed interest in attending webinar. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-14152 | 02/09/2025 | Email | Outgoing | N/A | N/A | Webinar registration details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62795 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62911 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63330 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63445 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

**Interest Groups - Enviro Group - State ID: O-02763 Bass Coast Landcare Network**

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14214 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00257 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13894 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62712 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63248 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

**Interest Groups - Enviro Group - State ID: I-03935 Name redacted**

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14587 | 19/08/2025 | Info Session | Incoming | Info sheet | N/A | RP raised opposition to fossil fuels, queries about and objection to Beach's carbon emissions. RP questioned the need for new gas and Australia’s gas exportation. Beach explained gas's backup role for renewables, regulation focus, local use, and community | Requested consultation | Not a relevant matter | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | consultation for the environment plan. | | | | |
| C-62904 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63437 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Marine Based Industry - Marine businesses ID: O-00756 Fishwell Consulting** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14287 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14345 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14396 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14432 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00199 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00356 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00357 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00374 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00402 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13851 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13992 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13993 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13994 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13995 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62670 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62807 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62808 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62809 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62810 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63205 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63342 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63343 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63344 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63345 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **Marine Based Industry - Marine businesses ID: O-01920 Richey Fishing Company** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14312 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14390 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00218 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00395 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13840 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14020 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62659 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62835 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63194 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63370 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Marine Based Industry - Marine businesses ID: O-02364 Top Fish Tasmania** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14343 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00425 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14009 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62824 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63359 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Marine Based Industry -Subsea Comms Cable ID: O-00094 Alcatel Submarine Networks** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14195 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14304 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00021 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00175 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00373 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13860 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13990 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-62679 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62806 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63213 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63340 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Marine Based Industry -Subsea Comms Cable ID: O-01365 Marinus Link** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14196 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14235 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14240 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14261 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14310 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14339 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14392 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14399 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00026 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00061 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00070 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00027 | 29/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00062 | 29/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00071 | 29/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00520 | 01/08/2025 | Email | Incoming | N/A | N/A | RP confirms contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00207 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00316 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00370 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00375 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00406 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00466 | 04/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-00469 | 04/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00521 | 12/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13836 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14025 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14078 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62655 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62839 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62891 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63190 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63374 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63425 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02787 Island Offshore Charters** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14298 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00272 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13915 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62735 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63270 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02508 Wildlife Coast Cruises** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14282 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14452 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00239 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00292 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00306 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13848 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14038 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14039 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-62664 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62852 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62854 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-64514 | 02/10/2025 | Engage Beach | Incoming | N/A | N/A | RP asked about marine mammal distribution data, exclusion zones, independent oversight, risk mitigation for vessel strikes, acoustic impact management, endangered southern right whales, spill response, and public access to monitoring data. | Requested further information | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-63021 | 08/10/2025 | Email | Outgoing | N/A | N/A | Beach provided information on data and research utilised, independent auditing, risk mitigation and noise impacts. Beach advised the considerations of marine life within the environment plan and outlines spilling response and emergency planning. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63200 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63387 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63389 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

**Tourism/Recreation - Marine Tourism ID: O-02795 Better than Working Charters**

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14183 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00277 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13920 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62739 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63275 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

**Tourism/Recreation - Peak Body ID: O-02788 Inverloch Tourism Association**

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14297 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00273 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13917 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62734 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63271 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **VIC - Local Government ID: O-00248 Bass Coast Shire Council** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-00169 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13847 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62662 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63202 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Local Government ID: O-00371 Cardinia Shire Council** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14229 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14370 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14421 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00033 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00173 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00367 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63053 | 22/08/2025 | Email | Outgoing | Other | Update, Project update - general | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00602 | 22/08/2025 | Email | Outgoing | Other | N/A | CRG minutes distributed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13903 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13997 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62721 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62813 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62924 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63257 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63347 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63457 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Local Government ID: O-01509 Mornington Peninsula Shire Council** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14354 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00030 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-00090 | 16/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00158 | 22/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00208 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00426 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13864 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14031 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62682 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62845 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63215 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63380 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - Local Government ID: O-02633 South Gippsland Council** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14211 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14232 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14302 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14302 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14322 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14331 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14334 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14335 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14369 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14416 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14448 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00031 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00224 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00295 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00318 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00331 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00333 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00338 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-00359 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00389 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00404 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00405 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00470 | 04/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00472 | 04/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00471 | 05/08/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00473 | 05/08/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00574 | 19/08/2025 | Email | Incoming | N/A | N/A | RP advising of updated contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-14591 | 20/08/2025 | Info Session | Incoming | Info sheet | Update | RP noted local environmental concerns near Willsons Promontory. Beach described spill modelling and regulations. RP enquired if Beach is consulting local First Nations groups and noted report of consultation fatigue. RP confirmed Beach's information have reached relevant council departments. | Requested further information | N/A no objections or claims made | N/A | N/A |
| C-00575 | 20/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13899 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13982 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13983 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13984 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13985 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13986 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13987 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13989 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14087 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62717 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62796 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62798 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62799 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-62800 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62801 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62802 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62804 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62900 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62945 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63043 | 08/10/2025 | Email | Incoming | N/A | N/A | RP noting attendance at Community information session and Beach's wide consultation on the plan, modeling and safety measures. | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-63044 | 09/10/2025 | Email | Outgoing | N/A | | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63253 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63332 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63333 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63334 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63335 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63336 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63337 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63339 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63434 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63476 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **VIC - State ID: O-01637 Member for Bass District** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14313 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14348 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00107 | 15/07/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00118 | 18/07/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP's email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00212 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00310 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00453 | 04/08/2025 | Email | Incoming | N/A | N/A | RP advised they shared Beach's consultation post on social media. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-13896 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13973 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14085 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62714 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62788 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62898 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63250 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63324 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63432 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

## OPGGS (E) 2023 - Commonwealth - 25(1)(e) Any other person or Organisation that the titleholder considers relevant / Other persons, OPGGS(E)R 25(1)(e) and OPGGSR 2021 (Vic) 13F(1)(c)

### Business - Local ID: O-02351 Toll Group

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14190 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00365 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14008 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62823 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63358 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

### Business - Local ID: O-00447 Total Marine Gippsland (Corporate Alliance Enterprises)

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14437 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00089 | 15/07/2025 | Email | Incoming | N/A | | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00138 | 31/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. Re-issue to updated email address. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00181 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13846 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62669 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63204 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

### Business - Oil & Gas ID: O-00111 Amplitude Energy

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14199 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14212 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14225 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14272 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14389 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00176 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00299 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00309 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00343 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00384 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00464 | 04/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00465 | 05/08/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00528 | 06/08/2025 | Email | Incoming | N/A | N/A | RP confirms contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00529 | 12/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00562 | 12/08/2025 | Email | Incoming | N/A | N/A | RP requesting contact details Beach is using. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00563 | 14/08/2025 | Email | Outgoing | N/A | N/A | Beach requesting contact confirmation. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00566 | 14/08/2025 | Email | Incoming | N/A | N/A | | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-13843 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14013 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14014 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14016 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62666 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62828 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62829 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62830 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63197 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63363 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-63364 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63365 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Business - Oil & Gas ID: O-00203 Australian Energy Producers** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14206 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14308 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00164 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00372 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13865 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13965 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62685 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62781 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63220 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63317 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Business - Oil & Gas ID: O-03220 ConocoPhillips** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14184 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14222 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14238 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14328 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14355 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14395 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00040 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00056 | 14/07/2025 | Email | Incoming | N/A | | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00057 | 29/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00104 | 29/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00492 | 01/08/2025 | Email | Incoming | N/A | N/A | RP confirms contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00180 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-00297 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00334 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00342 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00351 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00463 | 04/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00467 | 04/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00468 | 05/08/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00530 | 06/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00496 | 07/08/2025 | Email | Outgoing | N/A | N/A | Confirmation of contact update. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00531 | 12/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13844 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14010 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14011 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14012 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62667 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62825 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62826 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62827 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62951 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63198 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63360 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63361 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63362 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63483 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Business - Oil & Gas ID: O-00723 Esso** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14266 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14440 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-00197 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00383 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13842 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14015 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62665 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62831 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63196 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63366 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing - South Australian Fisheries ID: O-02651 South Australia Rock Lobster Advisory Council** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14356 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00244 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14063 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62877 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63412 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing -Tasmanian Fisheries ID: O-02221 TARFish** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14305 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14341 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00226 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00336 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00379 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14070 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14071 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14072 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62883 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62884 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62885 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-63418 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63419 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing -Tasmanian Fisheries ID: O-02251 Tasmanian Rock Lobster Council Ltd** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14427 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00093 | 23/07/2025 | Email | Incoming | N/A | N/A | RP advised of updated contact list. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00094 | 23/07/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP's email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00096 | 23/07/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00228 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13880 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62699 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63234 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Commercial fishing -Tasmanian Fisheries ID: O-02594 Tasmanian Seafood Industry Council** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14277 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14306 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14316 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00243 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00301 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00345 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00369 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13943 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13944 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13945 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62760 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62762 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62953 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63296 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-63297 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63485 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Community groups ID: O-02752 Flinders District Historical Society** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14269 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00249 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13870 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62688 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63223 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Local volunteer groups ID: O-02801 Cape Paterson Surf Life Saving Club** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14227 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00280 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13924 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62742 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63278 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Local volunteer groups ID: O-02762 San Remo Foreshore Committee** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14403 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00256 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13893 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62711 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63247 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Member ID: I-03931 Name redacted** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14465 | 01/09/2025 | Email | Incoming | N/A | N/A | Requesting to be added to Bass Gas Offshore Operations EP 5-year review DL via Engage Beach. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62902 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-63435 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **Community - Member ID: I-03730 Name redacted** | | | | | | | | | | |
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| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-64515 | 22/07/2025 | Engage Beach | Incoming | N/A | N/A | Request to be added to activity updates. | Requested further information | N/A no objections or claims made | N/A no objections or claims made | N/A |
| C-62991 | 24/07/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00433 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14069 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62882 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63417 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **Community - Recreational groups ID: O-02782 Bass Coast Aquatic and Leisure Centre** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14213 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00267 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13913 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62731 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63267 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **Community - Recreational groups ID: O-02786 Bass Strait Aquatic Club** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14215 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00271 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13916 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62732 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63269 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **Community - Recreational groups ID: O-02800 Cowes Yacht Club** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14239 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00279 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-13923 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62741 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63277 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-02751 Flinders Yacht Club** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14271 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00065 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00066 | 29/07/2025 | Email | Outgoing | N/A | N/A | Beach seeks confirmation on a contact and asks if RP wants to remain consulted. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00139 | 31/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. Re-issue to updated email address. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00248 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13869 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62687 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63222 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-02789 Inverloch Surf Life Saving Club** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14296 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00274 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13919 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62736 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63272 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-01541 NSW Port Authority - Port of Eden** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14363 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14368 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00209 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00417 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14059 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-14060 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62873 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62874 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63408 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63409 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-01631 Ocean Racing Club of Victoria** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14365 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00213 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13859 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62678 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63214 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-01988 SCUBA Divers Federation of Victoria** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14242 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14291 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14371 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00219 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00326 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00337 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00339 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13876 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13938 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13939 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14093 | 26/08/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-62696 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62754 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62755 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-62944 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63231 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63290 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63291 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63477 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-02120 South Gippsland Yacht Club** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14414 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14417 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00223 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00419 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13850 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14037 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62661 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62851 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63199 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63386 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-02804 Tasmanian Commercial Divers Association** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14425 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00283 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14053 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62867 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63402 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-02411 Venus Bay Surf Life Saving Club** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14388 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00234 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-00376 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13874 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62694 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62909 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63230 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63443 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-02753 Wonthaggi Angling Club** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14454 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00250 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13868 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62689 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63224 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Community - Recreational groups ID: O-02527 Woolamai Beach Surf Life Saving Club** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14236 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00240 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00242 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00401 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13925 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62743 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62920 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62932 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63279 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63451 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63464 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Education and Research Organisations - Research agency ID: O-00299 Blue Whale Study Inc** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |

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| C-14220 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14372 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00170 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13861 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62680 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63216 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Education and Research Organisations - University ID: O-02802 Deakin Marine Research and Innovation Centre** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14433 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00282 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13981 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62797 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62927 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63459 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Education and Research Organisations - University ID: O-00963 Institute for Marine and Antarctic Studies, University of Tasmania** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14293 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14309 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14323 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14359 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14398 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00041 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00051 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00054 | 14/07/2025 | Email | Incoming | N/A | N/A | Out of office response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00205 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00291 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00313 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00347 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-00400 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13895 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13974 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13975 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13976 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13977 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62713 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62789 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62790 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62791 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62792 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63249 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63325 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63326 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63327 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63328 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

**Indigenous - Aboriginal ID: O-03184 Aboriginal Land Council of Tasmania**

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14187 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14191 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14385 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00035 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00055 | 14/07/2025 | Email | Incoming | N/A | N/A | Bounce back email. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00172 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00284 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00286 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00315 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14045 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14046 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

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| C-14047 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62859 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62860 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62861 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62955 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63394 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63395 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63397 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63487 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Indigenous - Aboriginal ID: O-00746 First Nations Legal & Research Services Ltd** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14267 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14383 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14393 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00198 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13886 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62704 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63238 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Indigenous - Aboriginal ID: O-00759 Flinders Island Aboriginal Association Inc** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14270 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14324 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00200 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00409 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13883 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13958 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62701 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62773 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |

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|---|---|---|---|---|---|---|---|---|---|---|
| C-63236 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63309 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Indigenous - Aboriginal ID: O-03228 Tasmanian Aboriginal Centre** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14193 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14246 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14260 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14292 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00227 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00287 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00321 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00327 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00360 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14048 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14049 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14050 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14051 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62862 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62863 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62864 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62865 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62946 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63396 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63398 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63399 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63400 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63478 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - Local ID: O-02790 Inverloch Historical Society Inc** | | | | | | | | | | |

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14295 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00275 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13918 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62737 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63273 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - Local ID: O-02773 Phillip Island & District Historical Society** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14375 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00262 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13904 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62722 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63258 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - Local ID: O-02772 Phillip Island Nature Parks** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14376 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00029 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00261 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13902 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14134 | 28/08/2025 | Email | Incoming | N/A | N/A | RP expressed interest in attending webinar. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-14138 | 28/08/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14145 | 28/08/2025 | Email | Outgoing | N/A | N/A | Webinar registration details. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14461 | 08/09/2025 | Email | Outgoing | N/A | N/A | Beach resending requested webinar link as RP yet to register. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62720 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62901 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63256 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63436 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - Local ID: O-02498 Westernport Swamp Landcare Group** | | | | | | | | | | |

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14422 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14450 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00238 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00311 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14029 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14033 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62843 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62847 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63378 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63382 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - Local ID: O-02754 Wonthaggi and District Historical Society** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14453 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00251 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13871 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62691 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63227 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - National/International ID: O-00964 International Fund for Animal Welfare (Australia)** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14294 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00060 | 14/07/2025 | Email | Incoming | N/A | N/A | Automatic response. | N/A No objections or claims made | N/A no objections or claims made | N/A | N/A |
| C-00106 | 15/07/2025 | Email | Incoming | N/A | N/A | N/A | Acknowledgement of Beach email | N/A no objections or claims made | N/A | N/A |
| C-00117 | 18/07/2025 | Email | Outgoing | N/A | N/A | Beach acknowledging RP's email. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00206 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13862 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62681 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63217 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| **Interest Groups - Enviro Group - State ID: O-00633 Dolphin Research Institute** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14276 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00193 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00302 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13833 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14034 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62652 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62848 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63187 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63384 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Enviro Group - State ID: O-02749 Futurefish Foundation** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14244 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14451 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00246 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00252 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00431 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13867 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13873 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14065 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62686 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62693 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62880 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63221 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63226 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63415 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Interest Groups - Progress Association ID: I-03938 Name redacted** | | | | | | | | | | |

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14590 | 20/08/2025 | Info Session | Incoming | Info sheet | Update | RP asked about the plant, pipelines, Yolla platform location, lifespan, planning area, exclusion zones, and oil spill modelling. Beach addressed questions using maps and explained the EP scope. RP supports gas as a backup energy source. RP requested project updates. | Requested further information | Relevant matter | N/A | N/A |
| C-62905 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63439 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Landholder - Residential ID: I-03856 Name redacted** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-00571 | 15/08/2025 | Email | Incoming | N/A | N/A | RP requesting pipeline location and coastal impacts near Kilcunda. | Requested further information | Relevant matter | N/A no objections or claims made | N/A |
| C-00585 | 20/08/2025 | Email | Outgoing | N/A | N/A | Beach responding to RP enquiry confirming location. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14077 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62890 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63424 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Marine Based Industry - Business ID: O-02250 Tasmanian Divers Group** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14426 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00263 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13907 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62725 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63261 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Marine Based Industry - Desalination Plant ID: O-00163 Aquasure** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14203 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14230 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00160 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00354 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-13849 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13957 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62663 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62774 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63201 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63310 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Marine Based Industry - Marine businesses ID: O-02252 Tasmanian Seafoods** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14447 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00229 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00349 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13835 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14026 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62654 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62840 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63189 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63375 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **TAS - Local Government ID: O-00758 Flinders Council** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14268 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14382 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00201 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00408 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14064 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-14066 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62878 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62879 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63413 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-63414 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02794 BayPlay Adventure Tours** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14217 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00276 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13921 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62738 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63274 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02797 Blue Water Sailing School** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14219 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00278 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13922 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62740 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63276 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02750 Dive2U Mobile Adventures** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14258 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62930 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63462 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02785 Newhaven Fishing Charters** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14360 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00270 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13914 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62733 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63268 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02779 Newhaven Yacht Squadron** | | | | | | | | | | |

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14361 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00266 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13910 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62728 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63263 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02778 Ocean Adventures Phillip Island** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14364 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00265 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13909 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62727 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63262 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02766 S.E.A.L. Diving Services** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14401 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00260 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13898 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62716 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63252 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02760 T-Cat Charters** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14428 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00254 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13891 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62709 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63245 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Marine Tourism ID: O-02759 The Reel Thing Fishing Charters** | | | | | | | | | | |

| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
|---|---|---|---|---|---|---|---|---|---|---|
| C-14431 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00253 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13884 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62703 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63239 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |
| **Tourism/Recreation - Peak Body ID: O-02761 Destination Phillip Island Regional Tourism Board** | | | | | | | | | | |
| Engagement ID | Date | Engagement type | Direction | Attachments Provided | Summary of correspondance | Engagement summary | Summary of each response by relevant person | Assessment of merits of objection or claim about adverse impacts of EP activity | Titleholder response to objection or claim | Measures adopted or proposed because of consultations |
| C-14256 | 14/07/2025 | Email | Outgoing | Info sheet | Introduction | Notification of consultation period and EP activities scope. | N/A outgoing engagement | N/A | N/A | N/A |
| C-00255 | 04/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info sessions and webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-13892 | 26/08/2025 | Email | Outgoing | Link to Engage beach | Update | Reminder: Upcoming community info webinar dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-62710 | 30/09/2025 | Email | Outgoing | N/A | Update | Reminder: Consultation closing dates. | N/A outgoing engagement | N/A | N/A | N/A |
| C-63246 | 15/10/2025 | Email | Outgoing | N/A | Update | Notification consultation has closed. | N/A outgoing engagement | N/A | N/A | N/A |

# Appendix C - Sufficient information

**1. Information sheet – Bass Gas Offshore Operations environment plan 5-year review 2**

**2. Summary table of impacts and risks 8**

**3. Public notices advertising consultation and community information sessions (online and in-person) 13**

3.1 Herald Sun (21 July 2025) 13

3.2 South Gippsland Sentinel-Times (22 July 2025) 14

3.3 Phillip Island and San Remo Advertiser (23 July 2025) 15

3.4 National Indigenous Times (29 July 2025) 16

3.5 Koori Mail (30 July 2025) 17

3.6 Phillip Island and San Remo Advertiser (27 August 2025) 18

**4. Online advertising inviting consultation 19**

4.1 National Indigenous Times website (live from 28 July to 10 August and 13 to 28 September 2025) 19

4.2 National Indigenous Times e-newsletter (live from 28 July to 10 August and 13 to 28 September 2025) 20

4.3 Koori Mail website (live from 28 July to 10 August and 13 to 28 September 2025) 21

4.4 Facebook, Instagram, Meta (live from 28 July to 10 August and 1 to 14 September 2025) 22

4.5 Facebook, Instagram, Meta (live from 29 September to 3 October 2025) 22

4.6 South Gippsland Sentinel-Times website (live from 25 August to 7 September 2025) 23

4.7 NewsCorp websites (live from 25 August to 7 September 2025) 23

**5. Community information session material (poster boards) 24**

**6. Webinar presentations 26**

6.1 Open community information webinar (held Tuesday 9 and Wednesday 10 September 2025) 26

6.2 Dedicated First Nations community information webinar (offered Tuesday 9 and Wednesday 10 September 2025) 33

**7. Community Reference Group meeting (held 18 August 2025) 41**

## 1. Information sheet – Bass Gas Offshore Operations environment plan 5-year review

# Bass Gas Offshore Operations

## Environment plan 5-year review

Consultation information sheet | July 2025

On 14 July 2025, Beach Energy (**Beach**) began consultation on the Bass Gas Offshore Operations environment plan (**EP**) 5-year review. This information sheet outlines the proposed activities for consultation with relevant persons, as required by regulations.

### Project overview

Bass Gas Operations produces natural gas and condensate from the Yolla gas field in the Bass Strait. The gas field is serviced by the Yolla-A Offshore Platform (**Yolla Platform**), and an approximately 147 km subsea pipeline that transports the gas and liquids from the platform to the Victorian mainland via a coastline crossing near Kilcunda.

The associated 32 km onshore pipeline terminates at the Lang Lang Gas Plant (**LLGP**) where natural gas is processed before being distributed to the domestic east coast market, delivering energy to homes, businesses and industry.

Commercial production of gas from the Yolla field started in June 2006. Recent forecasts predict that production has the potential to extend to 2030, however there is also a possibility it could finish earlier.

In accordance with regulatory requirements Beach is undertaking a 5-year review of the Bass Gas Offshore Operations EP to cover ongoing production operations.

This information sheet covers the EP's scope, which includes the operation of the offshore wells, Yolla Platform and pipeline, and the ongoing maintenance and inspections to ensure safe ongoing field operations.

### Location

The activities are being carried out in the Bass Strait, within offshore Commonwealth and Victorian State waters. The Yolla gas field and Yolla Platform are located in Production Licence T/L1, 147 km south of Kilcunda, Victoria, in a water depth of 80 m. The subsea pipeline is located in Pipeline Licences T/PL2 and VIC/PL34 (see map on page 2).

### Timing

Commercial production of gas from the Yolla field started in June 2006. Recent forecasts predict that production has the potential to extend to 2030, however there is also a possibility it could finish earlier.

Production from the wells and processing on the Yolla Platform occur 24 hours a day, seven days a week.

### Environment protection regulations

The National Offshore Petroleum Safety and Environmental Management Authority (**NOPSEMA**) regulates activities in commonwealth waters in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023*[1]. The Victorian Department of Energy, Environment and Climate Action (**DEECA**) regulates offshore activities in Victorian state waters in accordance with the *Offshore Petroleum and Greenhouse Gas Storage Regulations 2021* (Vic)[2]. Both sets of regulations are referred to as **Regulations** in this information sheet. In accordance with the Regulations, the EP is required to be accepted by both NOPSEMA and DEECA for ongoing operations.

An EP must include:

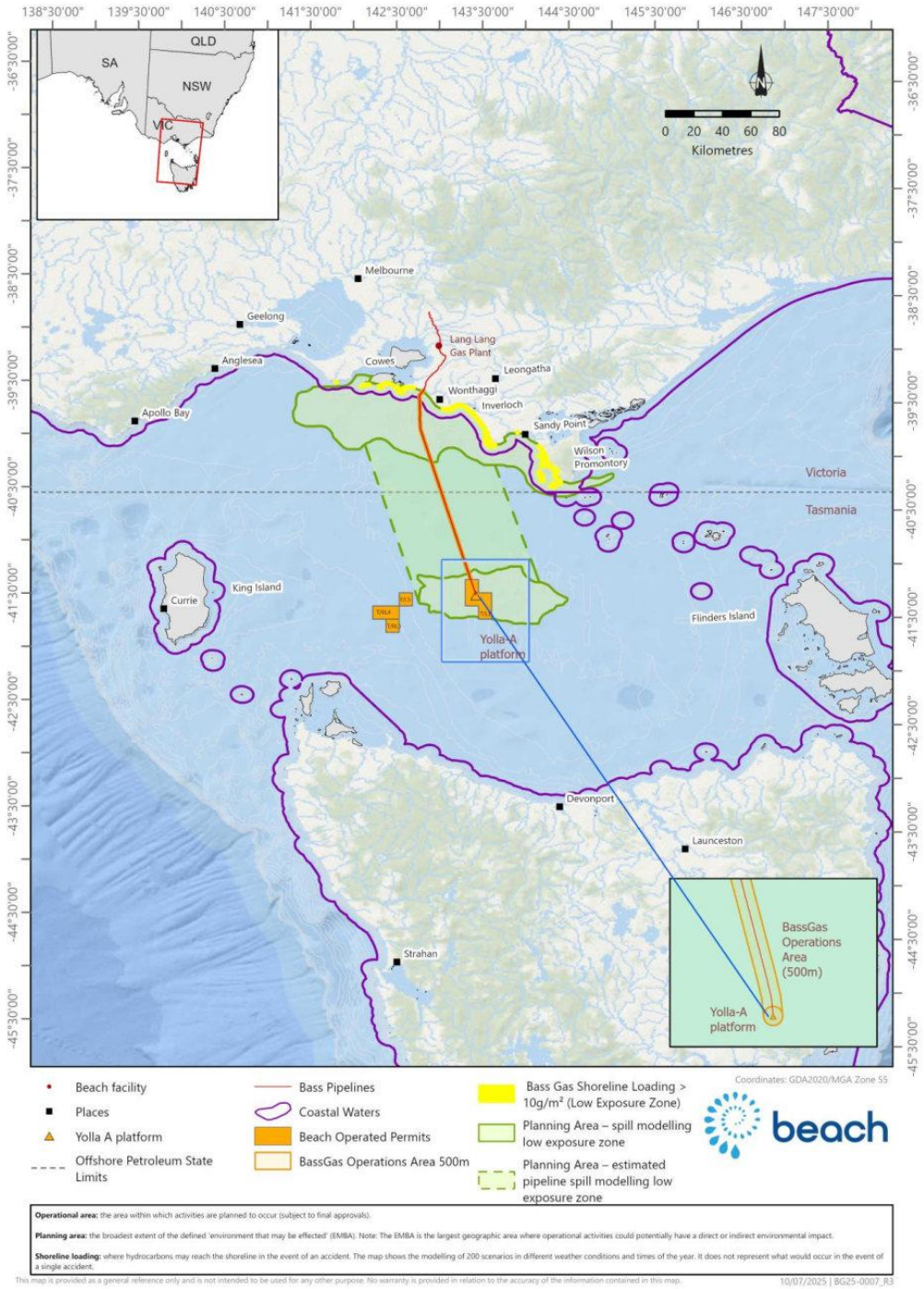
- a description of the existing environment
- a description of the proposed activities
- an evaluation of the impacts and risks, environmental performance outcomes and controls, implementation strategy, and reporting requirements.

EPs must also demonstrate that consultation with relevant persons whose functions, interests or activities may be affected by the activities in the EP (**relevant persons**) has been carried out in accordance with the Regulations.

[1] Under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth)

[2] Under the *Offshore Petroleum and Greenhouse Gas Storage Act 2010* (Vic)

**Location map**



## Facilities

### Yolla Platform

The existing Yolla Platform is a four-legged steel structure with a base covering approximately 50 m x 50 m. The main deck is a fully enclosed barge-like structure approximately 42 m x 50 m in size that provides support for the topside structures and equipment.

The platform is connected to the LLGP via a satellite link to enable the platform, in an uncrewed capacity, to be controlled and monitored remotely onshore from the plant.

The key elements of the Yolla Platform topsides structures are the:

- Well bay, which houses the production wellheads and subsea trees, production flowlines and manifolds, water pumping and sewage, and water discharge caisson
- Sea deck
- Main deck housing processing and utilities equipment, and the control room
- Flare / vent stack
- A pedestal crane for loading and unloading equipment from vessels
- Accommodation module
- Helideck.

### Wells and connections

The Yolla Platform currently supports production from four operational wells:

- Yolla-3
- Yolla-4
- Yolla-5
- Yolla-6.

### Offshore raw gas pipeline

The offshore raw gas pipeline exports dehydrated gas and condensate from the Yolla Platform to the pipeline shore crossing near Kilcunda. The key features of the offshore pipeline are:

- An offshore export riser
- A subsea laid 350 mm steel pipeline running approximately 147 km along the seabed to the shoreline.

The pipeline shore crossing consists of a horizontal directionally drilled buried pipeline approximately 1.4 km long that passes under the surf zone, beach and coastal dunes. The buried onshore pipeline, which is approximately 32 km in length, and the operation of the LLGP are both outside of the scope of the EP.

## Activities

The Yolla Platform is typically staffed part-time on a two-week-on and two-week-off roster. At other times, the platform has varying levels of staffing to support routine and non-routine operational, inspection, and maintenance activities. The Yolla Platform can accommodate up to 44 people.

The processing facilities on the Yolla Platform are designed to separate raw gas from the reservoir into gas, condensate and produced formation water streams. The gas is compressed and comingled with the condensate and exported via the raw gas pipeline to the onshore LLGP. Treated produced formation water is released to the sea at the platform. Gas is not routinely vented from the platform to the surrounding atmosphere. The flare is used as the main safety system to release gas and condensate in the case of an emergency.

Routine and non-routine activities described in the EP involve the use of both supply and support vessels and helicopter movements to transport personnel to and from the Yolla Platform.

Routine operational, inspection and maintenance activities include:

- Platform topside cleaning, inspection, repairs and maintenance
- Vessel-based remotely operated vehicle pipeline inspections
- Diving activities to conduct inspections, maintenance and repairs
- Geophysical surveys along the pipeline route
- Pipeline surveys and inspections.

Non-routine operational, inspection and maintenance activities include:

- Well intervention
- Workover
- Platform maintenance and shutdown inspection campaigns
- Pipeline repair and replacement campaigns

- Environmental surveys / monitoring
- Activities to be undertaken to safely suspend production activities ahead of decommissioning if required during the life of this EP.

### Environment description

The **operational area** (see map) is where the activities described in the EP are planned to occur (subject to final approvals).

The **planning area** (see map) is the broadest extent of the defined 'environment that may be affected' (**EMBA**) (subject to final approvals). The EMBA is the geographic area where operational activities could potentially have a direct or indirect environmental impact.

The EP includes a detailed description of the environment in the operational area and the EMBA, where there is a variety of marine fauna that are either known to occur or may occur, including:

- Blue whales, particularly during the summer months
- Southern right and humpback whales, particularly during the winter months
- Fin and Minke whales
- Dolphin and shark species throughout the year
- Several species of foraging and migratory sea birds including Little Penguins, and shearwater and albatross species
- New Zealand and Australian fur seals throughout the year
- Migratory turtle species.

There are no activities occurring within marine parks; however, the following National Marine Parks and State Marine Protected areas are within the EMBA:

- Cape Liptrap Coastal Conservation Park
- Yallock-Bulluk Marine National Park
- Powlett River Mouth, Nationally Important Wetland.

The Western Port, a Ramsar-listed site (wetlands of international importance designated under the Ramsar Convention on Wetlands) is within 10 km of the EMBA:

- Socio-economic and cultural values and sensitivities with the activity and planning areas include Commonwealth-managed fisheries including Eastern Tuna and Billfish Fishery, Bass Strait Scallop Central Zone Fishery, Skipjack Tuna Fishery, Southern Bluefin Tuna Fishery, Small Pelagic Fishery, Southern Squid Jig Fishery, Southern and Eastern Scalefish and Shark Fishery.
- Commercial and recreational marine and port communities along the Victorian coastline
- Coastal communities and onshore and offshore tourism activities
- Sea Country cultural values and sensitivities held by First Nation peoples
- Other commercial operations including offshore petroleum and renewable energy activities and the Victorian Desalination Plant.

### Impacts, performance outcomes and controls

Beach recognises the environmental, cultural, heritage, social and economic values in our operational and planning areas and has a proud track record of successful safety and environmental performance, adhering to performance measures set out in accepted EPs and safety cases.

The EP details potential risks and impacts on the environment and provides performance outcomes and standards. It also details control measures to reduce and manage environmental impacts and potential risks to 'As Low As Reasonably Practicable' (**ALARP**) and acceptable levels. ALARP is an assessment principle commonly used in the oil and gas industry to assess and reduce potential impacts and risks that cannot be eliminated. The control measures follow the principles of ecologically sustainable development. They include:

- The Yolla Platform, offshore pipelines and wells are marked on the Australian Hydrographic Office's navigational charts and are surrounded by an existing 500 m petroleum safety zone (**PSZ**) (see '**Exclusion zones**' below).
- Beach-utilised vessels are required to comply with applicable marine regulations and observe the minimum approach distances to whales and dolphins as set out in national guidelines.
- Ongoing engagement with other marine users in the area throughout the life of the operations.
- Venting and flaring activities at the Yolla Platform is limited to that required for safe operations.
- Continuous monitoring of produced formation water discharges.

- Beach operates in compliance with NOPSEMA-accepted Safety Cases and Well Operations Management Plans.
- The risk of loss of containment of hydrocarbons or chemicals is managed through equipment design, and the implementation of asset integrity and maintenance programs. In addition, process parameters are monitored 24/7 by trained and competent personnel.

A more detailed summary of the key risks and impacts, mitigations and management plans can be found here. For information on how NOPSEMA assesses ALARP, see ALARP Guidance Note.

### Recognising cultural values and sensitivities

Beach recognises First Nations groups and their spiritual and cultural connection to the environment. Beach's operations occur in the Sea Country adjacent to the coastal First Nations groups Bunurong Land Council Aboriginal Corporation, Gunaikurnai Land and Waters Aboriginal Corporation, Flinders Island Aboriginal Association. Beach consulted with these groups for the development of the EP. Beach will continue to consult with these groups, as well as any newly identified relevant First Nations groups, to identify cultural values and sensitivities associated with Sea Country and to address any potential impacts and control measures to be included in the revised EP.

### Exclusion zones

All vessels are required to abide by a 500 m PSZ around the Yolla Platform. PSZs are administered by NOPSEMA under Section 616 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth) (**OPGGS Act**).

The PSZ is a safety exclusion zone restricting all vessel and diver access and, along with a 3 km cautionary zone, is monitored from the Yolla Platform to minimise the risk of vessel collision. Entry into PSZs is prohibited to all vessels except those authorised to do so by NOPSEMA (as detailed in a gazetted notice) or those vessels exempted under Section 615 of the OPGGS Act. PSZs are shown as a 'Restricted Area' on navigation charts.

### Operating safely and maritime safety protocols

Safety takes precedence in every activity undertaken by Beach. The Yolla Platform and offshore portion of the raw gas pipeline have a dedicated Safety Case accepted by NOPSEMA.

Support vessels attending the Yolla Platform and the subsea pipeline for supplies and maintenance activities will operate in accordance with Australian Maritime Standards, regulated by the Australian Maritime Safety Authority including:

- Notifications to the Australian Hydrographic Office before mobilising and demobilising for construction, maintenance and survey activities in the operational area.
- Providing advanced notice of vessel contact details for construction, maintenance and survey activities to other vessels and marine users.
- Communicating with other vessels using standard maritime protocols.
- Maintaining safe operating distances.
- Compliance with Navigational Safety requirements, including lighting and Automatic Identification System.

### Emergency planning

There is an unlikely risk of a hydrocarbon gas, condensate or marine vessel fuel release during EP activities.

Beach's standard operating procedures require emergency response plans in all EPs. These plans are developed using worst-case spill modelling of all potential hydrocarbon release scenarios in the local area, assuming no control measures are in place. The modelling calculates the transport, spreading, entrainment and evaporation over time, based on:

- prevailing metocean conditions (wind, wave and climate) on a seasonal basis
- the volume released
- the physical and chemical properties for the hydrocarbon released.

The model output presents a combination of 200 different spill simulations for each scenario and is used to inform emergency planning and define the EMBA. The model output and resulting EMBA is not representative of the full extent of a single, highly unlikely release of hydrocarbons.

The revised EP will describe the EMBA and include an assessment of the likelihood and consequences of any hydrocarbon release, which must be reduced to ALARP through control measures and detailed response plans. For more information on hydrocarbon release modelling and why it is required for the preparation of EPs, click here to watch NOPSEMA's video.

An emergency response plan describes the arrangements that must be in place for responding to and monitoring any release of hydrocarbon, including:

- 24/7 on-call team for rapid response clean-up actions, including mobilisation of personnel and equipment
- 24/7 on-call team for modelling and monitoring of a hydrocarbon release to inform response activities, and monitoring of effectiveness of response activities
- control measures necessary for ensuring rapid response and maintenance of capabilities (personnel and equipment).

These arrangements are based on the worst-case event associated with the activities, to ensure that Beach has the appropriate level of response arrangements and capability.

Beach maintains a current contract with the Australian Marine Oil Spill Centre based in Geelong for access to spill response resources and personnel. The Victorian Department of Transport is the control agency for marine pollution emergencies within 3 nautical miles of the coast. Beach also conducts exercises to test the emergency response plans and identify any issues and improvements before, and during operations.

**Consultation with relevant persons**

**Purpose of consultation**

Consultation with relevant persons is an important part of developing EPs. The purpose of consultation is to ensure that potential impacts have been identified, and appropriate measures are considered and adopted as a result of consultation.

Beach is providing - and will continue to provide - a range of consultation methods and opportunities to relevant persons, including Beach's online consultation hub, **Engage Beach**, where you can find out more, leave feedback and ask questions; in-person and online information sessions; phone calls; emails; and meetings. Please contact us if you would like to discuss your preferred approach to consultation.

**Relevant persons**

A relevant person is defined in the **Regulations** as including a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under an EP.

Please contact us if you would like to discuss your functions, interest or activities in relation to the activities proposed under the revised EP. If you know of any person or organisation you believe may be a relevant person, please pass our contact details on to them.

**Sufficient information**

The Regulations also require that relevant persons must be provided sufficient information to allow them to make an informed assessment of the possible consequences of the EP activity on their functions, interests or activities.

On **Engage Beach** you will find information prepared in a variety of styles including short summaries; long descriptions; diagrams; maps; questions and answer formats; and detailed information on a range of topics related to the activities. Please contact us if you would like to discuss any EP activity information you are seeking.

**Reasonable period**

The Regulations also require that titleholders allow relevant persons a reasonable period of time for consultation. What is a reasonable period for consultation will depend on the nature of an activity, the potential impacts and risks on a relevant person's functions, interest or activities, and is considered on a case-by-case basis.

**Sensitive information**

In accordance with the Regulations, each EP must include a report on all consultations and a copy of the full text of any response by a relevant person.

Relevant persons may request the information they provide not be published, and in that case, it will be identified as 'sensitive information' and not published in the EP.

**NOPSEMA consultation brochure**

For further information regarding consultation, please see NOSPEMA's brochure 'Consultation on offshore petroleum environment plans', **found here**.

**Contact us**

Please contact Beach if you would like more information, have any questions or feedback, or wish to consult with us about how the EP activities may impact your functions, interests or activities. Beach will take into consideration all feedback, including any concerns or objections, and will explore measures to reduce any impacts and risks.

Online: **engage.beachenergy.com.au**

Phone: 1800 797 011

Email: **community@beachenergy.com.au**

## 2. Summary table of impacts and risks

### Page 1

Bass Gas Offshore Operations Environment Plan
Impacts and Risks Summary

**Summary of Impacts and Risks for Beach Energy Bass Gas Offshore Operations, Bass Strait Victoria**

| Aspect – Planned Activity | Relevant Activities | Potential Impact | Summary of Beach Energy Control Measures |
|---|---|---|---|
| Physical Presence of Infrastructure and Vessels | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | Yolla-A platform, operating vessels, offshore infrastructure and the Petroleum Safety Zones (PSZ), present a physical presence that may result in impacts and displacement of other marine users and snagging of fishing equipment, and marine visual amenity. | • Consultation with relevant persons who may be affected by the activity is undertaken as part of updating the environment plan. Consultation is ongoing during the activity, to avoid or limit any displacement.<br>• Stakeholders, including the Australian Hydrographic Office, are notified of activities at least three weeks before to mobilisation to enable the promulgation of Notice to Mariners and AusCoast navigational warnings.<br>• Petroleum Safety Zones (PSZs) administered by NOPSEMA for the OPGGS Act are marked on navigational charts.<br>• Implementation of Beach Energy's Fair Ocean Access protocol that details the process whereby commercial fishers can claim compensation for economic loss of catch associated with offshore operations activities.<br>• Vessels comply with AMSA<br>o Marine Orders Part 30 (Prevention of collisions)<br>o Marine Orders Part 27 (Safety of navigation and radio equipment).<br>• The Yolla-A PSZ (and 3-km radius cautionary zone) is actively monitored by the platform using AIS and radar to minimise the risk of vessel collision with the platform. |
| Routine Emissions - Light | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | Vessel and the Yolla-A platform lighting is required for navigational and safety purposes.<br>Artificial light may attract light sensitive species such as seabirds, turtles and | • Yolla-A platform navigation lighting complies with maritime standards and regulatory requirements.<br>• Vessel lighting complies with AMSA Marine Orders Part 30 (Prevention of Collisions). |

### Page 2

| Aspect – Planned Activity | Relevant Activities | Potential Impact | Summary of Beach Energy Control Measures |
|---|---|---|---|
| | | shorebirds affecting predator-prey dynamics and impacting migratory routes. | • A Light Management Plan is implemented for BassGas operational activities to reduce the impact of artificial light to seabirds, turtles and migrating shorebirds, to mitigate potential harm from light exposure, attraction and disorientation. |
| Routine Emissions - Atmospheric | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | The combustion of gas or diesel in generators, as well as the venting of fuel gas on the Yolla-A platform, may lead to a localised and temporary decline in air quality, contributing to the release of greenhouse gases (GHG) to the atmosphere.<br>Similarly, the combustion of marine diesel oil (MDO) from vessel engines, generators and deck equipment can result in a temporary decrease in air quality and further contribute to GHG emissions.<br>Additionally, the GHG emissions associated with the production, transport and use of hydrocarbon products for offshore operations also add to the GHG presence in the atmosphere. | • Beach Energy has an emissions reduction target – to reduce its scope 1 and 2 equity emissions intensity by 35% by 2030, from a 2018 baseline.<br>• Beach Energy has a GHG Management Plan which provides guidance for the management of greenhouse gas emissions from Beach Energy operated facilities.<br>• Vessels comply with AMSA<br>o Marine Orders Part 97 (Marine Pollution Prevention – Air Pollution (appropriate to vessel class) for emissions from combustion of fuel, which includes:<br>▪ Currency of a valid International Air Pollution Prevention certificate and an International Energy Efficiency certificate.<br>▪ A Ship Energy Efficiency Management Plan to reduce emissions.<br>▪ Engine $NO_2$ emission levels that comply with Regulation 13 of MARPOL 73/78 Annex VI.<br>▪ Low-sulphur (<0.5% m/m) diesel usage.<br>• Combustion equipment is serviced and maintained in accordance with OEM guidelines via CMMS (Computerised Maintenance Management System). |
| Routine Emissions - Noise and Vibration | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | Noise and vibration from offshore operations around the Yolla-A platform and from vessels can result in hearing damage and behavioural changes to sound-sensitive marina fauna including whales, sharks, cetaceans and seabirds.<br>Temporary disturbance to marine fauna may occur from surface and underwater sound emissions sources including: | • Vessels and helicopters comply with Part 8 Division 8.1 of the Environment Protection and Biodiversity Conservation (EPBC) Regulations 2000 titled "Interacting with Cetaceans", which outlines specific rules for approaching and interacting with whales and dolphins to minimise disturbance and potential harm to by establishing minimum separation distances and restrictions on certain activities.<br>• Where appropriate Adaptive Management Plans for marine-listed threatened species and ecological communities that align with National Recovery Plans (NRPs) will be implemented. |

## Page 3

| Aspect – Planned Activity | Relevant Activities | Potential Impact | Summary of Beach Energy Control Measures |
|---|---|---|---|
| | | Vessel engines and thrusters.<br>Helicopters<br>Subsea infrastructure maintenance and repair equipment.<br>Disturbance of birds through the use of deterrents to prevent risks to safe helicopter operations. | • Contractor vessel engines and thrusts are maintained in accordance with manufactures instructions via a Planned Maintenance System to ensure operational efficiency.<br>• Where appropriate for activities associated with pipeline surveys and monitoring, Beach Energy ensures contractors comply with Policy Statement 2.1 (Part A) EPBC Act 1999 to minimise the risk of acoustic injury to whales such as the Pygmy blue whale that migrate and forage in Bass Strait. |
| Routine Discharge – Produced Formation Water (PFW) | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | Routine discharges of PFW may cause adverse effects on the marine environment, impacting water quality and potentially leading to long-term toxicity impacts on fauna within the mixing zone. | • The Yolla-A platform PFW Sampling and Testing Maintenance Procedure is implemented by Beach Energy to ensure the following controls are in place:<br>o Dispersed OIW concentration discharges meet the specification for non-dissolved hydrocarbons.<br>o A distributed control system (DCS) and inline PFW analysers record PFW discharge rates, water quality results, and trigger alarms for occasions where OIW concentrations or discharge rates exceed specifications. The PFW discharge is automatically stopped if water quality limits are exceeded.<br>o The Beach Energy Chemical Management Plan is implemented, outlining the requirements for selecting chemicals that may be present in discharges to the marine environment to ensure that the lowest toxicity, most biodegradable, and least accumulative products which meet the technical requirements of the application are selected.<br>o A PFW sampling and laboratory analysis program is implemented to verify online analysers and ensure that the potential impact of discharges is reduced to as low as reasonably practicable. |
| Routine Marine Discharges | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | Routine marine discharges from vessels include cooling water, brine, bilge water, deck drainage, putrescible waste, sewage, and greywater. | • Vessels comply with the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which gives effect to MARPOL Annex IV relating to the discharge of noxious liquid substances, sewage, and putrescible waste. |

## Page 4

| Aspect – Planned Activity | Relevant Activities | Potential Impact | Summary of Beach Energy Control Measures |
|---|---|---|---|
| | Cessation of production (COP) | Marine discharges can alter water quality by increasing temperatures, salinity, nutrients, chemicals, and hydrocarbons.<br>Discharge of treated seawater from the RGP. | • Processes required to contain and recover waste substances for disposal are implemented in a Waste Management Plan.<br>• Equipment to treat marine discharges is serviced and maintained in accordance with OEM guidelines via CMMS (Computerised Maintenance Management System) to ensure they are operating efficiently.<br>• Yolla marine studies and modelling.<br>• A Chemical Management Plan is implemented, outlining the requirements for selecting chemicals that may be present in discharges to the marine environment to ensure that the lowest toxicity, most biodegradable, and least accumulative products which meet the technical requirements of the application are selected. |
| Accidental discharge of materials and waste to the ocean | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | The handling and storage of materials and waste on board a vessel or on the Yolla- A platform has the potential to result in accidental overboard release creating marine debris.<br>Grit may be used to remove paint or debris from the Yolla- A platform during maintenance. Waste materials associated with these activities may include a mix of grit and debris, and any unplanned discharges. | • Processes required to contain and recover waste materials for disposal are implemented in a Waste Management Plan.<br>• Waste with the potential to be windblown is stored in covered containers.<br>• Mitigations are in place to avoid objects with the potential to be dropped from vessels overboard by processes implemented in a Lifting and Load safety Operations procedure.<br>• Lifting gear is maintained and inspected regularly as per Lifting and Load Safety Operations procedure. All maintenance and inspection outside of pre-use are scheduled through CMMS (Computerised Maintenance Management System).<br>• When grit is used to remove paint or debris shelters are constructed and waste is contained. |

| Aspect – Unplanned events | Relevant Activities | Potential Risk | Beach Energy Summary of Control Measures |
|---|---|---|---|
| Vessel collision or disturbance of fauna | Operations<br>Inspection, Maintenance and | Vessels have the potential for collision with marine mammals which may cause injury or death. | • Vessels and helicopters comply with Part 8 Division 8.1 of the Environment Protection and Biodiversity Conservation (EPBC) Regulations 2000 titled "Interacting with Cetaceans", which outlines specific rules for approaching and interacting with whales and dolphins to minimise |

## Page 5

| Aspect – Unplanned events | Relevant Activities | Potential Risk | Beach Energy Summary of Control Measures |
|---|---|---|---|
| | Repair (IMR) and surveys | | disturbance and potential harm to by establishing minimum separation distances and restrictions on certain activities.<br>• Where appropriate Adaptive Management Plans for marine-listed threatened species and ecological communities that align with National Recovery Plans (NRPs) will be implemented. |
| Introduction and establishment of Invasive Marine Species (IMS) | Inspection, Maintenance and Repair (IMR) and surveys | The introduction of IMS, also known as marine pests, may occur when vessels discharge ballast water that contains foreign species or when these species translocate through biofouling on hulls, niches or in-water equipment. The potential impacts of introducing marine pests include:<br>Changes in the diversity and abundance of native marine species.<br>Alterations to commercial fish stocks, along with associated socio-economic effects.<br>Deterioration of conservation values in protected areas. | • Beach Energy's vessel contractors and operators of submersible equipment adhere to the biosecurity requirements of the Biosecurity Act 2015 administered by the Department of Agriculture, Fisheries and Forestry (DAFF).<br>• The Beach Energy's IMS Management Plan is implemented including:<br>o Compliance with Commonwealth and State regulatory requirements regarding marine biosecurity.<br>o Conducting a marine biosecurity risk assessment that involves:<br>▪ Identifying and evaluating potential IMS risk profiles<br>▪ Addressing any deficiencies in IMS controls and apply any additional controls to manage IMS risk to as low as reasonably practicable (ALARP).<br>o Taking measures to prevent the translocation and potential establishment of marine pests in unaffected marine environments.<br>o Reporting any suspected or confirmed instances of IMS individuals or communities that are observed or recorded to the appropriate regulatory agency. |
| Minor spills | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | Minor spills could occur at the. Yolla-A platform and from vessels due to the following activities:<br>The use, handling, and transfer of hydrocarbons and chemicals.<br>Hydraulic line failures from equipment.<br>Bunkering materials between a drilling rig and support vessel. | • Materials and substances from equipment that may spill onto decks or with the potential to be windblown are stored within a contained area or in covered containers.<br>• The Beach Chemical Management Plan is implemented, outlining the requirements for selecting chemicals that may be present in discharges to the marine environment to ensure that the lowest toxicity, most biodegradable, and least accumulative products which meet the technical requirements of the application are selected. |

## Page 6

| Aspect – Unplanned events | Relevant Activities | Potential Risk | Beach Energy Summary of Control Measures |
|---|---|---|---|
| | | These a minor spill could lead to temporary and localised changes in water quality. They might also affect the:<br>Behaviour of marine fauna in the surface waters impacted, potentially causing them to avoid the area.<br>Cultural values and sensitives.<br>Functions, interests or activities of marine users. | • If required, bunkering activities follow the rig and vessel contractor bunkering procedures that detail:<br>o Supervision of activities is conducted by trained and experienced operators.<br>o Transfer equipment meets manufacture instructions, industry standards, and compliance inspection checks as outlined in the Beach Energy Planned Maintenance System.<br>o Communications and visibility between the rig and vessel are tested before starting the activity and are maintained for the duration.<br>• Emergency spill response plans implemented include:<br>o Vessels will implement a Shipboard Marine pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (SOPEP) (dependent on vessel class).<br>o Beach Energy Offshore Victoria Oil Pollution Emergency Plan (OPEP).<br>o Beach Energy Operational Scientific Monitoring Plan (OSMP) detailing specific environmental and socio-economic operations activities for assessment, monitoring, and approvals for cessation of a spill response. |
| Loss of Containment: Loss of Well Control (LoWC).<br>Rupture of the Raw Gas Pipeline (RGP) during production.<br>Rupture of the Raw Gas Pipeline (RGP) while suspended. | Operations<br>COP | A loss of containment resulting in a condensate spill can occur due to:<br>Loss of well control (LoWC) during drilling<br>Unexpected failure leading to a rupture of the RGP during production releasing hydrocarbons to the marine environment.<br>Unexpected failure of the suspended RGP releasing treated seawater to the marine environment.<br>The environmental risks and impacts of a hydrocarbon spill are well understood, including pollution of the sea surface, water column and shoreline. Potential | • The Yolla Platform and the RGP are operated in accordance with the Offshore Facilities Safety Case, accepted by NOPSEMA.<br>• All producing, suspended and drilling wells have a Well Operations Management Plan (WOMP) accepted by NOPSEMA. A WOMP includes:<br>o Identification of risks to well integrity.<br>o Description of control measures in place.<br>o Assessment and demonstration of well integrity risks reduced to ALARP<br>o Systems established to test and monitor the effectiveness of these control measures.<br>• The RGP is designed, installed and continuously monitored to ensure compliance with regulations outlined in the Safety Case which demonstrates Beach Energy's capability to: |

## Page 7

| Aspect – Unplanned events | Relevant Activities | Potential Risk | Beach Energy Summary of Control Measures |
|---|---|---|---|
| | | impacts on the marine environment include:<br>Reduced water quality.<br>Injury or death of exposed marine fauna and seabirds.<br>Disruption of the food chain where contaminated organisms affect other marine life and seabirds.<br>Damage to sensitive habitats, that may lead to long-term ecological consequences if the spill reaches shorelines.<br>Potential effects on relevant persons, cultural values and sensitives.<br>Changes to the functions, interests or activities of marine users. | ○ manage major accident hazards and protect the health and safety of personnel.<br>○ detail the facility's hazards, risk assessments, safety management systems, and emergency response plans, providing evidence that risks are controlled to ALARP.<br>○ Beach Energy's emergency response capability to implement timely source control for wells is maintained in accordance with Source Control Contingency Plan (SCCP) and a Relief well Plan (RWP), specific to the Yolla field operations.<br>• Response measures are tested and implemented by the following plans<br>○ Beach Energy Offshore Victoria Oil Pollution Emergency Plan (OPEP).<br>○ Beach Energy Operational Scientific Monitoring Plan (OSMP) detailing specific environmental and socio-economic operations activities for assessment, monitoring, and approvals for cessation of a spill response. |
| Marine Diesel Oil (MDO) Release | Inspection, Maintenance and Repair (IMR) and surveys | Offshore vessels use MDO as fuel. A collision between a contracted vessel and a third-party vessel has the potential to result in an MDO fuel spill. Possible causes of such a collision may include:<br>Mechanical failure.<br>Loss of dynamic positioning, navigational error or floundering due to adverse weather conditions.<br>The known and potential impacts of an MDO spill to the marine environment are:<br>A temporary and localised reduction in water quality.<br>Injury and or death of exposed marine fauna and seabirds. | • Vessel collisions are avoided by:<br>○ Consultation with relevant persons who may be affected by the operations is undertaken as part of developing the environment plan. It is ongoing, both before and during the activity, to avoid or limit any marine incidents.<br>○ Stakeholders, including the Australian Hydrographic Office, are notified of activities at least three weeks before mobilisation to enable the promulgation of Notice to Mariners and AusCoast navigational warnings.<br>• Vessels comply with AMSA<br>○ Marine Orders Part 30 (Prevention of collisions): safety navigation and operations of vessels.<br>○ Marine Orders Part 27 (Safety of navigation and radio equipment): navigation safety measures, radio and communications.<br>○ Marine Orders Part 21 (Safety and Emergency Arrangements): safety measures for the crew, bridge visibility, pilot transfer arrangements |

## Page 8

| Aspect – Unplanned events | Relevant Activities | Potential Risk | Beach Energy Summary of Control Measures |
|---|---|---|---|
| | | Food chain disruption where contaminated organisms impact the food chain and expose marine fauna and seabirds.<br>Sensitive habitat damage that may lead to long term ecological consequences where the spill reaches shorelines.<br>Potential impact to relevant persons, cultural values and sensitives.<br>Changes to the functions, interests or activities of marine users. | and operation of steering gear, and signals and drills and duties of seafarers.<br>• Vessels have enabled an automatic identification system (AIS).<br>• Emergency spill response plans implemented include:<br>○ Vessels will implement a Shipboard Marine Pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (SOPEP) (dependent on vessel class).<br>○ Beach Energy Offshore Victoria Oil Pollution Emergency Plan (OPEP).<br>○ Beach Energy Operational Scientific Monitoring Plan (OSMP) detailing specific environmental and socio-economic operations activities for assessment, monitoring, and approvals for cessation of a spill response. |
| Hydrocarbon Spill Response Activities | Operations<br>Inspection, Maintenance and Repair (IMR) and surveys | Spill response strategies may be accompanied by a range of environmental and socio-economic impacts. | Preparedness measures<br>• Consultation with relevant persons who may be affected by the Yolla field operations activities is ongoing to maintain communications and awareness.<br>• Annual drills and spill response exercises to test internal and external emergency response capabilities to meet the requirements of Beach Energy Offshore Victoria Oil Pollution Emergency Plan (OPEP) and the Beach Energy Emergency Management Plan (EMP).<br>• Beach Energy maintains a current membership with the Australian Marine Oil Spill Centre (AMOSC) for access to spill response equipment and materials and core response personnel.<br>• Beach Energy maintains a response services contract for the activation of spill response capabilities to implement a well-specific Source Control Contingency Plan (SCCP) and/or a Relief Well Plan (RWP).<br>Response measures<br>• Beach Energy's Offshore Victoria Oil Pollution Emergency Plan (OPEP) details:<br>○ Notification and reporting requirements.<br>○ Priority Protection Areas. |

## Page 9

| Aspect – Unplanned events | Relevant Activities | Potential Risk | Beach Energy Summary of Control Measures |
|---|---|---|---|
| | | | ○ Response strategies including:<br>▪ access to resources and equipment requirements.<br>▪ developed Impact Action Plan and environmental assessments (Project specific) for readiness responses and responsibilities.<br>• Beach Energy's Operational Scientific Monitoring Plan (OSMP) detailing specific environmental and socio-economic operations activities for assessment, monitoring, and approvals for cessation of a spill response in consultation with or under the direction of the State Control Agency and or Commonwealth. |

## 3. Public notices advertising consultation and community information sessions (online and in-person)

### 3.1 Herald Sun (21 July 2025)



# Outrage at horse carcass

## Discovery on 'cruel' farm

**Regan Hodge**

The rotting carcass of a deceased horse has allegedly been found on the property of a former racing trainer already at the centre of an animal cruelty investigation.

Ex-trainer Maxine Fraser is the subject of an RSPCA probe over the alleged neglect of 30 horses at her property at Mt Eliza on the Mornington Peninsula.

A community-led animal welfare group has been protesting at the property weekly with hopes of action to save the horses.

The carcass of a horse was allegedly discovered by the group at Ms Fraser's stables just weeks ago.

The horse's entire ribcage and insides were visible as it lay dead on the Mt Eliza property.

Carly Wines, who is leading the protest group, claims the horse had been laying dead at for at least three weeks.

"These photos are horrific," she said.

"The pungent stench became apparent on June 26. This poor boy has suffered and died unnecessarily. This was preventable.

Ms Fraser, who also uses the surname Galpin, was stripped of her racing license in 2017.

Her Ilha property on the Mooroodue Highway is repeatedly visited by a large group of animal lovers from across Melbourne who are demanding the RSPCA and state government intervene.

"We wait with dread, more animals will perish under the watch of the RSPCA," Ms Wines said.

"Where is the prevention of cruelty to animals? It's completely evident that current animal protection laws do not meet expected standards."

The RSPCA said the horse had been assessed more than once and "there were no welfare concerns" prior to its death, which is not currently under investigation.

"We were saddened one of the horses on the property passed away and we understand how distressing and confronting the death of an animal can be," a statement read.

"This horse had pre-existing medical conditions and was under veterinary guidance.

"Our Inspectorate received an initial report for underweight horses at the property, which remains an ongoing investigation. We have attended the property on eight occasions since April 2025."

Animal Justice Party MP Georgie Purcell said she was "sickened" by the images of the rotting horse.

"This is a heartbreaking yet classic case of authorities in Victoria passing the buck because no one wants to take responsibility – and as always, it's the animals that pay the ultimate price," she said.

"These pictures are disturbing, and every Victorian should be sickened that this case was entirely preventable."

Ms Purcell called for the "archaic" legislation to be reviewed immediately.

"The horses on this property were not just failed by the woman who was supposed to care for them, but by the so-called authorities that were supposed to step in," she added.

"We know there is a proposed overhaul to Victoria's archaic animal welfare legislation that is currently sitting on Jacinta Allan's desk.

regan.hodge@news.com.au

Horses seen on a Mt Eliza property owned by former trainer Maxine Fraser; (inset) welfare protesters who have had a weekly presence at the site. Picture: Tony Gough

## Public Notice

## Consultation for Review of the Bass Gas Offshore Operations EP

beach

**Beach Energy (Beach) supplies natural gas from offshore Victoria to the local market through existing infrastructure. In accordance with regulatory requirements, Beach has commenced planning and consulting for the 5-year review of the Bass Gas Offshore Operations Environment Plan (EP) to cover ongoing production operations.**

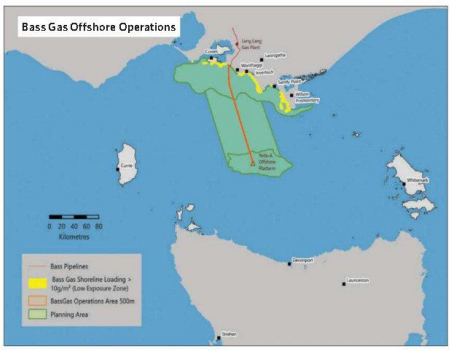
Bass Gas Operations produces natural gas and condensate from the Yolla gas field in the Bass Strait. The gas field is serviced by the Yolla-A Offshore Platform (Yolla Platform), and an approximately 147 km subsea pipeline that transports the gas and liquids from the platform to the Victorian mainland near Kilcunda. Commercial production of gas from the Yolla field started in June 2006 and may extend to 2030.

The revised EP includes the operation of the offshore wells, Yolla Platform and pipeline in the Bass Strait in commonwealth and state waters, and the ongoing maintenance and inspections to ensure safe ongoing field operations.

**Community information sessions**

Beach is committed to working with local communities, ensuring people are informed about our projects and can provide feedback. Stakeholder consultation is an important part of our planning as it helps identify local concerns and ensures management of potential impacts.

Consultation on the revised Bass Gas Offshore Operations EP is open from **Monday 14 July 2025** until close of business **Friday 10 October 2025.**




**Consultation dates and information**

| | |
|---|---|
| Online consultation hub | **engage.beachenergy.com.au**<br>Engage Beach, includes information in different formats including maps; diagrams; photos; questions and answers; detailed information sheets. |
| In-person community information sessions (registration not required) | **Wonthaggi RSL, 60 Graham Street, Wonthaggi**<br>Tuesday 19 August, 11am to 3pm (AEST) (Dedicated First Nations session)<br>Tuesday 19 August, 6pm to 8pm (AEST) (Open session)<br>Wednesday 20 August, 11am to 3pm (AEST) (Open session)<br>Wednesday 20 August, 6pm to 8pm (AEST) (Dedicated First Nations session) |
| Online information sessions (webinars) Please email community@beachenergy.com.au to register your interest in attending a webinar. | Tuesday 9 September, 2.15pm to 3pm (AEST) (Open session)<br>Tuesday 9 September, 7pm to 7.45pm (AEST) (Dedicated First Nations session)<br>Wednesday 10 September, 2.15pm to 3pm (AEST) (Dedicated First Nations session)<br>Wednesday 10 September, 7pm to 7.45pm (AEST) (Open session) |

For information regarding consultation, please see NOSPEMA's Brochure titled 'Consultation on offshore petroleum environment plans', at **consultation.nopsema.gov.au.**

For further project information scan the QR code or visit **engage.beach.com.au.**

We welcome your questions, please contact:

**P** 1800 797 011
**E** community@beachenergy.com.au
**beachenergy.com.au**

READ MORE

GD25-0116
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## 3.2 South Gippsland Sentinel-Times (22 July 2025)

# Local support a focus of new Procurement Policy

SOUTH Gippsland Shire councillors voted in support of an updated Procurement Policy to guide how council acquires goods, services, and works, while ensuring public funds are spent ethically, transparently and efficiently, councillors noting there is now a stronger emphasis on supporting local suppliers.

"Local businesses employ local people and that helps keep money circulating within our community," Cr Bron Beach said, noting economic and social sustainability principles are also included in the new Procurement Policy, promoting long-term growth and community wellbeing.

"By prioritising local suppliers and sustainable practices, this policy helps us to build a resilient, empowered community," Cr Beach said, adding that the aim is one of the key themes in the Council Plan.

Cr Nathan Hersey stressed the added importance of a local focus in the current economic environment.

"Whilst another level of government attempts to rip out money from our community, we as a local level of government are looking at how we can keep funds local," he said, wanting local businesses to get the council support they need, boosting the region's economic vibrancy in the process.

As a member of council's Audit and Risk Committee, Cr Sarah Gilligan has been going through the new Procurement Policy with a fine-tooth comb and spoke of the factors needing to be considered by council when spending ratepayer money.

She said the applicable criteria includes quality, longevity, fitness for purpose, operational costs, experience and performance history, flexibility, innovation and adaptation, whole of life costs including acquisition, decommissioning and disposal, environmental impact and economic and social sustainability.

# Poison bait warning at Blue Gum Reserve

BASS Coast Shire Council has moved quickly to tackle the threat of poison dog baits at Blue Gum Reserve off-leash dog park in Cowes, following the death of a much-loved regular at the park after ingesting rat poison a fortnight ago. Signs have now been erected in the area warning of the danger of poison baits.

'Please be aware baits have been found in this area.'

'Take extreme care while walking your dogs.'

'See something, say something, please contact Bass Coast Shire 5671 2211 or Police.'

Local dog owners at first kept their dogs away from the park, but according to the president of the Phillip Island Dog Owners Association, Cheryl Owens, the dogs and their owners are slowly starting to return.

"Initially, the number of people using the park dropped off, but we're encouraging them to go back, and keep a close watch on their dogs," said Cheryl.

Ms Owens said the baiting incident at the park was of massive concern.

"Watch your dog, keep your eye on it. It would be a real pity if the only dog park on Phillip Island is not used," said Cheryl.

Dog owner Roger, a regular at the park with his dog Rex, said it had to be of concern.

"Dogs moving around, you don't know what they find or sniff.

"In the off-leash area, no one gives you any problems, but you have to be careful and keep the area clean."

**Cooper and Sonny wait for a treat from Jenny at the Blue Gum Reserve off-leash dog park in Cowes.** B11_2925

Jen, with her dog Belle, is also a regular at the park.

"We're concerned about the bait," said Jen.

"You have to watch the dogs in the bushes.

"We come to the park because it is an off-leash area.

"I love the time with the dog. It is an important part of her socialising and being able to run free."

Cooper and Sonny have been coming to the park with their owner, Jenny, for eleven and a half years.

"We have to keep an eye on the dogs to make sure they don't run off into the bushes," said Jenny.

Not sure if the baiting was deliberately targeted at dogs, Jenny said wildlife in the area, such as possums, had also been found dead.

"We love this place, and the dogs love it. They have a wonderful time here.

"Cooper knows the other dogs, and they play well together."

The area has been mown by the Bass Shire Open Space team to keep the grass short and provide a clear line of sight for people walking their dogs in the park.

Community Safety Officers have also been walking the area to reassure dog owners.

No additional baits have been located, but Bass Coast Shire Council arranged for temporary cautionary signage to be installed during the school holidays.

Council encourages anyone who may have any information on the poison bait incident to report it directly to Council and/or Victoria Police so the matter can be properly investigated.

**Signs have been erected by Bass Coast Shire at Blue Gum Reserve in Cowes warning dog owners to take extreme care when walking their dogs.** B16_2925

Thanking Bass Coast Shire for their work in the area, Cheryl Owens asked dog owners to remain extra vigilant when walking their dogs and to keep a lookout for baits.

Signs of poisoning can include lethargy, swollen tummy, white gums, pale to white sdera (white part of the eye), black stools, bleeding from the gums, coughing with or without blood, difficulty breathing but eating and drinking as normal for a number of days.

If poisoning is suspected, seek veterinary advice immediately.


# Public Notice

## Consultation for Review of the Bass Gas Offshore Operations EP

beach

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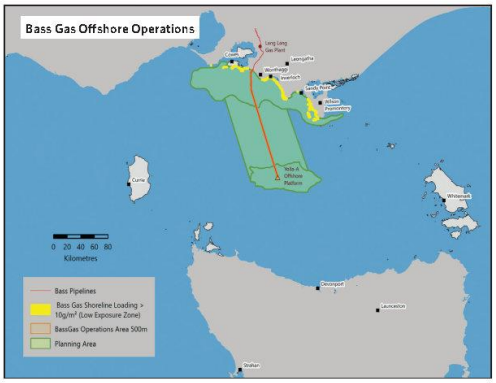


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GD25-0116

## 3.3 Phillip Island and San Remo Advertiser (23 July 2025)



# How to reduce your power bill

ENERGY

Concerned about the cost of your electricity bill?

Ever wondered how it is calculated or how it can be reduced?

Then Totally Renewable Phillip Island's (TRPI) monthly community meeting may be able to help.

The free meeting will be held on July 26, 10am-2pm, at the Cowes RSL Anzac Room.

According to TRPI's Garry Busowsky, many households are unaware of their electricity tariff and the meeting, titled "Cost of living: find the best electricity plan for Phillip Island", will simplify the process.

"Our goal is to explain the design of electricity plans and key information about how to decide which plan is best for you," Garry said.

TRPI will present two local case studies comparing people's existing electricity plans.

Please register your attendance at: *events.humanitix.com/find-the-best-electricity-plan-for-phillip-island*

TRPI is a community "non-profit, non-commercial, non-political," group promoting the transition to renewable energy, part of the roll-out of nine community batteries installed across Phillip Island.

Last month's meeting discussed how homes could become energy independent and save money, with local solar providers Sunscape Solar answering householder questions.

*totallyrenewablephillipisland.weebly.com/*

# Price tag for new Vietnam vets' museum skyrockets

COMMUNITY

The proposed new National Vietnam Veterans Museum (NVVM) has had a cost blowout, with the project now forecast to cost $80 million.

In 2020 the new build was set to cost $37 million, which was later rounded up to $50 million, but NVVM board member Phil Dressing said following a revised quantity surveyor's report at the end of last year, the new price tag was much higher.

"The longer you leave it the more expensive it gets, on the back of inflation, Covid, supply chain issues, and wages," Phil said.

"There's not only a financial impetus to get it underway, but also an emotional impetus, with Vietnam veterans ageing and passing away.

"There has been a degree of frustration with the process."

Last year the Victorian Planning Minister approved the new NVVM.

The new museum was initially approved by Bass Coast Shire councillors in 2022, but after two objectors fought it at VCAT, the permit was refused in 2023.

The ministerially-approved permit resurrected the museum at 24 Churchill Road, which is similar to the original permit and incorporated a number of tweaks that take on VCAT's concerns.

Phil said in the past month council planners had officially endorsed building plans, which means they could now progress to stage one.

He said the NVVM board had also recently put out to tender construction for the road from the Cape Woolamai roundabout, after Department of Planning and Transport approval, which is the first step in development.

Once a contractor is employed, construction of the roughly 50 metre road should start later in the year, funded from the remaining $1.5 million Federal grant funding.

Phil said while last year they hired a professional funding organisation, DGB Global, to help boost the coffers, so far their funding position had not changed, with $16 million in State And Federal Government grants already promised to the project.

*In 2020 the new National Vietnam Veterans Museum at 24 Churchill Road was set to cost $37 million. A revised quote now puts it at $80 million.*

Late last year NVVM board representatives visited Canberra to present a revised business case to Minister for Veterans' Affairs Matt Keogh, requesting $40 million in government funding.

"Our request was for $25 million in year one and $15 million in year two, which would enable us to embark on stage one," Phil said.

"The response we received was positive. But we are not oblivious to the political environment."

## USA

Phil said in August two board members - the museum founder John Methven and Vietnam Veterans Association of Australia (Victoria) president Bob Elworthy - will visit the USA to seek funds.

"They will attend the Vietnam Veterans of America annual convention in New Orleans, August 5 to 9, to network in the veteran movement and focus on high net worth individuals with links to the Vietnam conflict.

"Given Trump's executive order to reduce funding to their equivalent of the veterans affairs department, it's unlikely their government will give us any funding."

Phil acknowledged there was frustration at the slow pace of progress but they were "still highly optimistic".

"Things are moving forward but not as fast as we'd like.

"The contingencies going through the roof has not lessened our resolve. If anything it has increased.

"At this stage we are positive we will get funding from government, the USA and philanthropic individuals in Australia."

As previously reported, it is expected to take up to three years' for the completion of stage one construction.

Once the new building is open, the current site will transition into offices, a conservation centre and storage for the Churchill Road collection.


# Public Notice

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beach

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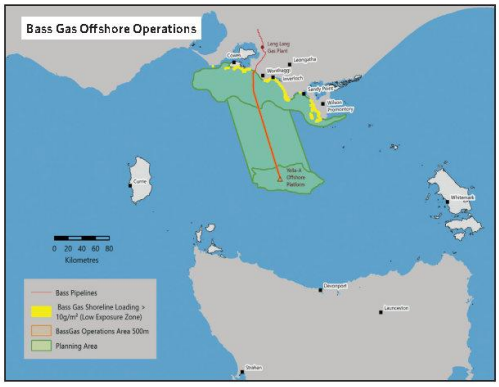


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JRS525484

## 3.4 National Indigenous Times (29 July 2025)

# Public Notice

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beach

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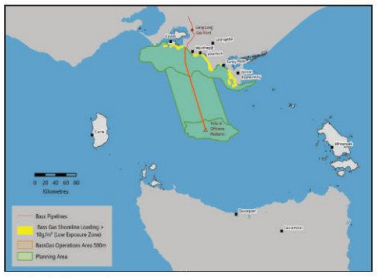

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G025-0116

## 3.5 Koori Mail (30 July 2025)

news

# Striving for cultural access

By COLE BAXTER

RESPECT in culture and our elders underpins Nyoongar Woman Rickeeta Walley's ongoing work within community, which is reinforcing safe spaces for our next generations. Rickeeta comes from a strong Nyoongar family of actors, advocates and community people whose legacies extend beyond Nyoongar Country across the many nations on this continent. It's these footprints that've been laid before her that inform many of her ways of practice.

"I realised in my late teens that not every Nyoongar child had the upbringing that I had," said.

"That being; a language speaker in our household (my Dad), access to our cultural knowledge, consistent time on Country and practising our traditional dance and songs.

"Being told I was "lucky to grow up with my culture" really ignited my passion to share and to teach it. I hope that the next generations will not view cultural access as a privileged upbringing and instead I hope it'll be the norm."

Rickeeta is often juggling many plates such as working through her family business Aboriginal Productions, being an Aboriginal Liaison Officer with Kings Park Botanic Garden and as a lecturer for the University of W.A. It's this strong foundation that has allowed Rickeeta to kick goals beyond the regular day to day scope of work, including establishing a cultural dance program in two of W.A.'s women's prisons.

With 70% of female Aboriginal prisoners being stuck in the recidivism cycle, Rickeeta has ambitions of extending her prison dance workshops into the outside, so women upon release will be able to engage with their families: allowing culture to fortify in safe spaces and adequately address behaviours that can lead to backsliding.

"Dance is a beautiful way to practise our culture, it's fun and active; but also involves learning language through song and cultural understanding behind the stories of each dance."

Much of Rickeeta's strength is seen in the form of when education and the arts meet to engage young folks, entire Nyoongar families and tie cultural practices that have thrived on this land since the dreaming into the present.

"My first priority is cultural continuation and providing a safe space for our next generation to learn their culture."

Images of Rickeeta. *Pictures by Cole Baxter.*

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beach

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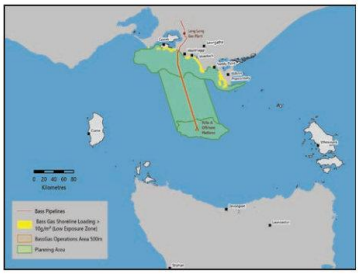

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GD25-0116

## 3.6 Phillip Island and San Remo Advertiser (27 August 2025)



# Switched on! Neighbourhood batteries officially launch

ENERGY

Minister for Energy and Resources Lily D'Ambrosio visited Cowes on Friday to officially launch six of the seven neighbourhood batteries erected across the island.

The official event was at Shearwater Reserve, in Seagrass Avenue in Cowes, with the other batteries located at Kembla Road, Goodwood Drive, Katherine Circuit in Cowes, Hallway Drive in Wimbledon Heights and the council depot in Settlement Road.

The final battery, at Bernineit, is expected to be switched on in December this year, or early in 2026.

The Minister said the batteries would provide a combined 900kw/1845kWh of energy storage capacity.

The first six batteries are designed to soak up excess solar energy during the day, and feed it back into the grid at peak times. They will not be able to power the grid in the event of a power failure.

Minister D'Ambrosio said she was delighted to launch the project, which is a partnership between the government, Mondo Energy, Bass Coast Shire Council and Totally Renewable Phillip Island (TRPI).

"These batteries will soak up cheap renewable energy during the day when it is plentiful, and discharge it into the grid when it is needed most," the Minister said.

"These together will help to lower energy bills and allow more rooftops solar to be fed into the grid, and make electricity more resilient to extreme weather events.

Minister Lily D'Ambrosio cuts the ribbon to launch the new neighbourhood batteries, with Jordan Crugnale MP, Simon Helps (TRPI) and Jon D'Sylva (AusNet) looking on.

Current TRPI Chair Simon Helps (right) with former chairs Moragh Mackay and Mary Whelan at the launch of the new neighbourhood batteries, part of TRPI's goal to make the island "100 per cent renewable".

"The project will also contribute seven per cent of the income each year, to a community fund for 15 years.

"There will be a process established for the community to come forward with ideas of the types of projects that could be supported through this fund, which is very exciting," the Minister said.

Jon D'Sylva, AusNet's Chief Development Officer, described the project as a "lighthouse for the rest of the state" that hopefully could be replicated in other areas as communities transition to net zero.

"It's a fantastic initiative to be part of. It supports our priorities and the community's priorities in reducing emissions and providing energy resilience."

He thanked the local groups involved, including TRPI and Bass Coast Shire Council, with its Climate Action Plan and carbon neutral targets.

"Extreme weather events are already impacting our coastal towns. The need for climate resilience is real and it's immediate," Mr De Silva said, noting that in the past five year's the electricity network had faced challenges from huge bushfires, storms and other issues.

"These investments at a local level are fundamental to our ongoing energy resilience."

### TRPI

Simon Helps, the current Chair of TRPI said the group was really motivated to move "Phillip Island to be 100 per cent renewable" and praised the working relationships that delivered the batteries.

He described the island as "an interesting community" for the project.

"There's a lot of houses on the island with nobody in them, because they are holiday homes, or temporary accommodation.

"For every occupied family home on the island, there is a home with a solar system on the roof," he said.

"Now not every home that's occupied has a solar system, but in essence, there a more than one to one ratio.

"The challenge is, a lot of those homes aren't occupied that have solar on the roof, so there's nobody utilising that energy.

"These community batteries are located in areas where there's a lot of surplus renewables, to soak that up and push it back into the network."

Local Member Jordan Crugnale said the batteries would deliver long-lasting benefits for the community, praising the partnerships that helped deliver the project.

But she said, "the catalyst has come from the community itself and the journey to make Phillip Island totally renewable".

The final battery at Bernineit in Cowes has one notable difference to the other neighbourhood batteries launched last week.

Unlike the other six batteries, it will be "behind the meter", which means it will be able to generate power when the grid is down, providing an emergency centre for charging devices during power outages.

The neighbourhood batteries are a joint project of Mondo Energy, Bass Coast Shire Council and TRPI, with support from the Phillip Island Business Network, the Energy Innovation Cooperative, the Gippsland Climate Change Network, Phillip Island Nature Parks and Westernport Water.


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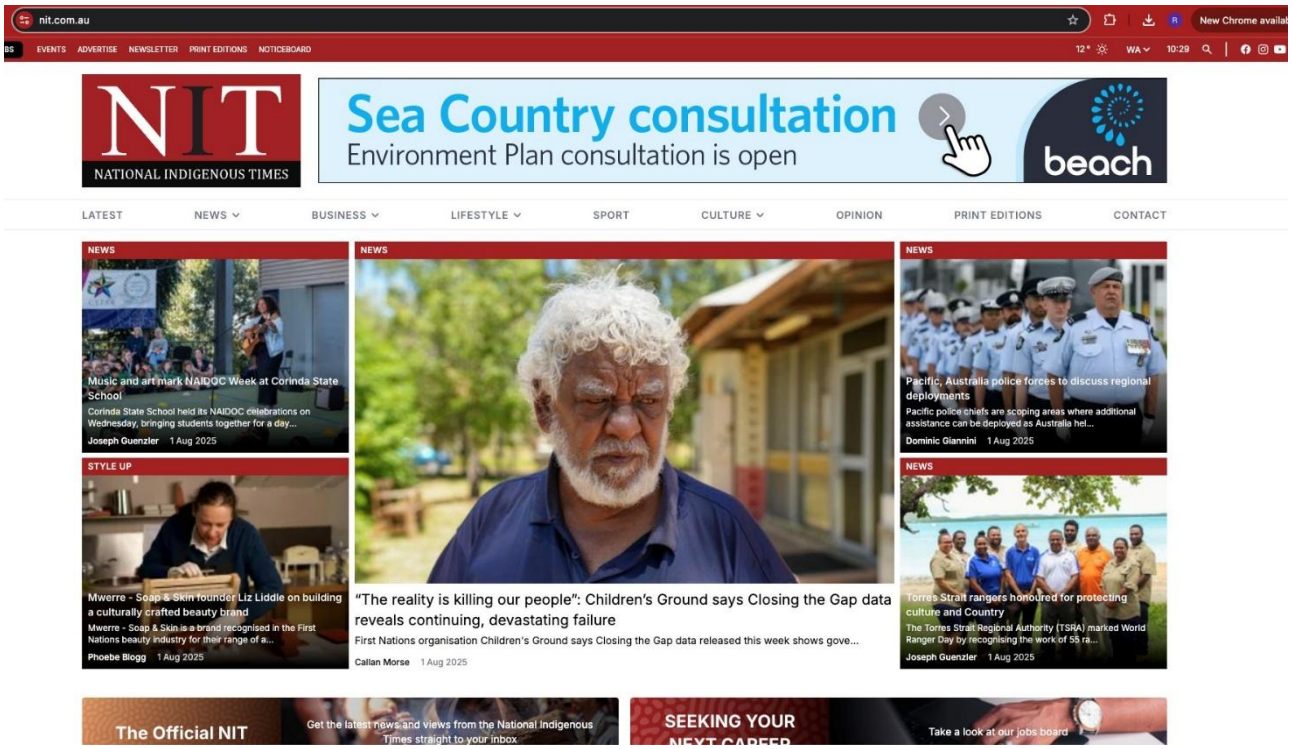
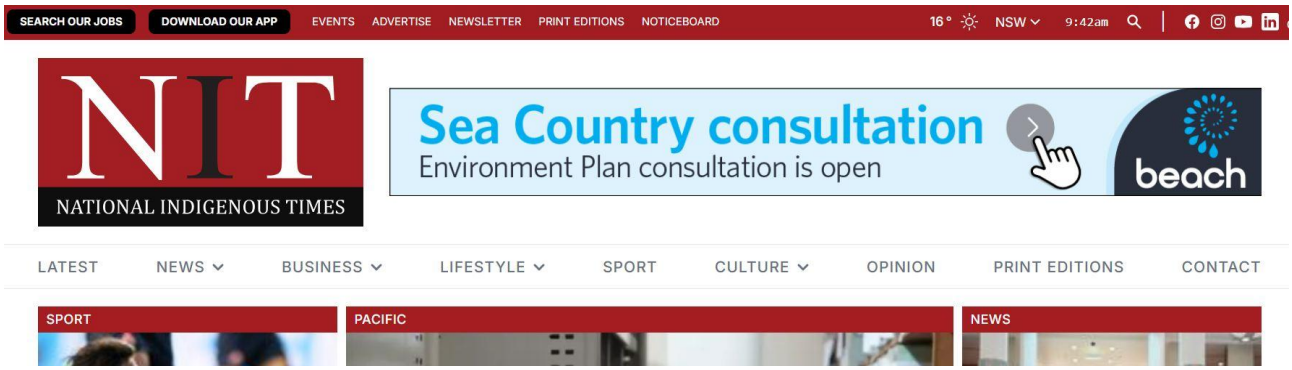
| Consultation dates and information | |
|---|---|
| **Online consultation hub** | **engage.beachenergy.com.au**<br>Engage Beach, includes information in different formats including maps; diagrams; questions and answers; and detailed information sheets. |
| **Online information sessions (webinars)**<br>Please email community@beachenergy.com.au to register your interest in attending a webinar. | Tuesday 9 September \| 2.15pm to 3pm \| AEST \| Open Session<br>Tuesday 9 September \| 7pm to 7.45pm \| AEST \| Dedicated First Nations Session<br>Wednesday 10 September \| 2.15pm to 3pm \| AEST \| Dedicated First Nations Session<br>Wednesday 10 September \| 7pm to 7.45pm \| AEST \| Open Session |

GD25-0116

## 4. Online advertising inviting consultation

### 4.1 National Indigenous Times website (live from 28 July to 10 August and 13 to 28 September 2025)



### 4.2 National Indigenous Times e-newsletter (live from 28 July to 10 August and 13 to 28 September 2025)

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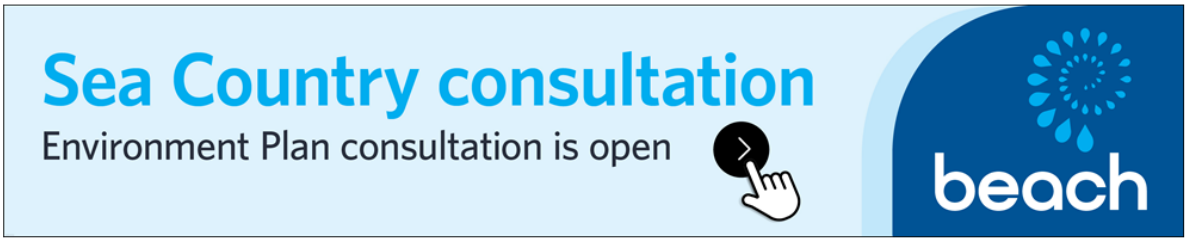
to drop him to reserve grade as he struggled for form midway through this season.

**→ Read more.**

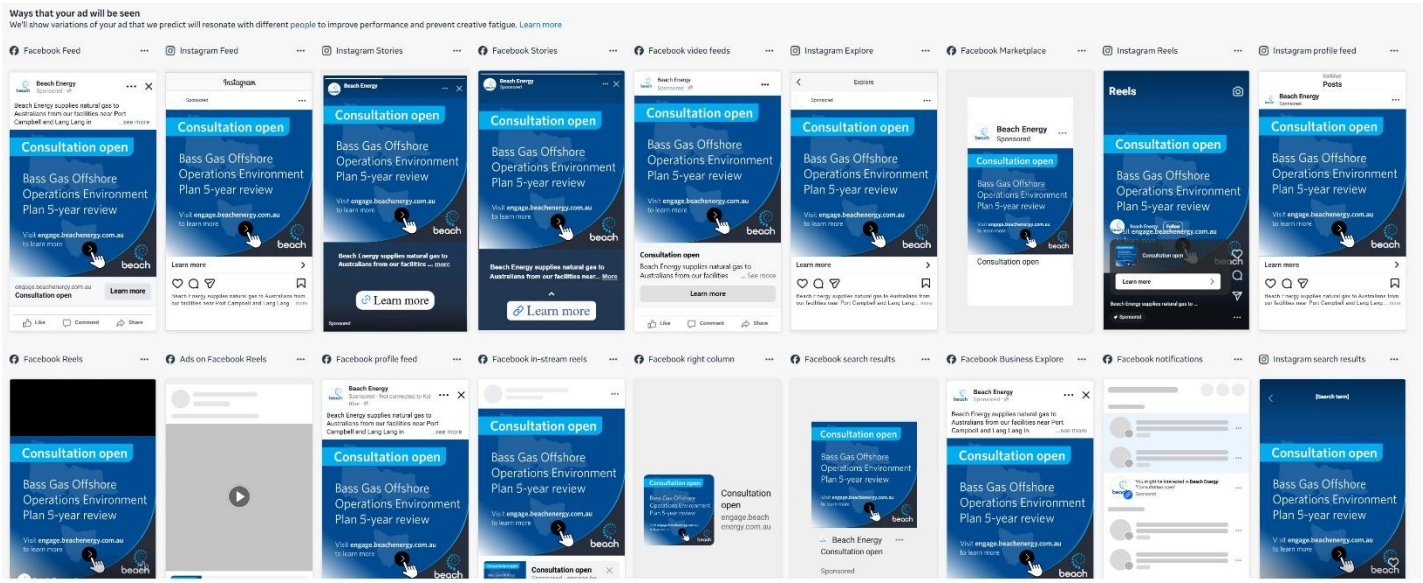
McRae opted against recalling the star small forward, according to reports on Thursday.

**→ Read more.**

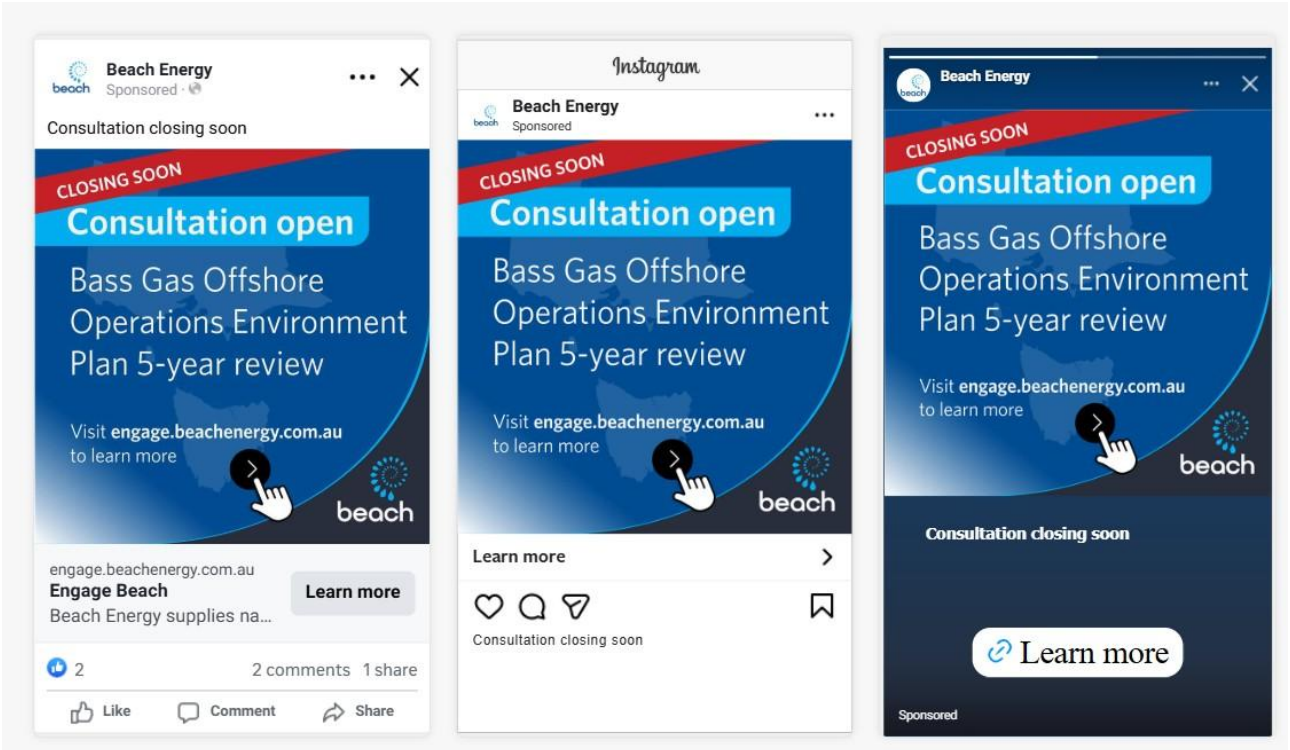


## 4.3 Koori Mail website (live from 28 July to 10 August and 13 to 28 September 2025)

## 4.4 Facebook, Instagram, Meta (live from 28 July to 10 August and 1 to 14 September 2025)




## 4.5 Facebook, Instagram, Meta (live from 29 September to 3 October 2025)



## 4.6 South Gippsland Sentinel-Times website (live from 25 August to 7 September 2025)

## 4.7 NewsCorp websites (live from 25 August to 7 September 2025)

## 5. Community information session material (poster boards)

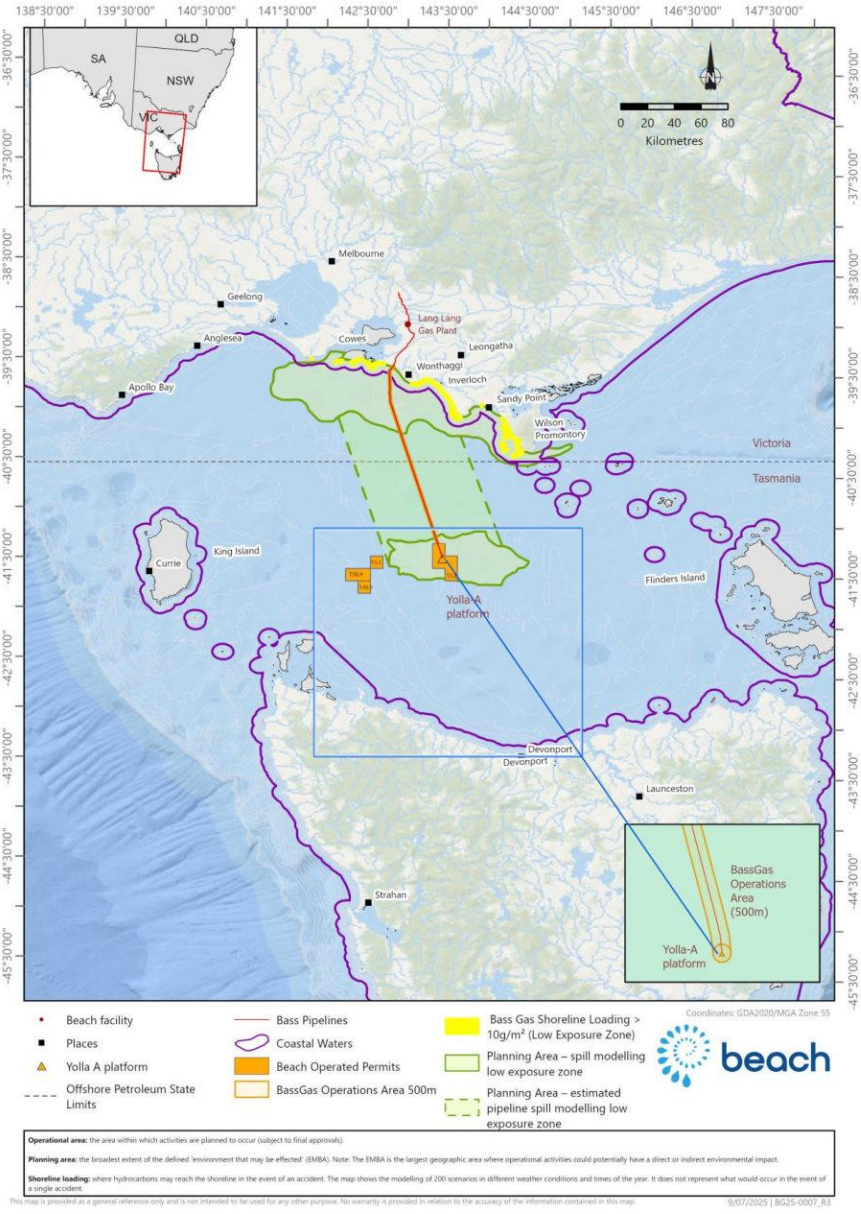
### Poster 1

# Bass Gas Offshore Operations

Environment Plan 5-year review

beach

Operational Area and Planning (Environment that May Be Affected) Area map



## Poster 2 (Yolla-A Platform)

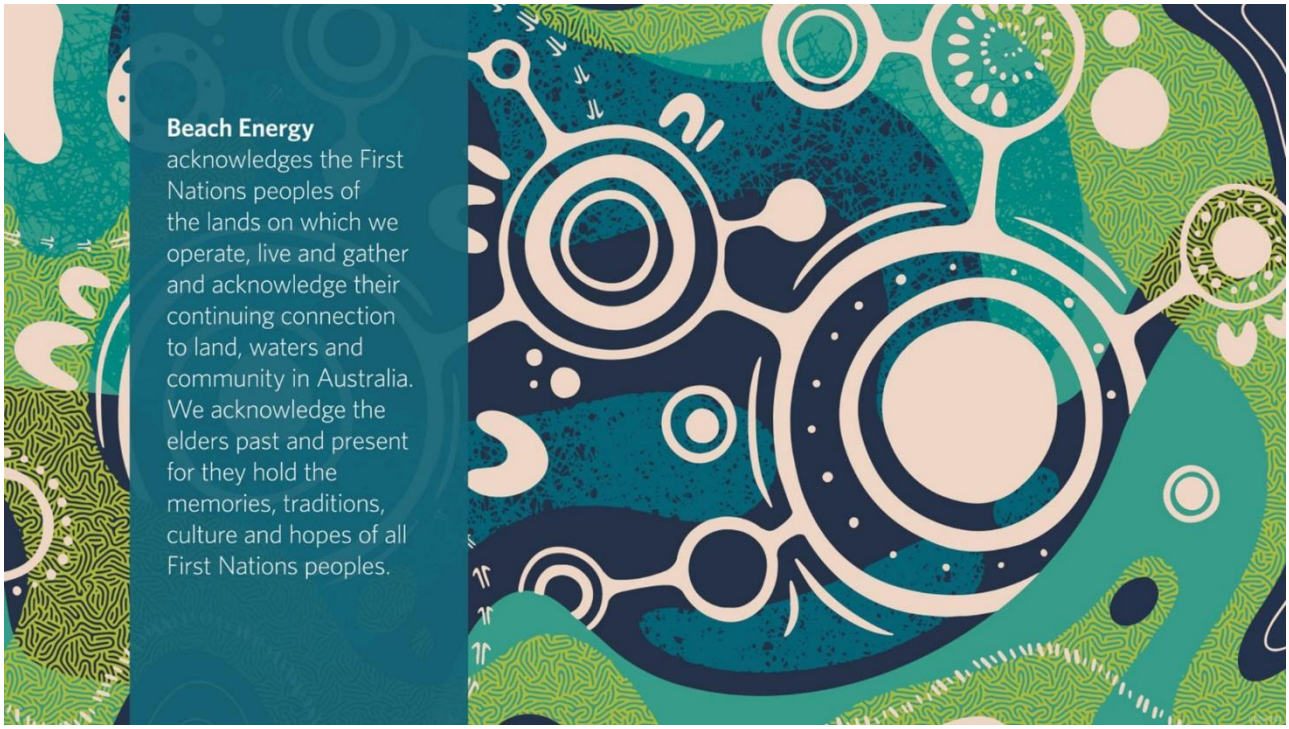
## Poster 3 (Yolla-A Platform)

# 6. Webinar presentations

## 6.1 Open community information webinar (held Tuesday 9 and Wednesday 10 September 2025)

**Slide 1**

**Slide 2**



**Slide 3**

## BassGas Offshore Operations Environment Plan 5-year review

Open Session Agenda

| | | | |
|---|---|---|---|
| Welcome<br>• Consultation requirements | **Sharon Donovan**<br>Senior Community Relations Manager | | 5mins |
| • BassGas Offshore Operational activities | **Paul Payne**<br>BassGas Production Manager | Presentation | 10min |
| • Activity and Planning area<br>• Emergency planning responses | **Catriona King**<br>Lead Environmental Adviser | Presentation | 10min |
| Speak with the Beach team | **Paul Payne**<br>**Catriona King**<br>**Ronie Magcamit**<br>Senior Environmental Adviser (Vic)<br>**Candice Nayda**<br>First Nations Engagement Manager | Q&A | 20min |
| Close | **Sharon Donovan** | | |

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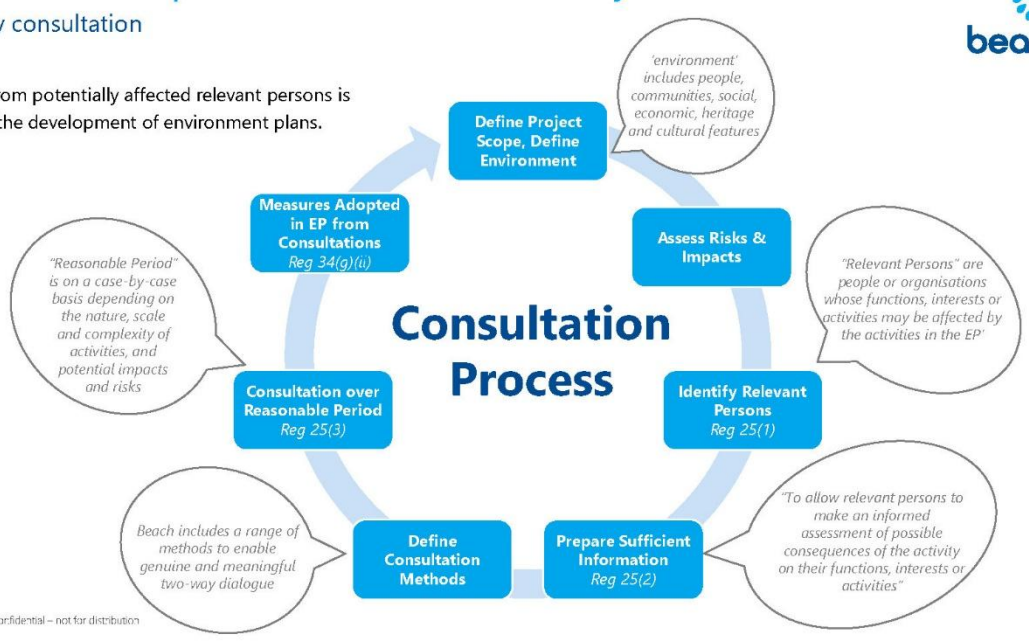
**Slide 4**

## BassGas Offshore Operations Environment Plan 5-year review

Regulatory consultation

Ensure input from potentially affected relevant persons is considered in the development of environment plans.

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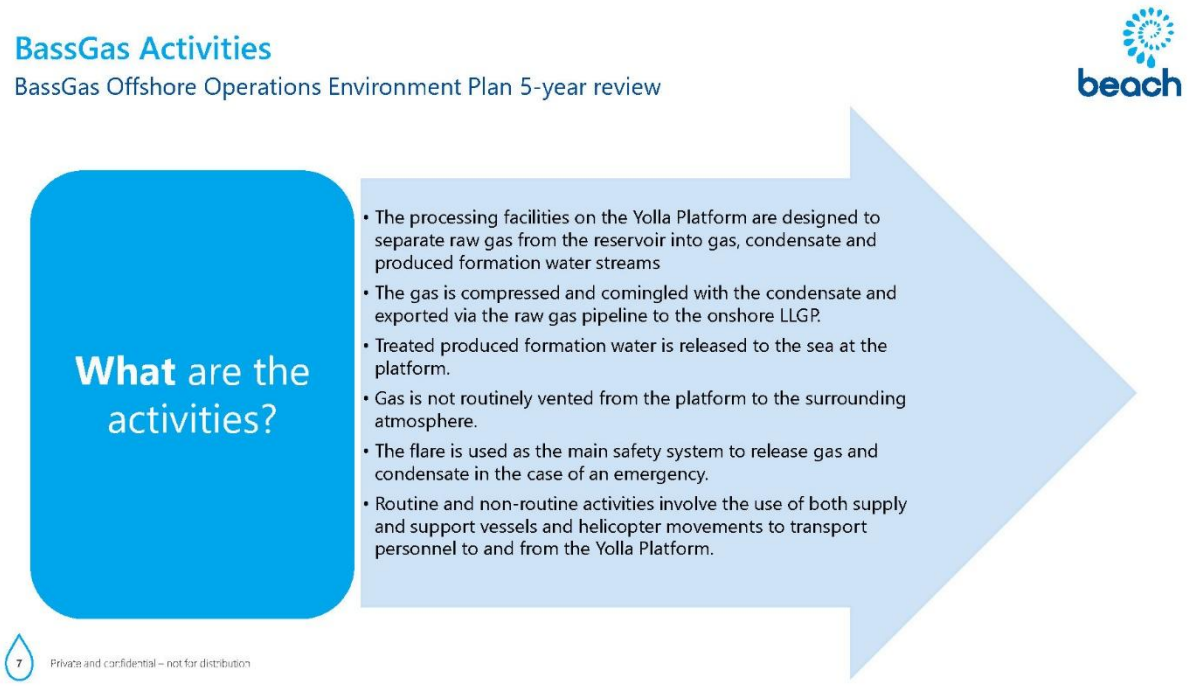
**Slide 5**

**Slide 6**

**Slide 7**

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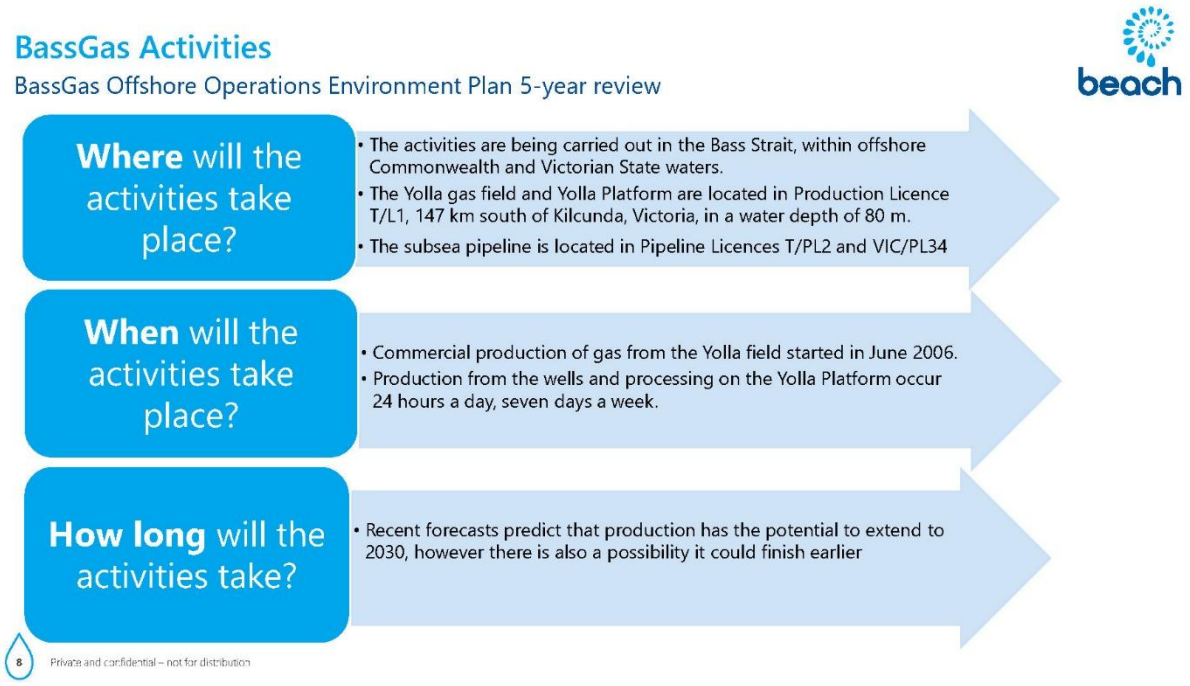


**Slide 9**

BASSGAS OFFSHORE OPERATIONS ENVIRONMENT PLAN 5-YR REVIEW

**Catriona King**
Lead Environmental Adviser

beach

**Slide 10**

## Activity - Location map

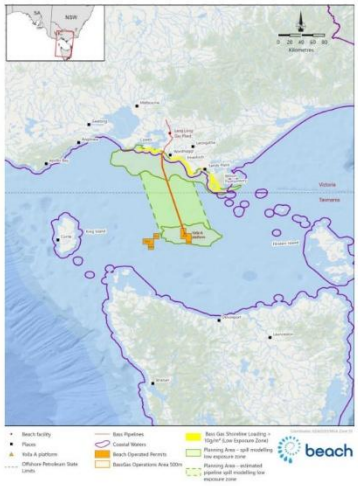
BassGas Offshore Operations Environment Plan 5-year review

beach

**Operational Area**
The area within which activities occur.

**Planning Area**
Defined by the 'environment that may be affected' (EMBA)

- Largest geographic area where operational activities could potentially have a direct or indirect environmental impact
- Conservative outer envelope of potential area that may be affected in the unlikely event of a hydrocarbon spill
- Based on stochastic spill modelling
  - 3 hypothetical release scenarios from well, pipeline and support vessel
  - modelling of 200 simulations in different weather conditions at different times of the year for each hypothetical spill scenario
  - thresholds as per National Offshore Petroleum Safety Authority (NOPSEMA) guidance
  - does not represent what would occur in the event of a single accident




**Shoreline Accumulation**

Indicates where hydrocarbons may reach the shoreline in the event of a hydrocarbon spill event.

10 Private and confidential – not for distribution

**Slide 11**

## Emergency planning and environment

BassGas Offshore Operations Environment Plan 5-year review

Beach must have an accepted Oil Pollution Emergency Plan prior to the activity taking place

- Describes arrangements for spill response and ensure effective use of resources
  - Skilled teams in Beach's Melbourne and Adelaide offices
  - Supported by international experts based in Geelong (Australian Maritime Oil Spill Centre (AMOSC)
  - Access to aerial and marine support with ground crews being available to mobilise in a short period of time
  - Tactical response plans for specific areas pre-designed to ensure fast and site specific response
- Describes interactions with Commonwealth and state agencies to support timely implementation of strategies based on credible risks
- Practical exercises are undertaken on a regular basis

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**Slide 12**

## Speak to the Beach team

BassGas Offshore Operations Environment Plan 5-year review

**Paul Payne**
BassGas Production Manager

**Catriona King**
Lead Environmental Adviser

**Ronie Magcamit**
Senior Environmental Adviser (Vic)

**Candice Nayda**
First Nations Engagement Manager

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**Slide 13**

## Community information session – Webinar close

Offshore Gas Victoria Project

Feedback received through consultation will be used to inform Environment Plans for the industry regulator, NOPSEMA.

Consultation and feedback with anyone whose functions, interests or activities may be affected by the project activities is an important part of developing these Environment Plans.

Beach will consider all feedback, including any concerns or objections and will explore measures to reduce any impacts and risks.

**ENGAGE WITH US**

Community Relations Team (Offshore)
Contact: Sharon Donovan, Senior Community Relations Manager
T: 1800 797 011
E: community@beachenergy.com.au
Engage with us: Home | Engage Beach

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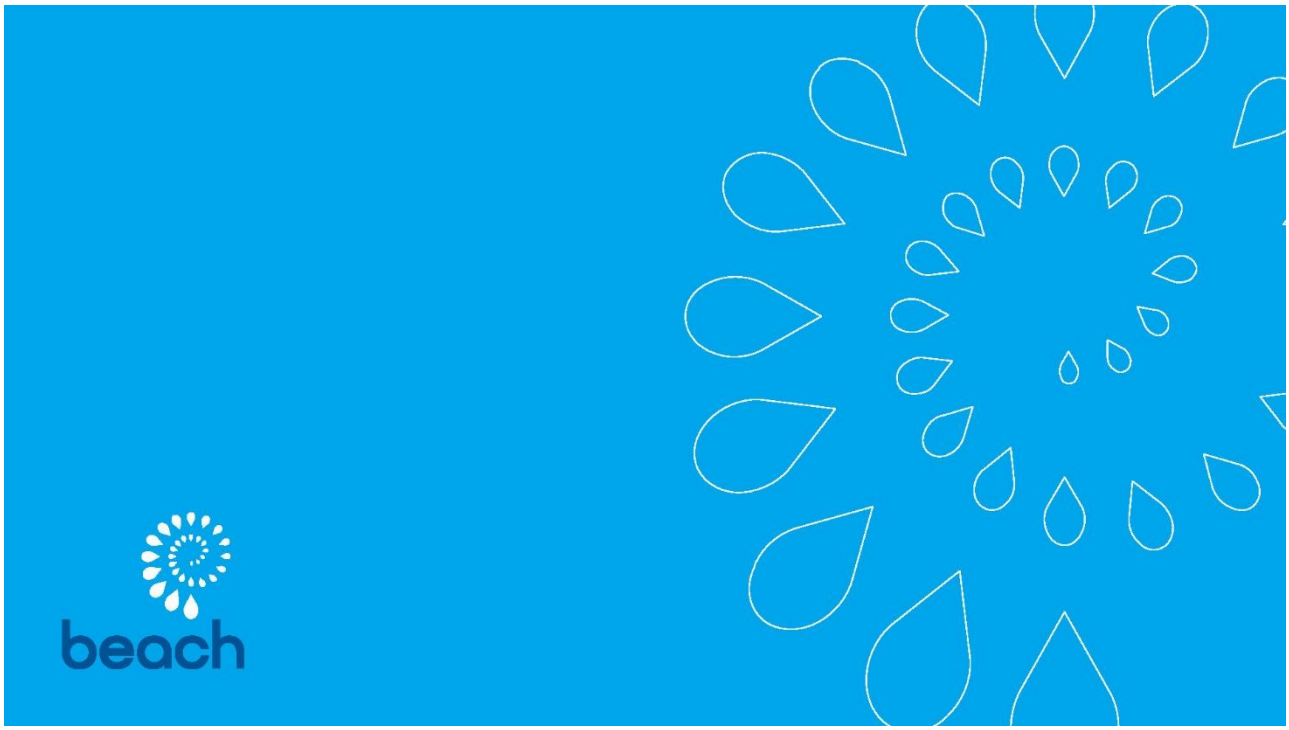
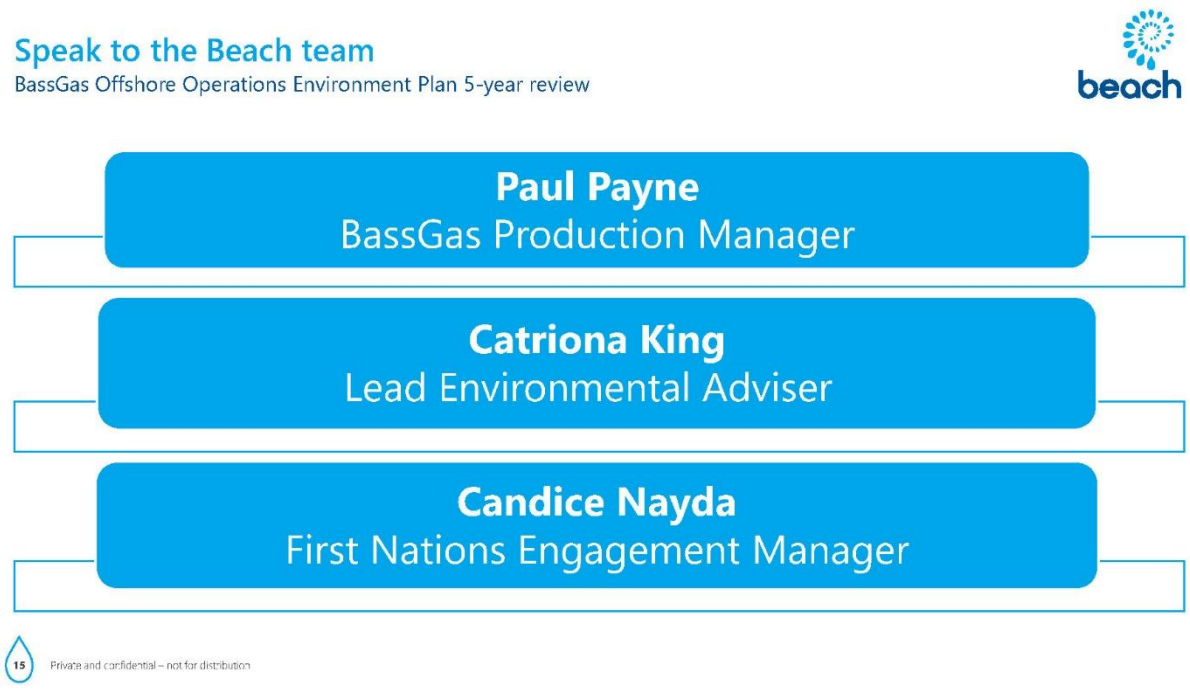
**Slide 14**



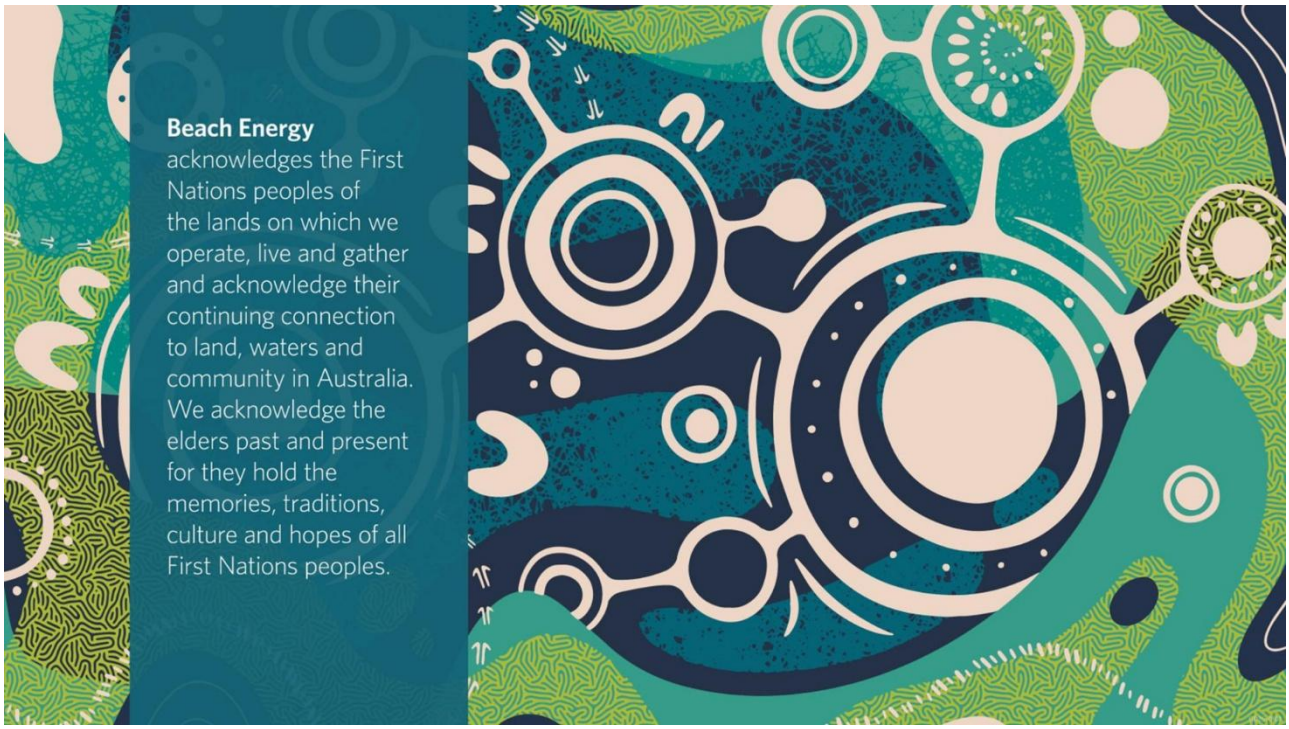
**Slide 15**




## 6.2 Dedicated First Nations community information webinar (offered Tuesday 9 and Wednesday 10 September 2025)

**Slide 1**

**Slide 2**




**Slide 3**

## BassGas Offshore Operations Environment Plan 5-year review

Open Session Agenda

beach

| | | | |
|---|---|---|---|
| Welcome<br>• Consultation requirements | **Candice Nayda**<br>First Nations Engagement Manager | | 5mins |
| • BassGas Offshore Operational activities | **Paul Payne**<br>BassGas Production Manager | Presentation | 10min |
| • Activity and Planning area<br>• Emergency planning responses | **Catriona King**<br>Lead Environmental Adviser | Presentation | 10min |
| Speak with the Beach team | **Paul Payne**<br>**Catriona King**<br>**Candice Nayda**<br>First Nations Engagement Manager | Q&A | 20min |
| Close | **Candice Nayda** | | |

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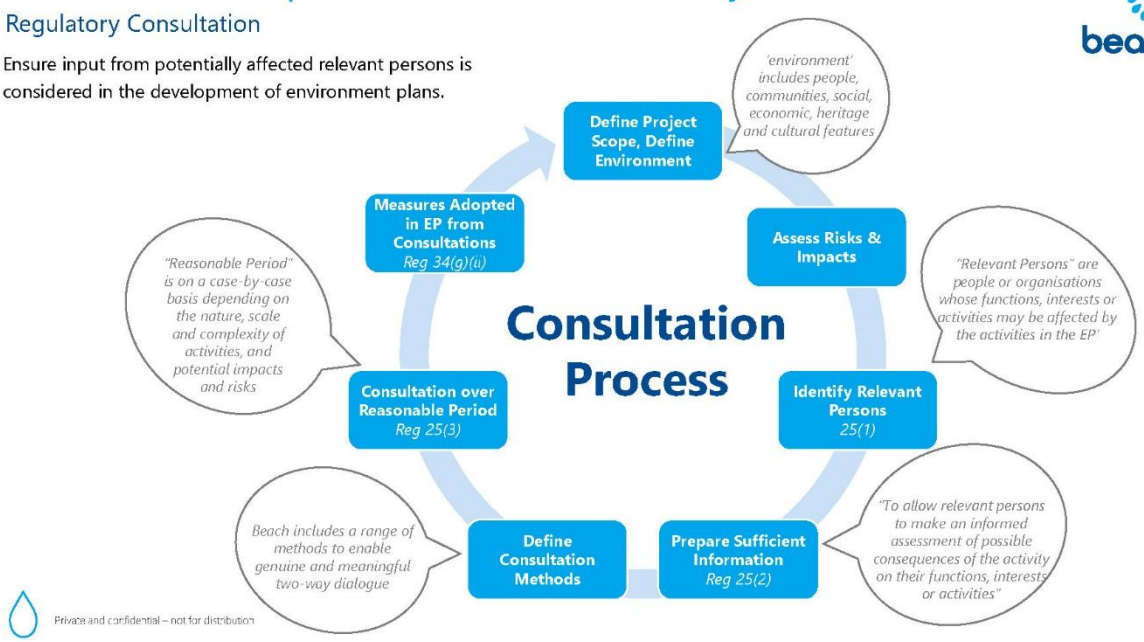
**Slide 4**

## BassGas Offshore Operations Environment Plan 5-year review

### Regulatory Consultation

Ensure input from potentially affected relevant persons is considered in the development of environment plans.

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**Slide 5**

## Consultation with First Nations Groups

For the development of the Bass Gas Offshore Operations EP 5-year review, Beach has undertaken consultation with First Nations groups within the Operational and adjacent to the Planning Areas, of the EP activities:

- Bunurong Land Council Aboriginal Corporation (BLCAC)
- Gunaikurnai Land and Waters Aboriginal Corporation (GLAWAC)
- Representative First Nations corporations in Tasmania including Circular Head Aboriginal Corporation

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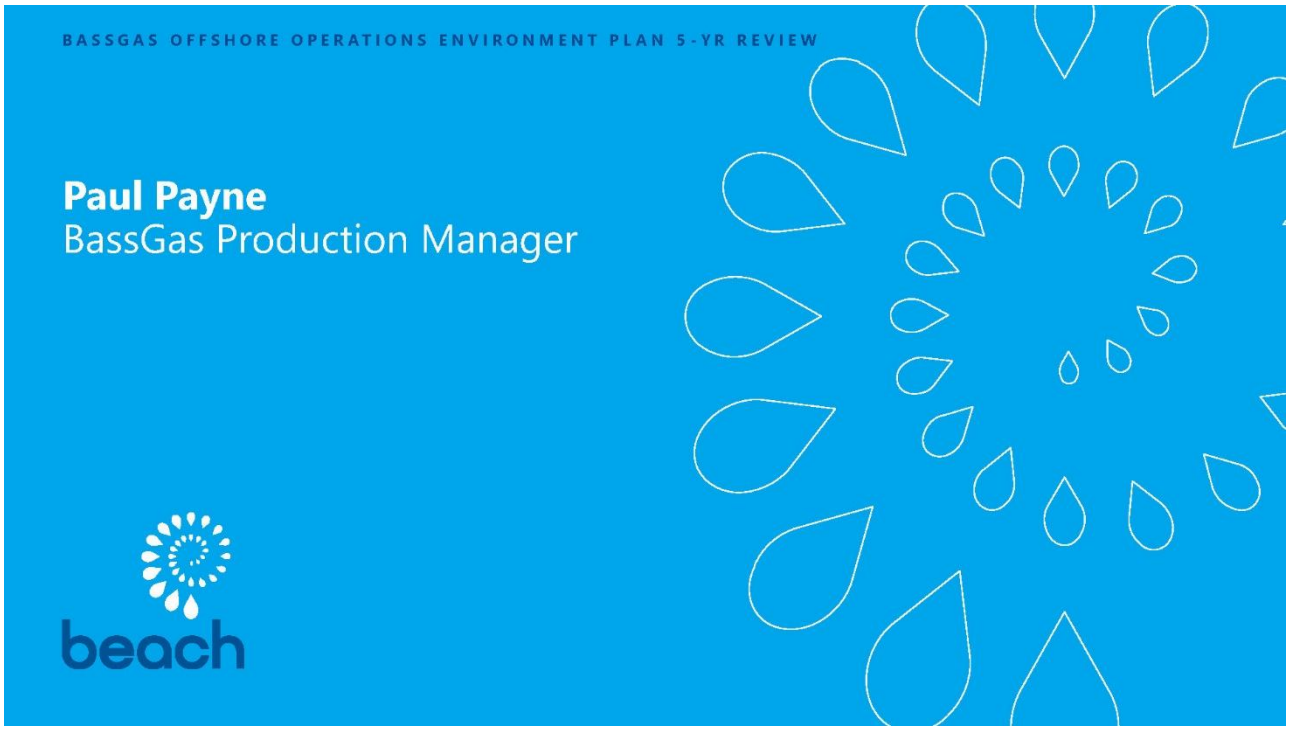
**Slide 6**

## Consultation with First Nations Groups

- Beach recognises that the definition of environment in the offshore regulations includes:
  - the heritage value of places; and
  - the social, economic, and cultural features of the broader environment.
- Beach understands that Country, including Sea Country, is the term used by First Nations groups to describe the lands, waterways, and seas to which they are connected.
- The EP includes a description of the environment which includes cultural features and values and this was developed through:
  - Consultation with First Nations groups with connection to Sea Country in the Operational and Planning Areas
  - Review of publically available literature, such as Sea Country plans



**Slide 7**



**Slide 8**

## BassGas Offshore Operations Environment Plan 5-year review

Overview

Bass Gas Operations produces natural gas and condensate from the Yolla gas field in the Bass Strait.

The gas field is serviced by the Yolla-A Offshore Platform (Yolla Platform), and an approximately 147 km subsea pipeline that transports the gas and liquids from the platform to the Victorian mainland via a coastline crossing near Kilcunda.

The associated 32 km onshore pipeline terminates at the Lang Lang Gas Plant where natural gas is processed before being distributed to the domestic east coast market, delivering energy to homes, businesses and industry.

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**Slide 9**

## BassGas Activities

BassGas Offshore Operations Environment Plan 5-year review

**What** are the activities?

- The processing facilities on the Yolla Platform are designed to separate raw gas from the reservoir into gas, condensate and produced formation water streams
- The gas is compressed and comingled with the condensate and exported via the raw gas pipeline to the onshore LLGP.
- Treated produced formation water is released to the sea at the platform.
- Gas is not routinely vented from the platform to the surrounding atmosphere.
- The flare is used as the main safety system to release gas and condensate in the case of an emergency.
- Routine and non-routine activities involve the use of both supply and support vessels and helicopter movements to transport personnel to and from the Yolla Platform.

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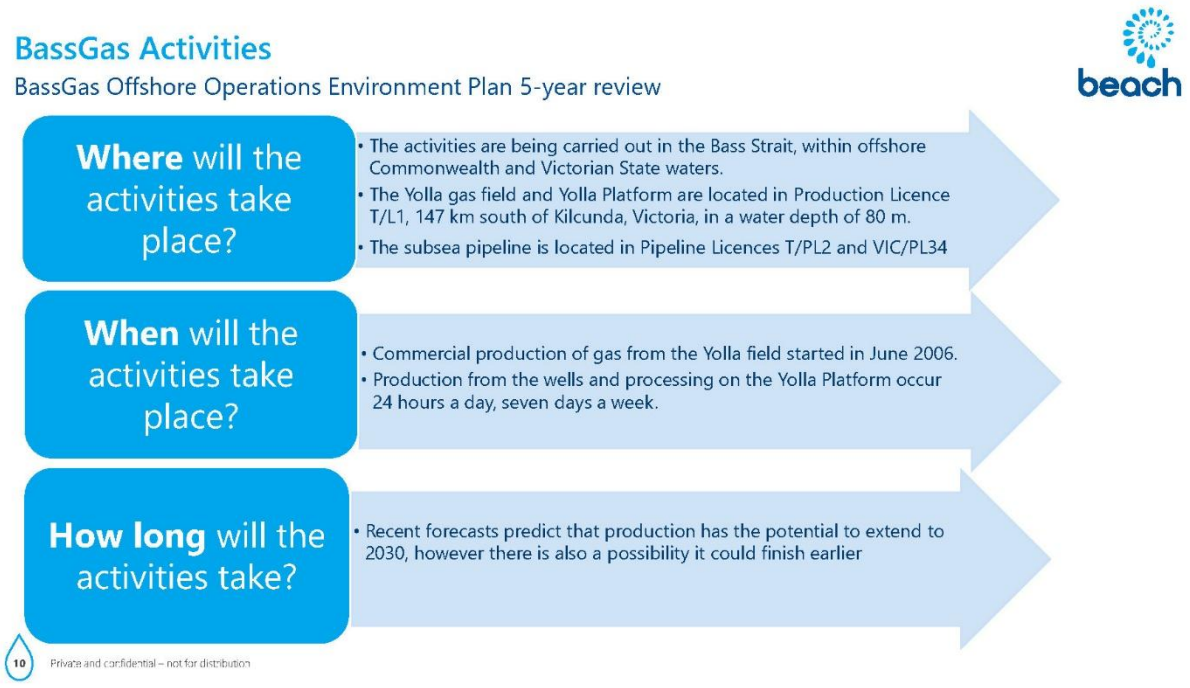
**Slide 10**

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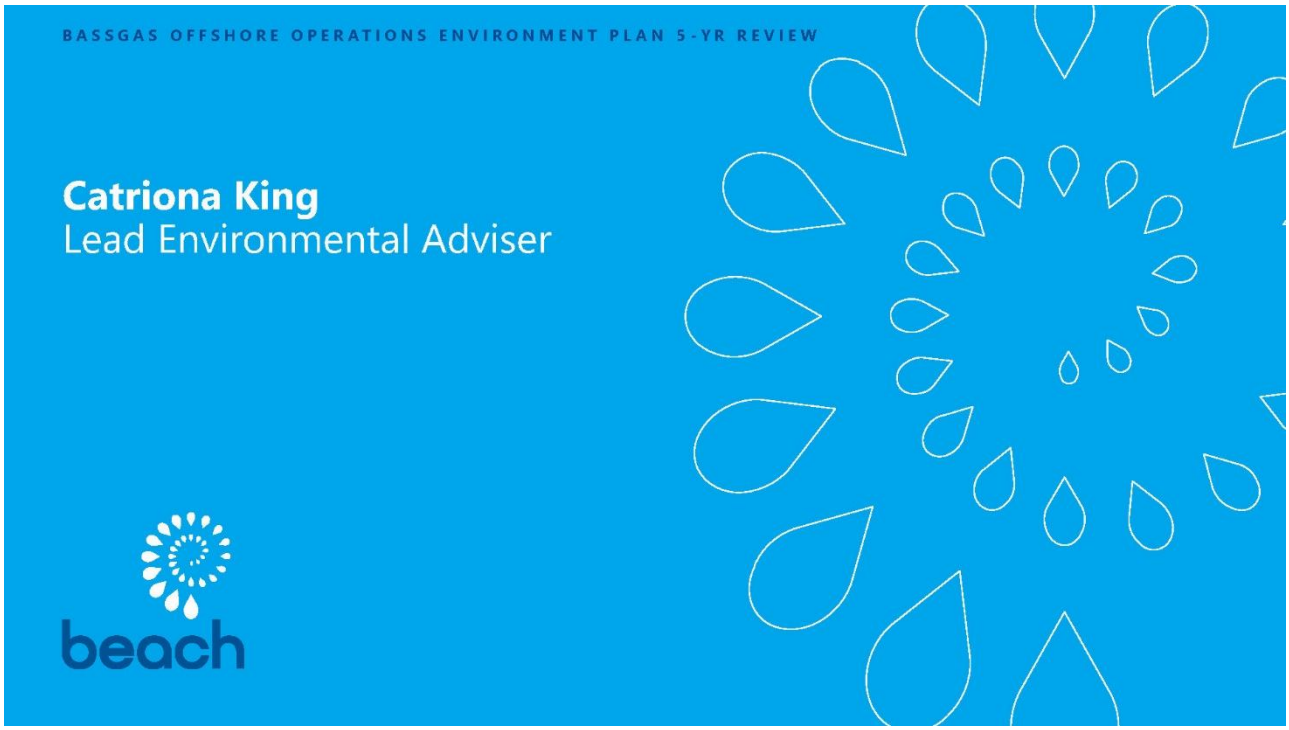

**Slide 12**

## Activity - Location Map

BassGas Offshore Operations Environment Plan 5-year review

**Operational Area**

The area within which the activities outlined in the EP will occur.

**Planning Area**

Defined by the 'environment that may be affected' (EMBA)

- Largest geographic area where operational activities could potentially have a direct or indirect environmental impact
- Conservative outer envelope of potential area that may be affected in the unlikely event of a hydrocarbon spill
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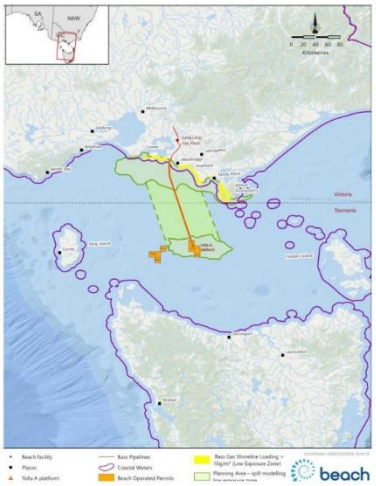

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**Slide 13**

## Emergency planning and environment

BassGas Offshore Operations Environment Plan 5-year review

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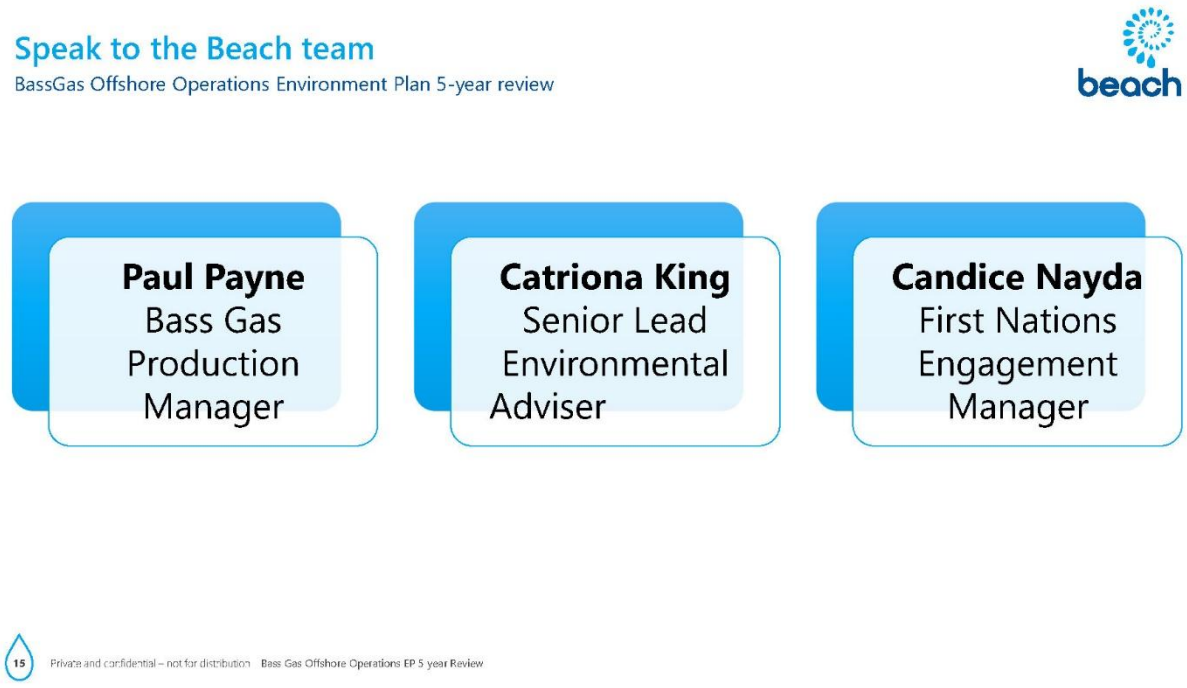
**Slide 14**

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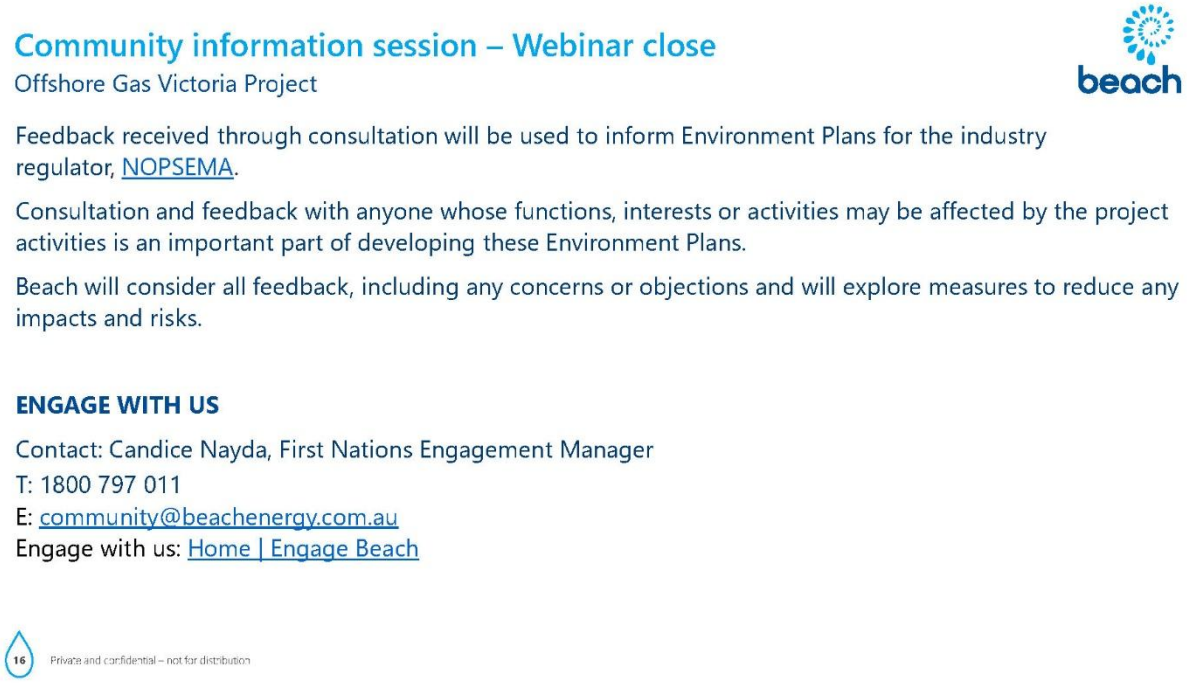

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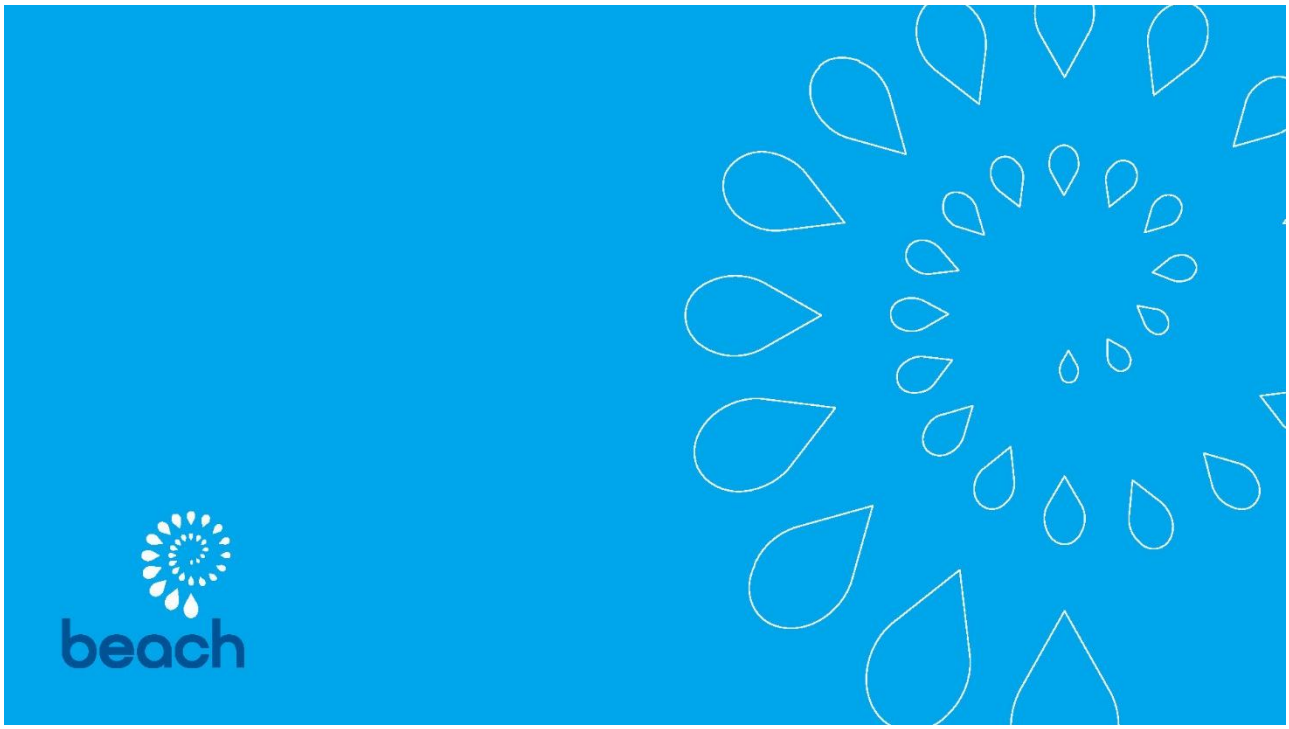


## 7. Community Reference Group meeting (held 18 August 2025)

**Slide 1**

**Slide 2**

## Agenda

| Time | Item | Presenter |
|---|---|---|
| 2:00-2:10PM | Welcome<br>Previous actions | Sharon Donovan |
| 2:10-2:30PM | General Plant updates<br>Equinox Plug and Abandonment<br>BassGas 5-year Environment Plan Review | Paul Payne<br>Sharon Donovan<br>Ivonne Milano |
| 2:30-2:35PM | Enivronmental updates | Ronie Magcamit |
| 2:35-2:40PM | General Health and Safety update | Chris O'Shea |
| 2:40-2:45PM | Community investment program | Kieran Keane |
| 2:45-3:00PM | Participant updates | All |
| 3:00PM | Meeting Close | |


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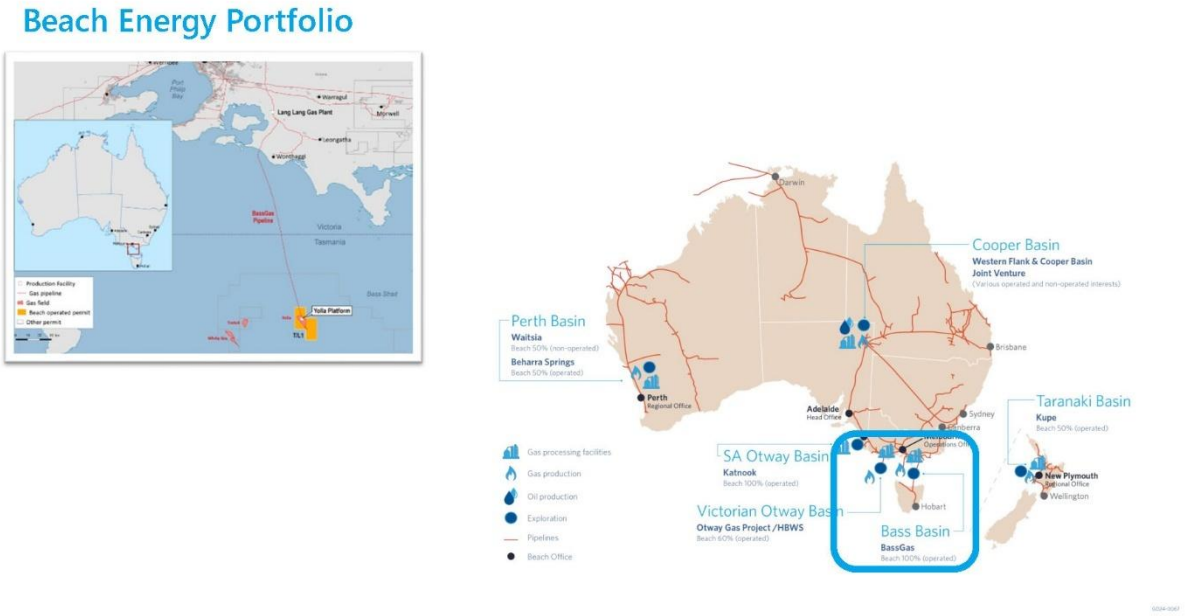
**Slide 3**

## Previous minutes

| Action | Responsible | Status |
|---|---|---|
| Beach Energy to follow up with Stewart to utilise Cardinia Shire newsletter for any applicable upcoming consultation periods. | Kieran K | Noted |
| Add item for next CRG to include consultation opportunities for CRG stakeholders | Kieran K | Complete |
| Chris O'Shea to contact Priscilla and arrange tours for SES. This will be to improve training. Requested out of hours session due to the volunteer nature of SES staff. | Chris O | Complete |
| Kieran to send summary of Community Investments as part of slide pack to CRG members | Kieran K | Complete |
| Kieran to send community investment application form to participants to share with their organisation and applicable groups. | Kieran K | Complete |
| Kieran to send PowerPoint to participants. Noting this can be shared within member organisations for relevance. | Kieran K | Complete |
| Priscilla to introduce Pakenham and San Remo Unit leaders to Ben Morgan/Paul Payne/ Chris O'Shea to facilitate tours. | Priscilla G | Complete |
| Beach to follow up with Justin on a presentation to Bass Coast Shire to provide an update at their quarterly meeting. | Kieran K | On hold |
| Kieran to follow up with MERC to participate in next BassGas CRG. | Kieran K | Complete |
| Pricilla to introduce Dean (SES) to Beach (Kieran, Paul/Ben, Chris) | Priscilla G | Complete |
| Kieran to follow up with participants to gain feedback on CRG and gather any recommendations for the next CRG. | Kieran K | Complete |

**Slide 4**




**Slide 5**

**Slide 6**

# BassGas Updates

Paul Payne
BassGas Production Manager
Sharon Donovan
Senior Manager Community Relations
Ivonne Milano
Regulatory Affairs Manager

beach

**Slide 7**

## BassGas – Update

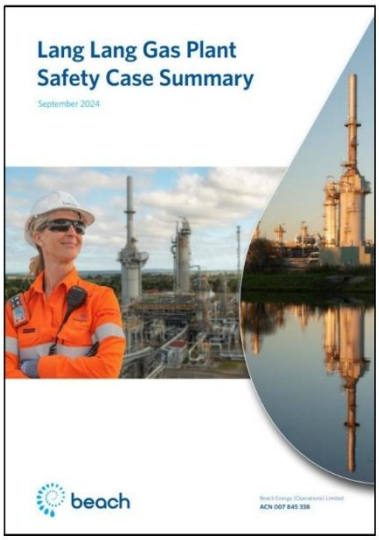
- Descale program has increased production by 91% and extended facility life. 2.7MMboe reserves upgrade post the activity
- Strong reliability over the year
- New four-year EBA has been agreed to.
- Pipeline integrity program (pigging) completed in 2024
- New ways of working have reduced site costs
- Yolla safety case approved by NOPSEMA/LLGP safety case approved by Worksafe Vic. /Pipeline safety case approved by ESV

beach

**Slide 8**

## Lang Lang Gas Plant Major Hazard Facility Licence Renewal Process

- Lang Lang Gas Plant is classified a Major Hazard Facility (MHF) in accordance with the Victorian Occupational Health and Safety Act and Regulations.
- The facility is required to have a Safety Case – a document that outlines the systems in place to manage the safety of personnel working on site and the safety of the local community.
- The Safety Case was revised as part of the WorkSafe 2024 MHF Licence renewal process.
- A full 5 year MHF licence with no conditions was granted (current MHF Licence expires on 26th July 2029).




LLGP-SafetyCaseSummary.pdf (beachenergy.com.au)

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**Slide 9**

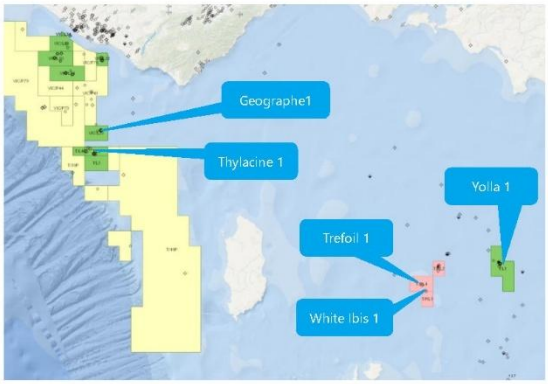
## Well Abandonments: Bass

### Multi-well P&A program

- Beach are part of a consortium sharing a drilling rig over the next 12 months.
- As part of the Equinox rig program Beach will be plugging and abandoning three wells across the Bass Basin:

| Well | Basin |
|---|---|
| Yolla 1 | Bass |
| Trefoil 1 | Bass |
| White Ibis 1 | Bass |

- These wells are historical exploration wells and are currently not producing.
- Two other abandonments for Beach in the Otway Basin.
- Further exploration wells in the Otway Basin no new wells for Bass.

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**Slide 10**

## BassGas 5-year review - Offshore Operations Environment Plan

Consultation now open

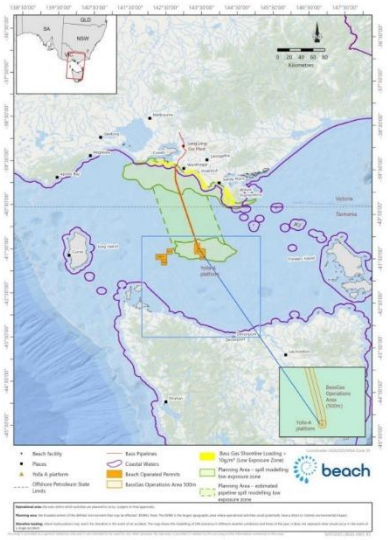
Bass Gas Operations produces natural gas and condensate from the Yolla gas field in the Bass Strait.

The gas field is serviced by the Yolla-A Offshore Platform **(Yolla Platform)**, and an approximately 147 km subsea pipeline that transports the gas and liquids from the platform to the Victorian mainland via a coastline crossing near Kilcunda.

The associated 32 km onshore pipeline terminates at the Lang Lang Gas Plant where natural gas is processed before being distributed to the domestic east coast market, delivering energy to homes, businesses and industry.

In accordance with regulatory requirements Beach is undertaking a 5-year review of the Bass Gas Offshore Operations Environment Plan (**EP**) to cover ongoing production operations. Beach commenced consultation in the course of preparing the EP on 14 July 2025.

The revised EP's scope includes the operation of the offshore wells, Yolla Platform and pipeline, and the ongoing maintenance and inspections to ensure safe ongoing field operations.



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**Slide 11**

## Consultation Opportunity – Community Information & Webinars

### Community consultation

If you think your functions, interests or activities may be affected, we would like to hear from you to:

- understand your concerns, and
- where possible, explore measures to reduce any impacts or risks.

### Community in-person information sessions

**Open community information sessions**

Wonthaggi RSL, 60 Graham Street, Wonthaggi

- Tuesday 19 August, 6pm to 8pm (AEST)
- Wednesday 20 August, 11am to 3pm (AEST)

**Dedicated culturally sensitive First Nations information sessions**

Wonthaggi RSL, 60 Graham Street, Wonthaggi

- Tuesday 19 August, 11am to 3pm (AEST)
- Wednesday 20 August, 6pm to 8pm (AEST)

### Online information sessions (webinars)

**Open community information webinars**

- Tuesday 9 September, 2.15pm to 3pm (AEST)
- Wednesday 10 September, 7pm to 7.45pm (AEST)

**Dedicated culturally sensitive First Nations webinars**

- Tuesday 9 September, 7pm to 7.45pm (AEST)
- Wednesday 10 September, 2.15pm to 3pm (AEST)

11 Private and confidential – not for distribution

**Slide 12**

# Environmental Update

## Ronie Magcamit

Senior Environmental Advisor (VIC)

beach

**Slide 13**

## Environmental Update

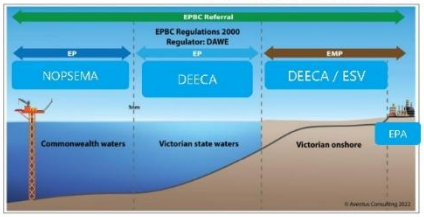
beach

### Approvals / Licence

- ONSHORE: Current Operating licence **OL000002797** (or EPA Licence # 2797): issued 16/05/2007, last amended **22/01/2025**
- OFFSHORE: Current *National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)* Approved Offshore Environment Plan (EP), Production Licence **T/L1**: accepted 23/12/2020 (due for renewal this **23/12/2025**)
- PIPELINES: **VIC/PL34**, **VIC/PL34(V)**, **T/PL2-COMM**

### Recent Monitoring

- No reportable exceedances.
  - March 2025: Quarterly Thermal Oxidiser monitoring completed.
  - September 2024: Stack Emission monitoring.
  - March, June 2025: Quarterly Stormwater discharge monitoring completed.
  - December 2024: Groundwater monitoring.
  - Monthly Noise monitoring check conducted.




### Operations - Support

- Environmental-related events (i.e. flaring) are logged in the EPA notification site.
- Feb-July 2025: Waste reduction and management strategy and external audit.

13

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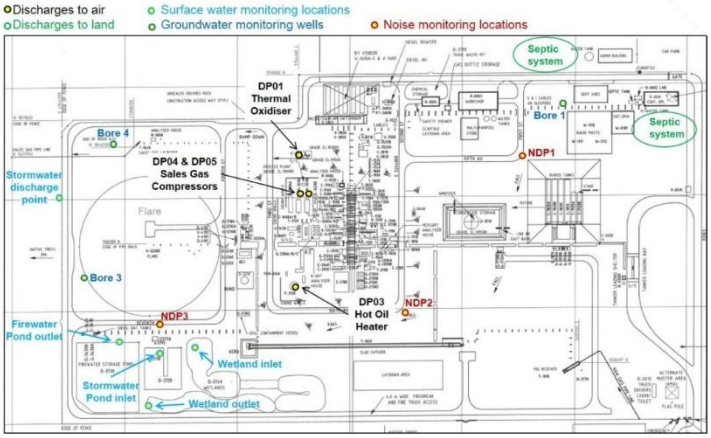
**Slide 14**

## BassGas Site Plans

The current Environment Plan (EP) was accepted by NOPSEMA on **23/12/2020** and by the former Victorian Department of Jobs, Precincts and Regions (DJPR) - Earth Resources Regulations (ERR) on 12/09/2022. DJPR was replaced by the Department of Energy, Environment and Climate Action (DEECA) in 2023.

All environmental monitoring in accordance with the **BassGas Environmental Management Plan (EMP)** with **Licence Monitoring Program (LMP)** to monitor groundwater quality, surface water, discharge, noise and air.






**Slide 15**

## Environmental Update

**Assurance / Reporting**

- September 2024: Annual Permission Information and Performance Statement (PIPS) to EPA
- September 2024: Annual Pipelines Report to DEECA/ESV
- January 2025: Annual Offshore Environmental Performance Report for 2024 to NOPSEMA
- Routine Assurance (Offshore EP Assurances, Monthly Environmental Inspection at LLGP, NOPSEMA Monthly report every 15th of the month)
- March 2025: NOPSEMA Inspection of Yolla
- September 2025: EPA Inspection of Lang Lang Gas Plant

**Incidents**

- No reportable incidents.
- Managed Bluegreen algae by treating Firewater pond from April-June 2025.
- EPA notified during brief flaring events.

Thermal Oxidiser

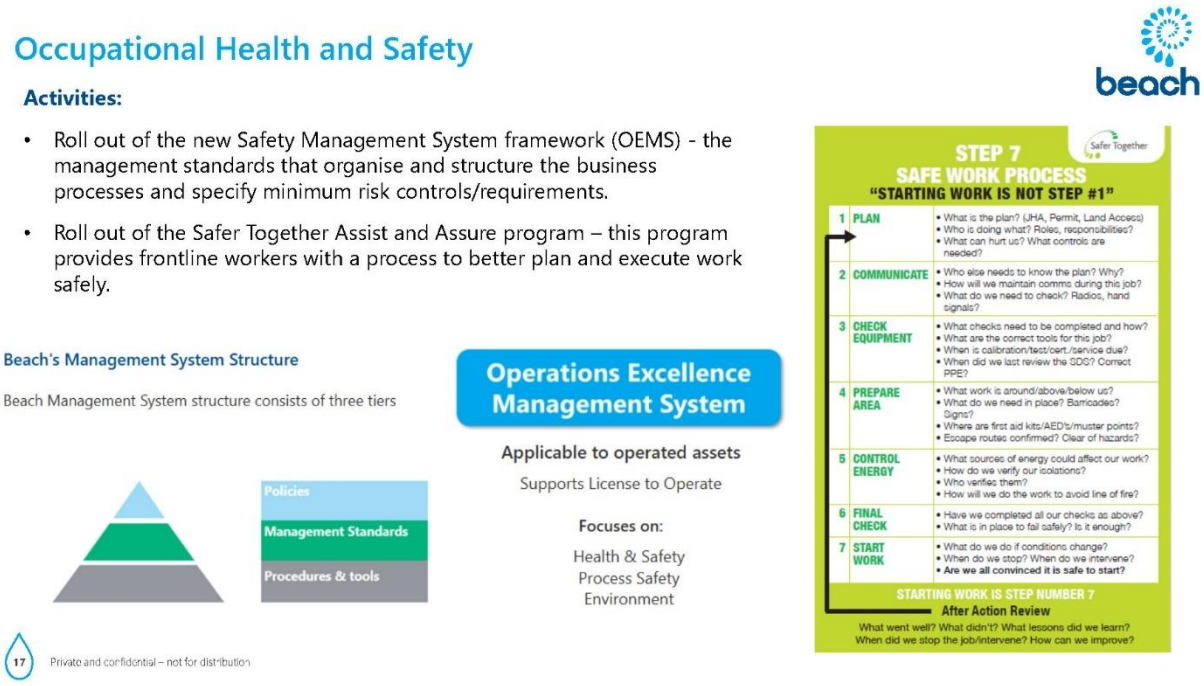
Stormwater Pond

Chemical Storage area

Stormwater Discharge

**Slide 16**

**Slide 17**



**Slide 18**

**Activities:**

- Emergency Response Exercises – SES site tour, CFA exercise planned for September
- New life saving equipment purchased for Yolla platform
- Yolla Safety Case accepted by NOPSEMA

**Incidents YTD 2025:**

- No injuries CY25
- No significant hydrocarbon releases

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**Slide 19**

# Community Investment Update

## Kieran Keane

Community Relations Adviser (VIC)

**Slide 20**

## Community Investment Update

***Beach invested over $200,000 to Victorian communities in 2024/2025***

**Examples of previous support in the area**

- Lang Lang Primary School
- Koo Wee Rup Secondary School
- Lang Lang Golf Club
- Koo Wee Rup Fire Brigade
- Poo Wong Recreation Reserve
- Loch Memorial Reserve
- SES Inverloch

**FY 2025**

**Westernport Swamp Landcare Group** - Lang Lang Primary School Arboretum

Community based not for profit organisation. Aims to preserve, protect and enhance the Western Port Catchment to achieve improved environmental and sustainable agricultural outcomes.

Support the facilitation of the Bug Blitz program

In addition, to volunteering at the Arboretum.

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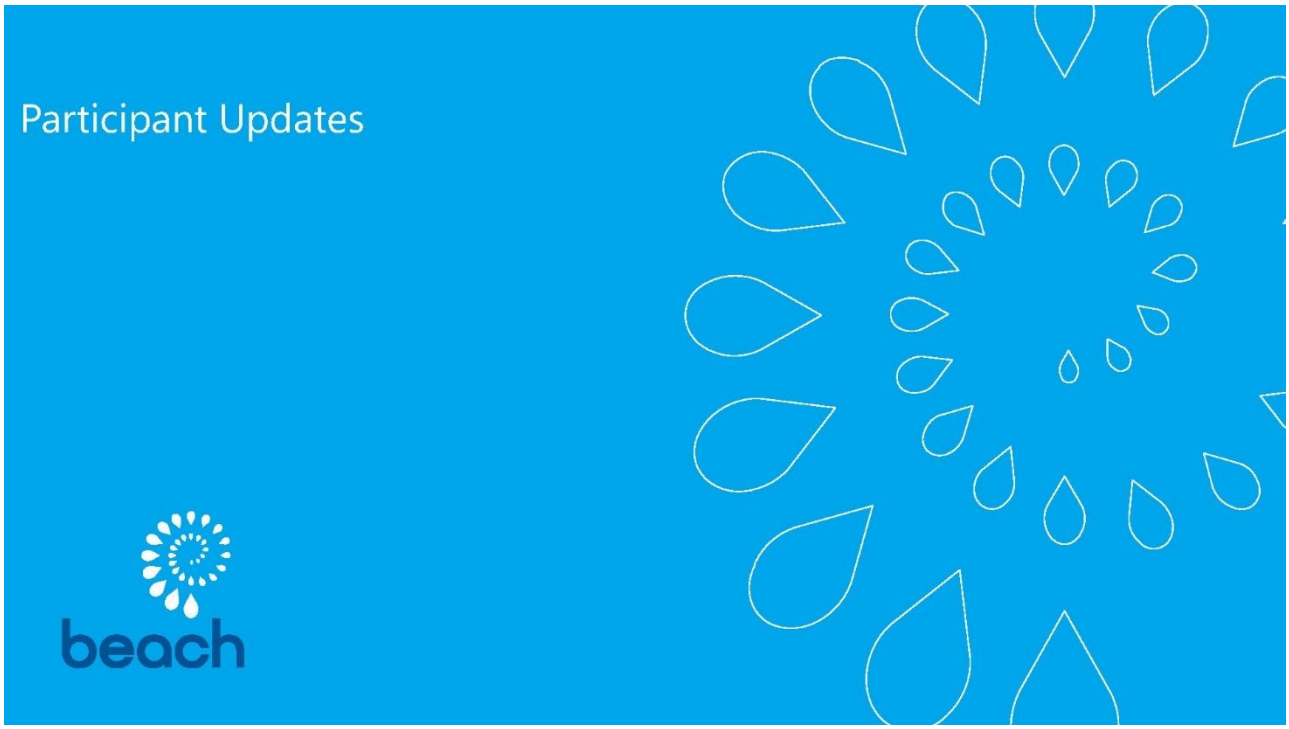
**Slide 21**

## Community Investment Update

21 Private and confidential – not for distribution

**Slide 22**




**Slide 23**

## Community and CRG contacts

beach

**Senior Manager Community Relations (Offshore)**
Sharon Donovan 0477 299 636 Sharon.Donovan@beachenergy.com.au

**Land Liaison Officer**
John King 0418 907 213 john.king@beachenergy.com.au

**Senior Land & Community Relations Adviser (Vic)**
Kieran Keane 0498 617 725 Kieran.keane@beachenergy.com.au

**SMS (text) message service**
Includes notices regarding operations, community meetings.
Opt-in, consent form required from neighbours

**Lang Lang Gas Plant:**
24-hour operations

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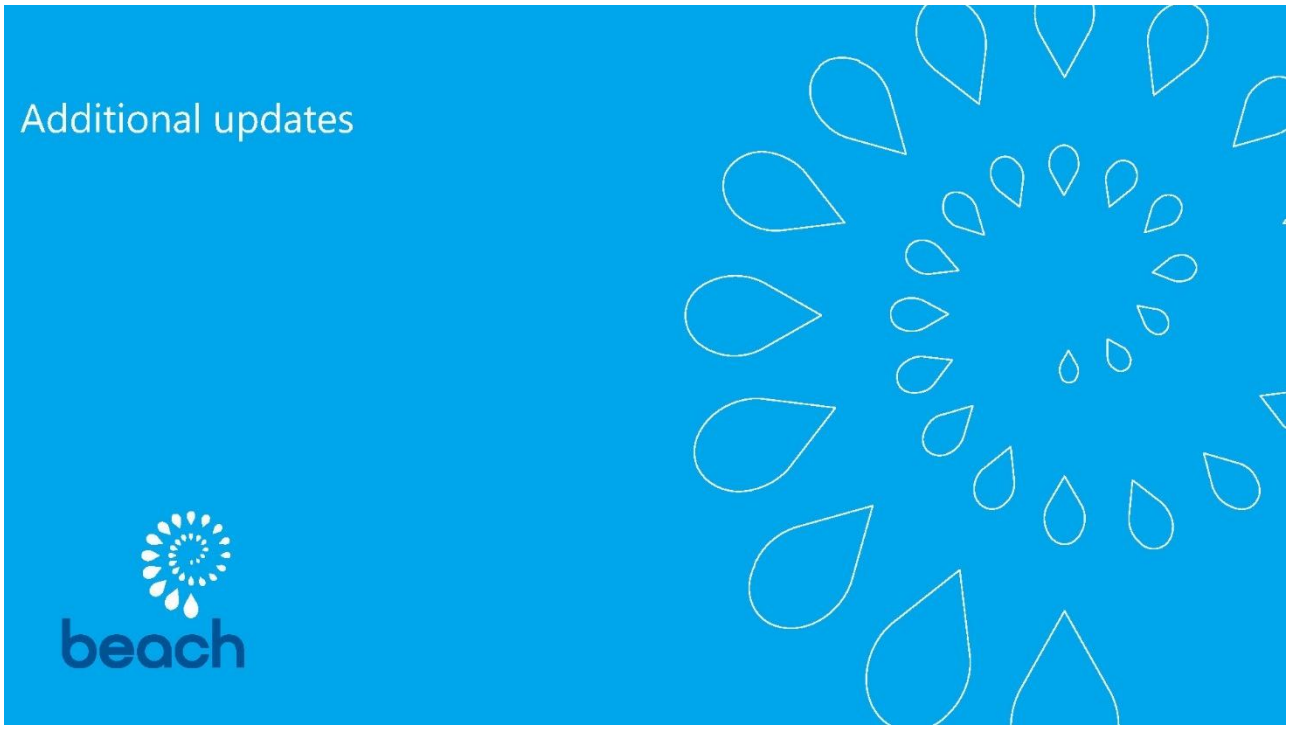
**Slide 24**



# Fair Ocean Access

## Minimising fishing impacts from offshore operations

Information Sheet | June 2021

## Introduction

Licenced commercial fishers and petroleum title holders have lawful rights and obligations to carry out their activities safely and without interference. Beach is committed to *Fair Ocean Access* by minimising impacts from its offshore activities to commercial fishers.

Beach's *Fair Ocean Access Procedure* sets out commitments by Beach to genuine consultation with fishers to understand and minimise safety, environmental and economic impacts.

Where impacts cannot be minimised by Beach, and a fisher has acted to avoid risks and impacts to a Beach project, Beach's *Fair Ocean Access Procedure* includes a simple and fair process for a fisher to claim compensation for an economic loss, and a rapid approval and payment process.

## Safety

Safety is Beach's first priority and operating safely will sometimes require restricted access for relatively small offshore areas over short periods. Beach will consult with fishers to seek to minimise potential disturbance to areas that are regular fishing grounds and where the fisher has no alternative fishing options.

## Environmental Protection

Beach's projects are subject to stringent assessment and mitigation of potential environmental impacts. Beach must prepare Environment Plans for its offshore projects. These identify all environmental and socio-economic impacts and set out mitigation measures to reduce impacts, so they are "as low as reasonably practicable" and acceptable by regulators. Mitigation measures may include compensation where impacts on the commercial fishing industry cannot be minimised and where these impacts cause an economic loss.

Assessment of impacts includes identifying State and Commonwealth commercial fisheries that are actively fished in Beach's project areas and any biological or economic impacts to those fisheries. Consultation with commercial fishers is an important part of Beach's environmental assessment process.

## Genuine consultation

Beach will consult with openness, transparency and mutual respect with fishers who may be directly impacted by Beach's projects. Beach will use its best endeavours to consult with all potentially impacted fishers during preparation of its Environment Plan for a project, and before projects commence.

Respecting the representative role of fishing associations, Beach will seek engagement with potentially impacted fishers via the relevant association. Beach will also engage directly with a fisher if they are not a member of an association, or where they request direct engagement with Beach.

Where a fishing association or fisher believes they will be impacted by a Beach project, Beach will share its fishing impact assessments, validate that with fishers, and discuss their specific circumstances with the objective of minimising potential impacts.

If project avoidance and impact minimisation is not possible, Beach will provide a copy of its full *Fair Ocean Access Procedure* and discuss mitigation options set out in the procedure, as appropriate to the individual fisher or association.

## Economic loss

Beach is committed to the principle that a fisher should not suffer an economic loss as a direct result of a Beach project. Losses may occur for different reasons such as:

- reduced catch from fishing in a new area in order to avoid a Beach project
- reduced catch due to impacts to a fishery from the project activities
- steaming costs to avoid a Beach project area
- costs to repair or replace fishing gear.

## Acting in good faith

Beach is committed to a fair, simple and transparent process for a fisher to claim compensation, where the fisher has consulted with Beach in good faith before a project, and provided the fisher has:

- acted to avoid risks and impacts to a Beach project
- acted to mitigate any economic losses to their business that may arise from avoiding risks and impacts to a Beach project
- evidence of fishing in the Beach project area during the same time of year as the project timing, for at least three years within the last five years, unless there are genuine fishery or fishing practice reasons for lesser periods
- historical and current catch and effort evidence and the ability to demonstrate an economic loss, as set out in Beach's *Fair Ocean Access Procedure*.

## Making a claim

The *Fair Ocean Access Procedure* sets out a simple claim form and describes the evidence required for a claim, such as historical catch and effort records, current catch and effort records, and fish prices.

Claims must be made within 60 days of completion of a Beach project unless there is evidence that the project has caused an impact to the fishery which has impacted future catch and caused an economic loss.

The *Fair Ocean* Access *Procedure* sets out timeframes for the rapid assessment and payment of successful claims and for ensuring the fisher is kept informed.

Beach will nominate a single point of contact at Beach for a fisher to liaise with.

Claims and evidence will be managed in accordance with Beach's Privacy Policy which can be found on Beach's website.

If a claim is not approved, Beach will provide written reasons for the decision.

## Resolving disagreements

Where a fisher and Beach cannot agree on a fisher's claim, the *Fair Ocean Access Procedure* includes steps for appointing an independent expert to resolve the matter. Beach will pay the reasonable costs of the independent expert, as set out in the *Fair Ocean Access Procedure*.

## We welcome your questions and feedback

P: 1800 797 011
E: community@beachenergy.com.au

**beachenergy.com.au**

beach

Draftable

# Draftable Comparison Export

This document is an exported comparison with limited functionality, generated by Draftable Desktop. To access full functionality, use Draftable's powerful comparison viewer in any of our products.

| | |
|---|---|
| **Left document:** | 10 ppb - Protected Matters - MNES layers - June 25th 2025.pdf |
| **Right document:** | Protected Matters - MNES layers - July 4th 2025.pdf |

## What is this document?

This is a comparison of two documents. The two documents are interleaved such that the left document is displayed on even pages and the right document is displayed on odd pages.

## Is there a specific way I should view this file?

This document is intended to be viewed in Two Page Continuous mode (or sometimes called 'Two Page Scrolling'). It should open in this mode by default when using Adobe Acrobat and most popular PDF readers.

If the document opens in a different view, you can often change this in the settings. In Adobe Acrobat, go to **View > Page Display > Two Page Scrolling**.

## Why are there blank pages?

Blank pages are inserted to keep both documents as aligned as much as possible.

## How do I read the changes?

Text deleted from the left document and, hence, not in right document is highlighted red. Text added to the right document and, hence, not in left document is highlighted green.

## Tip for printing

When printing this document, we recommend printing double-sided and include this first page. This will result in the matching text being displayed on different pages and easily readable, much like a book.

## For more information

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Australian Government

Department of Climate Change, Energy, the Environment and Water

# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 25-Jun-2025


Summary

Details

- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat

Acknowledgements

Australian Government

Department of Climate Change, Energy, the Environment and Water

# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 04-Jul-2025


Summary

Details

- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat

Acknowledgements

# Summary

## Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

| | |
|---|---|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International Importance (Ramsar | 2 |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Area: | 2 |
| Listed Threatened Ecological Communities: | 4 |
| Listed Threatened Species: | 90 |
| Listed Migratory Species: | 67 |

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

| | |
|---|---|
| Commonwealth Lands: | 9 |
| Commonwealth Heritage Places: | None |
| Listed Marine Species: | 115 |
| Whales and Other Cetaceans: | 15 |
| Critical Habitats: | None |
| Commonwealth Reserves Terrestrial: | None |
| Australian Marine Parks: | None |
| Habitat Critical to the Survival of Marine Turtles: | None |

## Extra Information

This part of the report provides information that may also be relevant to the area you have

| | |
|---|---|
| State and Territory Reserves: | 15 |
| Regional Forest Agreements: | 1 |
| Nationally Important Wetlands: | 3 |
| EPBC Act Referrals: | 36 |
| Key Ecological Features (Marine): | None |
| Biologically Important Areas: | 16 |
| Bioregional Assessments: | 1 |
| Geological and Bioregional Assessments: | None |

# Summary

## Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

| | |
|---|---|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International Importance (Ramsar | 2 |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Area: | 2 |
| Listed Threatened Ecological Communities: | 6 |
| Listed Threatened Species: | 89 |
| Listed Migratory Species: | 68 |

## Other Matters Protected by the EPBC Act

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A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

| | |
|---|---|
| Commonwealth Lands: | 1 |
| Commonwealth Heritage Places: | None |
| Listed Marine Species: | 115 |
| Whales and Other Cetaceans: | 15 |
| Critical Habitats: | None |
| Commonwealth Reserves Terrestrial: | None |
| Australian Marine Parks: | 1 |
| Habitat Critical to the Survival of Marine Turtles: | None |

## Extra Information

This part of the report provides information that may also be relevant to the area you have

| | |
|---|---|
| State and Territory Reserves: | 13 |
| Regional Forest Agreements: | 1 |
| Nationally Important Wetlands: | 4 |
| EPBC Act Referrals: | 32 |
| Key Ecological Features (Marine): | None |
| Biologically Important Areas: | 16 |
| Bioregional Assessments: | 1 |
| Geological and Bioregional Assessments: | None |

# Details

## Matters of National Environmental Significance

### Wetlands of International Importance (Ramsar Wetlands) [ Resource Information ]

| Ramsar Site Name | Proximity |
|---|---|
| Corner inlet | Within 10km of Ramsar site |
| Western port | Within Ramsar site |

### Commonwealth Marine Area [ Resource Information ]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

| Feature Name |
|---|
| Commonwealth Marine Areas (EPBC Act) |
| Commonwealth Marine Areas (EPBC Act) |

### Listed Threatened Ecological Communities [ Resource Information ]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

| Community Name | Threatened Category | Presence Text |
|---|---|---|
| Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community | Endangered | Community likely to occur within area |
| Giant Kelp Marine Forests of South East Australia | Endangered | Community may occur within area |
| Natural Damp Grassland of the Victorian Coastal Plains | Critically Endangered | Community likely to occur within area |
| Subtropical and Temperate Coastal Saltmarsh | Vulnerable | Community likely to occur within area |

### Listed Threatened Species [ Resource Information ]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| BIRD | | |

# Details

## Matters of National Environmental Significance

### Wetlands of International Importance (Ramsar Wetlands) [ Resource Information ]

| Ramsar Site Name | Proximity |
|---|---|
| Corner inlet | Within 10km of Ramsar site |
| Western port | Within Ramsar site |

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| Feature Name |
|---|
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Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

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|---|---|---|
| Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community | Endangered | Community likely to occur within area |
| Giant Kelp Marine Forests of South East Australia | Endangered | Community may occur within area |
| Natural Damp Grassland of the Victorian Coastal Plains | Critically Endangered | Community likely to occur within area |
| Subtropical and Temperate Coastal Saltmarsh | Vulnerable | Community likely to occur within area |
| Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (Eucalyptus ovata / E. brookeriana) | Critically Endangered | Community may occur within area |
| Tasmanian white gum (Eucalyptus viminalis) wet forest | Critically Endangered | Community may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Anthochaera phrygia<br>Regent Honeyeater [82338] | Critically Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Ardenna grisea<br>Sooty Shearwater [82651] | Vulnerable | Species or species habitat may occur within area |
| Arenaria interpres<br>Ruddy Turnstone [872] | Vulnerable | Roosting known to occur within area |
| Botaurus poiciloptilus<br>Australasian Bittern [1001] | Endangered | Species or species habitat known to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | Vulnerable | Roosting known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Vulnerable | Species or species habitat known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |
| Calidris tenuirostris<br>Great Knot [862] | Vulnerable | Roosting known to occur within area |
| Callocephalon fimbriatum<br>Gang-gang Cockatoo [768] | Endangered | Species or species habitat known to occur within area |
| Charadrius leschenaultii<br>Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Species or species habitat likely to occur within area |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |
| Climacteris picumnus victoriae<br>Brown Treecreeper (south-eastern) [67062] | Vulnerable | Species or species habitat may occur within area |

## Listed Threatened Species [ Resource Information ]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| BIRD | | |
| Anthochaera phrygia<br>Regent Honeyeater [82338] | Critically Endangered | Foraging, feeding or related behaviour likely to occur within area |
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| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Diomedea antipodensis<br>Antipodean Albatross [64458] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea antipodensis gibsoni<br>Gibson's Albatross [82270] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea epomophora<br>Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea sanfordi<br>Northern Royal Albatross [64456] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Falco hypoleucos<br>Grey Falcon [929] | Vulnerable | Species or species habitat likely to occur within area |
| Fregetta grallaria grallaria<br>White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438] | Vulnerable | Species or species habitat likely to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | Vulnerable | Species or species habitat known to occur within area |
| Grantiella picta<br>Painted Honeyeater [470] | Vulnerable | Species or species habitat may occur within area |
| Halobaena caerulea<br>Blue Petrel [1059] | Vulnerable | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Climacteris picumnus victoriae<br>Brown Treecreeper (south-eastern) [67062] | Vulnerable | Species or species habitat may occur within area |
| Diomedea antipodensis<br>Antipodean Albatross [64458] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea antipodensis gibsoni<br>Gibson's Albatross [82270] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea epomophora<br>Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
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| Falco hypoleucos<br>Grey Falcon [929] | Vulnerable | Species or species habitat likely to occur within area |
| Fregetta grallaria grallaria<br>White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438] | Vulnerable | Species or species habitat likely to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | Vulnerable | Species or species habitat known to occur within area |
| Grantiella picta<br>Painted Honeyeater [470] | Vulnerable | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Hirundapus caudacutus<br>White-throated Needletail [682] | Vulnerable | Species or species habitat known to occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Critically Endangered | Species or species habitat known to occur within area |
| Limosa lapponica baueri<br>Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380] | Endangered | Species or species habitat known to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | Endangered | Roosting known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Neophema chrysogaster<br>Orange-bellied Parrot [747] | Critically Endangered | Species or species habitat known to occur within area |
| Neophema chrysostoma<br>Blue-winged Parrot [726] | Vulnerable | Species or species habitat known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Pachyptila turtur subantarctica<br>Fairy Prion (southern) [64445] | Vulnerable | Species or species habitat known to occur within area |
| Pedionomus torquatus<br>Plains-wanderer [906] | Critically Endangered | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Halobaena caerulea<br>Blue Petrel [1059] | Vulnerable | Species or species habitat may occur within area |
| Hirundapus caudacutus<br>White-throated Needletail [682] | Vulnerable | Species or species habitat known to occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Critically Endangered | Species or species habitat known to occur within area |
| Limosa lapponica baueri<br>Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380] | Endangered | Species or species habitat known to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | Endangered | Roosting known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Neophema chrysogaster<br>Orange-bellied Parrot [747] | Critically Endangered | Species or species habitat known to occur within area |
| Neophema chrysostoma<br>Blue-winged Parrot [726] | Vulnerable | Species or species habitat known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Pachyptila turtur subantarctica<br>Fairy Prion (southern) [64445] | Vulnerable | Species or species habitat known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat likely to occur within area |
| Pluvialis squatarola<br>Grey Plover [865] | Vulnerable | Roosting known to occur within area |
| Pterodroma leucoptera leucoptera<br>Gould's Petrel, Australian Gould's Petrel [26033] | Endangered | Species or species habitat may occur within area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Species or species habitat may occur within area |
| Pycnoptilus floccosus<br>Pilotbird [525] | Vulnerable | Species or species habitat likely to occur within area |
| Rostratula australis<br>Australian Painted Snipe [77037] | Endangered | Species or species habitat likely to occur within area |
| Stagonopleura guttata<br>Diamond Firetail [59398] | Vulnerable | Species or species habitat known to occur within area |
| Sternula albifrons<br>Little Tern [82849] | Vulnerable | Species or species habitat may occur within area |
| Sternula nereis nereis<br>Australian Fairy Tern [82950] | Vulnerable | Species or species habitat known to occur within area |
| Thalassarche bulleri<br>Buller's Albatross, Pacific Albatross [64460] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche bulleri platei<br>Northern Buller's Albatross, Pacific Albatross [82273] | Vulnerable | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Pedionomus torquatus<br>Plains-wanderer [906] | Critically Endangered | Species or species habitat may occur within area |
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat likely to occur within area |
| Pluvialis squatarola<br>Grey Plover [865] | Vulnerable | Roosting known to occur within area |
| Pterodroma leucoptera leucoptera<br>Gould's Petrel, Australian Gould's Petrel [26033] | Endangered | Species or species habitat may occur within area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Species or species habitat may occur within area |
| Pycnoptilus floccosus<br>Pilotbird [525] | Vulnerable | Species or species habitat likely to occur within area |
| Rostratula australis<br>Australian Painted Snipe [77037] | Endangered | Species or species habitat likely to occur within area |
| Stagonopleura guttata<br>Diamond Firetail [59398] | Vulnerable | Species or species habitat known to occur within area |
| Sternula albifrons<br>Little Tern [82849] | Vulnerable | Species or species habitat may occur within area |
| Sternula nereis nereis<br>Australian Fairy Tern [82950] | Vulnerable | Species or species habitat known to occur within area |
| Thalassarche bulleri<br>Buller's Albatross, Pacific Albatross [64460] | Vulnerable | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Thalassarche carteri<br>Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat likely to occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche chrysostoma<br>Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Thinornis cucullatus cucullatus<br>Eastern Hooded Plover, Eastern Hooded Plover [90381] | Vulnerable | Species or species habitat known to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | Endangered | Species or species habitat known to occur within area |
| Xenus cinereus<br>Terek Sandpiper [59300] | Vulnerable | Roosting known to occur within area |
| FISH | | |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Thalassarche bulleri platei<br>Northern Buller's Albatross, Pacific Albatross [82273] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat likely to occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche chrysostoma<br>Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Thinornis cucullatus cucullatus<br>Eastern Hooded Plover, Eastern Hooded Plover [90381] | Vulnerable | Species or species habitat known to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | Endangered | Species or species habitat known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Galaxiella pusilla | | |
| Eastern Dwarf Galaxias, Dwarf Galaxias [56790] | Endangered | Species or species habitat known to occur within area |
| Nannoperca obscura | | |
| Yarra Pygmy Perch [26177] | Endangered | Species or species habitat may occur within area |
| Prototroctes maraena | | |
| Australian Grayling [26179] | Vulnerable | Species or species habitat likely to occur within area |
| Seriolella brama | | |
| Blue Warehou [69374] | Conservation Dependent | Species or species habitat known to occur within area |
| FROG | | |
| Litoria raniformis | | |
| Southern Bell Frog, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828] | Vulnerable | Species or species habitat known to occur within area |
| MAMMAL | | |
| Antechinus minimus maritimus | | |
| Swamp Antechinus (mainland) [83086] | Vulnerable | Species or species habitat known to occur within area |
| Balaenoptera borealis | | |
| Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera musculus | | |
| Blue Whale [36] | Endangered | Species or species habitat likely to occur within area |
| Balaenoptera physalus | | |
| Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Dasyurus maculatus maculatus (SE mainland population) | | |
| Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184] | Endangered | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| [Xenus cinereus](#)<br>Terek Sandpiper [59300] | Vulnerable | Roosting known to occur within area |
| **FISH** | | |
| [Galaxiella pusilla](#)<br>Eastern Dwarf Galaxias, Dwarf Galaxias [56790] | Endangered | Species or species habitat known to occur within area |
| [Prototroctes maraena](#)<br>Australian Grayling [26179] | Vulnerable | Species or species habitat likely to occur within area |
| [Seriolella brama](#)<br>Blue Warehou [69374] | Conservation Dependent | Species or species habitat known to occur within area |
| **FROG** | | |
| [Litoria raniformis](#)<br>Southern Bell Frog, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828] | Vulnerable | Species or species habitat known to occur within area |
| **MAMMAL** | | |
| [Antechinus minimus maritimus](#)<br>Swamp Antechinus (mainland) [83086] | Vulnerable | Species or species habitat known to occur within area |
| [Balaenoptera borealis](#)<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| [Balaenoptera musculus](#)<br>Blue Whale [36] | Endangered | Species or species habitat likely to occur within area |
| [Balaenoptera physalus](#)<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| [Dasyurus maculatus maculatus (SE mainland population)](#)<br>Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184] | Endangered | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Eubalaena australis | | |
| Southern Right Whale [40] | Endangered | Species or species habitat known to occur within area |
| Isoodon obesulus obesulus | | |
| Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050] | Endangered | Species or species habitat known to occur within area |
| Mastacomys fuscus mordicus | | |
| Broad-toothed Rat (mainland), Tooarrana [87617] | Endangered | Species or species habitat may occur within area |
| Perameles gunnii Victorian subspecies | | |
| Eastern Barred Bandicoot (Mainland) [88020] | Endangered | Translocated population known to occur within area |
| Petaurus australis australis | | |
| Yellow-bellied Glider (south-eastern) [87600] | Vulnerable | Species or species habitat likely to occur within area |
| Potorous tridactylus trisulcatus | | |
| Long-nosed Potoroo (southern mainland) [86367] | Vulnerable | Species or species habitat known to occur within area |
| Pseudomys novaehollandiae | | |
| New Holland Mouse, Pookila [96] | Vulnerable | Species or species habitat likely to occur within area |
| Pteropus poliocephalus | | |
| Grey-headed Flying-fox [186] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| PLANT | | |
| Amphibromus fluitans | | |
| River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215] | Vulnerable | Species or species habitat known to occur within area |
| Caladenia orientalis | | |
| Eastern Spider Orchid [83410] | Endangered | Species or species habitat known to occur within area |
| Caladenia tessellata | | |
| Thick-lipped Spider-orchid, Daddy Long-legs [2119] | Vulnerable | Species or species habitat known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Eubalaena australis | | |
| Southern Right Whale [40] | Endangered | Species or species habitat known to occur within area |
| Isoodon obesulus obesulus | | |
| Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050] | Endangered | Species or species habitat known to occur within area |
| Mastacomys fuscus mordicus | | |
| Broad-toothed Rat (mainland), Tooarrana [87617] | Endangered | Species or species habitat may occur within area |
| Perameles gunnii Victorian subspecies | | |
| Eastern Barred Bandicoot (Mainland) [88020] | Endangered | Translocated population known to occur within area |
| Petaurus australis australis | | |
| Yellow-bellied Glider (south-eastern) [87600] | Vulnerable | Species or species habitat likely to occur within area |
| Potorous tridactylus trisulcatus | | |
| Long-nosed Potoroo (southern mainland) [86367] | Vulnerable | Species or species habitat likely to occur within area |
| Pseudomys novaehollandiae | | |
| New Holland Mouse, Pookila [96] | Vulnerable | Species or species habitat known to occur within area |
| Pteropus poliocephalus | | |
| Grey-headed Flying-fox [186] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| PLANT | | |
| Amphibromus fluitans | | |
| River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215] | Vulnerable | Species or species habitat known to occur within area |
| Caladenia orientalis | | |
| Eastern Spider Orchid [83410] | Endangered | Species or species habitat known to occur within area |
| Caladenia tessellata | | |
| Thick-lipped Spider-orchid, Daddy Long-legs [2119] | Vulnerable | Species or species habitat known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Eucalyptus strzeleckii<br>Strzelecki Gum [55400] | Vulnerable | Species or species habitat likely to occur within area |
| Prasophyllum frenchii<br>Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid [9704] | Endangered | Species or species habitat likely to occur within area |
| Prasophyllum spicatum<br>Dense Leek-orchid [55146] | Vulnerable | Species or species habitat known to occur within area |
| Pterostylis chlorogramma<br>Green-striped Greenhood [56510] | Vulnerable | Species or species habitat likely to occur within area |
| Pterostylis cucullata<br>Leafy Greenhood [15459] | Vulnerable | Species or species habitat likely to occur within area |
| Pterostylis tenuissima<br>Swamp Greenhood, Dainty Swamp Orchid [13139] | Vulnerable | Species or species habitat likely to occur within area |
| Senecio psilocarpus<br>Swamp Fireweed, Smooth-fruited Groundsel [64976] | Vulnerable | Species or species habitat likely to occur within area |
| Thelymitra orientalis<br>Hoary Sun-orchid [88011] | Critically Endangered | Species or species habitat may occur within area |
| Xerochrysum palustre<br>Swamp Everlasting, Swamp Paper Daisy [76215] | Vulnerable | Species or species habitat likely to occur within area |
| REPTILE | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Eucalyptus strzeleckii<br>Strzelecki Gum [55400] | Vulnerable | Species or species habitat likely to occur within area |
| Prasophyllum frenchii<br>Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid [9704] | Endangered | Species or species habitat likely to occur within area |
| Prasophyllum spicatum<br>Dense Leek-orchid [55146] | Vulnerable | Species or species habitat known to occur within area |
| Pterostylis chlorogramma<br>Green-striped Greenhood [56510] | Vulnerable | Species or species habitat likely to occur within area |
| Pterostylis cucullata<br>Leafy Greenhood [15459] | Vulnerable | Species or species habitat likely to occur within area |
| Pterostylis tenuissima<br>Swamp Greenhood, Dainty Swamp Orchid [13139] | Vulnerable | Species or species habitat likely to occur within area |
| Senecio psilocarpus<br>Swamp Fireweed, Smooth-fruited Groundsel [64976] | Vulnerable | Species or species habitat likely to occur within area |
| Thelymitra orientalis<br>Hoary Sun-orchid [88011] | Critically Endangered | Species or species habitat may occur within area |
| Xerochrysum palustre<br>Swamp Everlasting, Swamp Paper Daisy [76215] | Vulnerable | Species or species habitat likely to occur within area |
| REPTILE | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Dermochelys coriacea | | |
| Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Lissolepis coventryi | | |
| Swamp Skink, Eastern Mourning Skink [84053] | Endangered | Species or species habitat known to occur within area |
| SHARK | | |
| Carcharodon carcharias | | |
| White Shark, Great White Shark [64470] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Galeorhinus galeus | | |
| School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453] | Conservation Dependent | Species or species habitat likely to occur within area |

| Listed Migratory Species | | [ Resource Information ] |
|---|---|---|
| Scientific Name | Threatened Category | Presence Text |
| Migratory Marine Birds | | |
| Apus pacificus | | |
| Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardenna carneipes | | |
| Flesh-footed Shearwater, Fleshy-footed Shearwater [82404] | | Foraging, feeding or related behaviour likely to occur within area |
| Ardenna grisea | | |
| Sooty Shearwater [82651] | Vulnerable | Species or species habitat may occur within area |
| Ardenna tenuirostris | | |
| Short-tailed Shearwater [82652] | | Breeding known to occur within area |
| Diomedea antipodensis | | |
| Antipodean Albatross [64458] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Dermochelys coriacea | | |
| Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Lissolepis coventryi | | |
| Swamp Skink, Eastern Mourning Skink [84053] | Endangered | Species or species habitat known to occur within area |
| SHARK | | |
| Carcharodon carcharias | | |
| White Shark, Great White Shark [64470] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Galeorhinus galeus | | |
| School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453] | Conservation Dependent | Species or species habitat likely to occur within area |

| Listed Migratory Species | | [ Resource Information ] |
|---|---|---|
| Scientific Name | Threatened Category | Presence Text |
| Migratory Marine Birds | | |
| Apus pacificus | | |
| Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardenna carneipes | | |
| Flesh-footed Shearwater, Fleshy-footed Shearwater [82404] | | Foraging, feeding or related behaviour likely to occur within area |
| Ardenna grisea | | |
| Sooty Shearwater [82651] | Vulnerable | Species or species habitat may occur within area |
| Ardenna tenuirostris | | |
| Short-tailed Shearwater [82652] | | Breeding known to occur within area |
| Diomedea antipodensis | | |
| Antipodean Albatross [64458] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Diomedea epomophora<br>Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea sanfordi<br>Northern Royal Albatross [64456] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat likely to occur within area |
| Sternula albifrons<br>Little Tern [82849] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche bulleri<br>Buller's Albatross, Pacific Albatross [64460] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat likely to occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Foraging, feeding or related behaviour likely to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Diomedea epomophora<br>Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea sanfordi<br>Northern Royal Albatross [64456] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat likely to occur within area |
| Sternula albifrons<br>Little Tern [82849] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche bulleri<br>Buller's Albatross, Pacific Albatross [64460] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat likely to occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Foraging, feeding or related behaviour likely to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Thalassarche chrysostoma<br>Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Migratory Marine Species | | |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Species or species habitat likely to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Caperea marginata<br>Pygmy Right Whale [39] | | Foraging, feeding or related behaviour may occur within area |
| Carcharias taurus<br>Grey Nurse Shark [64469] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Thalassarche chrysostoma<br>Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Migratory Marine Species | | |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Species or species habitat likely to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Caperea marginata<br>Pygmy Right Whale [39] | | Foraging, feeding or related behaviour may occur within area |
| Carcharias taurus<br>Grey Nurse Shark [64469] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Species or species habitat may occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Eubalaena australis as Balaena glacialis australis<br>Southern Right Whale [40] | Endangered | Species or species habitat known to occur within area |
| Isurus oxyrinchus<br>Shortfin Mako, Mako Shark [79073] | | Species or species habitat likely to occur within area |
| Lagenorhynchus obscurus<br>Dusky Dolphin [43] | | Species or species habitat may occur within area |
| Lamna nasus<br>Porbeagle, Mackerel Shark [83288] | | Species or species habitat likely to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | | Species or species habitat known to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat likely to occur within area |
| Migratory Terrestrial Species | | |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Species or species habitat may occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Eubalaena australis as Balaena glacialis australis<br>Southern Right Whale [40] | Endangered | Species or species habitat known to occur within area |
| Isurus oxyrinchus<br>Shortfin Mako, Mako Shark [79073] | | Species or species habitat likely to occur within area |
| Lagenorhynchus obscurus<br>Dusky Dolphin [43] | | Species or species habitat may occur within area |
| Lamna nasus<br>Porbeagle, Mackerel Shark [83288] | | Species or species habitat likely to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | | Species or species habitat known to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat likely to occur within area |
| Migratory Terrestrial Species | | |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Hirundapus caudacutus<br>White-throated Needletail [682] | Vulnerable | Species or species habitat known to occur within area |
| Motacilla flava<br>Yellow Wagtail [644] | | Species or species habitat may occur within area |
| **Migratory Wetlands Species** | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Arenaria interpres<br>Ruddy Turnstone [872] | Vulnerable | Roosting known to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | Vulnerable | Roosting known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Vulnerable | Species or species habitat known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat known to occur within area |
| Calidris ruficollis<br>Red-necked Stint [860] | | Roosting known to occur within area |
| Calidris tenuirostris<br>Great Knot [862] | Vulnerable | Roosting known to occur within area |
| Charadrius bicinctus<br>Double-banded Plover [895] | | Roosting known to occur within area |
| Charadrius leschenaultii<br>Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Species or species habitat likely to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Hirundapus caudacutus | | |
| White-throated Needletail [682] | Vulnerable | Species or species habitat known to occur within area |
| Motacilla flava | | |
| Yellow Wagtail [644] | | Species or species habitat may occur within area |
| **Migratory Wetlands Species** | | |
| Actitis hypoleucos | | |
| Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Arenaria interpres | | |
| Ruddy Turnstone [872] | Vulnerable | Roosting known to occur within area |
| Calidris acuminata | | |
| Sharp-tailed Sandpiper [874] | Vulnerable | Roosting known to occur within area |
| Calidris alba | | |
| Sanderling [875] | | Roosting known to occur within area |
| Calidris canutus | | |
| Red Knot, Knot [855] | Vulnerable | Species or species habitat known to occur within area |
| Calidris ferruginea | | |
| Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |
| Calidris melanotos | | |
| Pectoral Sandpiper [858] | | Species or species habitat known to occur within area |
| Calidris ruficollis | | |
| Red-necked Stint [860] | | Roosting known to occur within area |
| Calidris tenuirostris | | |
| Great Knot [862] | Vulnerable | Roosting known to occur within area |
| Charadrius bicinctus | | |
| Double-banded Plover [895] | | Roosting known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | Vulnerable | Species or species habitat known to occur within area |
| Gallinago megala<br>Swinhoe's Snipe [864] | | Roosting likely to occur within area |
| Gallinago stenura<br>Pin-tailed Snipe [841] | | Roosting likely to occur within area |
| Limicola falcinellus<br>Broad-billed Sandpiper [842] | | Roosting known to occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | Endangered | Roosting known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Numenius minutus<br>Little Curlew, Little Whimbrel [848] | | Roosting likely to occur within area |
| Numenius phaeopus<br>Whimbrel [849] | | Roosting known to occur within area |
| Pandion haliaetus<br>Osprey [952] | | Species or species habitat known to occur within area |
| Pluvialis fulva<br>Pacific Golden Plover [25545] | | Roosting known to occur within area |
| Pluvialis squatarola<br>Grey Plover [865] | Vulnerable | Roosting known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Charadrius leschenaultii<br>Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Species or species habitat likely to occur within area |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | Vulnerable | Species or species habitat known to occur within area |
| Gallinago megala<br>Swinhoe's Snipe [864] | | Roosting likely to occur within area |
| Gallinago stenura<br>Pin-tailed Snipe [841] | | Roosting known to occur within area |
| Limicola falcinellus<br>Broad-billed Sandpiper [842] | | Roosting known to occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | Endangered | Roosting known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Numenius minutus<br>Little Curlew, Little Whimbrel [848] | | Roosting likely to occur within area |
| Numenius phaeopus<br>Whimbrel [849] | | Roosting known to occur within area |
| Pandion haliaetus<br>Osprey [952] | | Species or species habitat known to occur within area |
| Pluvialis fulva<br>Pacific Golden Plover [25545] | | Roosting known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Thalasseus bergii<br>Greater Crested Tern [83000] | | Breeding known to occur within area |
| Tringa brevipes<br>Grey-tailed Tattler [851] | | Roosting known to occur within area |
| Tringa glareola<br>Wood Sandpiper [829] | | Roosting known to occur within area |
| Tringa incana<br>Wandering Tattler [831] | | Roosting known to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | Endangered | Species or species habitat known to occur within area |
| Tringa stagnatilis<br>Marsh Sandpiper, Little Greenshank [833] | | Roosting known to occur within area |
| Xenus cinereus<br>Terek Sandpiper [59300] | Vulnerable | Roosting known to occur within area |

## Other Matters Protected by the EPBC Act

| Commonwealth Lands | [ Resource Information ] |
|---|---|

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

| Commonwealth Land Name | State |
|---|---|
| Defence | |
| Defence - HMAS CERBERUS [20086] | VIC |
| Defence - HMAS CERBERUS [20087] | VIC |
| Defence - HMAS CERBERUS [20091] | VIC |
| Defence - HMAS CERBERUS [20090] | VIC |
| Defence - HMAS CERBERUS [20088] | VIC |
| Defence - HMAS CERBERUS [20089] | VIC |
| Defence - HMAS CERBERUS [20097] | VIC |
| Unknown | |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Pluvialis squatarola<br>Grey Plover [865] | Vulnerable | Roosting known to occur within area |
| Thalasseus bergii<br>Greater Crested Tern [83000] | | Breeding known to occur within area |
| Tringa brevipes<br>Grey-tailed Tattler [851] | | Roosting known to occur within area |
| Tringa glareola<br>Wood Sandpiper [829] | | Species or species habitat known to occur within area |
| Tringa incana<br>Wandering Tattler [831] | | Species or species habitat known to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | Endangered | Species or species habitat known to occur within area |
| Tringa stagnatilis<br>Marsh Sandpiper, Little Greenshank [833] | | Roosting known to occur within area |
| Xenus cinereus<br>Terek Sandpiper [59300] | Vulnerable | Roosting known to occur within area |

## Other Matters Protected by the EPBC Act

### Commonwealth Lands [ Resource Information ]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

| Commonwealth Land Name | State |
|---|---|
| Unknown | |
| Commonwealth Land - [21487] | VIC |

### Listed Marine Species [ Resource Information ]

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Bird | | |

| Commonwealth Land Name | State |
|---|---|
| Commonwealth Land - [22391] | VIC |
| Commonwealth Land - [21487] | VIC |

## Listed Marine Species [ Resource Information ]

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| **Bird** | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area overfly marine area |
| Ardenna carneipes as Puffinus carneipes<br>Flesh-footed Shearwater, Fleshy-footed Shearwater [82404] | | Foraging, feeding or related behaviour likely to occur within area |
| Ardenna grisea as Puffinus griseus<br>Sooty Shearwater [82651] | Vulnerable | Species or species habitat may occur within area |
| Ardenna tenuirostris as Puffinus tenuirostris<br>Short-tailed Shearwater [82652] | | Breeding known to occur within area |
| Arenaria interpres<br>Ruddy Turnstone [872] | Vulnerable | Roosting known to occur within area |
| Bubulcus ibis as Ardea ibis<br>Cattle Egret [66521] | | Species or species habitat may occur within area overfly marine area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | Vulnerable | Roosting known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Vulnerable | Species or species habitat known to occur within area overfly marine area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area overfly marine area |
| Ardenna carneipes as Puffinus carneipes<br>Flesh-footed Shearwater, Fleshy-footed Shearwater [82404] | | Foraging, feeding or related behaviour likely to occur within area |
| Ardenna grisea as Puffinus griseus<br>Sooty Shearwater [82651] | Vulnerable | Species or species habitat may occur within area |
| Ardenna tenuirostris as Puffinus tenuirostris<br>Short-tailed Shearwater [82652] | | Breeding known to occur within area |
| Arenaria interpres<br>Ruddy Turnstone [872] | Vulnerable | Roosting known to occur within area |
| Bubulcus ibis as Ardea ibis<br>Cattle Egret [66521] | | Species or species habitat may occur within area overfly marine area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | Vulnerable | Roosting known to occur within area |
| Calidris alba<br>Sanderling [875] | | Roosting known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Vulnerable | Species or species habitat known to occur within area overfly marine area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area overfly marine area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area<br>overfly marine area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat known to occur within area<br>overfly marine area |
| Calidris ruficollis<br>Red-necked Stint [860] | | Roosting known to occur within area<br>overfly marine area |
| Calidris tenuirostris<br>Great Knot [862] | Vulnerable | Roosting known to occur within area<br>overfly marine area |
| Chalcites osculans as Chrysococcyx osculans<br>Black-eared Cuckoo [83425] | | Species or species habitat likely to occur within area overfly marine area |
| Charadrius bicinctus<br>Double-banded Plover [895] | | Roosting known to occur within area<br>overfly marine area |
| Charadrius leschenaultii<br>Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Species or species habitat likely to occur within area |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |
| Charadrius ruficapillus<br>Red-capped Plover [881] | | Roosting known to occur within area<br>overfly marine area |
| Chroicocephalus novaehollandiae as Larus novaehollandiae<br>Silver Gull [82326] | | Breeding known to occur within area |
| Diomedea antipodensis<br>Antipodean Albatross [64458] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat known to occur within area<br>overfly marine area |
| Calidris ruficollis<br>Red-necked Stint [860] | | Roosting known to occur within area<br>overfly marine area |
| Calidris tenuirostris<br>Great Knot [862] | Vulnerable | Roosting known to occur within area<br>overfly marine area |
| Charadrius bicinctus<br>Double-banded Plover [895] | | Roosting known to occur within area<br>overfly marine area |
| Charadrius leschenaultii<br>Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Species or species habitat likely to occur within area |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |
| Charadrius ruficapillus<br>Red-capped Plover [881] | | Roosting known to occur within area<br>overfly marine area |
| Chroicocephalus novaehollandiae as Larus novaehollandiae<br>Silver Gull [82326] | | Breeding known to occur within area |
| Diomedea antipodensis<br>Antipodean Albatross [64458] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea antipodensis gibsoni as Diomedea gibsoni<br>Gibson's Albatross [82270] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea epomophora<br>Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Diomedea antipodensis gibsoni as Diomedea gibsoni | | |
| Gibson's Albatross [82270] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea epomophora | | |
| Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea exulans | | |
| Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea sanfordi | | |
| Northern Royal Albatross [64456] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Eudyptula minor | | |
| Little Penguin [1085] | | Breeding known to occur within area |
| Gallinago hardwickii | | |
| Latham's Snipe, Japanese Snipe [863] | Vulnerable | Species or species habitat known to occur within area overfly marine area |
| Gallinago megala | | |
| Swinhoe's Snipe [864] | | Roosting likely to occur within area overfly marine area |
| Gallinago stenura | | |
| Pin-tailed Snipe [841] | | Roosting likely to occur within area overfly marine area |
| Haliaeetus leucogaster | | |
| White-bellied Sea-Eagle [943] | | Breeding known to occur within area |
| Halobaena caerulea | | |
| Blue Petrel [1059] | Vulnerable | Species or species habitat may occur within area |
| Himantopus himantopus | | |
| Pied Stilt, Black-winged Stilt [870] | | Roosting known to occur within area overfly marine area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea sanfordi<br>Northern Royal Albatross [64456] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Eudyptula minor<br>Little Penguin [1085] | | Breeding known to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | Vulnerable | Species or species habitat known to occur within area<br>overfly marine area |
| Gallinago megala<br>Swinhoe's Snipe [864] | | Roosting likely to occur within area<br>overfly marine area |
| Gallinago stenura<br>Pin-tailed Snipe [841] | | Roosting known to occur within area<br>overfly marine area |
| Haliaeetus leucogaster<br>White-bellied Sea-Eagle [943] | | Breeding known to occur within area |
| Halobaena caerulea<br>Blue Petrel [1059] | Vulnerable | Species or species habitat may occur within area |
| Himantopus himantopus<br>Pied Stilt, Black-winged Stilt [870] | | Roosting known to occur within area<br>overfly marine area |
| Hirundapus caudacutus<br>White-throated Needletail [682] | Vulnerable | Species or species habitat known to occur within area<br>overfly marine area |
| Larus dominicanus<br>Kelp Gull [809] | | Breeding known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Hirundapus caudacutus<br>White-throated Needletail [682] | Vulnerable | Species or species habitat known to occur within area<br>overfly marine area |
| Larus dominicanus<br>Kelp Gull [809] | | Breeding known to occur within area |
| Larus pacificus<br>Pacific Gull [811] | | Breeding known to occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Critically Endangered | Species or species habitat known to occur within area<br>overfly marine area |
| Limicola falcinellus<br>Broad-billed Sandpiper [842] | | Roosting known to occur within area<br>overfly marine area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | Endangered | Roosting known to occur within area<br>overfly marine area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Merops ornatus<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area overfly marine area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Larus pacificus<br>Pacific Gull [811] | | Breeding known to occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Critically Endangered | Species or species habitat known to occur within area overfly marine area |
| Limicola falcinellus<br>Broad-billed Sandpiper [842] | | Roosting known to occur within area overfly marine area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | Endangered | Roosting known to occur within area overfly marine area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Merops ornatus<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area overfly marine area |
| Monarcha melanopsis<br>Black-faced Monarch [609] | | Species or species habitat may occur within area overfly marine area |
| Motacilla flava<br>Yellow Wagtail [644] | | Species or species habitat may occur within area overfly marine area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Monarcha melanopsis<br>Black-faced Monarch [609] | | Species or species habitat may occur within area overfly marine area |
| Motacilla flava<br>Yellow Wagtail [644] | | Species or species habitat may occur within area overfly marine area |
| Myiagra cyanoleuca<br>Satin Flycatcher [612] | | Species or species habitat known to occur within area overfly marine area |
| Neophema chrysogaster<br>Orange-bellied Parrot [747] | Critically Endangered | Species or species habitat known to occur within area overfly marine area |
| Neophema chrysostoma<br>Blue-winged Parrot [726] | Vulnerable | Species or species habitat known to occur within area overfly marine area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Numenius minutus<br>Little Curlew, Little Whimbrel [848] | | Roosting likely to occur within area overfly marine area |
| Numenius phaeopus<br>Whimbrel [849] | | Roosting known to occur within area |
| Pachyptila turtur<br>Fairy Prion [1066] | | Species or species habitat known to occur within area |
| Pandion haliaetus<br>Osprey [952] | | Species or species habitat known to occur within area |
| Pelecanoides urinatrix<br>Common Diving-Petrel [1018] | | Breeding known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Myiagra cyanoleuca<br>Satin Flycatcher [612] | | Species or species habitat known to occur within area<br>overfly marine area |
| Neophema chrysogaster<br>Orange-bellied Parrot [747] | Critically Endangered | Species or species habitat known to occur within area<br>overfly marine area |
| Neophema chrysostoma<br>Blue-winged Parrot [726] | Vulnerable | Species or species habitat known to occur within area<br>overfly marine area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Numenius minutus<br>Little Curlew, Little Whimbrel [848] | | Roosting likely to occur within area<br>overfly marine area |
| Numenius phaeopus<br>Whimbrel [849] | | Roosting known to occur within area |
| Pachyptila turtur<br>Fairy Prion [1066] | | Species or species habitat known to occur within area |
| Pandion haliaetus<br>Osprey [952] | | Species or species habitat known to occur within area |
| Pelecanoides urinatrix<br>Common Diving-Petrel [1018] | | Breeding known to occur within area |
| Phalacrocorax fuscescens<br>Black-faced Cormorant [59660] | | Breeding known to occur within area |
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat likely to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Phalacrocorax fuscescens<br>Black-faced Cormorant [59660] | | Breeding known to occur within area |
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat likely to occur within area |
| Pluvialis fulva<br>Pacific Golden Plover [25545] | | Roosting known to occur within area |
| Pluvialis squatarola<br>Grey Plover [865] | Vulnerable | Roosting known to occur within area overfly marine area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Species or species habitat may occur within area |
| Recurvirostra novaehollandiae<br>Red-necked Avocet [871] | | Roosting known to occur within area overfly marine area |
| Rhipidura rufifrons<br>Rufous Fantail [592] | | Species or species habitat known to occur within area overfly marine area |
| Rostratula australis as Rostratula benghalensis (sensu lato)<br>Australian Painted Snipe [77037] | Endangered | Species or species habitat likely to occur within area overfly marine area |
| Stercorarius antarcticus as Catharacta skua<br>Brown Skua [85039] | | Species or species habitat may occur within area |
| Sterna striata<br>White-fronted Tern [799] | | Foraging, feeding or related behaviour likely to occur within area |
| Sternula albifrons as Sterna albifrons<br>Little Tern [82849] | Vulnerable | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Pluvialis fulva<br>Pacific Golden Plover [25545] | | Roosting known to occur within area |
| Pluvialis squatarola<br>Grey Plover [865] | Vulnerable | Roosting known to occur within area<br>overfly marine area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Species or species habitat may occur within area |
| Recurvirostra novaehollandiae<br>Red-necked Avocet [871] | | Species or species habitat known to occur within area<br>overfly marine area |
| Rhipidura rufifrons<br>Rufous Fantail [592] | | Species or species habitat known to occur within area<br>overfly marine area |
| Rostratula australis as Rostratula benghalensis (sensu lato)<br>Australian Painted Snipe [77037] | Endangered | Species or species habitat likely to occur within area overfly marine area |
| Stercorarius antarcticus as Catharacta skua<br>Brown Skua [85039] | | Species or species habitat may occur within area |
| Sterna striata<br>White-fronted Tern [799] | | Foraging, feeding or related behaviour likely to occur within area |
| Sternula albifrons as Sterna albifrons<br>Little Tern [82849] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche bulleri<br>Buller's Albatross, Pacific Albatross [64460] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche bulleri platei as Thalassarche sp. nov.<br>Northern Buller's Albatross, Pacific Albatross [82273] | Vulnerable | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Thalassarche bulleri<br>Buller's Albatross, Pacific Albatross [64460] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche bulleri platei as Thalassarche sp. nov.<br>Northern Buller's Albatross, Pacific Albatross [82273] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat likely to occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche chrysostoma<br>Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Thalasseus bergii as Sterna bergii<br>Greater Crested Tern [83000] | | Breeding known to occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Thalassarche carteri<br>Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat likely to occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche chrysostoma<br>Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Thalasseus bergii as Sterna bergii<br>Greater Crested Tern [83000] | | Breeding known to occur within area |
| Thinornis cucullatus as Thinornis rubricollis<br>Hooded Plover, Hooded Dotterel [87735] | | Species or species habitat known to occur within area<br>overfly marine area |
| Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis<br>Eastern Hooded Plover, Eastern Hooded Plover [90381] | Vulnerable | Species or species habitat known to occur within area<br>overfly marine area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Thinornis cucullatus as Thinornis rubricollis | | |
| Hooded Plover, Hooded Dotterel [87735] | | Species or species habitat known to occur within area overfly marine area |
| Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis | | |
| Eastern Hooded Plover, Eastern Hooded Plover [90381] | Vulnerable | Species or species habitat known to occur within area overfly marine area |
| Tringa brevipes as Heteroscelus brevipes | | |
| Grey-tailed Tattler [851] | | Roosting known to occur within area |
| Tringa glareola | | |
| Wood Sandpiper [829] | | Roosting known to occur within area overfly marine area |
| Tringa incana as Heteroscelus incanus | | |
| Wandering Tattler [831] | | Roosting known to occur within area |
| Tringa nebularia | | |
| Common Greenshank, Greenshank [832] | Endangered | Species or species habitat known to occur within area overfly marine area |
| Tringa stagnatilis | | |
| Marsh Sandpiper, Little Greenshank [833] | | Roosting known to occur within area overfly marine area |
| Xenus cinereus | | |
| Terek Sandpiper [59300] | Vulnerable | Roosting known to occur within area overfly marine area |
| Fish | | |
| Heraldia nocturna | | |
| Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227] | | Species or species habitat may occur within area |
| Hippocampus abdominalis | | |
| Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233] | | Species or species habitat may occur within area |
| Hippocampus breviceps | | |
| Short-head Seahorse, Short-snouted Seahorse [66235] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| [Tringa brevipes as Heteroscelus brevipes](#)<br>Grey-tailed Tattler [851] | | Roosting known to occur within area |
| [Tringa glareola](#)<br>Wood Sandpiper [829] | | Species or species habitat known to occur within area overfly marine area |
| [Tringa incana as Heteroscelus incanus](#)<br>Wandering Tattler [831] | | Species or species habitat known to occur within area |
| [Tringa nebularia](#)<br>Common Greenshank, Greenshank [832] | Endangered | Species or species habitat known to occur within area overfly marine area |
| [Tringa stagnatilis](#)<br>Marsh Sandpiper, Little Greenshank [833] | | Roosting known to occur within area overfly marine area |
| [Xenus cinereus](#)<br>Terek Sandpiper [59300] | Vulnerable | Roosting known to occur within area overfly marine area |
| Fish | | |
| [Heraldia nocturna](#)<br>Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227] | | Species or species habitat may occur within area |
| [Hippocampus abdominalis](#)<br>Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233] | | Species or species habitat may occur within area |
| [Hippocampus breviceps](#)<br>Short-head Seahorse, Short-snouted Seahorse [66235] | | Species or species habitat may occur within area |
| [Hippocampus minotaur](#)<br>Bullneck Seahorse [66705] | | Species or species habitat may occur within area |
| [Histiogamphelus briggsii](#)<br>Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Hippocampus minotaur<br>Bullneck Seahorse [66705] | | Species or species habitat may occur within area |
| Histiogamphelus briggsii<br>Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242] | | Species or species habitat may occur within area |
| Histiogamphelus cristatus<br>Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243] | | Species or species habitat may occur within area |
| Hypselognathus rostratus<br>Knifesnout Pipefish, Knife-snouted Pipefish [66245] | | Species or species habitat may occur within area |
| Kaupus costatus<br>Deepbody Pipefish, Deep-bodied Pipefish [66246] | | Species or species habitat may occur within area |
| Kimblaeus bassensis<br>Trawl Pipefish, Bass Strait Pipefish [66247] | | Species or species habitat may occur within area |
| Leptoichthys fistularius<br>Brushtail Pipefish [66248] | | Species or species habitat may occur within area |
| Lissocampus caudalis<br>Australian Smooth Pipefish, Smooth Pipefish [66249] | | Species or species habitat may occur within area |
| Lissocampus runa<br>Javelin Pipefish [66251] | | Species or species habitat may occur within area |
| Maroubra perserrata<br>Sawtooth Pipefish [66252] | | Species or species habitat may occur within area |
| Mitotichthys mollisoni<br>Mollison's Pipefish [66260] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Histiogamphelus cristatus<br>Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243] | | Species or species habitat may occur within area |
| Hypselognathus rostratus<br>Knifesnout Pipefish, Knife-snouted Pipefish [66245] | | Species or species habitat may occur within area |
| Kaupus costatus<br>Deepbody Pipefish, Deep-bodied Pipefish [66246] | | Species or species habitat may occur within area |
| Kimblaeus bassensis<br>Trawl Pipefish, Bass Strait Pipefish [66247] | | Species or species habitat may occur within area |
| Leptoichthys fistularius<br>Brushtail Pipefish [66248] | | Species or species habitat may occur within area |
| Lissocampus caudalis<br>Australian Smooth Pipefish, Smooth Pipefish [66249] | | Species or species habitat may occur within area |
| Lissocampus runa<br>Javelin Pipefish [66251] | | Species or species habitat may occur within area |
| Maroubra perserrata<br>Sawtooth Pipefish [66252] | | Species or species habitat may occur within area |
| Mitotichthys mollisoni<br>Mollison's Pipefish [66260] | | Species or species habitat may occur within area |
| Mitotichthys semistriatus<br>Halfbanded Pipefish [66261] | | Species or species habitat may occur within area |
| Mitotichthys tuckeri<br>Tucker's Pipefish [66262] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Mitotichthys semistriatus<br>Halfbanded Pipefish [66261] | | Species or species habitat may occur within area |
| Mitotichthys tuckeri<br>Tucker's Pipefish [66262] | | Species or species habitat may occur within area |
| Notiocampus ruber<br>Red Pipefish [66265] | | Species or species habitat may occur within area |
| Phycodurus eques<br>Leafy Seadragon [66267] | | Species or species habitat may occur within area |
| Phyllopteryx taeniolatus<br>Common Seadragon, Weedy Seadragon [66268] | | Species or species habitat may occur within area |
| Pugnaso curtirostris<br>Pugnose Pipefish, Pug-nosed Pipefish [66269] | | Species or species habitat may occur within area |
| Solegnathus robustus<br>Robust Pipehorse, Robust Spiny Pipehorse [66274] | | Species or species habitat may occur within area |
| Solegnathus spinosissimus<br>Spiny Pipehorse, Australian Spiny Pipehorse [66275] | | Species or species habitat may occur within area |
| Stigmatopora argus<br>Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276] | | Species or species habitat may occur within area |
| Stigmatopora nigra<br>Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277] | | Species or species habitat may occur within area |
| Stipecampus cristatus<br>Ringback Pipefish, Ring-backed Pipefish [66278] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
| --- | --- | --- |
| Notiocampus ruber<br>Red Pipefish [66265] | | Species or species habitat may occur within area |
| Phycodurus eques<br>Leafy Seadragon [66267] | | Species or species habitat may occur within area |
| Phyllopteryx taeniolatus<br>Common Seadragon, Weedy Seadragon [66268] | | Species or species habitat may occur within area |
| Pugnaso curtirostris<br>Pugnose Pipefish, Pug-nosed Pipefish [66269] | | Species or species habitat may occur within area |
| Solegnathus robustus<br>Robust Pipehorse, Robust Spiny Pipehorse [66274] | | Species or species habitat may occur within area |
| Solegnathus spinosissimus<br>Spiny Pipehorse, Australian Spiny Pipehorse [66275] | | Species or species habitat may occur within area |
| Stigmatopora argus<br>Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276] | | Species or species habitat may occur within area |
| Stigmatopora nigra<br>Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277] | | Species or species habitat may occur within area |
| Stipecampus cristatus<br>Ringback Pipefish, Ring-backed Pipefish [66278] | | Species or species habitat may occur within area |
| Urocampus carinirostris<br>Hairy Pipefish [66282] | | Species or species habitat may occur within area |
| Vanacampus margaritifer<br>Mother-of-pearl Pipefish [66283] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| Urocampus carinirostris<br>Hairy Pipefish [66282] | | Species or species habitat may occur within area |
| Vanacampus margaritifer<br>Mother-of-pearl Pipefish [66283] | | Species or species habitat may occur within area |
| Vanacampus phillipi<br>Port Phillip Pipefish [66284] | | Species or species habitat may occur within area |
| Vanacampus poecilolaemus<br>Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285] | | Species or species habitat may occur within area |
| **Mammal** | | |
| Arctocephalus forsteri<br>Long-nosed Fur-seal, New Zealand Fur-seal [20] | | Species or species habitat may occur within area |
| Arctocephalus pusillus<br>Australian Fur-seal, Australo-African Fur-seal [21] | | Breeding known to occur within area |
| **Reptile** | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Species or species habitat may occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |

| Whales and Other Cetaceans | | [ Resource Information ] |
|---|---|---|
| Current Scientific Name | Status | Type of Presence |
| Mammal | | |
| Balaenoptera acutorostrata<br>Minke Whale [33] | | Species or species habitat may occur within area |

| Scientific Name | Threatened Category | Presence Text |
|---|---|---|
| [Vanacampus phillipi](#)<br>Port Phillip Pipefish [66284] | | Species or species habitat may occur within area |
| [Vanacampus poecilolaemus](#)<br>Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285] | | Species or species habitat may occur within area |
| **Mammal** | | |
| [Arctocephalus forsteri](#)<br>Long-nosed Fur-seal, New Zealand Fur-seal [20] | | Species or species habitat may occur within area |
| [Arctocephalus pusillus](#)<br>Australian Fur-seal, Australo-African Fur-seal [21] | | Breeding known to occur within area |

| | | |
|---|---|---|
| **Reptile** | | |
| [Caretta caretta](#)<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| [Chelonia mydas](#)<br>Green Turtle [1765] | Vulnerable | Species or species habitat may occur within area |
| [Dermochelys coriacea](#)<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |

| Whales and Other Cetaceans | | [ Resource Information ] |
|---|---|---|
| Current Scientific Name | Status | Type of Presence |
| Mammal | | |
| [Balaenoptera acutorostrata](#)<br>Minke Whale [33] | | Species or species habitat may occur within area |
| [Balaenoptera borealis](#)<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| [Balaenoptera musculus](#)<br>Blue Whale [36] | Endangered | Species or species habitat likely to occur within area |

| Current Scientific Name | Status | Type of Presence |
| --- | --- | --- |
| [Balaenoptera borealis](#)<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| [Balaenoptera musculus](#)<br>Blue Whale [36] | Endangered | Species or species habitat likely to occur within area |
| [Balaenoptera physalus](#)<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| [Caperea marginata](#)<br>Pygmy Right Whale [39] | | Foraging, feeding or related behaviour may occur within area |
| [Delphinus delphis](#)<br>Common Dolphin, Short-beaked Common Dolphin [60] | | Species or species habitat may occur within area |
| [Eubalaena australis](#)<br>Southern Right Whale [40] | Endangered | Species or species habitat known to occur within area |
| [Globicephala macrorhynchus](#)<br>Short-finned Pilot Whale [62] | | Species or species habitat may occur within area |
| [Grampus griseus](#)<br>Risso's Dolphin, Grampus [64] | | Species or species habitat may occur within area |
| [Lagenorhynchus obscurus](#)<br>Dusky Dolphin [43] | | Species or species habitat may occur within area |
| [Megaptera novaeangliae](#)<br>Humpback Whale [38] | | Species or species habitat known to occur within area |
| [Orcinus orca](#)<br>Killer Whale, Orca [46] | | Species or species habitat likely to occur within area |

| Current Scientific Name | Status | Type of Presence |
| --- | --- | --- |
| [Balaenoptera physalus](#)<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| [Caperea marginata](#)<br>Pygmy Right Whale [39] | | Foraging, feeding or related behaviour may occur within area |
| [Delphinus delphis](#)<br>Common Dolphin, Short-beaked Common Dolphin [60] | | Species or species habitat may occur within area |
| [Eubalaena australis](#)<br>Southern Right Whale [40] | Endangered | Species or species habitat known to occur within area |
| [Globicephala macrorhynchus](#)<br>Short-finned Pilot Whale [62] | | Species or species habitat may occur within area |
| [Grampus griseus](#)<br>Risso's Dolphin, Grampus [64] | | Species or species habitat may occur within area |
| [Lagenorhynchus obscurus](#)<br>Dusky Dolphin [43] | | Species or species habitat may occur within area |
| [Megaptera novaeangliae](#)<br>Humpback Whale [38] | | Species or species habitat known to occur within area |
| [Orcinus orca](#)<br>Killer Whale, Orca [46] | | Species or species habitat likely to occur within area |
| [Pseudorca crassidens](#)<br>False Killer Whale [48] | | Species or species habitat likely to occur within area |
| [Tursiops aduncus](#)<br>Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418] | | Species or species habitat likely to occur within area |

| Current Scientific Name | Status | Type of Presence |
|---|---|---|
| [Pseudorca crassidens](#)<br>False Killer Whale [48] | | Species or species habitat likely to occur within area |
| [Tursiops aduncus](#)<br>Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418] | | Species or species habitat likely to occur within area |
| [Tursiops truncatus s. str.](#)<br>Bottlenose Dolphin [68417] | | Species or species habitat may occur within area |

## Extra Information

### State and Territory Reserves [ Resource Information ]

| Protected Area Name | Reserve Type | State |
|---|---|---|
| Anser Island | Reference Area | VIC |
| Bunurong | Marine National Park | VIC |
| Cape Liptrap Coastal Park | Conservation Park | VIC |
| Churchill Island | Marine National Park | VIC |
| Mornington Peninsula | National Park | VIC |
| Phillip Island Nature Park | Other | VIC |
| Southern Wilsons Promontory | Remote and Natural Area - Schedule 6, National Parks Act | VIC |
| Unnamed C0293 | Private Nature Reserve | VIC |
| Ventnor B.R. | Natural Features Reserve | VIC |
| Wilsons Promontory | National Park | VIC |
| Wilsons Promontory | Marine National Park | VIC |
| Wilsons Promontory Islands | Remote and Natural Area - Schedule 6, National Parks Act | VIC |
| Wilsons Promontory Marine Park | National Parks Act Schedule 4 park or reserve | VIC |
| Wilsons Promontory Marine Reserve | National Parks Act Schedule 4 park or reserve | VIC |

| Current Scientific Name | Status | Type of Presence |
|---|---|---|
| Tursiops truncatus s. str.<br>Bottlenose Dolphin [68417] | | Species or species habitat may occur within area |

| Australian Marine Parks | [ Resource Information ] |
|---|---|
| Park Name | Zone & IUCN Categories |
| Beagle | Multiple Use Zone (IUCN VI) |

## Extra Information

| State and Territory Reserves | | [ Resource Information ] |
|---|---|---|
| Protected Area Name | Reserve Type | State |
| Anser Island | Reference Area | VIC |
| Bunurong | Marine National Park | VIC |
| Cape Liptrap Coastal Park | Conservation Park | VIC |
| Phillip Island Nature Park | Other | VIC |
| Rodondo Island | Nature Reserve | TAS |
| Shallow Inlet Marine and Coastal Park | National Parks Act Schedule 4 park or reserve | VIC |
| Southern Wilsons Promontory | Remote and Natural Area - Schedule 6, National Parks Act | VIC |
| Wilsons Promontory | National Park | VIC |
| Wilsons Promontory | Marine National Park | VIC |
| Wilsons Promontory Islands | Remote and Natural Area - Schedule 6, National Parks Act | VIC |
| Wilsons Promontory Marine Park | National Parks Act Schedule 4 park or reserve | VIC |
| Wilsons Promontory Marine Reserve | National Parks Act Schedule 4 park or reserve | VIC |
| Yallock-Bulluk Marine and Coastal Park | National Parks Act Schedule 3 Other Parks | VIC |

| Protected Area Name | Reserve Type | State |
|---|---|---|
| Yallock-Bulluk Marine and Coastal Park | National Parks Act Schedule 3 Other Parks | VIC |

## Regional Forest Agreements [ Resource Information ]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

| RFA Name | State |
|---|---|
| Gippsland RFA | Victoria |

## Nationally Important Wetlands [ Resource Information ]

| Wetland Name | State |
|---|---|
| Anderson Inlet | VIC |
| Powlett River Mouth | VIC |
| Western Port | VIC |

## EPBC Act Referrals [ Resource Information ]

| Title of referral | Reference | Referral Outcome | Assessment Status |
|---|---|---|---|
| Gippsland Skies Offshore Wind Project marine surveys (investigations) | 2024/09991 | | Referral Decision |
| Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East | 2024/09795 | | Completed |
| Shearwater 2D and 3D marine seismic survey | 2005/2180 | | Completed |
| SMAP telecommunications submarine cable installation | 2024/09989 | | Completed |
| **Controlled action** | | | |
| Victorian Desalination Project, Bass Coast | 2008/3948 | Controlled Action | Post-Approval |
| Yolla Gas Field (TRL1) Development | 2001/321 | Controlled Action | Post-Approval |
| **Not controlled action** | | | |
| accomodation units and associatedadministration and recreational facilities | 2001/430 | Not Controlled Action | Completed |
| Aquacullture facility for rainbow trout and yabbies and recreational facilities | 2002/822 | Not Controlled Action | Completed |

## Regional Forest Agreements [ Resource Information ]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

| RFA Name | State |
|---|---|
| Gippsland RFA | Victoria |

## Nationally Important Wetlands [ Resource Information ]

| Wetland Name | State |
|---|---|
| Anderson Inlet | VIC |
| Powlett River Mouth | VIC |
| Shallow Inlet Marine & Coastal Park | VIC |
| Western Port | VIC |

## EPBC Act Referrals [ Resource Information ]

| Title of referral | Reference | Referral Outcome | Assessment Status |
|---|---|---|---|
| | | | |
| Gippsland Skies Offshore Wind Project marine surveys (investigations) | 2024/09991 | | Referral Decision |
| Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East | 2024/09795 | | Completed |
| Shearwater 2D and 3D marine seismic survey | 2005/2180 | | Completed |
| SMAP telecommunications submarine cable installation | 2024/09989 | | Completed |
| Controlled action | | | |
| Victorian Desalination Project, Bass Coast | 2008/3948 | Controlled Action | Post-Approval |
| Yolla Gas Field (TRL1) Development | 2001/321 | Controlled Action | Post-Approval |
| Not controlled action | | | |
| accomodation units and associatedadministration and recreational facilities | 2001/430 | Not Controlled Action | Completed |
| Communications tower extension | 2003/1099 | Not Controlled Action | Completed |
| Construct a Recycled Water Pipeline from Somers Treatment Plant to Blue Scope S | 2009/4982 | Not Controlled Action | Completed |

| Title of referral | Reference | Referral Outcome | Assessment Status |
|---|---|---|---|
| Not controlled action | | | |
| Bass Basin - Pee Jay-1 - Drilling Program | 2007/3908 | Not Controlled Action | Completed |
| Communications tower extension | 2003/1099 | Not Controlled Action | Completed |
| Construct a Recycled Water Pipeline from Somers Treatment Plant to Blue Scope S | 2009/4982 | Not Controlled Action | Completed |
| Cowes Primary School Gymnasium | 2020/8683 | Not Controlled Action | Completed |
| Exploration Drilling Well Trefoil-1 | 2003/1058 | Not Controlled Action | Completed |
| Ferry Service Infrastructure Development | 2001/269 | Not Controlled Action | Completed |
| Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia | 2015/7522 | Not Controlled Action | Completed |
| INDIGO Central Submarine Telecommunications Cable | 2017/8127 | Not Controlled Action | Completed |
| Installation of optic fibre cable from Inverloch, Victoria to Stanley, Tasmania | 2002/906 | Not Controlled Action | Completed |
| Newhaven Yacht Squadron marina extension | 2004/1450 | Not Controlled Action | Completed |
| Optic fibre cable installation - San Remo to Cowes | 2005/2386 | Not Controlled Action | Completed |
| Spikey Beach 1, West Triton Drilling Program, Bass Basin Permit T/38P | 2007/3914 | Not Controlled Action | Completed |
| Telstra optic fibre cable across Bass Strait - Sub bottom profiler Surve | 2002/779 | Not Controlled Action | Completed |
| Venus Bay Outfall Extension | 2004/1555 | Not Controlled Action | Completed |
| Not controlled action (particular manner) | | | |
| 2D & 3D seismic survey T/39P | 2005/2237 | Not Controlled Action (Particular Manner) | Post-Approval |
| 2D Seismic Survey | 2008/4066 | Not Controlled Action (Particular Manner) | Post-Approval |

| Title of referral | Reference | Referral Outcome | Assessment Status |
|---|---|---|---|
| Not controlled action | | | |
| Exploration Drilling Well Trefoil-1 | 2003/1058 | Not Controlled Action | Completed |
| Ferry Service Infrastructure Development | 2001/269 | Not Controlled Action | Completed |
| Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia | 2015/7522 | Not Controlled Action | Completed |
| INDIGO Central Submarine Telecommunications Cable | 2017/8127 | Not Controlled Action | Completed |
| Installation of optic fibre cable from Inverloch, Victoria to Stanley, Tasmania | 2002/906 | Not Controlled Action | Completed |
| Newhaven Yacht Squadron marina extension | 2004/1450 | Not Controlled Action | Completed |
| Optic fibre cable installation - San Remo to Cowes | 2005/2386 | Not Controlled Action | Completed |
| Telstra optic fibre cable across Bass Strait - Sub bottom profiler Surve | 2002/779 | Not Controlled Action | Completed |
| Venus Bay Outfall Extension | 2004/1555 | Not Controlled Action | Completed |
| Not controlled action (particular manner) | | | |
| 2D & 3D seismic survey T/39P | 2005/2237 | Not Controlled Action (Particular Manner) | Post-Approval |
| 2D Seismic Survey | 2008/4066 | Not Controlled Action (Particular Manner) | Post-Approval |
| Aroo Chappell 3D seismic survey | 2010/5701 | Not Controlled Action (Particular Manner) | Post-Approval |
| Bass Basin 2D and 3D seismic surveys (T/38P & T/37P) | 2007/3650 | Not Controlled Action (Particular Manner) | Post-Approval |
| Dalrymple 3D Seismic Survey | 2010/5680 | Not Controlled Action (Particular Manner) | Post-Approval |
| Exploration drilling of the Craigow-1 and Tolpuddle-1 wells | 2010/5725 | Not Controlled Action | Post-Approval |

| Title of referral | Reference | Referral Outcome | Assessment Status |
|---|---|---|---|
| Not controlled action (particular manner) | | | |
| Aroo Chappell 3D seismic survey | 2010/5701 | Not Controlled Action (Particular Manner) | Post-Approval |
| Bass Basin 2D and 3D seismic surveys (T/38P & T/37P) | 2007/3650 | Not Controlled Action (Particular Manner) | Post-Approval |
| Dalrymple 3D Seismic Survey | 2010/5680 | Not Controlled Action (Particular Manner) | Post-Approval |
| Exploration drilling of the Craigow-1 and Tolpuddle-1 wells | 2010/5725 | Not Controlled Action (Particular Manner) | Post-Approval |
| INDIGO Marine Cable Route Survey (INDIGO) | 2017/7996 | Not Controlled Action (Particular Manner) | Post-Approval |
| Inspection of project vessels for presence of invasive marine pests in Commonwealth waters off Victo | 2012/6362 | Not Controlled Action (Particular Manner) | Post-Approval |
| Labatt 3D Seismic Survey T/47P Bass Strait | 2007/3759 | Not Controlled Action (Particular Manner) | Post-Approval |
| OTE10 2D Marine Seismic Survey | 2009/5223 | Not Controlled Action (Particular Manner) | Post-Approval |
| Rockhopper-1 and Trefoil-2 Exploration Drilling in Permit Area T/18P | 2009/4776 | Not Controlled Action (Particular Manner) | Post-Approval |
| Tap Oil Ltd Molson 2D Seismic Survey T47P | 2008/3967 | Not Controlled Action (Particular Manner) | Post-Approval |
| Referral decision | | | |
| All actions taken in response to the current severe bushfires in Victoria. | 2009/4787 | Referral Decision | Completed |
| Darymple 3D Seismic Survey, Petroleum Exploration Permit T/41P | 2010/5322 | Referral Decision | Completed |

| Title of referral | Reference | Referral Outcome | Assessment Status |
|---|---|---|---|
| Not controlled action (particular manner) | | | |
| | | (Particular Manner) | |
| INDIGO Marine Cable Route Survey (INDIGO) | 2017/7996 | Not Controlled Action (Particular Manner) | Post-Approval |
| Inspection of project vessels for presence of invasive marine pests in Commonwealth waters off Victo | 2012/6362 | Not Controlled Action (Particular Manner) | Post-Approval |
| Labatt 3D Seismic Survey T/47P Bass Strait | 2007/3759 | Not Controlled Action (Particular Manner) | Post-Approval |
| OTE10 2D Marine Seismic Survey | 2009/5223 | Not Controlled Action (Particular Manner) | Post-Approval |
| Rockhopper-1 and Trefoil-2 Exploration Drilling in Permit Area T/18P | 2009/4776 | Not Controlled Action (Particular Manner) | Post-Approval |
| Tap Oil Ltd Molson 2D Seismic Survey T47P | 2008/3967 | Not Controlled Action (Particular Manner) | Post-Approval |
| Referral decision | | | |
| All actions taken in response to the current severe bushfires in Victoria. | 2009/4787 | Referral Decision | Completed |
| Darymple 3D Seismic Survey, Petroleum Exploration Permit T/41P | 2010/5322 | Referral Decision | Completed |

| Biologically Important Areas | | [ Resource Information ] |
|---|---|---|
| Scientific Name | Behaviour | Presence |
| Seabirds | | |
| Ardenna tenuirostris<br>Short-tailed Shearwater [82652] | Breeding | Known to occur |
| Ardenna tenuirostris<br>Short-tailed Shearwater [82652] | Foraging | Known to occur |

| Title of referral | Reference | Referral Outcome | Assessment Status |
|---|---|---|---|
| Referral decision | | | |

## Biologically Important Areas [ Resource Information ]

| Scientific Name | Behaviour | Presence |
|---|---|---|
| **Seabirds** | | |
| Ardenna tenuirostris<br>Short-tailed Shearwater [82652] | Breeding | Known to occur |
| Ardenna tenuirostris<br>Short-tailed Shearwater [82652] | Foraging | Known to occur |
| Diomedea exulans (sensu lato)<br>Wandering Albatross [1073] | Foraging | Known to occur |
| Eudyptula minor<br>Little Penguin [1085] | Breeding | Known to occur |
| Eudyptula minor<br>Little Penguin [1085] | Foraging | Known to occur |
| Morus serrator<br>Australasian Gannet [1020] | Foraging | Known to occur |
| Pelagodroma marina<br>White-faced Storm-petrel [1016] | Foraging | Known to occur |
| Pelecanoides urinatrix<br>Common Diving-petrel [1018] | Foraging | Known to occur |
| Thalassarche bulleri<br>Bullers Albatross [64460] | Foraging | Known to occur |
| Thalassarche cauta cauta<br>Shy Albatross [82345] | Foraging likely | Likely to occur |
| Thalassarche chlororhynchos bassi<br>Indian Yellow-nosed Albatross [85249] | Foraging | Known to occur |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Foraging | Known to occur |
| Thalassarche melanophris impavida<br>Campbell Albatross [82449] | Foraging | Known to occur |

| Scientific Name | Behaviour | Presence |
|---|---|---|
| Diomedea exulans (sensu lato)<br>Wandering Albatross [1073] | Foraging | Known to occur |
| Eudyptula minor<br>Little Penguin [1085] | Breeding | Known to occur |
| Eudyptula minor<br>Little Penguin [1085] | Foraging | Known to occur |
| Morus serrator<br>Australasian Gannet [1020] | Foraging | Known to occur |
| Pelagodroma marina<br>White-faced Storm-petrel [1016] | Foraging | Known to occur |
| Pelecanoides urinatrix<br>Common Diving-petrel [1018] | Foraging | Known to occur |
| Thalassarche bulleri<br>Bullers Albatross [64460] | Foraging | Known to occur |
| Thalassarche cauta cauta<br>Shy Albatross [82345] | Foraging likely | Likely to occur |
| Thalassarche chlororhynchos bassi<br>Indian Yellow-nosed Albatross [85249] | Foraging | Known to occur |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Foraging | Known to occur |
| Thalassarche melanophris impavida<br>Campbell Albatross [82449] | Foraging | Known to occur |
| **Sharks** | | |
| Carcharodon carcharias<br>White Shark [64470] | Foraging | Known to occur |
| **Whales** | | |
| Balaenoptera musculus brevicauda<br>Pygmy Blue Whale [81317] | Foraging | Likely to be present |
| Balaenoptera musculus brevicauda<br>Pygmy Blue Whale [81317] | Known Foraging Area | Known to occur |

| Scientific Name | Behaviour | Presence |
|---|---|---|
| **Sharks** | | |
| Carcharodon carcharias | | |
| White Shark [64470] | Foraging | Known to occur |
| **Whales** | | |
| Balaenoptera musculus brevicauda | | |
| Pygmy Blue Whale [81317] | Foraging | Likely to be present |
| Balaenoptera musculus brevicauda | | |
| Pygmy Blue Whale [81317] | Known Foraging Area | Known to occur |

**Bioregional Assessments** [ Resource Information ]

| SubRegion | BioRegion | Website |
|---|---|---|
| Gippsland | Gippsland Basin | BA website |

| Scientific Name | Behaviour | Presence |
|---|---|---|

## Bioregional Assessments

[ Resource Information ]

| SubRegion | BioRegion | Website |
|---|---|---|
| Gippsland | Gippsland Basin | BA website |

# Caveat

## 1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

## 2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

## 3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

## 4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

# Caveat

## 1 PURPOSE

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# Acknowledgements

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-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

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-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
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The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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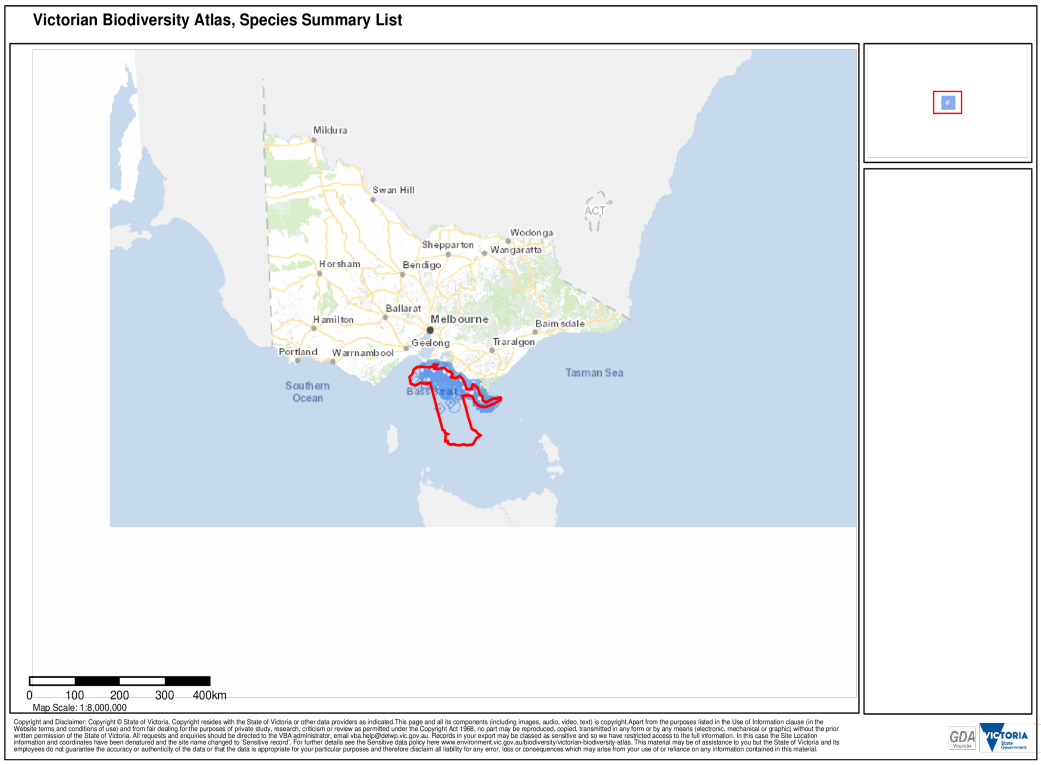
# Victorian Biodiversity Atlas, Species Summary List

(Date: 29/07/2025 10:48 AM)




## Selected Area

Type: User Polygon Value: POLYGON ((145.029343 -38.506185,145.053571 -38.458515,145.144504 -38.463207,145.077902 -38.539526,145.15072 -38.53

## Common Filter

| | | | |
|---|---|---|---|
| Scientific Name : | | Common Name : | |
| VBA Taxon ID : | | Conservation Status : | |
| Taxon Level : | Species | Taxon Type : | |
| Other Agency Codes : | | Discipline : | |
| Date Since : | (dd/mm/yyyy) | Date To : | (dd/mm/yyyy) |

Last Review Date:28 Apr 2025

| Taxon ID | Scientific Name | Common Name | FFG Status | Conservation Status | Discipline | Taxon Origin | Short Name | Count of Sightings | Last Record |
|---|---|---|---|---|---|---|---|---|---|
| 1680 | Engaeus cunicularius | Granular Burrowing Crayfish | | | Aquatic fauna, Aquatic invertebrates, Terrestrial fauna | | eng cun | 1 | 19/06/1999 |
| 4651 | Anguilla australis | Southern Shortfin Eel | | | Aquatic fauna, Aquatic invertebrates, Marine, Terrestrial fauna | | ang aus | 1 | 23/06/1960 |
| 4655 | Conger verreauxi | Southern Conger | | | Marine, Aquatic fauna | | | 1 | 16/11/2000 |
| 4756 | Pseudophycis bachus | Red Rock Cod | | | Aquatic fauna, Marine | | | 3 | 16/12/2001 |
| 4757 | Pseudophycis barbata | Bearded Rock Cod | | | Aquatic fauna, Marine | | | 2 | 30/05/2002 |
| 4761 | Genypterus tigerinus | Rock Ling | | | Marine, Aquatic fauna | | | 1 | 12/06/2000 |
| 4929 | Girella elevata | Rock Blackfish | | | Marine, Aquatic fauna | | | 1 | 14/11/2000 |
| 4930 | Girella tricuspidata | Luderick | | | Marine, Aquatic fauna | | | 3 | 20/06/2005 |
| 4933 | Atypichthys strigatus | Mado | | | Marine, Aquatic fauna | | | 9 | 30/05/2002 |
| 4935 | Scorpis aequipinnis | Sea Sweep | | | Marine, Aquatic fauna | | | 41 | 20/06/2005 |
| 4938 | Enoplosus armatus | Old Wife | | | Marine, Aquatic fauna | | | 34 | 20/06/2005 |
| 4955 | Dactylophora nigricans | Dusky Morwong | | | Marine, Aquatic fauna | | | 4 | 20/06/2005 |
| 4975 | Notolabrus fucicola | Purple Wrasse | | | Marine, Aquatic fauna | | | 49 | 20/06/2005 |
| 4976 | Notolabrus tetricus | Blue Throated Wrasse | | | Marine, Aquatic fauna, Terrestrial fauna | | | 50 | 20/06/2005 |
| 4990 | Parablennius tasmanianus | Tasmanian Blenny | | | Marine, Aquatic fauna | | | 1 | 10/03/2005 |
| 5000 | Trinorfolkia clarkei | Clarks Threefin | | | Marine, Aquatic fauna | | | 4 | 27/05/2002 |
| 5010 | Heteroclinus perspicillatus | Common Weedfish | | | Marine, Aquatic fauna | | | 3 | 06/03/2003 |
| 5085 | Acanthaluteres vittiger | Toothbrush Leatherjacket | | | Marine, Aquatic fauna | | | 38 | 20/06/2005 |
| 5090 | Meuschenia trachylepis | Yellow-finned Leatherjacket | | | Marine, Aquatic fauna | | | 2 | 10/03/2005 |
| 5097 | Scobinichthys granulatus | Rough Leatherjacket | | | Marine, Aquatic fauna, Aquatic invertebrates | | | 2 | 04/03/2005 |
| 5101 | Aracana ornata | Ornate Cowfish | | | Marine, Aquatic fauna, Aquatic invertebrates | | | 1 | 01/05/2001 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5107 | Tetractenos glaber | Smooth Toadfish | | | Marine, Aquatic fauna, Terrestrial fauna | 2 | 08/03/2002 |
| 5117 | Diodon nicthemerus | Globefish | | | Marine, Aquatic fauna, Aquatic invertebrates, Terrestrial fauna | 12 | 20/06/2005 |
| 10001 | Dromaius novaehollandiae | Emu | | | Terrestrial fauna | 7 | 20/01/1979 |
| 10003 | Eudyptes chrysocome | Rockhopper Penguin | | | Marine, Terrestrial fauna | 2 | 01/01/1901 |
| 10004 | Eudyptes pachyrhynchus | Fiordland Penguin | | | Marine, Terrestrial fauna | 3 | 27/09/1984 |
| 10005 | Eudyptula minor | Little Penguin | | | Marine, Terrestrial fauna | 192 | 02/10/2018 |
| 10009 | Coturnix pectoralis | Stubble Quail | | | Terrestrial fauna | 14 | 01/12/1981 |
| 10010 | Synoicus ypsilophorus | Brown Quail | | | Terrestrial fauna | 5 | 01/03/1981 |
| 10012 | Synoicus chinensis | King Quail | Endangered | en | Terrestrial fauna | 3 | 01/01/1973 |
| 10014 | Turnix varius | Painted Button-quail | | | Terrestrial fauna | 6 | 01/09/1975 |
| 10018 | Turnix velox | Little Button-quail | | | Terrestrial fauna | 3 | 01/01/1901 |
| 10020 | Pedionomus torquatus | Plains-wanderer | Critically Endangered | CR cr | Terrestrial fauna | 3 | 01/01/1901 |
| 10030 | Geopelia placida | Peaceful Dove | | | Terrestrial fauna | 2 | 25/04/1981 |
| 10034 | Phaps chalcoptera | Common Bronzewing | | | Terrestrial fauna | 16 | 08/11/2012 |
| 10035 | Phaps elegans | Brush Bronzewing | | | Terrestrial fauna | 28 | 16/03/2001 |
| 10043 | Ocyphaps lophotes | Crested Pigeon | | | Terrestrial fauna | 2 | 23/06/2017 |
| 10045 | Lewinia pectoralis | Lewin's Rail | Vulnerable | vu | Terrestrial fauna | 6 | 01/01/1973 |
| 10046 | Hypotaenidia philippensis | Buff-banded Rail | | | Terrestrial fauna | 3 | 01/03/1981 |
| 10049 | Porzana fluminea | Australian Spotted Crake | | | Terrestrial fauna | 5 | 21/01/1978 |
| 10050 | Porzana pusilla | Baillon's Crake | | | Terrestrial fauna | 3 | 01/01/1901 |
| 10051 | Porzana tabuensis | Spotless Crake | | | Terrestrial fauna | 3 | 01/01/1901 |
| 10055 | Tribonyx ventralis | Black-tailed Native-hen | | | Terrestrial fauna | 2 | 01/01/1898 |
| 10056 | Gallinula tenebrosa | Dusky Moorhen | | | Terrestrial fauna | 20 | 01/03/1981 |
| 10058 | Porphyrio melanotus | Australasian Swamphen | | | Terrestrial fauna | 30 | 01/03/1981 |
| 10059 | Fulica atra | Eurasian Coot | | | Terrestrial fauna | 19 | 01/03/1981 |
| 10060 | Podiceps cristatus | Great Crested Grebe | | | Terrestrial fauna | 6 | 04/05/1974 |
| 10061 | Tachybaptus novaehollandiae | Australasian Grebe | | | Terrestrial fauna | 14 | 01/03/1981 |
| 10062 | Poliocephalus poliocephalus | Hoary-headed Grebe | | | Terrestrial fauna | 17 | 18/12/2005 |
| 10063 | Oceanites oceanicus | Wilson's Storm-Petrel | | | Terrestrial fauna | 1 | 26/02/1980 |
| 10064 | Garrodia nereis | Grey-backed Storm-Petrel | | | Terrestrial fauna | 1 | 28/07/1986 |
| 10065 | Pelagodroma marina | White-faced Storm-Petrel | Endangered | en | Terrestrial fauna, Coastal | 11 | 01/03/1981 |
| 10068 | Puffinus gavia | Fluttering Shearwater | | | Terrestrial fauna | 30 | 16/03/2001 |
| 10070 | Ardenna grisea | Sooty Shearwater | | VU | Terrestrial fauna | 7 | 12/11/1978 |
| 10071 | Ardenna tenuirostris | Short-tailed Shearwater | | | Terrestrial fauna | 189 | 03/10/2009 |
| 10072 | Ardenna carneipes | Flesh-footed Shearwater | | | Terrestrial fauna | 3 | 17/02/1977 |
| 10074 | Fulmarus glacialoides | Southern Fulmar | | | Terrestrial fauna | 12 | 21/10/2007 |
| 10075 | Pterodroma macroptera | Great-winged Petrel | | | Terrestrial fauna | 6 | 29/08/1984 |
| 10077 | Pterodroma lessonii | White-headed Petrel | | | Terrestrial fauna | 8 | 27/09/1984 |
| 10078 | Pterodroma leucoptera | Gould's Petrel | | EN | Terrestrial fauna | 4 | 26/12/1972 |
| 10079 | Macronectes spp. | Giant-Petrel species | | | Terrestrial fauna | 3 | 04/10/1981 |
| 10080 | Daption capense | Cape Petrel | | | Terrestrial fauna | 7 | 29/06/1980 |
| 10081 | Halobaena caerulea | Blue Petrel | | VU | Terrestrial fauna, Coastal | 10 | 13/08/1985 |
| 10082 | Pachyptila vittata | Broad-billed Prion | | | Terrestrial fauna | 1 | 30/07/1967 |
| 10083 | Pachyptila turtur | Fairy Prion | | | Terrestrial fauna, Coastal | 61 | 25/10/2017 |
| 10084 | Pachyptila desolata | Antarctic Prion | | | Terrestrial fauna | 9 | 22/06/1986 |
| 10085 | Pelecanoides urinatrix | Common Diving-Petrel | | | Terrestrial fauna, Coastal | 44 | 13/08/1985 |
| 10086 | Diomedea exulans | Wandering Albatross | Critically Endangered | VU cr | Terrestrial fauna, Coastal | 18 | 04/10/1981 |
| 10088 | Thalassarche melanophris | Black-browed Albatross | | VU | Terrestrial fauna, Coastal | 38 | 22/04/2019 |
| 10089 | Thalassarche carteri | Indian Yellow-nosed Albatross | Endangered | VU en | Terrestrial fauna, Coastal | 20 | 05/11/1981 |
| 10090 | Thalassarche chrysostoma | Grey-headed Albatross | Endangered | EN en | Terrestrial fauna, Coastal | 9 | 26/08/1978 |
| 10091 | Thalassarche cauta | Shy Albatross | Endangered | EN en | Terrestrial fauna, Coastal | 53 | 26/05/2019 |
| 10096 | Phalacrocorax carbo | Great Cormorant | | | Terrestrial fauna | 74 | 03/10/2009 |
| 10097 | Phalacrocorax sulcirostris | Little Black Cormorant | | | Terrestrial fauna | 48 | 25/07/2018 |
| 10098 | Phalacrocorax fuscescens | Black-faced Cormorant | | | Terrestrial fauna, Coastal | 66 | 04/07/2019 |
| 10099 | Phalacrocorax varius | Pied Cormorant | | | Terrestrial fauna, Coastal | 47 | 20/02/2019 |
| 10100 | Microcarbo melanoleucos | Little Pied Cormorant | | | Terrestrial fauna | 78 | 27/02/2020 |
| 10101 | Anhinga novaehollandiae | Australasian Darter | | | Terrestrial fauna | 9 | 01/03/1979 |
| 10104 | Morus serrator | Australasian Gannet | | | Terrestrial fauna | 94 | 26/05/2019 |
| 10106 | Pelecanus conspicillatus | Australian Pelican | | | Terrestrial fauna | 44 | 27/01/2019 |
| 10109 | Chlidonias leucopterus | White-winged Black Tern | | | Terrestrial fauna | 1 | 01/01/1973 |
| 10110 | Chlidonias hybrida | Whiskered Tern | | | Terrestrial fauna, Coastal | 3 | 01/10/1973 |
| 10111 | Gelochelidon macrotarsa | Australian Gull-billed Tern | Endangered | en | Terrestrial fauna, Coastal | 3 | 01/01/1973 |
| 10112 | Hydroprogne caspia | Caspian Tern | Vulnerable | vu | Terrestrial fauna, Coastal | 31 | 26/02/2017 |
| 10114 | Sterna striata | White-fronted Tern | | | Terrestrial fauna, Coastal | 20 | 04/10/1981 |
| 10115 | Thalasseus bergii | Crested Tern | | | Terrestrial fauna | 121 | 26/05/2019 |
| 10117 | Sternula albifrons | Little Tern | Critically Endangered | VU cr | Terrestrial fauna, Coastal | 6 | 01/03/1981 |
| 10118 | Sternula nereis | Fairy Tern | Critically Endangered | VU cr | Terrestrial fauna, Coastal | 9 | 01/03/1981 |
| 10125 | Chroicocephalus novaehollandiae | Silver Gull | | | Terrestrial fauna | 249 | 30/04/2021 |

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|---|---|---|---|---|---|---|---|
| 10128 | Stercorarius parasiticus | Arctic Jaeger | | | Terrestrial fauna | 12 | 05/11/1981 |
| 10129 | Arenaria interpres | Ruddy Turnstone | Endangered | VU en | Terrestrial fauna, Coastal | 12 | 01/03/1981 |
| 10130 | Haematopus longirostris | Pied Oystercatcher | | | Terrestrial fauna | 32 | 01/03/1981 |
| 10131 | Haematopus fuliginosus | Sooty Oystercatcher | | | Terrestrial fauna, Coastal | 131 | 22/06/2019 |
| 10132 | Erythrogonys cinctus | Red-kneed Dotterel | | | Terrestrial fauna | 5 | 10/02/1980 |
| 10133 | Vanellus miles | Masked Lapwing | | | Terrestrial fauna | 116 | 24/02/2019 |
| 10135 | Vanellus tricolor | Banded Lapwing | | | Terrestrial fauna | 14 | 12/03/1981 |
| 10136 | Pluvialis squatarola | Grey Plover | Vulnerable | VU vu | Terrestrial fauna, Coastal | 7 | 01/03/1981 |
| 10137 | Pluvialis fulva | Pacific Golden Plover | Vulnerable | vu | Terrestrial fauna, Coastal | 10 | 01/03/1981 |
| 10138 | Thinornis cucullatus | Hooded Plover | Vulnerable | VU vu | Terrestrial fauna, Coastal | 305 | 20/07/2019 |
| 10139 | Charadrius mongolus | Lesser Sand Plover | Endangered | EN en | Terrestrial fauna, Coastal | 8 | 01/10/1981 |
| 10140 | Charadrius bicinctus | Double-banded Plover | | | Terrestrial fauna | 22 | 01/03/1981 |
| 10141 | Charadrius leschenaultii | Greater Sand Plover | Vulnerable | VU vu | Terrestrial fauna, Coastal | 6 | 28/03/1984 |
| 10143 | Charadrius ruficapillus | Red-capped Plover | | | Terrestrial fauna | 54 | 01/10/1981 |
| 10144 | Elseyornis melanops | Black-fronted Dotterel | | | Terrestrial fauna | 17 | 01/01/1981 |
| 10147 | Cladorhynchus leucocephalus | Banded Stilt | | | Terrestrial fauna | 1 | 01/01/1898 |
| 10148 | Recurvirostra novaehollandiae | Red-necked Avocet | | | Terrestrial fauna | 4 | 01/10/1973 |
| 10149 | Numenius madagascariensis | Eastern Curlew | Critically Endangered | CR cr | Terrestrial fauna, Coastal | 29 | 01/03/1981 |
| 10150 | Numenius phaeopus | Whimbrel | Endangered | en | Terrestrial fauna, Coastal | 14 | 04/12/1978 |
| 10151 | Numenius minutus | Little Curlew | | | Terrestrial fauna | 2 | 01/01/1971 |
| 10153 | Limosa lapponica | Bar-tailed Godwit | Vulnerable | EN vu | Terrestrial fauna, Coastal | 19 | 01/10/1981 |
| 10154 | Tringa glareola | Wood Sandpiper | Endangered | en | Terrestrial fauna, Coastal | 3 | 10/02/1980 |
| 10155 | Tringa brevipes | Grey-tailed Tattler | Critically Endangered | cr | Terrestrial fauna, Coastal | 7 | 01/03/1981 |
| 10157 | Actitis hypoleucos | Common Sandpiper | Vulnerable | vu | Terrestrial fauna, Coastal | 6 | 01/03/1981 |
| 10158 | Tringa nebularia | Common Greenshank | Endangered | EN en | Terrestrial fauna, Coastal | 13 | 01/03/1981 |
| 10160 | Xenus cinereus | Terek Sandpiper | Endangered | VU en | Terrestrial fauna, Coastal | 3 | 01/10/1973 |
| 10161 | Calidris ferruginea | Curlew Sandpiper | Critically Endangered | CR cr | Terrestrial fauna, Coastal | 18 | 01/10/1981 |
| 10162 | Calidris ruficollis | Red-necked Stint | | | Terrestrial fauna | 24 | 01/10/1981 |
| 10163 | Calidris acuminata | Sharp-tailed Sandpiper | | VU | Terrestrial fauna | 20 | 01/10/1981 |
| 10164 | Calidris canutus | Red Knot | Endangered | VU en | Terrestrial fauna, Coastal | 8 | 01/03/1981 |
| 10165 | Calidris tenuirostris | Great Knot | Critically Endangered | VU cr | Terrestrial fauna, Coastal | 5 | 01/03/1981 |
| 10166 | Calidris alba | Sanderling | | | Terrestrial fauna, Coastal | 9 | 15/06/2019 |
| 10168 | Gallinago hardwickii | Latham's Snipe | | VU | Terrestrial fauna, Coastal | 12 | 01/10/1981 |
| 10170 | Rostratula australis | Australian Painted-snipe | Critically Endangered | EN cr | Terrestrial fauna, Coastal | 9 | 19/10/1986 |
| 10172 | Glareola maldivarum | Oriental Pratincole | | | Terrestrial fauna | 2 | 01/10/1973 |
| 10174 | Burhinus grallarius | Bush Stone-curlew | Critically Endangered | cr | Terrestrial fauna | 1 | 01/01/1901 |
| 10176 | Ardeotis australis | Australian Bustard | Critically Endangered | cr | Terrestrial fauna | 3 | 01/01/1898 |
| 10177 | Antigone rubicunda | Brolga | Endangered | en | Terrestrial fauna | 4 | 01/01/1953 |
| 10178 | Plegadis falcinellus | Glossy Ibis | | | Terrestrial fauna | 1 | 01/01/1860 |
| 10179 | Threskiornis molucca | Australian White Ibis | | | Terrestrial fauna | 94 | 24/02/2019 |
| 10180 | Threskiornis spinicollis | Straw-necked Ibis | | | Terrestrial fauna | 54 | 25/07/2018 |
| 10181 | Platalea regia | Royal Spoonbill | | | Terrestrial fauna, Coastal | 35 | 10/02/2019 |
| 10182 | Platalea flavipes | Yellow-billed Spoonbill | | | Terrestrial fauna | 18 | 01/03/1981 |
| 10185 | Egretta garzetta | Little Egret | Endangered | en | Terrestrial fauna, Coastal | 6 | 01/03/1981 |
| 10186 | Ardea intermedia plumifera | Plumed Egret | Critically Endangered | cr | Terrestrial fauna, Coastal | 4 | 01/01/1901 |
| 10188 | Egretta novaehollandiae | White-faced Heron | | | Terrestrial fauna | 145 | 26/05/2019 |
| 10189 | Ardea pacifica | White-necked Heron | | | Terrestrial fauna | 25 | 01/03/1981 |
| 10191 | Egretta sacra | Eastern Reef Egret | | | Terrestrial fauna | 2 | 20/04/1976 |
| 10192 | Nycticorax caledonicus | Nankeen Night-Heron | | | Terrestrial fauna | 8 | 21/01/1978 |
| 10195 | Ixobrychus dubius | Australian Little Bittern | Endangered | en | Terrestrial fauna, Coastal | 2 | 01/01/1898 |
| 10197 | Botaurus poiciloptilus | Australasian Bittern | Critically Endangered | EN cr | Terrestrial fauna, Coastal | 4 | 04/05/1974 |
| 10198 | Cereopsis novaehollandiae | Cape Barren Goose | | | Terrestrial fauna | 85 | 06/03/2021 |
| 10199 | Anseranas semipalmata | Magpie Goose | Vulnerable | vu | Terrestrial fauna | 2 | 01/01/1898 |
| 10202 | Chenonetta jubata | Australian Wood Duck | | | Terrestrial fauna | 14 | 01/06/1981 |
| 10203 | Cygnus atratus | Black Swan | | | Terrestrial fauna | 82 | 26/05/2018 |
| 10204 | Dendrocygna arcuata | Wandering Whistling-Duck | | | Terrestrial fauna | 2 | 01/01/1898 |
| 10205 | Dendrocygna eytoni | Plumed Whistling-Duck | | | Terrestrial fauna | 1 | 01/01/1898 |
| 10207 | Tadorna tadornoides | Australian Shelduck | | | Terrestrial fauna | 27 | 01/03/1981 |
| 10208 | Anas superciliosa | Pacific Black Duck | | | Terrestrial fauna | 48 | 01/09/1981 |
| 10209 | Anas querquedula | Garganey | | | Terrestrial fauna | 1 | 01/01/1898 |
| 10210 | Anas castanea | Chestnut Teal | | | Terrestrial fauna | 19 | 01/03/1981 |
| 10211 | Anas gracilis | Grey Teal | | | Terrestrial fauna | 20 | 01/03/1981 |
| 10212 | Spatula rhynchotis | Australasian Shoveler | Vulnerable | vu | Terrestrial fauna, Coastal | 11 | 15/11/2017 |
| 10213 | Malacorhynchus membranaceus | Pink-eared Duck | | | Terrestrial fauna | 3 | 01/01/1973 |
| 10214 | Stictonetta naevosa | Freckled Duck | Endangered | en | Terrestrial fauna | 3 | 01/01/1951 |
| 10215 | Aythya australis | Hardhead | | | Terrestrial fauna | 11 | 01/01/1981 |
| 10216 | Oxyura australis | Blue-billed Duck | Vulnerable | vu | Terrestrial fauna | 7 | 18/12/2005 |
| 10217 | Biziura lobata | Musk Duck | Vulnerable | vu | Terrestrial fauna | 20 | 01/03/1981 |
| 10218 | Circus assimilis | Spotted Harrier | | | Terrestrial fauna | 6 | 01/06/1977 |
| 10219 | Circus approximans | Swamp Harrier | | | Terrestrial fauna | 55 | 04/10/2003 |

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|---|---|---|---|---|---|---|---|
| 10220 | Accipiter novaehollandiae | Grey Goshawk | Endangered | en | Terrestrial fauna, Coastal | 5 | 01/09/1981 |
| 10221 | Accipiter fasciatus | Brown Goshawk | | | Terrestrial fauna | 32 | 01/03/2019 |
| 10222 | Accipiter cirrocephalus | Collared Sparrowhawk | | | Terrestrial fauna | 3 | 01/01/1901 |
| 10224 | Aquila audax | Wedge-tailed Eagle | | | Terrestrial fauna | 41 | 06/08/2006 |
| 10225 | Hieraaetus morphnoides | Little Eagle | Vulnerable | vu | Terrestrial fauna | 3 | 01/03/1981 |
| 10226 | Haliaeetus leucogaster | White-bellied Sea-Eagle | Endangered | en | Terrestrial fauna, Coastal | 35 | 04/03/2019 |
| 10228 | Haliastur sphenurus | Whistling Kite | | | Terrestrial fauna | 22 | 01/04/1993 |
| 10229 | Milvus migrans | Black Kite | | | Terrestrial fauna | 1 | 01/12/1979 |
| 10232 | Elanus axillaris | Black-shouldered Kite | | | Terrestrial fauna | 40 | 01/09/1981 |
| 10233 | Elanus scriptus | Letter-winged Kite | | | Terrestrial fauna | 4 | 14/10/1980 |
| 10235 | Falco longipennis | Australian Hobby | | | Terrestrial fauna | 13 | 01/10/1981 |
| 10237 | Falco peregrinus | Peregrine Falcon | | | Terrestrial fauna | 35 | 01/04/1993 |
| 10238 | Falco subniger | Black Falcon | Critically Endangered | cr | Terrestrial fauna | 3 | 17/02/1977 |
| 10239 | Falco berigora | Brown Falcon | | | Terrestrial fauna | 43 | 03/09/2010 |
| 10240 | Falco cenchroides | Nankeen Kestrel | | | Terrestrial fauna | 71 | 19/03/2009 |
| 10241 | Pandion cristatus | Eastern Osprey | | | Terrestrial fauna | 2 | 01/01/1901 |
| 10242 | Ninox boobook | Southern Boobook | | | Terrestrial fauna | 33 | 01/12/1981 |
| 10246 | Ninox connivens | Barking Owl | Critically Endangered | cr | Terrestrial fauna | 4 | 01/01/1901 |
| 10248 | Ninox strenua | Powerful Owl | Vulnerable | vu | Terrestrial fauna | 3 | 01/01/1973 |
| 10249 | Tyto alba | Barn Owl | | | Terrestrial fauna | 15 | 01/06/1981 |
| 10250 | Tyto novaehollandiae | Masked Owl | Critically Endangered | cr | Terrestrial fauna | 2 | 01/01/1898 |
| 10252 | Tyto longimembris | Eastern Grass Owl | | | Terrestrial fauna | 1 | 01/01/1898 |
| 10253 | Tyto tenebricosa | Sooty Owl | Endangered | en | Terrestrial fauna | 1 | 01/01/1860 |
| 10254 | Trichoglossus moluccanus | Rainbow Lorikeet | | | Terrestrial fauna | 23 | 18/01/2020 |
| 10258 | Glossopsitta concinna | Musk Lorikeet | | | Terrestrial fauna | 2 | 01/12/1978 |
| 10259 | Parvipsitta porphyrocephala | Purple-crowned Lorikeet | | | Terrestrial fauna | 3 | 01/01/1901 |
| 10260 | Parvipsitta pusilla | Little Lorikeet | | | Terrestrial fauna | 7 | 01/12/1978 |
| 10267 | Calyptorhynchus funereus | Yellow-tailed Black-Cockatoo | | | Terrestrial fauna | 48 | 29/12/2018 |
| 10268 | Callocephalon fimbriatum | Gang-gang Cockatoo | Endangered | EN en | Terrestrial fauna | 27 | 19/09/1981 |
| 10269 | Cacatua galerita | Sulphur-crested Cockatoo | | | Terrestrial fauna | 18 | 01/12/1981 |
| 10272 | Cacatua tenuirostris | Long-billed Corella | | | Terrestrial fauna | 4 | 01/01/1898 |
| 10273 | Eolophus roseicapilla | Galah | | | Terrestrial fauna | 33 | 31/12/2018 |
| 10274 | Nymphicus hollandicus | Cockatiel | | | Terrestrial fauna | 2 | 01/01/1901 |
| 10281 | Alisterus scapularis | Australian King-Parrot | | | Terrestrial fauna | 8 | 21/04/2018 |
| 10282 | Platycercus elegans | Crimson Rosella | | | Terrestrial fauna | 86 | 27/09/2017 |
| 10288 | Platycercus eximius | Eastern Rosella | | | Terrestrial fauna | 56 | 01/10/1981 |
| 10295 | Psephotus haematonotus | Red-rumped Parrot | | | Terrestrial fauna | 6 | 01/03/1981 |
| 10305 | Neophema chrysogaster | Orange-bellied Parrot | Critically Endangered | CR cr | Terrestrial fauna, Coastal | 6 | 01/06/1985 |
| 10306 | Neophema chrysostoma | Blue-winged Parrot | | VU | Terrestrial fauna | 11 | 01/01/1981 |
| 10309 | Lathamus discolor | Swift Parrot | Critically Endangered | CR cr | Terrestrial fauna | 5 | 22/12/1975 |
| 10310 | Melopsittacus undulatus | Budgerigar | | | Terrestrial fauna | 1 | 01/01/1798 |
| 10311 | Pezoporus wallicus | Ground Parrot | Endangered | en | Terrestrial fauna, Coastal | 5 | 01/01/1901 |
| 10313 | Podargus strigoides | Tawny Frogmouth | | | Terrestrial fauna | 9 | 08/12/1980 |
| 10317 | Aegotheles cristatus | Australian Owlet-nightjar | | | Terrestrial fauna | 4 | 01/01/1973 |
| 10318 | Eurystomus orientalis | Oriental Dollarbird | | | Terrestrial fauna | 2 | 01/01/1901 |
| 10319 | Ceyx azureus | Azure Kingfisher | | | Terrestrial fauna | 5 | 25/12/1974 |
| 10322 | Dacelo novaeguineae | Laughing Kookaburra | | | Terrestrial fauna | 96 | 26/12/2018 |
| 10326 | Todiramphus sanctus | Sacred Kingfisher | | | Terrestrial fauna | 10 | 01/01/2010 |
| 10329 | Merops ornatus | Rainbow Bee-eater | | | Terrestrial fauna | 5 | 01/01/1971 |
| 10330 | Eurostopodus mystacalis | White-throated Nightjar | | | Terrestrial fauna | 2 | 01/01/1901 |
| 10334 | Hirundapus caudacutus | White-throated Needletail | Vulnerable | VU vu | Terrestrial fauna | 29 | 01/03/1981 |
| 10335 | Apus pacificus | Fork-tailed Swift | | | Terrestrial fauna | 6 | 01/03/1979 |
| 10337 | Cacomantis pallidus | Pallid Cuckoo | | | Terrestrial fauna | 16 | 01/10/1981 |
| 10338 | Cacomantis flabelliformis | Fan-tailed Cuckoo | | | Terrestrial fauna | 35 | 13/08/2017 |
| 10339 | Cacomantis variolosus | Brush Cuckoo | | | Terrestrial fauna | 1 | 01/01/1800 |
| 10341 | Chrysococcyx osculans | Black-eared Cuckoo | | | Terrestrial fauna | 1 | 01/01/1972 |
| 10342 | Chrysococcyx basalis | Horsfield's Bronze-Cuckoo | | | Terrestrial fauna | 26 | 01/12/1981 |
| 10344 | Chrysococcyx lucidus | Shining Bronze-Cuckoo | | | Terrestrial fauna | 18 | 19/09/1981 |
| 10350 | Menura novaehollandiae | Superb Lyrebird | | | Terrestrial fauna | 3 | 01/01/1901 |
| 10357 | Hirundo neoxena | Welcome Swallow | | | Terrestrial fauna | 142 | 30/04/2021 |
| 10358 | Cheramoeca leucosterna | White-backed Swallow | | | Terrestrial fauna | 1 | 01/06/1984 |
| 10359 | Petrochelidon nigricans | Tree Martin | | | Terrestrial fauna | 12 | 01/03/1981 |
| 10360 | Petrochelidon ariel | Fairy Martin | | | Terrestrial fauna | 11 | 01/03/1981 |
| 10361 | Rhipidura albiscapa | Grey Fantail | | | Terrestrial fauna | 109 | 03/09/2010 |
| 10362 | Rhipidura rufifrons | Rufous Fantail | | | Terrestrial fauna | 17 | 01/03/1981 |
| 10364 | Rhipidura leucophrys | Willie Wagtail | | | Terrestrial fauna | 98 | 14/07/2018 |
| 10365 | Myiagra rubecula | Leaden Flycatcher | | | Terrestrial fauna | 5 | 01/11/1980 |
| 10366 | Myiagra cyanoleuca | Satin Flycatcher | | | Terrestrial fauna | 14 | 01/11/1980 |

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|---|---|---|---|---|---|---|---|
| 10369 | Myiagra inquieta | Restless Flycatcher | | | Terrestrial fauna | 4 | 01/01/1901 |
| 10373 | Monarcha melanopsis | Black-faced Monarch | | | Terrestrial fauna | 1 | 22/12/1975 |
| 10377 | Microeca fascinans | Jacky Winter | | | Terrestrial fauna | 9 | 04/12/1978 |
| 10380 | Petroica boodang | Scarlet Robin | | | Terrestrial fauna | 33 | 19/09/1981 |
| 10381 | Petroica goodenovii | Red-capped Robin | | | Terrestrial fauna | 1 | 04/01/1846 |
| 10382 | Petroica phoenicea | Flame Robin | | | Terrestrial fauna | 45 | 06/04/2008 |
| 10383 | Petroica rodinogaster | Pink Robin | | | Terrestrial fauna | 7 | 01/02/1980 |
| 10384 | Petroica rosea | Rose Robin | | | Terrestrial fauna | 3 | 20/11/1978 |
| 10385 | Melanodryas cucullata | Hooded Robin | Vulnerable | EN vu | Terrestrial fauna | 2 | 01/01/1973 |
| 10392 | Eopsaltria australis | Eastern Yellow Robin | | | Terrestrial fauna | 78 | 16/05/2000 |
| 10398 | Pachycephala pectoralis | Golden Whistler | | | Terrestrial fauna | 41 | 01/01/2010 |
| 10401 | Pachycephala rufiventris | Rufous Whistler | | | Terrestrial fauna | 25 | 01/10/1981 |
| 10405 | Pachycephala olivacea | Olive Whistler | | | Terrestrial fauna | 30 | 16/05/2000 |
| 10408 | Colluricincla harmonica | Grey Shrike-thrush | | | Terrestrial fauna | 110 | 02/06/2007 |
| 10415 | Grallina cyanoleuca | Magpie-lark | | | Terrestrial fauna | 113 | 25/09/2017 |
| 10416 | Falcunculus frontatus | Eastern Shrike-tit | | | Terrestrial fauna | 13 | 08/12/1980 |
| 10421 | Psophodes olivaceus | Eastern Whipbird | | | Terrestrial fauna | 28 | 06/01/2017 |
| 10424 | Coracina novaehollandiae | Black-faced Cuckoo-shrike | | | Terrestrial fauna | 48 | 08/10/1981 |
| 10430 | Lalage tricolor | White-winged Triller | | | Terrestrial fauna | 3 | 01/01/1901 |
| 10436 | Cinclosoma punctatum | Spotted Quail-thrush | | | Terrestrial fauna | 4 | 01/01/1973 |
| 10443 | Pomatostomus temporalis | Grey-crowned Babbler | Vulnerable | vu | Terrestrial fauna | 5 | 30/08/1958 |
| 10448 | Epthianura albifrons | White-fronted Chat | | | Terrestrial fauna | 53 | 06/04/2008 |
| 10465 | Smicrornis brevirostris | Weebill | | | Terrestrial fauna | 5 | 04/12/1978 |
| 10466 | Aphelocephala leucopsis | Southern Whiteface | | VU | Terrestrial fauna | 1 | 01/01/1860 |
| 10470 | Acanthiza lineata | Striated Thornbill | | | Terrestrial fauna | 38 | 01/12/1981 |
| 10471 | Acanthiza nana | Yellow Thornbill | | | Terrestrial fauna | 10 | 01/03/1981 |
| 10475 | Acanthiza pusilla | Brown Thornbill | | | Terrestrial fauna | 88 | 03/09/2010 |
| 10484 | Acanthiza reguloides | Buff-rumped Thornbill | | | Terrestrial fauna | 2 | 01/01/1973 |
| 10486 | Acanthiza chrysorrhoa | Yellow-rumped Thornbill | | | Terrestrial fauna | 51 | 30/12/1999 |
| 10488 | Sericornis frontalis | White-browed Scrubwren | | | Terrestrial fauna | 98 | 07/06/2020 |
| 10498 | Calamanthus pyrrhopygius | Chestnut-rumped Heathwren | Vulnerable | vu | Terrestrial fauna | 2 | 04/03/2017 |
| 10500 | Calamanthus fuliginosus | Striated Fieldwren | | | Terrestrial fauna | 16 | 01/03/1981 |
| 10504 | Pyrrholaemus sagittatus | Speckled Warbler | Endangered | en | Terrestrial fauna | 1 | 01/01/1904 |
| 10506 | Pycnoptilus floccosus | Pilotbird | Vulnerable | VU vu | Terrestrial fauna | 1 | 01/01/1901 |
| 10508 | Cincloramphus cruralis | Brown Songlark | | | Terrestrial fauna | 5 | 01/12/1978 |
| 10509 | Cincloramphus mathewsi | Rufous Songlark | | | Terrestrial fauna | 3 | 01/01/1901 |
| 10522 | Poodytes gramineus | Little Grassbird | | | Terrestrial fauna | 12 | 01/03/1981 |
| 10524 | Acrocephalus australis | Reed-Warbler | | | Terrestrial fauna | 10 | 10/02/1980 |
| 10525 | Cisticola exilis | Golden-headed Cisticola | | | Terrestrial fauna | 21 | 04/10/2003 |
| 10526 | Stipiturus malachurus | Southern Emu-wren | | | Terrestrial fauna | 14 | 22/01/1980 |
| 10529 | Malurus cyaneus | Superb Fairy-wren | | | Terrestrial fauna | 141 | 23/01/2010 |
| 10544 | Artamus personatus | Masked Woodswallow | | | Terrestrial fauna | 4 | 01/12/1978 |
| 10545 | Artamus superciliosus | White-browed Woodswallow | | | Terrestrial fauna | 8 | 19/10/1980 |
| 10547 | Artamus cyanopterus | Dusky Woodswallow | | | Terrestrial fauna | 27 | 19/09/1981 |
| 10549 | Daphoenositta chrysoptera | Varied Sittella | | | Terrestrial fauna | 10 | 23/04/1978 |
| 10558 | Cormobates leucophaea | White-throated Treecreeper | | | Terrestrial fauna | 32 | 19/09/1981 |
| 10560 | Climacteris erythrops | Red-browed Treecreeper | | | Terrestrial fauna | 1 | 22/12/1975 |
| 10564 | Dicaeum hirundinaceum | Mistletoebird | | | Terrestrial fauna | 11 | 24/04/1999 |
| 10565 | Pardalotus punctatus | Spotted Pardalote | | | Terrestrial fauna | 27 | 08/12/2006 |
| 10574 | Zosterops lateralis | Silvereye | | | Terrestrial fauna | 120 | 23/01/2010 |
| 10578 | Melithreptus lunatus | White-naped Honeyeater | | | Terrestrial fauna | 16 | 05/07/1981 |
| 10583 | Melithreptus brevirostris | Brown-headed Honeyeater | | | Terrestrial fauna | 18 | 19/09/1981 |
| 10591 | Acanthorhynchus tenuirostris | Eastern Spinebill | | | Terrestrial fauna | 50 | 22/09/2018 |
| 10593 | Glyciphila melanops | Tawny-crowned Honeyeater | | | Terrestrial fauna | 11 | 01/02/1980 |
| 10603 | Anthochaera phrygia | Regent Honeyeater | Critically Endangered | CR cr | Terrestrial fauna | 1 | 01/01/1898 |
| 10605 | Meliphaga lewinii | Lewin's Honeyeater | | | Terrestrial fauna | 7 | 01/12/1981 |
| 10608 | Gavicalis virescens | Singing Honeyeater | | | Terrestrial fauna | 22 | 19/03/2009 |
| 10613 | Ptilotula fusca | Fuscous Honeyeater | | | Terrestrial fauna | 2 | 01/01/1971 |
| 10614 | Caligavis chrysops | Yellow-faced Honeyeater | | | Terrestrial fauna | 37 | 19/09/1981 |
| 10617 | Nesoptilotis leucotis | White-eared Honeyeater | | | Terrestrial fauna | 46 | 19/09/1981 |
| 10619 | Lichenostomus melanops | Yellow-tufted Honeyeater | | | Terrestrial fauna | 3 | 01/01/1912 |
| 10620 | Lichenostomus cratitius | Purple-gaped Honeyeater | Vulnerable | vu | Terrestrial fauna | 1 | 01/01/1898 |
| 10622 | Ptilotula ornata | Yellow-plumed Honeyeater | | | Terrestrial fauna | 1 | 01/01/1860 |
| 10625 | Ptilotula penicillata | White-plumed | | | Terrestrial fauna | 37 | 01/10/1981 |

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|---|---|---|---|---|---|---|---|---|
| | | Honeyeater | | | | | | |
| 10630 | Phylidonyris pyrrhopterus | Crescent Honeyeater | | | Terrestrial fauna | | 44 | 16/05/2000 |
| 10631 | Phylidonyris novaehollandiae | New Holland Honeyeater | | | Terrestrial fauna | | 93 | 07/06/2020 |
| 10633 | Manorina melanophrys | Bell Miner | | | Terrestrial fauna | | 4 | 01/06/1937 |
| 10634 | Manorina melanocephala | Noisy Miner | | | Terrestrial fauna | | 20 | 26/09/2018 |
| 10637 | Anthochaera chrysoptera | Little Wattlebird | | | Terrestrial fauna | | 80 | 18/01/2020 |
| 10638 | Anthochaera carunculata | Red Wattlebird | | | Terrestrial fauna | | 65 | 01/04/1993 |
| 10640 | Acanthagenys rufogularis | Spiny-cheeked Honeyeater | | | Terrestrial fauna | | 12 | 02/06/2007 |
| 10645 | Philemon corniculatus | Noisy Friarbird | | | Terrestrial fauna | | 3 | 01/01/1901 |
| 10647 | Anthus australis | Australian Pipit | | | Terrestrial fauna | | 71 | 06/04/2008 |
| 10648 | Mirafra javanica | Horsfield's Bushlark | | | Terrestrial fauna | | 3 | 01/03/1979 |
| 10650 | Stagonopleura bella | Beautiful Firetail | | | Terrestrial fauna | | 20 | 19/09/1981 |
| 10652 | Stagonopleura guttata | Diamond Firetail | Vulnerable | VU vu | Terrestrial fauna | | 4 | 22/01/1881 |
| 10662 | Neochmia temporalis | Red-browed Finch | | | Terrestrial fauna | | 54 | 19/09/1981 |
| 10671 | Oriolus sagittatus | Olive-backed Oriole | | | Terrestrial fauna | | 6 | 01/01/1973 |
| 10673 | Dicrurus bracteatus | Spangled Drongo | | | Terrestrial fauna | | 2 | 01/01/1901 |
| 10679 | Ptilonorhynchus violaceus | Satin Bowerbird | | | Terrestrial fauna | | 4 | 01/01/1901 |
| 10693 | Corcorax melanorhamphos | White-winged Chough | | | Terrestrial fauna | | 5 | 01/01/1901 |
| 10694 | Strepera graculina | Pied Currawong | | | Terrestrial fauna | | 20 | 01/06/1981 |
| 10697 | Strepera versicolor | Grey Currawong | | | Terrestrial fauna | | 27 | 19/09/1981 |
| 10702 | Cracticus torquatus | Grey Butcherbird | | | Terrestrial fauna | | 58 | 18/01/2020 |
| 10705 | Gymnorhina tibicen | Australian Magpie | | | Terrestrial fauna | | 174 | 27/02/2020 |
| 10779 | Zoothera lunulata | Bassian Thrush | | | Terrestrial fauna | | 23 | 16/05/2000 |
| 10858 | Spheniscus magellanicus | Magellanic Penguin | | | Marine, Terrestrial fauna | | 2 | 31/03/1979 |
| 10867 | Corvus splendens | House Crow | | * | Terrestrial fauna | Introduced | 1 | 29/05/1959 |
| 10868 | Corvus tasmanicus | Forest Raven | | | Terrestrial fauna | | 23 | 19/09/1981 |
| 10913 | Puffinus huttoni | Hutton's Shearwater | | | Terrestrial fauna | | 3 | 12/09/1981 |
| 10919 | Pterodroma inexpectata | Mottled Petrel | | | Terrestrial fauna | | 4 | 01/06/1978 |
| 10929 | Macronectes giganteus | Southern Giant-Petrel | Endangered | EN en | Terrestrial fauna, Coastal | | 6 | 01/01/1981 |
| 10930 | Corvus coronoides | Australian Raven | | | Terrestrial fauna | | 50 | 08/12/2006 |
| 10931 | Thalassarche bulleri | Buller's Albatross | Endangered | VU en | Terrestrial fauna, Coastal | | 1 | 05/06/1985 |
| 10935 | Aphrodroma brevirostris | Kerguelen Petrel | | | Terrestrial fauna | | 3 | 01/01/1981 |
| 10937 | Macronectes halli | Northern Giant-Petrel | Endangered | VU en | Terrestrial fauna, Coastal | | 3 | 17/05/1996 |
| 10941 | Pachyptila salvini | Salvin's Prion | | | Terrestrial fauna | | 6 | 22/06/1986 |
| 10942 | Pachyptila belcheri | Slender-billed Prion | | | Terrestrial fauna | | 14 | 13/08/1985 |
| 10945 | Stercorarius pomarinus | Pomarine Jaeger | | | Terrestrial fauna | | 5 | 05/11/1981 |
| 10952 | Sterna paradisaea | Arctic Tern | | | Terrestrial fauna | | 3 | 17/08/1974 |
| 10953 | Sterna hirundo | Common Tern | | | Terrestrial fauna | | 5 | 01/03/1981 |
| 10954 | Corvus mellori | Little Raven | | | Terrestrial fauna | | 32 | 25/07/2018 |
| 10957 | Columba livia | Domestic Pigeon | | * | Terrestrial fauna | Introduced | 17 | 05/07/1981 |
| 10959 | Eudyptes sclateri | Erect-crested Penguin | | | Marine, Terrestrial fauna | | 1 | 24/02/1979 |
| 10974 | Diomedea epomophora | Southern Royal Albatross | Critically Endangered | VU cr | Terrestrial fauna, Coastal | | 4 | 25/10/2017 |
| 10976 | Pardalotus striatus | Striated Pardalote | | | Terrestrial fauna | | 14 | 19/09/1981 |
| 10977 | Bubulcus coromandus | Eastern Cattle Egret | | | Terrestrial fauna | | 14 | 21/03/1986 |
| 10978 | Calidris melanotos | Pectoral Sandpiper | | | Terrestrial fauna, Coastal | | 1 | 01/01/1973 |
| 10980 | Stercorarius antarcticus | Great Skua | | | Terrestrial fauna | | 7 | 08/08/1985 |
| 10981 | Larus dominicanus | Kelp Gull | | | Terrestrial fauna | | 14 | 19/03/2009 |
| 10989 | Spilopelia chinensis | Spotted Dove | | * | Terrestrial fauna | Introduced | 43 | 06/01/1999 |
| 10991 | Turdus merula | Common Blackbird | | * | Terrestrial fauna | Introduced | 124 | 03/10/2009 |
| 10992 | Turdus philomelos | Song Thrush | | * | Terrestrial fauna | Introduced | 2 | 01/10/1977 |
| 10993 | Alauda arvensis | Eurasian Skylark | | * | Terrestrial fauna | Introduced | 45 | 15/11/1981 |
| 10994 | Passer montanus | Eurasian Tree Sparrow | | * | Terrestrial fauna | Introduced | 4 | 05/12/1980 |
| 10995 | Passer domesticus | House Sparrow | | * | Terrestrial fauna | Introduced | 67 | 06/01/1999 |
| 10997 | Chloris chloris | European Greenfinch | | * | Terrestrial fauna | Introduced | 29 | 15/11/1981 |
| 10998 | Acridotheres tristis | Common Myna | | * | Terrestrial fauna | Introduced | 53 | 01/12/1981 |
| 10999 | Sturnus vulgaris | Common Starling | | * | Terrestrial fauna | Introduced | 130 | 19/01/2008 |
| 11003 | Tachyglossus aculeatus | Short-beaked Echidna | | | Terrestrial fauna | | 13 | 12/10/2019 |
| 11028 | Antechinus agilis | Agile Antechinus | | | Terrestrial fauna | | 5 | 22/05/2006 |
| 11034 | Antechinus minimus maritimus | Swamp Antechinus | Vulnerable | VU vu | Terrestrial fauna | | 54 | 27/04/2023 |
| 11113 | Trichosurus vulpecula | Common Brush-tailed Possum | | | Terrestrial fauna | | 1 | 01/01/1760 |
| 11129 | Pseudocheirus peregrinus | Eastern Ring-tailed Possum | | | Terrestrial fauna | | 4 | 17/01/2017 |
| 11138 | Petaurus notatus | Krefft's Glider | | | Terrestrial fauna | | 1 | 23/06/1982 |
| 11162 | Phascolarctos cinereus | Koala | | | Terrestrial fauna | | 32 | 31/08/1986 |
| 11165 | Vombatus ursinus | Bare-nosed Wombat | | | Terrestrial fauna | | 1 | 27/05/1977 |
| 11175 | Potorous tridactylus trisulcatus | Long-nosed Potoroo | Vulnerable | VU vu | Terrestrial fauna | | 3 | 15/11/1990 |
| 11242 | Wallabia bicolor | Black-tailed Wallaby | | | Terrestrial fauna | | 23 | 08/04/2019 |
| 11265 | Macropus giganteus | Eastern Grey Kangaroo | | | Terrestrial fauna | | 3 | 21/12/2018 |
| 11280 | Pteropus poliocephalus | Grey-headed Flying-fox | Vulnerable | VU vu | Terrestrial fauna | | 1 | 01/01/1952 |
| 11395 | Rattus fuscipes | Bush Rat | | | Terrestrial fauna | | 25 | 10/08/2007 |
| 11398 | Rattus lutreolus | Swamp Rat | | | Terrestrial fauna | | 1 | 22/05/2006 |
| 11408 | Rattus rattus | Black Rat | | * | Terrestrial fauna | Introduced | 3 | 08/11/2012 |
| 11412 | Mus musculus | House Mouse | | * | Terrestrial fauna | Introduced | 2 | 18/05/2000 |
| 11510 | Oryctolagus cuniculus | European Rabbit | | * | Terrestrial fauna | Introduced | 4 | 01/01/1981 |

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|---|---|---|---|---|---|---|---|---|
| 11536 | Felis catus | Domestic Cat (feral) | | * | Terrestrial fauna | Introduced | 1 | 14/11/1975 |
| 11542 | Arctocephalus pusillus doriferus | Australian Fur Seal | | | Marine, Terrestrial fauna | | 9 | 07/08/2020 |
| 11543 | Arctophoca forsteri | Long-nosed Fur Seal | Vulnerable | vu | Marine, Coastal, Terrestrial fauna | | 7 | 29/10/2016 |
| 11546 | Mirounga leonina | Southern Elephant Seal | | VU | Marine, Coastal, Terrestrial fauna | | 1 | 01/01/1760 |
| 11549 | Hydrurga leptonyx | Leopard Seal | | | Marine, Terrestrial fauna | | 3 | 07/02/2002 |
| 11561 | Eubalaena australis | Southern Right Whale | Endangered | EN en | Marine, Coastal, Terrestrial fauna | | 31 | 08/08/2023 |
| 11567 | Balaenoptera musculus | Blue Whale | Endangered | EN en | Marine, Coastal, Terrestrial fauna | | 4 | 30/03/2005 |
| 11569 | Balaenoptera physalus | Fin Whale | | VU | Marine, Terrestrial fauna | | 1 | 01/09/1956 |
| 11575 | Megaptera novaeangliae australis | Southern Humpback Whale | Critically Endangered | cr | Marine, Coastal, Terrestrial fauna | | 27 | 07/08/2020 |
| 11578 | Physeter macrocephalus | Sperm Whale | | | Marine, Terrestrial fauna | | 1 | 04/05/1984 |
| 11581 | Kogia breviceps | Pygmy Sperm Whale | | | Marine, Terrestrial fauna | | 1 | 09/06/1970 |
| 11593 | Mesoplodon grayi | Gray's Beaked Whale | | | Marine, Terrestrial fauna | | 1 | 16/01/1991 |
| 11600 | Orcinus orca | Killer Whale | | | Marine, Terrestrial fauna | | 3 | 04/07/2016 |
| 11612 | Tursiops truncatus | Common Bottle-nosed dolphin | | | Marine, Terrestrial fauna | | 5 | 07/08/2020 |
| 11616 | Delphinus delphis | Short-beaked Common Dolphin | | | Marine, Terrestrial fauna | | 30 | 07/08/2020 |
| 11617 | Tursiops australis | Burrunan Dolphin | Critically Endangered | cr | Marine, Coastal, Terrestrial fauna | | 1 | 08/07/2016 |
| 11830 | Arctophoca tropicalis | Subantarctic Fur Seal | | EN | Marine, Coastal, Terrestrial fauna | | 1 | 17/07/2019 |
| 12013 | Dermochelys coriacea | Leathery Turtle | Critically Endangered | EN cr | Marine, Coastal, Terrestrial fauna | | 1 | 12/05/1961 |
| 12451 | Lampropholis guichenoti | Garden Skink | | | Terrestrial fauna | | 6 | 26/08/1966 |
| 12452 | Saproscincus mustelinus | Weasel Skink | | | Terrestrial fauna | | 2 | 11/09/1971 |
| 12462 | Niveoscincus metallicus | Metallic Skink | | | Terrestrial fauna | | 10 | 21/06/1977 |
| 12578 | Tiliqua nigrolutea | Blotched Blue-tongued Lizard | | | Terrestrial fauna | | 8 | 30/12/2017 |
| 12665 | Drysdalia coronoides | White-lipped Snake | | | Terrestrial fauna | | 1 | 20/04/1977 |
| 12681 | Notechis scutatus | Tiger Snake | | | Terrestrial fauna | | 1 | 19/01/2019 |
| 12682 | Acritoscincus duperreyi | Eastern Three-lined Skink | | | Terrestrial fauna | | 1 | 01/06/1970 |
| 12973 | Austrelaps superbus | Lowland Copperhead | | | Terrestrial fauna | | 3 | 27/10/2002 |
| 12994 | Pseudemoia entrecasteauxii | Southern Grass Skink | | | Terrestrial fauna | | 3 | 01/06/1970 |
| 13063 | Limnodynastes tasmaniensis | Spotted Marsh Frog (race unknown) | | | Terrestrial fauna, Aquatic fauna, Aquatic invertebrates | | 4 | 27/07/1971 |
| 13134 | Crinia signifera | Common Froglet | | | Terrestrial fauna, Aquatic fauna, Aquatic invertebrates | | 4 | 08/10/2022 |
| 13182 | Litoria ewingii | Southern Brown Tree Frog | | | Terrestrial fauna, Aquatic fauna, Aquatic invertebrates | | 55 | 22/08/1985 |
| 13207 | Litoria raniformis | Growling Grass Frog | Vulnerable | VU vu | Terrestrial fauna, Aquatic fauna, Aquatic invertebrates | | 1 | 01/01/1788 |
| 14178 | Meuschenia galii | Blue-lined Leatherjacket | | | Marine, Aquatic fauna | | 1 | 08/03/2002 |
| 15251 | Apsolidium densum | Sea Cucumber 5251 | Endangered | en | Marine, Coastal, Terrestrial fauna | | 1 | 22/01/1982 |
| 19030 | Heteronympha merope | Common Brown Butterfly | | | Terrestrial fauna | | 3 | 01/03/2019 |
| 50233 | Osteichthyes spp. | Bony fish | | | Marine, Aquatic fauna | | 4 | 20/06/2005 |
| 50240 | Corvus spp. | Ravens and Crows | | | Terrestrial fauna | | 8 | 20/07/2019 |
| 50250 | Rattus spp. | Rats | | | Terrestrial fauna | | 1 | 01/01/1760 |
| 50253 | Otariidae spp. | Eared Seals | | | Marine | | 1 | 13/03/2015 |
| 50254 | Scincidae spp. | Unidentified skink | | | Terrestrial fauna | | 3 | 01/01/1981 |
| 50255 | Eulamprus spp. | Unidentified water skink | | | Terrestrial fauna | | 4 | 01/04/1993 |
| 50256 | Austrelaps spp. | Australian Copperheads | | | Terrestrial fauna | | 1 | 01/04/1993 |
| 50269 | Rhodophyta spp. | Red Algae | | | Marine, Flora | | 1 | 04/03/2005 |
| 50275 | Distromium spp. | Brown Algae | | | Marine | | 2 | 23/08/2004 |
| 50290 | Rhodymenia spp. | Red Algae | | | Marine, Flora | | 10 | 11/11/2002 |
| 50291 | Sargassum spp. | Brown Algae | | | Marine, Flora | | 22 | 20/06/2005 |
| 50297 | Corallinaceae spp. | Coralline Algae | | | Marine | | 41 | 20/06/2005 |
| 50302 | Chaetomorpha spp. | Green Algae | | | Marine, Flora | | 1 | 16/12/2001 |
| 50303 | Cladophora spp. | Green Algae | | | Marine, Flora | | 1 | 14/11/2000 |
| 50305 | Gelidium spp. | Red Algae | | | Marine, Flora | | 1 | 14/11/2000 |
| 50307 | Halopteris spp. | Brown Algae | | | Flora | | 34 | 20/06/2005 |
| 50309 | Peyssonneliaceae spp. | Red Algae | | | Marine | | 7 | 20/06/2005 |
| 50310 | Phaeophyceae spp. | Brown Algae | | | Marine, Flora | | 8 | 20/06/2005 |
| 50316 | Phalacrocoracidae spp. | | | | Terrestrial fauna | | 1 | 03/09/2017 |
| 60126 | Larus pacificus | Pacific Gull | | | Terrestrial fauna, Coastal | | 280 | 18/01/2020 |
| 60294 | Barnardius zonarius zonarius | Port Lincoln Parrot | | | Terrestrial fauna | | 2 | 01/01/1981 |
| 60555 | Climacteris picumnus | Brown Treecreeper | | VU | Terrestrial fauna | | 2 | 01/01/1912 |
| 62430 | Liopholis whitii GROUP | White's Skink | | | Terrestrial fauna | | 42 | 30/10/2002 |
| 63914 | Limnodynastes dumerilii insularis | Pobblebonk Frog | | | Terrestrial fauna, Aquatic fauna, Aquatic invertebrates | | 3 | 28/06/1975 |
| 80142 | Lepispilus sulcicollis | | | | Aquatic invertebrates, Terrestrial fauna | | 1 | 02/04/1966 |
| 100001 | Heterodontus portusjacksoni | Port Jackson Shark | | | Marine, Terrestrial fauna | | 3 | 08/03/2002 |
| 100003 | Cephaloscyllium laticeps | Draughtboard Shark | | | Marine, Terrestrial fauna | | 5 | 20/06/2005 |
| 100019 | Helicolenus percoides | Reef Ocean Perch | | | Marine | | 1 | 07/11/2002 |
| 100024 | Caesioperca lepidopterus | Butterfly Perch | | | Marine | | 4 | 10/03/2005 |
| 100025 | Caesioperca rasor | Barber Perch | | | Marine | | 29 | 10/03/2005 |
| 100026 | Hypoplectrodes maccullochi | Halfbanded Seaperch | | | Marine | | 1 | 08/03/2001 |
| 100027 | Trachinops caudimaculatus | Southern Hulafish | | | Marine | | 22 | 10/03/2005 |

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| 100028 | Dinolestes lewini | Longfin Pike | Marine | 30 | 20/06/2005 |
| 100033 | Parequula melbournensis | Silverbelly | Marine | 1 | 08/04/2002 |
| 100034 | Upeneichthys vlamingii | Bluespotted Goatfish | Marine | 13 | 23/08/2004 |
| 100035 | Pempheris multiradiata | | Marine | 6 | 23/08/2004 |
| 100039 | Girella zebra | Zebra fish | Marine, Aquatic fauna | 31 | 20/06/2005 |
| 100041 | Scorpis lineolata | Silver Sweep | Marine | 11 | 20/06/2005 |
| 100044 | Pentaceropsis recurvirostris | Longsnout boarfish | Marine | 3 | 04/03/2005 |
| 100045 | Chromis hypsilepis | Onespot Puller | Marine | 6 | 03/05/2001 |
| 100046 | Parma microlepis | White-ear | Marine | 6 | 12/11/2002 |
| 100047 | Parma victoriae | Scalyfin | Marine | 41 | 20/06/2005 |
| 100048 | Aplodactylus arctidens | Marblefish | Marine, Aquatic fauna | 20 | 20/06/2005 |
| 100049 | Cheilodactylus nigripes | Magpie Perch | Marine | 49 | 20/06/2005 |
| 100050 | Cheilodactylus spectabilis | Banded Morwong | Marine, Terrestrial fauna | 21 | 10/03/2005 |
| 100052 | Nemadactylus macropterus | | Marine | 2 | 16/11/2000 |
| 100053 | Latridopsis forsteri | Bastard Trumpeter | Marine | 5 | 10/03/2005 |
| 100056 | Dotalabrus aurantiacus | | Marine | 7 | 20/06/2005 |
| 100057 | Pictilabrus laticlavius | Senator Wrasse | Marine | 31 | 20/06/2005 |
| 100059 | Pseudolabrus mortonii | Rosy Wrasse | Marine | 12 | 20/06/2005 |
| 100061 | Odax acroptilus | | Marine | 16 | 04/03/2005 |
| 100062 | Siphonognathus attenuatus | Slender Weed Whiting | Marine | 1 | 23/08/2004 |
| 100063 | Neoodax balteatus | Little Weed Whiting | Marine | 1 | 08/03/2002 |
| 100064 | Siphonognathus beddomei | Pencil Weed Whiting | Marine | 16 | 04/03/2005 |
| 100066 | Olisthops cyanomelas | Herring Cale | Marine | 50 | 20/06/2005 |
| 100068 | Bovichtus angustifrons | | Marine | 5 | 20/06/2005 |
| 100073 | Heteroclinus johnstoni | Johnston's Weedfish | Marine | 1 | 11/09/1999 |
| 100087 | Eubalichthys gunnii | Gunn's Leatherjacket | Marine, Aquatic fauna, Aquatic invertebrates | 14 | 04/03/2005 |
| 100088 | Meuschenia australis | Brownstriped Leatherjacket | Marine, Aquatic fauna | 1 | 04/03/2005 |
| 100089 | Meuschenia flavolineata | Yellowstriped Leatherjacket | Marine, Aquatic fauna | 22 | 20/06/2005 |
| 100090 | Meuschenia freycineti | Sixspine Leatherjacket | Marine, Aquatic fauna, Aquatic invertebrates, Terrestrial fauna | 30 | 20/06/2005 |
| 100091 | Meuschenia hippocrepis | Horse-shoe leatherjacket | Marine, Aquatic fauna | 26 | 20/06/2005 |
| 100101 | Aetapcus maculatus | Warty Prowfish | Marine | 1 | 06/03/2003 |
| 100105 | Parascyllium variolatum | Varied Catshark | Marine | 3 | 06/03/2003 |
| 100111 | Ophthalmolepis lineolatus | Southern Maori Wrasse | Marine | 1 | 06/12/1999 |
| 100122 | Gymnothorax prasinus | Green Moray | Marine | 1 | 16/11/2000 |
| 100170 | Eupetrichthys angustipes | Snakeskin Wrasse | Marine | 1 | 16/11/2000 |
| 100200 | Cenolia trichoptera | Feather star | Marine | 43 | 20/06/2005 |
| 100201 | Cenolia tasmaniae | Feather star | Marine | 7 | 04/03/2005 |
| 100202 | Heliocidaris erythrogramma | Sea urchin | Marine | 45 | 20/06/2005 |
| 100203 | Centrostephanus rodgersii | Black Sea Urchin | Marine | 2 | 23/08/2004 |
| 100206 | Goniocidaris tubaria | Thorny Sea Urchin | Marine | 1 | 16/11/2000 |
| 100208 | Fromia polypora | Seastar | Marine | 31 | 20/06/2005 |
| 100210 | Nectria ocellata | Seastar | Marine | 45 | 20/06/2005 |
| 100211 | Meridiastra gunnii | Seastar | Marine | 25 | 20/06/2005 |
| 100212 | Petricia vernicina | Velvet Seastar | Marine | 39 | 20/06/2005 |
| 100213 | Pentagonaster duebeni | Vermillion Seastar | Marine | 25 | 20/06/2005 |
| 100214 | Plectaster decanus | Seastar | Marine | 30 | 04/03/2005 |
| 100215 | Tosia magnifica | Biscuit Star | Marine | 4 | 20/06/2005 |
| 100216 | Tosia australis | Biscuit Star | Marine | 26 | 20/06/2005 |
| 100222 | Pseudonepanthia troughtoni | Seastar | Marine | 26 | 20/06/2005 |
| 100223 | Echinaster arcystatus | Seastar | Marine | 36 | 20/06/2005 |
| 100224 | Nectria macrobrachia | Seastar | Marine | 44 | 20/06/2005 |
| 100233 | Holopneustes purpurascens | Sea urchin | Marine | 2 | 14/12/2001 |
| 100240 | Haliotis laevigata | Green-lip Abalone | Marine | 3 | 08/03/2002 |
| 100241 | Haliotis rubra | Black-lip Abalone | Marine | 50 | 20/06/2005 |
| 100242 | Pleuroploca australasia | Australian Horse Conch | Marine | 12 | 20/06/2005 |
| 100243 | Lunella (Subninella) undulatus | Common Warrener | Marine | 32 | 20/06/2005 |
| 100244 | Penion mandarinus | Waite's Buccinum Whelk | Marine | 1 | 07/11/2002 |
| 100247 | Cabestana tabulata | Ploughed Triton | Marine | 1 | 14/11/2000 |
| 100249 | Mimachlamys asperrima | Doughboy Scallop | Marine | 1 | 04/03/2005 |
| 100250 | Dicathais orbita | Cart-wheel Purple | Marine | 37 | 20/06/2005 |
| 100257 | Cabestana spengleri | Spengler's Triton | Marine | 5 | 06/03/2003 |
| 100258 | Amoria undulata | Benthic Volute | Marine | 1 | 30/05/2002 |
| 100261 | Sepioteuthis australis | Southern Calamari Squid | Marine | 3 | 08/04/2002 |
| 100262 | Cymatium (Monoplex) parthenopeum | Hairy Triton | Marine | 1 | 15/02/2000 |
| 100264 | Astralium tentoriformis | Common Tent Shell | Marine | 1 | 04/03/2005 |
| 100266 | Scutus (Scutus) antipodes | Boat Shell | Marine, Terrestrial fauna | 21 | 20/06/2005 |
| 100270 | Jasus edwardsii | Red Rock Lobster | Marine | 17 | 20/06/2005 |
| 100271 | Nectocarcinus tuberculosus | Rough Rock Crab | Marine | 8 | 20/06/2005 |
| 100272 | Guinusia chabrus | Cleft-fronted Shore Crab | Marine | 37 | 20/06/2005 |
| 100273 | Strigopagurus strigimanus | Stridulating Hermit | Marine | 10 | 23/08/2004 |

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|---|---|---|---|---|---|
| | | Crab | | | |
| 100278 | Paguroidea spp. | Hermit crab | Marine | 1 | 14/11/2000 |
| 100300 | Acrocarpia paniculata | Brown algae | Marine, Flora | 42 | 20/06/2005 |
| 100302 | Carpoglossum confluens | Brown algae | Marine, Flora | 1 | 04/03/2005 |
| 100309 | Cystophora monilifera | Brown Algae | Marine, Flora | 3 | 20/06/2005 |
| 100310 | Cystophora moniliformis | Brown Algae | Marine, Flora | 23 | 20/06/2005 |
| 100313 | Cystophora retorta | Brown Algae | Marine, Flora | 1 | 17/11/2001 |
| 100314 | Cystophora retroflexa | Brown Algae | Marine, Flora | 11 | 20/06/2005 |
| 100315 | Cystophora siliquosa | Brown Algae | Marine, Flora | 1 | 14/12/2001 |
| 100319 | Dictyopteris muelleri | Brown algae | Marine, Flora | 1 | 04/03/2005 |
| 100320 | Dictyota dichotoma | Brown algae | Marine, Flora | 9 | 10/03/2005 |
| 100321 | Durvillaea potatorum | Brown algae | Marine, Flora | 1 | 15/02/2000 |
| 100322 | Ecklonia radiata | Brown algae | Marine, Flora | 35 | 20/06/2005 |
| 100330 | Macrocystis pyrifera | Brown algae | Marine, Flora | 1 | 30/11/1999 |
| 100332 | Perithalia caudata | Brown algae | Marine, Flora | 13 | 20/06/2005 |
| 100333 | Phyllospora comosa | Brown algae | Marine, Flora | 50 | 20/06/2005 |
| 100334 | Sargassum fallax | Brown Algae | Marine, Flora | 1 | 06/12/1999 |
| 100336 | Phyllotricha verruculosum | Brown algae | Marine, Flora | 12 | 23/08/2004 |
| 100338 | Seirococcus axillaris | Brown algae | Marine, Flora | 14 | 23/08/2004 |
| 100342 | Zonaria angustata | Brown algae | Marine, Flora | 3 | 06/12/1999 |
| 100343 | Zonaria turneriana | Brown algae | Marine, Flora | 34 | 20/06/2005 |
| 100345 | Carpomitra costata | Brown algae | Marine, Flora | 27 | 10/03/2005 |
| 100350 | Phyllotricha sonderi | Brown algae | Marine, Flora | 3 | 04/03/2005 |
| 100351 | Caulerpa brownii | Green algae | Marine, Flora | 10 | 20/06/2005 |
| 100353 | Caulerpa flexilis | Green algae | Marine, Flora | 3 | 11/09/1999 |
| 100354 | Caulerpa geminata | Green algae | Marine, Flora | 1 | 08/04/2002 |
| 100358 | Caulerpa simpliciuscula | Green algae | Marine, Flora | 2 | 10/03/2001 |
| 100366 | Caulerpa obscura | Green algae | Marine, Flora | 2 | 16/11/2000 |
| 100369 | Caulerpa flexilis var. muelleri | Green algae | Marine, Flora | 12 | 20/06/2005 |
| 100370 | Ballia callitricha | | Marine, Flora | 48 | 20/06/2005 |
| 100371 | Callophyllis rangiferina | | Marine, Flora | 17 | 23/08/2004 |
| 100376 | Hemineura frondosa | | Marine, Flora | 2 | 04/03/2005 |
| 100377 | Hypnea ramentacea | | Marine, Flora | 1 | 04/03/2005 |
| 100382 | Melanthalia obtusata | | Marine, Flora | 35 | 20/06/2005 |
| 100383 | Phacelocarpus peperocarpus | | Marine | 44 | 20/06/2005 |
| 100384 | Plocamium angustum | | Marine, Flora | 39 | 20/06/2005 |
| 100385 | Plocamium cartilagineum | | Marine, Flora | 11 | 20/06/2005 |
| 100386 | Plocamium costatum | | Marine, Flora | 4 | 20/06/2005 |
| 100387 | Plocamium dilatatum | | Marine, Flora | 39 | 20/06/2005 |
| 100388 | Plocamium leptophyllum | | Marine, Flora | 2 | 12/11/2002 |
| 100389 | Plocamium mertensii | | Marine, Flora | 13 | 06/03/2003 |
| 100390 | Plocamium patagiatum | | Marine, Flora | 1 | 06/03/2003 |
| 100395 | Phacelocarpus alatus | | Marine, Flora | 3 | 08/04/2002 |
| 100399 | Rhodophyta other thallose red algae | Red Algae | Marine | 30 | 20/06/2005 |
| 100407 | Cordylecladia furcellata | | Marine | 2 | 06/03/2003 |
| 100409 | Pterocladia lucida | | Marine, Flora | 24 | 10/03/2005 |
| 100410 | Euptilota articulata | | Marine, Flora | 2 | 04/03/2005 |
| 100412 | Plocamium pressianum | | Marine | 5 | 07/11/2002 |
| 100415 | Ptilonia australasica | | Marine, Flora | 8 | 06/03/2003 |
| 100416 | Cladostephus spongiosus | Brown algae | Marine, Flora | 1 | 08/03/2001 |
| 100425 | Callophyllis lambertii | | Marine, Flora | 2 | 12/06/2000 |
| 100429 | Sonderopelta coriacea | | Marine, Flora | 14 | 06/03/2003 |
| 100430 | Peyssonnelia novaehollandiae | | Marine, Flora | 1 | 10/03/2005 |
| 100448 | Laurencia elata | | Marine, Flora | 2 | 20/06/2005 |
| 100454 | Asparagopsis armata | | Marine, Flora | 1 | 11/11/2002 |
| 100507 | Dictyota spp. | Brown Algae | Marine, Flora | 1 | 01/12/1999 |
| 100509 | Lobophora variegata | Brown algae | Marine, Flora | 2 | 08/03/2002 |
| 100512 | Gelidium asperum | | Marine, Flora | 4 | 20/06/2005 |
| 100515 | Gelidium australe | | Marine, Flora | 4 | 20/06/2005 |
| 100517 | Melanthalia concinna | | Marine, Flora | 2 | 04/03/2005 |
| 100518 | Corallina officinalis | | Marine, Flora | 1 | 17/11/2001 |
| 100552 | Nectria multispina | Seastar | Marine | 20 | 20/06/2005 |
| 100572 | Paguristes frontalis | Common Hermit Crab | Marine | 1 | 20/06/2005 |
| 100593 | Laurencia filiformis | | Marine, Flora | 1 | 06/03/2003 |
| 100702 | Lobospira bicuspidata | Brown algae | Marine, Flora | 13 | 20/06/2005 |
| 100704 | Homoeostrichus sinclairii | Brown algae | Marine, Flora | 18 | 20/06/2005 |
| 100705 | Chlanidophora microphylla | brown alga | Marine, Flora | 7 | 20/06/2005 |
| 100713 | Conus anemone | Anemone cone | Marine | 1 | 16/11/2001 |
| 100786 | Rhodopeltis australis | | Marine | 1 | 20/06/2005 |
| 100799 | Solieria robusta | | Marine, Flora | 1 | 20/06/2005 |
| 100805 | Amphiroa anceps | | Marine, Flora | 23 | 20/06/2005 |
| 100806 | Jania rosea | | Marine, Flora | 50 | 20/06/2005 |
| 100833 | Metagoniolithon radiatum | | Marine, Flora | 22 | 20/06/2005 |
| 100837 | Cheilosporum sagittatum | | Marine, Flora | 15 | 20/06/2005 |
| 100842 | Zonaria spiralis | Brown algae | Marine, Flora | 1 | 14/11/2000 |
| 100845 | Metamastophora flabellata | | Marine, Flora | 3 | 07/11/2002 |

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|---|---|---|---|---|---|---|---|---|---|
| 100859 | Dictyopteris acrostichoides | Brown algae | | | Marine, Flora | | | 2 | 27/05/2002 |
| 100938 | Tilodon sexfasciatus | Moonlighter | | | Marine | | | 4 | 20/06/2005 |
| 102304 | Phasianotrochus eximius | Kelp Shell | | | Marine | | | 1 | 03/05/2001 |
| 102306 | Delisea pulchra | | | | Marine, Flora | | | 14 | 10/03/2005 |
| 102311 | Gracilaria secundata | | | | Marine, Flora | | | 1 | 04/03/2005 |
| 102313 | Notocypraea angustata | Brown Cowry | | | Marine | | | 1 | 01/12/1999 |
| 102314 | Polyopes constrictus | | | | Marine, Flora | | | 5 | 20/06/2005 |
| 102316 | Hypselodoris bennetti | Sea slug | | | Marine | | | 1 | 21/05/2000 |
| 102319 | Neodoris chrysoderma | Sea slug | | | Marine | | | 2 | 23/08/2004 |
| 102321 | Tambja verconis | Sea slug | | | Marine | | | 2 | 01/05/2001 |
| 102322 | Curdiea angustata | | | | Marine, Flora | | | 1 | 08/03/2001 |
| 102405 | Distromium flabellatum | Brown Algae | | | Marine, Flora | | | 3 | 10/03/2005 |
| 102439 | Callophycus laxus | | | | Marine, Flora | | | 4 | 07/11/2002 |
| 102443 | Acrotylus australis | | | | Marine, Flora | | | 10 | 04/03/2005 |
| 102447 | Nizymenia australis | | | | Marine, Flora | | | 6 | 06/03/2003 |
| 102449 | Rhodophyllis multipartita | | | | Marine, Flora | | | 1 | 06/12/1999 |
| 102454 | Craspedocarpus tenuifolius | | | | Marine, Flora | | | 2 | 04/03/2005 |
| 102463 | Rhodymenia australis | | | | Marine | | | 14 | 20/06/2005 |
| 102465 | Rhodymenia obtusa | | | | Marine, Flora | | | 1 | 03/12/2001 |
| 102466 | Rhodymenia prolificans | | | | Marine, Flora | | | 1 | 20/06/2005 |
| 102559 | Arthrocardia wardii | | | | Marine, Flora | | | 12 | 20/06/2005 |
| 102576 | Pterocladiella capillacea | | | | Marine, Flora | | | 8 | 04/03/2005 |
| 102588 | Sagaminopteron ornatum | bubble snail | | | Marine | | | 2 | 08/04/2002 |
| 102589 | Melanthalia abscissa | | | | Marine, Flora | | | 9 | 10/03/2005 |
| 102679 | Clanculus undatus | Top snail | | | Marine | | | 1 | 23/08/2004 |
| 102681 | Calliostoma (Fautor) armillatum | Jewelled Top Shell | | | Marine | | | 1 | 11/11/2002 |
| 102734 | Exallosorus olsenii | | | | Marine, Flora | | | 2 | 16/11/2001 |
| 500053 | Acacia longifolia subsp. longifolia | Sallow Wattle | | # | Flora | Native but some stands may be alien | Aca long.l | 3 | 18/11/1999 |
| 500088 | Acacia longifolia subsp. sophorae | Coast Wattle | | # | Flora | Native but some stands may be alien | Aca l.soph | 8 | 01/01/2010 |
| 500091 | Acacia stricta | Hop Wattle | | | Flora | | Acac stri | 4 | 01/12/1998 |
| 500105 | Acaena novae-zelandiae | Bidgee-widgee | | | Flora | | Acae nova | 12 | 29/12/2009 |
| 500112 | Cyrtostylis reniformis | Small Gnat-orchid | | | Flora | | Cyrt reni | 1 | 01/09/1981 |
| 500118 | Acrotriche affinis | Ridged Ground-berry | | | Flora | | Acro affi | 1 | 11/12/1983 |
| 500127 | Actites megalocarpus | Dune Thistle | | | Flora | | Acti mega | 4 | 29/12/2009 |
| 500142 | Thinopyrum junceiforme | Sea Wheat-grass | | * | Flora | Introduced | Thin junc | 1 | 01/11/1980 |
| 500146 | Anthosachne scabra s.l. | Common Wheat-grass | | | Flora | | Anth sc.sl | 3 | 29/12/2009 |
| 500151 | Lachnagrostis filiformis s.l. | Common Blown-grass | | | Flora | | Lach fi.sl | 1 | 01/10/1980 |
| 500152 | Lachnagrostis billardierei s.l. | Coast Blown-grass | | | Flora | | Agro bi.sl | 7 | 29/12/2009 |
| 500164 | Aira caryophyllea subsp. caryophyllea | Silvery Hair-grass | | * | Flora | Introduced | Aira cary | 7 | 29/12/2009 |
| 500165 | Aira cupaniana | Quicksilver Grass | | * | Flora | Introduced | Aira cupa | 2 | 11/01/2000 |
| 500166 | Aira elegantissima | Delicate Hair-grass | | * | Flora | Introduced | Aira eleg | 1 | 18/11/1999 |
| 500167 | Aira praecox | Early Hair-grass | | * | Flora | Introduced | Aira prae | 2 | 29/12/2009 |
| 500169 | Paraserianthes lophantha subsp. lophantha | Cape Wattle | | * | Flora | Introduced | Paras loph | 4 | 07/03/2008 |
| 500188 | Alyxia buxifolia | Sea Box | | | Flora | | Alyx buxi | 10 | 01/12/1998 |
| 500205 | Calamagrostis arenaria | Marram Grass | | * | Flora | Introduced | Calam aren | 9 | 01/01/2010 |
| 500207 | Amphibolis antarctica | Sea Nymph | | | Flora | | Amph anta | 2 | 01/10/1980 |
| 500223 | Lysimachia arvensis | Pimpernel | | * | Flora | Introduced | Lysi arve | 3 | 21/11/1999 |
| 500236 | Anthoxanthum odoratum | Sweet Vernal-grass | | * | Flora | Introduced | Anth odor | 1 | 01/10/1980 |
| 500246 | Apium insulare | Island Celery | Vulnerable | vu | Flora | | Apiu insu | 3 | 01/12/1998 |
| 500247 | Apium prostratum subsp. prostratum | Sea Celery | | | Flora | | Apiu pros | 8 | 29/12/2009 |
| 500255 | Arctotheca calendula | Cape Weed | | * | Flora | Introduced | Arct cale | 4 | 17/11/1999 |
| 500278 | Asperula conferta | Common Woodruff | | | Flora | | Aspe conf | 1 | 01/10/1980 |
| 500288 | Asplenium flabellifolium | Necklace Fern | | | Flora | | Aspl flab | 2 | 17/11/1999 |
| 500291 | Asplenium decurrens | Shore Spleenwort | Endangered | en | Flora | | Aspl decu | 6 | 01/01/1983 |
| 500304 | Styphelia humifusa | Cranberry Heath | | | Flora | | Styp humi | 1 | 01/10/1980 |
| 500316 | Atriplex cinerea | Coast Saltbush | | | Flora | | Atri cine | 1 | 28/12/2009 |
| 500318 | Atriplex prostrata | Hastate Orache | | * | Flora | Introduced | Atri pros | 2 | 29/12/2009 |
| 500362 | Banksia integrifolia subsp. integrifolia | Coast Banksia | | | Flora | | Bank inte | 6 | 01/01/2010 |
| 500418 | Borago officinalis | Borage | | * | Flora | Introduced | Bora offi | 1 | 15/11/1984 |
| 500456 | Brachyscome diversifolia | Tall Daisy | | | Flora | | Brac dive | 6 | 01/12/1998 |
| 500469 | Brachyscome parvula | Coast Daisy | | | Flora | | Brac parv | 3 | 18/11/1999 |
| 500488 | Brassica fruticulosa | Twiggy Turnip | | * | Flora | Introduced | Bras frut | 1 | 16/11/1999 |
| 500491 | Brassica nigra | Black Mustard | | * | Flora | Introduced | Bras nigr | 1 | 25/11/1984 |
| 500495 | Briza maxima | Large Quaking-grass | | * | Flora | Introduced | Briz maxi | 1 | 01/10/1980 |
| 500496 | Briza minor | Lesser Quaking-grass | | * | Flora | Introduced | Briz mino | 2 | 18/11/1999 |
| 500498 | Bromus catharticus | Prairie Grass | | * | Flora | Introduced | Brom cath | 3 | 17/11/1999 |
| 500500 | Bromus diandrus | Great Brome | | * | Flora | Introduced | Brom dian | 12 | 28/12/2009 |
| 500501 | Bromus hordeaceus | Soft Brome | | * | Flora | Introduced | Brom hord | 3 | 18/11/1999 |
| 500503 | Bromus madritensis | Madrid Brome | | * | Flora | Introduced | Brom madr | 1 | 15/12/1982 |

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|---|---|---|---|---|---|---|---|---|---|
| 500510 | Bulbine bulbosa | Bulbine Lily | | | Flora | | Bulb bulb | 1 | 01/01/1983 |
| 500511 | Bulbine semibarbata | Leek Lily | | | Flora | | Bulb semi | 1 | 01/01/1983 |
| 500515 | Bursaria spinosa subsp. spinosa | Sweet Bursaria | | | Flora | | Burs sp.sp | 5 | 01/01/2010 |
| 500520 | Cakile edentula | American Sea Rocket | | * | Flora | Introduced | Caki eden | 1 | 01/10/1980 |
| 500521 | Cakile maritima subsp. maritima | Sea Rocket | | * | Flora | Introduced | Caki mari | 1 | 18/11/1999 |
| 500537 | Caladenia latifolia | Pink Fairies | | | Flora | | Cala lati | 4 | 12/07/2008 |
| 500551 | Calandrinia calyptrata | Pink Purslane | | | Flora | | Cala caly | 7 | 01/12/1998 |
| 500581 | Leucophyta brownii | Cushion Bush | | | Flora | | Leuc brow | 15 | 29/12/2009 |
| 500583 | Calocephalus lacteus | Milky Beauty-heads | | | Flora | | Calo lact | 2 | 08/09/1981 |
| 500613 | Cardamine gunnii s.l. | Common Bitter-cress | | | Flora | | Card gu.sl | 4 | 01/09/1981 |
| 500617 | Cardamine tenuifolia | Slender Bitter-cress | | | Flora | | Carda tenu | 1 | 01/09/1981 |
| 500620 | Carduus pycnocephalus | Slender Thistle | | * | Flora | Introduced | Card pycn | 2 | 01/10/1980 |
| 500621 | Carduus tenuiflorus | Winged Slender-thistle | | * | Flora | Introduced | Cardu ten | 4 | 16/11/1999 |
| 500627 | Carex breviculmis | Common Grass-sedge | | | Flora | | Care brev | 1 | 17/11/1999 |
| 500638 | Carex fascicularis | Tassel Sedge | | | Flora | | Care fasc | 1 | 01/10/1980 |
| 500648 | Carex pumila | Strand Sedge | | | Flora | | Care pumi | 1 | 01/10/1980 |
| 500657 | Carpobrotus rossii | Karkalla | | | Flora | | Carp ross | 11 | 11/01/2000 |
| 500685 | Allocasuarina verticillata | Drooping Sheoak | | | Flora | | Allo vert | 3 | 01/12/1998 |
| 500687 | Catapodium rigidum | Fern Grass | | * | Flora | Introduced | Cata rigi | 2 | 29/12/2009 |
| 500702 | Centaurium erythraea | Common Centaury | | * | Flora | Introduced | Cent eryt | 1 | 01/10/1980 |
| 500705 | Centaurium tenuiflorum | Slender Centaury | | * | Flora | Introduced | Cent tenu | 3 | 29/12/2009 |
| 500719 | Cerastium glomeratum s.l. | Common Mouse-ear Chickweed | | * | Flora | Introduced | Cera gl.sl | 4 | 01/01/2010 |
| 500736 | Chenopodium album | Fat Hen | | * | Flora | Introduced | Chen albu | 5 | 25/03/2006 |
| 500746 | Chenopodium murale | Sowbane | | * | Flora | Introduced | Chen mura | 3 | 17/11/1999 |
| 500777 | Cicendia quadrangularis | Square Cicendia | | * | Flora | Introduced | Cice quad | 1 | 18/11/1999 |
| 500782 | Cirsium vulgare | Spear Thistle | | * | Flora | Introduced | Cirs vulg | 3 | 18/11/1999 |
| 500790 | Clematis microphylla s.l. | Small-leaved Clematis | | | Flora | | Clem mi.sl | 13 | 01/01/2010 |
| 500801 | Comesperma volubile | Love Creeper | | | Flora | | Come volu | 1 | 18/11/1999 |
| 500812 | Erigeron bonariensis | Flaxleaf Fleabane | | * | Flora | Introduced | Erig bona | 3 | 18/11/1999 |
| 500813 | Erigeron canadensis s.l. | Canadian Fleabane | | * | Flora | Introduced | Erig ca.sl | 1 | 01/10/1980 |
| 500815 | Erigeron primulifolius | Rough Fleabane | | * | Flora | Introduced | Erig prim | 6 | 18/11/1999 |
| 500829 | Correa alba | White Correa | | | Flora | | Corr alba | 11 | 01/12/1998 |
| 500846 | Cotula australis | Common Cotula | | # | Flora | Native but some stands may be alien | Cotu aust | 4 | 18/11/1999 |
| 500848 | Cotula coronopifolia | Water Buttons | | * | Flora | Introduced | Cotu coro | 1 | 01/12/1998 |
| 500859 | Crassula colorata | Dense Crassula | | | Flora | | Crass colo | 1 | 29/12/2009 |
| 500860 | Crassula decumbens var. decumbens | Spreading Crassula | | | Flora | | Crass decu | 2 | 01/09/1981 |
| 500866 | Crassula sieberiana s.l. | Sieber Crassula | | | Flora | | Cras si.sl | 9 | 18/11/1999 |
| 500890 | Cyrtostylis robusta | Large Gnat-orchid | | | Flora | | Cyrt robu | 1 | 08/09/1981 |
| 500900 | Leptecophylla oxycedrus | Crimson Berry | Critically Endangered | cr | Flora | | Lept oxy | 8 | 25/03/2006 |
| 500903 | Cymbonotus preissianus | Austral Bear's-ear | | | Flora | | Cymb prei | 1 | 01/10/1980 |
| 500907 | Cynodon dactylon | Couch | | # | Flora | Native but some stands may be alien | Cyno dact | 1 | 01/10/1980 |
| 500908 | Cynoglossum australe | Australian Hound's-tongue | | | Flora | | Cyno aust | 6 | 01/01/2010 |
| 500912 | Cynosurus echinatus | Rough Dog's-tail | | * | Flora | Introduced | Cyno echi | 1 | 01/10/1980 |
| 500948 | Dactylis glomerata | Cocksfoot | | * | Flora | Introduced | Dact glom | 1 | 01/10/1980 |
| 500961 | Rytidosperma caespitosum | Common Wallaby-grass | | | Flora | | Rytid caes | 2 | 29/12/2009 |
| 500965 | Rytidosperma geniculatum | Kneed Wallaby-grass | | | Flora | | Rytid geni | 1 | 29/12/2009 |
| 500975 | Rytidosperma pilosum | Velvet Wallaby-grass | | | Flora | | Rytid pilo | 1 | 01/10/1980 |
| 500977 | Rytidosperma racemosum var. racemosum | Slender Wallaby-grass | | | Flora | | Rytid race | 3 | 29/12/2009 |
| 500980 | Rytidosperma setaceum | Bristly Wallaby-grass | | | Flora | | Rytid seta | 3 | 18/11/1999 |
| 500989 | Daucus glochidiatus | Australian Carrot | | | Flora | | Dauc gloc | 10 | 29/12/2009 |
| 500992 | Daviesia benthamii subsp. humilis spp. agg. | Spiny Bitter-pea | | | Flora | | Davi bent | 3 | 21/11/2009 |
| 501023 | Deyeuxia quadriseta | Reed Bent-grass | | | Flora | | Deye quad | 1 | 01/10/1980 |
| 501029 | Dianella revoluta s.l. | Black-anther Flax-lily | | | Flora | | Dian re.sl | 9 | 01/12/1998 |
| 501033 | Dichelachne crinita | Long-hair Plume-grass | | | Flora | | Dich crin | 4 | 18/11/1999 |
| 501034 | Dichelachne sciurea spp. agg. | Short-hair Plume-grass | | | Flora | | Dich sciur | 1 | 01/10/1980 |
| 501036 | Dichondra repens | Kidney-weed | | | Flora | | Dich repe | 18 | 01/01/2010 |
| 501073 | Disphyma crassifolium subsp. clavellatum | Rounded Noon-flower | | | Flora | | Disp cras | 16 | 29/12/2009 |
| 501076 | Distichlis distichophylla | Australian Salt-grass | | | Flora | | Dist dist | 6 | 29/12/2009 |
| 501079 | Diuris orientis | Wallflower Orchid | | | Flora | | Diur orie | 1 | 01/10/2007 |
| 501128 | Ehrharta erecta | Panic Veldt-grass | | * | Flora | Introduced | Ehrh erec | 1 | 28/12/2009 |
| 501129 | Ehrharta longiflora | Annual Veldt-grass | | * | Flora | Introduced | Ehrh long | 7 | 01/01/2010 |
| 501156 | Enchylaena tomentosa var. tomentosa | Ruby Saltbush | | | Flora | | Ench tome | 2 | 18/11/1999 |
| 501219 | Eriochilus cucullatus s.l. | Parson's Bands | | | Flora | | Erio cucu | 1 | 01/10/2007 |
| 501232 | Erodium cicutarium | Common Heron's-bill | | * | Flora | Introduced | Erod cicu | 1 | 01/10/1980 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 501235 | Erodium moschatum | Musky Heron's-bill | | * | Flora | Introduced | Erod mosc | 1 | 24/10/1978 |
| 501331 | Euphorbia paralias | Sea Spurge | | * | Flora | Introduced | Euph para | 1 | 15/12/1982 |
| 501332 | Euphorbia peplus | Petty Spurge | | * | Flora | Introduced | Euph pepl | 2 | 01/01/2010 |
| 501353 | Exocarpos strictus | Pale-fruit Ballart | | | Flora | | Exoc stri | 1 | 15/12/1982 |
| 501354 | Exocarpos syrticola | Coast Ballart | Endangered | en | Flora | | Exoc syrt | 1 | 01/10/1980 |
| 501356 | Festuca arundinacea | Tall Fescue | | * | Flora | Introduced | Fest arun | 1 | 01/10/1980 |
| 501397 | Gahnia trifida | Coast Saw-sedge | | | Flora | | Gahn trif | 1 | 01/10/1980 |
| 501402 | Galium aparine | Cleavers | | * | Flora | Introduced | Gali apar | 1 | 17/11/1999 |
| 501403 | Galium australe s.l. | Tangled Bedstraw | | | Flora | | Gali aust | 3 | 11/01/2000 |
| 501412 | Galium murale | Small Goosegrass | | * | Flora | Introduced | Gali mura | 1 | 18/11/1999 |
| 501413 | Galium leiocarpum | Maori Bedstraw | | | Flora | | Gali prop | 1 | 01/12/1998 |
| 501428 | Geranium molle | Dove's Foot | | * | Flora | Introduced | Gera moll | 2 | 15/12/1982 |
| 501432 | Geranium retrorsum s.l. | Grassland Crane's-bill | | | Flora | | Ger ret.sl | 1 | 01/10/1980 |
| 501434 | Geranium solanderi s.l. | Austral Crane's-bill | | | Flora | | Ger sol.sl | 5 | 21/11/1999 |
| 501466 | Euchiton japonicus s.s. | Creeping Cudweed | | | Flora | | Euch co.ss | 3 | 29/12/2009 |
| 501470 | Gamochaeta purpurea s.l. | Purple Cudweed | | * | Flora | Introduced | Gamo pu.sl | 2 | 18/11/1999 |
| 501507 | Goodenia ovata | Hop Goodenia | | | Flora | | Good ovat | 1 | 01/10/1980 |
| 501578 | Halophila australis | Paddle Weed | | | Flora, Marine | | Halop aust | 1 | 01/10/1980 |
| 501606 | Chrysocephalum apiculatum s.l. | Common Everlasting | | | Flora | | Chry ap.sl | 1 | 01/10/1980 |
| 501607 | Ozothamnus argophyllus | Spicy Everlasting | Endangered | en | Flora | | Ozot argo | 2 | 01/12/1998 |
| 501622 | Ozothamnus turbinatus | Coast Everlasting | | | Flora | | Ozot turb | 15 | 29/12/2009 |
| 501660 | Heterozostera tasmanica | Eelgrass | Endangered | en | Flora | | H'zost tas | 1 | 01/10/1980 |
| 501692 | Holcus lanatus | Yorkshire Fog | | * | Flora | Introduced | Holc lana | 8 | 29/12/2009 |
| 501701 | Hordeum leporinum | Barley Grass | | * | Flora | Introduced | Hord lepo | 4 | 29/12/2009 |
| 501722 | Hydrocotyle hirta | Hairy Pennywort | | | Flora | | Hydr hirt | 3 | 18/11/1999 |
| 501725 | Hydrocotyle muscosa | Mossy Pennywort | | | Flora | | Hydr musc | 2 | 15/12/1982 |
| 501741 | Hypericum gramineum | Small St John's Wort | | | Flora | | Hype gram | 1 | 17/11/1999 |
| 501747 | Hypochaeris glabra | Smooth Cat's-ear | | * | Flora | Introduced | Hypoc gla | 2 | 18/11/1999 |
| 501748 | Hypochaeris radicata | Flatweed | | * | Flora | Introduced | Hypoc rad | 13 | 29/12/2009 |
| 501760 | Imperata cylindrica | Blady Grass | | # | Flora | Native but some stands may be alien | Impe cyli | 1 | 01/10/1980 |
| 501772 | Isolepis cernua s.s. | Nodding Club-sedge | | | Flora | | Iso cer.ss | 1 | 01/10/1980 |
| 501775 | Isolepis fluitans | Floating Club-sedge | | | Flora | | Isol flui | 1 | 01/10/1980 |
| 501777 | Isolepis hookeriana | Grassy Club-sedge | | | Flora | | Isol hook | 1 | 01/10/1980 |
| 501780 | Ficinia marginata | Little Club-sedge | | | Flora | | Fici marg | 1 | 08/12/1978 |
| 501782 | Ficinia nodosa | Knobby Club-sedge | | | Flora | | Fici nodo | 28 | 01/01/2010 |
| 501810 | Juncus bufonius | Toad Rush | | # | Flora | Native but some stands may be alien | Junc bufo | 1 | 01/10/1980 |
| 501826 | Juncus kraussii subsp. australiensis | Sea Rush | | | Flora | | Junc krau | 1 | 01/10/1980 |
| 501831 | Juncus pauciflorus | Loose-flower Rush | | | Flora | | Junc pauc | 1 | 01/10/1980 |
| 501833 | Juncus planifolius | Broad-leaf Rush | | | Flora | | Junc plan | 1 | 01/10/1980 |
| 501847 | Kennedia prostrata | Running Postman | | | Flora | | Kenn pros | 1 | 18/11/1999 |
| 501854 | Kunzea ambigua | White Kunzea | | # | Flora | Native but some stands may be alien | Kunz ambi | 2 | 01/12/1998 |
| 501863 | Lagenophora stipitata s.l. | Common Bottle-daisy | | | Flora | | Lag sti.sl | 4 | 29/12/2009 |
| 501864 | Lagurus ovatus | Hare's-tail Grass | | * | Flora | Introduced | Lagu ovat | 13 | 01/01/2010 |
| 501885 | Malva preissiana s.l. | Australian Hollyhock | | | Flora | | Malv pr.sl | 7 | 01/12/1998 |
| 501895 | Leontodon saxatilis subsp. saxatilis | Hairy Hawkbit | | * | Flora | Introduced | Leon saxa | 4 | 11/01/2000 |
| 501896 | Lepidium africanum | Common Peppercress | | * | Flora | Introduced | Lepi afri | 1 | 01/10/1980 |
| 501902 | Lepidium foliosum | Leafy Peppercress | Endangered | en | Flora | | Lepi foli | 3 | 01/12/1998 |
| 501908 | Lepidium pseudohyssopifolium | Native Peppercress | | | Flora | | Lepi p'hy | 1 | 01/12/1998 |
| 501922 | Lepidosperma gladiatum | Coast Sword-sedge | | | Flora | | Lepi glad | 8 | 21/11/1999 |
| 501923 | Lepidosperma laterale | Variable Sword-sedge | | | Flora | | Lepi late | 1 | 18/11/1999 |
| 501957 | Gaudium laevigatum | Coast Tea-tree | | # | Flora | Native but some stands may be alien | Gaud laev | 17 | 01/01/2010 |
| 501983 | Leucopogon affinis | Lance Beard-heath | | | Flora | | Leuc affin | 2 | 15/12/1982 |
| 501987 | Leucopogon parviflorus | Coast Beard-heath | | | Flora | | Leuc parv | 16 | 29/12/2009 |
| 502024 | Lobelia anceps | Angled Lobelia | | | Flora | | Lobe ance | 7 | 29/12/2009 |
| 502036 | Lolium perenne | Perennial Rye-grass | | * | Flora | Introduced | Loli pere | 2 | 01/10/1980 |
| 502046 | Lomandra longifolia | Spiny-headed Mat-rush | | | Flora | | Loma long | 4 | 01/12/1998 |
| 502054 | Rostraria cristata | Annual Cat's-tail | | * | Flora | Introduced | Rost cris | 3 | 21/11/1999 |
| 502060 | Lotus subbiflorus | Hairy Bird's-foot Trefoil | | * | Flora | Introduced | Lotu subb | 1 | 01/10/1980 |
| 502078 | Lycium ferocissimum | African Box-thorn | | * | Flora | Introduced | Lyci fero | 7 | 29/12/2009 |
| 502122 | Malva parviflora | Small-flower Mallow | | * | Flora | Introduced | Malva parv | 4 | 17/11/1999 |
| 502134 | Medicago arabica | Spotted Medic | | * | Flora | Introduced | Medi arab | 1 | 01/10/1980 |
| 502140 | Medicago polymorpha | Burr Medic | | * | Flora | Introduced | Medi poly | 2 | 21/11/1999 |
| 502145 | Melaleuca armillaris subsp. armillaris | Giant Honey-myrtle | Endangered | en # | Flora | Native but some stands may be alien | Mela armi | 1 | 01/12/1998 |
| 502147 | Melaleuca ericifolia | Swamp Paperbark | | # | Flora | Native but some stands may be alien | Mela eric | 2 | 01/01/2010 |
| 502161 | Melilotus indicus | Sweet Melilot | | * | Flora | Introduced | Meli indi | 8 | 29/12/2009 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 502179 | Microlaena stipoides var. stipoides | Weeping Grass | | | Flora | | | Micr stip | 2 | 18/11/1999 |
| 502183 | Microsorum pustulatum subsp. pustulatum | Kangaroo Fern | | | Flora | | | Micr pust | 2 | 01/10/1980 |
| 502189 | Microtis unifolia | Common Onion-orchid | | | Flora | | | Micr unif | 1 | 01/10/1980 |
| 502198 | Minuartia mediterranea | Fine-leaved Sandwort | | * | Flora | | Introduced | Minu medi | 1 | 01/10/1980 |
| 502216 | Hainardia cylindrica | Common Barb-grass | | * | Flora | | Introduced | Hain cyli | 1 | 01/10/1980 |
| 502225 | Muehlenbeckia adpressa | Climbing Lignum | | | Flora | | | Mueh adpr | 2 | 01/12/1998 |
| 502239 | Myoporum insulare | Common Boobialla | | # | Flora | | Native but some stands may be alien | Myop insu | 7 | 01/01/2010 |
| 502258 | Microtis arenaria | Notched Onion-orchid | | | Flora | | | Micr aren | 3 | 18/11/1999 |
| 502301 | Olearia axillaris | Coast Daisy-Bush | | | Flora | | | Olea axil | 20 | 01/01/2010 |
| 502308 | Olearia glutinosa | Sticky Daisy-bush | | | Flora | | | Olea glut | 2 | 01/01/1983 |
| 502311 | Olearia lepidophylla | Club-moss Daisy-bush | | | Flora | | | Olea lepi | 3 | 31/03/2011 |
| 502319 | Olearia phlogopappa | Dusty Daisy-bush | | | Flora | | | Olea phlo | 3 | 01/12/1998 |
| 502348 | Olearia sp. 2 | Peninsula Daisy-bush | Endangered | en | Flora | | | Olea sp.2 | 4 | 01/01/2010 |
| 502379 | Oxalis corniculata s.l. | Yellow Wood-sorrel | | | Flora | | | Ox corn.sl | 3 | 01/09/1981 |
| 502390 | Oxalis rubens | Dune Wood-sorrel | Endangered | en | Flora | | | Oxal rube | 10 | 28/12/2009 |
| 502418 | Parapholis incurva | Coast Barb-grass | | * | Flora | | Introduced | Para incu | 1 | 01/10/1980 |
| 502421 | Bellardia viscosa | Yellow Bartsia | | * | Flora | | Introduced | Bella visc | 2 | 15/12/1982 |
| 502422 | Parietaria debilis s.l. | Shade Pellitory | | | Flora | | | Pari de.sl | 3 | 17/11/1999 |
| 502430 | Paspalum dilatatum | Paspalum | | * | Flora | | Introduced | Pasp dila | 1 | 01/10/1980 |
| 502442 | Pelargonium australe | Austral Stork's-bill | | | Flora | | | Pela aust | 9 | 01/12/1998 |
| 502451 | Cenchrus clandestinus | Kikuyu | | * | Flora | | Introduced | Cenc clan | 1 | 01/10/1980 |
| 502497 | Phragmites australis | Common Reed | | | Flora | | | Phra aust | 1 | 01/01/2010 |
| 502511 | Helminthotheca echioides | Ox-tongue | | * | Flora | | Introduced | Helm echi | 1 | 01/10/1980 |
| 502512 | Picris angustifolia | Native Picris | | | Flora | | | Picr angu | 2 | 28/12/2009 |
| 502525 | Pimelea linifolia | Slender Rice-flower | | | Flora | | | Pime lini | 4 | 01/12/1998 |
| 502530 | Pimelea serpyllifolia subsp. serpyllifolia | Thyme Rice-flower | | | Flora | | | Pime serp | 1 | 01/10/1980 |
| 502553 | Plantago coronopus | Buck's-horn Plantain | | * | Flora | | Introduced | Plan coro | 6 | 18/11/1999 |
| 502561 | Plantago lanceolata | Ribwort | | * | Flora | | Introduced | Plan lanc | 1 | 01/10/1980 |
| 502566 | Plantago varia | Variable Plantain | | | Flora | | | Plan vari | 2 | 18/11/1999 |
| 502580 | Poa annua s.l. | Annual Meadow-grass | | * | Flora | | Introduced | Poa ann.sl | 2 | 01/12/1998 |
| 502600 | Poa labillardierei | Common Tussock-grass | | | Flora | | | Poa labill | 2 | 01/01/2010 |
| 502605 | Poa poiformis | Coast Tussock-grass | | | Flora | | | Poa poif | 27 | 29/12/2009 |
| 502622 | Polycarpon tetraphyllum | Four-leaved Allseed | | * | Flora | | Introduced | Poly tetr | 18 | 28/12/2009 |
| 502626 | Polygonum aviculare s.l. | Prostrate Knotweed | | * | Flora | | Introduced | Poly av.sl | 1 | 01/10/1980 |
| 502640 | Polypogon monspeliensis | Annual Beard-grass | | * | Flora | | Introduced | Poly mons | 1 | 01/10/1980 |
| 502713 | Pomaderris oraria | Bassian Pomaderris | | | Flora | | | Poma orar | 2 | 01/12/1998 |
| 502762 | Laphangium luteoalbum | Jersey Cudweed | | | Flora | | | Laph lute | 11 | 11/01/2000 |
| 502777 | Pteridium esculentum subsp. esculentum | Austral Bracken | | | Flora | | | Pterid esc | 8 | 01/01/2010 |
| 502779 | Pteris tremula | Tender Brake | | | Flora | | | Pteri tre | 1 | 01/01/1992 |
| 502806 | Pterostylis nutans | Nodding Greenhood | | | Flora | | | Pter nuta | 1 | 01/10/2007 |
| 502834 | Puccinellia stricta s.l. | Australian Saltmarsh-grass | | | Flora | | | Pucc stri | 1 | 01/10/1980 |
| 502844 | Pultenaea daphnoides | Large-leaf Bush-pea | | | Flora | | | Pult daph | 1 | 18/11/1999 |
| 502877 | Pultenaea tenuifolia | Slender Bush-pea | | | Flora | | | Pult tenu | 1 | 18/11/1999 |
| 502907 | Ranunculus amphitrichus | Small River Buttercup | | | Flora | | | Ranu amph | 1 | 06/12/1975 |
| 502912 | Ranunculus sessiliflorus | Annual Buttercup | | | Flora | | | Ranu sess | 1 | 18/11/1999 |
| 502927 | Rhagodia candolleana subsp. candolleana | Seaberry Saltbush | | | Flora | | | Rhag cand | 33 | 01/01/2010 |
| 502948 | Nasturtium officinale | Watercress | | * | Flora | | Introduced | Nast offi | 1 | 01/10/1980 |
| 502966 | Acetosella vulgaris | Sheep Sorrel | | * | Flora | | Introduced | Acet vulg | 1 | 01/10/1980 |
| 502968 | Rumex brownii | Slender Dock | | | Flora | | | Rume brow | 1 | 01/10/1980 |
| 502970 | Rumex crispus | Curled Dock | | * | Flora | | Introduced | Rume cris | 1 | 01/10/1980 |
| 502985 | Sagina apetala | Common Pearlwort | | * | Flora | | Introduced | Sagi apet | 2 | 18/11/1999 |
| 502987 | Sagina procumbens | Spreading Pearlwort | | * | Flora | | Introduced | Sagi proc | 1 | 01/10/1980 |
| 502999 | Sambucus gaudichaudiana | White Elderberry | | | Flora | | | Samb gaud | 15 | 01/01/2010 |
| 503001 | Samolus repens | Creeping Brookweed | | | Flora | | | Samo repe | 3 | 29/12/2009 |
| 503012 | Salicornia quinqueflora | Beaded Glasswort | | | Flora | | | Salic quin | 5 | 29/12/2009 |
| 503039 | Schoenus apogon | Common Bog-sedge | | | Flora | | | Scho apog | 1 | 18/11/1999 |
| 503051 | Schoenus nitens | Shiny Bog-sedge | | | Flora | | | Scho nite | 4 | 29/12/2009 |
| 503100 | Goodenia radicans | Shiny Swamp-mat | | | Flora | | | Good radi | 1 | 01/10/1980 |
| 503102 | Senecio biserratus | Jagged Fireweed | | | Flora | | | Sene bise | 1 | 18/11/1999 |
| 503105 | Senecio elegans | Purple Groundsel | | * | Flora | | Introduced | Sene eleg | 3 | 08/02/2001 |
| 503107 | Senecio glomeratus | Annual Fireweed | | | Flora | | | Sene glom | 2 | 01/01/2010 |
| 503114 | Senecio pinnatifolius | Variable Groundsel | | | Flora | | | Sene pinn | 22 | 29/12/2009 |
| 503119 | Senecio minimus | Shrubby Fireweed | | | Flora | | | Sene mini | 1 | 11/12/1983 |
| 503120 | Senecio odoratus | Scented Groundsel | | | Flora | | | Sene odor | 2 | 01/12/1998 |
| 503151 | Silene gallica | French Catchfly | | * | Flora | | Introduced | Sile gall | 1 | 17/11/1999 |

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|---|---|---|---|---|---|---|---|---|---|
| 503156 | Silybum marianum | Variegated Thistle | | * | Flora | Introduced | Sily mari | 3 | 25/11/1984 |
| 503169 | Solanum aviculare | Kangaroo Apple | | # | Flora | Native but some stands may be alien | Sola avic | 7 | 01/12/1998 |
| 503178 | Solanum linnaeanum | Apple of Sodom | | * | Flora | Introduced | Sola linn | 4 | 09/12/2020 |
| 503179 | Solanum laciniatum | Large Kangaroo Apple | | | Flora | | Sola laci | 1 | 01/10/1980 |
| 503183 | Solanum nigrum s.l. | Black Nightshade | | * | Flora | Introduced | Sol nig.sl | 2 | 17/11/1999 |
| 503184 | Solanum opacum | Green-berry Nightshade | | | Flora | | Sola opac | 3 | 17/11/1999 |
| 503203 | Sonchus asper s.l. | Rough Sow-thistle | | * | Flora | Introduced | Sonc as.sl | 5 | 17/11/1999 |
| 503204 | Sonchus oleraceus | Common Sow-thistle | | * | Flora | Introduced | Sonc oler | 24 | 29/12/2009 |
| 503219 | Spergularia rubra s.l. | Red Sand-spurrey | | * | Flora | Introduced | Sper ru.sl | 1 | 01/10/1980 |
| 503222 | Spinifex sericeus | Hairy Spinifex | | | Flora | | Spin seri | 8 | 28/12/2009 |
| 503226 | Sporobolus africanus | Rat-tail Grass | | * | Flora | Introduced | Spor afri | 1 | 01/10/1980 |
| 503230 | Sporobolus virginicus | Salt Couch | | | Flora | | Spor virg | 1 | 01/10/1980 |
| 503251 | Stellaria media | Chickweed | | * | Flora | Introduced | Stel medi | 5 | 01/09/1981 |
| 503252 | Stellaria multiflora | Rayless Starwort | | | Flora | | Stel mult | 1 | 01/10/1980 |
| 503253 | Stellaria pallida | Lesser Chickweed | | * | Flora | Introduced | Stel pall | 1 | 15/12/1982 |
| 503260 | Stenotaphrum secundatum | Buffalo Grass | | * | Flora | Introduced | Sten secu | 1 | 01/10/1980 |
| 503276 | Austrostipa flavescens | Coast Spear-grass | | | Flora | | A'stip fla | 9 | 29/12/2009 |
| 503293 | Austrostipa stipoides | Prickly Spear-grass | | | Flora | | A'stip sti | 15 | 29/12/2009 |
| 503318 | Swainsona lessertiifolia | Coast Swainson-pea | | | Flora | | Swai less | 8 | 01/01/2010 |
| 503343 | Tetragonia implexicoma | Bower Spinach | | | Flora | | Tetr impl | 34 | 11/01/2019 |
| 503344 | Tetragonia tetragonioides | New Zealand Spinach | | | Flora | | Tetr tetr | 2 | 27/09/2017 |
| 503382 | Thelymitra pauciflora s.l. | Slender Sun-orchid | | | Flora | | Thel pa.sl | 2 | 01/10/2007 |
| 503393 | Threlkeldia diffusa | Coast Bonefruit | | | Flora | | Thre diff | 5 | 29/12/2009 |
| 503405 | Tmesipteris parva | Small Fork-fern | Endangered | en | Flora | | Tmes parv | 3 | 05/01/1939 |
| 503423 | Trifolium angustifolium var. angustifolium | Narrow-leaf Clover | | * | Flora | Introduced | Trif angu | 1 | 17/11/1999 |
| 503424 | Trifolium arvense var. arvense | Hare's-foot Clover | | * | Flora | Introduced | Trif arve | 1 | 17/11/1999 |
| 503425 | Trifolium campestre var. campestre | Hop Clover | | * | Flora | Introduced | Trif camp | 1 | 01/10/1980 |
| 503427 | Trifolium dubium | Suckling Clover | | * | Flora | Introduced | Trif dubi | 4 | 29/12/2009 |
| 503429 | Trifolium glomeratum | Cluster Clover | | * | Flora | Introduced | Trif glom | 3 | 18/11/1999 |
| 503435 | Trifolium repens var. repens | White Clover | | * | Flora | Introduced | Trif repe | 1 | 01/10/1980 |
| 503449 | Triglochin striata | Streaked Arrowgrass | | | Flora | | Trig stri | 1 | 01/10/1980 |
| 503468 | Typha domingensis | Narrow-leaf Cumbungi | | | Flora | | Typh domi | 1 | 01/10/1980 |
| 503476 | Urtica incisa | Scrub Nettle | | | Flora | | Urti inci | 4 | 17/11/1999 |
| 503477 | Urtica urens | Small Nettle | | * | Flora | Introduced | Urti uren | 3 | 28/12/2009 |
| 503491 | Vellereophyton dealbatum | White Cudweed | | * | Flora | Introduced | Vell deal | 1 | 01/10/1980 |
| 503494 | Verbascum thapsus subsp. thapsus | Great Mullein | | * | Flora | Introduced | Verb thap | 1 | 01/10/1980 |
| 503512 | Veronica plebeia | Trailing Speedwell | | | Flora | | Vero pleb | 2 | 18/11/1999 |
| 503518 | Vicia sativa | Common Vetch | | * | Flora | Introduced | Vici sati | 1 | 01/10/1980 |
| 503528 | Viola hederacea sensu Willis (1973) | Ivy-leaf Violet | | | Flora | | Viol he.Wi | 5 | 29/12/2009 |
| 503544 | Vulpia bromoides | Squirrel-tail Fescue | | * | Flora | Introduced | Vulp brom | 4 | 21/11/1999 |
| 503546 | Vulpia myuros f. megalura | Fox-tail Fescue | | * | Flora | Introduced | Vulp my.me | 1 | 16/11/1999 |
| 503547 | Vulpia fasciculata | Dune Fescue | | * | Flora | Introduced | Vulp fasc | 2 | 15/12/1982 |
| 503548 | Vulpia muralis | Wall Fescue | | * | Flora | Introduced | Vulp mura | 1 | 21/11/1999 |
| 503549 | Vulpia myuros | Rat's-tail Fescue | | * | Flora | Introduced | Vulp myur | 1 | 29/12/2009 |
| 503558 | Wahlenbergia gracilis | Sprawling Bluebell | | | Flora | | Wah grac's | 1 | 29/12/2009 |
| 503560 | Wahlenbergia multicaulis | Branching Bluebell | | | Flora | | Wahl mult | 1 | 18/11/1999 |
| 503593 | Xanthosia pusilla spp. agg. | Heath Xanthosia | | | Flora | | Xant pusi | 1 | 17/11/1999 |
| 503615 | Roepera billardierei | Coast Twin-leaf | Endangered | en | Flora | | Roep bill | 2 | 01/12/1998 |
| 503657 | Bulbine glauca | Rock Lily | | | Flora | | Bulb glau | 2 | 01/12/1998 |
| 503695 | Hordeum murinum s.l. | Barley-grass | | * | Flora | Introduced | Hord muri | 2 | 17/11/1999 |
| 503749 | Euchiton involucratus s.l. | Common Cudweed | | | Flora | | Euch in.sl | 2 | 01/12/1998 |
| 503841 | Luzula meridionalis | Common Woodrush | | | Flora | | Luzu meri | 2 | 18/11/1999 |
| 503912 | Ornithopus compressus | Yellow Serradella | | * | Flora | Introduced | Orni comp | 1 | 07/10/2002 |
| 503947 | Pomaderris paniculosa subsp. paralia | Coast Pomaderris | | | Flora | | Pom pa.par | 4 | 01/01/2010 |
| 503975 | Senecio spathulatus s.l. | Dune Groundsel | | | Flora | | Sen spa.sl | 7 | 01/01/2010 |
| 504012 | Trifolium resupinatum var. resupinatum | Shaftal Clover | | * | Flora | Introduced | Trif res.r | 1 | 15/12/1982 |
| 504221 | Lachnagrostis billardierei subsp. billardierei | Coast Blown-grass | | | Flora | | Lach bi.ss | 1 | 15/12/1982 |
| 504236 | Apium prostratum subsp. prostratum var. filiforme | Sea Celery | | | Flora | | Apiu pr.f | 1 | 04/02/1984 |
| 504281 | Chrysocephalum apiculatum s.s. | Common Everlasting | | | Flora | | Chry ap.ss | 1 | 08/12/1978 |
| 504370 | Correa reflexa var. reflexa | Common Correa | | | Flora | | Corr re.re | 2 | 01/01/1770 |
| 504378 | Crassula sieberiana s.s. | Sieber Crassula | | | Flora | | Cras si.ss | 2 | 29/12/2009 |
| 504397 | Picris angustifolia subsp. angustifolia | Coast Picris | | | Flora | | Picr ang.a | 1 | 11/12/1983 |
| 504412 | Dianella brevicaulis | Small-flower Flax-lily | | | Flora | | Dian brev | 13 | 01/01/2010 |
| 504421 | Dodonaea viscosa subsp. spatulata | Sticky Hop-bush | | | Flora | | Dodo v.sp | 2 | 25/03/2006 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 504445 | Epilobium billardiereanum subsp. cinereum | Grey Willow-herb | | | Flora | | Ep bill.c | 2 | 11/01/2000 |
| 504650 | Craspedia variabilis | Variable Billy-buttons | | | Flora | | Crasp vari | 1 | 11/09/1989 |
| 504652 | Euchiton japonicus s.l. | Clustered/Creeping Cudweed | | | Flora | | Euch co.sl | 1 | 01/10/1980 |
| 504714 | Lomandra longifolia subsp. longifolia | Spiny-headed Mat-rush | | | Flora | | Loma lo.lo | 4 | 18/11/1999 |
| 504821 | Plantago coronopus subsp. coronopus | Buck's-horn Plantain | | * | Flora | Introduced | Plan co.cr | 1 | 11/12/1978 |
| 504826 | Poa poiformis var. ramifer | Dune Poa | Endangered | en | Flora | | Poa po.ram | 10 | 01/01/2010 |
| 504833 | Poa poiformis var. poiformis | Coast Tussock-grass | | | Flora | | Poa poif.p | 5 | 01/12/1998 |
| 504912 | Ranunculus sessiliflorus var. sessiliflorus | Annual Buttercup | | | Flora | | Ranu se.s | 1 | 17/11/1999 |
| 505022 | Cardamine hirsuta s.s. | Common Bitter-cress | | * | Flora | Introduced | Card hi.ss | 1 | 08/09/1981 |
| 505036 | Parietaria debilis s.s. | Shade Pellitory | | | Flora | | Pari de.ss | 2 | 28/12/2009 |
| 505054 | Vicia sativa subsp. sativa | Common Vetch | | * | Flora | Introduced | Vici sat.s | 1 | 16/11/1999 |
| 505056 | Viola cleistogamoides | Hidden Violet | | | Flora | | Viol clei | 1 | 27/09/1995 |
| 505128 | Acacia longifolia | Sallow Wattle | | # | Flora | Native but some stands may be alien | Acac long | 2 | 01/01/1983 |
| 505238 | Cerastium glomeratum s.s. | Sticky Mouse-ear Chickweed | | * | Flora | Introduced | Cera gl.ss | 2 | 28/12/2009 |
| 505244 | Senecio pinnatifolius var. lanceolatus | Lance-leaf Groundsel | | | Flora | | Sen pin.la | 4 | 21/11/1999 |
| 505308 | Salsola tragus subsp. pontica | Coast Saltwort | Endangered | en | Flora | | Sals tr.po | 2 | 25/03/2006 |
| 505344 | Geranium sp. 3 | Pale-flower Crane's-bill | Endangered | en | Flora | | Gera sp.3 | 1 | 17/11/1999 |
| 505345 | Geranium gardneri | Rough Crane's-bill | | | Flora | | Gera gard | 3 | 18/11/1999 |
| 505425 | Xerochrysum papillosum | Island Everlasting | Critically Endangered | cr | Flora | | Xero papi | 4 | 01/12/1998 |
| 505516 | Ficus carica | Fig | | * | Flora | Introduced | Ficus cari | 1 | 01/01/2010 |
| 506413 | Lembophyllum divulsum s.l. | Catkin Moss | | | Flora | | Lemb di.sl | 1 | 25/03/2006 |
| 506703 | Tortula muralis | Common Wall-moss | | # | Flora | Native but some stands may be alien | Tort mura | 1 | 03/11/1970 |
| 506739 | Weissia controversa | Green-tufted Stubble-moss | | | Flora | | Weis cont | 1 | 12/05/1941 |
| 507065 | Caryophyllaceae spp. | Carnation | | | Flora | | Caryo spp. | 2 | 01/09/1981 |
| 507386 | Clematis microphylla s.s. | Small-leaved Clematis | | | Flora | | Clem mi.ss | 2 | 01/01/2010 |
| 507551 | Aira caryophyllea/elegantissima | Silvery/Delicate Hair-grass | | * | Flora | Introduced | Aira ca/el | 1 | 01/10/1980 |
| 507554 | Asteraceae spp. | Composite | | | Flora | | Astera spp | 3 | 01/09/1981 |
| 507703 | Bulbine crassa | Coast Lily | Endangered | en | Flora | | Bulb cras | 11 | 01/12/1998 |
| 508024 | Aira spp. | Hair Grass | | * | Flora | Introduced | Aira spp. | 4 | 21/11/2009 |
| 508038 | Amaranthus spp. | Amaranth | | | Flora | | Amaran spp | 1 | 01/10/1980 |
| 508046 | Amphibromus spp. | Swamp Wallaby-grass | | | Flora | | Amp'br spp | 1 | 21/11/2009 |
| 508049 | Amyema spp. | Mistletoe | | | Flora | | Amyema spp | 1 | 21/11/2009 |
| 508079 | Arthropodium spp. | Vanilla Lily | | | Flora | | Arth'p spp | 1 | 21/11/2009 |
| 508082 | Asperula spp. | Woodruff | | | Flora | | Asper spp. | 1 | 20/11/2009 |
| 508098 | Avena spp. | Oat | | * | Flora | Introduced | Avena spp. | 6 | 21/11/2009 |
| 508160 | Xerochrysum spp. | Everlasting | | | Flora | | Xeroc spp. | 2 | 01/12/1998 |
| 508171 | Caladenia spp. | Caladenia | | | Flora | | Calad spp. | 1 | 17/11/1999 |
| 508191 | Cardamine spp. | Bitter Cress | | | Flora | | Cardam spp | 1 | 01/10/1980 |
| 508208 | Centaurium spp. | Centaury | | * | Flora | Introduced | Cent'm spp | 6 | 18/11/1999 |
| 508222 | Chenopodium spp. | Goosefoot | | | Flora | | Chenop spp | 1 | 29/12/2009 |
| 508253 | Erigeron spp. | Fleabane | | * | Flora | Introduced | Eriger spp | 2 | 16/11/1999 |
| 508260 | Corybas spp. | Helmet Orchid | | | Flora | | Coryba spp | 1 | 17/11/1999 |
| 508265 | Crassula spp. | Crassula | | | Flora | | Crass spp. | 1 | 21/11/2009 |
| 508271 | Hordeum spp. | Barley Grass | | * | Flora | Introduced | Hordeum sp | 4 | 21/11/2009 |
| 508289 | Cynoglossum spp. | Hound's Tongue | | | Flora | | Cynog spp. | 1 | 21/11/1999 |
| 508313 | Rytidosperma spp. | Wallaby Grass | | | Flora | | Rytido spp | 6 | 21/11/2009 |
| 508327 | Dianella spp. | Flax Lily | | | Flora | | Dianel spp | 2 | 18/11/1999 |
| 508377 | Ehrharta spp. | Veldt Grass | | * | Flora | Introduced | Ehrhar spp | 1 | 17/11/1999 |
| 508398 | Eragrostis spp. | Love Grass | | | Flora | | Eragro spp | 1 | 21/11/2009 |
| 508409 | Erodium spp. | Heron's Bill | | | Flora | | Erod spp. | 1 | 20/11/2009 |
| 508474 | Geranium spp. | Crane's Bill | | | Flora | | Geran spp. | 3 | 29/12/2009 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 508488 | Gnaphalium spp. | Cudweed | | | Flora | | Gnaph spp. | 1 | 01/09/1981 |
| 508492 | Goodenia spp. | Goodenia | | | Flora | | Gooden spp | 2 | 21/11/2009 |
| 508527 | Coronidium spp. | Everlasting | | | Flora | | Helich spp | 1 | 01/09/1981 |
| 508548 | Hydrocotyle spp. | Pennywort | | | Flora | | Hydro spp. | 1 | 01/09/1981 |
| 508601 | Juncus spp. | Rush | | | Flora | | Juncus spp | 4 | 21/11/2009 |
| 508633 | Lactuca spp. | Lettuce | | * | Flora | Introduced | Lactuc spp | 1 | 21/11/2009 |
| 508643 | Lavandula spp. | Lavender | | * | Flora | Introduced | Lavand spp | 1 | 21/11/2009 |
| 508653 | Lepidosperma spp. | Sword Sedge | | | Flora | | Lepidos sp | 1 | 17/11/1999 |
| 508683 | Lolium spp. | Rye Grass | | * | Flora | Introduced | Lolium spp | 5 | 21/11/2009 |
| 508715 | Malva spp. | Mallow | | | Flora | | Malva spp. | 1 | 21/11/2009 |
| 508722 | Medicago spp. | Medic | | * | Flora | Introduced | Medic spp. | 1 | 19/11/2009 |
| 508739 | Microtis spp. | Onion Orchid | | | Flora | | Microt spp | 2 | 01/10/2008 |
| 508813 | Olearia spp. | Daisy Bush | | | Flora | | Olear spp. | 12 | 31/03/2011 |
| 508821 | Opuntia spp. | Prickly Pear | | * | Flora | Introduced | Opunt spp. | 1 | 21/11/2009 |
| 508901 | Plantago spp. | Plantain | | | Flora | | Planta spp | 1 | 01/06/1981 |
| 508909 | Poa spp. | Tussock Grass | | | Flora | | Poa spp. | 1 | 21/11/2009 |
| 508936 | Prunus spp. | Prunus | | * | Flora | Introduced | Prunus spp | 1 | 21/11/2009 |
| 508946 | Pterostylis spp. | Greenhood | | | Flora | | Pteros spp | 1 | 01/06/1981 |
| 509000 | Rumex spp. | Dock | | | Flora | | Rumex spp. | 3 | 21/11/2009 |
| 509018 | Salix spp. | Willow | | * | Flora | Introduced | Salix spp. | 1 | 21/11/2009 |
| 509058 | Senecio spp. | Groundsel | | | Flora | | Senec spp. | 2 | 01/09/1981 |
| 509067 | Sinapis spp. | Mustard | | * | Flora | Introduced | Sinap spp. | 1 | 21/11/2009 |
| 509072 | Solanum spp. | Nightshade | | | Flora | | Solan spp. | 2 | 19/11/2009 |
| 509083 | Spergula spp. | Corn Spurrey | | * | Flora | Introduced | Sp'ula spp | 1 | 21/11/2009 |
| 509094 | Stellaria spp. | Starwort | | | Flora | | Stella spp | 1 | 28/12/2009 |
| 509099 | Austrostipa spp. | Spear Grass | | | Flora | | A'stip spp | 3 | 21/11/2009 |
| 509122 | Taraxacum spp. | Dandelion | | | Flora | | Tarax spp. | 2 | 16/11/1999 |
| 509134 | Thelymitra spp. | Sun Orchid | | | Flora | | Thelym spp | 3 | 21/11/2009 |
| 509161 | Trifolium spp. | Clover | | * | Flora | Introduced | Trifol spp | 6 | 21/11/2009 |
| 509217 | Vicia spp. | Vetch | | * | Flora | Introduced | Vicia spp. | 1 | 20/11/2009 |
| 509223 | Vulpia spp. | Fescue | | * | Flora | Introduced | Vulpia spp | 1 | 19/11/2009 |
| 509236 | Wahlenbergia spp. | Bluebell | | | Flora | | Wahlen spp | 3 | 21/11/2009 |
| 509386 | Frullania spp. | Scalewort | | | Flora | | Frull spp. | 1 | 25/03/2006 |
| 509447 | Metzgeria spp. | Veilwort | | | Flora | | Metzg spp. | 1 | 25/03/2006 |
| 509569 | Xanthoparmelia spp. | Foliose Lichen | | | Flora | | Xanthop sp | 1 | 25/03/2006 |
| 528552 | Vulpes vulpes | Red Fox | | * | Terrestrial fauna | Introduced | | 3 | 08/11/2012 |
| 528553 | Limosa limosa | Black-tailed Godwit | Critically Endangered | EN cr | Terrestrial fauna, Coastal | | | 5 | 01/03/1981 |
| 528555 | Himantopus leucocephalus | Pied Stilt | | | Terrestrial fauna | | | 6 | 10/02/1980 |
| 528559 | Carduelis carduelis | European Goldfinch | | * | Terrestrial fauna | Introduced | | 81 | 30/10/2005 |
| 528611 | Galium australe s.s. | Tangled Bedstraw | | | Flora | | Gali au.ss | 1 | 28/12/2009 |
| 826030 | Zonaria spp. | Brown Algae | | | Marine, Flora | | | 1 | 20/06/2005 |
| 903268 | Ardea alba | Great Egret | | | Terrestrial fauna, Aquatic fauna, Coastal | | | 34 | 01/03/1981 |

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# Bass Gas: Yolla Operations Update

## Acoustic Modelling for Assessing Marine Fauna Sound Exposures

JASCO Applied Sciences (Australia) Pty Ltd

4 December 2025

Submitted to:

Zacc Paparella
Beach Energy
Purchase Order BE00099790

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P002050-001
Document 04179
Version 1.0

JASCO APPLIED SCIENCES

Suggested citation:

Liu, J., Connell, C.S and A McDonald. 2025. Bass Gas: Yolla Operations Update: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Document 04179, Version 1.0. Technical report by JASCO Applied Sciences for Beach Energy.

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# Contents

Executive Summary ..... 1
1. Introduction ..... 3
1.1. Modelling Scenarios ..... 3
2. Noise Effect Criteria ..... 6
2.1. Marine Mammals ..... 6
2.1.1. Behavioural Response ..... 7
2.1.2. Injury and Hearing Sensitivity Changes ..... 7
2.2. Fish, Sea Turtles, Fish Eggs, and Fish Larvae ..... 7
3. Methods and Parameters ..... 9
3.1. Modelling parameters ..... 9
3.2. Sound Sources ..... 9
3.2.1. Production Platform ..... 10
3.2.2. Vessel Noise Sources ..... 10
3.3. Geometry and Modelled Regions ..... 11
3.4. Accumulated SEL ..... 11
4. Results ..... 13
4.1. Tabulated Results ..... 13
4.2. Sound Field Maps ..... 14
4.2.1. SPL Sound Level Contour Maps ..... 15
4.2.2. Accumulated $SEL_{24h}$ Sound level Contour Maps ..... 17
5. Discussion and conclusion ..... 21
5.1. Effect of vessel sizing on modelled results ..... 21
5.1.1. Accumulated sound exposure ..... 21
5.2. Geology and bathymetry influence on results assumptions ..... 21
5.3. Conclusion ..... 22
Glossary ..... 23
Literature Cited ..... 31
Appendix A. Acoustic Metrics ..... A-1
Appendix B. Methods and Parameters ..... B-1

# Figures

Figure 1. Overview map of the modelling sites and regional context. ..... 5
Figure 2. Decidecade monopole source level (MSL) spectra for all three sound sources. ..... 9
Figure 3. *Scenario 1, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (4 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals. ..... 15
Figure 4. *Scenario 2, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (8 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals. ..... 15
Figure 5. *Scenario 3, Yolla Platform Operations + generic OSV under DP conducting Resupply Ops (4 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals. ..... 16
Figure 6. *Scenario 4, Yolla Platform Operations + generic OSV under DP conducting Resupply Ops (8 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals. ..... 16
Figure 7. *Scenario 1, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (4 h), accumulated $SEL_{24h}$*: Sound level contour map showing maximum-over-depth $SEL_{24h}$ results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans otariid seals and sea turtles. ..... 17
Figure 8. *Scenario 2, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (8 h), accumulated $SEL_{24h}$*: Sound level contour map showing maximum-over-depth $SEL_{24h}$ results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans otariid seals and sea turtles. ..... 18
Figure 9. *Scenario 3, Yolla Platform Operations + Generic OSV under DP conducting Resupply Ops (4 h), accumulated $SEL_{24h}$*: Sound level contour map showing maximum-over-depth $SEL_{24h}$ results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans otariid seals and sea turtles. ..... 19
Figure 10. *Scenario 4, Yolla Platform Operations + Generic OSV under DP conducting Resupply Ops (8 h), accumulated $SEL_{24h}$*: Sound level contour map showing maximum-over-depth $SEL_{24h}$ results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans, otariid seals and sea turtles. ..... 20

Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale. ..... A-2
Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale. ..... A-3
Figure A-3. Auditory weighting functions for functional marine mammal hearing groups used in this project as recommended by NMFS (2024). ..... A-6
Figure B-1. Bathymetry in the modelled area. ..... B-1

Figure B-2. The sound speed profile considered for acoustic modelling corresponding to August (dashed curve) and other considered monthly profiles Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). ..... B-2
Figure B-3. The N×2-D and maximum-over-depth modelling approach used by MONM. ..... B-4
Figure B-4. Sample areas ensonified to an arbitrary sound level with $R_{max}$ and $R_{95\%}$ ranges shown for two different scenarios. ..... B-5

# Tables

Table 1. Summary of maximum ($R_{max}$) horizontal distances (in km) from all scenarios considered to the marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) and LF-cetacean $SEL_{24h}$ PTS/AUD INJ and TTS thresholds based on NMFS 2024. ..... 2
Table 2. Summary of fish results ..... 2
Table 3. Description of modelled scenarios. ..... 4
Table 4. Modelled site locations and source information. ..... 4
Table 5. Criteria for effects of non-impulsive noise exposure, including vessel noise, for marine mammals: unweighted SPL and weighted $SEL_{24h}$ thresholds. ..... 7
Table 6. Criteria for vessel noise exposure for fish and sea turtles ..... 8
Table 7. Acoustic effects of non-impulsive noise on sea turtles ..... 8
Table 8. Assumed broadband source levels (dB re 1 $\mu Pa^2m^2$) for all updated sound sources and comparison to previous modelling ..... 10
Table 9. *SPL*: Maximum ($R_{max}$) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from most appropriate location for considered sources per scenario. ..... 13
Table 10. $SEL_{24h}$: Maximum ($R_{max}$) horizontal distances (in km) to frequency-weighted $SEL_{24h}$ PTS and TTS thresholds for marine mammals (NMFS 2024), and sea turtles (Accomando et al. 2025) from the vessel location, along with ensonified area ($km^2$). ..... 14
Table 11. Summary of the maximum ($R_{max}$) horizontal distances (in km) to relevant thresholds for marine fauna across the scenario with larger effects, for scenarios involved the SEA1 AHTS and Generic OSV. ..... 22

Table A-1. Parameters for the auditory weighting functions used in this project as recommended by NMFS (2024). The ‘flo’ and ‘fhi’ parameters used by Finneran (2015) are now referred to as ‘f1’ and ‘f2’ in the latest guidance. ..... A-5
Table B-1. Geoacoustic profile for all modelled sites. ..... B-3

# Executive Summary

JASCO Applied Sciences (JASCO) undertook a revision of scenarios within a previously completed modelling study of underwater sound levels associated with Beach Energy operated Yolla Platform and associated support vessel operations.

This report presents updated results that were initially reported within the Yolla Drilling Campaign Modelling Report 02741, issued in June 2022. The updates made in this report were made to account for recent changes in noise effect criteria as well as modelling scenario assumptions to better reflect changes in the operational context;

- Previously, the Platform was represented by a jack up rig. This assumption has now been updated, with the Platform's sound source profile now based on measurements made of a similar platform in the local region.
- Incorporation of the sound source profile of a SEA1 operated Anchor Handling Tug Supply (AHTS) vessel conducting supply transfer to the platform. This vessel is assumed to be louder than the previously modelled offshore supply vessel (OSV), to account for the fact a vessel of this size may now conduct these activities under Beach current supply transfer and logistical arrangements.
- Updated criteria for assessing the effects of underwater noise on marine mammals, as per NMFS 2024, and for sea turtles as per Accomando et al. 2025.

This modelling report considers four scenarios;

- Scenario 1. Yolla Platform with a SEA1 AHTS conducting re-supply for four hours.
- Scenario 2. Yolla Platform with a SEA1 AHTS conducting re-supply for eight hours.
- Scenario 3. Yolla Platform with a generic OSV conducting re-supply for four hours.
- Scenario 4. Yolla Platform with a generic OSV conducting re-supply for eight hours.

This report outlines the distances from operations to where underwater sound levels were modelled as reaching thresholds corresponding to various levels of potential effect to marine fauna. The fauna considered here included marine mammals, fish, and marine turtles. Due to the variety of species considered, there are several different thresholds for evaluating effects, which include behavioral response and auditory impairment (temporary threshold shift (TTS) and permanent threshold shift (PTS)). PTS is a form of auditory impairment/injury as it is referred to in NMFS (2024) (using the acronym AUD INJ), however in this report, for consistency with previous work, the term PTS is retained.

Key results are summarised below. Within the report, maps are provided in the report to assist with contextualizing tabulated distances.

**Marine mammals**

The maximum distances to the marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) ranged between 5.94 km (Scenarios 3 and 4) and 21.9 km (Scenarios 1 and 2) (Table 1).

Table 1 also summarises the maximum distances to impairment criteria for marine mammals, presenting the hearing group associated with the longest effect radii for each scenario.

Table 1. Summary of maximum ($R_{max}$) horizontal distances (in km) from all scenarios considered to the marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) and LF-cetacean $SEL_{24h}$ PTS/AUD INJ and TTS thresholds based on NMFS 2024.

| Scenario | Description | Maximum ($R_{max}$) distance to threshold (km) | | |
|---|---|---|---|---|
| | | Marine Mammal Behavioural Response [a] | LF-cetacean TTS | LF-cetacean PTS/ AUD INJ [b] |
| 1 | Yolla Platform Operations + SEA1 AHTS under DP (4 h) | 21.9 | 2.88 | 0.11 |
| 2 | Yolla Platform Operations + SEA1 AHTS under DP (8 h) | 21.9 | 4.26 | 0.20 |
| 3 | Yolla Platform Operations + Generic OSV under DP (4 h) | 5.94 | 0.57 | 0.03 |
| 4 | Yolla Platform Operations + Generic OSV under DP (8 h) | 5.94 | 0.94 | 0.04 |

Noise exposure criteria: [a] NOAA (2024) and [b] NMFS (2024).
A dash indicates the level was not reached within the limits of the modelled resolution (20 m).

### Sea turtles

The $SEL_{24h}$ threshold criteria from Accomando et al. (2025) were used to assess TTS and PTS for sea turtles. Across all scenarios, the maximum distances to threshold were 2.31 km for TTS and 0.08 km for PTS.

As is the case with marine mammals, a reported radius for $SEL_{24h}$ criteria does not mean that sea turtles travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound levels associated with TTS or PTS if it remained within the respective ensonified areas for 24 hours.

### Fish

Sound produced by all scenarios did not reach the sound levels associated with recoverable injury. Sound levels for TTS for fish species with a swim bladder involved in hearing were reached within 0.03 and 0.08 km of the sound sources respectively (Table 2).

Table 2. Summary of fish results : Maximum ($R_{max}$) horizontal distances (in km), from all scenarios considered, to sound pressure level (SPL) criteria based on Popper *et al*. (2014).

| Scenario Number | Description | Maximum ($R_{max}$) distance to threshold (km) | |
|---|---|---|---|
| | | Recoverable injury (48 h) | TTS (12 h) |
| 1 | Yolla Platform Operations + SEA1 AHTS under DP (4 h) | – | 0.08 |
| 2 | Yolla Platform Operations + SEA1 AHTS under DP (8 h) | – | 0.08 |
| 3 | Yolla Platform Operations + Generic OSV under DP (4 h) | – | 0.03 |
| 4 | Yolla Platform Operations + Generic OSV under DP (8 h) | – | 0.03 |

A dash indicates the level was not reached within the limits of the modelled resolution (20 m)

# 1. Introduction

JASCO Applied Sciences (JASCO) undertook updates to a modelling study of underwater acoustic noise levels presented in the 2022 report Yolla Drilling – Bass Gas Operations (Stroot et al. 2022). These updates primarily relate to Scenario 4 in Report 02741, which has now been updated and expanded up to account for new impact assessment criteria and for alternative vessel / rig sound source representations and activity assumptions as follows;

- Change the representation of the Yolla platform to that of one of the public measurements of an Esso Gippsland Platform, previously represented as a jack up drilling rig due to absence of alternate surrogate.
- Present results for both the SEA1 vessel and a generic OSV (modification of the original report Scenario 4) to account for a circumstance where this type of vessel is used for the activity.
- Reprocessing of all scenarios using the recently revised NMFS 2024 / Accomando 2025 noise effect criteria.

This modelling study specifically predicted the distances from vessel operations at which underwater sound levels reached noise effect thresholds and criteria applicable to marine fauna including marine mammals, sea turtles, and fish. Due to the variety of species considered, there are several different thresholds for evaluating effects, which include behavioural response and impairment (temporary threshold shift (TTS) and permanent threshold shift (PTS)). PTS is a form of auditory injury as it is referred to in NMFS (2024) (using the acronym AUD INJ), however in this report, for consistency with previous work, the term PTS is used.

Estimated underwater acoustic levels are presented as sound pressure levels (SPL, $L_p$), and accumulated sound exposure levels (SEL, $L_E$), as appropriate for non-impulsive (continuous) noise sources. In this report, the duration period for SEL accumulation is defined as a 24-hour period over which sound energy is integrated; the level is specified with the abbreviation $SEL_{24h}$.

$SEL_{24h}$ is a cumulative metric that reflects the dosimetric effect of noise levels within 24 hours, based on the assumption that a receiver (e.g., an animal) is consistently exposed to such noise levels at a fixed position. More realistically, marine mammals, fish, and sea turtles would not stay in the same location for 24 hours (especially in the absence of location-specific habitat) but rather a shorter period, depending on the animal's behaviour and the source's proximity and movements. Therefore, a reported radius for the $SEL_{24h}$ criteria does not mean that marine fauna travelling within this radius of the source will be impaired, but rather that an animal could be exposed to the sound level associated with impairment (either temporary threshold shift (TTS) or permanent threshold shift (PTS)) if it remained within the ensonified area for 24 hours.

This report is further structured as follows, the remainder of Section 1 provides details on the scenarios considered for modelling, Section 2 explains the metrics used to represent underwater acoustic fields and the effect criteria considered. Section 3 details the methodology for predicting the source levels and modelling the sound propagation, including the specifications of the sound sources considered and the environmental parameters. Section 4 presents the acoustic results as tabulated ranges to thresholds, Section 4.2 provides sound level contour maps. The acoustic modelling results are then discussed in Section 5.

## 1.1. Modelling Scenarios

This study considered the following activities associated with operations of the Yolla Platform:

- Typical operational noise from the platform,

- Vessel noise from two different types of vessel assumed to be conducting re-supply operations under dynamic positioning (DP) for a period of either four or eight hours.

Details of each scenario are shown in Table 3. Details of the modelled sites are presented Table 4 and displayed graphically in Figure 1.

Table 3. Description of modelled scenarios.

| Scenario number | Scenario number in Report 02741 | Site(s) | Source(s) | Description |
|---|---|---|---|---|
| 1 | 4 | 1,3 | Platform, SEA1 AHTS | Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (4 h) |
| 2 | NA | 1,3 | Platform, SEA1 AHTS | Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (8 h) |
| 3 | NA | 1,4 | Platform, Generic OSV | Yolla Platform Operations + Generic OSV under DP conducting Resupply Ops (4 h) |
| 4 | NA | 1,4 | Platform, Generic OSV | Yolla Platform Operations + Generic OSV under DP conducting Resupply Ops (8 h) |

Table 4. Modelled site locations and source information.

| Source | Location | Latitude (S) | Longitude (E) | MGA Zone 55 (GDA94) | | Water Depth (m) |
|---|---|---|---|---|---|---|
| | | | | X (m) | Y (m) | |
| Yolla Platform | Platform location in Bass Strait | 39° 50' 37.98" | 145° 49' 4.98" | 398878 | 5588902 | 80.0 |
| SEA1 Operated OSV (e.g. Siem Sapphire) | Within 20m of Yolla, to the SE | 39° 50' 40.68" | 145° 49' 7.85" | 398880 | 5588319 | 80.0 |
| Generic OSV | | | | | | |

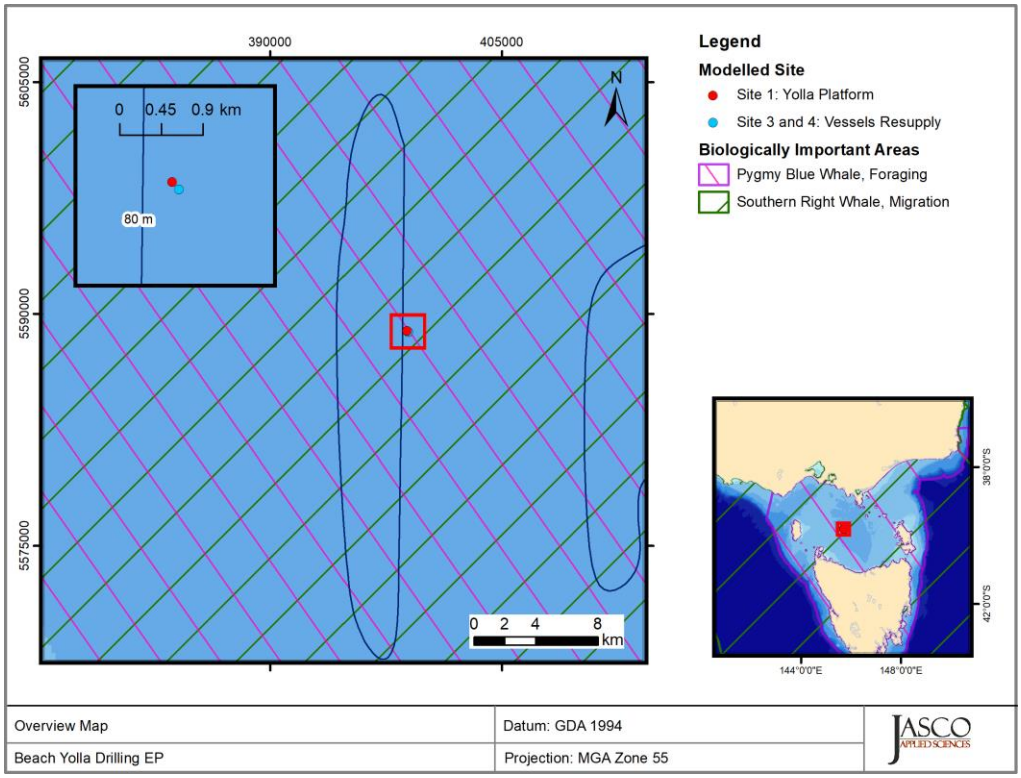


Figure 1. Overview map of the modelling sites and regional context.

# 2. Noise Effect Criteria

To assess the potential effects of a sound-producing activity, it is necessary to first establish exposure criteria (thresholds) for which sound levels may be expected to have an adverse effect on animals. Whether acoustic levels might injure or disturb marine fauna is an active research topic. Since 2007, several expert groups have developed SEL-based assessment approaches for evaluating auditory injury, with key works including Southall et al. (2007), Finneran and Jenkins (2012), Popper et al. (2014), United States National Marine Fisheries Service (NMFS 2018), Southall et al. (2019), NMFS (2024) and Accomando et al. (2025). The number of studies that investigate the level of behavioural disturbance to marine fauna by anthropogenic sound has also increased substantially.

Two sound level metrics, SPL and SEL, are commonly used to evaluate non-impulsive noise and its effects on marine life. In this report, the duration of the SEL accumulation is defined as integrated over a 24-hour period. Appropriate subscripts indicate any frequency weighting applied (see Appendix A.4). The acoustic metrics in this report reflect the ANSI and ISO standards for acoustic terminology, ANSI S1.1 (S1.1-2013) and ISO 18405:2017 (2017).

The following thresholds and guidelines for this study were chosen because they represent the best available science:

- Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from NMFS (2024) for the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS) in marine mammals for non-impulsive sound sources. As discussed within Accomando et al (2025) and NMFS (2024), intense noise exposures can cause auditory injury (represented by either AUD INJ or AINJ) without PTS occurring. In this report, the terms PTS and auditory injury can be considered to be used interchangeably, however it is acknowledged that auditory injury may occur without PTS.
- Marine mammal behavioural threshold based on the current US National Oceanic and Atmospheric Administration (NOAA) 2024 criterion for marine mammals of 120 dB re 1 µPa (SPL; $L_p$) for non-impulsive sound sources.
- Sound exposure guidelines for fish, fish eggs, and larvae (Popper et al. 2014).
- Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Accomando et al. (2025) for the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS)/AUD INJ in sea turtles.

Section 2.1, along with Appendices A.3 and A.4, expand on the relevant thresholds, guidelines, and sound levels applicable to marine mammals. Section 2.2 expands on the guidelines for fish and sea turtles.

## 2.1. Marine Mammals

The criteria applied in this study to assess possible effects of non-impulsive noise sources on marine mammals are summarised in Table 5. Cetaceans and otariids were identified as the marine mammals requiring assessment. Details on thresholds related to auditory threshold shifts or hearing loss and behavioural response are provided in Appendix A.3, with frequency weighting explained in detail in Appendix A.4.

Table 5. Criteria for effects of non-impulsive noise exposure, including vessel noise, for marine mammals: unweighted SPL and weighted $SEL_{24h}$ thresholds.

| Hearing group | NOAA (2024) | NMFS (2024) and Accomando et al. (2025) for sirenians | |
|---|---|---|---|
| | Behaviour | TTS onset thresholds (received level) | PTS/AUD INJ onset thresholds (received level) |
| | SPL ($L_p$; dB re 1 µPa) | Weighted $SEL_{24h}$ ($L_{E,24h}$; dB re 1 $\mu Pa^2 \cdot s$) | Weighted $SEL_{24h}$ ($L_{E,24h}$; dB re 1 $\mu Pa^2 \cdot s$) |
| Low-frequency (LF) cetaceans | 120 | 177 | 197 |
| High-frequency (HF) cetaceans | | 181 | 201 |
| Very High-frequency (VHF) cetaceans | | 161 | 181 |
| Otariid Seals | | 179 | 199 |

$L_p$ denotes sound pressure level and has a reference value of 1 µPa.
$L_E$ denotes cumulative sound exposure over a 24 h period and has a reference value of 1 $\mu Pa^2 \cdot s$.

### 2.1.1. Behavioural Response

The NOAA continuous noise criterion was selected for this assessment because it represents the most commonly applied behavioural response criterion by regulators. The distances at which behavioural responses could occur are therefore determined by areas ensonified above an unweighted SPL of 120 dB re 1 µPa NOAA (2024). Appendix A.3 provides more information about the development of this criterion.

### 2.1.2. Injury and Hearing Sensitivity Changes

There are two categories of auditory threshold shifts or hearing loss: temporary threshold shift (TTS), a temporary reduction in an animal's hearing sensitivity as the result of receptor hair cells in the cochlea becoming fatigued; and permanent threshold shift (PTS), a physical injury to an animal's hearing organs. As discussed within Accomando et al (2025) and NMFS (2024), intense noise exposures can cause auditory injury (represented by either AUD INJ or AINJ) without PTS occurring. In this report, the terms PTS and auditory injury can be considered to be used interchangeably, however it is acknowledged that auditory injury may occur without PTS.

To assist in assessing the potential for effect on marine mammals, this report applies the criteria recommended by NMFS (2024), considering both TTS and PTS/AUD INJ (see Table 5). Appendix A.3 provides more information about the criteria.

## 2.2. Fish, Sea Turtles, Fish Eggs, and Fish Larvae

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to continue developing noise exposure criteria for fish and sea turtles based on work began by a NOAA panel two years earlier. The Working Group developed guidelines with specific thresholds for different levels of effects for several species groups (Popper et al. 2014). The guidelines define quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death;
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma;

- TTS.

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. However, as these depend upon activity-based subjective ranges, these effects are not addressed in this report, and are included in Table 6 for completeness only. Because the presence or absence of a swim bladder has a role in hearing, fish susceptibility to injury from noise exposure depends on the species and the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Sea turtles, fish eggs, and fish larvae are considered separately.

Table 6 lists the relevant effects thresholds from Popper et al. (2014) for shipping and continuous noise. Some evidence suggests that fish sensitive to acoustic pressure show a recoverable loss in hearing sensitivity, or injury when exposed to high levels of noise (Scholik and Yan 2002, Amoser and Ladich 2003, Smith et al. 2006); this is reflected in the SPL thresholds for fish with a swim bladder involved in hearing (shaded cells in Table 6). Accomando et al. (2025) presented revised thresholds for sea turtle TTS and PTS onset from non-impulsive noise sources, considering frequency weighted SEL, which have been applied in this study (Table 7).

Table 6. Criteria for vessel noise exposure for fish and sea turtles, adapted from Popper et al. (2014).

| Type of animal | Mortality and Potential mortal injury | Impairment | | | Behaviour |
|---|---|---|---|---|---|
| | | Recoverable injury | TTS | Masking | |
| Fish:<br>No swim bladder (particle motion detection) | (N) Low<br>(I) Low<br>(F) Low | (N) Low<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low | (N) High<br>(I) High<br>(F) Moderate | (N) Moderate<br>(I) Moderate<br>(F) Low |
| Fish:<br>Swim bladder not involved in hearing (particle motion detection) | (N) Low<br>(I) Low<br>(F) Low | (N) Low<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low | (N) High<br>(I) High<br>(F) Moderate | (N) Moderate<br>(I) Moderate<br>(F) Low |
| Fish:<br>Swim bladder involved in hearing (primarily pressure detection) | (N) Low<br>(I) Low<br>(F) Low | 170 dB SPL for 48 h | 158 dB SPL for 12 h | (N) High<br>(I) High<br>(F) High | (N) High<br>(I) Moderate<br>(F) Low |
| Sea Turtles | (N) Low<br>(I) Low<br>(F) Low | (N) Low<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low | (N) High<br>(I) High<br>(F) Moderate | (N) High<br>(I) Moderate<br>(F) Low |
| Fish eggs and fish larvae | (N) Low<br>(I) Low<br>(F) Low | (N) Low<br>(I) Low<br>(F) Low | (N) Low<br>(I) Low<br>(F) Low | (N) High<br>(I) Moderate<br>(F) Low | (N) Moderate<br>(I) Moderate<br>(F) Low |

Sound pressure level dB re 1 µPa.
Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of metres, intermediate (I) – hundreds of metres, and far (F) – thousands of metres.

Table 7. Acoustic effects of non-impulsive noise on sea turtles, weighted $SEL_{24h}$, Accomando et al. (2025).

| TTS onset thresholds (received level) | PTS/AUD INJ onset thresholds (received level) |
|---|---|
| Weighted $SEL_{24h}$ ($L_{E,24h}$; dB re 1 µPa²s) | Weighted $SEL_{24h}$ ($L_{E,24h}$; dB re 1 µPa²s) |
| 178 | 198 |

$L_E$ denotes cumulative sound exposure over a 24 h period and has a reference value of 1 µPa²s.

# 3. Methods and Parameters

## 3.1. Modelling parameters

The modelled site for the activities considered in this study was centered around the Yolla platform, located in a depth of approximately 80 m. A description of regional bathymetry is provided in Appendix B.1.1.

To allow for operational flexibility, the sound speed profile implemented within the modelling was selected through a sensitivity analysis considering all months of the year conducted previously for Beach as part of Yolla Operational modelling.

The month of August was found to be the most favourable for sound propagation, resulting in the largest ranges to noise effect criteria. As such, August was selected as the conservative choice for modelling. Additional detail can be found in Appendix B.1.2.

The seabed beneath the modelled sites will likely consist of predominantly of fine sand. Further details on the associated geoacoustic properties used in this modelling study are provided in Appendix B.1.3.

The following sections provide a description of the inputs and methods used for this underwater noise modelling study. The sections are divided into subsections detailing the source inputs for the vessels (Section 3.2.2) with Sections 3.3–3.4 providing details on the applied modelling techniques and model configuration information.

## 3.2. Sound Sources

The assumed monopole source levels for the Yolla platform and vessels involved in each scenario are shown in Figure 2.

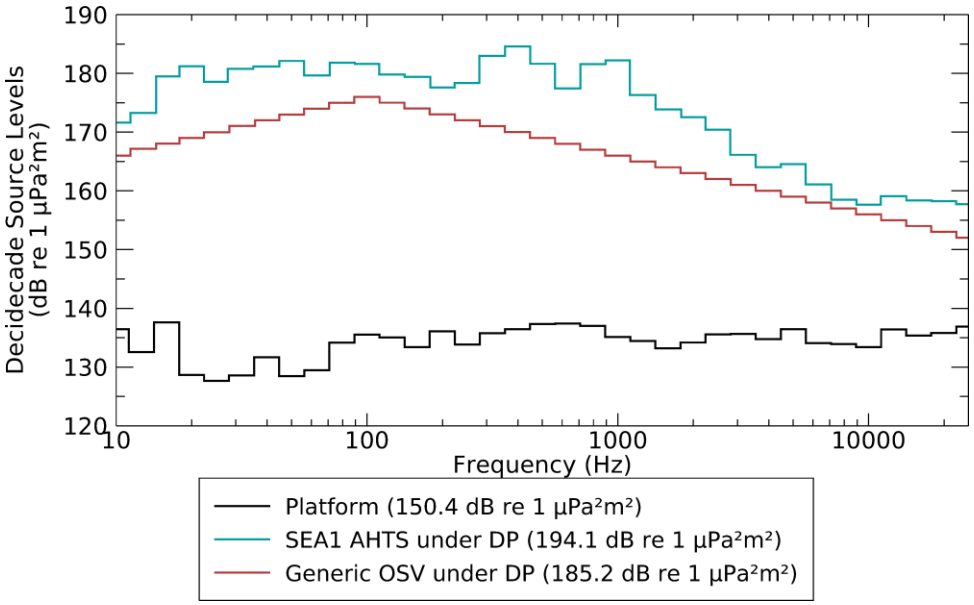


Figure 2. Decidecade monopole source level (MSL) spectra for all three sound sources.

A comparison of the revised broadband source levels for activities that are included in the previous modelling report as compared with this update are shown in Table 8. It should be noted that a source level of 194.1 dB re 1 $\mu Pa^2m^2$ for an AHTS is approximately the loudest type of vessel that may be engaged in these activities.

Table 8. Assumed broadband source levels (dB re 1 $\mu Pa^2m^2$) for all updated sound sources and comparison to previous modelling

| Source | Previous Report | This Report |
|---|---|---|
| Yolla Platform | 160.6 | 150.4 |
| Vessel conducting re-supply to Yolla Platform, on DP | 185.2 | 194.1 |

### 3.2.1. Production Platform

Fixed structures such as the Production Platforms have lower radiated sound levels than floating platforms (Spence et al. 2007). Equipment operating onboard floating platforms can contribute to marine environment sound however, airborne and structure-borne (vibration) pathways are considered more significant on these facilities, where equipment can be located below the water line. Underwater noise produced from platforms standing on metal jack-up legs is relatively low given the small surface areas available for sound transmission and also given the location of machinery above the waterline. It is therefore expected that the dominant pathway for sound generation is structure-borne (i.e., vibration from machinery passing through the legs) (Spence et al. 2007).

JASCO completed an underwater noise monitoring study (McPherson *et al.* 2022) in proximity of Esso's Barracouta (BTA) and Kingfish B (KFB) production platforms. The monopole source level spectra for the platforms in isolation were derived during the monitoring project. Moreover, the monitoring program recommended the creation of a composite platform MSL spectrum eliminating the possible flow noise at low frequencies and the noise from snapping shrimps at high frequencies to better represent a generic platform and was created in the publicly available Esso Bass Strait Operations Modelling report (Esso Australia Resources Pty Ltd and ExxonMobil 2024). The monopole source representing the generic platform was also modelled in the middle of the water column, i.e., at a depth of 40 m.

### 3.2.2. Vessel Noise Sources

Underwater sound that radiates from vessels is produced mainly by propeller and thruster cavitation, with a smaller fraction of noise produced by sound transmitted through the hull, such as by engines, gearing, and other mechanical systems. Sound levels tend to be the highest when thrusters are used to position the vessel and when the vessel is transiting at high speeds. A vessel's sound signature depends on the vessel's size, power output, propulsion system (e.g., conventional propellers vs. Voith Schneider propulsion), and the design characteristics of the given system (e.g., blade shape and size). A vessel produces broadband acoustic energy with most of the energy emitted below a few kilohertz. Sound from onboard machinery, particularly sound below 200 Hz, dominates the sound spectrum before cavitation begins (Spence et al. 2007).

Additional detail on the vessel sources and assumptions used as inputs to this modelling report is provided below.

#### 3.2.2.1. SEA1 Anchor Handling Tug Supply Vessel

Beach Energy advised JASCO that contractual arrangements with SEA1 to provide support vessel services to Yolla platform mean that a range of vessels of opportunity may be used to support Bass Gas operations. The largest vessel assumed to be providing such support services was a vessel

analogous to the *SEA1 Sapphire* (previously *Siem Sapphire*), an Anchor Handling Tug Supply Vessel (AHTS).

Sound source levels for the OSV conducting resupply in scenarios 1 and 2 were based on the Siem Sapphire and are referred to as an AHTS for differentiation from the generic offshore supply vessel.

This vessel features two bow tunnel thrusters rated at 1000 kW each and two stern tunnel thrusters rated at 880 kW each. These tunnel thrusters are unlikely to be used in normal operations; however they could potentially be engaged if the tug must hold station in heavy weather. While performing resupply duties the vessel will be on DP.

The depth of the source was based on the approximate location of cavitation on the propellers using 70% of the vessels draft as specified in ISO 17208-1 [ISO] International Organization for Standardization (2016). The modelled source depth was set to 4.9 m while the vessel is on DP. The source level and spectra of the *Siem Sapphire* are publicly available (McPherson et al. 2021). The broadband (10 Hz to 25 kHz) source level of this vessel has been modelled as 194.1 dB re 1 $\mu Pa^2m^2$.

#### 3.2.2.2. Generic OSV

Previous modelling assumed platform supply operations would be from a smaller/quieter vessel, such as an offshore supply vessel. An example OSV may be a vessel that operated in the region in 2022, the *Mermaid Coral*, which had significantly less thrust capacity as compared with Sapphire.

The MSL spectra assumed for the generic OSV is shown in Figure 2, and an overall broadband source level of 185.2 dB re 1 $\mu Pa^2m^2$ was used for operations involving the OSV under typical DP. The vessel was modelled as a monopole sound source at a depth of 4.9 m.

## 3.3. Geometry and Modelled Regions

JASCO's Marine Operations Noise Model (MONM; see Appendix B.2.2) was used to predict the acoustic field at frequencies of 10 Hz to 25 kHz for all vessels. To supplement the MONM results (10 Hz to 1 kHz), high-frequency results for propagation loss were modelled using BELLHOP (Porter and Liu 1994) for frequencies from 1.26 to 25 kHz. The MONM and BELLHOP results were combined to produce results for the full frequency range of interest.

The sound field modelling calculated propagation losses up to 100 km from the source, with a horizontal separation of 20 m between receiver points along the modelled radials. The sound fields were modelled with a horizontal angular resolution of $\Delta\theta$ = 2.5° for a total of N = 144 radial planes. Receiver depths were chosen to span the entire water column over the modelled areas, from 2 m to a maximum of 85 m.

To produce the maps of received sound level isopleths, and to calculate distances to specified sound level thresholds, the maximum-over-depth level was calculated at each sampling point within the modelled region. The radial grids of maximum-over-depth levels were then resampled (by linear triangulation) to produce a regular Cartesian grid. The contours and threshold ranges were calculated from these grids of the modelled acoustic fields.

## 3.4. Accumulated SEL

In this study, the sound sources were considered to be continuously operating with new sound energy constantly being introduced to the environment. The reported source levels are usually in terms of sound pressure levels (SPL), representing the root-mean-square (rms) pressure level of a considered source. The evaluation of the cumulative sound field (i.e., in terms of SEL24h) depends on the number of seconds of operation during the accumulation period.

The SPL modelling results were converted to SEL by the duration of the measurement, which is appropriate for a non-impulsive noise source. Here, SEL was assessed over 24 hours. For a stationary vessel, the conversion from SPL was obtained by increasing the levels by 10*log10(T), where T is 86,400 (the number of seconds in 24 hours). In the case of the OSV which was considered as operating under DP for only 4 or 8 hours a day, it's 24 h SEL is calculated using a T value of 14,400 (seconds in 4 h) or 28,800 (seconds in 8 h).

# 4. Results

The maximum-over-depth sound fields for the modelled scenarios are presented below in two formats: as tables of distances to sound levels and, where the distances are long enough, as contour maps showing the directivity and range to various sound levels.

For the results below, the distances to isopleths/thresholds were reported from either the centroid of several sources or from the most dominant single source. When an isopleth completely envelopes multiple sources, the centroid was used. When several closed isopleths exist, the most dominant source was used. Maps are provided in Section 4.2 to assist with contextualising tabulated distances.

## 4.1. Tabulated Results

The maximum and 95% horizontal distances to specific SPL contours are shown in Table 9. The SPL sound footprints represent instantaneous sound fields and do not depend on time accumulation, therefore scenarios that differ only on duration are combined for ease of interpretation.

The maximum distances to frequency-weighted $SEL_{24h}$ thresholds, as well as total ensonified area are shown in Table 10.

Table 9. *SPL*: Maximum ($R_{max}$) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from most appropriate location for considered sources per scenario.

| SPL ($L_p$; dB re 1 µPa) | Scenario 1 & 2 Yolla Platform + SEA1 AHTS under DP conducting Resupply | | Scenario 3 & 4 Yolla Platform + Generic OSV under DP conducting Resupply | |
|---|---|---|---|---|
| | $R_{max}$ (km) | $R_{95\%}$ (km) | $R_{max}$ (km) | $R_{95\%}$ (km) |
| 180 | – | – | – | – |
| 170[a] | – | – | – | – |
| 160 | 0.06 | 0.06 | 0.02 | 0.02 |
| 158[b] | 0.08 | 0.08 | 0.03 | 0.03 |
| 150 | 0.34 | 0.31 | 0.11 | 0.07 |
| 140 | 1.81 | 1.51 | 0.49 | 0.46 |
| 130 | 6.37 | 5.98 | 2.00 | 1.87 |
| 120[c] | 21.9 | 20.9 | 5.94 | 5.54 |
| 110 | > 100 | > 100 | 15.4 | 14.6 |

[a] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[b] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[c] Threshold for marine mammal behavioural response to non-impulsive noise (NOAA 2024).
A dash indicates the level was not reached within the limits of the modelled resolution (20 m).

Table 10. $SEL_{24h}$: Maximum ($R_{max}$) horizontal distances (in km) to frequency-weighted $SEL_{24h}$ PTS and TTS thresholds for marine mammals (NMFS 2024), and sea turtles (Accomando et al. 2025) from the vessel location, along with ensonified area ($km^2$).

| Hearing group | Frequency-weighted $SEL_{24h}$ threshold ($L_{E,24h}$; dB re 1 $\mu Pa^2 \cdot s$) | Scenario 1: Yolla Platform Operations + OSV SEA1 under DP conducting Resupply Ops (4 h) | | Scenario 2: Yolla Platform Operations + OSV SEA1 under DP conducting Resupply Ops (8 h) | | Scenario 3: Yolla Platform Operations + OSV Generic under DP conducting Resupply Ops (4 h) | | Scenario 4: Yolla Platform Operations + OSV Generic under DP conducting Resupply Ops (8 h) | |
|---|---|---|---|---|---|---|---|---|---|
| | | $R_{max}$ (km) | Area ($km^2$) | $R_{max}$ (km) | Area ($km^2$) | $R_{max}$ (km) | Area ($km^2$) | $R_{max}$ (km) | Area ($km^2$) |
| **PTS/AUD INJ** | | | | | | | | | |
| LF cetaceans | 197 | 0.11 | 0.03 | 0.20 | 0.11 | 0.03 | 0.03 | 0.04 | 0.04 |
| HF cetaceans | 201 | – | \ | – | \ | – | \ | – | \ |
| VHF cetaceans | 181 | 0.02 | 0.03 | 0.04 | 0.04 | – | 0.02 | – | 0.02 |
| Otariid Seals | 199 | – | \ | – | \ | – | \ | – | \ |
| Sea turtles | 198 | 0.05 | 0.01 | 0.08 | 0.02 | – | \ | 0.03 | \ |
| **TTS** | | | | | | | | | |
| LF cetaceans | 177 | 2.88 | 20.5 | 4.26 | 50.9 | 0.57 | 0.80 | 0.94 | 2.36 |
| HF cetaceans | 181 | 0.20 | 0.11 | 0.33 | 0.25 | 0.04 | 0.04 | 0.05 | 0.06 |
| VHF cetaceans | 161 | 0.33 | 0.34 | 0.50 | 0.71 | 0.20 | 0.10 | 0.28 | 0.23 |
| Otariid Seals | 179 | 0.14 | 0.06 | 0.24 | 0.17 | 0.04 | 0.04 | 0.05 | 0.06 |
| Sea turtles | 178 | 1.48 | 5.54 | 2.31 | 13.0 | 0.37 | 0.42 | 0.73 | 1.19 |

A dash indicates the level was not reached within the limits of the modelled resolution (20 m).
A slash indicates that the area is less than an area associated with the modelled resolution (0.0013 $km^2$).

For the results tables presented in this section, thresholds may or may not have been reached for many scenarios, and in the results tables a dash is used in place of a horizontal distance. Due to the discretely sampled 20 m calculation grids of the modelled sound fields, distances to these thresholds could not be estimated for practicable computational purposes. It is likely that SPL isopleths could be reached at distances between the source and the modelled horizontal resolution (20 m); however, distances to injurious accumulated SEL thresholds may not be reached at any range greater than the point source representation of the platform and OSVs, due to the species-specific frequency weighing functions. Additionally, if close-to-source radii are comparable to the dimensions of the modelled source then they may only be reached within close proximity to the source, if at all.

## 4.2. Sound Field Maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for SPL and $SEL_{24h}$ sound fields are presented below for the modelled scenarios.

## 4.2.1. SPL Sound Level Contour Maps

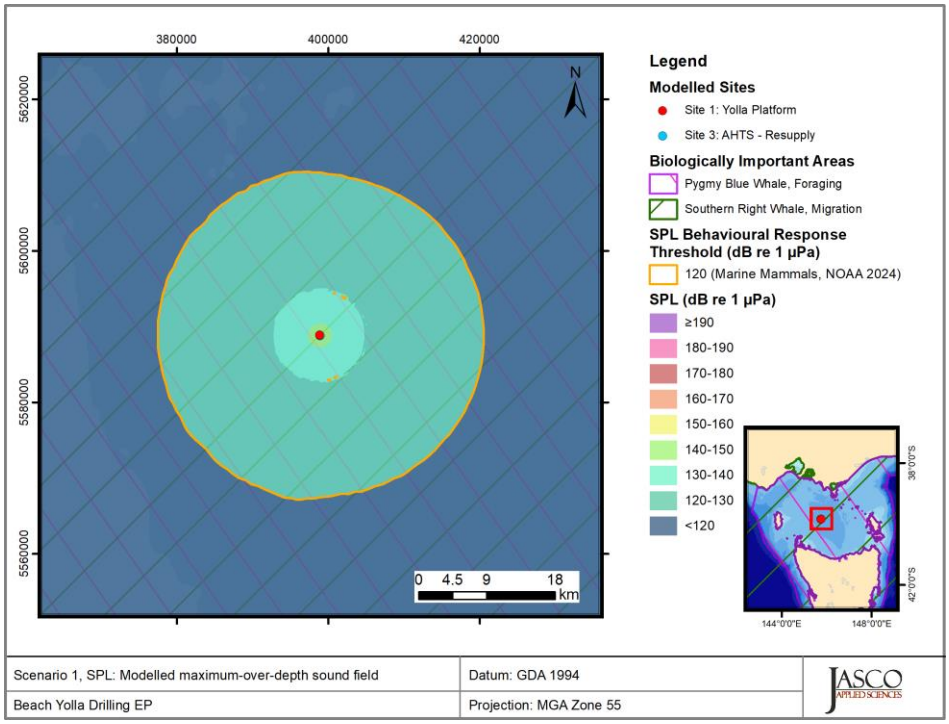


Figure 3. *Scenario 1, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (4 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

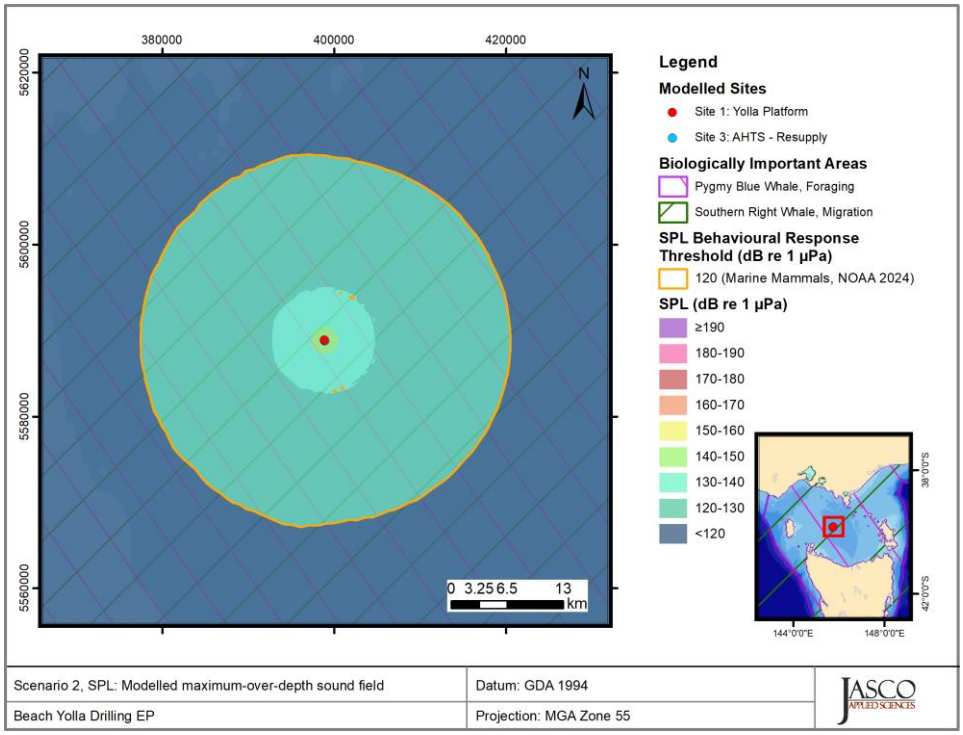


Figure 4. *Scenario 2, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (8 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

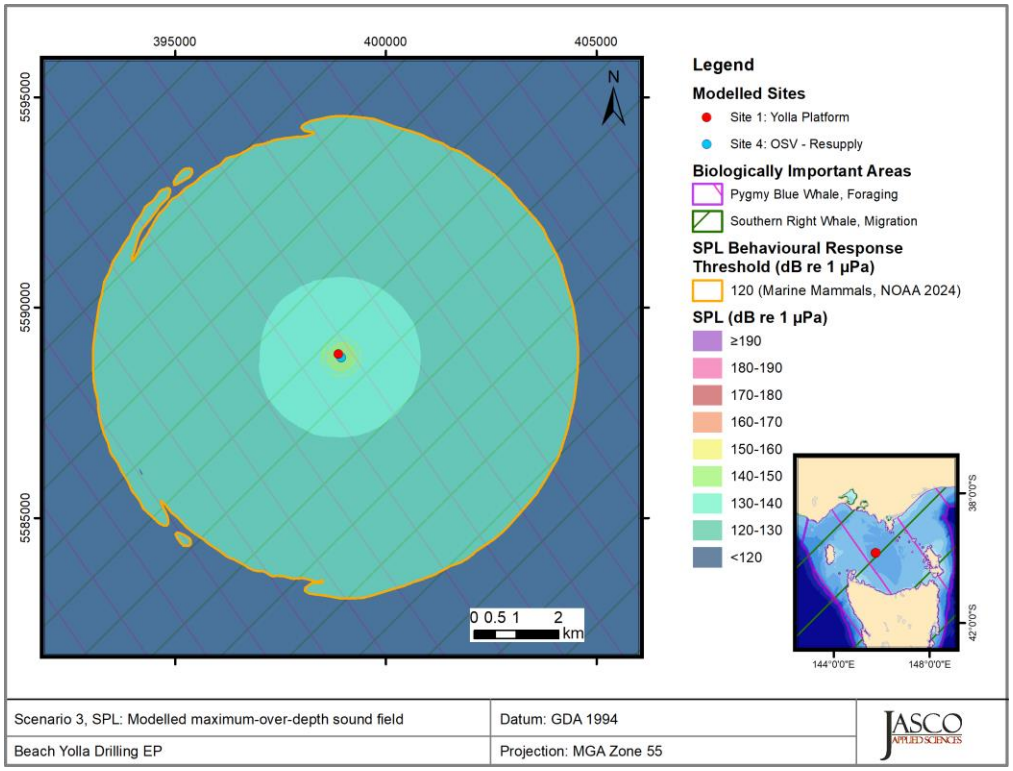


Figure 5. *Scenario 3, Yolla Platform Operations + generic OSV under DP conducting Resupply Ops (4 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

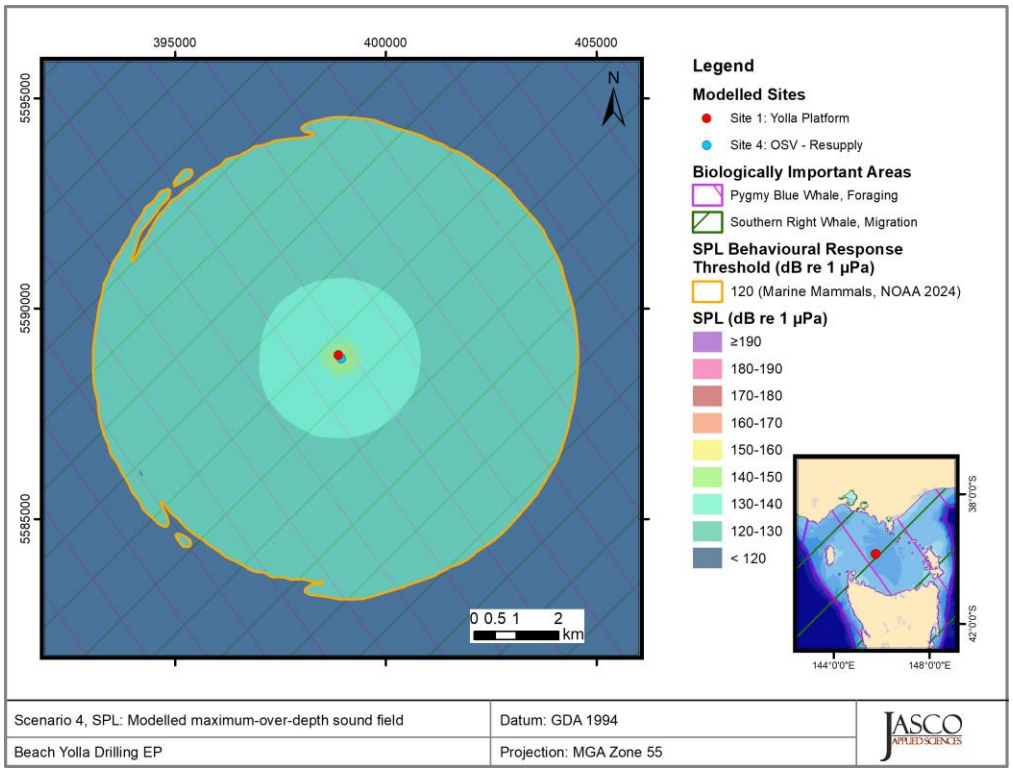


Figure 6. *Scenario 4, Yolla Platform Operations + generic OSV under DP conducting Resupply Ops (8 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

## 4.2.2. Accumulated $SEL_{24h}$ Sound level Contour Maps

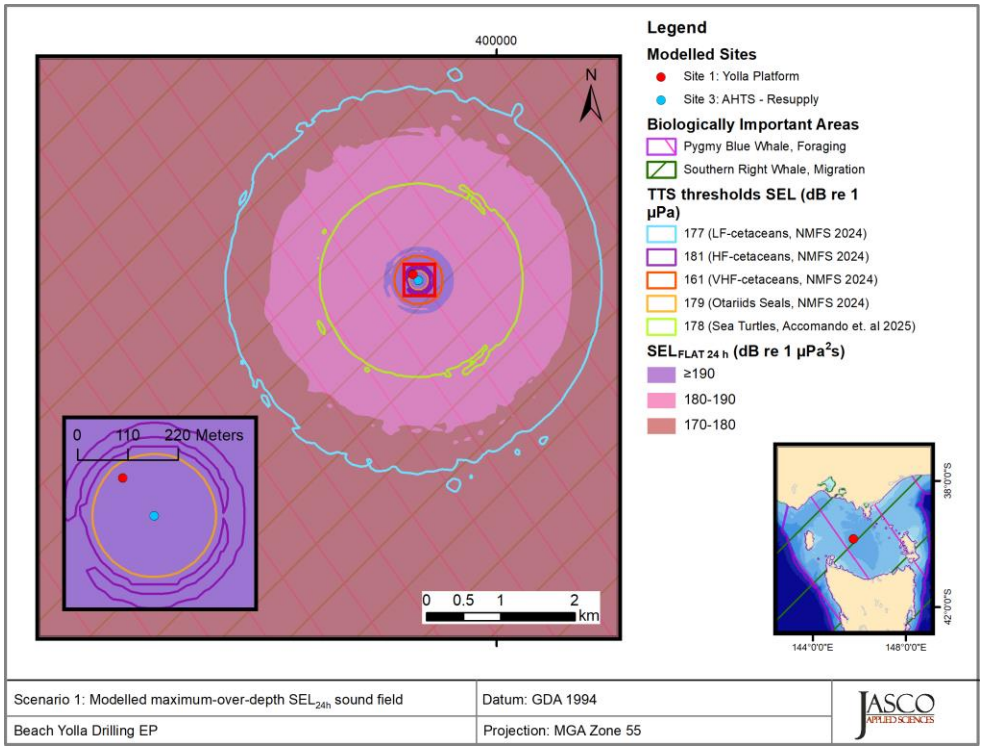


Figure 7. *Scenario 1, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (4 h), accumulated $SEL_{24h}$*: Sound level contour map showing maximum-over-depth $SEL_{24h}$ results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans otariid seals and sea turtles. Thresholds omitted here were not reached or not long enough to display graphically.

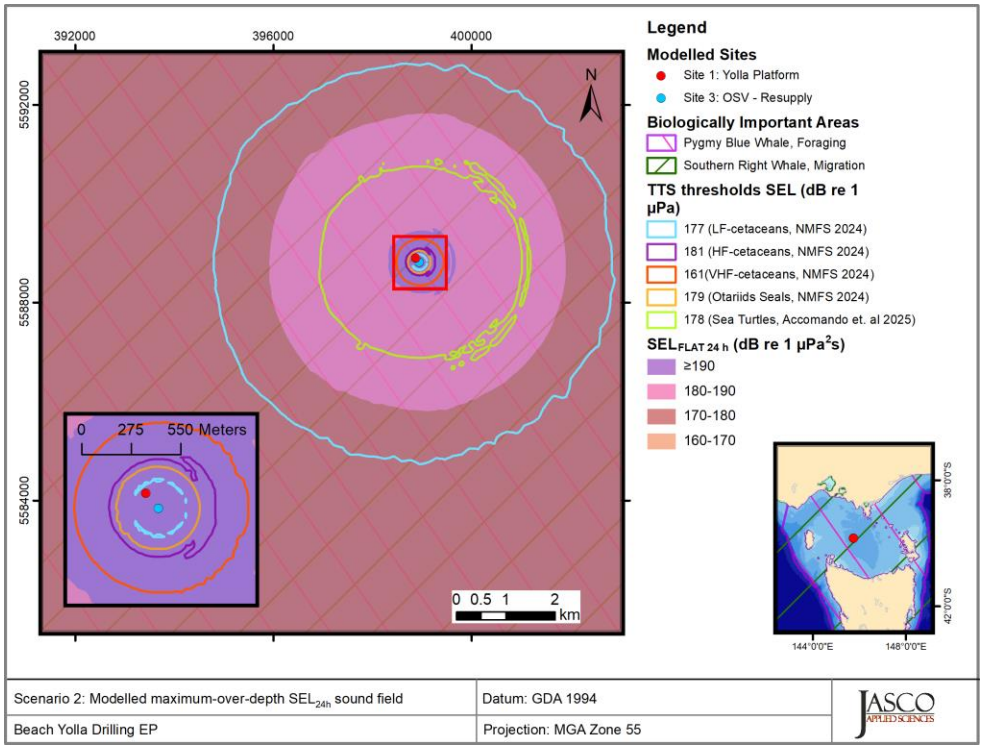


Figure 8. *Scenario 2, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (8 h), accumulated $SEL_{24h}$*: Sound level contour map showing maximum-over-depth $SEL_{24h}$ results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans otariid seals and sea turtles. Thresholds omitted here were not reached or not long enough to display graphically.

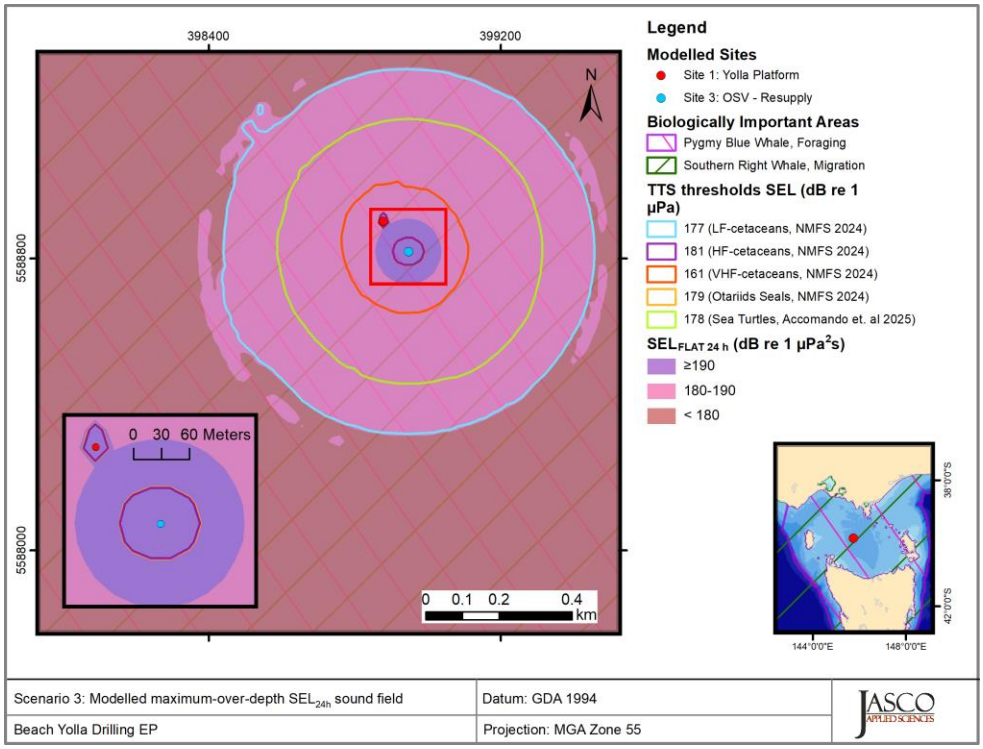


Figure 9. *Scenario 3, Yolla Platform Operations + Generic OSV under DP conducting Resupply Ops (4 h), accumulated $SEL_{24h}$*: Sound level contour map showing maximum-over-depth $SEL_{24h}$ results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans otariid seals and sea turtles. Thresholds omitted here were not reached or not long enough to display graphically.

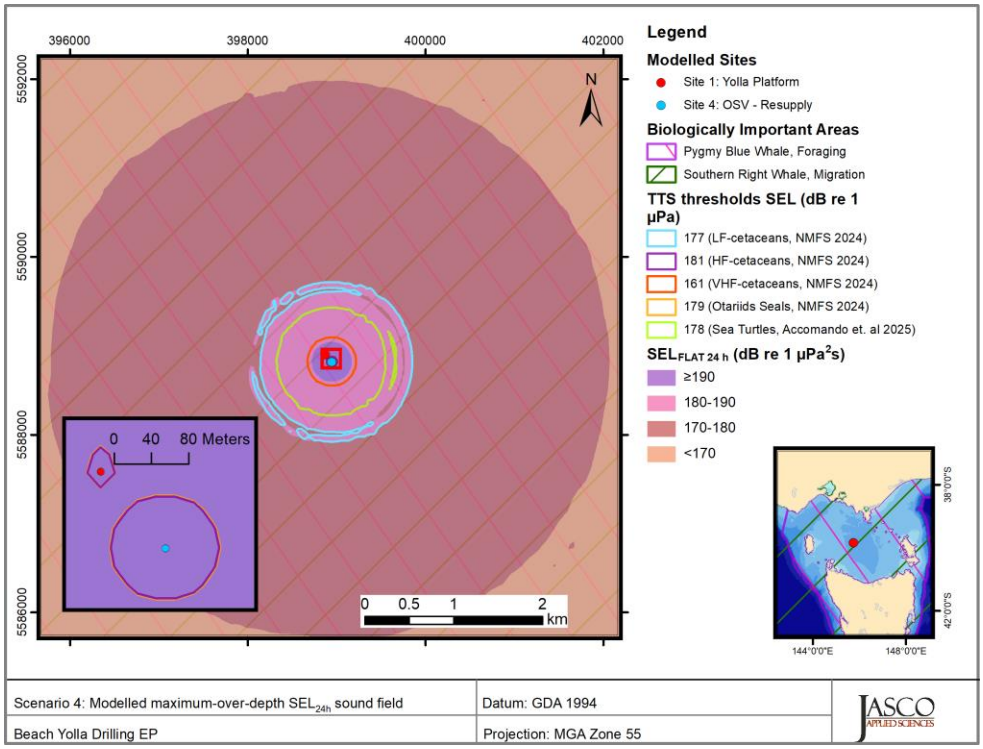


Figure 10. *Scenario 4, Yolla Platform Operations + Generic OSV under DP conducting Resupply Ops (8 h), accumulated $SEL_{24h}$*: Sound level contour map showing maximum-over-depth $SEL_{24h}$ results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans, otariid seals and sea turtles. Thresholds omitted here were not reached or not long enough to display graphically.

# 5. Discussion and conclusion

## 5.1. Effect of vessel sizing on modelled results

This study updates previous modelling of Bass Gas activities to consider the effect of a larger supply vessel, a SEA1 AHTS, which may conduct activities in proximity to the Yolla Platform. The AHTS is modelled as being notably louder (~10 dB) than the alternate OSV, which aligns with the increased thrust capacity and bollard pull associated with the AHTS vessel type. It is important to note that the modelled scenario is intended to represent the 'maximum expected' noise the vessel may produce in the modelled operations and real-world operations may be associated with different sound levels as compared with those assumed in this study.

This difference in source level between the AHTS and OSV results in a 268.9% increase in the maximum distance to the marine mammal behavioural response threshold (120 dB). As per Scenario 2, the maximum distance to the 120 dB threshold for the AHTS scenario was 21.9 km, as compared with 5.94 km for the quieter OSV. As this threshold is based on the sound pressure level of received noise, the duration of the vessel's presence alongside the platform does not influence the maximum distance at which that sound level is received.

### 5.1.1. Accumulated sound exposure

When considering accumulated sound exposure, results, both the louder AHTS and the increased duration of operations considered in the revised scenarios contributed to increased distances to noise effect thresholds from the AHTS as compared with the OSV.

For the eight hour scenario involving the AHTS vessel, the distance to the low-frequency cetacean TTS threshold was 4.26 km and for PTS was 0.20 km. This is significantly greater than the eequivilent duration scenario involving the generic OSV, which resulted in predicted effect ranges to TTS and PTS in low frequency cetaceans of 0.57 km and 0.03 km respectively.

## 5.2. Geology and bathymetry influence on results assumptions

The Yolla platform is located in central Bass Strait, and the modelled area has only a gradual variation in bathymetry, with a slow decrease in depth towards the shores of Tasmania and Victoria. This bathymetry had little effect on the propagation model, as manifested in the generally symmetric sound field footprints. The modelled seabed composition is reflective at the seafloor and increased the propagation distances for all scenarios.

The sound speed profile (Appendix B.1.2) was derived from data from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). The water conditions were chosen to provide the most conservative estimate. These correspond to the month of August, which was determined to result in the greatest sound propagation through a sensitivity analysis considering multiple months. The final sound speed profile consisted of a composite profile representative of the environmental conditions likely to occur within the modelled area to capture associated propagation effects.

The considered sound speed profile for August contained a small thermocline which resulted in an upward refracting layer extending from the sea-surface down to approximately 40 m depth. This layer has the potential to trap high frequency energy near the sea surface that would otherwise dissipate more rapidly in range due to propagation, absorption, and seabed losses. The slight upward refracting

layer in the sound speed profile only has the potential to effectively trap frequencies above 741 Hz based on the thickness of the refracting layer (Jensen et al. 2011).

## 5.3. Conclusion

Across modelling scenarios, those involving the SEA1 AHTS present at the platform for longer duration (Scenario 2) had the longest range to all assessed noise effect criteria (Table 11).

The distances to cumulative noise effect criteria (i.e. $L_{E,24h}$) were the longest for low-frequency cetaceans across scenarios, as compared with other taxa. In Scenario 2, the distance to the low-frequency cetacean TTS threshold was 4.26 km and for PTS was 0.20 km. The taxa with the next longest distance to effect criteria were sea turtles, but distance to PTS/TTS thresholds for sea turtles was than half the distance than for LF cetaceans, as per Table 11.

In all scenarios, cumulative sound exposure did not reach the PTS/AUD INJ threshold for high-frequency cetaceans or otariid seals at any distance. In Scenario 2, distances to the PTS threshold for these taxa were 0.33 km and 0.24 km respectively.

In all scenarios, sound did not reach the threshold associated with recoverable injury for fish species with a swim bladder involved in hearing, although TTS thresholds for this group were reached at a maximum distance of 0.08 km.

The greatest distance to any noise effect criteria was for the marine mammal behavioural response threshold, which was reached at ($R_{max}$) 21.9 km in Scenario 2.

Table 11. Summary of the maximum ($R_{max}$) horizontal distances (in km) to relevant thresholds for marine fauna across the scenario with larger effects, for scenarios involved the SEA1 AHTS and Generic OSV.

| Hearing group | Threshold Type | Metric | Threshold | Scenario 2: Yolla + SEA1 AHTS | Scenario 4: Yolla + Generic OSV |
|---|---|---|---|---|---|
| | | | | $R_{max}$ (km) | $R_{max}$ (km) |
| Low frequency cetaceans | PTS/AUD INJ [a] | $L_{E,24h}$ | 197 | 0.20 | 0.04 |
| | TTS [a] | $L_{E,24h}$ | 177 | 4.26 | 0.94 |
| High frequency cetaceans | PTS/AUD INJ [a] | $L_{E,24h}$ | 201 | – | – |
| | TTS [a] | $L_{E,24h}$ | 181 | 0.33 | 0.05 |
| Very high-frequency cetaceans | PTS/AUD INJ [a] | $L_{E,24h}$ | 181 | 0.04 | – |
| | TTS [a] | $L_{E,24h}$ | 161 | 0.50 | 0.28 |
| Otariid Seals | PTS/AUD INJ [a] | $L_{E,24h}$ | 199 | – | – |
| | TTS [a] | $L_{E,24h}$ | 179 | 0.24 | 0.05 |
| All Marine Mammal Groups | Behavioural Response [b] | $L_p$ | 120 | 21.9 | 5.94 |
| Fish with swim bladder involved in hearing | TTS [c] | $L_p$ | 158 | 0.08 | 0.03 |
| | Recoverable injury [c] | $L_p$ | 170 | – | – |
| Sea turtles | PTS/AUD INJ [d] | $L_{E,24h}$ | 198 | 0.08 | – |
| | TTS [d] | $L_{E,24h}$ | 178 | 2.31 | 0.73 |

A dash indicates the level was not reached within the limits of the modelled resolution (20 m).
$L_p$ denotes unweighted sound pressure level and has a reference value of 1 µPa.
$L_{E,24h}$ denotes cumulative sound exposure over a 24 h period and has a reference value of 1 µPa$^2$·s and is unweighted for fish and frequency weighted for all other groups
[a] NMFS (2024) criteria for marine fauna.
[b] NOAA (2024) recommended unweighted behavioural threshold for marine mammals.
[c] Popper et al. (2014).
[d] Accomando et al. (2025).

# Glossary

Unless otherwise stated in an entry, these definitions are consistent with ISO 80000-3 (2017).

### 1/3-octave

One third of an octave. *Note*: A one-third octave is approximately equal to one decidecade (1/3 oct ≈ 1.003 ddec).

### 1/3-octave-band

Frequency band whose bandwidth is one one-third octave. *Note*: The bandwidth of a one-third octave-band increases with increasing centre frequency.

### acoustic impedance

The ratio of the sound pressure in a medium to the volume flow rate of the medium through a specified surface due to the sound wave.

### acoustic noise

Sound that interferes with an acoustic process.

### ambient sound

Sound that would be present in the absence of a specified activity, usually a composite of sound from many sources near and far, e.g., shipping vessels, seismic activity, precipitation, sea ice movement, wave action, and biological activity.

### attenuation

The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

### audiogram

A graph or table of hearing threshold as a function of frequency that describes the hearing sensitivity of an animal over its hearing range.

### auditory frequency weighting

The process of applying an auditory frequency weighting function. In human audiometry, C-weighting is the most commonly used function, an example for marine mammals are the auditory frequency weighting functions published by Southall et al. (2007).

### auditory frequency weighting function

Frequency weighting function describing a compensatory approach accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity. Example hearing groups are low-, mid-, and high-frequency cetaceans, phocid and otariid pinnipeds.

### azimuth

A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

### bandwidth

The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI S1.13-2005 (R2010)).

**broadband level**

The total level measured over a specified frequency range.

**cavitation**

A rapid formation and collapse of vapor cavities (i.e., bubbles or voids) in water, most often caused by a rapid change in pressure. Fast-spinning vessel propellers typically cause cavitation, which creates a lot of noise.

**cetacean**

Any animal in the order Cetacea. These are aquatic species and include whales, dolphins, and porpoises.

**compressional wave**

A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

**conductivity-temperature-depth (CTD)**

Measurement data of the ocean's conductivity, temperature, and depth; used to compute sound speed and salinity.

**continuous sound**

A sound whose sound pressure level remains above ambient sound during the observation period. A sound that gradually varies in intensity with time, for example, sound from a marine vessel.

**decade**

Logarithmic frequency interval whose upper bound is ten times larger than its lower bound (ISO 80000-3:2006).

**decidecade**

One tenth of a decade. *Note*: An alternative name for decidecade (symbol ddec) is "one-tenth decade". A decidecade is approximately equal to one third of an octave (1 ddec ≈ 0.3322 oct) and for this reason is sometimes referred to as a "one-third octave".

**decidecade band**

Frequency band whose bandwidth is one decidecade. *Note*: The bandwidth of a decidecade band increases with increasing centre frequency.

**decibel (dB)**

Unit of level used to express the ratio of one value of a power quantity to another on a logarithmic scale. Unit: dB.

**energy source level**

A property of a sound source obtained by adding to the sound exposure level measured in the far field the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 $\mu Pa^2m^2s$.

### energy spectral density source level

A property of a sound source obtained by adding to the energy spectral density level of the sound pressure measured in the far field the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 $\mu Pa^2m^2s/Hz$.

### ensonified

Exposed to sound.

### far field

The zone where, to an observer, sound originating from an array of sources (or a spatially distributed source) appears to radiate from a single point.

### Fourier transform (or Fourier synthesis)

A mathematical technique which, although it has varied applications, is referenced in the context of this report as a method used in the process of deriving a spectrum estimate from time-series data (or the reverse process, termed the inverse Fourier transform). A computationally efficient numerical algorithm for computing the Fourier transform is known as fast Fourier transform (FFT).

### flat weighting

Term indicating that no frequency weighting function is applied. Synonymous with unweighted.

### frequency

The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: $f$. 1 Hz is equal to 1 cycle per second.

### frequency weighting

The process of applying a frequency weighting function.

### frequency-weighting function

The squared magnitude of the sound pressure transfer function. For sound of a given frequency, the frequency weighting function is the ratio of output power to input power of a specified filter, sometimes expressed in decibels. Examples include the following:

- *Auditory frequency weighting function*: compensatory frequency weighting function accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.
- *System frequency weighting function*: frequency weighting function describing the sensitivity of an acoustic acquisition system, typically consisting of a hydrophone, one or more amplifiers, and an analogue to digital converter.

### geoacoustic

Relating to the acoustic properties of the seabed.

### hearing group

Category of animal species when classified according to their hearing sensitivity and to the susceptibility to sound. Examples for marine mammals include very low-frequency (VLF) cetaceans, low-frequency (LF) cetaceans, mid-frequency (MF) cetaceans, high-frequency (HF) cetaceans, very high-frequency (VHF) cetaceans, otariid pinnipeds in water (OPW), phocid pinnipeds in water (PPW), sirenians (SI), other marine carnivores in air (OCA), and other marine carnivores in water (OCW) (NMFS 2018, Southall et al. 2019). See **auditory frequency weighting functions**, which are often applied to these groups. Examples for fish include species for which the swim bladder is involved in

hearing, species for which the swim bladder is not involved in hearing, and species without a swim bladder (Popper et al. 2014).

### hearing threshold

The sound pressure level for any frequency of the hearing group that is barely audible for a given individual for specified background noise during a specific percentage of experimental trials.

### hertz (Hz)

A unit of frequency defined as one cycle per second.

### high-frequency (HF) cetacean

See **hearing group**.

### impulsive sound

Qualitative term meaning sounds that are typically transient, brief (less than 1 second), broadband, with rapid rise time and rapid decay. They can occur in repetition or as a single event. Examples of impulsive sound sources include explosives, seismic airguns, and impact pile drivers.

### isopleth

A line drawn on a map through all points having the same value of some quantity.

### knot

One nautical mile per hour. Symbol: kn.

### level

A measure of a quantity expressed as the logarithm of the ratio of the quantity to a specified reference value of that quantity. Examples include sound pressure level, sound exposure level, and peak sound pressure level. For example, a value of sound exposure level with reference to 1 $\mu Pa^2$ s can be written in the form *x* dB re 1 $\mu Pa^2$ s.

### low-frequency (LF) cetacean

See **hearing group**.

### median

The 50th percentile of a statistical distribution.

### mid-frequency (MF) cetacean

See **hearing group**.

### monopole source level (MSL)

A source level that has been calculated using an acoustic model that accounts for the effect of the sea-surface and seabed on sound propagation, assuming a point-like (monopole) sound source. Also see **radiated noise level**.

### M-weighting

See **auditory frequency weighting function** (as proposed by Southall et al. 2007).

**mysticete**

A suborder of cetaceans that use baleen plates to filter food from water. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

**non-impulsive sound**

Sound that is not an impulsive sound. A non-impulsive sound is not necessarily a continuous sound.

**octave**

The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

**odontocete**

The presence of teeth, rather than baleen, characterizes these whales. Members of the Odontoceti are a suborder of cetaceans, a group comprised of whales, dolphins, and porpoises. The skulls of toothed whales are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

**otariid**

A common term used to describe members of the Otariidae, eared seals, commonly called sea lions and fur seals. Otariids are adapted to a semi-aquatic life; they use their large fore flippers for propulsion. Their ears distinguish them from phocids. Otariids are one of the three main groups in the superfamily Pinnipedia; the other two groups are phocids and walrus.

**otariid pinnipeds in water (OPW)**

See **hearing group**.

**other marine carnivores in water (OCW)**

See **hearing group**.

**permanent threshold shift (PTS)**

An irreversible loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

**phocid**

A common term used to describe all members of the family Phocidae. These true/earless seals are more adapted to in-water life than are otariids, which have more terrestrial adaptations. Phocids use their hind flippers to propel themselves. Phocids are one of the three main groups in the superfamily Pinnipedia; the other two groups are otariids and walrus.

**phocid pinnipeds in water (PPW)**

See **hearing group**.

**pinniped**

A common term used to describe all three groups that form the superfamily Pinnipedia: phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

**point source**

A source that radiates sound as if from a single point.

### power spectral density level

The level ($L_{P,f}$) of the power spectral density ($P_f$). Unit: decibel (dB).

$$L_{P,f} := 10 \log_{10}\left(P_f / P_{f,0}\right) \text{ dB} .$$

The frequency band and integration time should be specified.

Power spectral density level can be expressed in terms of various field variables (e.g., sound pressure, sound particle displacement). The reference value ($P_{f,0}$) for power spectral density level depends on the nature of field variable.

### power spectral density source level

A property of a sound source obtained by adding to the power spectral density level of the sound pressure measured in the far field the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 $\mu Pa^2 m^2/Hz$.

### pressure, acoustic

The deviation from the ambient pressure caused by a sound wave. Also called sound pressure. Unit: pascal (Pa).

### pressure, hydrostatic

The pressure at any given depth in a static liquid that is the result of the weight of the liquid acting on a unit area at that depth, plus any pressure acting on the surface of the liquid. Unit: pascal (Pa).

### propagation loss (PL)

Difference between a source level (SL) and the level at a specified location, PL(x) = SL − L(x). Also see **transmission loss**.

### radiated noise level (RNL)

A source level that has been calculated assuming sound pressure decays geometrically with distance from the source, with no influence of the sea-surface and seabed. Also see **monopole source level**.

### received level

The level measured (or that would be measured) at a defined location. The type of level should be specified.

### reference values

standard underwater references values used for calculating sound **levels**, e.g., the reference value for expressing sound pressure level in decibels is 1 µPa.

| Quantity | Reference value |
|---|---|
| Sound pressure | 1 µPa |
| Sound exposure | 1 $\mu Pa^2$ s |
| Sound particle displacement | 1 pm |
| Sound particle velocity | 1 nm/s |
| Sound particle acceleration | 1 $\mu m/s^2$ |

### rms

abbreviation for root-mean-square.

### shear wave

A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called a secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

### sound

A time-varying disturbance in the pressure, stress, or material displacement of a medium propagated by local compression and expansion of the medium.

### sound exposure

Time integral of squared sound pressure over a stated time interval. The time interval can be a specified time duration (e.g., 24 hours) or from start to end of a specified event (e.g., a pile strike, an airgun pulse, a construction operation). Unit: $Pa^2$ s.

### sound exposure level

The level ($L_E$) of the sound exposure ($E$). Unit: decibel (dB). Reference value ($E_0$) for sound in water: 1 $\mu Pa^2$ s.

$$L_E := 10 \log_{10}(E/E_0)\ \text{dB} = 20 \log_{10}\left(E^{1/2}/E_0^{1/2}\right)\ \text{dB}$$

The frequency band and integration time should be specified. Abbreviation: SEL.

### sound exposure spectral density

Distribution as a function of frequency of the time-integrated squared sound pressure per unit bandwidth of a sound having a continuous spectrum. Unit: $Pa^2$ s/Hz.

### sound field

Region containing sound waves.

### sound intensity

Product of the sound pressure and the sound particle velocity. The magnitude of the sound intensity is the sound energy flowing through a unit area perpendicular to the direction of propagation per unit time.

### sound pressure

The contribution to total pressure caused by the action of sound.

### sound pressure level (rms sound pressure level)

The level ($L_{p,\text{rms}}$) of the time-mean-square sound pressure ($p^2_{\text{rms}}$). Unit: decibel (dB). Reference value ($p_0^2$) for sound in water: 1 $\mu Pa^2$.

$$L_{p,\text{rms}} := 10 \log_{10}(p^2_{\text{rms}}/p_0^2)\ \text{dB} = 20 \log_{10}(p_{\text{rms}}/p_0)\ \text{dB}$$

The frequency band and averaging time should be specified. Abbreviation: SPL or Lrms.

### sound speed profile

The speed of sound in the water column as a function of depth below the water surface.

### soundscape

The characterization of the ambient sound in terms of its spatial, temporal, and frequency attributes, and the types of sources contributing to the sound field.

**source level (SL)**

A property of a sound source obtained by adding to the sound pressure level measured in the far field the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 $\mu Pa^2m^2$.

**spectrogram**

A visual representation of acoustic amplitude compared with time and frequency.

**spectrum**

An acoustic signal represented in terms of its power, energy, mean-square sound pressure, or sound exposure distribution with frequency.

**surface duct**

The upper portion of a water column within which the sound speed profile gradient causes sound to refract upward and therefore reflect off the surface resulting in relatively long-range sound propagation with little loss.

**temporary threshold shift (TTS)**

Reversible loss of hearing sensitivity. TTS can be caused by noise exposure.

**thermocline**

The depth interval near the ocean surface that experiences temperature gradients due to warming or cooling by heat conduction from the atmosphere and by warming from solar heating.

**transmission loss (TL)**

The difference between a specified level at one location and that at a different location, TL(x1,x2) = L(x1) − L(x2). Also see **propagation loss**.

**unweighted**

Term indicating that no frequency weighting function is applied. Synonymous with flat weighting.

**very high-frequency (VHF) cetacean**

See **hearing group**.

**very low-frequency (VLF) cetacean**

See **hearing group**.

**wavelength**

Distance over which a wave completes one cycle of oscillation. Unit: metre (m). Symbol: λ.

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# Appendix A. Acoustic Metrics

This section describes in detail the acoustic metrics, impact criteria, and frequency weighting relevant to the modelling study.

## A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of $p_0$ = 1 µPa. Because the perceived loudness of sound, especially pulsed sound such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate sound and its effects on marine life. Here we provide specific definitions of relevant metrics used in the accompanying report. Where possible, we follow International Organization for Standardization definitions and symbols for sound metrics (e.g., ISO 2017, ANSI S1.1-2013).

The sound pressure level (SPL or $L_p$; dB re 1 µPa) is the root-mean-square (rms) pressure level in a stated frequency band over a specified time window ($T$; s). It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$L_p = 10 \log_{10} \left( \frac{1}{T} \int_T g(t)\, p^2(t)\, dt / p_0^2 \right) \text{ dB} \qquad \text{(A-1)}$$

where $g(t)$ is an optional time weighting function. In many cases, the start time of the integration is marched forward in small time steps to produce a time-varying SPL function.

The sound exposure level (SEL or $L_E$; dB re 1 µPa$^2$·s) is the time-integral of the squared acoustic pressure over a duration ($T$):

$$L_E = 10 \log_{10} \left( \int_T p^2(t)\, dt / T_0 p_0^2 \right) \text{ dB} \qquad \text{(A-2)}$$

where $T_0$ is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to impact to the exposed recipients.

SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events. When applied to pulsed sounds, SEL can be calculated by summing the SEL of the $N$ individual pulses. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the $N$ individual events:

$$L_{E,N} = 10 \log_{10} \left( \sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}} \right) \text{ dB}. \qquad \text{(A-3)}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LFC,24h}$; Appendix A.4). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should also be specified.

## A.2. Decidecade Band Analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analysing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. A decidecade is sometimes referred to as a "1/3 octave" because one tenth of a decade is approximately equal to one third of an octave. Each decade represents a factor 10 in sound frequency. Each octave represents a factor 2 in sound frequency. The centre frequency of the $i$th band, $f_c(i)$, is defined as:

$$f_c(i) = 10^{\frac{i}{10}} \text{ kHz} \tag{A-4}$$

and the low $(f_{lo})$ and high $(f_{hi})$ frequency limits of the $i$th decade band are defined as:

$$f_{lo,i} = 10^{\frac{-1}{20}} f_c(i) \quad \text{and} \quad f_{hi,i} = 10^{\frac{1}{20}} f_c(i) \tag{A-5}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure A-1). The acoustic modelling spans from band 10 ($f_c$ (10) = 10 Hz) to band 44 ($f_c(44)$ = 25 kHz).

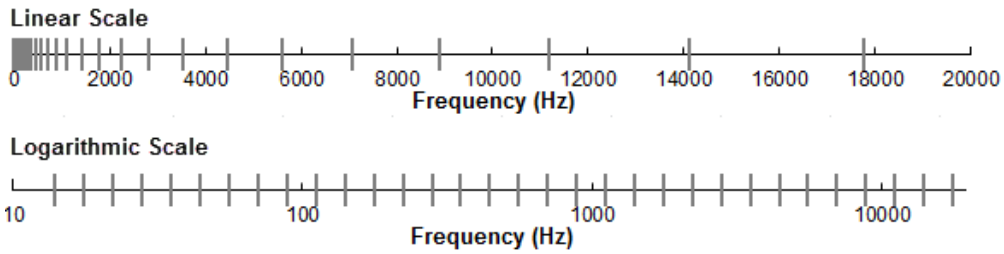


Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the $i$th band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{lo,i}$ and $f_{hi,i}$:

$$L_{p,i} = 10\, log_{10} \int_{f_{lo,i}}^{f_{hi,i}} S(f)\, df \text{ dB} \tag{A-6}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10 \log_{10} \sum_i 10^{\frac{L_{p,i}}{10}} \text{ dB} \tag{A-7}$$

Figure A-2 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient sound signal. Because the decidecade bands are wider than 1 Hz, the decidecade band SPL is higher than the spectral levels at higher frequencies. Acoustic modelling of decidecade bands requires less computation time than 1 Hz bands and still resolves the frequency-dependence of the sound source and the propagation environment.

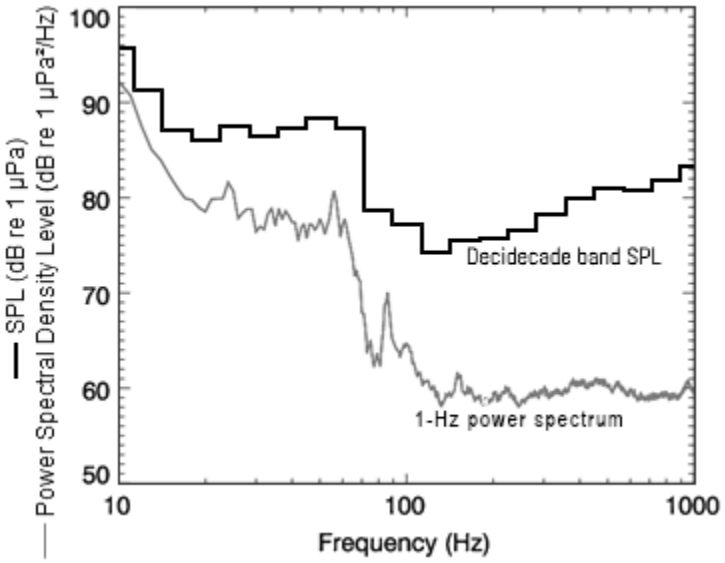


Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the power spectrum.

## A.3. Marine Mammal Noise Effect Criteria

It has been long recognised that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggest that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for auditory injury, impairment, and disturbance. The following sections summarise the recent development of thresholds; however, this field remains an active research topic.

### A.3.1. Injury and Hearing Sensitivity Changes

In recognition of shortcomings of the SPL-only based auditory injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual auditory injury criteria for impulsive sounds that included peak pressure level thresholds and $SEL_{24h}$ thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas $SEL_{24h}$ is frequency weighted according to one of four marine mammal species hearing groups: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for humans; see Appendix A.4). The $SEL_{24h}$ thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower PTS and TTS values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 $\mu Pa^2 \cdot s$. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF cetaceans on results obtained from MF cetacean studies. In particular they referenced the Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 $\mu Pa^2 \cdot s$.

As of present, a definitive approach is still not apparent. There is consensus in the research community that an SEL-based method is preferable, either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2016). The guidance describes auditory injury criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). Further revisions were published by NMFS in 2018 (NMFS 2018). Southall et al. (2019) revisited the interim criteria published in 2007. All noise exposure criteria in NMFS (2018) and Southall et al. (2019) are identical (for impulsive and non-impulsive sounds); however, the mid-frequency cetaceans from NMFS (2018) are classified as high-frequency cetaceans in Southall et al. (2019), and high-frequency cetaceans from NMFS (2018) are classified as very high-frequency cetaceans in Southall et al. (2019).

The latest revision to noise exposure criteria was published by NMFS in 2024 (NMFS 2024), with revised sirenian criteria presented in Accomando et al. (2025), and these criteria are applied in the current report. In both of these publications, the term auditory injury (represented by either AUD INJ or AINJ) is used to encompass auditory injury with and without PTS, however for consistency with historic assessments the term PTS is used within this report.

### A.3.2. Behavioural Response

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016).

NMFS currently uses a step function (all-or-none) threshold of 120 dB re 1 µPa SPL (unweighted) for non-impulsive sounds to assess and regulate noise-induced behavioural impacts on marine mammals (NOAA 2019). The 120 dB re 1 µPa threshold is associated with continuous sources and was derived based on studies examining behavioural responses to drilling and dredging (NOAA 2018), referring to Malme et al. (1983), Malme et al. (1984), and Malme et al. (1986), which were considered in Southall et al. (2007). Malme et al. (1986) found that playback of drillship noise did not produce clear evidence of disturbance or avoidance for levels below 110 dB re 1 µPa (SPL), possible avoidance occurred for exposure levels approaching 119 dB re 1 µPa. Malme et al. (1984) determined that measurable reactions usually consisted of rather subtle short-term changes in speed and/or heading of the whale(s) under observation. It has been shown that both received level and proximity of the sound source is a contributing factor in eliciting behavioural reactions in humpback whales (Dunlop et al. 2017, Dunlop et al. 2018).

## A.4. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

### A.4.1. Marine Mammal Frequency Weighting Functions

In 2015, a US Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^{2}\right]^{a}\left[1+(f/f_{hi})^{2}\right]^{b}}\right)\right] \quad \text{(A-8)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively), phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses acoustic impacts on marine mammals (NMFS 2018), and in the latest guidance by NMFS (2024). The updates did not affect the content related to either the definitions of frequency-weighting functions or the threshold values, however, the terminology for mid- and high-frequency cetaceans was changed to high- and very high-frequency cetaceans (VHF cetaceans), respectively. Table A-1. lists the frequency-weighting parameters for each hearing group relevant to this assessment, and Figure A-3 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions used in this project as recommended by NMFS (2024). The 'flo' and 'fhi' parameters used by Finneran (2015) are now referred to as 'f1' and 'f2' in the latest guidance.

| | NMFS (2024) | | | | |
|---|---|---|---|---|---|
| **Functional Hearing group** | **a** | **b** | **flo (kHz)** | **fhi (kHz)** | **C (dB)** |
| Low-frequency cetaceans (baleen whales) | 0.99 | 5 | 0.168 | 26.6 | 0.12 |
| High-frequency cetaceans (most dolphins, plus sperm, beaked, and bottlenose whales) | 1.55 | 5 | 1.73 | 129 | 0.32 |
| Very high-frequency cetaceans (true porpoises, *Kogia*, river dolphins, *Cephalorhynchus* spp.) | 2.23 | 5 | 5.93 | 186 | 0.91 |
| Otariid Seals in water | 1.58 | 5 | 2.53 | 43.8 | 1.37 |

* The 'C' parameter in NMFS (2024) is equivalent to the 'K' parameter in Finneran (2015).

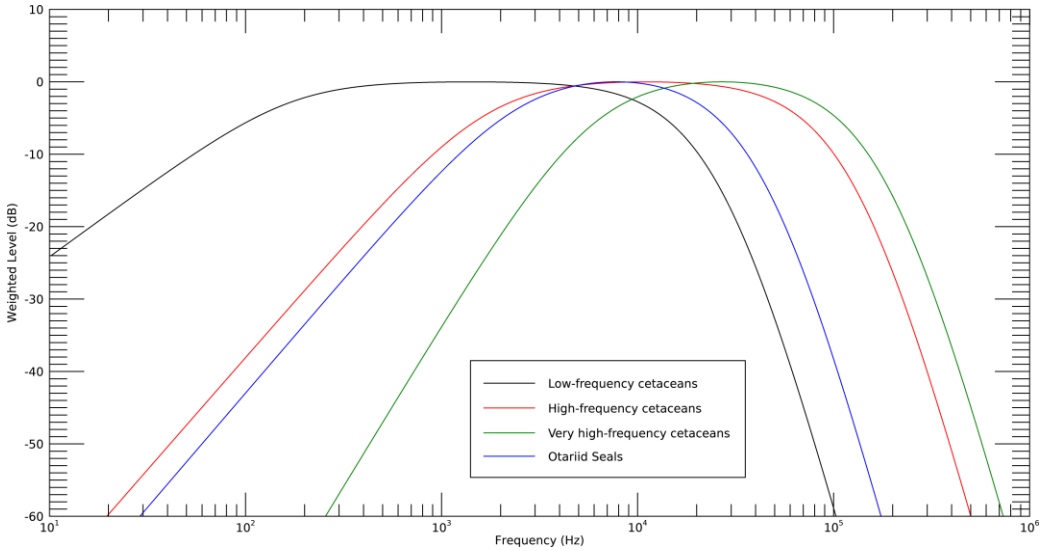


Figure A-3. Auditory weighting functions for functional marine mammal hearing groups used in this project as recommended by NMFS (2024).

# Appendix B. Methods and Parameters

## B.1. Environmental Parameters

### B.1.1. Bathymetry

Bathymetry throughout the modelled area was extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Beaman 2023). Bathymetry data were re-gridded and combined onto a Map Grid of Australia (MGA) coordinate projection (Zone 55) with a regular grid spacing of 250 × 250 m (Figure B-1).

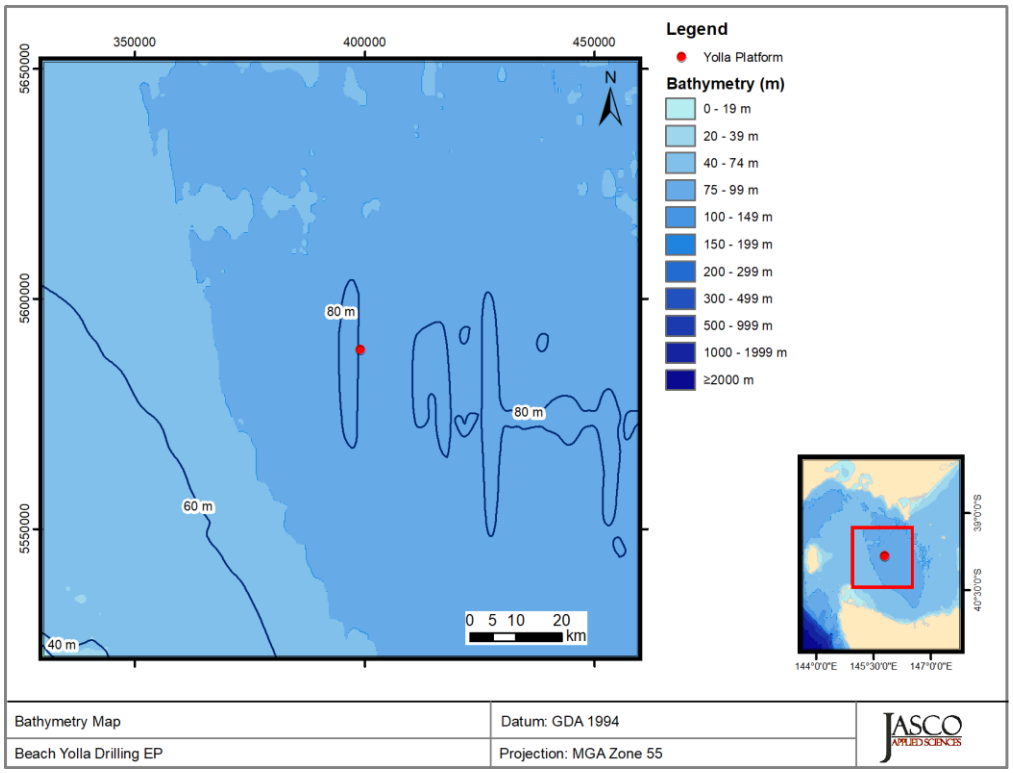


Figure B-1. Bathymetry in the modelled area.

### B.1.2. Sound Speed Profile

The sound speed profile in the area was derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

Mean monthly sound speed profiles were derived from the GDEM profiles in the locality of the modelled sites. Following a sensitivity analysis from previous Yolla modelling study (Stroot et al. 2022), the August sound speed profile was found to be most favourable to longer-range sound propagation. As such, August was selected for sound propagation modelling to ensure precautionary estimates of

distances to received sound level thresholds. Figure B-2 shows the resulting profile, which was used as input to the sound propagation modelling.

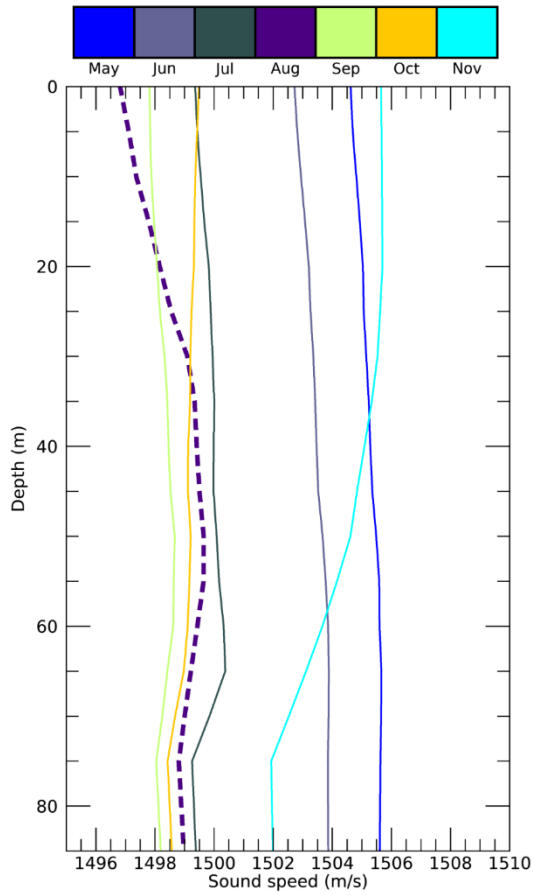


Figure B-2. The sound speed profile considered for acoustic modelling corresponding to August (dashed curve) and other considered monthly profiles Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

## B.1.3. Geoacoustics

A single representative geoacoustic profile was used for all modelled sites based on geotechnical site investigations conducted at the Yolla WHP. The seabed composition at the seafloor was taken from the results of multiple grab samples provided by the client surrounding the Yolla WHP. These data indicated that the seafloor sediments consist predominantly of fine sand. Additionally, a geotechnical survey report including the results of a core sample was also provided by the client. This described the composition at a depth of 100 m as very fine sand or silt. These grain sizes were then linearly interpolated as a function of depth between the two sediment grainsizes.

The geoacoustic properties were then calculated using the sediment grain-shearing model of Buckingham (2005). The grain sizes were used as input to the grain-shearing model to estimate the geoacoustic parameters required by the sound propagation models. Table B-1 presents the geoacoustic profile for all modelled sites.

Table B-1. Geoacoustic profile for all modelled sites. Each parameter varies linearly within the stated range.

| Depth below seafloor (m) | Predicted lithology | Density (g/cm3) | Compressional wave | | Shear wave | |
|---|---|---|---|---|---|---|
| | | | Speed (m/s) | Attenuation (dB/λ) | Speed (m/s) | Attenuation (dB/λ) |
| 0–10 | Very Fine Sand (unconsolidated) | 2.07–2.06 | 1665–1873 | 0.22–0.95 | 390 | 3.65 |
| 10–20 | Very Fine Sand (unconsolidated increasing in compaction) | 2.06–2.06 | 1873–1938 | 0.95–1.13 | | |
| 20–50 | | 2.06–2.05 | 1938–2009 | 1.13–1.34 | | |
| 50–75 | Sandy Silt (unconsolidated increasing in compaction) | 2.05–2.02 | 2009–1989 | 1.34–1.34 | | |
| 75–100 | | 1.93 | 1989–1877 | 1.20–1.34 | | |
| 100–150 | Silt (unconsolidated increasing in compaction) | 1.93 | 1877–1933 | 1.34–1.45 | | |
| 150–200 | | 1.93 | 1979–2053 | 1.34–1.60 | | |
| ≥300 | Consolidated sandy silt/sedimentary rock | 1.93 | 2035 | 1.60 | | |

## B.2. Sound Propagation Models

### B.2.1. Propagation Loss

The propagation of sound through the environment was modelled by predicting the acoustic propagation loss—a measure, in decibels, of the decrease in sound level between a source and a receiver some distance away. Geometric spreading of acoustic waves is the predominant way by which propagation loss occurs. Propagation loss also happens when the sound is absorbed and scattered by the seawater, and absorbed scattered, and reflected at the water surface and within the seabed. Propagation loss depends on the acoustic properties of the ocean and seabed; its value changes with frequency.

If the acoustic energy source level (ESL), expressed in dB re 1 $\mu Pa^2 \cdot s\ m^2$, and propagation loss (PL), in units of dB, at a given frequency are known, then the received level (RL) at a receiver location can be calculated in dB re 1 $\mu Pa^2 \cdot s$ by:

$$RL = SL - PL. \quad \text{(B-1)}$$

### B.2.2. MONM-BELLHOP

Long-range sound fields were computed using JASCO's Marine Operations Noise Model (MONM). While other models may be more accurate for steep-angle propagation in high-shear environment, MONM is well suited for effective longer-range estimation. This model computes sound propagation at frequencies of 10 Hz to 1.6 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies > 1.6 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM

incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

MONM computes acoustic fields in three dimensions by modelling propagation loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding N = 360°/$\Delta\theta$ number of planes (Figure B-3).

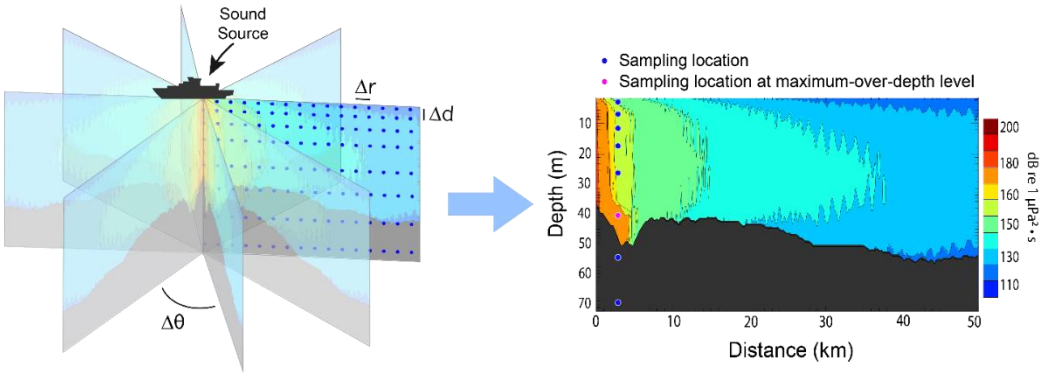


Figure B-3. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic propagation loss at the centre frequencies of decidecade bands. Sufficiently many decidecade frequency-bands, starting at 10 Hz, are modelled to include most of the acoustic energy emitted by the source. At each centre frequency, the propagation loss is modelled within each of the N vertical planes as a function of depth and range from the source. The decidecade received per-second SEL are computed by subtracting the band propagation loss values from the directional source level in that frequency band. Composite broadband received per-second SEL are then computed by summing the received decidecade levels.

The received 1-s SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. For areas with deep water, sampling is not performed at depths beyond those reachable by marine mammals. The received per-second SEL at a surface sampling location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-second SEL. These maximum-over-depth per-second SEL are presented as colour contours around the source.

## B.3. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) $R_{max}$, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure B-4).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure B-4(a). In cases such as this, where relatively few points are excluded in any given

direction, $R_{max}$ can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure B-4(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases $R_{max}$ might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between $R_{max}$ and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

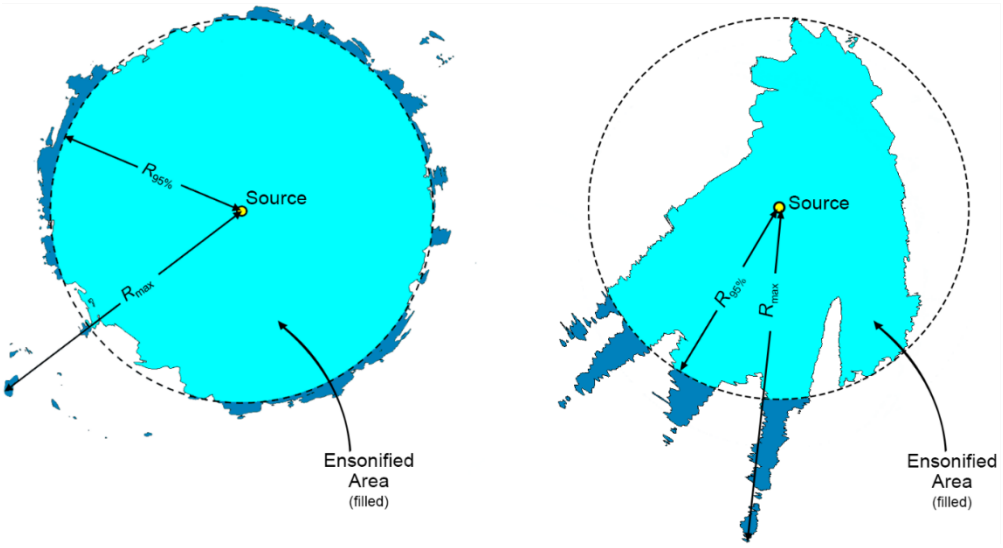


Figure B-4. Sample areas ensonified to an arbitrary sound level with $R_{max}$ and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine $R_{max}$.

## B.4. Model Validation Information

Predictions from JASCO's propagation models (MONM, FWRAM, and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including programs in the United States and Canadian Arctic, Canadian and southern United States waters, Greenland, Russia and Australia (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Matthews and MacGillivray 2013, Martin et al. 2015, Racca et al. 2015, Martin et al. 2017a, Martin et al. 2017b, Warner et al. 2017, MacGillivray 2018, McPherson et al. 2018, McPherson and Martin 2018).

In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities that have included internal validation of the modelling (including McCrodan et al. 2011, Austin and Warner 2012, McPherson and Warner 2012, Austin and Bailey 2013, Austin et al. 2013, Zykov and MacDonnell 2013, Austin 2014, Austin et al. 2015, Austin and Li 2016, Martin and Popper 2016, Austin et al. 2018, Beach Energy Limited 2020)

Beach Energy Limited

# BassGas GHG Assessment

## Greenhouse Gas Emissions Assessment Technical Note

**ASSIGNMENT** P200288-S00
**DOCUMENT** P-200288-S00-A-REPT-001

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| I02 | 06/11/2025 | Issued for use | MH | AA | MH | Beach |
| I01 | 31/10/2025 | Issued for use | MH | AA | MH | Beach |
| R01 | 03/10/2025 | Issued for review | MH | AA | MH | - |

# CONTENTS

1 INTRODUCTION 4

2 METHODOLOGY 7
2.1 Source and activity identification 7
2.2 Input information 7
2.2.1 Yolla Platform, RGP and LLGP 8
2.2.2 Product Use 8
2.2.3 Support activities 9
2.2.4 Purchased goods and services 9
2.2.5 Waste 9

3 RESULTS 10

APPENDIX A BOUNDARY, ASSUMPTION AND INPUT LIST

# 1 INTRODUCTION

Beach Energy Limited (Beach) has engaged Xodus to develop a greenhouse gas (GHG) emissions assessment ('this report') for the BassGas Offshore Operations to inform the Environment Plan (EP) revision. Beach defined the scope boundary as the Project, as outlined in Figure 1.

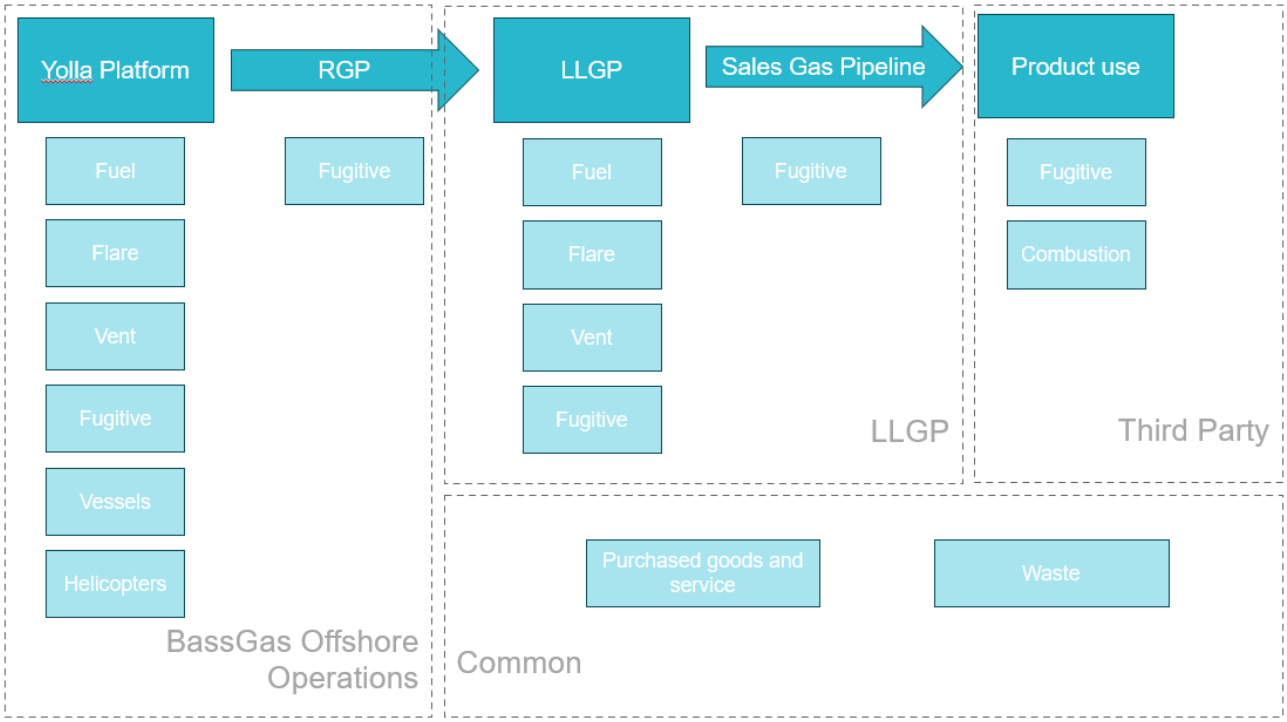


*Figure 1: Boundary showing the BassGas Offshore Operations, and relationship between the BassGas Offshore Operations and the Lang Lang Gas Plant (LLGP)*

This report describes the GHG emissions from the BassGas Offshore Operations within the context of the operation of the LLGP. The GHG emissions are categorised as follows:

- Scope 1: Direct emissions from the combustion of fuel, venting, flaring and fugitive emissions from Beach owned or controlled sources.
- Scope 1*: Emissions from the combustion of fuel, venting, flaring and fugitive emissions from Beach owned or controlled sources, but not within the scope of the BassGas EP.
- Scope 2: Indirect emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the company.
- Scope 3: All other indirect emissions not covered in scope 2, which occur in the value chain.

Emissions were calculated on an operational control basis, whereby Beach has operational control over the BassGas Offshore Operations, LLGP and Sales Gas Pipeline and so all relevant emissions are apportioned to Beach based the emissions scope definitions in Table 1.

Table 1 summarises the activities and sources that emit GHG emissions during the duration of the BassGas Offshore Operations EP, i.e. 2026-2030.

*Table 1: GHG emissions source categorisation*

| GHG SCOPE | CATEGORY | SOURCE / ACTIVITIES |
|---|---|---|
| **BassGas Offshore Operations** | | |
| 1 | Fuel Gas | Platform Gas Turbine Compressors |
| | | Platform Gas Turbine Generators |
| | Fuel Diesel | Platform emergency generator |
| | | Pedestal crane |
| | | Firewater pumps |
| | | Additional diesel for workovers |
| | Fugitives | Fugitive emissions from:<br>• Platform and RGP<br>• Produced formation water |
| | Flaring | Platform Flare System |
| | Venting | Glycol Dehydrator |
| | | Gas Driven Pneumatic Device |
| **LLGP** | | |
| 1* | Fuel Gas | LLGP Gas Turbine Compressors |
| | | LLGP Gas Turbine Generators |
| | Fuel Diesel | LLGP emergency generator |
| | | Firewater pumps, etc. |
| | Fugitives | Fugitive emissions from:<br>• LLGP<br>• Sales Gas Pipeline |
| | Flaring | LLGP Flare |
| | Venting | LLGP Reservoir carbon dioxide ($CO_2$) Vent |
| | | LLGP Non routine venting |
| **Indirect Emissions** | | |
| 2 | There are no scope 2 emissions. | |

| GHG SCOPE | CATEGORY | SOURCE / ACTIVITIES |
|---|---|---|
| 3 | Product use | Natural gas<br>Condensate<br>Liquefied petroleum gas (LPG)<br>$CO_2$<br>Fugitive emissions from third party natural gas transmission |
| | Support activities | Vessels |
| | | Helicopters |
| | Purchased goods and services | Purchased diesel |
| | Waste | Waste |

Emissions were forecast for the duration of the EP, from 2026 to 2030. As operations is planned to occur throughout this duration, no end of field life or decommissioning activities were considered.

# 2 METHODOLOGY

## 2.1 Source and activity identification

The assumptions list (Appendix A) was developed by Xodus based on information provided by Beach and defines the activities and sources of GHG emissions included in the GHG emissions inventory for BassGas Offshore Operations.

## 2.2 Input information

The primary source of input information for this report is the BassGas Offshore Operations EP. This document outlines the scope of activities, operational boundaries, and environmental considerations associated with offshore operations at BassGas. It serves as the foundational reference for identifying GHG emission sources relevant to the operations, noting that this GHG assessment considers indirect emissions sources not included in the EP. To define these emissions sources, a review of the BassGas Offshore Operations value chain was conducted, this identified emissions sources both upstream including purchased goods and downstream including processing at LLGP and use of sales products.

Once the GHG emission sources throughout the value chain of the BassGass Offshore Operations were identified, emissions data was obtained. As an existing operating asset, there is considerable existing emissions data for the BassGas Offshore Operations value chain, including:

- Reports submitted under Section 19 of the *National Greenhouse and Energy Reporting Act 2007* (Cth). These reports are lodged annually by corporations that meet specific thresholds for greenhouse gas emissions, energy production, or energy consumption. They provide detailed, regulated disclosures of emissions and energy data, ensuring consistency and transparency in reporting across the industry.
- Scope 3 emissions calculations from Beach's Corporate Scope 3 Calculator. This tool calculates the scope 3 emissions to be disclosed in Beach's sustainability disclosures. Results used from the Corporate Scope 3 Calculator have been converted to operational control.

Where it was deemed that there was likely to be material differences between the historical emissions calculations and forecast emissions alternative inputs where used. This is particularly relevant to the use of product sold. In this case the BassGass Offshore Operations production profile, and associated estimated sales gas, condensate and LPG was determined to calculate the associated scope 3 emissions. The volume of $CO_2$ sold was used to forecast future $CO_2$ sales emissions.

In addition, contracted vessels and helicopter operations were calculated separately based on the forecast vessel and helicopter usage.

Section 19 reports from the period of financial year (FY) 2020 to FY25 were considered. This provided a substantial duration to enable the heterogeneity of production to be included, for example, well workovers, shutdowns, non-routine operations, etc.

All emissions reported under Section 19 are shown in tonnes of carbon dioxide equivalent (t $CO_2$-e) inclusive of the relevant GHGs, such as $CO_2$, nitrous oxide ($N_2O$) and methane ($CH_4$).

Specific details associated with the calculation methodology of emissions sources is outlined in the sections below. A full list of assumptions and inputs used can be found in Appendix A.

### 2.2.1 Yolla Platform, RGP and LLGP

Section 19 reports were the basis of the emissions estimates for the Yolla Platform, RGP and LLGP. These reports were reviewed to determine the historical emissions from both the BassGas Offshore Operations and the LLGP. Emissions estimates were calculated by averaging the calculated emissions over the period considered FY2020 to FY25. Any emissions sources absent from the Section 19 report in certain years were excluded from the averaging calculations.

For the calculation of fugitive emissions from natural gas processing and production, Beach changed the calculation methodology during the FY2020 to FY2025 period, changing from Method 1 use of default emissions factors to Method 3 sampling and analysis to documentation standards. Because Method 3 involves site specific calculations, it is deemed to be more accurate than Method 1, and so the results from the Method 1 have been excluded from the averaging process used to forecast emissions for the BasGas Offshore Operations.

### 2.2.2 Product Use

As stated in Section 2.2, the BassGas Offshore Operations production profile was used to determine the amount of products developed and sold due to the BassGas Offshore Operations. The relevant hydrocarbon products are:

- Sales gas
- Condensate
- LPG
- $CO_2$

The National Greenhouse and Energy Reporting (Measurement) Determination 2008 emission factors for Method 1 were applied for product use calculations. The calculation for product combustion related emissions is as follows:

- Emissions [$CH_4$, $CO_2$, $N_2O$] (tonnes $CO_2e$) = Activity / Source [e.g., condensate product] × EF [$CH_4$, $CO_2$, $N_2O$]

Fugitive emissions post sales gate was calculated by determining the amount of natural gas sold into the Victorian Market, which is static at 300PJ/year, determining the representative losses of the transmission network this is determined by using the Section 19 reported emissions from the Victorian Market participants AusNet Gas Services (AGS), Australian Gas Networks (AGN) and Multinet Gas Distribution Network (MPDN) and calculating the proportion of transmission losses given the forecast of natural gas to be sold as a result of the BassGas Offshore Operations.

For conservatism it was assumed that all sold hydrocarbons, less transmission losses, are combusted.

### 2.2.3 Support activities

Support activities include vessel operations and helicopters. Vessel operations include:

- Platform ROV Inspection
- Pipeline Inspection (ROV, MBES and/or spud can survey)
- Platform supply vessel
- Standby vessels

Emissions for vessel activities and helicopters were calculated by:

- Emissions (tonnes $CO_2$-e) = Forecast fuel use × EF [diesel or aviation kerosene]

### 2.2.4 Purchased goods and services

No supplier / reference dataset for materials and equipment, or design basis was available. Therefore, the emissions from purchased goods and services was calculated by determining the historical spend of purchased goods from BassGas (including LLGP) and applying a spend based emissions factor.

- Emissions (tonnes $CO_2$-e = Spend on Material / Equipment × EF [material, equipment] ÷ 0.8875 [Beach equity share]

Purchased diesel was considered as a purchased good and service.

### 2.2.5 Waste

No supplier / reference dataset for materials and equipment, or design basis was available to calculate emissions from waste. Therefore, the emissions from waste was calculated by determining the historical spend of waste management services from BassGas (including LLGP) and applying a spend based emissions factor.

- Emissions (tonnes $CO_2$-e) = Spend on waste management × EF [waste] ÷ 0.8875 [Beach equity share]

# 3 RESULTS

Over the five year duration of the EP revision, the scope 1 emissions associated with the BassGas Offshore Operations is 224,632 t $CO_2$-e. This represents an annual average emissions of 44,926 t $CO_2$-e/year.

Over the five year duration of the EP revision, the scope 1* emissions associated with the LLGP is 406,040t $CO_2$-e. This represents an annual average emissions of 81,208 t $CO_2$-e/year.

The scope 3 emissions associated with the BassGas Offshore Operations over this duration is forecast to be 1,707,270t $CO_2$-e, or an annual average of 341,454 t $CO_2$-e/year.

An overview of the results of the GHG emissions assessment is provided in Table 2.

*Table 2: Outlines the emissions estimated from the BassGas Offshore Operations, including throughout the value chain (i.e. LLGP, Sales Gas Pipeline, use of sales product)*

| EMISSIONS SOURCE (t $CO_2$-e) | EMISSIONS SCOPE | | |
|---|---|---|---|
| | 1 | 1* | 3 |
| UPSTREAM | 224,632 | | |
| Flaring | 54,855 | | |
| Fuel | 165,251 | | |
| Yolla 2 x GTG (1,400kW) | 58,271 | | |
| Yolla Diesel driven emergency generator (640 kW) | 333 | | |
| Yolla GT compressors | 106,647 | | |
| Fugitives | 5,128 | | |
| Yolla PFW Fugitives | 1,364 | | |
| Yolla Platform and RGP Fugitives | 2,844 | | |
| Venting | 318 | | |
| Helicopter | | | 9,407 |
| Purchased diesel | | | 574 |
| ONSHORE | | 406,040 | |
| Flaring | | 791 | |
| Fuel | | 261,526 | |
| LLGP Fuel Gas (GTGs, GT compressors) | | 260,402 | |
| LLGP LPG, Deisel Fuel and Lubricants Use | | 1,125 | |
| Fugitives | | 7,096 | |

| EMISSIONS SOURCE ($t CO_2$-e) | EMISSIONS SCOPE | | |
|---|---|---|---|
| | 1 | 1* | 3 |
| LLGP Fugitives, including Sales Pipeline | | 7,096 | |
| Venting | | 136,627 | |
| SALES PRODUCT | | | 1,641,996 |
| Fugitives Transmission of Natural Gas | | | 32,019 |
| Product Use - Condensate | | | 273,839 |
| Product Use - LPG | | | 210,278 |
| Product Use - Natural Gas | | | 915,823 |
| Product Use - $CO_2$ | | | 210,037 |
| VESSELS | | | 54,823 |
| Pipeline Inspection (ROV, MBES and/or spud can survey) | | | 571 |
| Platform ROV Inspection | | | 720 |
| Platform supply vessel | | | 47,759 |
| Standby vessels | | | 5,772 |
| WASTE | | | 470 |
| GRAND TOTAL | 224,632 | 406,040 | 1,707,270 |
| | 2,337,942 | | |

The largest emissions source, considering scope 1, 1* and 3 emissions, is the use of sales product, which contributes 70% of the overall emissions. The next largest emissions contributor is fuel use on the Yolla Platform and LLGP (18%), followed by venting at the Yolla Platform and LLGP (6%), with flaring at the Yolla Platform and LLGP contributing a minor portion (2%). Vessels contribute 2% to the total emissions. All other emissions sources contributing less than 1% of the total each.

Figure 2 provides an overview of the relative contribution of each emissions source to the total emissions, inclusive of scope 1, 1* and 3, associated with the BassGas Offshore Operations.

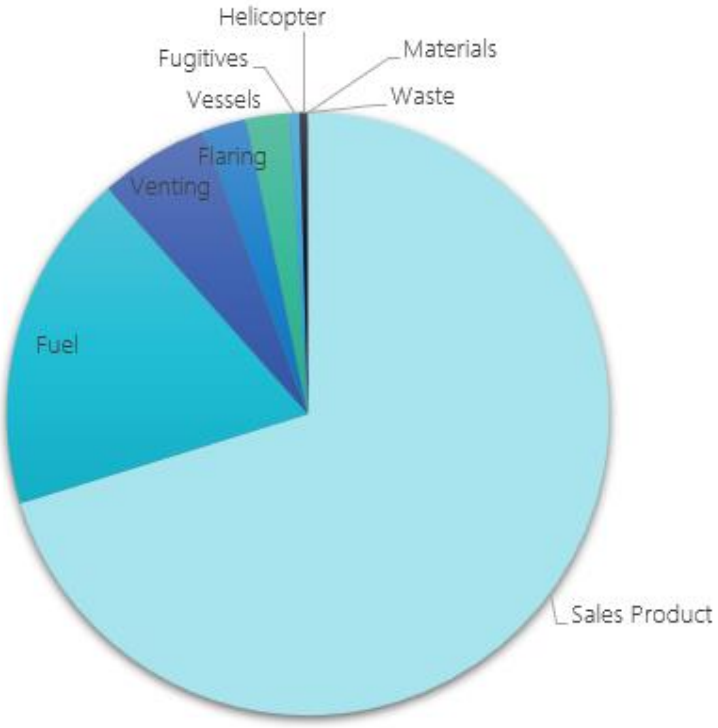


*Figure 2: Proportion of emissions by source*

Each GHG emissions scope contributes the following percentages to the overall emissions (Figure 3):

- Scope 1 emissions contribute 9.6%.
- Scope 1* emissions contribute 17.4%.
- Scope 3 emissions contribute 73.0%

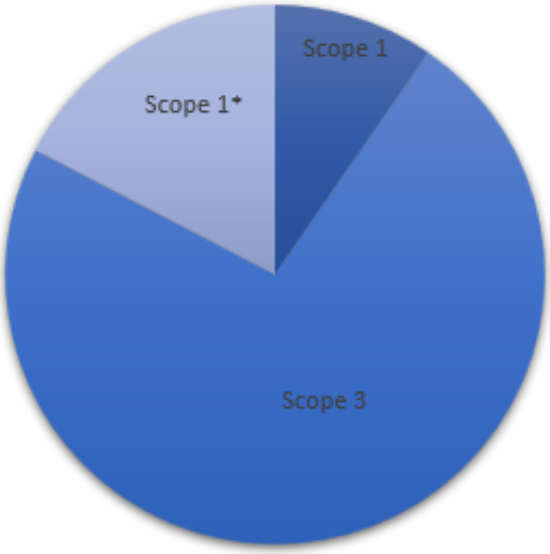


*Figure 3: Proportion of emissions by scope*

Within these scope 1 emissions, fuel combustion is the dominant emission source (73.6%) followed by flaring (24.4%), fugitives (1.9%) and venting (0.1%; Figure 4).

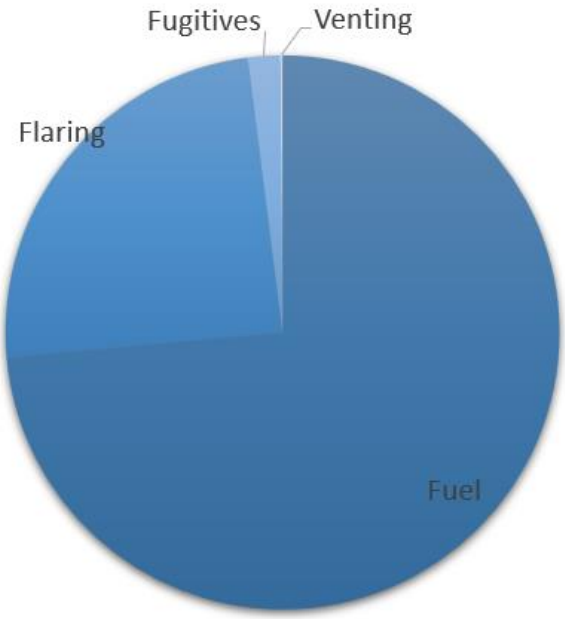


*Figure 4: Proportion of scope 1 emissions by source*

# APPENDIX A BOUNDARY, ASSUMPTION AND INPUT LIST

| EMISSIONS SOURCE | ASSUMPTION / GIVEN |
|---|---|
| **General** | Physical Properties (for conversions and calculations):<br>• Marine Diesel Oil: 38.6 MJ/L<br>• Aviation Kerosene: 36.8 MJ/L<br>• Condensate: 0.75 kg/L<br>• LPG: 25.7 GJ/kL; 46 GJ/tonne |
| | GHG emission forecast is calendar years 2026 to 2030. |
| | No capital works are included in the emissions forecast. |
| **Yolla Platform** | Section 19 Reports over the period of FY2020 to FY2025 are representative of the operational scenarios to be expected for the forecast duration of this assessment. |
| **RGP** | Section 19 Reports over the period of FY2020 to FY2025 are representative of the operational scenarios to be expected for the forecast duration of this assessment. |
| **LLGP** | Electricity is not purchased or sold; all generated electricity is consumed. |
| | Section 19 Reports over the period of FY2020 to FY2025 are representative of the operational scenarios to be expected for the forecast duration of this assessment. |
| **Product use** | Fugitive emissions from the Beach owned Sales Gas Pipeline are considered scope 1*. Fugitive emissions from the third party owned gas distribution network are considered scope 3. |
| | GHG emissions from downstream transmission and distribution losses. Estimates of the fugitive emissions from NG downstream of the sales gate, i.e., from Beach owned assets to non-Beach owned assets to customers in the Victorian market are based on the following assumptions:<br>• All gas sold from BassGas Offshore Operations is to the Victorian Market.<br>• The Market is static at 300 PJ / year.<br>• The Market GHG scope 1 emissions are reported under the safeguard mechanism, and these reported values from the entities.<br>• AGS, AGN and MPDN are representative of the Market transmission and distribution losses.<br>• The publicly available information for year 2022/23 as follows:<br>– AGS: 185,486 tonnes $CO_2$-e<br>– AGN: 172, 611 tonnes $CO_2$-e<br>– MPDN - 182,383 tonnes $CO_2$-e<br>• The GHG emissions apportioned to the Project is by energy supplied by the BassGas Offshore Operations into the Market. |
| | Hydrocarbon products assumed to be 100% combusted, less transmission losses. |
| | Assumed 100% of $CO_2$ product to be released to atmosphere. |

| EMISSIONS SOURCE | ASSUMPTION / GIVEN |
|---|---|
| **Support activities (vessels and helicopters)** | Chartered support vessel and helicopters emissions project-wide considered as scope 3 emissions |
| | All vessels will be sourced from Geelong, Portland or Barry Beach. For conservatism, assume furthest practicable supply port at Portland. Distance from Portland to the Yolla Platform is 398 km. |
| | Vessel requirements included are:<br>- Platform ROV Inspection / Project Support Vessel<br>- Pipeline Inspection (ROV, MBES and/or spud can survey) / Project Support Vessel<br>- Platform supply vessel / Project Support Vessel<br>- Standby vessels / Small standby only with fast rescue craft. |
| | All vessels use Marine Diesel Oil (MDO) as fuel. |
| | Project Support Vessels are considered to use 12,000 L/day of MDO |
| | Standby Vessels are considered to use 2,000 L/day of MDO |
| **Purchased goods and services** | Inputs taken from the Beach Corporate Scope 3 Calculator. These values are provided in equity share. Beach's equity of the BassGas Offshore Operations and LLGP is 88.75%. Results presented in this report are provided based on operational control, that is at 100%. |
| | Diesel is the material contributor to purchased goods and services not considered in other emissions sources/categories. |
| **Waste** | Inputs taken from the Beach Corporate Scope 3 Calculator. These values are provided in equity share. Beach's equity of the BassGas Offshore Operations and LLGP is 88.75%. Results presented in this report are provided based on operational control, that is at 100%. |

# BEACH - YOLLA PLATFORM

## Oil Spill Modelling Report

GOC376530
14 July 2025
Rev 2

rpsgroup.com

## Document status

| Version | Purpose of document | Authored by | Reviewed by | Approved by | Review date |
|---|---|---|---|---|---|
| Rev A | Draft issued for internal review | L. Perez | N. Benfer | N. Benfer | 17/02/2025 |
| Rev 0 | Draft issued to client | | | N. Benfer | 17/02/2025 |
| Rev 1 | Issued to client | | | N. Benfer | 12/03/2025 |
| Rev 2 | Issued to client | L. Perez | | N. Benfer | 14/07/2025 |

## Approval for issue

Nathan Benfer 14 July 2025

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# Contents

**TERMS AND ABBREVIATIONS** ..... **XVI**

**EXECUTIVE SUMMARY** ..... **XVIII**
Background ..... xviii
Methodology ..... xviii
Oil Properties ..... xviii
Results ..... xix

**1 INTRODUCTION** ..... **1**
1.1 Background ..... 1

**2 SCOPE OF WORK** ..... **3**

**3 REGIONAL CURRENTS** ..... **3**
3.1 Tidal currents ..... 5
3.1.1 Grid Setup ..... 5
3.1.2 Tidal Conditions ..... 7
3.1.3 Surface Elevation Validation ..... 7
3.2 Ocean Currents ..... 11

**4 WIND DATA** ..... **18**

**5 WATER TEMPERATURE AND SALINITY** ..... **24**

**6 SUBSEA PLUME MODEL – OILMAP DEEP** ..... **27**

**7 OIL SPILL MODEL – SIMAP** ..... **29**
7.1 Stochastic Modelling ..... 29

**8 THRESHOLDS** ..... **30**
8.1 Floating Oil Exposure Thresholds ..... 30
8.2 Shoreline Accumulation Thresholds ..... 32
8.3 In-water Exposure Thresholds ..... 32
8.3.1 Dissolved Hydrocarbons ..... 33
8.3.2 Entrained Hydrocarbons ..... 33

**9 DISPERSION COEFFICIENTS AND MIXED LAYER DEPTH** ..... **35**

**10 OIL PROPERTIES** ..... **35**
10.1 Oil Characteristics ..... 35
10.2 Weathering Characteristics ..... 37
Yolla Condensate Mass Balance Forecasts ..... 37
Marine Diesel Mass Balance Forecasts ..... 37

**11 MODEL SETTINGS** ..... **40**

**12 PRESENTATION AND INTERPRETATION OF MODEL RESULTS** ..... **41**
12.1 Seasonal Analysis ..... 41
12.1.1 Statistics ..... 41
12.2 Receptors Assessed ..... 42

**13 RESULTS – SURBSEA RELEASE OF CONDENSATE DUE TO A LOWC** ..... **44**
13.1 Stochastic Analysis ..... 44
13.1.1 Area of Exposure ..... 44
13.1.2 Floating Oil Exposure ..... 47
13.1.3 Shoreline Accumulation ..... 56
13.1.4 In-water exposure ..... 56

**14 RESULTS – SUBSEA RELEASE OF CONDENSATE 3NM FROM SHORE DUE TO PIPELINE RUPTURE** ..... **89**

14.1 Stochastic Analysis ....89
14.1.1 Area of Exposure ....89
14.1.2 Floating Oil Exposure ....92
14.1.3 Shoreline Accumulation ....109
14.1.4 In-water exposure ....113

**15 RESULTS – SURFACE RELEASE OF MDO 3NM FROM SHORE ....11**
15.1 Stochastic Analysis ....11
15.1.1 Area of Exposure ....11
15.1.2 Floating Oil Exposure ....14
15.1.3 Shoreline Accumulation ....31
15.1.4 In-water exposure ....35

**16 REFERENCES ....1**

## Tables

Table 1.1 Location of the release sites used for the dispersion modelling assessment. ....1
Table 3.1 Statistical comparison between the observed and HYDROMAP predicted surface elevations. ....8
Table 3-2 Predicted monthly average and maximum surface current speeds nearby the Yolla Well Head. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2010–2019 (inclusive). ....12
Table 3-3 Predicted monthly average and maximum surface current speeds nearby the MDO and Pipeline release location. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2010–2019 (inclusive). ....13
Table 4-1 Predicted average and maximum winds representative for the selected node closest to the Yolla Well Head. Data derived from CFSR hindcast model from 2010–2019 (inclusive). ....19
Table 4-2 Predicted average and maximum winds representative for the selected node closest to the MDO and Pipeline release location. Data derived from CFSR hindcast model from 2010–2019 (inclusive). ....19
Table 5.1 Monthly average sea surface temperature and salinity near the Yolla Well Head. ....24
Table 5.2 Monthly average sea surface temperature and salinity near the MDO and Pipeline release location. ....24
Table 8.1 Summary of the thresholds applied in this study. ....30
Table 8-2 The Bonn Agreement Oil Appearance Code. ....31
Table 8-3 Floating oil exposure thresholds used in this report (in alignment with NOPSEMA, 2019). ....31
Table 8-4 Thresholds used to assess shoreline accumulation. ....32
Table 8.5 Dissolved and entrained hydrocarbon exposure thresholds assessed over a 1-hour time step used in the oil spill modelling study (in alignment NOPSEMA, 2019). ....34
Table 10-1 Physical properties for Yolla condensate and MDO. ....35
Table 10-2 Boiling point ranges for Yolla condensate and MDO. ....36
Table 11-1 Summary of the oil spill model settings and thresholds used in this assessment. ....40
Table 12.1 Summary of receptors assessed for floating oil exposure, in-water column exposure (entrained and dissolved hydrocarbons), and shoreline oil accumulation. Results for these receptors have been presented. ....42
Table 12.2 Summary of receptors assessed for floating oil exposure, in-water column exposure (entrained and dissolved hydrocarbons), and shoreline oil accumulation. Results for these receptors have not been presented but can be provided upon request. ....43
Table 13-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 70,489 bbl subsea release of condensate over 86 days

from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations per season. ....47
Table 13-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to summer conditions. ....48
Table 13-3 Summary of the potential floating oil exposure to individual receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to winter conditions. ....49
Table 13-4 Maximum distance and direction from the release location to the edge of dissolved oil exposure. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations per season. ....56
Table 13-5 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to summer conditions. ....57
Table 13-6 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to winter conditions. ....59
Table 13-7 Maximum distance and direction from the release location to the edge of entrained oil exposure. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations per season. ....71
Table 13-8 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to summer conditions. ....72
Table 13-9 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to winter conditions. ....75
Table 14-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations per season. ....92
Table 14-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to summer conditions. ....93
Table 14-3 Summary of the potential floating oil exposure to individual receptors. Results are based on 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to winter conditions. ....94
Table 14-4 Summary of oil accumulation across all shorelines. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations per season. ....109
Table 14-5 Summary of oil accumulation on individual shoreline receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations and refer to summer conditions. ....110

Table 14-6 Summary of oil accumulation on individual shoreline receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to winter conditions. ....110
Table 14-7 Maximum distance and direction from the release location to the edge of dissolved oil exposure. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations per season. ....113
Table 14-8 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to summer conditions. ....114
Table 14-9 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to winter conditions. ....116
Table 14-10 Maximum distance and direction from the release location to the edge of entrained oil exposure. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations per season. ....128
Table 14-11 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to summer conditions. ....129
Table 14-12 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations and refer to winter conditions. ....132
Table 15-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations per season. ....14
Table 15-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to summer conditions. ....15
Table 15-3 Summary of the potential floating oil exposure to individual receptors. Results are based on 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to winter conditions. ....16
Table 15-4 Summary of oil accumulation across all shorelines. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations per season. ....31
Table 15-5 Summary of oil accumulation on individual shoreline receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill and refer to summer conditions. ....32
Table 15-6 Summary of oil accumulation on individual shoreline receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to winter conditions. ....32
Table 15-7 Maximum distance and direction from the release location to the edge of dissolved oil exposure. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations per season. ....35

Table 15-8 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to summer conditions. ....36
Table 15-9 Summary of dissolved hydrocarbons exposure to marine based receptors in the 0–10 m dept. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to winter conditions. ....38
Table 15-10 Maximum distance and direction from the release location to the edge of entrained oil exposure. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations per season. ....50
Table 15-11 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to summer conditions. ....51
Table 15-12 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to winter conditions. ....55

## Figures

Figure 1.1 Location of the hypothetical spill release sites as used in the oil spill modelling. ....2
Figure 3.1 HYCOM averaged seasonal surface drift currents during summer and winter. ....4
Figure 3.2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh. ....6
Figure 3.3 Bathymetry defined throughout the tidal model domain. ....6
Figure 3.4 Location of the tide stations used in the surface elevation validation. ....8
Figure 3.5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image). ....9
Figure 3.6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image). ....10
Figure 3.7 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and shoals. Colourations of individual vectors indicate current speed. ....11
Figure 3-8 Monthly surface current rose plots nearby the Yolla Well Head (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive). ....14
Figure 3-9 Total surface current rose plot nearby the Yolla Well Head (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive). ....15
Figure 3-10 Monthly surface current rose plots nearby the MDO and Pipeline release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive). ....16
Figure 3-11 Total surface current rose plot nearby the MDO and Pipeline release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive). ....17
Figure 4-1 Spatial resolution of the CFSR modelled wind data used as input into the oil spill model. ....18
Figure 4-2 Modelled monthly wind rose distributions from 2010–2019 (inclusive) for the node nearby the Yolla Well Head. ....20
Figure 4-3 Modelled total wind rose distributions from 2010–2019 (inclusive) for the node nearby the Yolla Well Head. ....21

Figure 4-4 Modelled monthly wind rose distributions from 2010–2019 (inclusive) for the node nearby the MDO and Pipeline release location. ....22
Figure 4-5 Modelled total wind rose distributions from 2010–2019 (inclusive) for the node nearby the MDO and Pipeline release location. ....23
Figure 5.1 Temperature and salinity profiles nearby the Yolla Well Head. ....25
Figure 5.2 Temperature and salinity profiles nearby the MDO and Pipeline release location. ....26
Figure 6-1 Schematic of the various stages of the plume in the water column (Source: ASA, 2011). ....27
Figure 6-2 Plot of time-varying release rate for the Yolla Well Head release location. ....28
Figure 8-1 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oil Spill Solutions, 2015). ....31
Figure 10-1 Proportional mass balance plot representing the weathering of Yolla condensate spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature. ....38
Figure 10-2 Proportional mass balance plot representing the weathering of Yolla condensate spilled onto the water over 1 hour and subject to variable wind speeds (1-12 knots or 1.9-23 m/s) at 15°C water temperature. ....38
Figure 10-3 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature. ....39
Figure 10-4 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to variable wind speeds (1-12 knots) at 15°C water temperature. ....39
Figure 13-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head during summer conditions. ....45
Figure 13-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head during winter conditions. ....46
Figure 13-3 Zones of potential floating oil exposure in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....50
Figure 13-4 Zones of potential floating oil exposure in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....51
Figure 13-5 Probability of floating oil exposure above 1 g/m$^2$, in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....52
Figure 13-6 Probability of floating oil exposure above 1 g/m$^2$, in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....53
Figure 13-7 Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....54
Figure 13-8 Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....55
Figure 13-9 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....61
Figure 13-10 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at

the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....62
Figure 13-11 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....63
Figure 13-12 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....64
Figure 13-13 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....65
Figure 13-14 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....66
Figure 13-15 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....67
Figure 13-16 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....68
Figure 13-17 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....69
Figure 13-18 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....70
Figure 13-19 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....79
Figure 13-20 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....80
Figure 13-21 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....81
Figure 13-22 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....82
Figure 13-23 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a

loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....83
Figure 13-24 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....84
Figure 13-25 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....85
Figure 13-26 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions. ....86
Figure 13-27 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....87
Figure 13-28 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions. ....88
Figure 14-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore during summer conditions. ....90
Figure 14-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore during winter conditions. ....91
Figure 14-3 Zones of potential floating oil exposure in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....95
Figure 14-4 Zones of potential floating oil exposure in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....96
Figure 14-5 Probability of floating oil exposure above 1 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....97
Figure 14-6 Probability of floating oil exposure above 1 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....98
Figure 14-7 Probability of floating oil exposure above 10 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....99
Figure 14-8 Probability of floating oil exposure above 10 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....100
Figure 14-9 Probability of floating oil exposure above 50 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....101
Figure 14-10 Probability of floating oil exposure above 50 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....102

Figure 14-11Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. .....103
Figure 14-12Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. .....104
Figure 14-13Minimum time before floating oil exposure above 10 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. .....105
Figure 14-14Minimum time before floating oil exposure above 10 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. .....106
Figure 14-15Minimum time before floating oil exposure above 50 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. .....107
Figure 14-16Minimum time before floating oil exposure above 50 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. .....108
Figure 14-17Maximum potential shoreline loading in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. .....111
Figure 14-18Maximum potential shoreline loading in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. .....112
Figure 14-19Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. .....118
Figure 14-20Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. .....119
Figure 14-21Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. .....120
Figure 14-22Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. .....121
Figure 14-23Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. .....122
Figure 14-24Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. .....123
Figure 14-25Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. .....124

Figure 14-26Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....125
Figure 14-27Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....126
Figure 14-28Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....127
Figure 14-29Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....1
Figure 14-30Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....2
Figure 14-31Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....3
Figure 14-32Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....4
Figure 14-33Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....5
Figure 14-34Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....6
Figure 14-35Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....7
Figure 14-36Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions. ....8
Figure 14-37Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....9
Figure 14-38Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter conditions. ....10

Figure 15-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore during summer conditions. ....12
Figure 15-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore during winter conditions. ....13
Figure 15-3 Zones of potential floating oil exposure in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....17
Figure 15-4 Zones of potential floating oil exposure in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....18
Figure 15-5 Probability of floating oil exposure above 1 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....19
Figure 15-6 Probability of floating oil exposure above 1 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....20
Figure 15-7 Probability of floating oil exposure above 10 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....21
Figure 15-8 Probability of floating oil exposure above 10 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....22
Figure 15-9 Probability of floating oil exposure above 50 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....23
Figure 15-10 Probability of floating oil exposure above 50 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....24
Figure 15-11 Minimum time before floating oil exposure above 1 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....25
Figure 15-12 Minimum time before floating oil exposure above 1 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....26
Figure 15-13 Minimum time before floating oil exposure above 10 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....27
Figure 15-14 Minimum time before floating oil exposure above 10 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....28
Figure 15-15 Minimum time before floating oil exposure above 50 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....29
Figure 15-16 Minimum time before floating oil exposure above 50 $g/m^2$, in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....30
Figure 15-17 Maximum potential shoreline loading in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....33

Figure 15-18Maximum potential shoreline loading in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....34
Figure 15-19Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....40
Figure 15-20Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....41
Figure 15-21Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....42
Figure 15-22Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....43
Figure 15-23Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....44
Figure 15-24Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....45
Figure 15-25Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....46
Figure 15-26Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....47
Figure 15-27Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....48
Figure 15-28Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....49
Figure 15-29Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....1
Figure 15-30Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....2
Figure 15-31Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....3

Figure 15-32 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....4
Figure 15-33 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....5
Figure 15-34 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....6
Figure 15-35 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....7
Figure 15-36 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions. ....8
Figure 15-37 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions. ....9
Figure 15-38 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions ....10

# TERMS AND ABBREVIATIONS

| | |
|---|---|
| AMP | Australian Marine Park |
| AMSA | Australian Maritime Safety Authority |
| ANZECC | Australian and New Zealand Environment and Conservation Council |
| API | American Petroleum Institute gravity. A measure of how heavy or light a petroleum liquid is compared to water. |
| ARMCANZ | Agriculture and Resource Management Council of Australia and New Zealand |
| BIA | Biologically Important Areas |
| Bonn Agreement | An agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983, includes: Governments of the Kingdom of Belgium, the Kingdom of Denmark, the French Republic, the Federal Republic of Germany, the Republic of Ireland, the Kingdom of the Netherlands, the Kingdom of Norway, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland and the European Union. |
| BP | Boiling point. The temperature at which the vapor pressure of the liquid is equal to the pressure exerted on it by the surrounding atmosphere |
| BTEX | Benzene, Toluene, Ethylbenzene, and Xylenes |
| Decay | The process where oil components are changed either chemically or biologically (biodegradation) to another compound. It includes breakdown to simpler organic carbon compounds by bacteria and other organisms, photo-oxidation by solar energy, and other chemical reactions. |
| Deterministic (single) oil spill modelling | Oil spill modelling involving a computer simulation of a single hypothetical oil spill event subject to a single sequence of wind, current and other sea conditions over time. Single oil spill modelling, also referred to as “deterministic modelling” provides a simulation of one possible outcome of a given spill scenario, subject to the metocean conditions that are imposed. Single oil spill modelling is commonly used to consider the fate and effects of ‘worst-case’ oil spill scenarios that are carefully selected in consideration of the nature and scale of the offshore petroleum activity and the local environment (NOPSEMA, 2017). Because the outcomes of a single oil spill simulation can only represent the outcome of that scenario under one sequence of metocean conditions, worst-case conditions are often identified from stochastic modelling. It is impossible to calculate the likelihood of any outcome from a single oil spill simulation. Single oil spill modelling is generally used for response planning, preparedness planning and for supporting oil spill response operations in the event of an actual spill |
| Dynamic viscosity | The dynamic viscosity of a fluid expresses its resistance to shearing flows, where adjacent layers move parallel to each other with different speeds. |
| Floating oil exposure | Contact by floating oil on the sea surface at concentrations equal to or exceeding defined threshold concentrations. The consequence will vary depending on the threshold and the receptors |
| HYCOM | Hybrid Coordinate Ocean Model. A data-assimilative, three-dimensional ocean model |
| HYDROMAP | Advanced ocean/coastal tidal model used to predict tidal water levels, current speed and current direction. |
| IMCRA | Integrated marine and coastal regionalisation areas |
| KEF | Key Ecological Feature |
| LGA | Local Government Areas |
| MAHs | Monoaromatic Hydrocarbons |
| MNP | Marine National Park |
| MP | Marine Park |
| MS | Marine Sanctuary |
| NOPSEMA | National Offshore Petroleum Safety and Environmental Management Authority |
| NP | National Park |

| | |
|---|---|
| NR | Nature Reserve |
| PAH | Polycyclic? Aromatic Hydrocarbons |
| Pour Point | The pour point of a liquid is the temperature below which the liquid loses its flow characteristics |
| Ramsar site | A site listed under the Ramsar Convention on wetlands which is an international intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources. |
| RSB | Reefs, Shoals and Banks |
| Shoreline accumulation | Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations. Shoreline contact is judged for floating oil arriving within a 2 km buffer zone from any shoreline as a conservative measure |
| SIMAP | Spill Impact Model Application Package. SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for surface or subsea releases |
| Stochastic (multiple) oil spill modelling | Stochastic oil spill modelling is created by overlaying and statistically analysing the outcomes of many single oil-spill simulations of a defined spill scenario, where each simulation was subject to a different sequence of metocean conditions, selected objectively (typically by random selection) from a long sequence of historic conditions for the study area. Analysis of this larger set of simulations provides a more accurate indication of the environment that maybe affected (EMBA) and indicates which locations are more likely to be affected (as well as other statistics). Stochastic oil spill modelling avoids biases that affect single oil spill modelling (due to the reliance on only one possible sequence of conditions). However, when interpreting stochastic modelling, which is based on a wide range of potential conditions that might happen to occur, it is essential to understand that calculations will encompass a much larger area than could be affected in any single spill event, where a more limited set of conditions will occur. Consequently, it is misleading to imply that the region derived from stochastic modelling indicate the outcomes expected from a single spill event (NOPSEMA, 2017) Stochastic modelling is generally used for risk assessment and preparedness planning by indicating locations that could be exposed and may require response or subsequent impact assessment |
| Shoreline accumulation | Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations. |

# EXECUTIVE SUMMARY

## Background

Beach Energy (Beach) is updating their Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP) for operations in the Yolla field. This field is situated within production licence T/L1, located 147 km south of Kilcunda (Victoria) in Bass Strait. Hence, RPS was commissioned to conduct an oil spill modelling study which considered the following hypothetical scenarios:

- A 70,489 bbl (~11,207 $m^3$) subsea release of Yolla condensate over 86 days at the Yolla Platform due to a loss of well control;
- A 14,500 bbl (~2,305 $m^3$) subsea release of Yolla condensate over 36 minutes at a location 3 nm away from the shore; and
- A 300 $m^3$ surface release of Marine Diesel Oil (MDO) over 6 hours at a location 3 nm away from the shore.

The modelling assessment was undertaken on a seasonal basis as follows:

- Summer (November through to March); and
- Winter (April to October).

The purpose of the modelling is to provide an understanding of a conservative 'outer envelope' of the potential area that may be affected in the unlikely event of hydrocarbon spill. The modelling does not take into consideration any of the spill prevention, mitigation and response strategies that would be implemented in response to a spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbon may influence.

The spill modelling was performed using an advanced three-dimensional trajectory and fates model; Spill Impact Model Application Program (SIMAP). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

## Methodology

The modelling study was carried out in several stages. Firstly, a 10-year wind and current dataset (2010–2019) was generated and the currents included the combined influence of three-dimensional large-scale ocean currents and tidal currents. Secondly, the currents, winds and detailed hydrocarbon characteristics were used as inputs in the three-dimensional oil spill model (SIMAP) to simulate the drift, spread, weathering and fate of the spilled hydrocarbons.

As spills can occur during any set of wind and current conditions, modelling was conducted using a stochastic (random or non-deterministic) approach, which involved running 100 randomly selected single trajectory simulations per season, with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This ensured that each spill simulation was subject to a unique set of wind and current conditions.

The SIMAP system, the methods and analysis presented herein, use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 "*Standard Practice for Development and Use of Oil Spill Models*".

## Oil Properties

The Yolla condensate has an API of 52.5 and a density of 770.6 kg/$m^3$ (at 15ºC) with a viscosity value (0.14 cP) classifying it as a Group I (not-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2020) and US EPA/USCG classifications.

The condensate is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 80.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C), a further 12.0% should evaporate within the first 24 hours (180°C < BP < 265°C) and a further 6.6% should evaporate over several days (265°C < BP < 380°C). Approximately 1.4% of the oil is shown to be persistent.

Marine diesel (MDO) has an API of 37.6 and a density of 829.1 kg/$m^3$ (at 25ºC) with a viscosity value (4.0 cP) classifying it as a Group II (light-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2020) and US EPA/USCG classifications.

The MDO is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 6.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C); a further 34.6% should evaporate within the first 24 hours (180°C < BP < 265°C); and a further 54.4% should evaporate over several days (265°C < BP < 380°C). Approximately 5.0% of the oil is shown to be persistent.

## Results

A detailed summary of the results for all modelled scenarios is provided in the table below.

**Summary of key results**

| Scenario description | | Subsea LOWC | Subsea pipeline rupture | Surface MDO release |
|---|---|---|---|---|
| **Spill volume** | | 70,489 bbl | 14,500 bbl | 300 $m^3$ |
| **Oil type** | | Yolla condensate | Yolla condensate | MDO |
| **Release depth** | | Subsea (70 m) | Subsea (50 m) | Surface |
| **Release duration** | | 86 days | 36 minutes | 6 hours |
| **Simulation length** | | 100 days | 10 days | 30 days |
| **Floating Oil Exposure** | Maximum distances from the release location to floating oil exposure thresholds | The maximum distances from the release location to the low (1–10 g/$m^2$) exposure zones were 3 km (West-Northwest) both during winter conditions. No exposure was predicted for the moderate (10–50 g/$m^2$) and high thresholds (> 50 g/$m^2$). | The maximum distances from the release location to the low (1–10 g/$m^2$), moderate (10–50 g/$m^2$) and high (> 50 g/$m^2$) exposure zones were 13.03 km (south-southwest, summer) and 4.58 km (west-northwest, summer) and 0.46 km (southwest, both seasons). | The maximum distances from the release location to the low (1–10 g/$m^2$), moderate (10–50 g/$m^2$) and high (> 50 g/$m^2$) exposure zones were 49.27 km (east-southeast, winter), 8.21 km (west, summer) and 4.45 km (west-southwest, winter). |
| | Highest probability of floating oil exposure to a receptor at, or above, 1 g/$m^2$ | Only the receptors that the Yolla Well Head resides within forecast to reveal floating oil exposure above the low threshold. | Various receptors, including Kilcunda nearshore waters and South-east, 100 % - summer and winter. | Little Penguin - Foraging (Buffer around Phillip Island) BIA, 69% - summer |
| | Quickest time before exposure to a receptor at, or above, 1 g/$m^2$ | Only the receptors that the Yolla Well Head resides within forecast to reveal floating oil exposure above the low threshold. | Various receptors, including Kilcunda nearshore waters and South-east, 0.01 day - summer and winter. | Little Penguin - Foraging (Buffer around Phillip Island) BIA, 0.06 days - summer |
| **Shoreline Oil Accumulation** | Probability of oil accumulation on **any** shoreline at, or above, 10 g/$m^2$ | NC | Summer – 66%<br>Winter – 84% | Summer – 94%<br>Winter – 100% |
| | Absolute minimum time for oil to accumulate on shoreline cells at, or above, 10 g/$m^2$ | NC | Summer – 0.52 days<br>Winter – 0.59 days | Summer – 0.51 days<br>Winter – 0.48 days |
| | Maximum volume of oil ashore from a single spill simulation at, or above, 10 g/$m^2$ | NC | Summer – 24.70 $m^3$<br>Winter – 23.71 $m^3$ | Summer – 51.64 $m^3$<br>Winter – 98.73 $m^3$ |
| | Highest probability of oil accumulation for a specific shoreline cell at, or above, 10 g/$m^2$ | NC | Venus Bay, 60% - winter | Venus Bay, 84% - winter |

| Scenario description | | Subsea LOWC | Subsea pipeline rupture | Surface MDO release |
|---|---|---|---|---|
| | Maximum volume of oil ashore from a single spill simulation for a specific shoreline cell at, or above, 10 g/m$^2$ | NC | Kilkunda, 24.7 m$^3$ - summer | Kilkunda, 93.0 m$^3$ - winter |
| **Dissolved Hydrocarbons** | Maximum distances from the release location to dissolved hydrocarbon exposure thresholds | Maximum distances to the low (10 ppb) and moderate (50 ppb) thresholds may reach 68.01 km (southeast, winter) and 59.68 km (southeast, winter) respectively. | Maximum distances to the low (10 ppb) and moderate (50 ppb) thresholds may reach 8.16 km (southeast, winter) and 2.77 km (west-northwest) respectively. | Maximum distances to the low (10 ppb) and moderate (50 ppb) thresholds may reach 12.92 km (east-southeast, both seasons) and 1.39 km (south-southeast, winter) respectively. |
| | Highest probability of dissolved hydrocarbon exposure to a receptor at, or above, 10 ppb | Only the receptors that the Yolla Well Head resides within revealed dissolved hydrocarbon exposure to the low and moderate thresholds. | Little Penguin - Foraging (Buffer around Phillip Island) and White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) BIAs, 2% - summer | Little Penguin - Foraging (Buffer around Phillip Island) BIA, 21% - summer |
| | Quickest time before exposure to a receptor at, or above, 10 ppb | Only the receptors that the Yolla Well Head resides within revealed dissolved hydrocarbon exposure to the low and moderate thresholds. | Little Penguin - Foraging (Buffer around Phillip Island) BIA, 0.18 days - summer | Little Penguin - Foraging (Buffer around Phillip Island) BIA, 0.11 days - winter |
| **Entrained Hydrocarbons** | Maximum distances from the release location to entrained hydrocarbons exposure thresholds | Maximum distances to the 10 ppb and 100 ppb thresholds may reach 552.28 km (northeast, winter) and 7.59 km (east-southeast, winter) respectively. | Maximum distances to the 10 ppb and 100 ppb thresholds may reach 80.2 km (east-southeast, winter) and 47.43 km (east-southeast, summer) respectively. | Maximum distances to the 10 ppb and 100 ppb thresholds may reach 117.97 km (east-southeast, winter) and 90.11 km (east-southeast, winter) respectively. |
| | Highest probability of entrained hydrocarbon exposure to a receptor at, or above, 10 ppb | Southeast Shelf Transition IMCRA and the Tasmanian State Waters, 24% - summer<br>Southeast Shelf Transition IMCRA, 24% - winter | Kilcunda, 88% - winter | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promotory) BIA, White Shark - Distribution (Between the 60-120m depth contour) BIA and the Kilcunda, 99% - winter |
| | Quickest time before exposure to a receptor at, or above, 10 ppb | Little Penguin - Foraging (North-western edge of Cape Barren Island) BIA, White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) BIA, Flinders IMCRA-MESO, Southeast Shelf Transition IMCRA-PROV, North NRM Region (TAS) NRMR and Tasmanian State Waters 46.93 days - winter | Little Penguin - Foraging (Buffer around Phillip Island) BIA, 0.05 days - summer | Little Penguin - Foraging (Buffer around Phillip Island) BIA, 0.04 days - winter |

NC: No contact to receptor predicted for specified threshold.

# 1 INTRODUCTION

## 1.1 Background

Beach Energy (Beach) is updating their Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP) for operations in the Yolla field. This field is situated within production licence T/L1, located 147 km south of Kilcunda (Victoria) in Bass Strait. Hence, RPS was commissioned to conduct an oil spill modelling study which considered the following hypothetical scenarios:

- A 70,489 bbl (~11,207 $m^3$) subsea release of Yolla condensate over 86 days at the Yolla Platform due to a loss of well control;
- A 14,500 bbl (~2,305 $m^3$) subsea release of Yolla condensate over 36 minutes at a location 3 nm away from the shore; and
- A 300 $m^3$ surface release of Marine Diesel Oil (MDO) over 6 hours at a location 3 nm away from the shore.

The modelling assessment was undertaken on a seasonal basis as follows:

- Summer (November through to March); and
- Winter (April to October).

The spill modelling was performed using an advanced three-dimensional trajectory and fates model, SIMAP (Spill Impact Mapping Analysis Program). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties of the oil.

The SIMAP system, the methods and analysis presented herein, use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 “Standard Practice for Development and Use of Oil Spill Models”.

Note that the modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that Origin propose to have in place during the operations. The modelling makes no allowance for intervention following a spill to reduce volumes and/or prevent hydrocarbons from reaching sensitive areas.

**Table 1.1 Location of the release sites used for the dispersion modelling assessment.**

| Release site | Latitude | Longitude | Depth (m) |
|---|---|---|---|
| Yolla Platform | 39° 50’ 45.9” S | 145° 49’ 1.4” E | 70 |
| MDO and Pipeline | 38° 37’ 7.58” S | 145° 27’ 47.7” E | 50 |

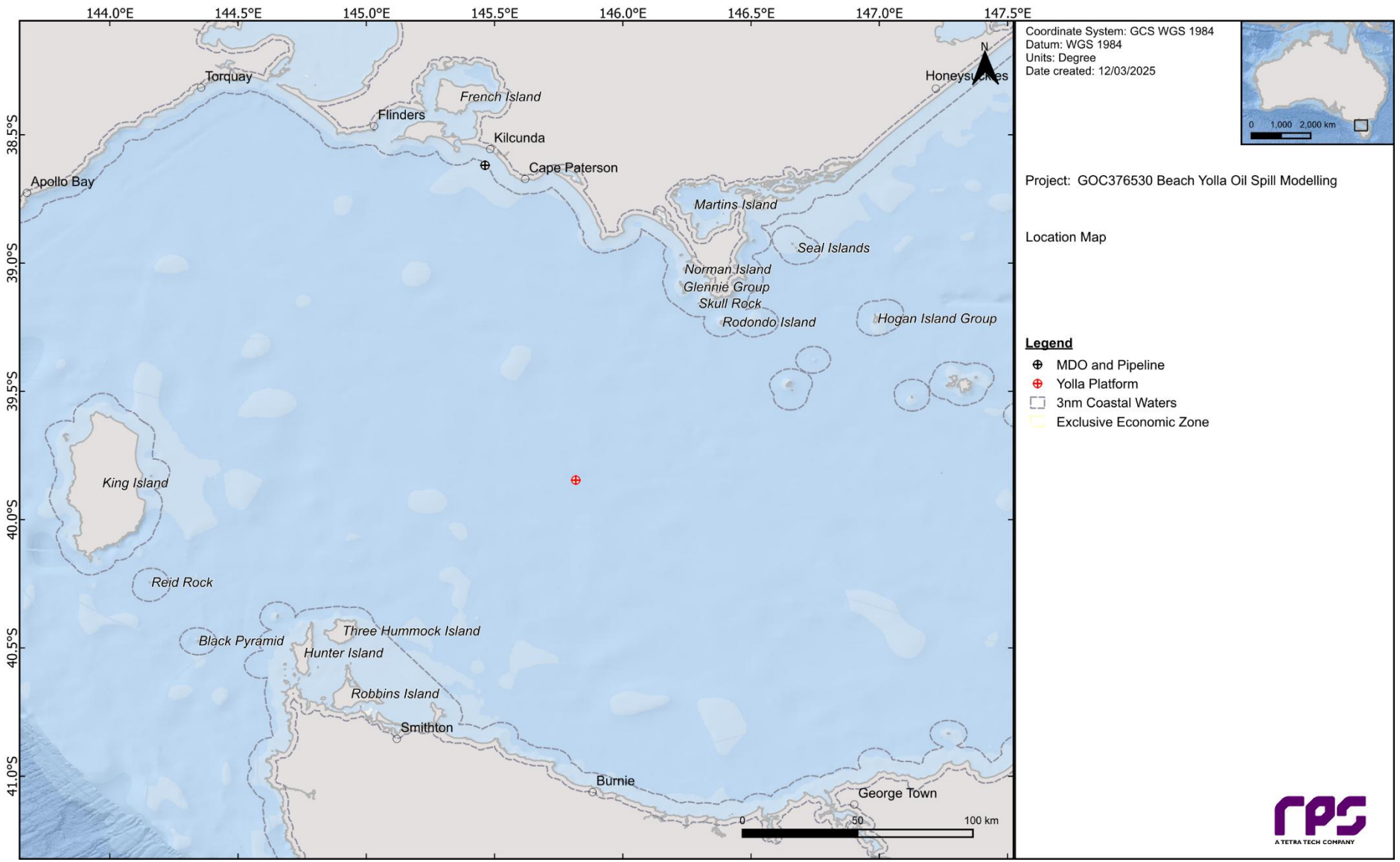


**Figure 1.1 Location of the hypothetical spill release sites as used in the oil spill modelling.**

# 2 SCOPE OF WORK

The scope of work included the following components:

- Generate 10-years of winds and three-dimensional currents from 2010 to 2019 (inclusive). The currents included the combined influence of tidal and ocean currents.
- Include the wind and current data and characteristics of the released hydrocarbons as input into the three-dimensional oil spill model (SIMAP), to model the movement, spreading, weathering and shoreline contact by hydrocarbons over time.
- Use SIMAP's stochastic model (also known as a probability model) to calculate exposure to surrounding waters and shorelines. This involved running 100 randomly selected single trajectory simulations per season, with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This ensured that each spill simulation was subject to a unique set of wind and current conditions.
- Assess modelling to determine the exposure to surrounding waters and contact to shorelines based upon thresholds.

# 3 REGIONAL CURRENTS

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area off the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the strait are primarily driven by tides, winds, incident continental shelf waves and density driven flows; high winds and strong tidal currents are frequent within the area (Jones, 1980).

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 3.1 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with surface tidal currents developed by RPS. The following sections provide a summary of the hybrid regional data set.

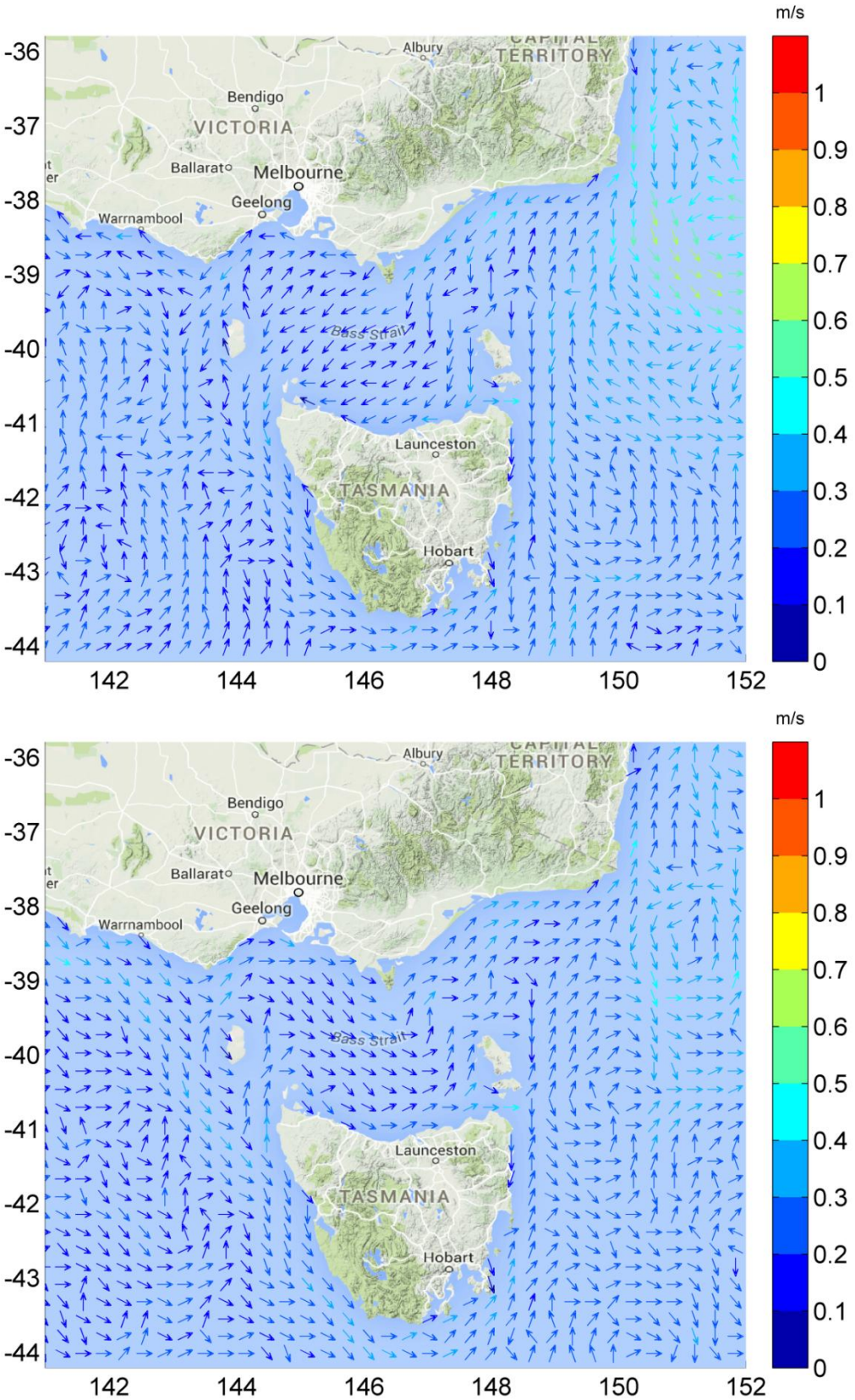


**Figure 3.1 HYCOM averaged seasonal surface drift currents during summer and winter.**

## 3.1 Tidal currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for more than 30 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

### 3.1.1 Grid Setup

RPS has a global tidal model with global coverage. The model is sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids are progressively allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3.2 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 3.3). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

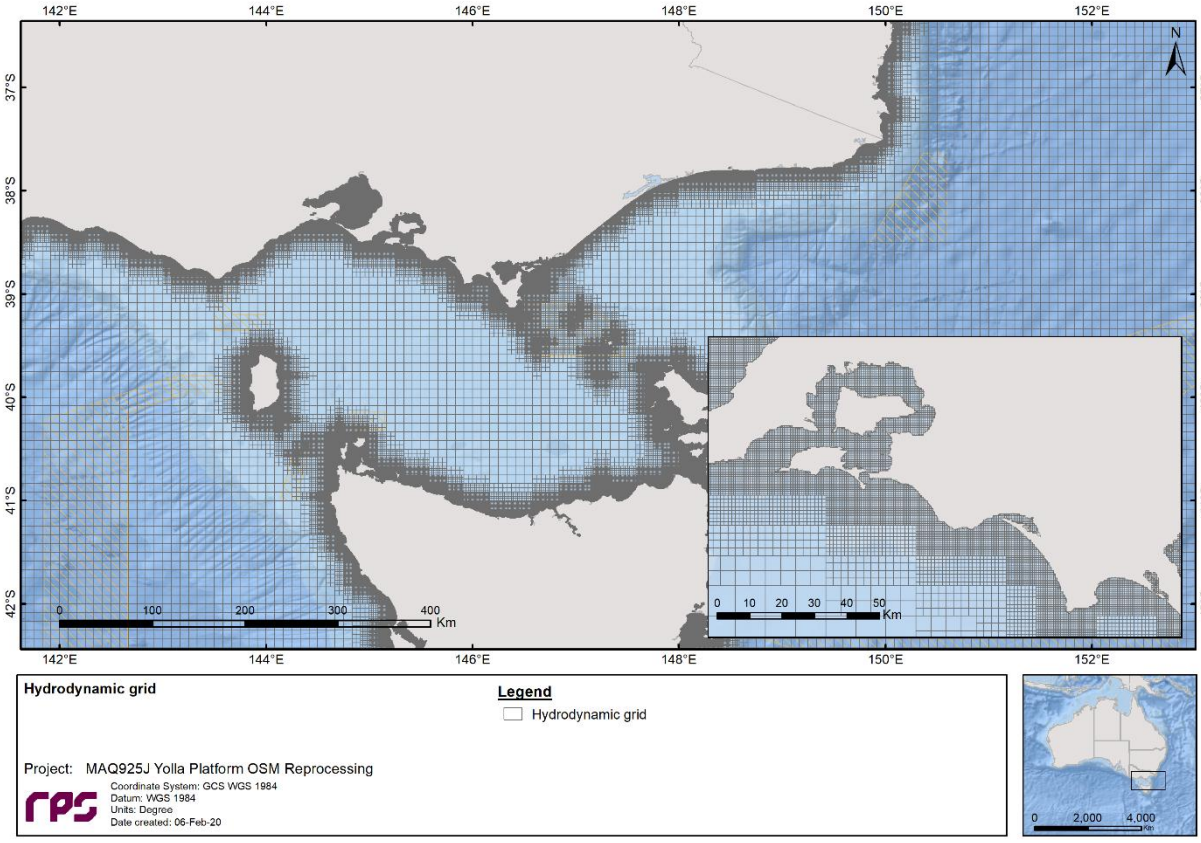


**Figure 3.2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.**

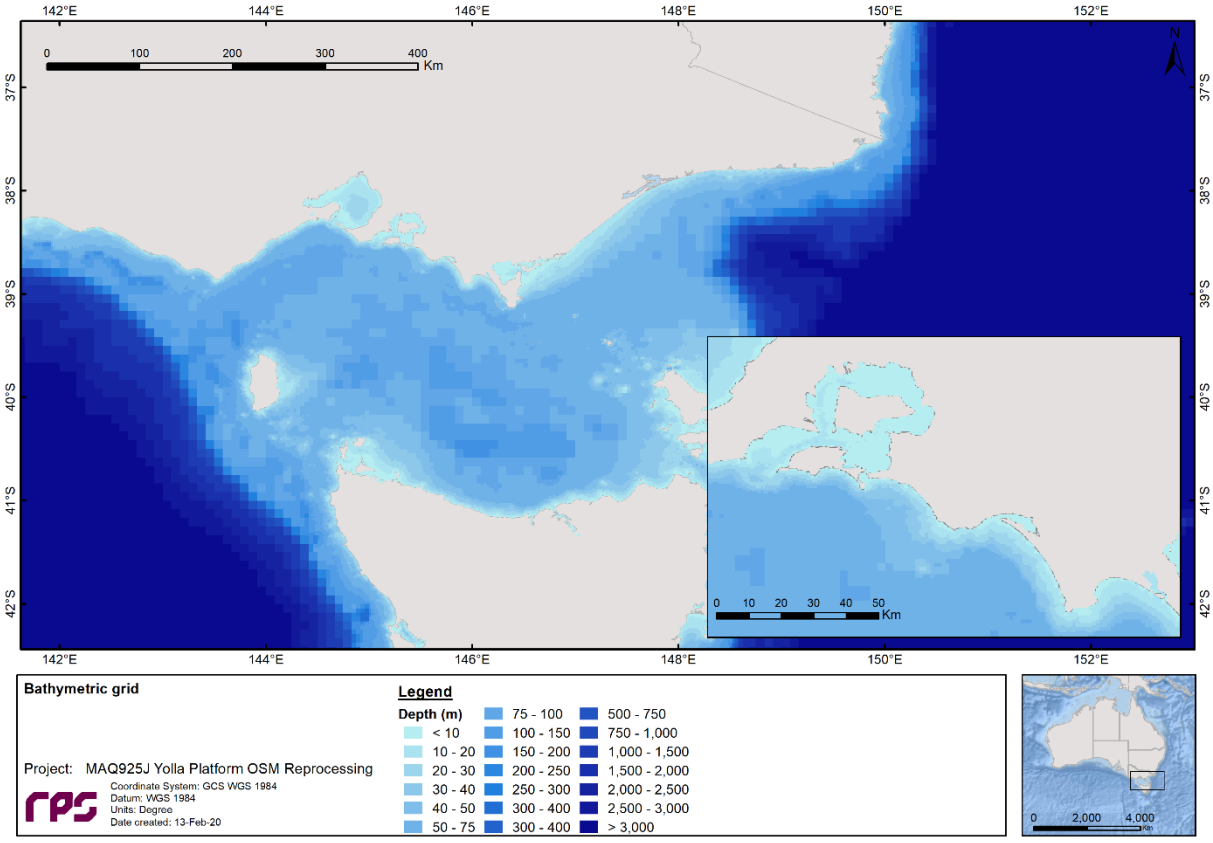


**Figure 3.3 Bathymetry defined throughout the tidal model domain.**

### 3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 8.0) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were $K_2$, $S_2$, $M_2$, $N_2$, $K_1$, $P_1$, $O_1$ and $Q_1$. Using the tidal data, time series surface heights were calculated along the open boundaries for the simulation period.

The Topex/Poseidon satellite data has a resolution of 0.25 degrees globally, with higher resolution in coastal regions, and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The data capturing satellites, equipped with two altimeters capable of taking sea level measurements accurate to less than ± 5 cm, measured oceanic surface elevations (and the resultant tides) for the period 1992–2005. In total these satellites carried out 62,000 orbits of the planet. The Topex-Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen 2010). The Topex/Poseidon tidal data is considered suitably accurate for this study.

### 3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at a location situated within the study area (Figure 3.4).

To provide a statistical measure of the model performance, the Index of Agreement (IOA – Willmott, 1981) and the Mean Absolute Error (MAE – Willmott, 1982; Willmott & Matsuura, 2005) were used.

The MAE (Eq.1) is simply the average of the absolute values of the difference between the model-predicted (P) and observed (O) variables. It is a more natural measure of the average error (Willmott and Matsuura, 2005) and more readily understood. The MAE is determined by:

$$MAE = N^{-1} \sum_{i=1}^{N} |P_i - O_i| \qquad \text{Eq.1}$$

Where: $N$ = Number of observations

$P_i$ = Model predicted surface elevation

$O_i$ = Observed surface elevation

The Index of Agreement (IOA; Eq. 2) in contrast, gives a non-dimensional measure of model accuracy or performance. A perfect agreement between the model predicted and observed surface elevations exists if the index gives an agreement value of 1, and complete disagreement between model and observed surface elevations will produce an index measure of 0 (Wilmott, 1981). Willmott et al (1985) also suggests that values larger than 0.5 may represent good model performance. The IOA is determined by:

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: $X_{model}$ = Model predicted surface elevation

$X_{obs}$ = Observed surface elevation

Clearly, a greater IOA and lower MAE represent a better model performance.

Figure 3.5 and Figure 3.6 illustrate a comparison of the predicted and observed surface elevations in February 2017. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

Table 3.1 shows the IOA and MAE values for the selected tide station locations indicating that the model is performing well.

**Table 3.1 Statistical comparison between the observed and HYDROMAP predicted surface elevations.**

| Tide Station | IOA | MAE (m) |
|---|---|---|
| Gabo Island | 0.98 | 0.08 |
| Port MacDonnell | 0.98 | 0.05 |
| Port Welshpool | 0.92 | 0.30 |
| Portland | 0.97 | 0.07 |
| Stack Island | 0.96 | 0.22 |

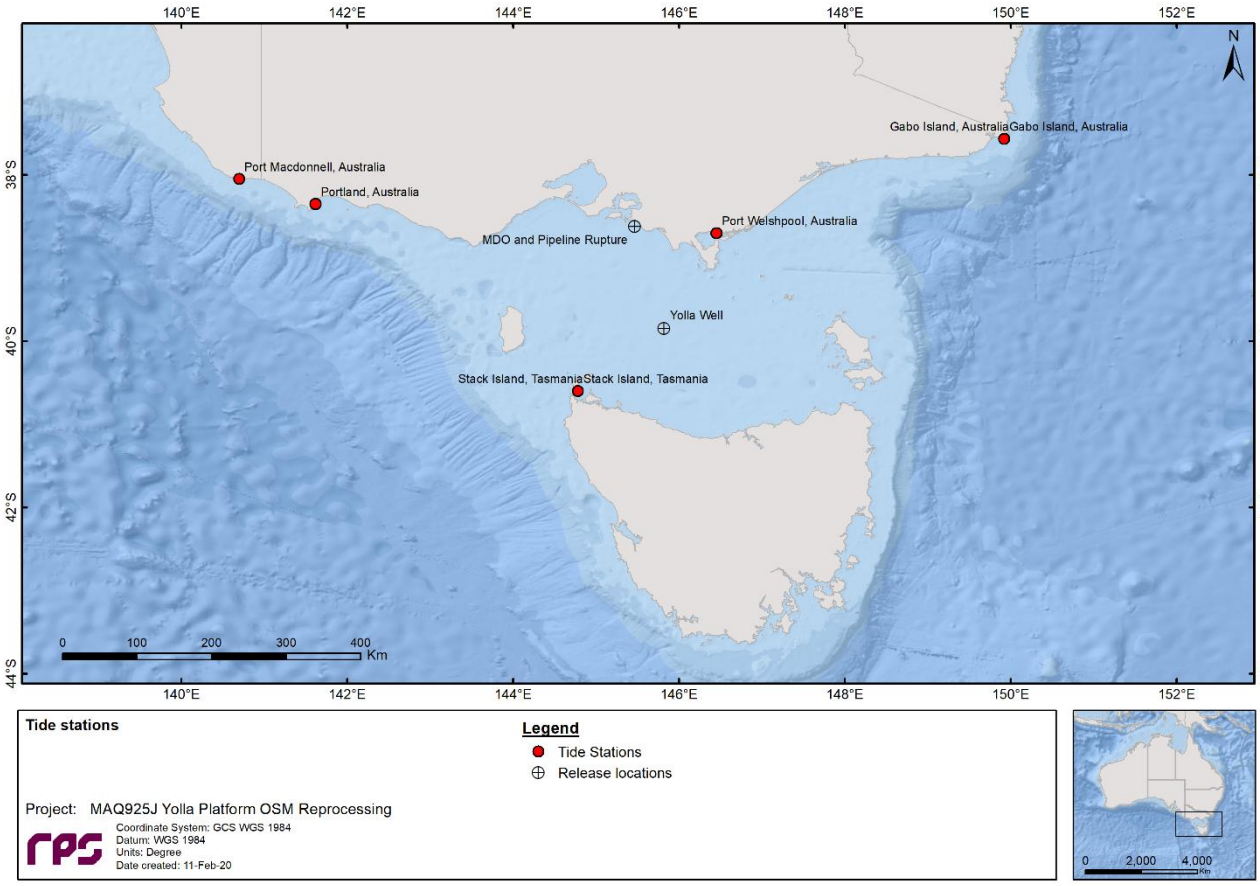


**Figure 3.4 Location of the tide stations used in the surface elevation validation.**

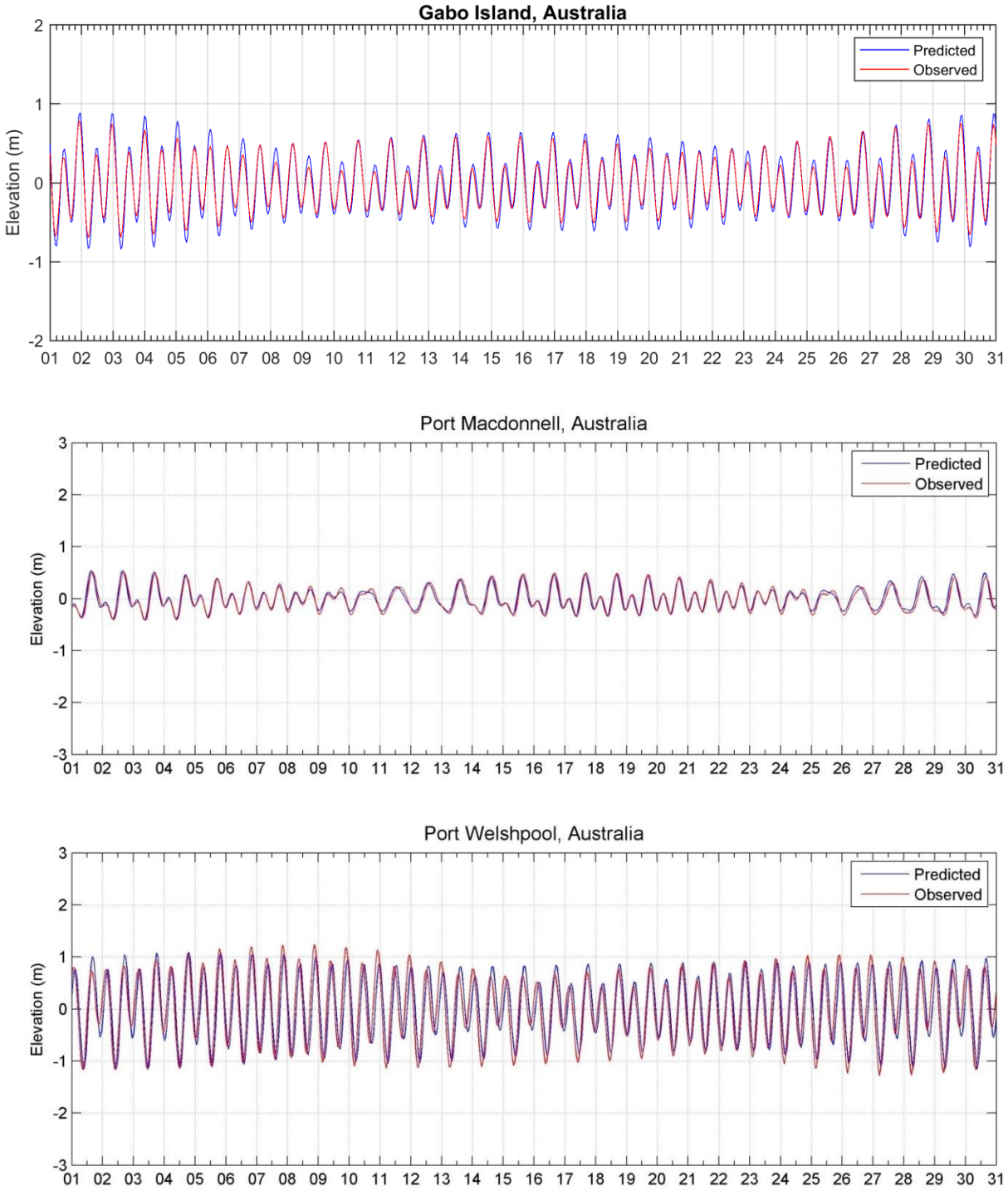


**Figure 3.5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).**

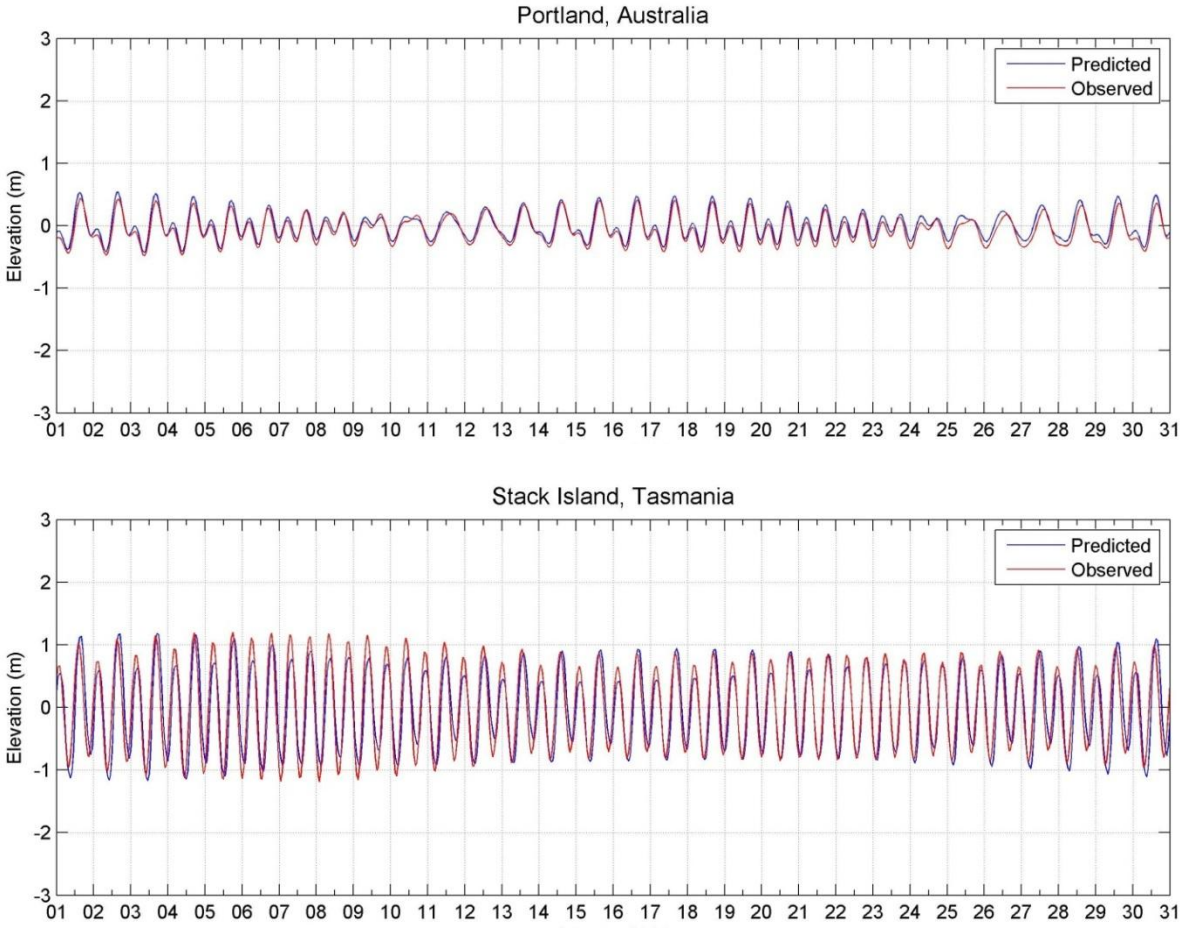


**Figure 3.6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).**

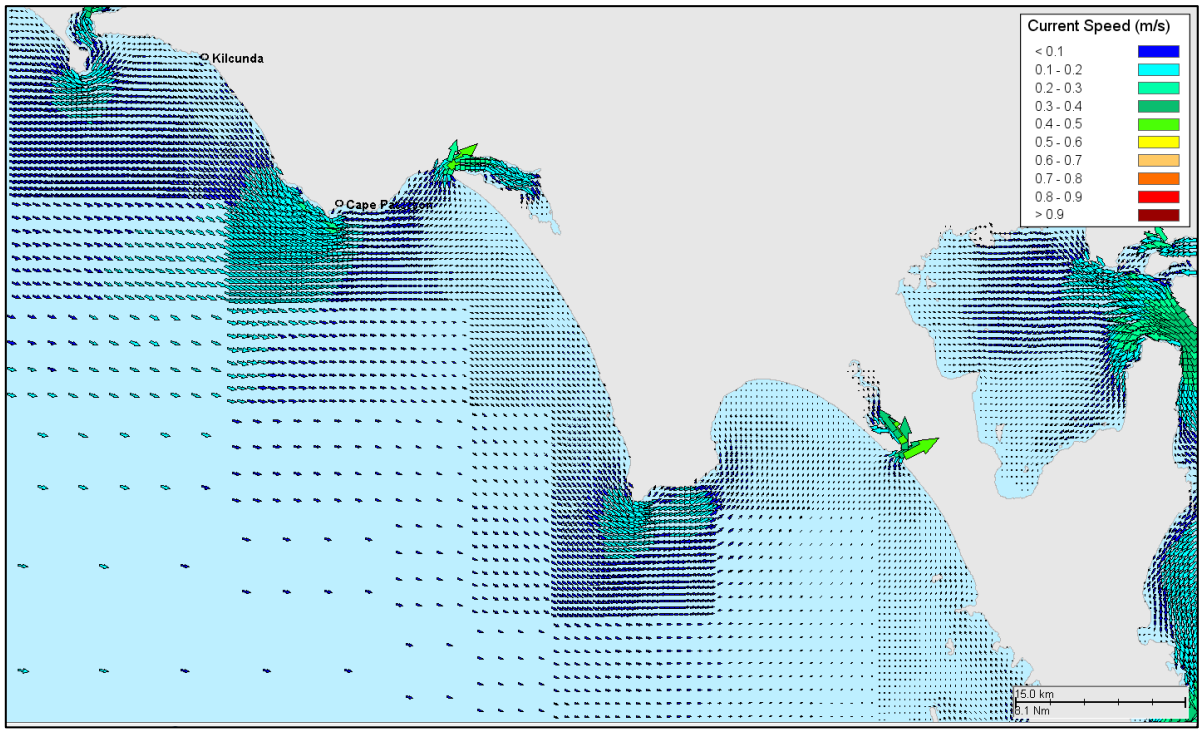


**Figure 3.7 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and shoals. Colourations of individual vectors indicate current speed.**

## 3.2 Ocean Currents

Table 3-2 and Table 3-3 present the monthly average and maximum net surface current speeds nearby the release locations by combining the ocean and tidal currents.

Current speeds near the Yolla Well Head varied throughout the year with monthly maximum current speeds ranging between 0.61 m/s (January) and 0.98 m/s (July). The dominant surface current directions throughout the year were identified as (towards) the east and east-southeast.

Current speeds near the MDO and Pipeline release location varied throughout the year with maximum current speeds ranging between approximately 0.52 m/s (October) and 0.72 m/s (July). The dominant surface current directions throughout the year were identified as (towards) east-southeast.

Figure 3-8 and Figure 3-9 show the monthly and total surface current rose distributions nearby the Yolla Platform.

Figure 3-10 and Figure 3-11 show the monthly and total surface current rose distributions nearby the MDO and Pipeline release location.

Note the convention for defining current direction is the direction the current flows towards, which is used to reference current direction throughout this report. Each branch of the rose represents the currents flowing to that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.1 m/s are predominantly used in these current roses. The length of each coloured segment is relative to the proportion of currents flowing within the corresponding speed and direction.

**Table 3-2** **Predicted monthly average and maximum surface current speeds nearby the Yolla Well Head. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2010–2019 (inclusive).**

| Month | Average current speed (m/s) | Maximum current speed (m/s) | General direction(s) (towards) |
|---|---|---|---|
| January | 0.18 | 0.61 | Varied |
| February | 0.18 | 0.65 | East-west axis |
| March | 0.17 | 0.75 | East |
| April | 0.17 | 0.75 | East-southeast |
| May | 0.20 | 0.96 | East |
| June | 0.19 | 0.80 | East-southeast |
| July | 0.23 | 0.98 | East-southeast |
| August | 0.21 | 0.91 | East |
| September | 0.20 | 0.78 | East |
| October | 0.18 | 0.70 | East |
| November | 0.18 | 0.67 | East-northeast |
| December | 0.19 | 0.63 | East-northeast |
| **Minimum** | **0.17** | **0.61** | - |
| **Maximum** | **0.23** | **0.98** | - |

**Table 3-3** **Predicted monthly average and maximum surface current speeds nearby the MDO and Pipeline release location. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2010–2019 (inclusive).**

| Month | Average current speed (m/s) | Maximum current speed (m/s) | General direction(s) (towards) |
|---|---|---|---|
| January | 0.09 | 0.55 | East-west axis |
| February | 0.10 | 0.58 | East-west axis |
| March | 0.10 | 0.58 | East-west axis |
| April | 0.09 | 0.54 | East-west axis |
| May | 0.12 | 0.59 | East-southeast |
| June | 0.12 | 0.57 | East-southeast |
| July | 0.14 | 0.72 | East-southeast |
| August | 0.13 | 0.54 | East-southeast |
| September | 0.12 | 0.65 | East |
| October | 0.11 | 0.52 | East |
| November | 0.11 | 0.57 | East |
| December | 0.10 | 0.56 | East |
| **Minimum** | **0.09** | **0.52** | - |
| **Maximum** | **0.14** | **0.72** | - |

**Figure 3-8 Monthly surface current rose plots nearby the Yolla Well Head (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).**

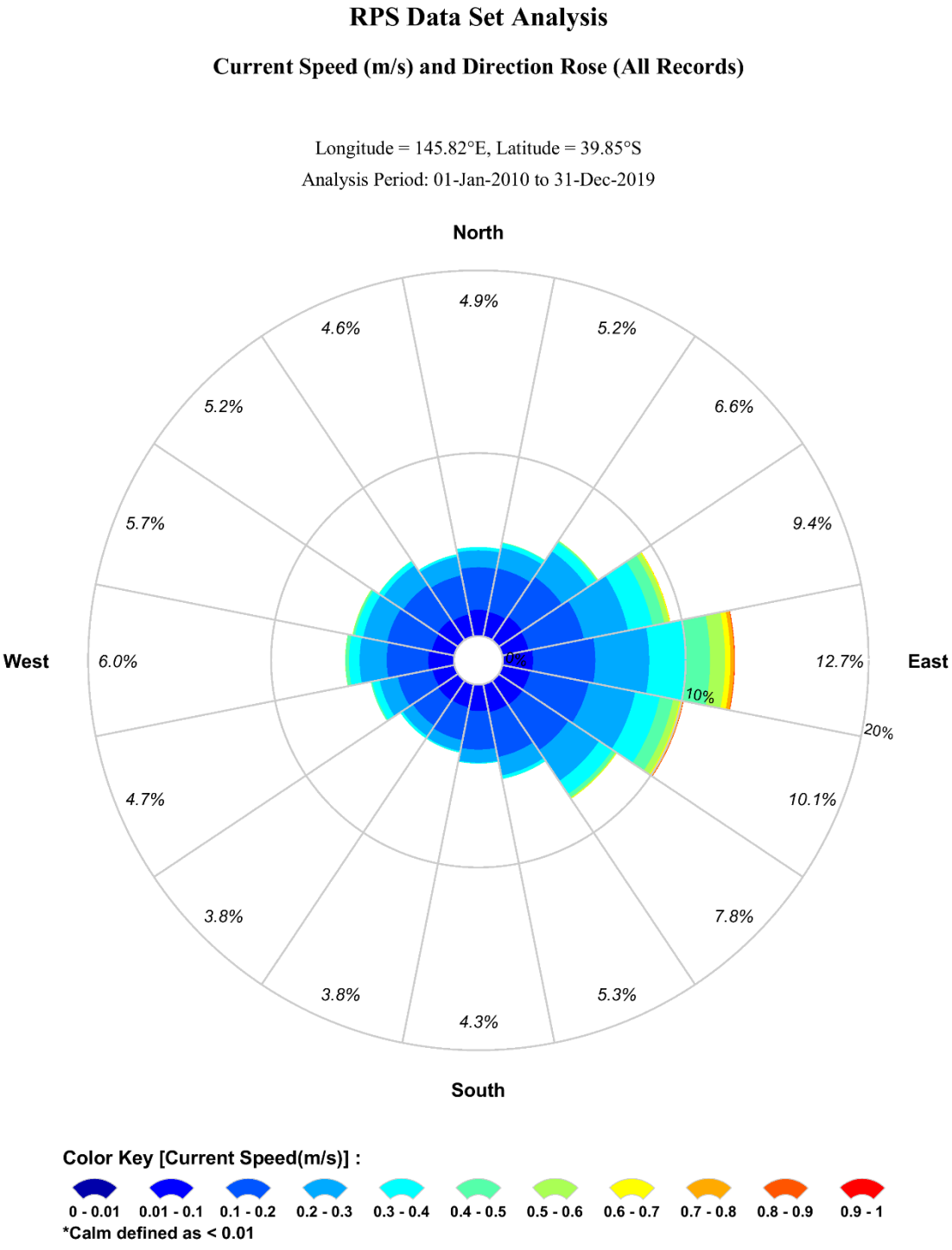


**Figure 3-9 Total surface current rose plot nearby the Yolla Well Head (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).**

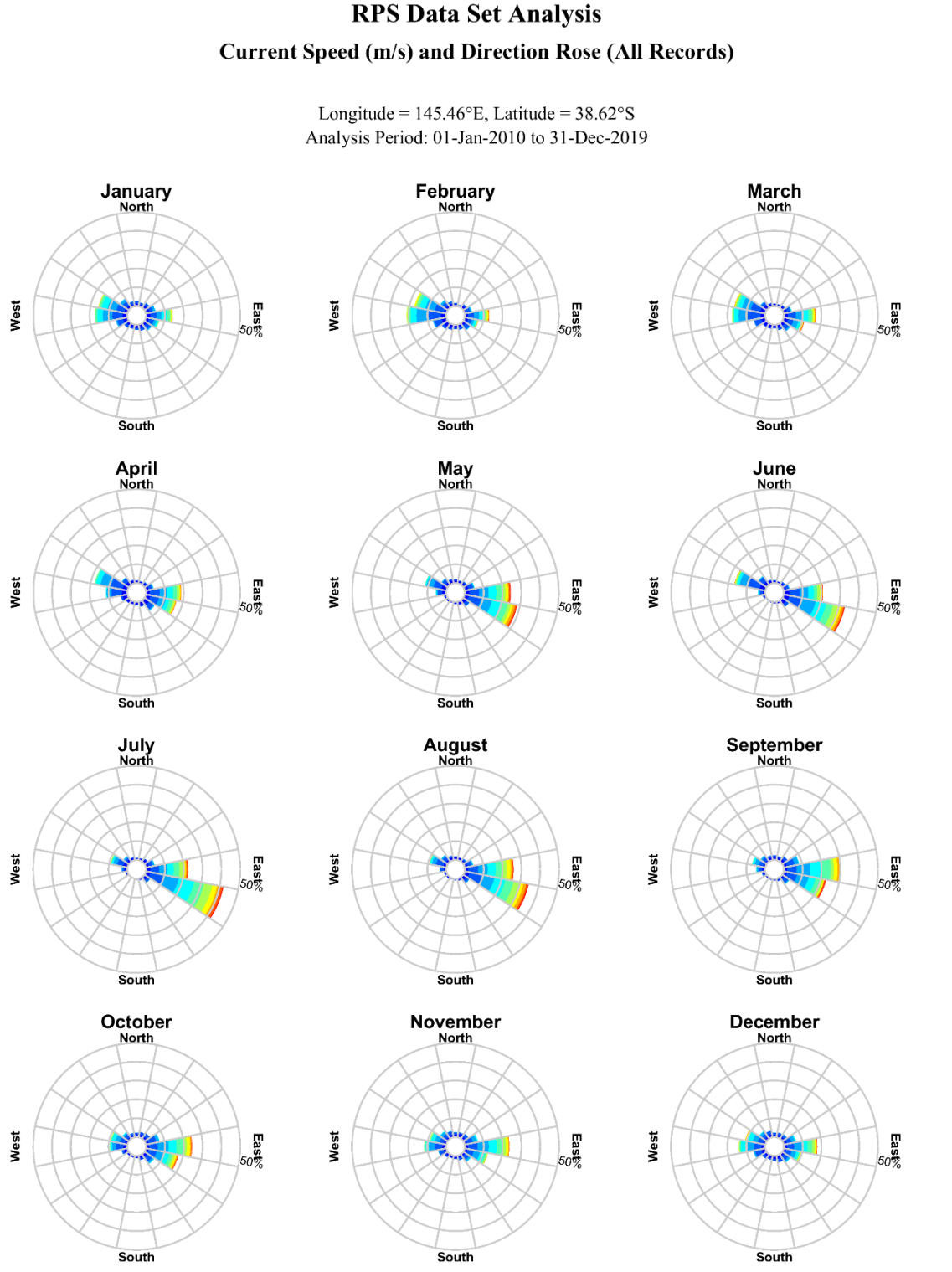


**Figure 3-10 Monthly surface current rose plots nearby the MDO and Pipeline release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).**

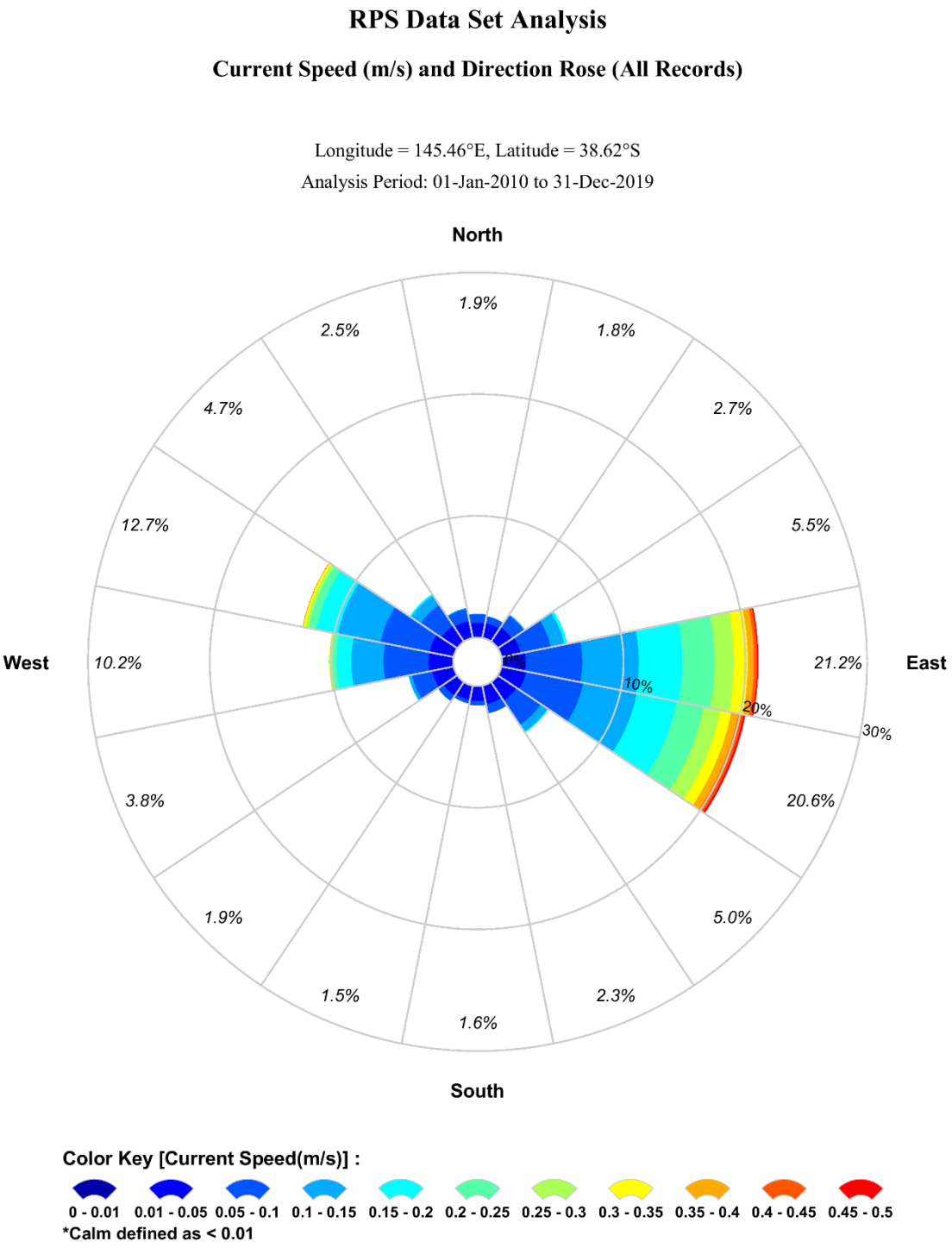


**Figure 3-11 Total surface current rose plot nearby the MDO and Pipeline release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).**

# 4 WIND DATA

High resolution wind data for the years 2010 to 2019 (inclusive) was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis dataset (CFSR; see Saha et al., 2010). The CFSR wind model is a fully coupled, data-assimilative hindcast model representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at ¼ of a degree resolution (~33 km) and 1-hourly time intervals. Figure 4-1 shows the spatial resolution of the wind field used as input into the oil spill model.

Table 4-1 and Table 4-2 present the monthly average and maximum winds derived from a CFSR wind node nearby the Yolla Well Head and the MDO and Pipeline release location, respectively.

The wind data demonstrated for the Yolla Well Head the average monthly wind speeds ranging from 15.5 knots (April) and 19.6 knots (July), whilst maximums ranged from 39.1 knots (January) to 50.2 knots (July).

The wind data demonstrated for MDO and Pipeline release location the average monthly wind speeds ranging from 13.0 knots (April) to 17.4 knots (July) with maximums ranging between 38.5 knots (January) and 47.3 knots (September).

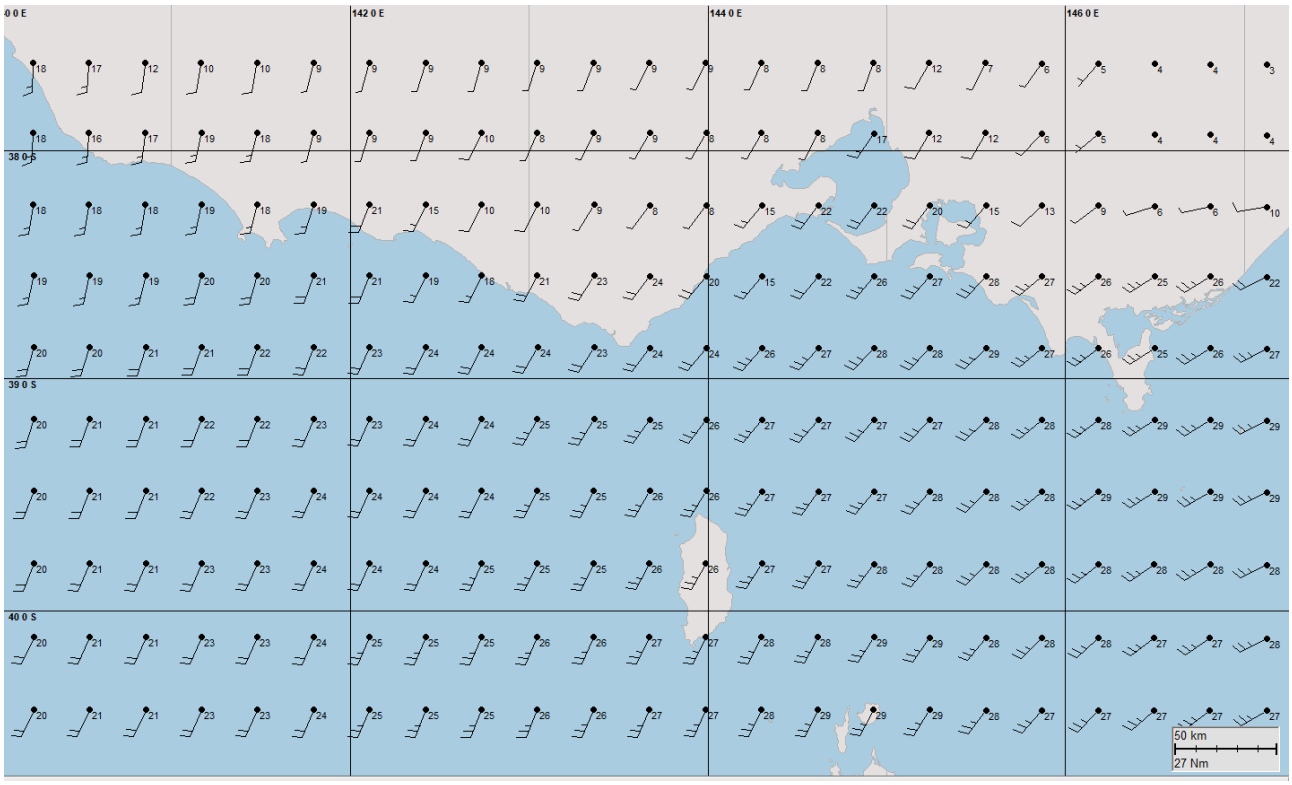


**Figure 4-1 Spatial resolution of the CFSR modelled wind data used as input into the oil spill model.**

Figure 4-2 and Figure 4-3 show the monthly and total wind rose distributions derived from the CFSR data for the node closest to the Yolla Well Head.

Figure 4-4 and Figure 4-5 show the monthly and total wind rose distributions derived from the CFSR data for the node closest to the MDO and Pipeline release location.

Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows from, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 5 knots are predominantly used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

**Table 4-1** **Predicted average and maximum winds representative for the selected node closest to the Yolla Well Head. Data derived from CFSR hindcast model from 2010–2019 (inclusive).**

| Month | Average wind speed (knots) | Maximum wind speed (knots) | General direction(s) (from) |
|---|---|---|---|
| January | 15.6 | 39.1 | Southwest |
| February | 15.9 | 42.3 | Southwest-northeast axis |
| March | 15.9 | 43.1 | Southwest |
| April | 15.5 | 44.4 | Southwest |
| May | 17.9 | 48.7 | West-southwest |
| June | 17.3 | 45.4 | West |
| July | 19.6 | 50.2 | West-northwest |
| August | 18.7 | 44.2 | West |
| September | 18.0 | 45.4 | West-southwest |
| October | 16.7 | 45.8 | West-southwest |
| November | 16.3 | 40.7 | West-southwest |
| December | 16.0 | 42.2 | Southwest-northeast axis |
| **Minimum** | **15.5** | **39.1** | - |
| **Maximum** | **19.6** | **50.2** | - |

**Table 4-2** **Predicted average and maximum winds representative for the selected node closest to the MDO and Pipeline release location. Data derived from CFSR hindcast model from 2010–2019 (inclusive).**

| Month | Average wind speed (knots) | Maximum wind speed (knots) | General direction(s) (from) |
|---|---|---|---|
| January | 13.1 | 38.5 | Southwest |
| February | 13.5 | 41.8 | East and south-southwest |
| March | 13.4 | 41.0 | Varied |
| April | 13.0 | 39.5 | West-southwest |
| May | 15.6 | 39.2 | Northwest and west-southwest |
| June | 15.3 | 41.4 | Northwest |
| July | 17.4 | 43.8 | Northwest |
| August | 16.5 | 43.0 | Northwest |
| September | 15.1 | 47.3 | Southwest |
| October | 14.1 | 40.4 | Southwest |
| November | 13.5 | 40.1 | Southwest |
| December | 13.3 | 42.9 | Southwest |
| **Minimum** | **13.0** | **38.5** | - |
| **Maximum** | **17.4** | **47.3** | - |

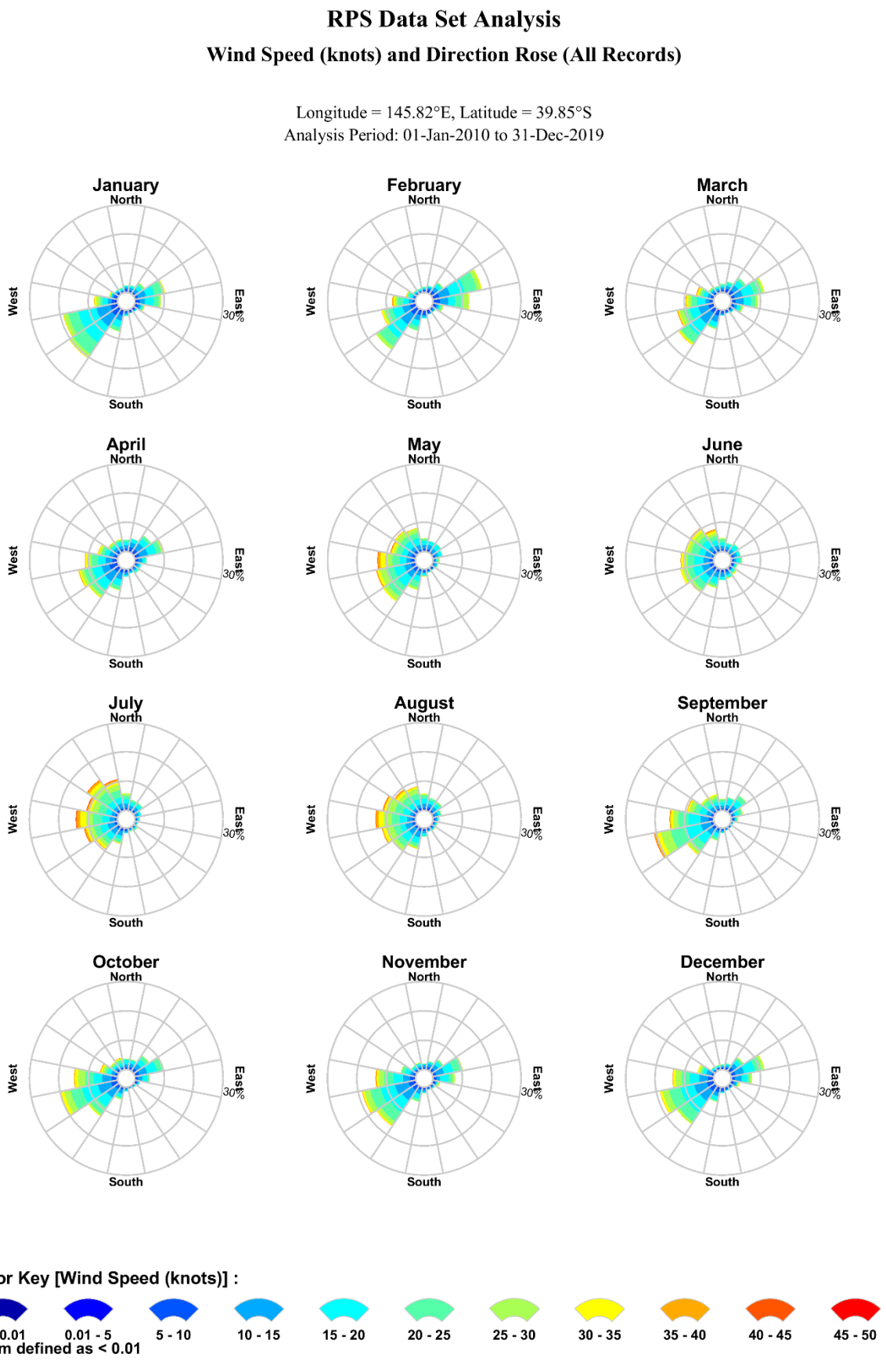


**Figure 4-2 Modelled monthly wind rose distributions from 2010–2019 (inclusive) for the node nearby the Yolla Well Head.**

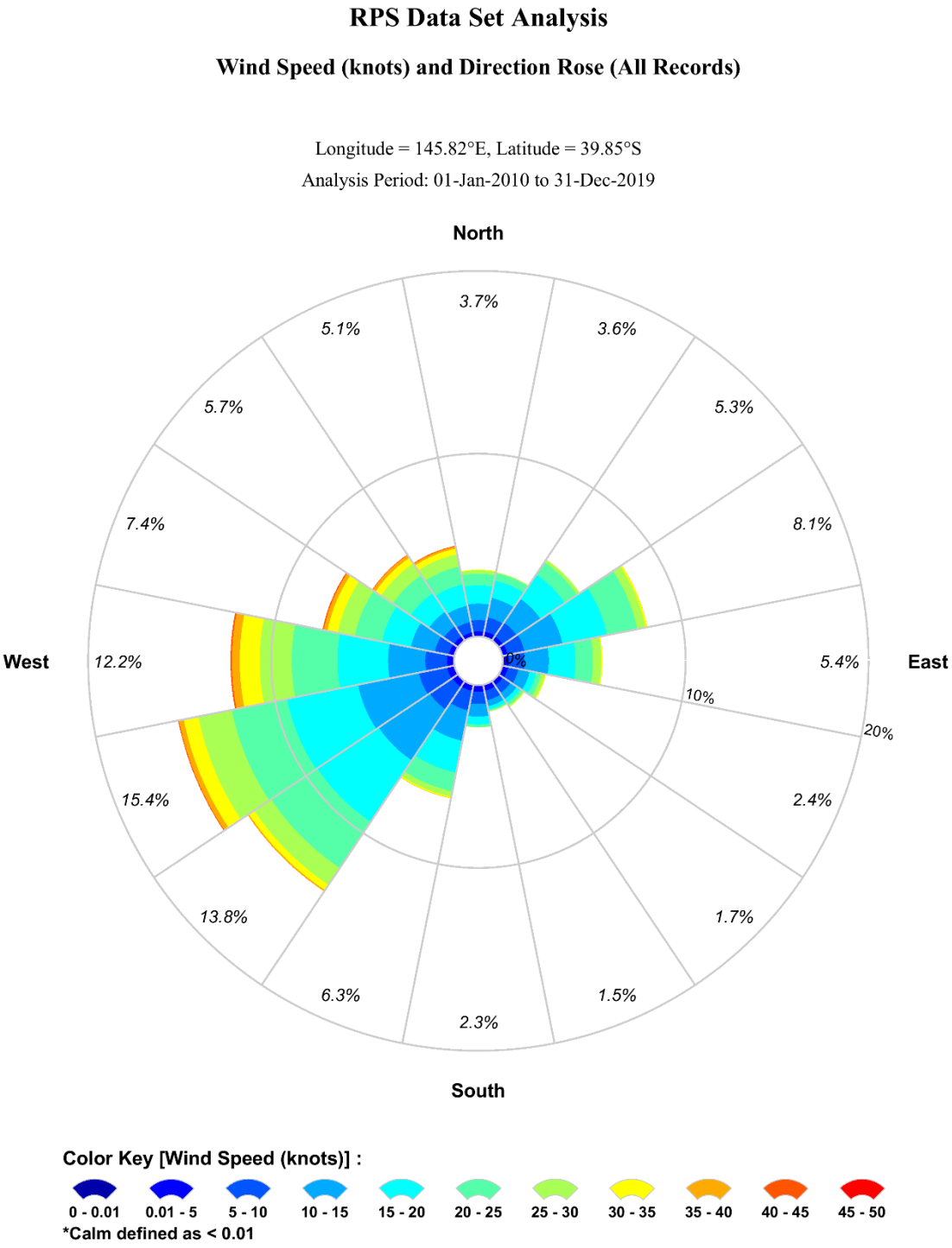


**Figure 4-3** **Modelled total wind rose distributions from 2010–2019 (inclusive) for the node nearby the Yolla Well Head.**

**Figure 4-4 Modelled monthly wind rose distributions from 2010–2019 (inclusive) for the node nearby the MDO and Pipeline release location.**

**Figure 4-5** **Modelled total wind rose distributions from 2010–2019 (inclusive) for the node nearby the MDO and Pipeline release location.**

# 5 WATER TEMPERATURE AND SALINITY

The monthly sea temperature and salinity profiles of the water column within the study was obtained from the World Ocean Atlas 2018 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Center for Oceanography (see Levitus et al., 2013).

To account for depth-varying sea temperature and salinity the modelling used monthly average sea temperature and salinity profiles. Table 5.1 and Table 5.2 presents the sea temperature and salinity of the surface layer nearby the release sites.

At the Yolla Well Head, the monthly average sea surface temperatures ranged between 12.7°C and 19.3°C. The monthly average salinity values remain relatively consistent ranging between 35.2 and 35.5 psu. At the MDO and Pipeline location, the monthly average temperature varied between 12.5°C and 20.3°C, with salinity varying between 35.4 and 35.5 psu.

These parameters were used as factors to inform the weathering, movement and evaporative loss of hydrocarbon spills in the surface and sub-surface layers.

Figure 5.1 and Figure 5.2 illustrate the vertical profile of sea temperature and salinity nearby the release sites.

**Table 5.1 Monthly average sea surface temperature and salinity near the Yolla Well Head.**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (ºC) | 17.8 | 19.3 | 19.3 | 18.1 | 16.6 | 14.9 | 13.4 | 12.7 | 12.3 | 13.1 | 14.4 | 15.9 |
| Salinity (PSU) | 35.4 | 35.4 | 35.5 | 35.5 | 35.5 | 35.4 | 35.3 | 35.3 | 35.3 | 35.3 | 35.2 | 35.3 |

**Table 5.2 Monthly average sea surface temperature and salinity near the MDO and Pipeline release location.**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (ºC) | 19.8 | 20.3 | 19.7 | 18.5 | 16.2 | 14.6 | 13.4 | 12.5 | 12.6 | 13.8 | 15.6 | 17.1 |
| Salinity (PSU) | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 | 35.4 | 35.4 | 35.4 | 35.4 | 35.4 | 35.4 |

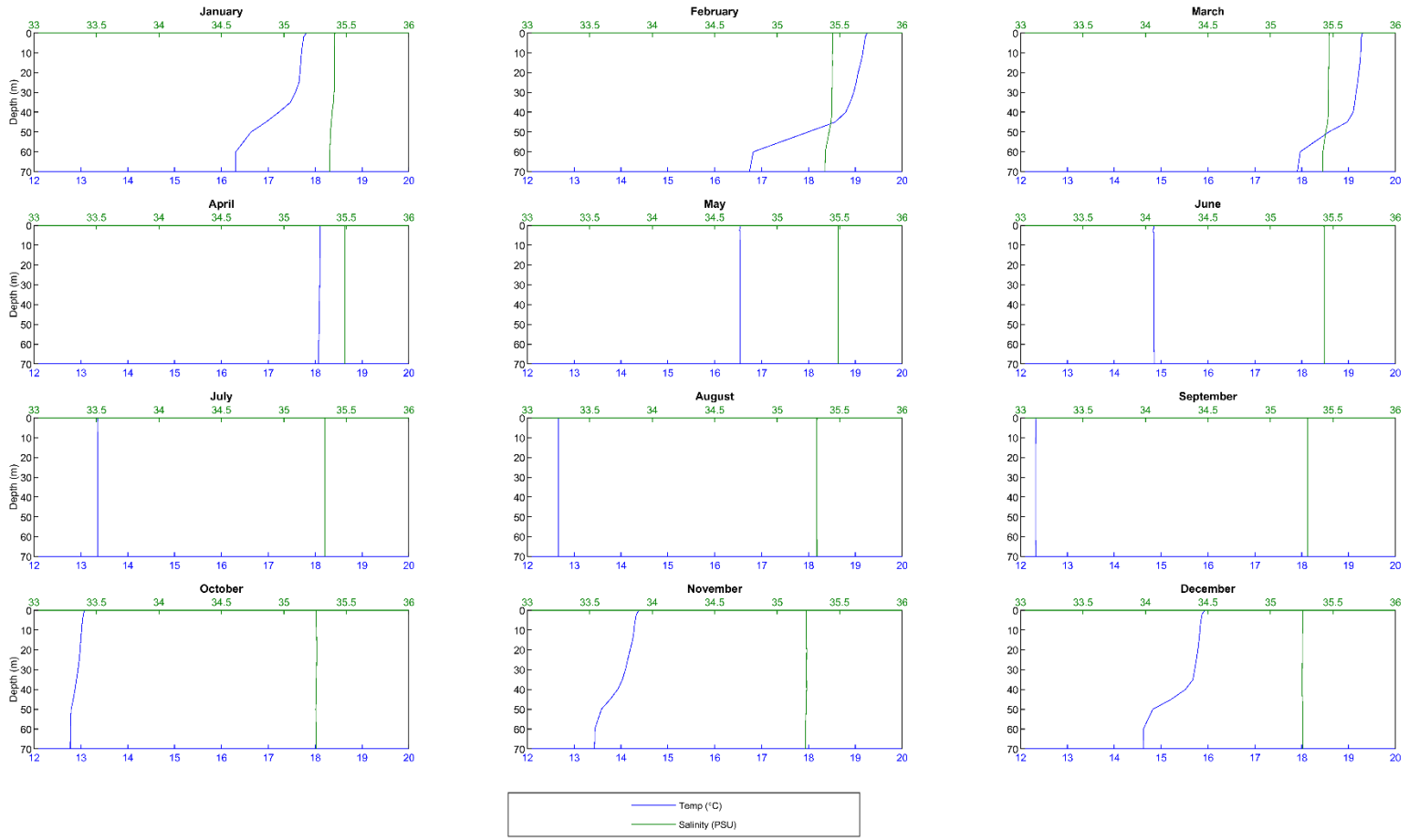


**Figure 5.1 Temperature and salinity profiles nearby the Yolla Well Head.**

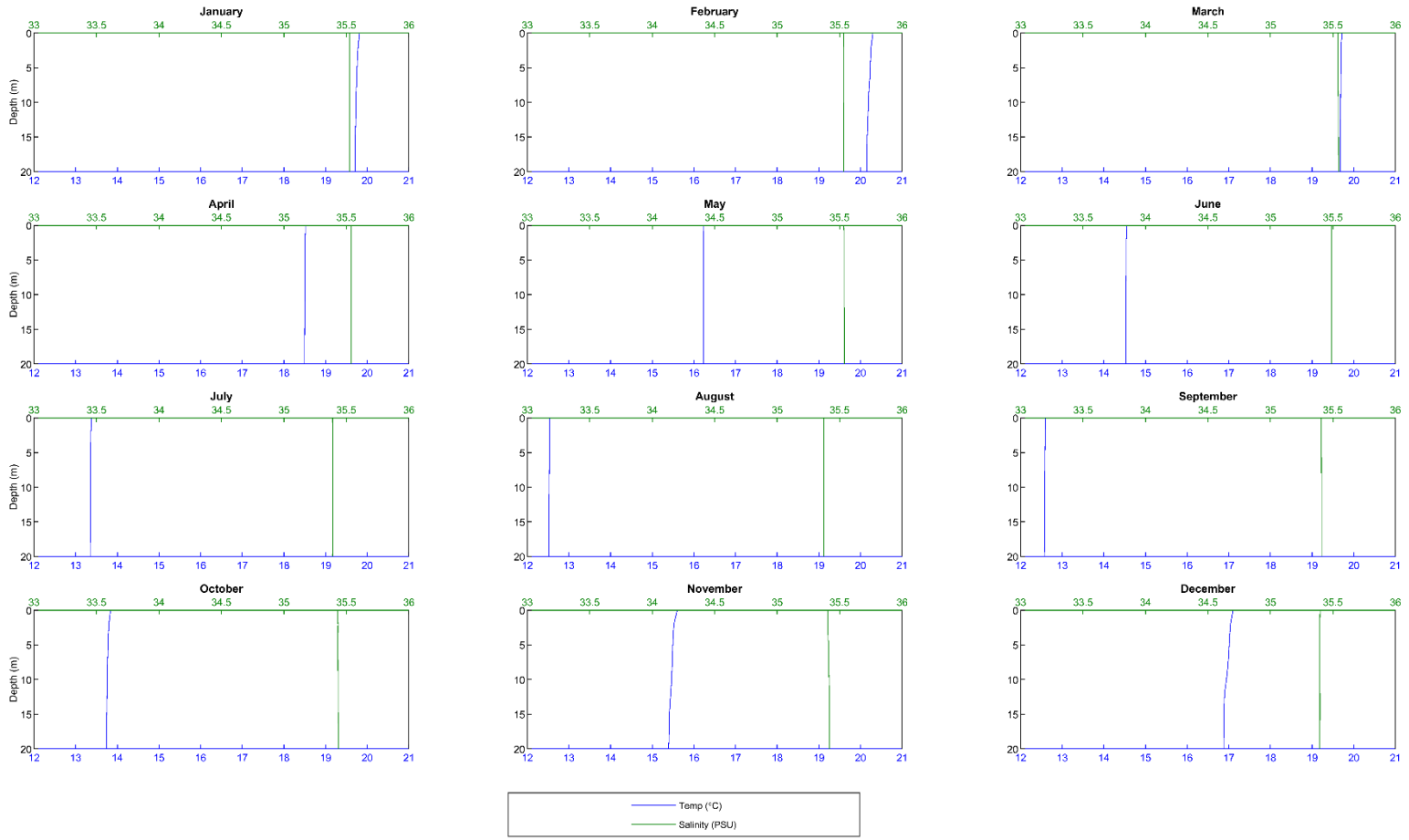


**Figure 5.2 Temperature and salinity profiles nearby the MDO and Pipeline release location.**

# 6 SUBSEA PLUME MODEL – OILMAP DEEP

In the event of a subsea release, the gas and condensate will initially behave like a jet, which dissipates in the water column over a short distance (<10 m). The escaping condensate shears? into small droplets due to turbulence generated by passing through the exit hole and subsequent turbulence generated in the plume jet. The size-distribution of the droplets will vary with the exit velocity and viscosity of the condensate. Following this phase, the density and buoyancy difference of the gas and condensate mixture relative to the surrounding waters forces the plume upward. As the plume rises, the volume of gas will increase due to reduction of water pressure, with gas bubbles dividing into an increasing number of bubbles due to the shearing effect exerted by the water column.

In shallow water (<200 m) the rising plume will tend to reach the sea surface before deflecting away from the centre of the plume (Spaulding et al., 2000). Figure 6-1 conceptually illustrates the various stages of a subsea release of oil and gas.

The OILMAP Deep model (Spaulding et al. 2015) was used to simulate the near-field behaviour of the gas-condensate subsea release in two phases – the initial jet phase and the buoyant plume phase. The initial jet phase is predominately driven by the exit velocity. During this phase, the condensate droplet-size-distributions are calculated for a range of classes or bins. Next, the plume model predicts the rise dynamics of the condensate and gas plume to calculate at which point gas lift will be lost (i.e., the trapping height).

Outputs which include the plume trapping height, plume diameter and droplet size distribution are used as input to the SIMAP model to simulate the rise and dispersion of the condensate droplets from this point onwards.

More details on the OILMAP-DEEP model, can be found in Spaulding et al. (2015). The model has been validated against observations from Deepwater Horizon as well as small and large-scale laboratory studies on subsurface oil releases (Brandvik et al 2013, 2014; Belore 2014; Spaulding et al. 2015; Li et al. 2017).

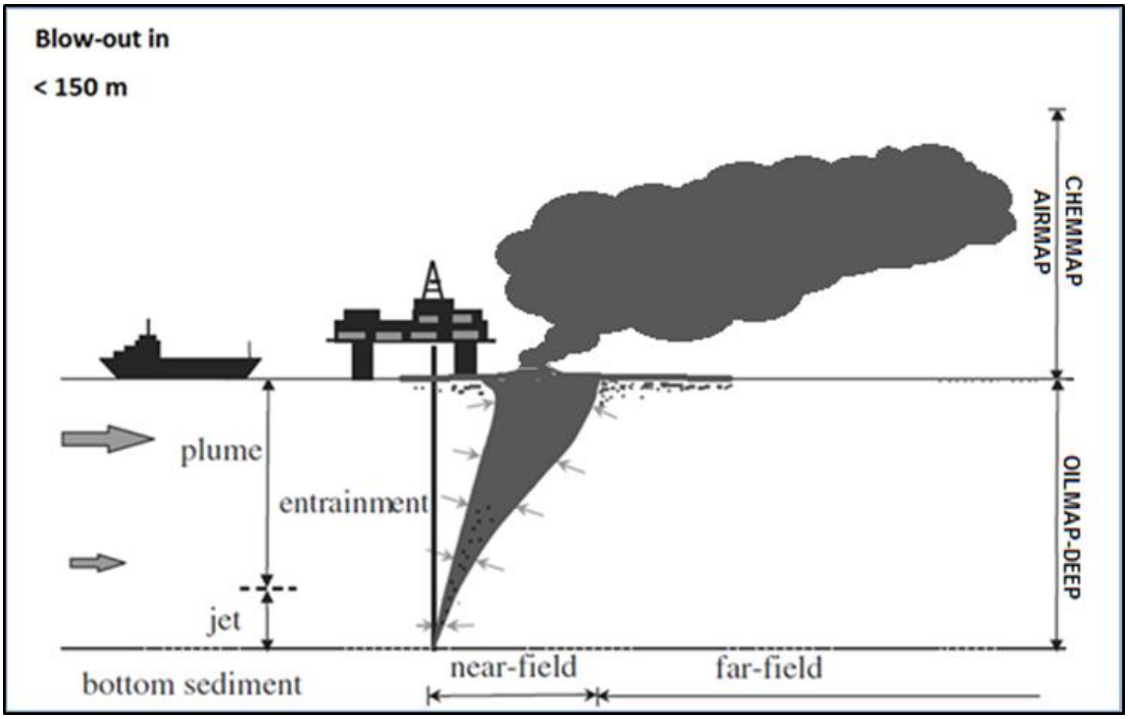


**Figure 6-1 Schematic of the various stages of the plume in the water column (Source: ASA, 2011).**

Table 6-1 presents the input parameters and key results for the subsea plume modelling.

Figure 6-2 illustrates the time-varying release rate used for the LOWC scenario at the Yolla Well Head.

The blowout modelling showed that in the event of a loss of well control at the Yolla Well Head (Scenario 1), the amalgamated gas and condensate would propel rapidly upward from the seabed and breach the sea surface. Droplet sizes would initially range from 82 µm to 354 µm on day-1 and increase in size to 105 µm to 370 µm by day-86.

The pipeline rupture modelling showed that in the event of a subsea release at the release location, the amalgamated gas and condensate would propel rapidly upward from the seabed and breach the sea surface. Droplet sizes would range from 65 µm to 280 µm.

**Table 6-1 Input data and key results for the subsea plume modelling.**

| Input Variable | Subsea LOWC | Subsea pipeline rupture |
|---|---|---|
| Scenario | Loss of well control | Subsea pipeline rupture |
| Water depth | 70 m | 50 m |
| Tubing diameter | 4 1/2" | 13” |
| Condensate discharge rate | Day-1: 836.6 STB/day<br>Day-86: 802.9 STB/day | 24,167 STB/hour |
| Gas discharge rate | Day-1: 28.3 MMscf/day<br>Day-86: 27.1 MMscf/day | 23,450 scf/hour |
| Formation water discharge rate | Day-1: 646.0 STB/day<br>Day-86: 2611.3 STB/day | NIL |
| **Key Results** | | |
| Plume execution depth (m BMSL) | 0<br>(Breach the sea surface) | 0<br>(Breach the sea surface) |
| Droplet sizes (µm) | Day-1: 82 to 354<br>Day-86: 105 to 370 | 65 to 280 |

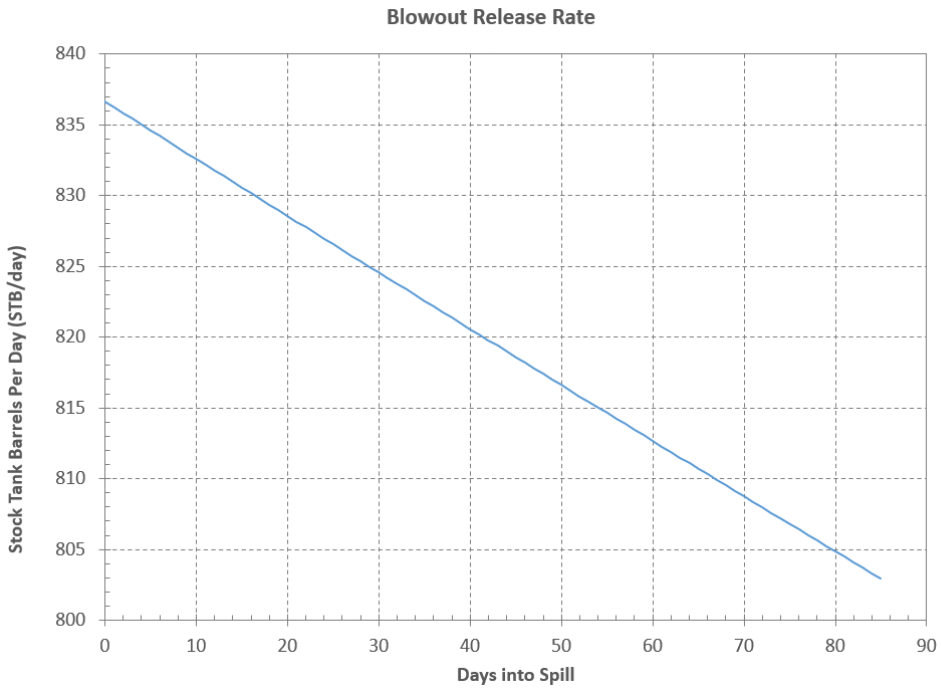


**Figure 6-2 Plot of time-varying release rate for the Yolla Well Head release location.**

# 7 OIL SPILL MODEL – SIMAP

Modelling of the fate of oil was performed using the Spill Impact Model Application Program (SIMAP). SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases (Spaulding et al., 1994; French et al., 1999; French-McCay, 2003, 2004; French-McCay et al., 2004).

SIMAP has been used to predict the weathering and fate of oil spills during and after major incidents including: Montara (Australia) well blowout August 2009 in the Timor Sea (Asia-Pacific ASA, 2010); Macondo (USA) well blowout April 2010 in the Gulf of Mexico; Bohai Bay (China) oil spill August 2011; and the pipeline oil spill July 2013 in the Gulf of Thailand.

The SIMAP model calculates the transport, spreading, entrainment, evaporation and decay of surface hydrocarbon slicks as well as the entrained and dissolved oil components in the water column, either from surface slicks or from oil discharged subsea. The movement and weathering of the spilled oil is calculated for specific oil types. Input specifications for oil mixtures include the density, viscosity, pour point, distillation curve (volume lost versus temperature) and the aromatic/aliphatic component ratios within given boiling point (BP) ranges.

SIMAP is a three-dimensional model that allows for various response actions to be modelled including oil removal from skimming, burning, or collection booms, and surface and subsurface dispersant application.

The SIMAP oil spill model includes advanced weathering algorithms, specifically focussed on unique oils that tend to form emulsions and/or tar balls. The weathering algorithms are based on 5 years of extensive research conducted in response to the Deepwater Horizon oil spill in the Gulf of Mexico (French-McCay et al., 2015).

Biodegradation is included in the oil spill model. In the SIMAP model degradation is calculated for the surface slick, deposited oil on the shore, the entrained oil and dissolved constituents in the water column, and oil in the sediments. For surface oil, water column oil and sedimented oil a first order degradation rate is specified. Biodegradation rates are relatively high for hydrocarbons in dissolved state or in dispersed small droplets.

## 7.1 Stochastic Modelling

For the stochastic modelling presented herein, 200 simulations (100 per season) were modelled for each of the scenarios using the same spill information (release location, spill volume, duration and oil type) but with varied start dates per scenario. During each simulation, the model records whether any grid cells are exposed to any oil concentrations, the concentrations involved and the elapsed time before exposure. The results of all 100 oil spill simulations per season (per scenario) were analysed to determine the following statistics for every grid cell:

- Exposure load (concentrations).
- Minimum time before exposure.
- Maximum duration of exposure.
- Probability of shoreline contact above defined concentrations.
- Volume of oil that may accumulate on shorelines from any single simulation.
- Concentration that might occur on sections of individual shorelines.
- Exposure (instantaneous) to dissolved hydrocarbons in the water column.
- Exposure (instantaneous) to entrained hydrocarbons in the water column.
- Residence time, or the longest continuous period floating oil, and dissolved and entrained hydrocarbons persisted at a point above a threshold.

# 8 THRESHOLDS

The SIMAP model will track oil concentrations to very low levels. Hence, it is useful to define meaningful threshold concentrations for the recording of contact by oil components and determining the probability of exposure at a location (calculated from the number of replicate simulations in which this contact occurred).

The judgement of meaningful levels is complicated and will depend upon the mode of action, sensitivity of the biota contacted, the duration of the contact and the toxicity of the compounds that are represented in the oil. The latter factor is further complicated by the change in the composition of an oil type over time due to weathering processes. Without specific testing of the oil types, at different states of weathering against a wide range of the potential local receptors, such considerations are beyond the scope of this investigation.

It is important to note that the thresholds herein are based on the thresholds outlined in the NOPSEMA Oil Spill Modelling Bulletin (NOPSEMA, 2019), which are summarised in Table 8.1. Their relationship to exposure for the sea surface, shoreline, and water column (entrained and dissolved hydrocarbons) are presented in Sections 8.1 to 8.3. Supporting justifications of the adopted thresholds applied during the study and additional context relating to the area of exposure are also provided.

**Table 8.1 Summary of the thresholds applied in this study.**

| Floating hydrocarbon concentration ($g/m^2$) | Shoreline accumulation ($g/m^2$) | Entrained hydrocarbons concentration (ppb) | Instantaneous dissolved hydrocarbons (ppb) |
|---|---|---|---|
| 1 | 10 | 10 | 10 |
| 10 | 100 | 100 | 50 |
| 50 | 1,000 | | 400 |

## 8.1 Floating Oil Exposure Thresholds

The modelling results can be presented to any levels; therefore, thresholds have been specified (based on scientific literature) to record floating oil exposure to the sea-surface at meaningful levels only, described in the following paragraphs.

The low threshold to assess the potential for floating oil exposure, was 1 $g/m^2$, which equates approximately to an average thickness of 1 µm, referred to as visible oil. Oil of this thickness is described as rainbow sheen in appearance, according to the Bonn Agreement Oil Appearance Code (Bonn Agreement, 2009; AMSA, 2014) (see Table 8-2). Figure 8-1 shows photographs highlighting the difference in appearance between a silvery sheen, rainbow sheen and metallic sheen. This threshold is considered below levels which would cause environmental harm and it is more indicative of the areas perceived to be affected due to its visibility on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. Table 8-2 provides a description of the appearance in relation to exposure zone thresholds used to classify the zones of floating oil exposure.

Ecological impact has been estimated to occur at 10 $g/m^2$ (a film thickness of approximately 10 µm or 0.01 mm) according to French et al. (1996) and French-McCay (2009) as this level of fresh oiling has been observed to mortally impact some birds through adhesion of oil to their feathers, exposing them to secondary effects such as hypothermia. The appearance of oil at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009). For this study the medium exposure threshold was set to 10 $g/m^2$.

Scholten et al. (1996) and Koops et al. (2004) indicated that at oil concentrations on the sea surface of 25 $g/m^2$ (or greater), would be harmful for all birds that have landed in an oil film due to potential contamination of their feathers, with secondary effects such as loss of temperature regulation and ingestion of oil through preening. The appearance of oil at this thickness is also described as metallic sheen (Bonn Agreement, 2009). For this study the high exposure threshold was set to 50 $g/m^2$ and above based on NOPSEMA (2019). This threshold can also be used to inform response planning.

Table 8-3 defines the thresholds used to classify the zones of floating oil exposure reported herein.

**Table 8-2 The Bonn Agreement Oil Appearance Code.**

| Code | Description Appearance | Layer Thickness Interval ($g/m^2$ or µm) | Litres per $km^2$ |
|---|---|---|---|
| 1 | Sheen (silvery/grey) | 0.04 – 0.30 | 40 – 300 |
| 2 | Rainbow | 0.30 – 5.0 | 300 – 5,000 |
| 3 | Metallic | 5.0 – 50 | 5,000 – 50,000 |
| 4 | Discontinuous True Oil Colour | 50 – 200 | 50,000 – 200,000 |
| 5 | Continuous True Oil Colour | ≥ 200 | ≥ 200,000 |

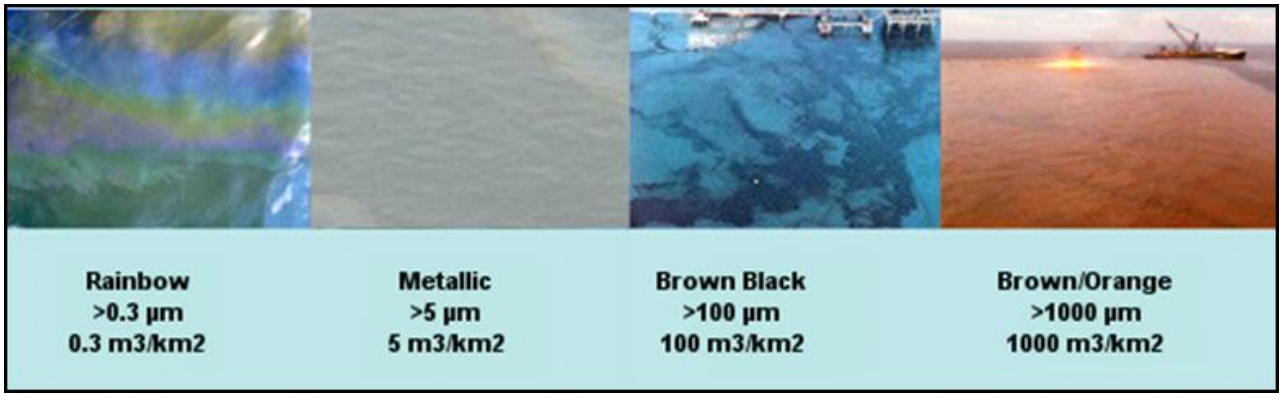


**Figure 8-1 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oil Spill Solutions, 2015).**

**Table 8-3 Floating oil exposure thresholds used in this report (in alignment with NOPSEMA, 2019).**

| Threshold level | Floating oil ($g/m^2$) | Description |
|---|---|---|
| Low | 1 | Approximates area of potential socioeconomic effects and establishes planning area for scientific monitoring and determination of any effects. |
| Moderate | 10 | Approximates lower limit for harmful exposures to birds and marine mammals |
| High | 50 | Approximates surface oil slick and informs response planning |

## 8.2 Shoreline Accumulation Thresholds

There are many different types of shorelines, ranging from cliffs, rocky beaches, sandy beaches, mud flats and mangroves, and each of these influences the volume of oil that can remain stranded ashore and its thickness before the shoreline saturation point occurs. For instance, a sandy beach may allow oil to percolate through the sand, thus increasing its ability to hold more oil ashore over tidal cycles and various wave actions than an equivalent area of water; hence oil can increase in thickness onshore over time. A sandy beach shoreline was assumed as the default shoreline type for the modelling herein, as it allows for the highest carrying capacity of oil (of the available open/exposed shoreline types). Hence the results contained herein would be indicative of a worst-case scenario, where the highest volume of oil may be stranded on the shoreline (when compared to other shoreline types, such as exposed rocky shores).

In previous risk assessment studies, French-McCay et al. (2005a; 2005b) used a threshold of 10 g/m$^2$ to assess the potential for shoreline accumulation. This is a conservative threshold used to define regions of socio-economic impact, such as triggering temporary closures of adjoining fisheries or the need for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). It would equate to approximately 2 teaspoons of hydrocarbon per square meter of shoreline accumulation. The appearance is described as a stain/film. On that basis, the 10 g/m$^2$ shoreline accumulation threshold has been selected to define the zone of potential “low shoreline accumulation”.

French et al. (1996) and French-McCay (2009) define a shoreline oil accumulation threshold of 100 g/m$^2$, or above, would potentially harm shorebirds and wildlife (furbearing aquatic mammals and marine reptiles on or along the shore) based on studies for sub-lethal and lethal impacts. This threshold has been used in previous environmental risk assessment studies (see French-McCay, 2003; French-McCay et al., 2004, French-McCay et al., 2011; 2012; NOAA, 2013). Additionally, a shoreline concentration of 100 g/m$^2$, or above, is the minimum limit that the oil can be effectively cleaned according to the AMSA (2015) guideline. This threshold equates to approximately ½ a cup of oil per square meter of shoreline accumulation. The appearance is described as a thin oil coat. Therefore, 100 g/m$^2$ has been selected to define the zone of potential “moderate shoreline accumulation”.

Observations by Lin & Mendelssohn (1996) demonstrated that loadings of more than 1,000 g/m$^2$ of hydrocarbon during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing hydrocarbon impacts on mangroves (Grant et al., 1993; Suprayogi & Murray, 1999). Hence, 1,000 g/m$^2$ has been selected to define the zone of potential “high shoreline accumulation”. It equates to approximately 1 litre of hydrocarbon per square meter of shoreline accumulation. The appearance is described as a hydrocarbon cover.

It is worth noting that the shoreline accumulation thresholds derived from extensive literature review (outlined in Table 8-4) agree with the commonly used threshold values for oil spill modelling specified in NOPSEMA (2019).

**Table 8-4 Thresholds used to assess shoreline accumulation.**

| Threshold level | Shoreline loading (g/m$^2$) | Description |
|---|---|---|
| Low (socioeconomic/sublethal) | 10 | Loading predicts potential socio-economic impact |
| Moderate | 100 | Loading predicts area likely to require clean-up effort |
| High | > 1,000 | Loading predicts area likely to require intensive clean-up effort |

## 8.3 In-water Exposure Thresholds

Oil is a mixture of thousands of hydrocarbons of varying physical, chemical, and toxicological characteristics, and therefore, demonstrate varying fates and impacts on organisms. As such, for in-water exposure, the SIMAP model provides separate outputs for dissolved and entrained hydrocarbons from oil droplets. The consequences of exposure to dissolved and entrained components will differ because they have different modes and magnitudes of effect.

Entrained hydrocarbon concentrations were calculated based on oil droplets that are suspended in the water column, though not dissolved. The composition of this oil would vary with the state of weathering (oil age) and may contain soluble hydrocarbons when the oil is fresh. Calculations for dissolved hydrocarbons

specifically calculates oil components which are dissolved in water, which are known to be the primary source of toxicity exerted by oil.

A complicating factor that should be considered when assessing the consequence of dissolved and entrained oil distributions is that there will be some areas where both physically entrained oil droplets and dissolved hydrocarbons co-exist. Higher concentrations of each will tend to occur close to the source where sea conditions can force mixing of relatively unweathered oil into the water column, resulting in more rapid dissolution of soluble compounds.

### 8.3.1 Dissolved Hydrocarbons

Laboratory studies have shown that dissolved hydrocarbons exert most of the toxic effects of oil on aquatic biota (Carls et al., 2008; Nordtug et al., 2011; Redman, 2015). The mode of action is a narcotic effect, which is positively related to the concentration of soluble hydrocarbons in the body tissues of organisms (French-McCay, 2002). Dissolved hydrocarbons are taken up by organisms directly from the water column by absorption through external surfaces and gills, as well as through the digestive tract. Thus, soluble hydrocarbons are termed “bioavailable”.

Hydrocarbon compounds vary in water-solubility and the toxicity exerted by individual compounds is inversely related to solubility, however bioavailability will be modified by the volatility of individual compounds (Nirmalakhandan and Speece, 1988; Blum and Speece, 1990; McCarty, 1986; McCarty et al., 1992a, 1992b; McCarty and Mackay, 1993; Verhaar et al., 1992, 1999; Swartz et al., 1995; French-McCay, 2002; McGrath and Di Toro, 2009). Of the soluble compounds, the greatest contributor to toxicity for water-column and benthic organisms are the lower-molecular-weight aromatic compounds, which are both volatile and soluble in water. Although they are not the most water-soluble hydrocarbons within most oil types, the polynuclear aromatic hydrocarbons (PAHs) containing 2–3 aromatic ring structures typically exert the largest narcotic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant accumulation to occur (Anderson et al., 1974; 1987; Neff and Anderson, 1981; Malins and Hodgins, 1981; McAuliffe, 1987; NRC, 2003). The monoaromatic hydrocarbons (MAHs), including the BTEX compounds (benzene, toluene, ethylbenzene, and xylenes), and the soluble alkanes (straight chain hydrocarbons) also contribute to toxicity, but these compounds are highly volatile, so that their contribution will be low when oil is exposed to evaporation and higher when oil is discharged at depth where volatilisation does not occur (French-McCay, 2002).

French-McCay (2002) reviewed available toxicity data, where marine biota was exposed to dissolved hydrocarbons prepared from oil mixtures, finding that 95% of species and life stages exhibited 50% population mortality ($LC_{50}$) between 6 and 400 ppb (with an average of 50 ppb) total PAH concentration after 96 hrs exposure. Therefore, concentrations lower than 6 ppb total PAH value should be protective of 97.5% of species and life stages even with exposure periods of days (at least 96 hours). Early life-history stages of fish appear to be more sensitive than older fish stages and invertebrates.

Exceedances of 10, 50 or 400 ppb over a 1 hour timestep (see Table 8.5) were applied in this study to indicate the increasing potential for sub-lethal to lethal toxic effects (or low to high), based on NOPSEMA (2019).

### 8.3.2 Entrained Hydrocarbons

Entrained hydrocarbons consist of oil droplets that are suspended in the water column and insoluble. Insoluble compounds in oil cannot be absorbed from the water column by aquatic organisms, therefore they are not bioavailable through absorption of compounds from the water. Exposure to these compounds would require routes of uptake other than absorption of soluble compounds. The route of exposure of organisms to whole oil alone include direct contact with tissues of organisms and uptake of oil by direct consumption, with potential for biomagnification through the food chain (NRC, 2003).

Thresholds of 10 ppb, 100 ppb were applied over a 1-hour time exposure (Table 8.5) as per NOPSEMA (2019). The 10-ppb threshold exposure zone is not considered to be of significant biological impact and represents the area contacted by the spill.

**Table 8.5 Dissolved and entrained hydrocarbon exposure thresholds assessed over a 1-hour time step used in the oil spill modelling study (in alignment NOPSEMA, 2019).**

| | Exposure level | In-water threshold (ppb) | Description |
|---|---|---|---|
| Dissolved hydrocarbons | Low | 10 | Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers |
| | Moderate | 50 | Approximates potential toxic effects, particularly sublethal effects to sensitive species |
| | High | 400 | Approximates toxic effects including lethal effects to sensitive species |
| Entrained hydrocarbons | Low | 10 | Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers |
| | Moderate | 100 | As appropriate given oil characteristics for informing risk evaluation |

* Not included in the thresholds outlined in the NOPSEMA Oil Spill Modelling Bulletin (NOPSEMA, 2019)

# 9 DISPERSION COEFFICIENTS AND MIXED LAYER DEPTH

A horizontal dispersion coefficient of 10 $m^2/s$ was used to account for dispersive processes acting on the floating oil that are at scales finer than the modelled wind and currents, based on typical values for open waters (Okubo, 1971).

Vertical dispersion coefficients (*Dv)* of 128 $cm^2/s$ and 106 $cm^2/s$ were used to represent the turbulent mixing and diffusion processes in the wave-mixed layer in the upper water column at the Yolla Well Head and MDO and Pipeline release locations, respectively. Those are site-specific values computed using the 50$^{th}$ percentile wind speed at each of the release sites, derived from the 10-year dataset (at 10 m above the sea surface, $W_{10}$) based on French-McCay (2004).

The mixed layer depth corresponds to the top layer of the water column, where vertical mixing is strong enough to cause uniform temperature and salinity, and is influenced by factors like wind, ocean currents and waves. The 50$^{th}$ percentile value at the site was calculated using Copernicus' 10 years (2010 to 2019) of monthly-averaged mixed layer depth data and were found to be 34 m and 9 m for Yolla Well Head and MDO and Pipeline release locations, respectively.

# 10 OIL PROPERTIES

## 10.1 Oil Characteristics

Table 10-1 and Table 10-2 present the physical properties and boiling point ranges of Marine Diesel and Yolla condensate used for the study.

The Yolla condensate has an API of 52.5 and a density of 770.6 $kg/m^3$ (at 15ºC) with a viscosity value (0.14 cP) classifying it as a Group I (not-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2020) and US EPA/USCG classifications.

The condensate is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 80.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C), a further 12.0% should evaporate within the first 24 hours (180°C < BP < 265°C) and a further 6.6% should evaporate over several days (265°C < BP < 380°C). Approximately 1.4% of the oil is shown to be persistent.

Marine diesel (MDO) has an API of 37.6 and a density of 829.1 $kg/m^3$ (at 25ºC) with a viscosity value (4.0 cP) classifying it as a Group II (light-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2020) and US EPA/USCG classifications.

The MDO is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 6.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C); a further 34.6% should evaporate within the first 24 hours (180°C < BP < 265°C); and a further 54.4% should evaporate over several days (265°C < BP < 380°C). Approximately 5.0% of the oil is shown to be persistent.

**Table 10-1 Physical properties for Yolla condensate and MDO.**

| Characteristic | Yolla Condensate | MDO |
|---|---|---|
| Density ($kg/m^3$) | 770.6 (at 15°C) | 829.1 (at 25 °C) |
| API | 52.2 | 37.6 |
| Dynamic viscosity (cP) | 0.14 (at 25°C) | 4.0 (at 25 °C) |
| Pour point (°C) | -3 | -14 |
| Hydrocarbon property category | Group I | Group II |
| Hydrocarbon property classification | Not – Persistent | Light - Persistent |

**Table 10-2 Boiling point ranges for Yolla condensate and MDO.**

| Oil Type | Component | Volatile (%) | Semi-volatile (%) | Low-volatile (%) | Residual (%) |
|---|---|---|---|---|---|
| | Boiling point (°C) | <180 $C_4$ to $C_{10}$ | 180-265 $C_{11}$ to $C_{15}$ | 265-380 $C_{16}$ to $C_{20}$ | >380 >$C_{20}$ |
| Yolla Condensate | % of total | 80.0 | 12 | 6.6 | 1.4 |
| Marine Diesel | % of total | 6.0 | 34.6 | 54.4 | 5.0 |

The BP are dictated by the length of the carbon chains, with the longer and more complex compounds having a higher boiling point, and therefore lower volatility and evaporation rate.

Typical evaporation times once the hydrocarbons reach the surface and are exposed to the atmosphere are:

- Up to 12 hours for the $C_4$ to $C_{10}$ compounds (or <180°C BP).
- Up to 24 hours for the $C_{11}$ to $C_{15}$ compounds (180–265°C BP).
- Several days for the $C_{16}$ to $C_{20}$ compounds (265–380°C BP).
- Not applicable for the residual compounds (BP >380°C), which will resist evaporation, persist in the marine environment for longer periods, and be subject to relatively slow degradation.

The actual fate of oil will depend greatly on the amount that reaches the surface.

## 10.2 Weathering Characteristics

A series of model weather tests were conducted to illustrate the potential behaviour of Yolla condensate and marine diesel when exposed to idealised and representative environmental conditions:

- A 50 $m^3$ surface release over 1-hour under calm wind conditions (constant 5 knots or 2.6 m/s), assuming low seasonal water temperature (15°C) and ambient tidal and drift currents; and
- A 50 $m^3$ surface release over 1-hour under variable wind conditions (1-12 knots or 1.9-23 m/s, drawn from representative data files), assuming low seasonal water temperature (15°C) and ambient tidal and drift currents.

Note, a surface release is used in the weathering test to solely focus on the weathering and fates of the hydrocarbons when exposed to atmospheric conditions.

The first case is indicative conditions that would not generate entrainment, while the second case may represent conditions that could cause a minor degree of entrainment. Both scenarios provide examples of potential behaviour during a spill once the oil reaches the surface.

### Yolla Condensate Mass Balance Forecasts

The mass balance for the condensate under the constant 5 knot wind case (Figure 10-1) shows that 92.0% of the oil is predicted to evaporate within 24 hours. Under calm conditions, the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation shall cease when the residual compounds remain, and they will be subject to more gradual decay through biological and photochemical processes.

Under the variable-wind case (Figure 10-2), where the winds are of greater strength on average, entrainment of the condensate into the water column is predicted to increase. Approximately 24 hours after the spill, 9.3% of the oil mass is forecast to have entrained and a further 89.4% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<0.5%).

### Marine Diesel Mass Balance Forecasts

The mass balance for the MDO under the constant 5 knot (~2.5 m/s) wind case (Figure 10-3) shows that 40.3% of the oil is predicted to evaporate within 24 hours. Under calm conditions, the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation shall cease when the residual compounds remain, and they will be subject to more gradual decay through biological and photochemical processes.

Under the variable-wind case (Figure 10-4), where the winds are of greater strength on average, entrainment of MDO into the water column is predicted to increase. Approximately 24 hours after the spill, 60.1% of the oil mass is forecast to have entrained and a further 38.4% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<0.1%).

The increased level of entrainment in the variable-wind case result in a higher percentage decaying at an approximate rate of 1.5% per day with or ~10.5% after 7 days, compared to <0.1% per day and a total of 0.9% after 7 days for the constant-wind case. Given the proportion of entrained oil and the tendency for it to remain mixed in the water column, the remaining hydrocarbons will decay over time scales of several weeks.

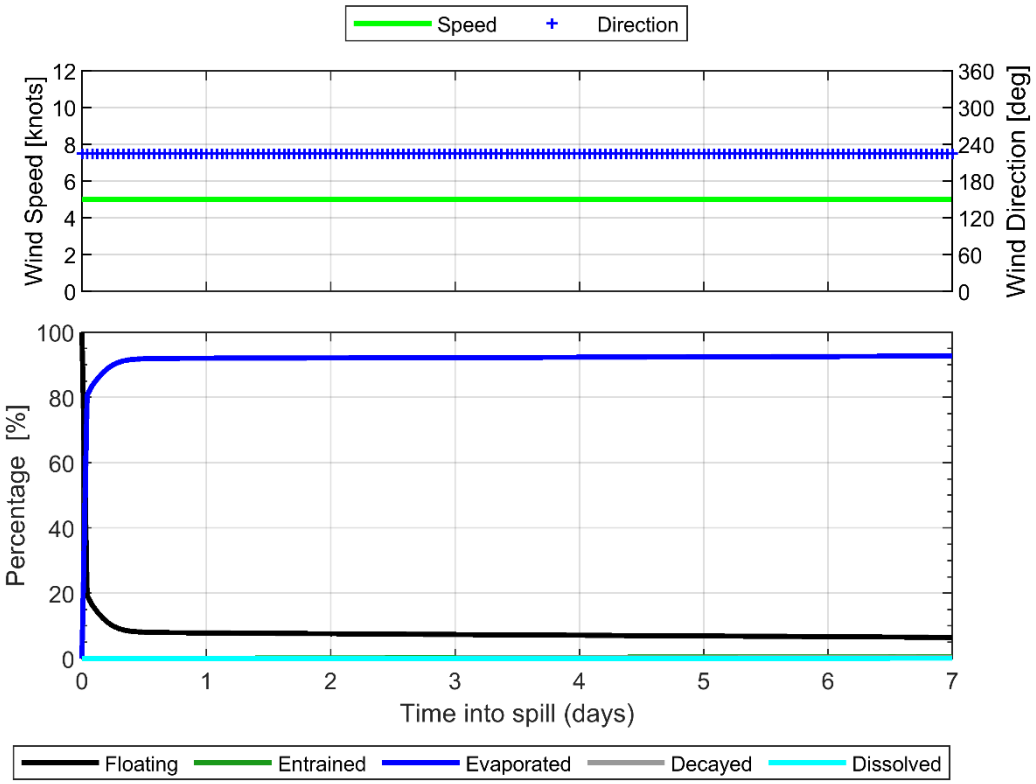


**Figure 10-1 Proportional mass balance plot representing the weathering of Yolla condensate spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature.**

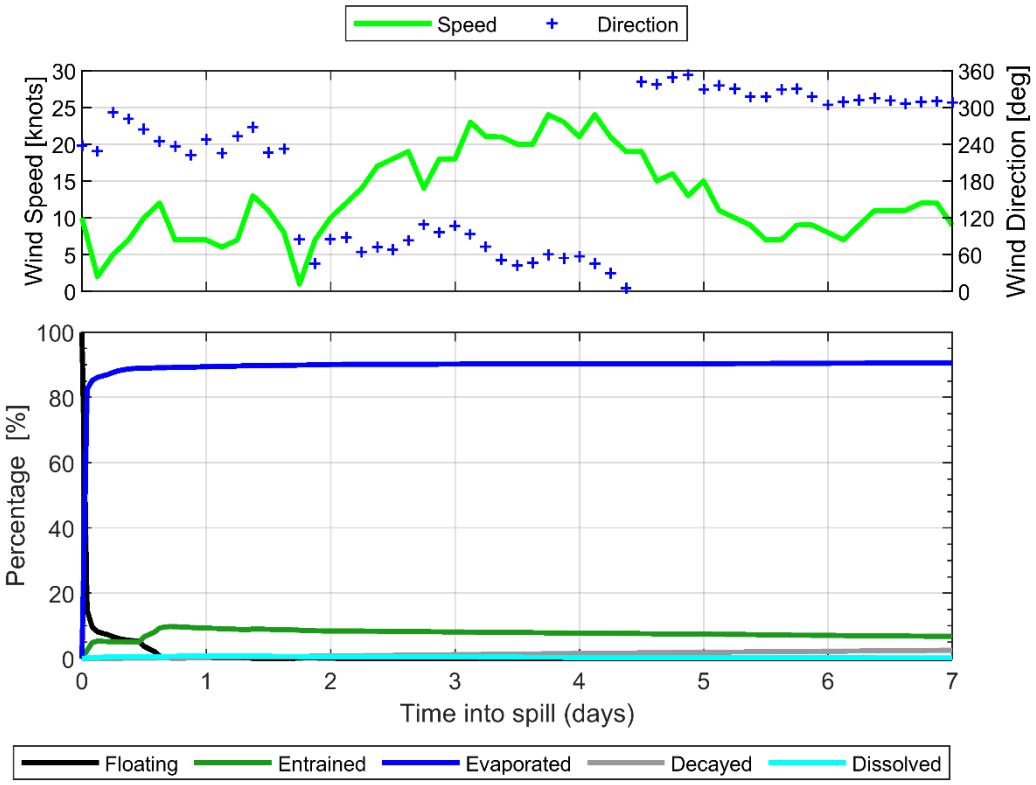


**Figure 10-2 Proportional mass balance plot representing the weathering of Yolla condensate spilled onto the water over 1 hour and subject to variable wind speeds (1-12 knots or 1.9-23 m/s) at 15°C water temperature.**

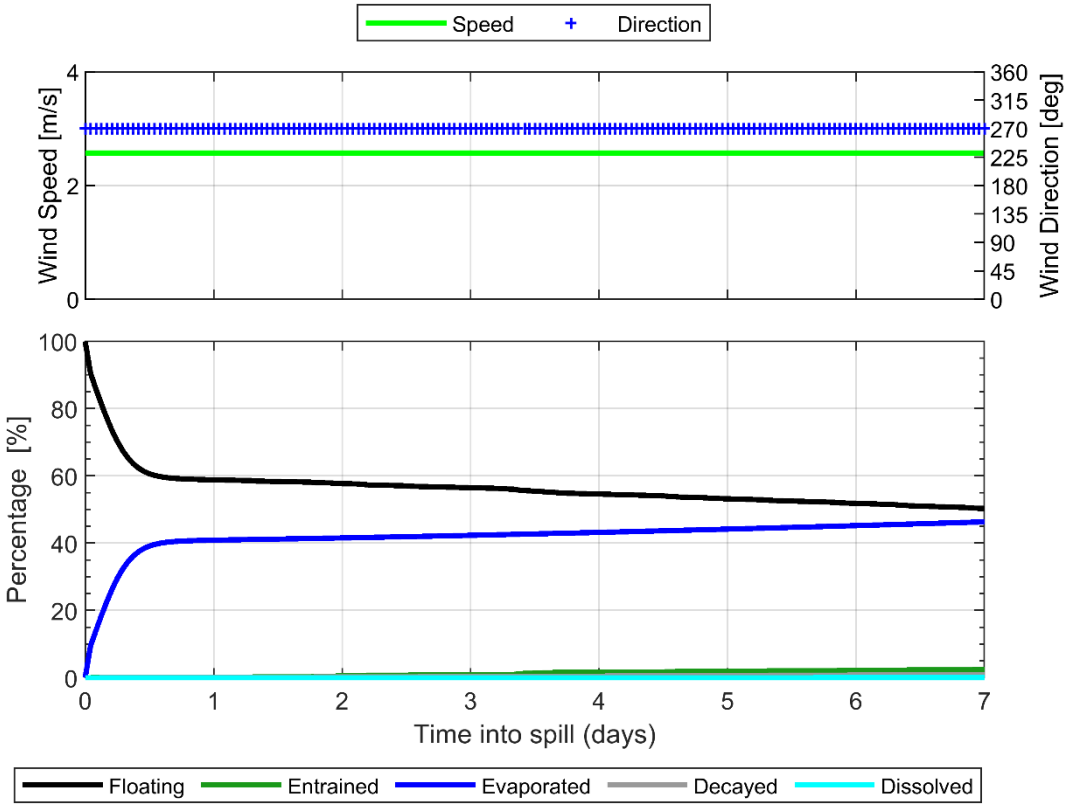


**Figure 10-3 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature.**

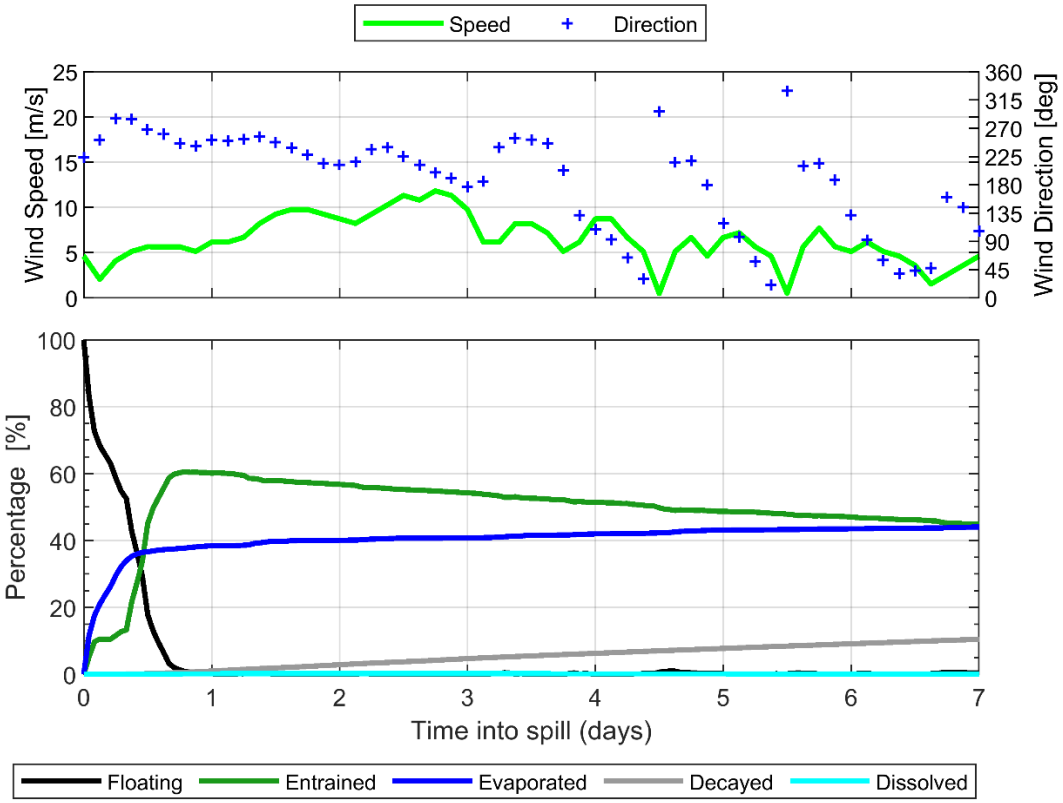


**Figure 10-4 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to variable wind speeds (1-12 knots) at 15°C water temperature.**

# 11 MODEL SETTINGS

Table 11-1 provides a summary of the oil spill model settings.

**Table 11-1 Summary of the oil spill model settings and thresholds used in this assessment.**

| Parameter | Yolla Well Head | 3 nm from shore | |
|---|---|---|---|
| Description | Loss of well control | Pipeline rupture | Surface MDO release |
| Number of randomly selected spill start times | 100 per season | | |
| Model period | Summer (November through to March) and Winter (April to October) | | |
| Oil type | Yolla condensate | Yolla condensate | MDO |
| Spill volume | 70,489 bbl | 14,500 bbl | 300 $m^3$ |
| Release type | Subsea (70 m) | Subsea (50 m) | Surface |
| Release duration | 86 days | 36 minutes | 6 hours |
| Simulation length | 100 days | 10 days | 30 days |
| Surface oil concentration thresholds ($g/m^2$)^ | 1 (low); 10 (moderate); 50 (high) | | |
| Shoreline oil accumulation thresholds ($g/m^2$)^ | 10 (low); 100 (moderate); 1,000 (high) | | |
| Dissolved hydrocarbon concentrations (ppb)^ | 10 (low); 50 (moderate); 400 (high) | | |
| Entrained hydrocarbon concentrations (ppb)^ | 10 (low); 100 (moderate) | | |

^Thresholds based on NOPSEMA (2019)

# 12 PRESENTATION AND INTERPRETATION OF MODEL RESULTS

The results from the modelling study are presented in a number of tables and figures, which aim to provide an understanding of the predicted sea-surface and water column (subsurface) exposure and shoreline accumulation (if predicted).

## 12.1 Seasonal Analysis

### 12.1.1 Statistics

The statistics are based on the following principles:

- The ***greatest distance travelled by a spill trajectory*** – is determined by a) recording the maximum and b) second greatest distance travelled (or 99$^{th}$ percentile) by a single trajectory, within a scenario, from the release location to the identified exposure thresholds.

- The ***probability of oil exposure to a receptor*** – is determined by recording the number of spill trajectories to reach a specified sea surface or subsea threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.

- The ***minimum time before oil exposure to a receptor*** – is determined by ranking the elapsed time before sea surface exposure, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.

- The ***maximum residence time for oil exposure within a receptor*** – is determined by recording the longest continuous length of time a grid cell is exposed to either floating, entrained or dissolved hydrocarbon above each threshold, within each receptor.

- The ***probability of oil accumulation at a receptor*** – is determined by recording the number of spill trajectories to reach a specified shoreline accumulation threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.

- The ***maximum potential oil loading within a receptor*** – is determined by identifying the maximum loading to any grid cell within a receptor polygon, for a scenario.

- The ***dissolved and entrained hydrocarbon exposure*** – is determined by recording the maximum instantaneous concentrations at each grid cell.

- ***Maximum total volume ashore*** (found in shoreline statistics table) – is the total volume of oil stranded on the shorelines throughout the duration of the simulation, regardless of timing.

- ***Maximum instantaneous peak volume ashore*** (found in the deterministic analysis section and derived from the histogram) – is the peak volume of oil accumulated on shorelines at a single point in time. This peak value does not include oil that came ashore earlier in the simulation and was subsequently lost through evaporative or other weathering processes.

## 12.2 Receptors Assessed

A comprehensive receptor database was compiled from multiple sources to evaluate floating oil exposure, in-water column exposure (entrained and dissolved hydrocarbons), and shoreline oil accumulation. These sources include:

- Protected Matters Search Tool (PMST) from Department of Climate Change, Energy, the Environment and Water (https://pmst.awe.gov.au);
- Shoreline cells from the Victorian Marine Pollution Risk Assessment (VMRA11) (https://www.emv.vic.gov.au); and
- Additional receptors, such as Habitat Critical to Turtles from Department of Climate Change, Energy, the Environment and Water (https://fed.dcceew.gov.au).

Table 12.1 summarises the receptors assessed for hydrocarbon exposure and presented in the report. Exposure risks were calculated separately for each receptor, and results are presented only for those receptors predicted to be exposed at, or above, the minimum thresholds.

Additionally, Table 12.2 lists other receptor categories that were assessed but not presented in the report for conciseness. However, these can be provided upon request if needed.

**Table 12.1 Summary of receptors assessed for floating oil exposure, in-water column exposure (entrained and dissolved hydrocarbons), and shoreline oil accumulation. Results for these receptors have been presented.**

| Receptor Category | Acronym | Source | Hydrocarbon Exposure Assessment | | |
|---|---|---|---|---|---|
| | | | Water Column | Floating oil | Shoreline |
| Australian Marine Park | AMP | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Exclusive Economic Zone | EEZ | http://www.marineregions.org | ✓ | ✓ | × |
| Indigenous Protected Area | IPA | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Key Ecological Feature | KEF | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Management Agreement Area | MAA | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Marine Park | MP | https://pmst.awe.gov.au | ✓ | ✓ | × |
| National Parks | NP | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Nature Reserve | NR | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Ramsar wetland | Ramsar | https://pmst.awe.gov.au | ✓ | ✓ | ✓ |
| Reefs, Shoals and Banks | RSB | Digital nautical charts | ✓ | ✓ | × |
| State and Territory Waters | State and Territory Waters | https://www.ga.gov.au/scientific-topics/marine/jurisdiction | ✓ | ✓ | × |
| Victorian Marine Pollution Risk Assessment Shoreline Segments (VIC-MPRA) | Shoreline cells | https://www.emv.vic.gov.au/ | × | × | ✓ |

**Table 12.2 Summary of receptors assessed for floating oil exposure, in-water column exposure (entrained and dissolved hydrocarbons), and shoreline oil accumulation. Results for these receptors have not been presented but can be provided upon request.**

| Receptor Category | Acronym | Source | Hydrocarbon Exposure Assessment | | |
|---|---|---|---|---|---|
| | | | Water Column | Floating oil | Shoreline |
| 5(1)(g) Reserve | S5G | https://pmst.awe.gov.au | ✓ | ✓ | × |
| 5(1)(h) Reserve | S5H | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Commonwealth Heritage Place Historic | CHPH | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Commonwealth Heritage Place Natural | CHPN | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Conservation Park | CP | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Fish Habitat Protected Area | FHPA | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Habitat Critical to Turtles | TUR | https://fed.dcceew.gov.au | ✓ | ✓ | × |
| Integrated Marine and Coastal Regionalisation of Australia (Meso-scale) | IMCRA | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Nationally Important Wetlands | NIW | https://pmst.awe.gov.au | ✓ | ✓ | × |
| Shipwreck Protection Zones | SPZ | https://pmst.awe.gov.au | ✓ | ✓ | × |
| World Heritage Properties (Australia Only) | WHP | https://pmst.awe.gov.au | ✓ | ✓ | × |

# 13 RESULTS – SURBSEA RELEASE OF CONDENSATE DUE TO A LOWC

This scenario examined a 70,489 bbl (~11,207 $m^3$) subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head location. A total of 200 spill simulations were run (i.e., 100 spills per season) and tracked for 100 days. The results for all 100 simulations per season were combined and are presented on a seasonal basis (i.e., summer and winter).

## 13.1 Stochastic Analysis

### 13.1.1 Area of Exposure

Figure 13-1 and Figure 13-2 present the combined area of potential exposure for surface, shoreline, entrained and dissolved, by overlaying the results from all 200 simulations (i.e., 100 per season) during summer and winter conditions. Note that, when generating the EMBAs, a filter has been applied to remove numerical artifacts introduced by the model.

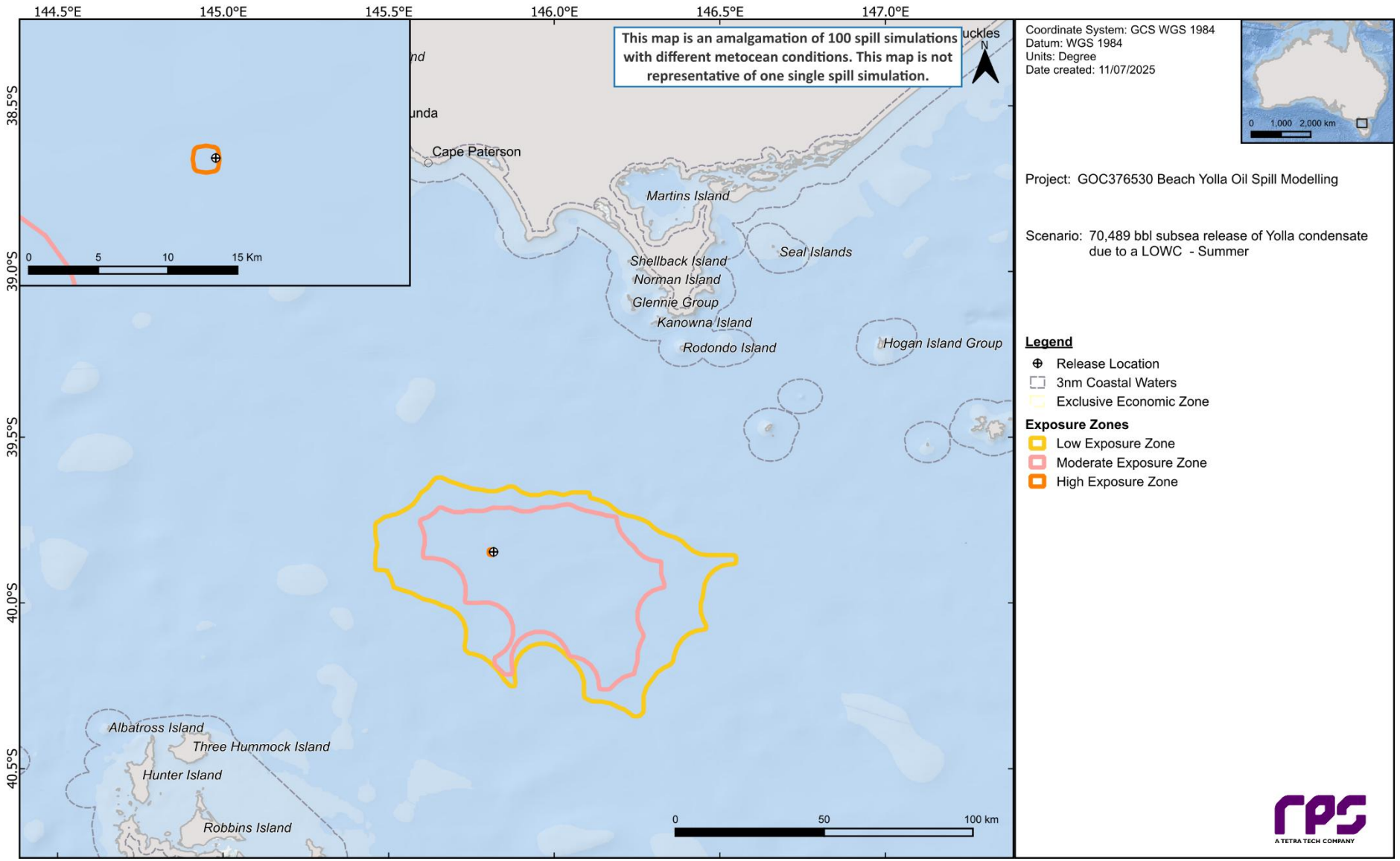


**Figure 13-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head during summer conditions.**

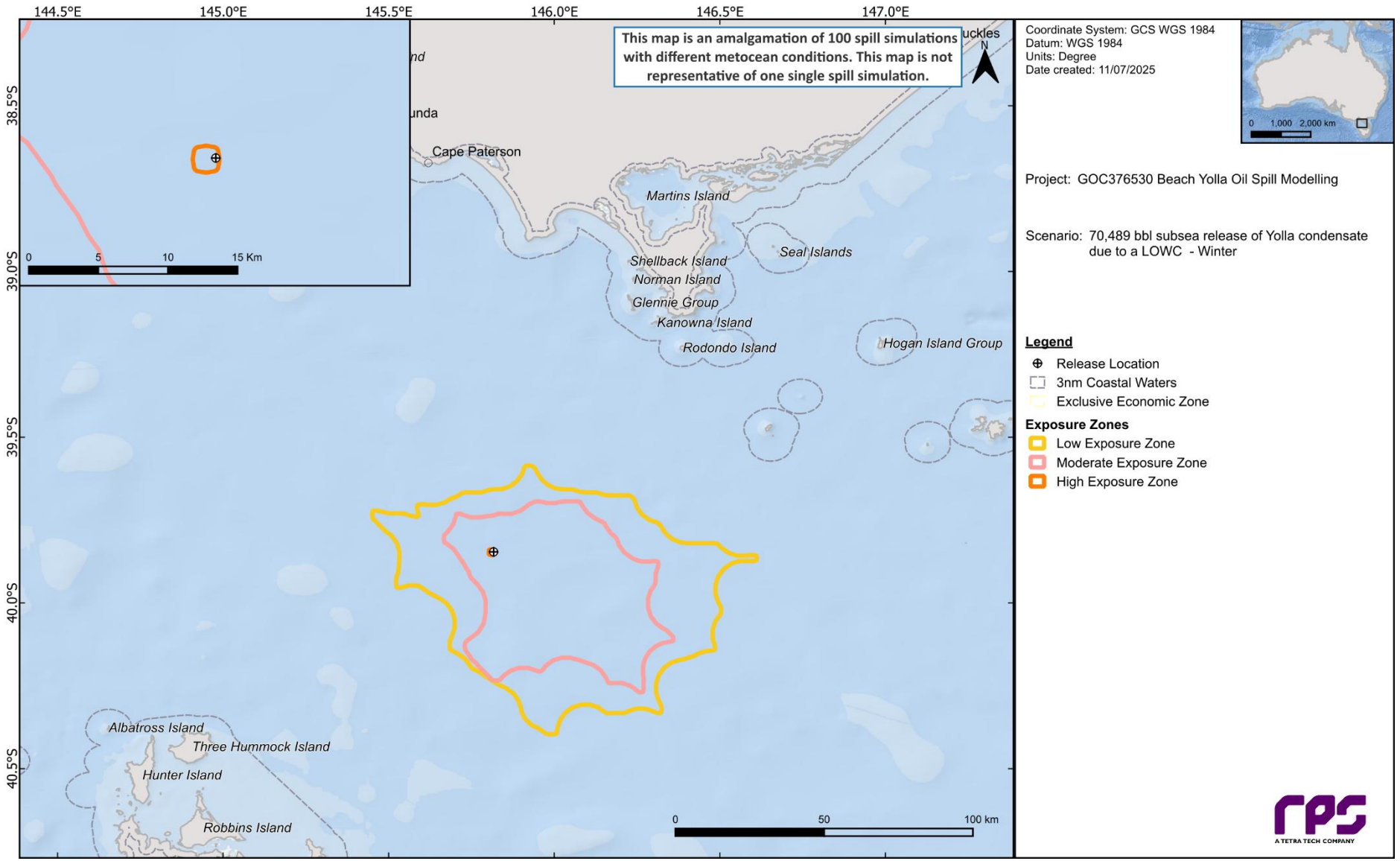


**Figure 13-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head during winter conditions.**

### 13.1.2 Floating Oil Exposure

Table 13-1 summarises the maximum distance travelled by floating oil on the sea surface at each threshold. The maximum distances from the release location to the low (1–10 g/m$^2$) exposure zones were 3 km (West-Northwest) both during winter conditions. No exposure was predicted for the moderate (10–50 g/m$^2$) and high thresholds (> 50 g/m$^2$).

Table 13-2 and Table 13-3 summarise the potential floating oil exposure to individual receptors during the summer and winter conditions. Only the receptors that the Yolla Well Head resides within forecast to reveal floating oil exposure above the low threshold.

Figure 13-3 and Figure 13-4 present the zones of potential floating oil exposure for all thresholds under summer and winter conditions, respectively.

Figure 13-5 to Figure 13-8 present the probability maps and minimum time before floating oil exposure for the NOPSEMA thresholds during summer and winter.

**Table 13-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential floating oil exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Maximum distance (km) from release location | 3 | - | - |
| | Direction | West-Northwest | - | - |
| Winter | Maximum distance (km) from release location | 3 | - | - |
| | Direction | West-Northwest | - | - |

**Table 13-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Probability of floating oil exposure (%) | | | Minimum time before floating oil exposure (days) | | | Maximum residence time for floating oil exposure (hours) | | |
| | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Pygmy Blue Whale - Distribution (None)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | White Shark - Distribution (Between the 60-120m depth contour)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| | White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| IMCRA-MESO | Central Bass Strait** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |
| MR | South-east (Marine)** | 100 | - | - | 0.04 | - | - | 4.25 | - | - |

**The release location resides within the receptor boundaries.

**Table 13-3 Summary of the potential floating oil exposure to individual receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Probability of floating oil exposure (%) | | | Minimum time before floating oil exposure (days) | | | Maximum residence time for floating oil exposure (hours) | | |
| | | Low (1mg/m$^3$) | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Pygmy Blue Whale - Distribution (None)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | White Shark - Distribution (Between the 60-120m depth contour)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| | White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| IMCRA-MESO | Central Bass Strait** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |
| MR | South-east (Marine)** | 100 | - | - | 0.04 | - | - | 5.5 | - | - |

**The release location resides within the receptor boundaries.

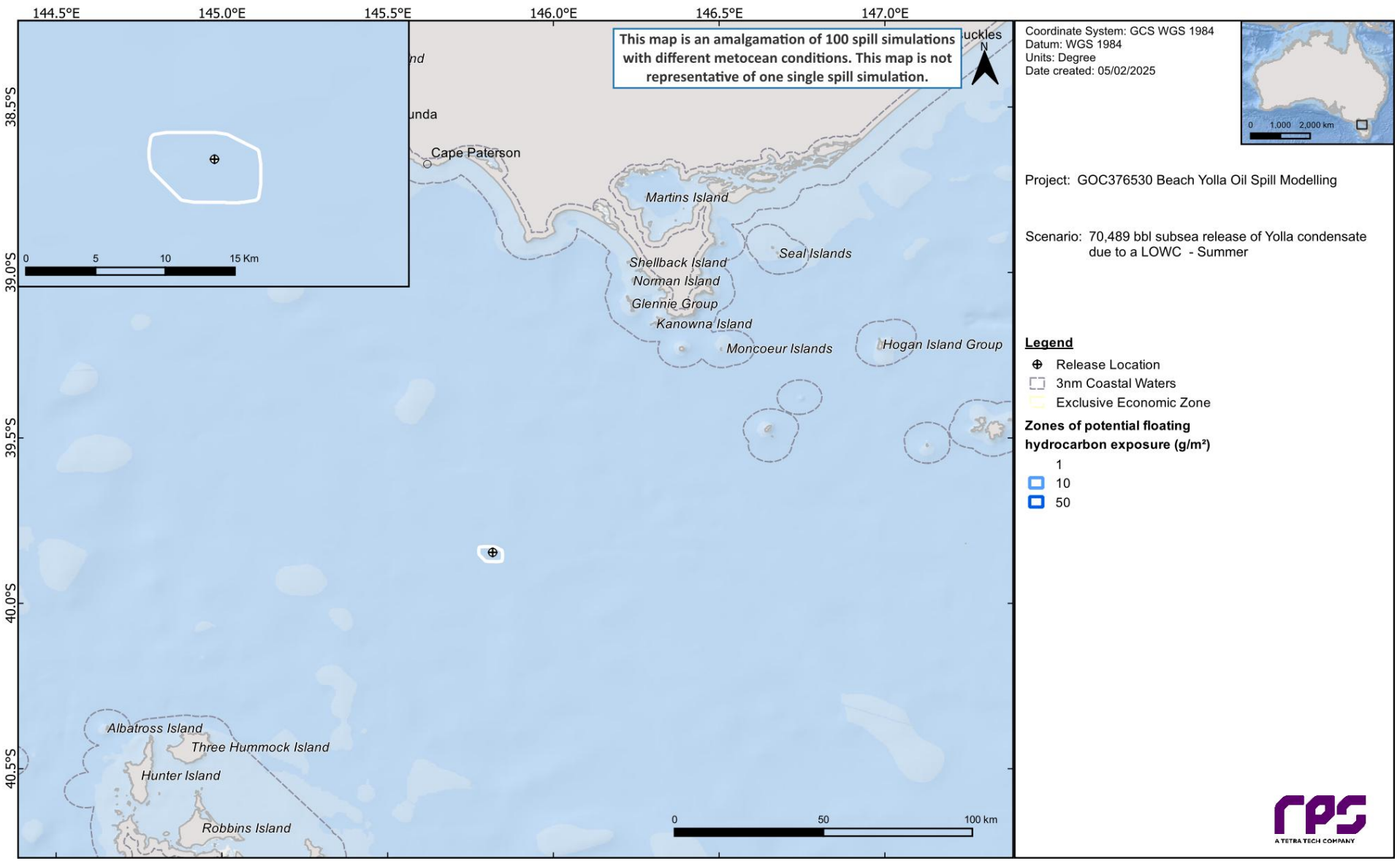


**Figure 13-3 Zones of potential floating oil exposure in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

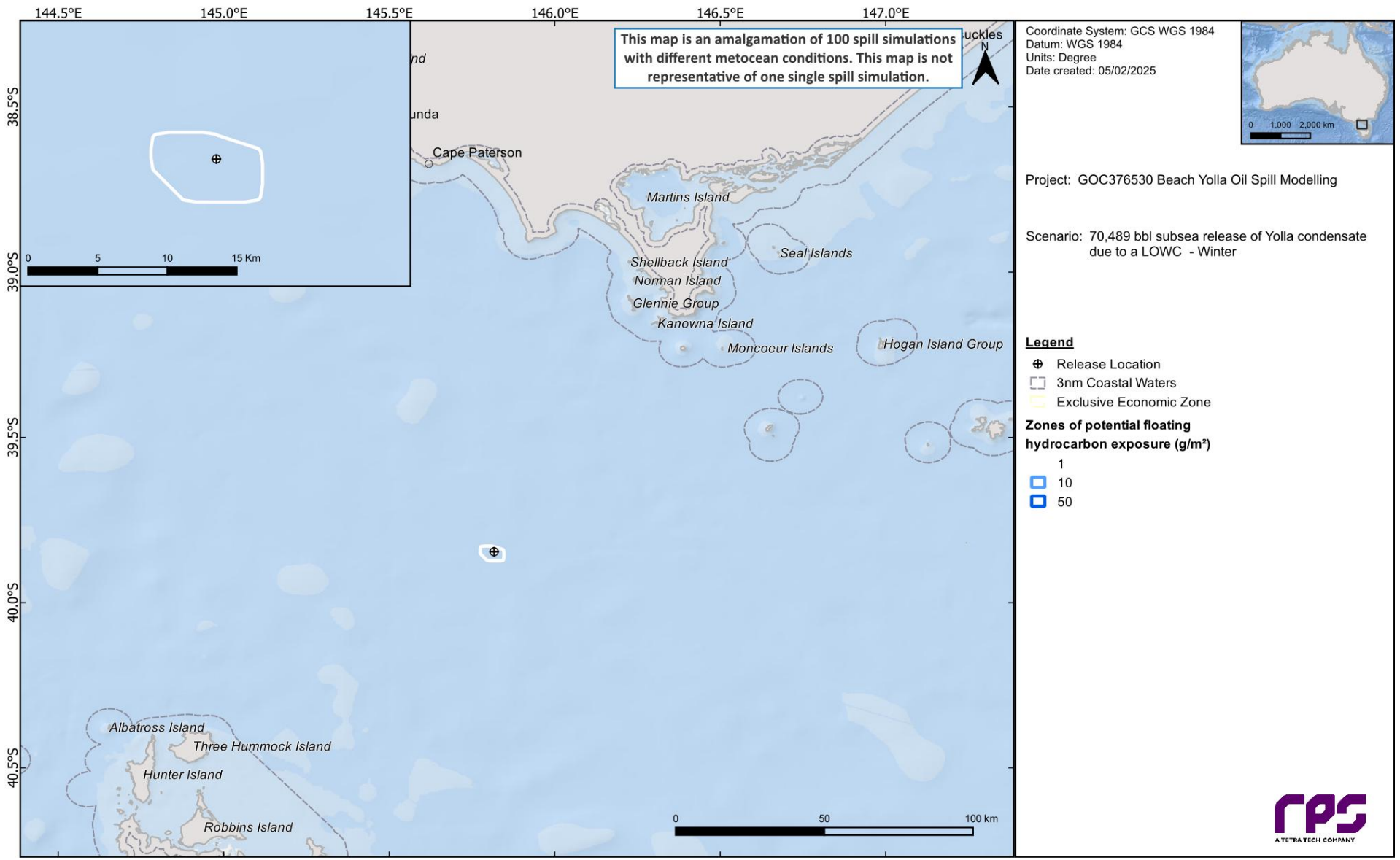


**Figure 13-4 Zones of potential floating oil exposure in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

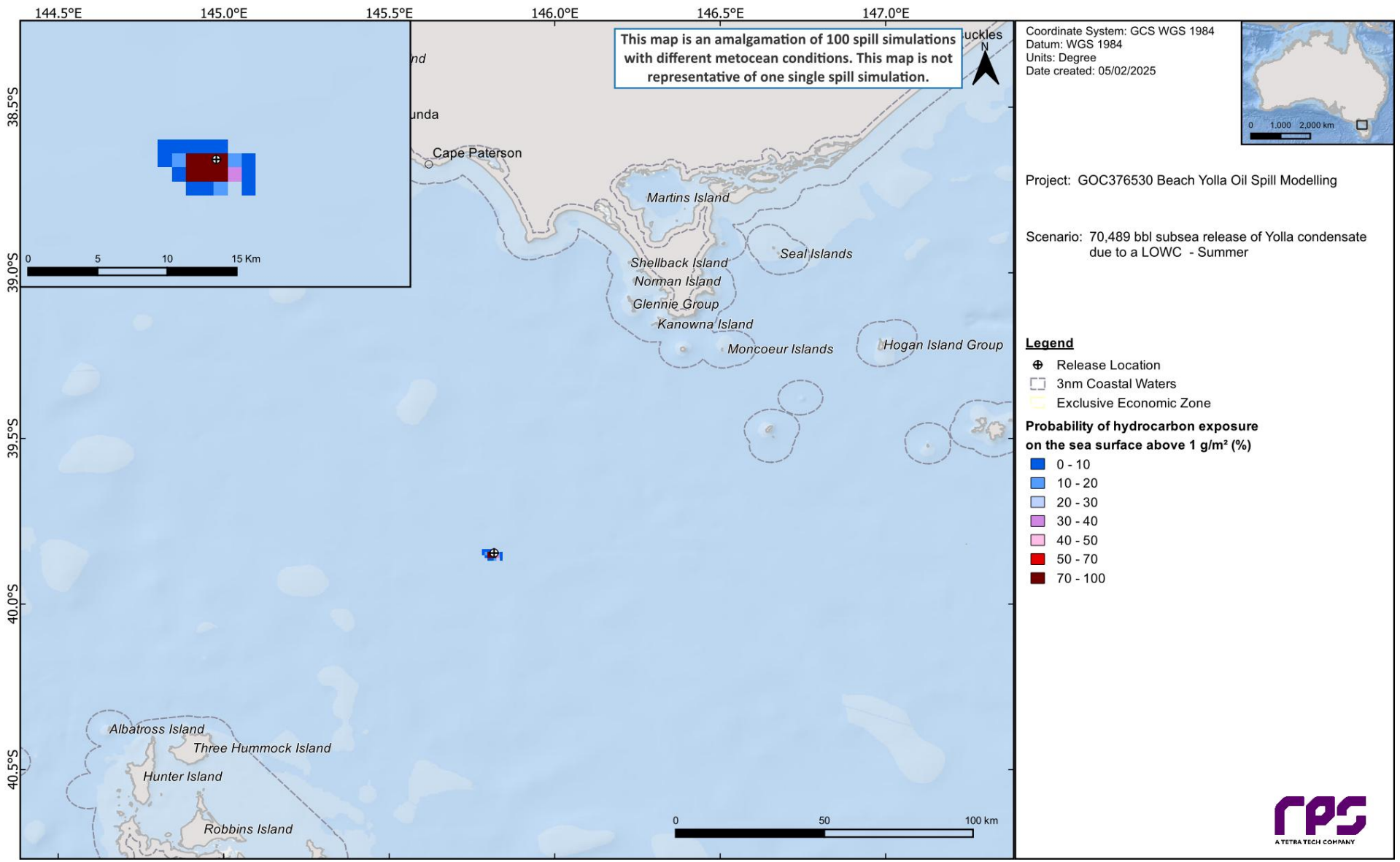


**Figure 13-5 Probability of floating oil exposure above 1 g/m², in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

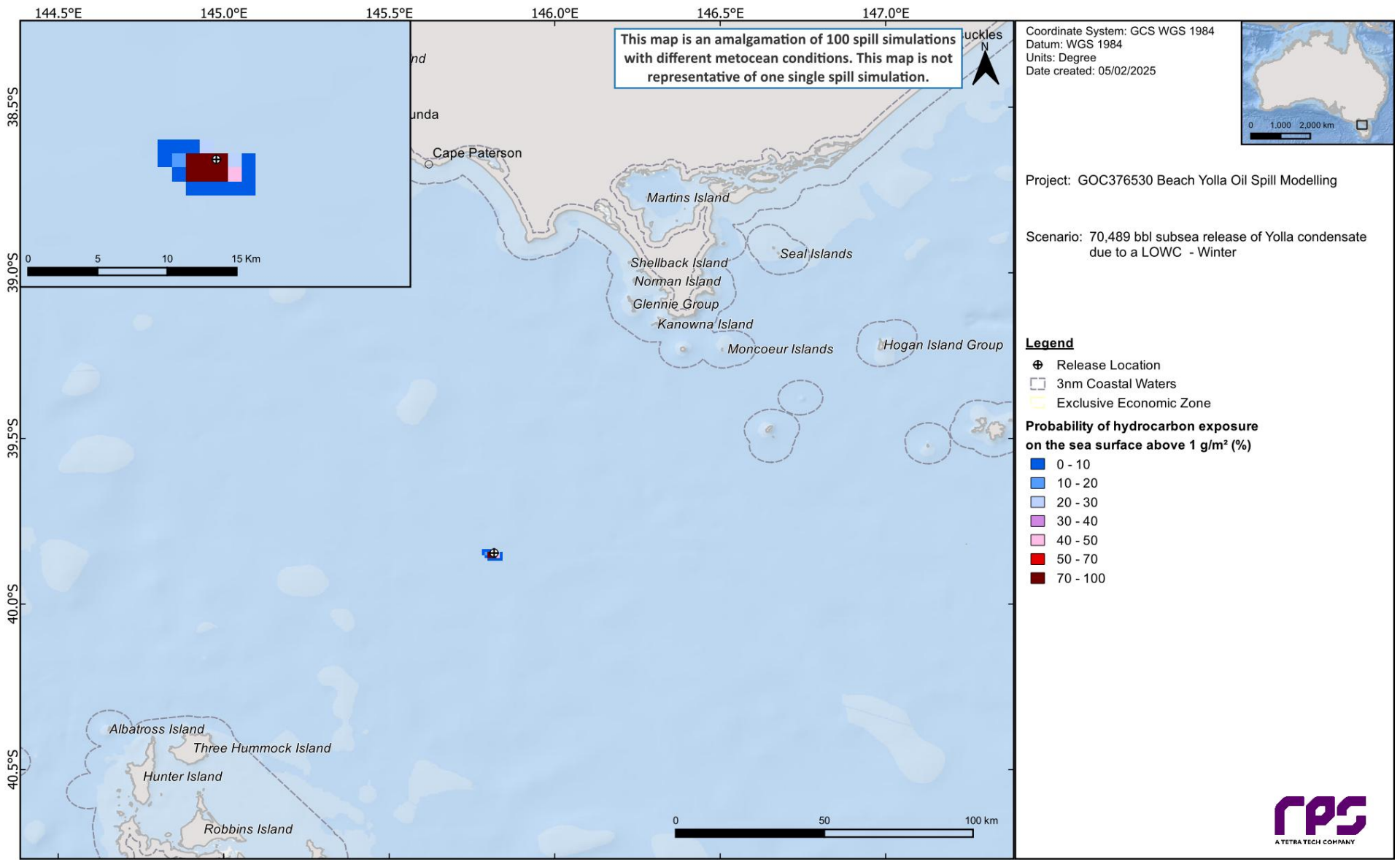


**Figure 13-6 Probability of floating oil exposure above 1 g/m², in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

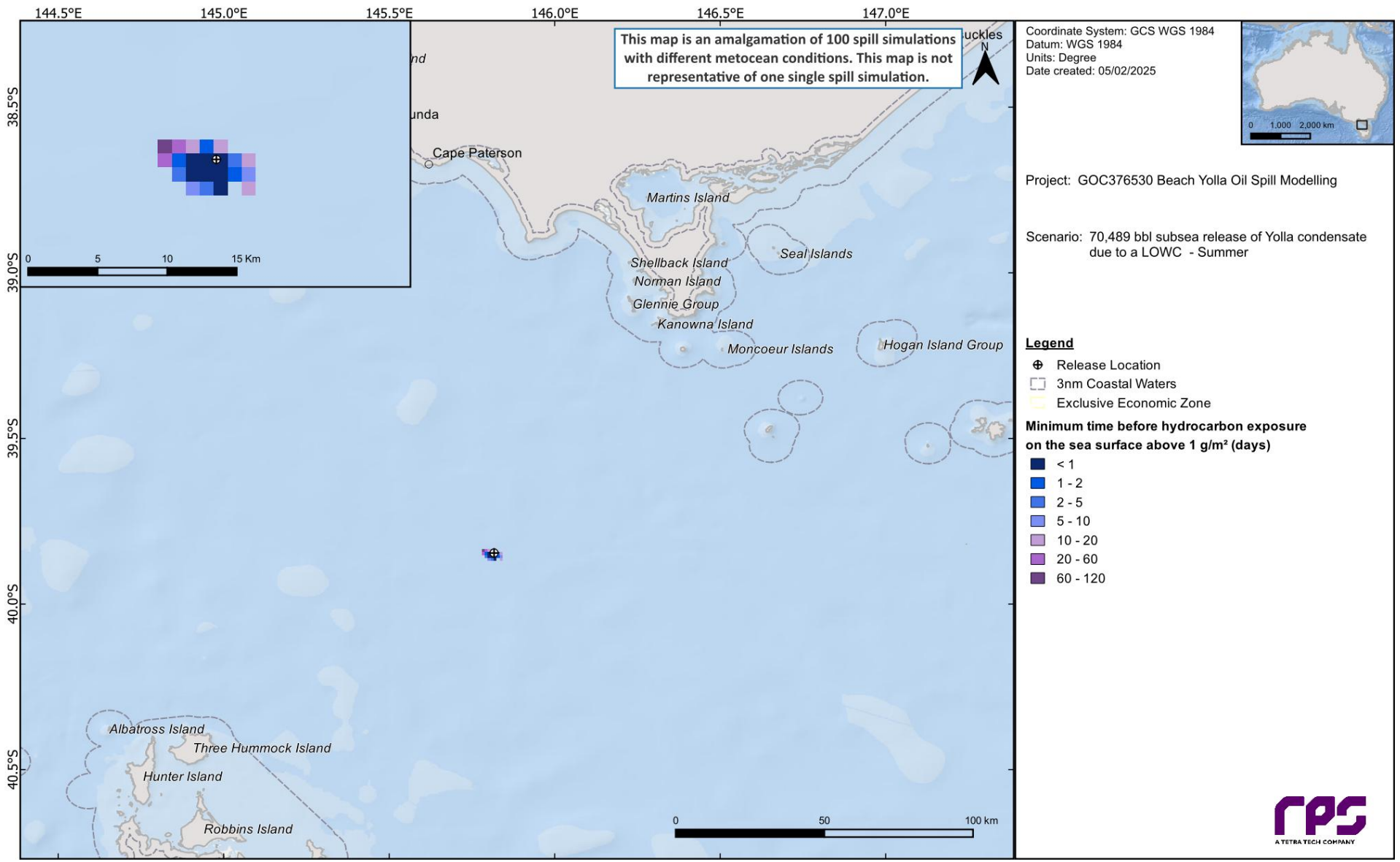


**Figure 13-7 Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

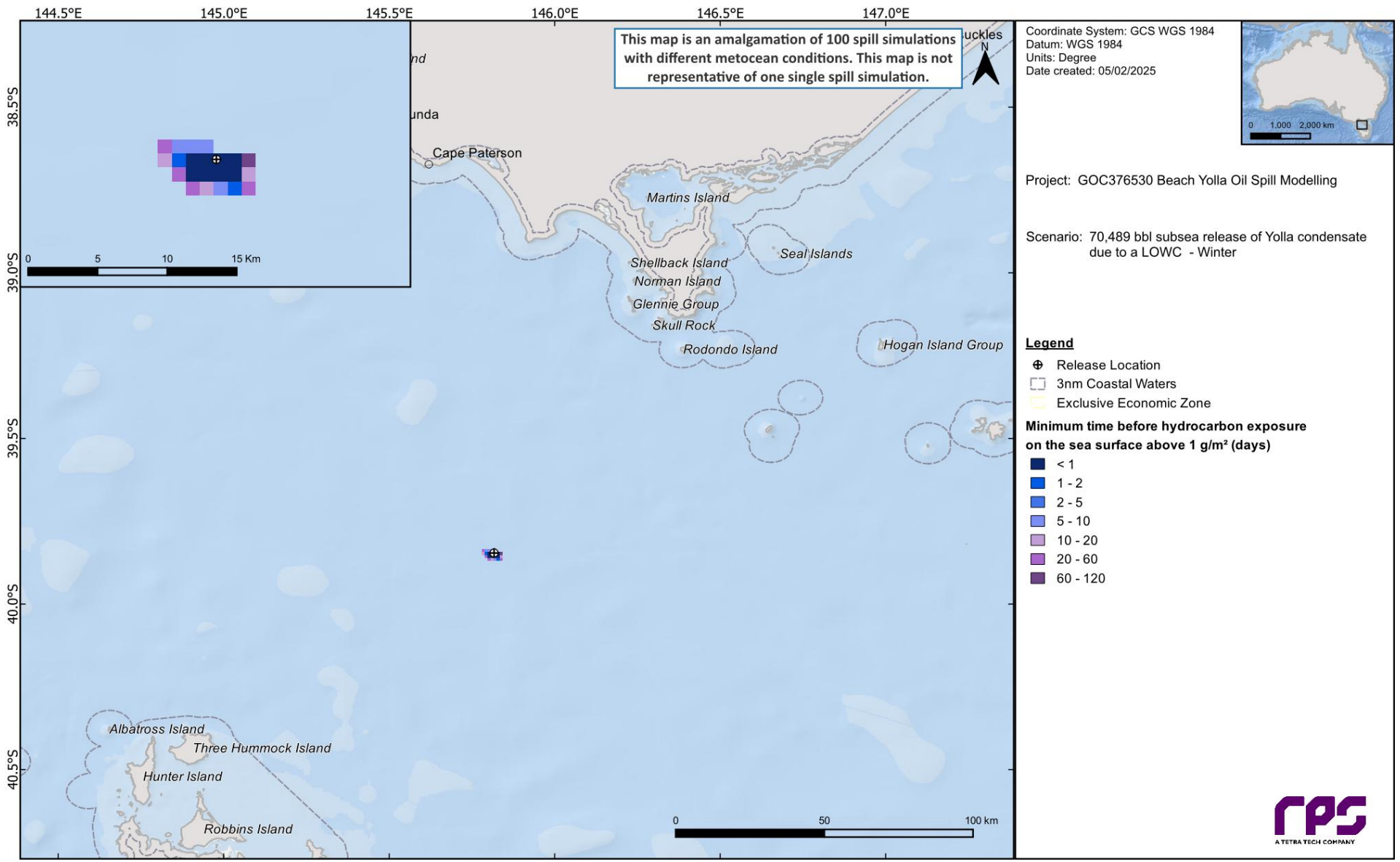


**Figure 13-8 Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

### 13.1.3 Shoreline Accumulation

No shoreline oil contact at, or above, 10 g/m$^2$ was predicted. Therefore, no results are presented.

### 13.1.4 In-water exposure

#### 13.1.4.1 Dissolved Hydrocarbons

Table 13-4 reveals the maximum distances to dissolved oil exposure during summer and winter conditions. Maximum distances to the low (10 ppb) and moderate (50 ppb) thresholds may reach 68.01 km (southeast, winter) and 59.68 km (southeast, winter) respectively.

Table 13-5 and Table 13-6 summarises the exposure to individual receptors from dissolved hydrocarbons during the summer and winter conditions.

Only the receptors that the Yolla Well Head resides within revealed dissolved hydrocarbon exposure to the low and moderate thresholds, with 100% probability. The minimum times before low exposure were 0.05 and 0.06 days in summer and winter respectively.

Figure 13-9 and Figure 13-10 present the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 13-11 to Figure 13-18 present the probability maps and the maximum residence time of dissolved hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

**Table 13-4 Maximum distance and direction from the release location to the edge of dissolved oil exposure. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential dissolve oil exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Maximum distance (km) from release location | 65.61 | 53.86 | - |
| | Direction | Southeast | Southeast | - |
| Winter | Maximum distance (km) from release location | 68.01 | 59.68 | - |
| | Direction | Southeast | Southeast | - |

**Table 13-5 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Pygmy Blue Whale - Distribution (None)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | White Shark - Distribution (Between the 60-120m depth contour)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |

| Receptor | | Summer (November through to March) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| | White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| IMCRA-MESO | Central Bass Strait** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |
| MR | South-east (Marine)** | 149.98 | 100 | 100 | - | 0.05 | 0.68 | - | 26.25 | 8 | - |

**The release location resides within the receptor boundaries.

**Table 13-6 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Pygmy Blue Whale - Distribution (None)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | White Shark - Distribution (Between the 60-120m depth contour)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |

| Receptor | | Winter (April through to October) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| | White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| IMCRA-MESO | Central Bass Strait** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |
| MR | South-east (Marine)** | 141.56 | 100 | 100 | - | 0.06 | 0.98 | - | 59.25 | 6.25 | - |

**The release location resides within the receptor boundaries.

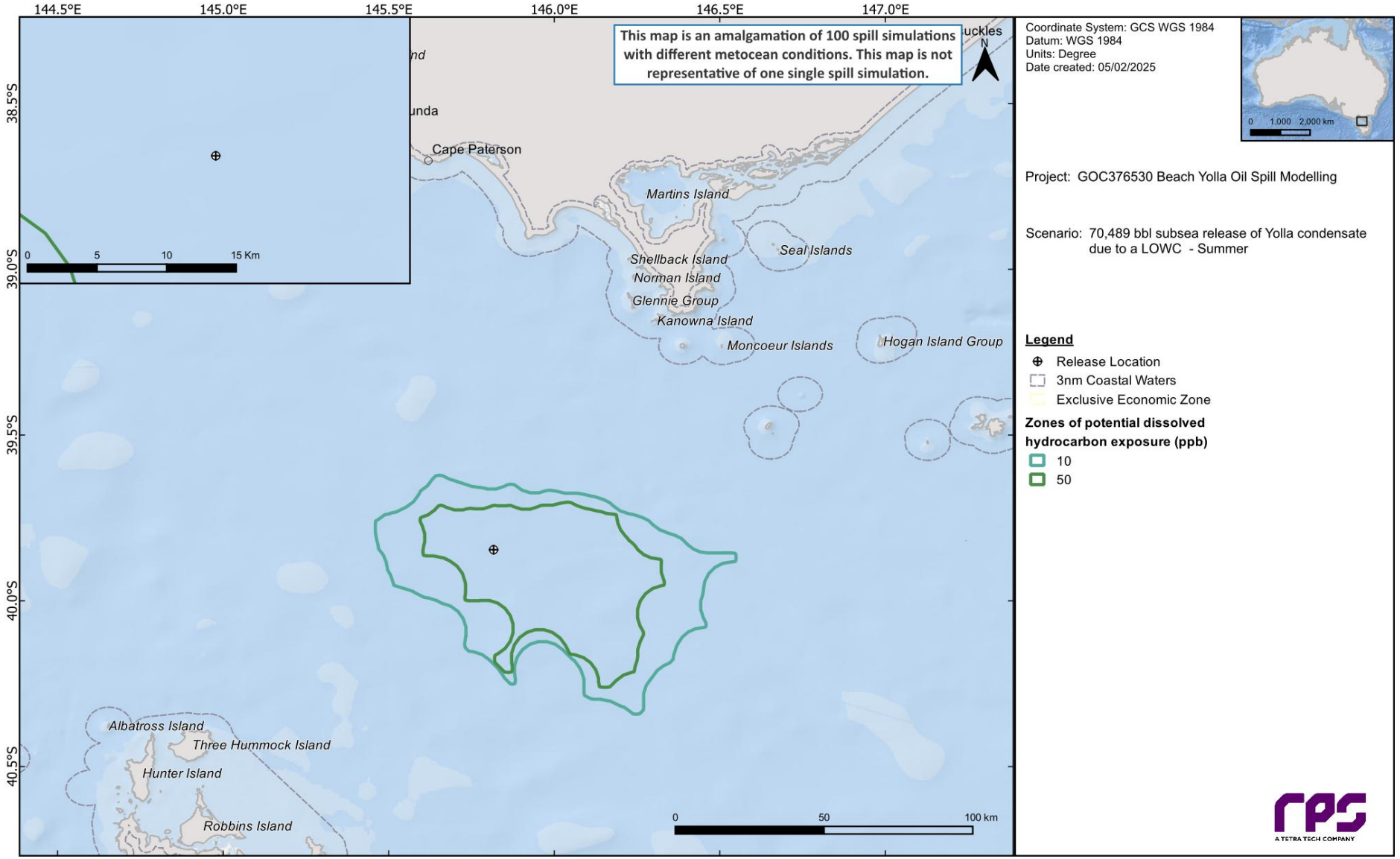


**Figure 13-9** **Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

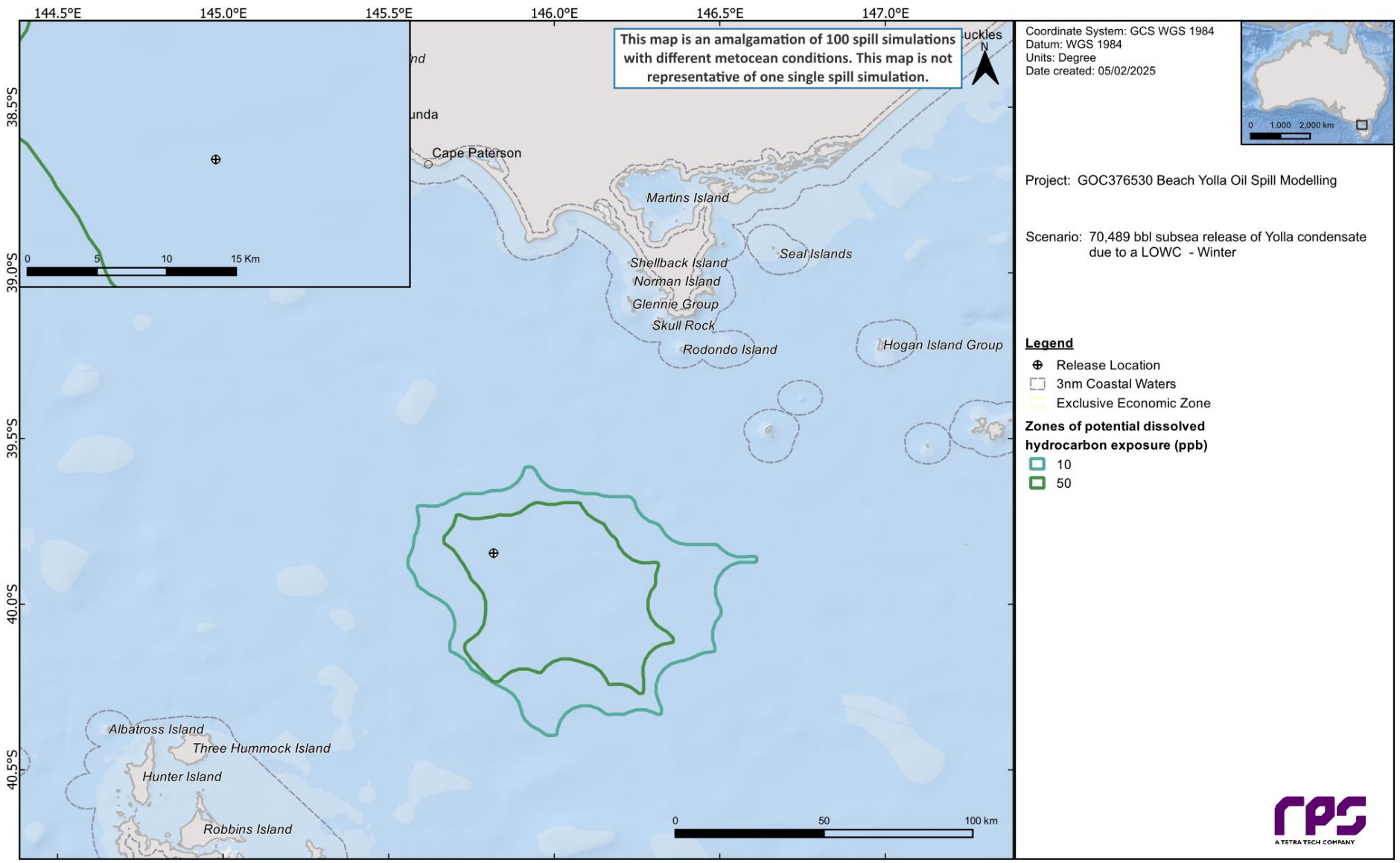


**Figure 13-10 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

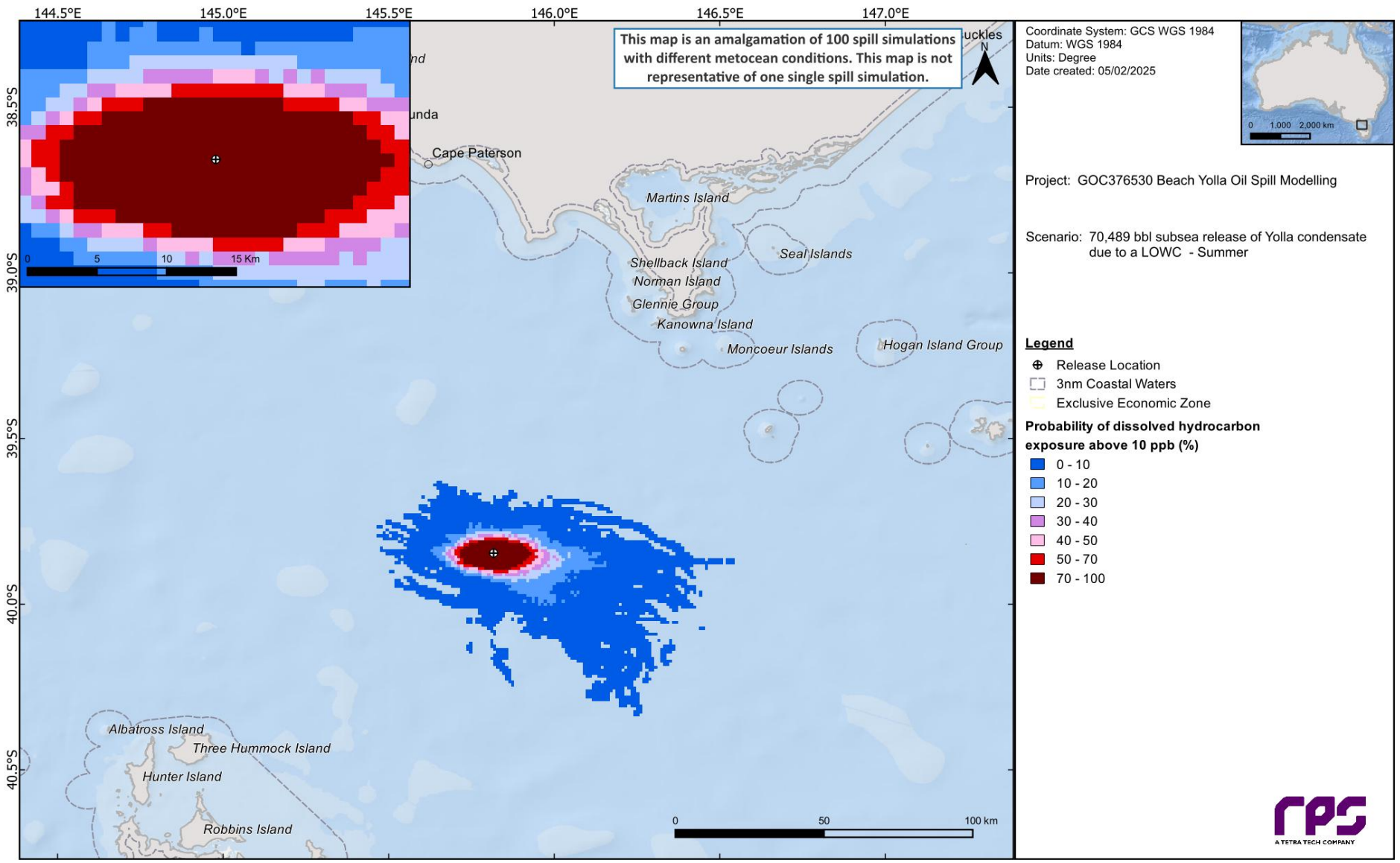


**Figure 13-11 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

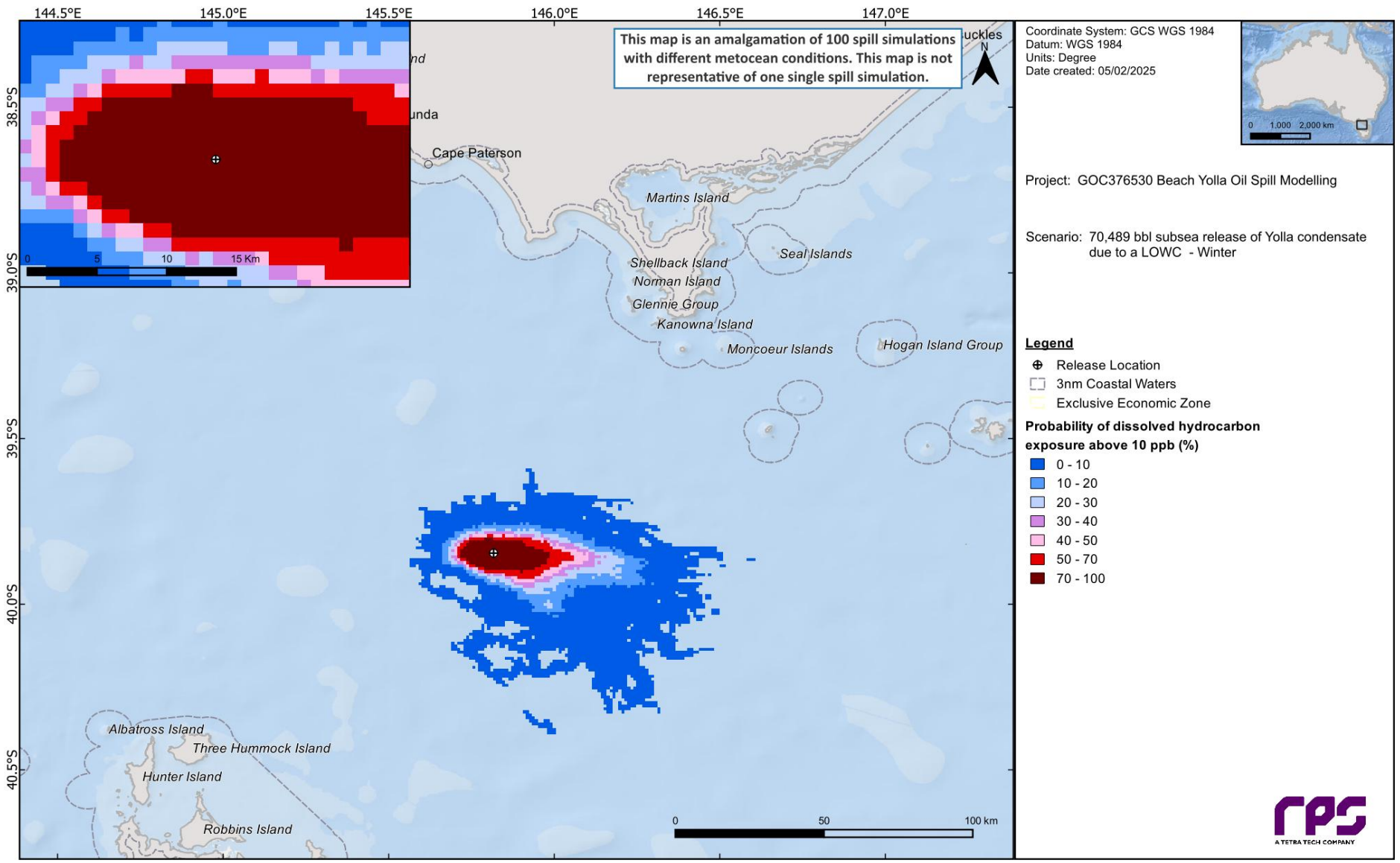


**Figure 13-12 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

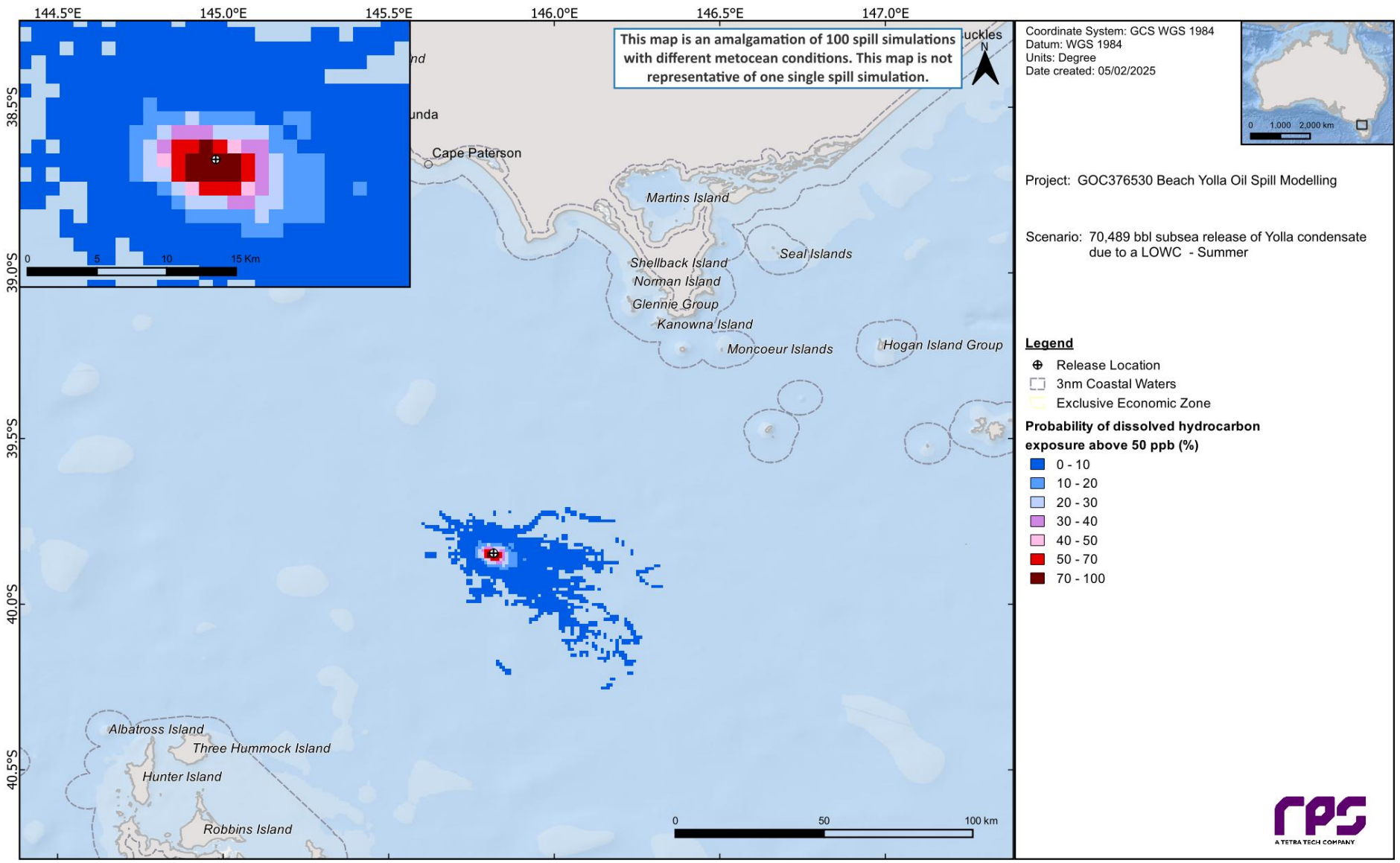


**Figure 13-13 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

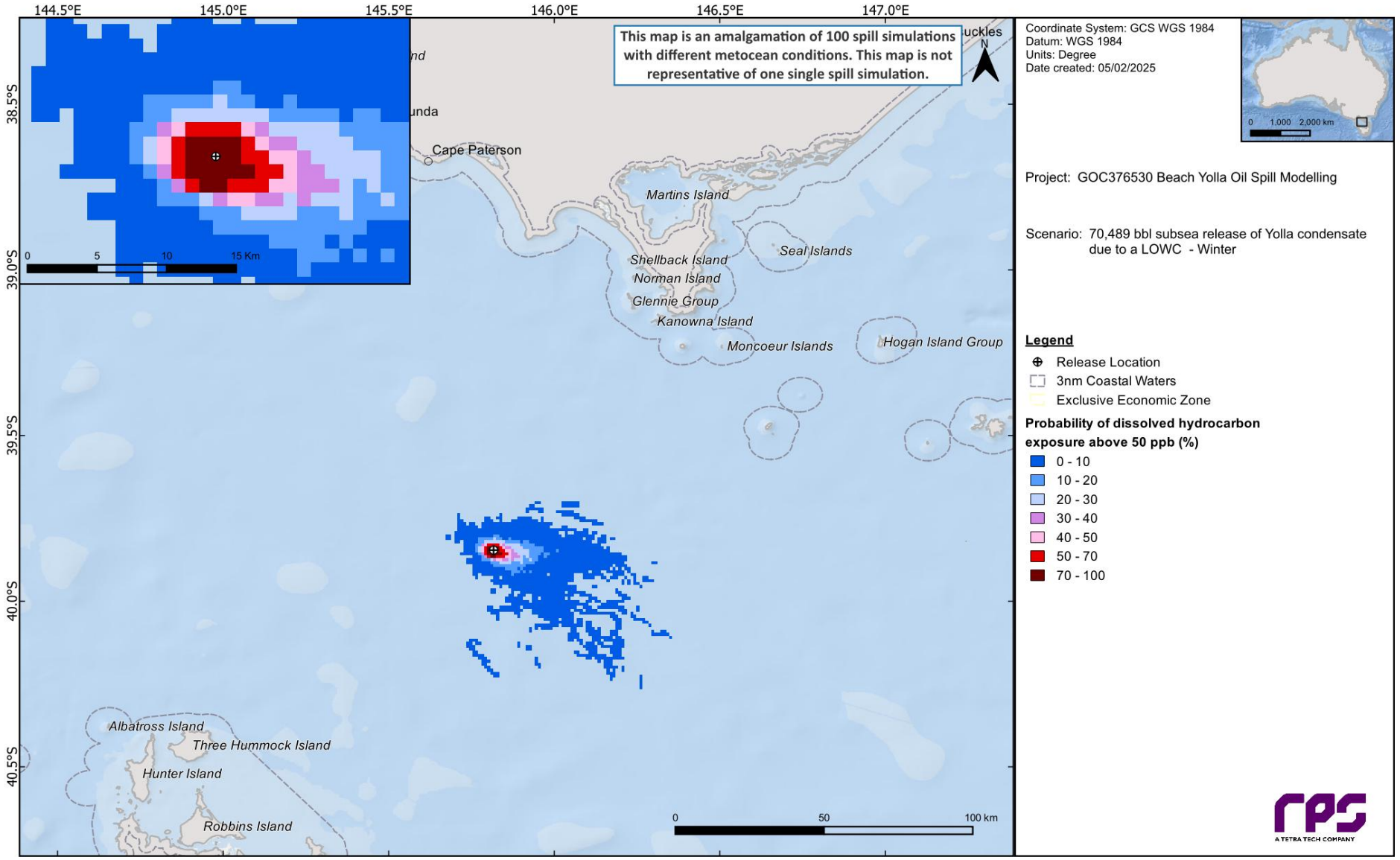


**Figure 13-14 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

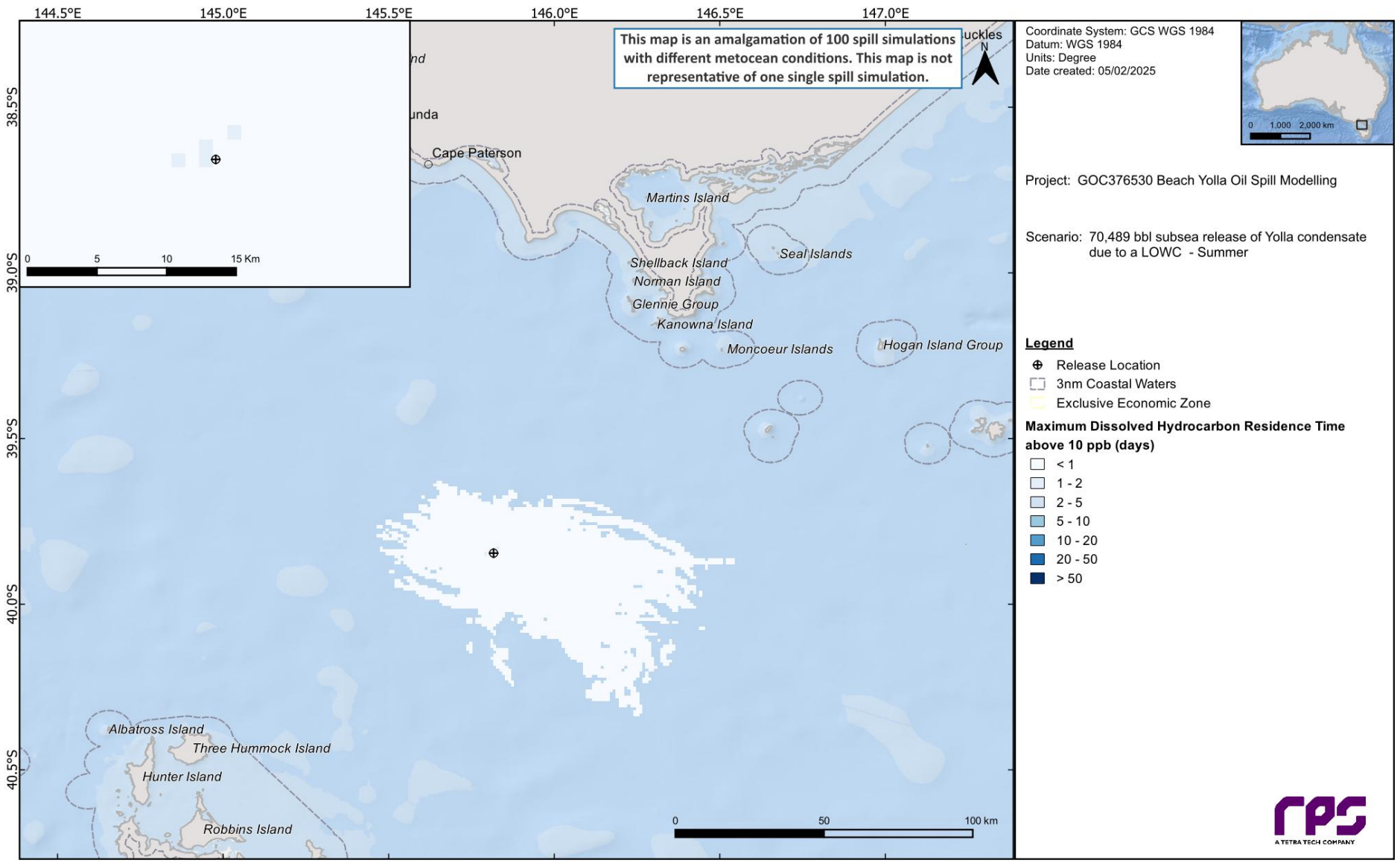


**Figure 13-15 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

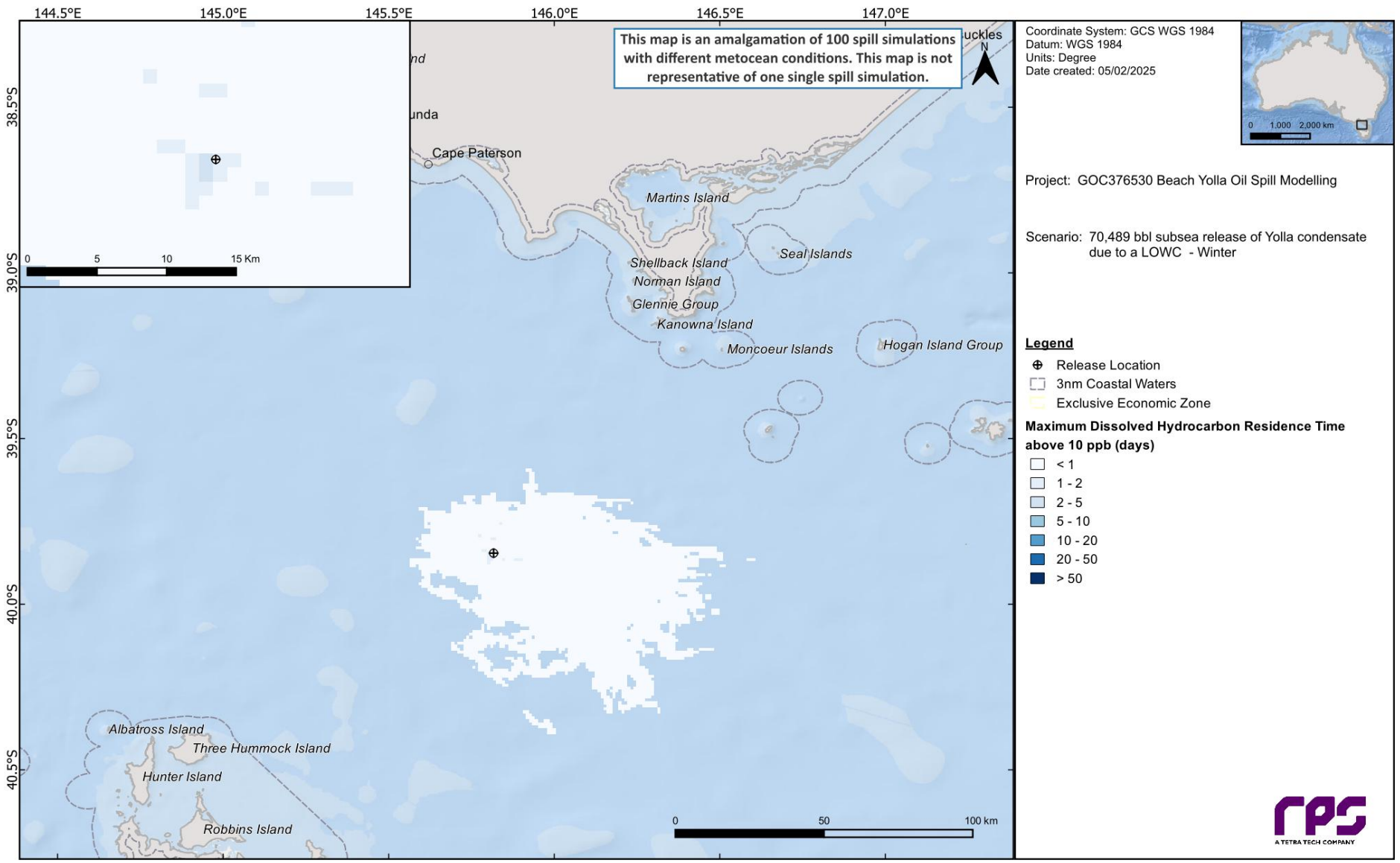


**Figure 13-16 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

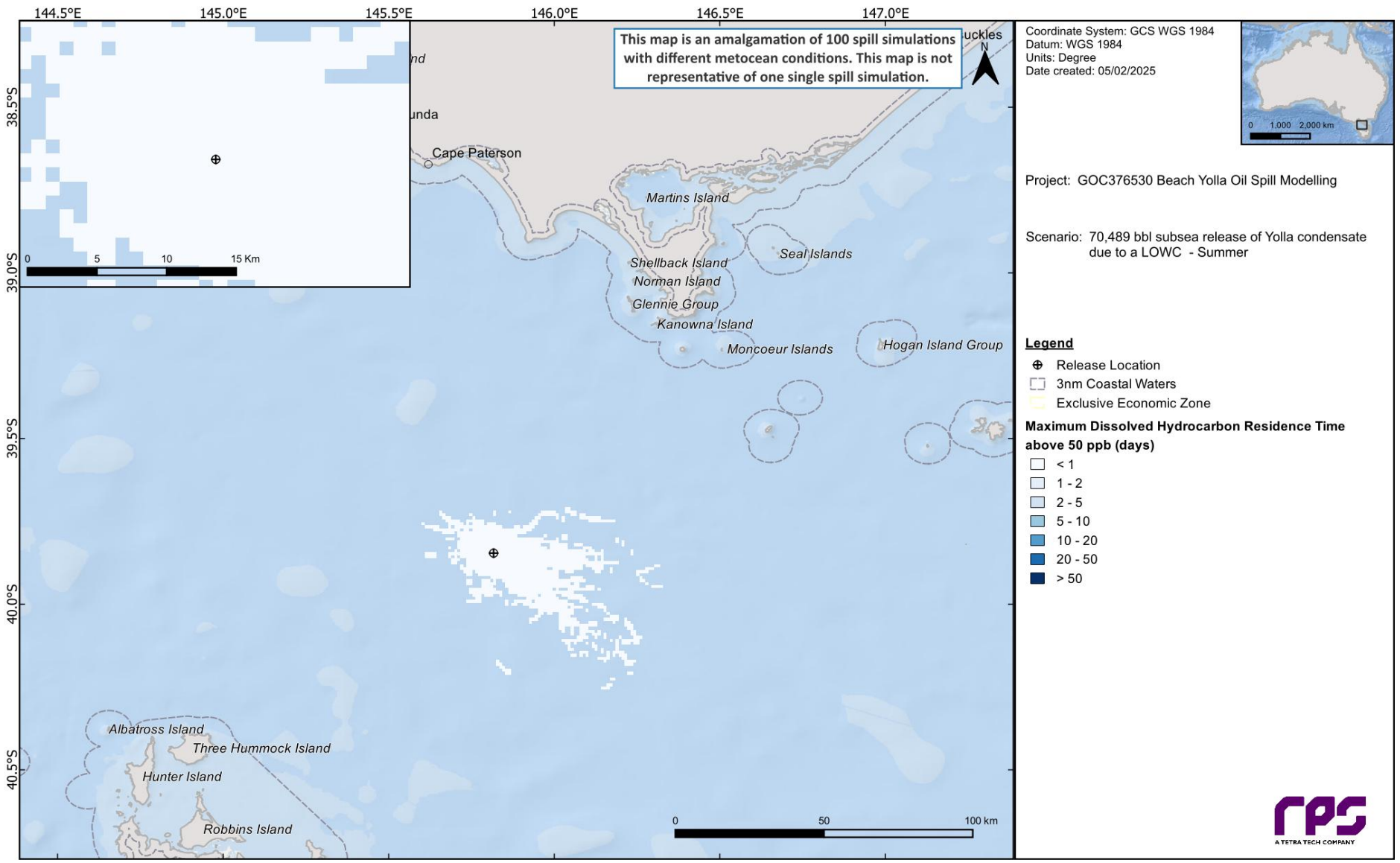


**Figure 13-17 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

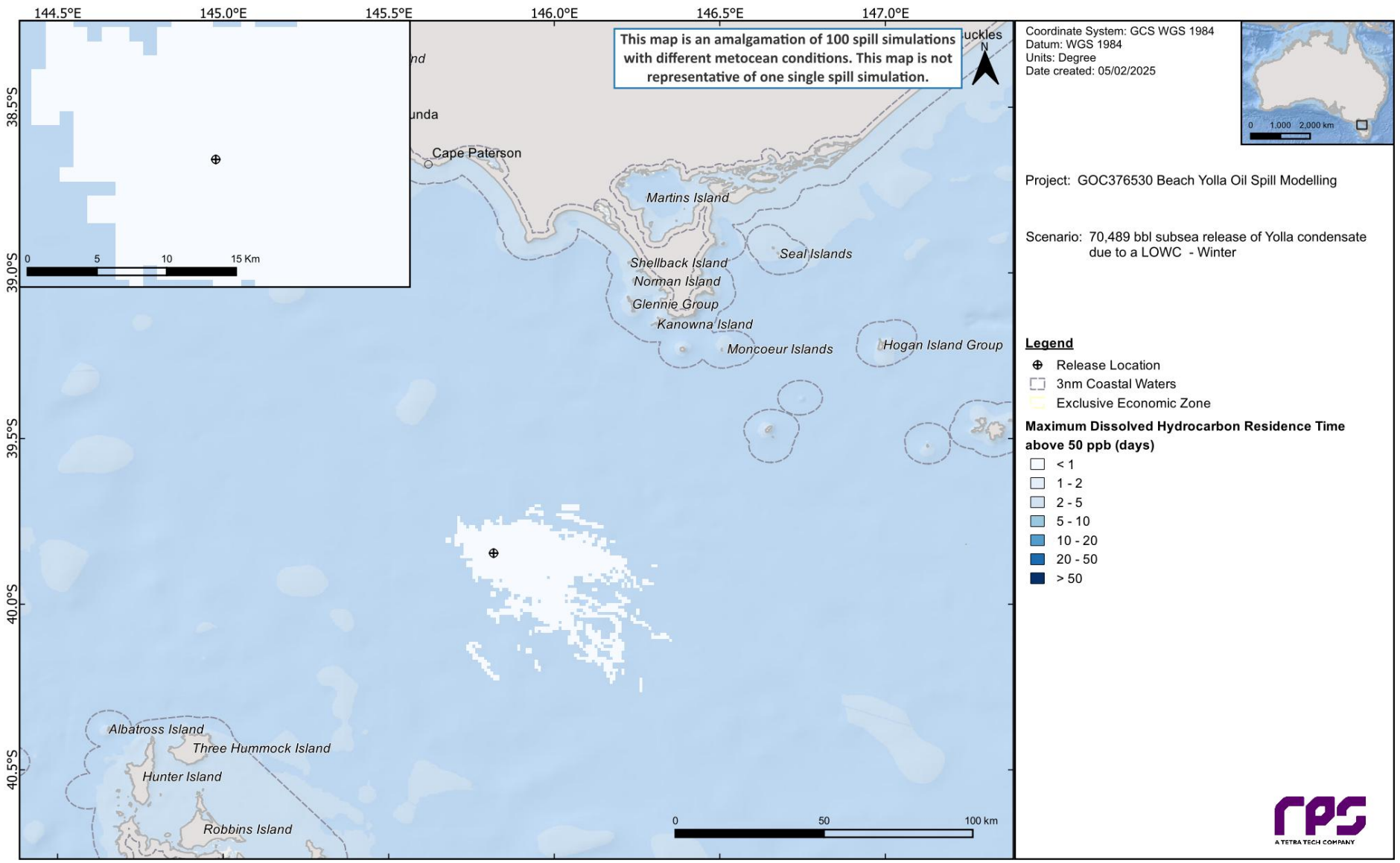


**Figure 13-18 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

### 13.1.4.2 Entrained Hydrocarbons

Table 13-7 reveals the maximum distances to entrained oil exposure during summer and winter conditions. Maximum distances to the 10 ppb and 100 ppb thresholds may reach 552.28 km (northeast, winter) and 7.59 km (east-southeast, winter) respectively.

Table 13-8 and Table 13-9 present a summary of exposure to individual receptors from entrained hydrocarbons for the summer and winter conditions.

Except for the receptors that the Yolla Well Head resides within, the highest probabilities of entrained hydrocarbons at, or above, 10 ppb with probabilities were 24% for the Southeast Shelf Transition IMCRA and the Tasmanian State Waters during summer and 24% for the Southeast Shelf Transition IMCRA in winter. The minimum time before exposure was 57.3 days and 46.93 days in summer and winter respectively.

Figure 13-19 and Figure 13-20 present the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 13-21 to Figure 13-28 present the probability maps and the maximum residence time of entrained hydrocarbon exposure for the 10 ppb and 100 ppb thresholds in summer and winter.

**Table 13-7 Maximum distance and direction from the release location to the edge of entrained oil exposure. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential entrained oil exposure | |
|---|---|---|---|
| | | 10 ppb | 100 ppb |
| Summer | Maximum distance (km) from release location | 435.95 | 7.58 |
| | Direction | East-Northeast | Southeast |
| Winter | Maximum distance (km) from release location | 552.28 | 7.59 |
| | Direction | Northeast | East-Southeast |

**Table 13-8 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| AMP | Beagle | 36.56 | 18 | - | 57.3 | - | 135 | - |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Black-faced Cormorant - Foraging (Wendar Island and The Coffee Pot) | 11.5 | 1 | - | 96.69 | - | 10.75 | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Little Penguin - Foraging (Gabo Island) | 29.35 | 7 | - | 70.17 | - | 159.5 | - |
| | Little Penguin - Foraging (North-western edge of Cape Barren Island) | 18.23 | 3 | - | 63.69 | - | 36.75 | - |
| | Pygmy Blue Whale - Distribution (None)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Soft-plumaged Petrel - Foraging (Buffer around the south of Tasmania) | 15.64 | 3 | - | 86.84 | - | 65 | - |
| | Sooty Shearwater - Foraging (Buffer around the south of Tasmania) | 11.5 | 1 | - | 96.69 | - | 10.75 | - |
| | Southern Right Whale - Connecting habitat (Coastal areas around Tasmania) | 15.64 | 3 | - | 86.84 | - | 65 | - |

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Southern Right Whale - Migration and resting on migration (Gippsland coast region) | 29.35 | 7 | - | 70.17 | - | 159.5 | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Montague Island (NSW)) | 29.35 | 7 | - | 70.17 | - | 159.5 | - |
| | White Shark - Distribution (Between the 60-120m depth contour)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 36.56 | 20 | - | 57.3 | - | 135 | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | White-faced Storm-petrel - Foraging (Gabo Island) | 29.35 | 7 | - | 70.17 | - | 159.5 | - |
| IBRA | Furneaux | 16.19 | 14 | - | 60.43 | - | 89.25 | - |
| IMCRA-MESO | Central Bass Strait** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Davey | 11.5 | 1 | - | 96.69 | - | 10.75 | - |
| | Flinders | 18.23 | 9 | - | 63.69 | - | 36.75 | - |
| | Franklin | 15.64 | 3 | - | 86.84 | - | 65 | - |

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | Twofold Shelf | 36.56 | 21 | - | 57.3 | - | 159.5 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| | Southeast Shelf Transition | 36.56 | 24 | - | 57.3 | - | 159.5 | - |
| | Tasmanian Shelf Province | 15.64 | 3 | - | 86.84 | - | 65 | - |
| KEF | Upwelling East of Eden | 29.35 | 7 | - | 70.17 | - | 159.5 | - |
| MR | South-east (Marine)** | 1,119.87 | 100 | 100 | 0.01 | 0.01 | 2,075.75 | 2,065 |
| NP | Kent Group | 36.56 | 16 | - | 57.3 | - | 135 | - |
| NRMR | East Gippsland (VIC) | 29.35 | 7 | - | 70.17 | - | 159.5 | - |
| | North NRM Region (TAS) | 36.56 | 21 | - | 57.3 | - | 135 | - |
| | North West NRM Region (TAS) | 15.64 | 3 | - | 86.84 | - | 65 | - |
| | South NRM Region (TAS) | 11.5 | 1 | - | 96.69 | - | 10.75 | - |
| SHORE-LGA | Flinders Council (TAS) | 36.56 | 17 | - | 57.3 | - | 135 | - |
| | Gabo Island (Unincorporated) (VIC) | 29.35 | 7 | - | 70.17 | - | 159.5 | - |
| | Huon Valley Council (TAS) | 11.5 | 1 | - | 96.69 | - | 10.75 | - |
| | West Coast Council (TAS) | 15.64 | 3 | - | 86.84 | - | 65 | - |
| SHORE-VIC-MPRA | Cape Howe / Mallacoota | 29.35 | 7 | - | 70.17 | - | 159.5 | - |
| State Waters | Tasmania | 36.56 | 24 | - | 57.3 | - | 135 | - |
| | Victoria | 29.35 | 7 | - | 70.17 | - | 159.5 | - |

**The release location resides within the receptor boundaries.

**Table 13-9 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| AMP | Beagle | 13.92 | 5 | - | 69.28 | - | 24.5 | - |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Crested Tern - Breeding (Montague Island) | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| | Crested Tern - Foraging (Montague Island) | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| | Grey Nurse Shark - Foraging (From North of the Solitary Islands to south of Bermagui) | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| | Grey Nurse Shark - Foraging (Off the coast of Eden) | 37.2 | 7 | - | 65.56 | - | 209 | - |
| | Humpback Whale - Foraging (From NSW-QLD border to Eden) | 37.2 | 7 | - | 65.56 | - | 209 | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Indo-Pacific/Spotted Bottlenose Dolphin - Breeding (Throughout statewaters of the East Marine Region, within the 20 metre contour) | 37.2 | 7 | - | 65.56 | - | 209 | - |
| | Little Penguin - Breeding (Montague Island) | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| | Little Penguin - Foraging (Gabo Island) | 28.47 | 2 | - | 68.05 | - | 200.5 | - |
| | Little Penguin - Foraging (North-western edge of Cape Barren Island) | 21.18 | 9 | - | 46.93 | - | 65 | - |
| | Pygmy Blue Whale - Distribution (None)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Short-tailed Shearwater - Foraging (Buffer around Montague Island) | 37.2 | 7 | - | 65.56 | - | 209 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Short-tailed Shearwater - Foraging (Montague Island) | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Sooty Shearwater - Foraging (Montague Island) | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Southern Right Whale - Migration and resting on migration (Gippsland coast region) | 37.2 | 12 | - | 65.56 | - | 209 | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Montague Island (NSW)) | 37.2 | 7 | - | 65.56 | - | 209 | - |
| | White Shark - Distribution (Between the 60-120m depth contour)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 21.18 | 18 | - | 46.93 | - | 76.75 | - |

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | White-faced Storm-petrel - Breeding (120km buffer around the Tollgate Islands, Batemans Bay) | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| | White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | White-faced Storm-petrel - Foraging (Gabo Island) | 37.2 | 12 | - | 65.56 | - | 209 | - |
| IBRA | Furneaux | 13.92 | 5 | - | 69.28 | - | 24.5 | - |
| IMCRA-MESO | Batemans Shelf | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| | Central Bass Strait** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Flinders | 21.18 | 9 | - | 46.93 | - | 65 | - |
| | Twofold Shelf | 37.2 | 16 | - | 65.56 | - | 209 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| | Southeast Shelf Transition | 37.2 | 24 | - | 46.93 | - | 209 | - |
| KEF | Upwelling East of Eden | 37.2 | 12 | - | 65.56 | - | 209 | - |
| MNP | Point Hicks | 14.96 | 5 | - | 87.01 | - | 76.75 | - |
| MP | Batemans | 10.41 | 1 | - | 89.83 | - | 0.5 | - |
| MR | South-east (Marine)** | 1,064.92 | 100 | 100 | 0.01 | 0.01 | 2,073.50 | 2,064.75 |
| NP | Kent Group | 13.92 | 5 | - | 69.28 | - | 24.5 | - |
| NRMR | East Gippsland (VIC) | 28.47 | 7 | - | 68.05 | - | 200.5 | - |
| | North NRM Region (TAS) | 21.18 | 13 | - | 46.93 | - | 65 | - |
| | South East NSW (NSW) | 37.2 | 7 | - | 65.56 | - | 209 | - |
| SHORE-LGA | Bega Valley Shire Council (NSW) | 37.2 | 7 | - | 65.56 | - | 209 | - |
| | Flinders Council (TAS) | 13.92 | 5 | - | 69.28 | - | 24.5 | - |
| | Gabo Island (Unincorporated) (VIC) | 28.47 | 2 | - | 68.05 | - | 200.5 | - |
| | Cape Howe / Mallacoota | 28.47 | 2 | - | 68.05 | - | 200.5 | - |

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| SHORE-VIC-MPRA | Point Hicks | 14.96 | 5 | - | 87.01 | - | 76.75 | - |
| State Waters | New South Wales | 37.2 | 7 | - | 65.56 | - | 209 | - |
| | Tasmania | 21.18 | 13 | - | 46.93 | - | 65 | - |
| | Victoria | 28.47 | 7 | - | 68.05 | - | 200.5 | - |

**The release location resides within the receptor boundaries.

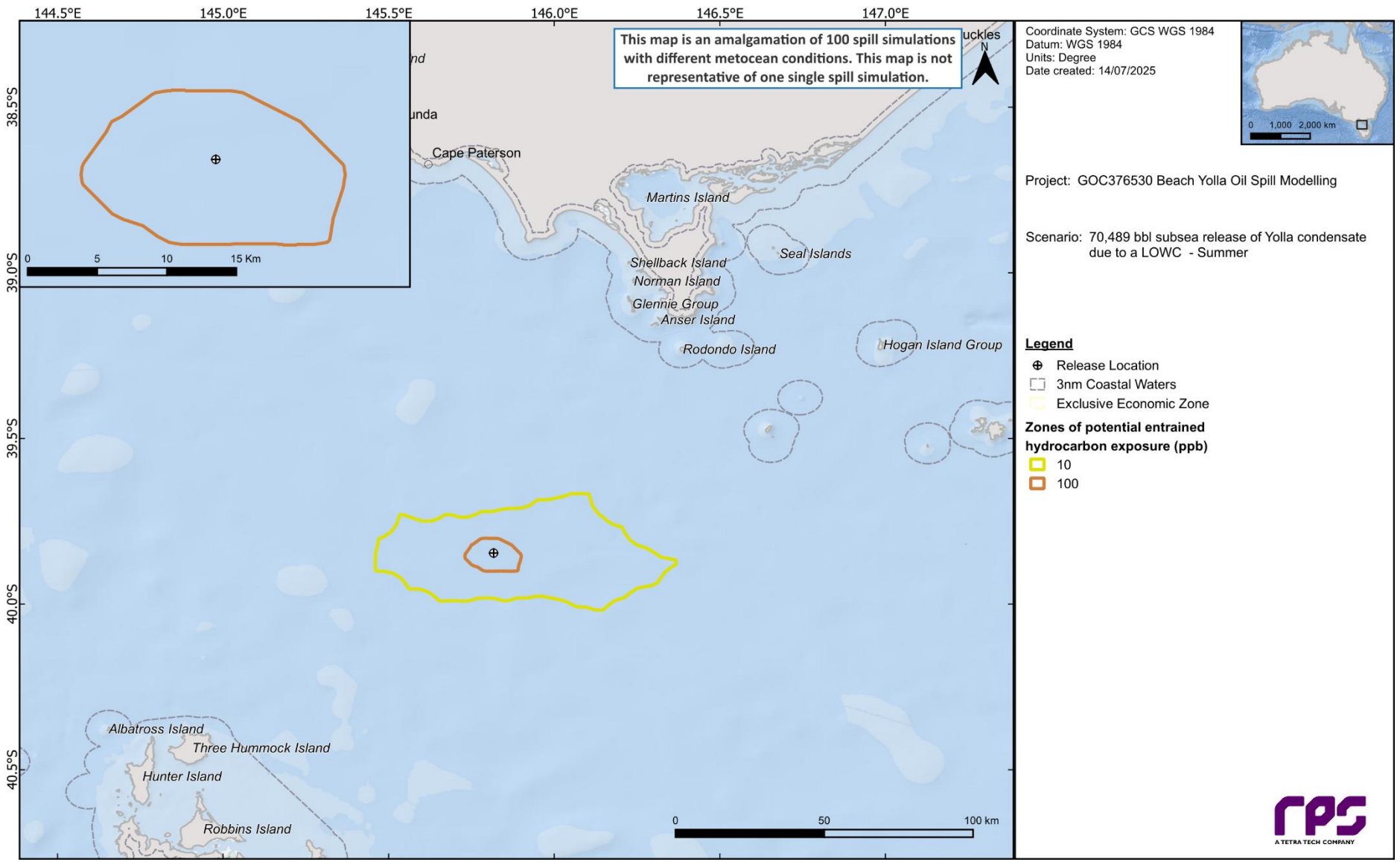


**Figure 13-19 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

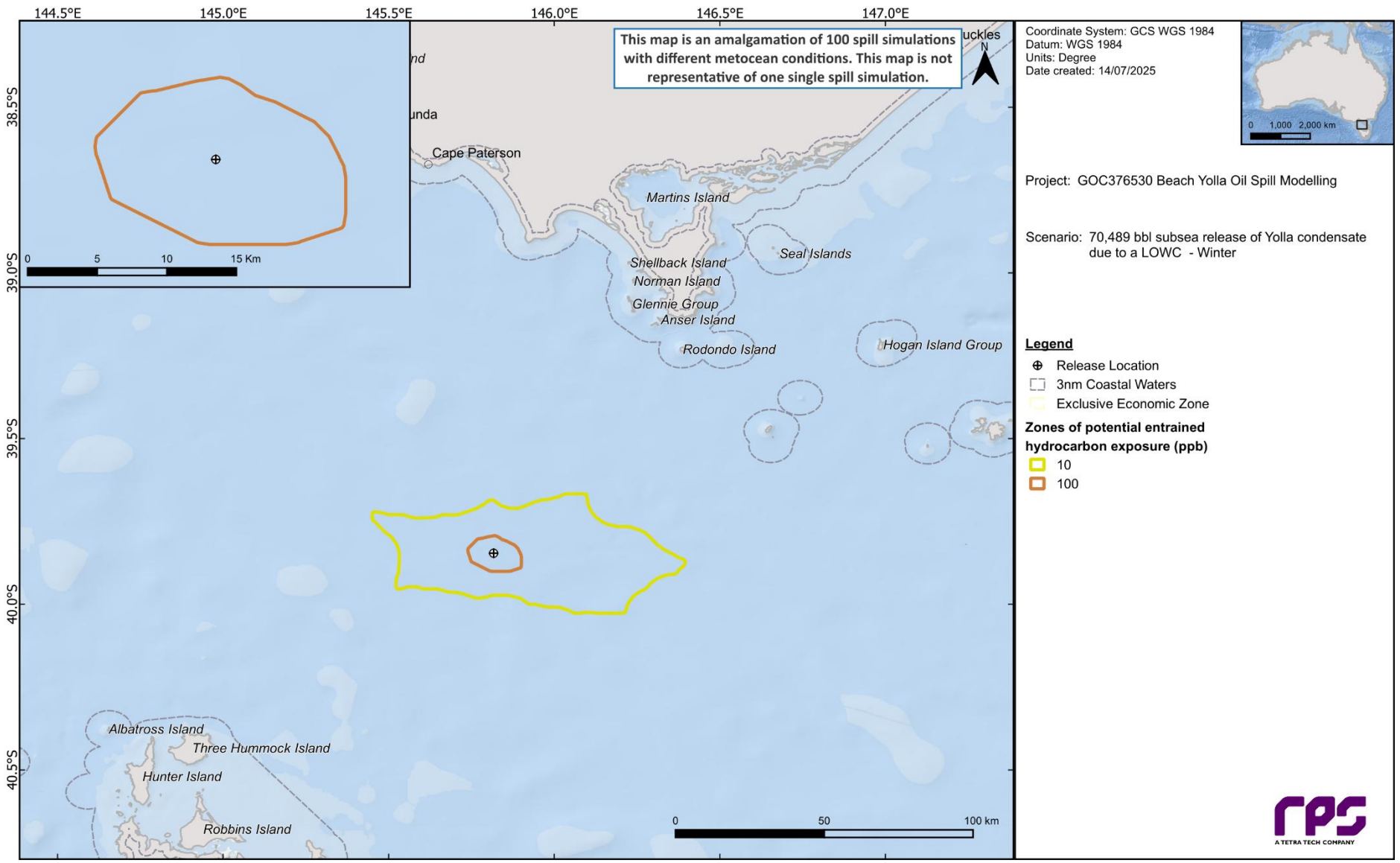


**Figure 13-20 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

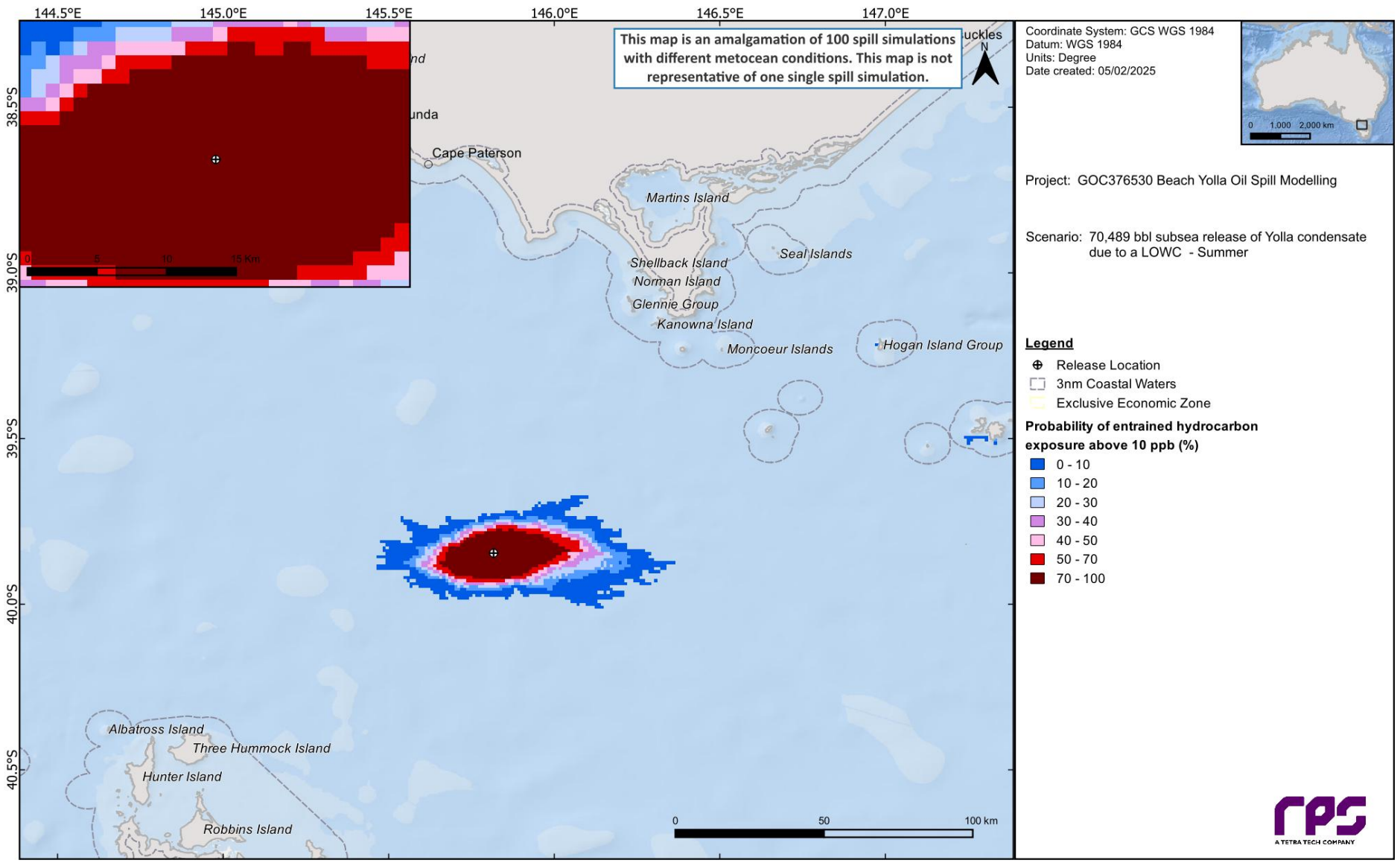


**Figure 13-21 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

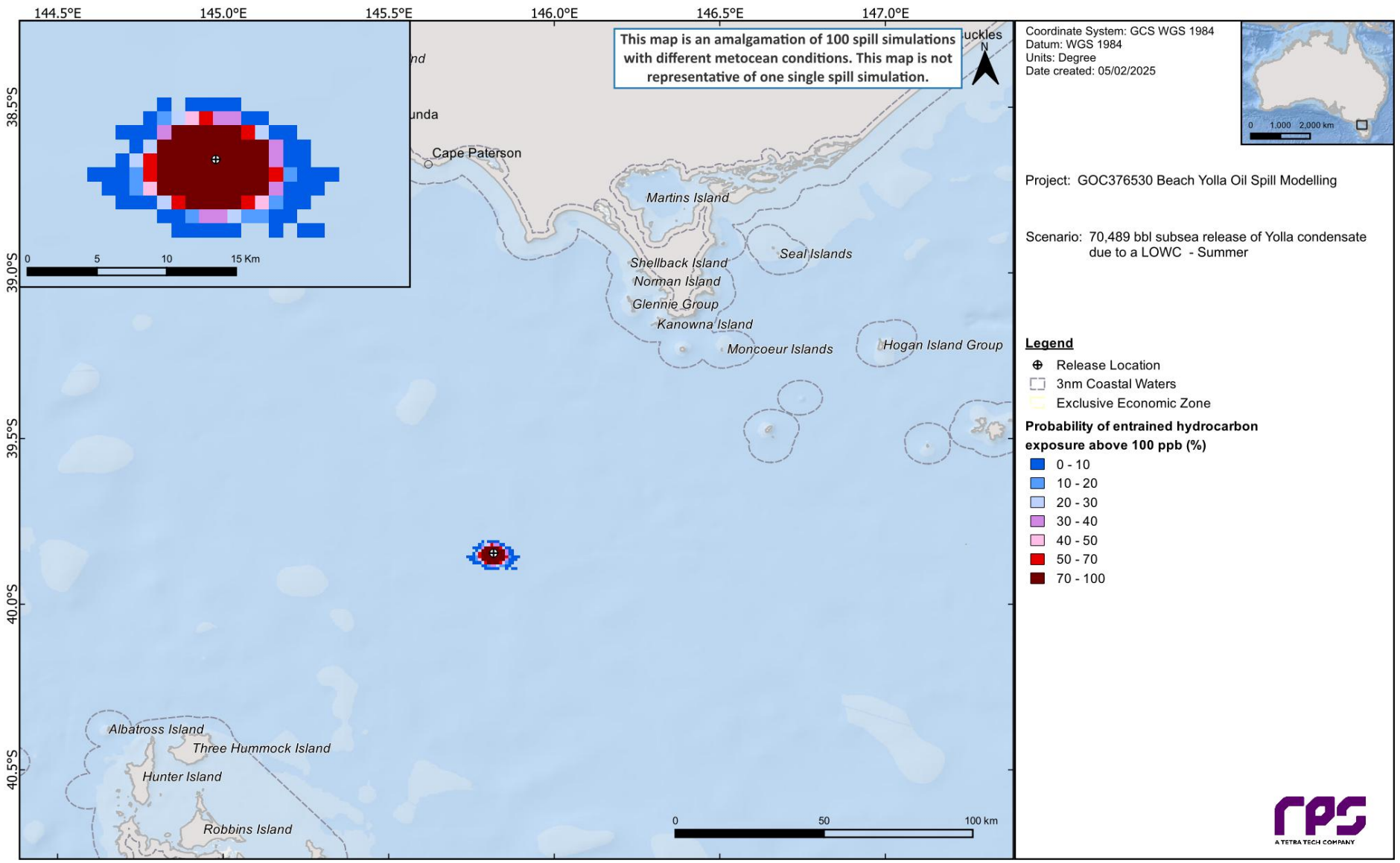


**Figure 13-22 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

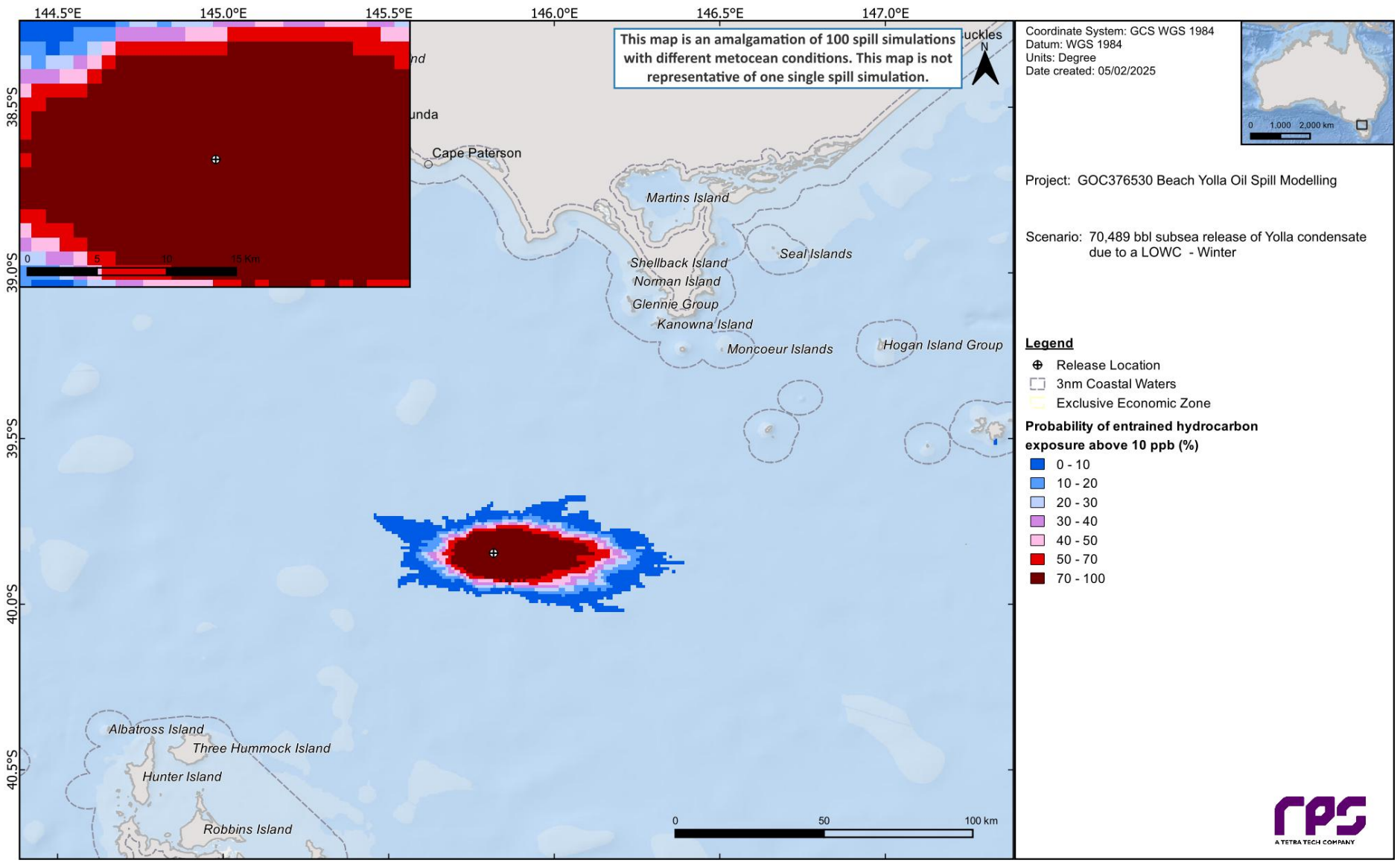


**Figure 13-23 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

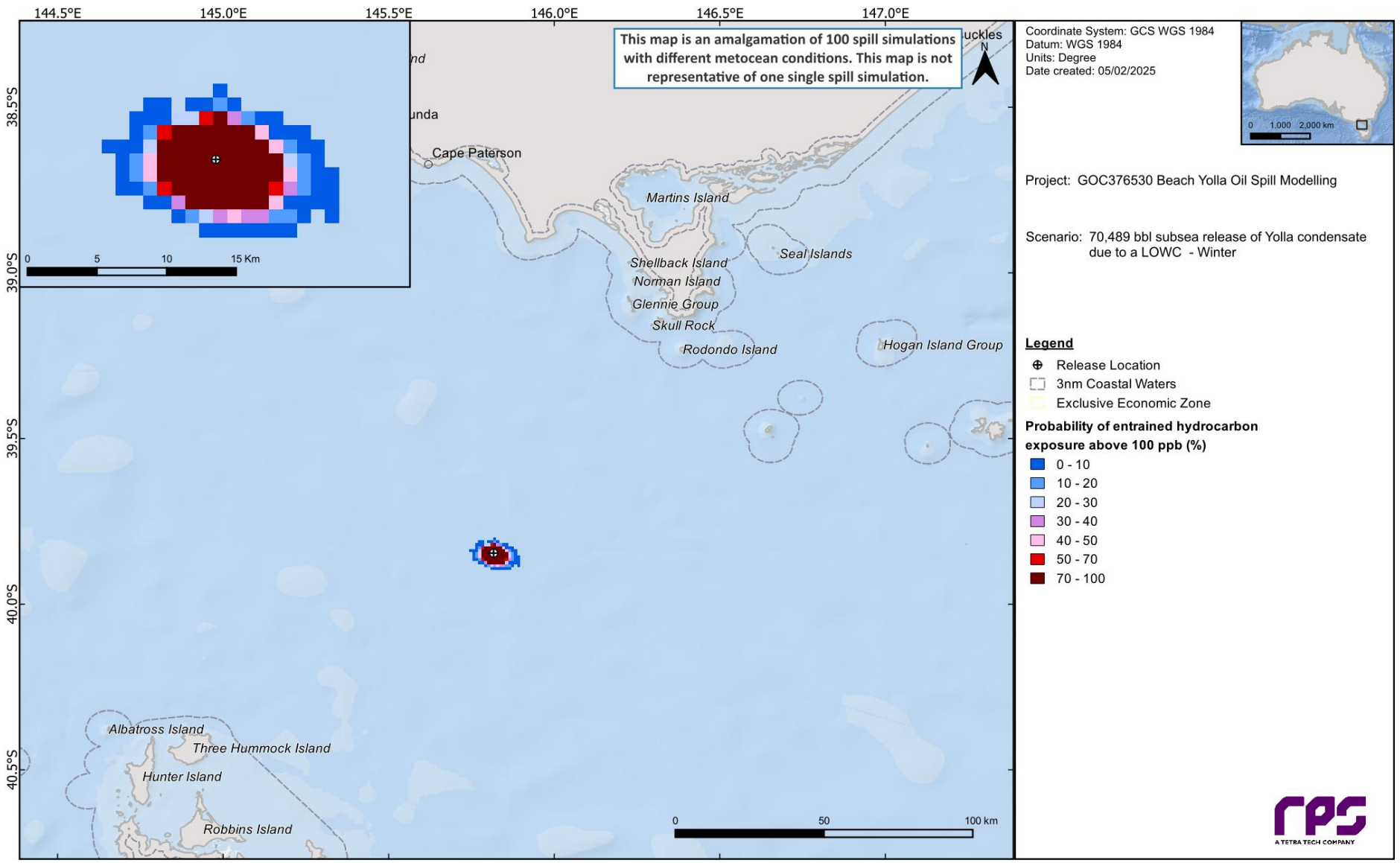


**Figure 13-24 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

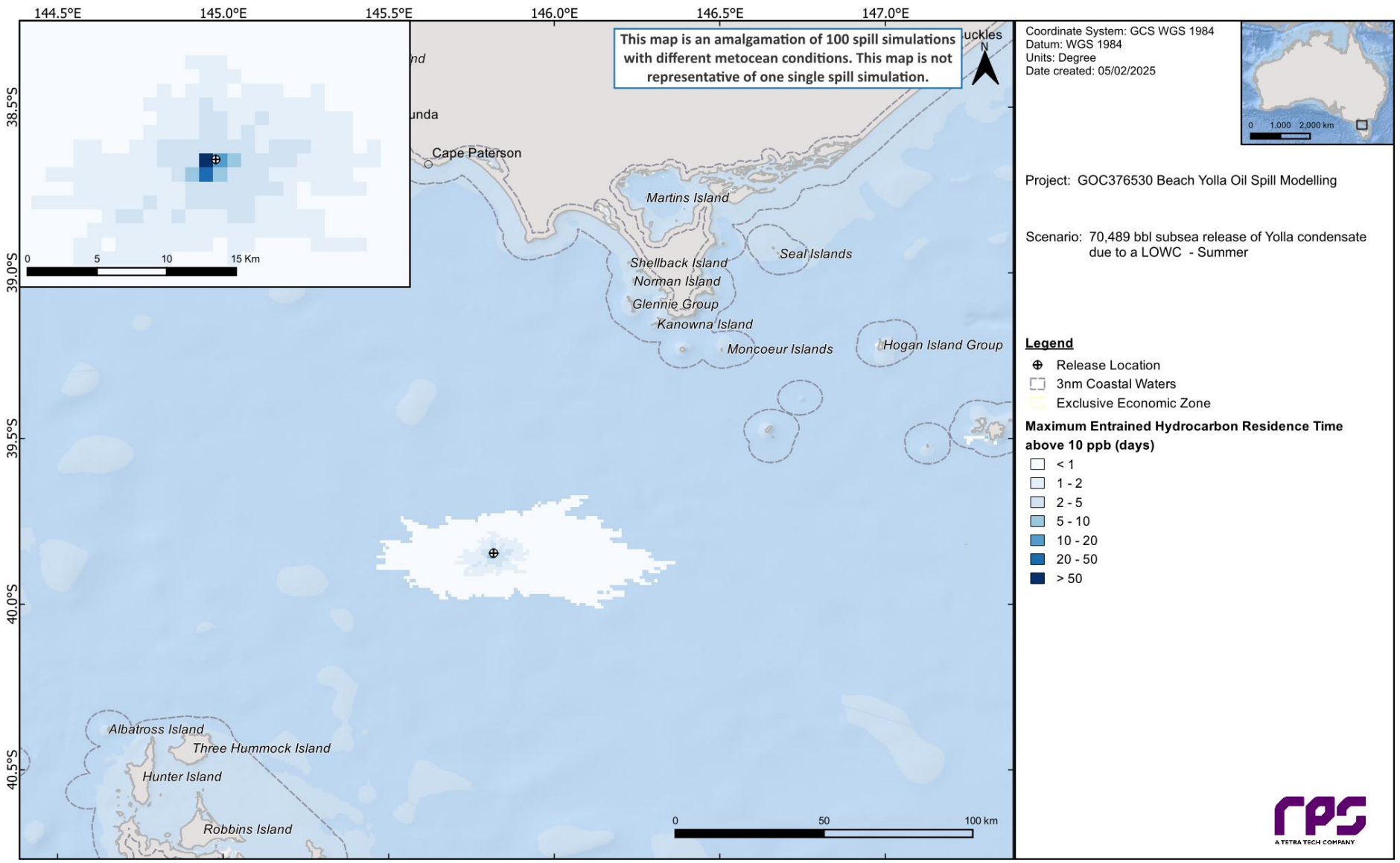


**Figure 13-25 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

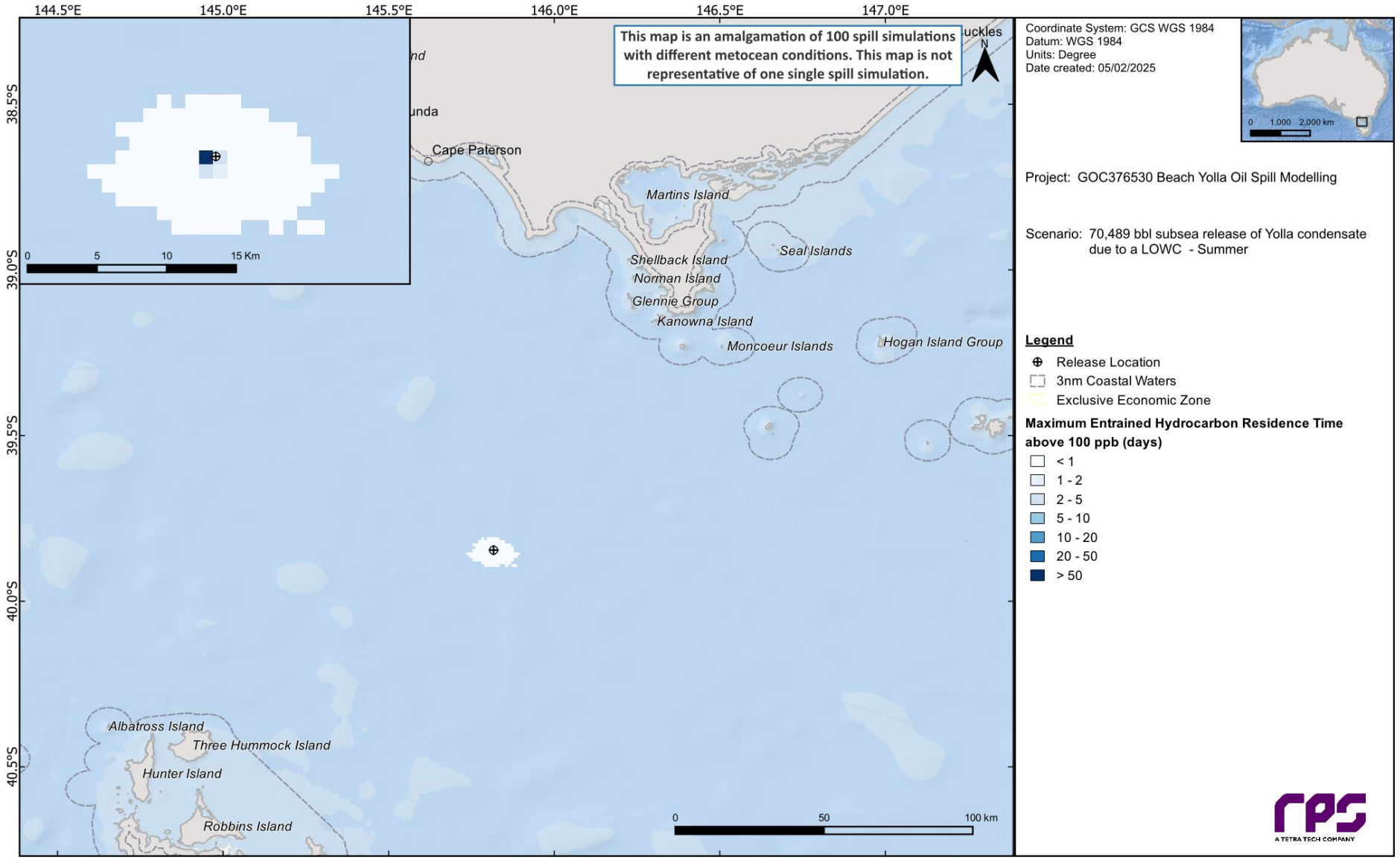


**Figure 13-26 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

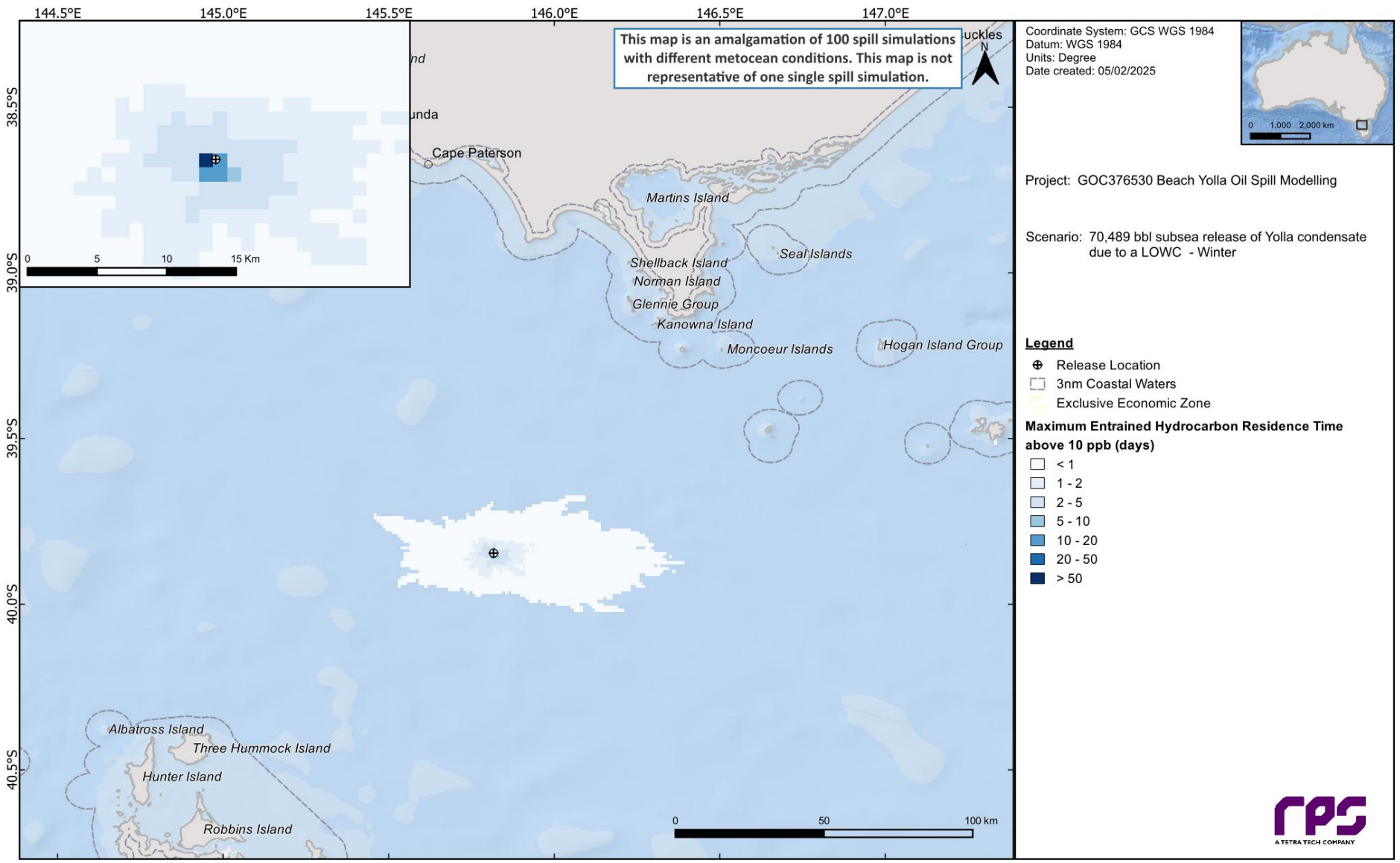


**Figure 13-27 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

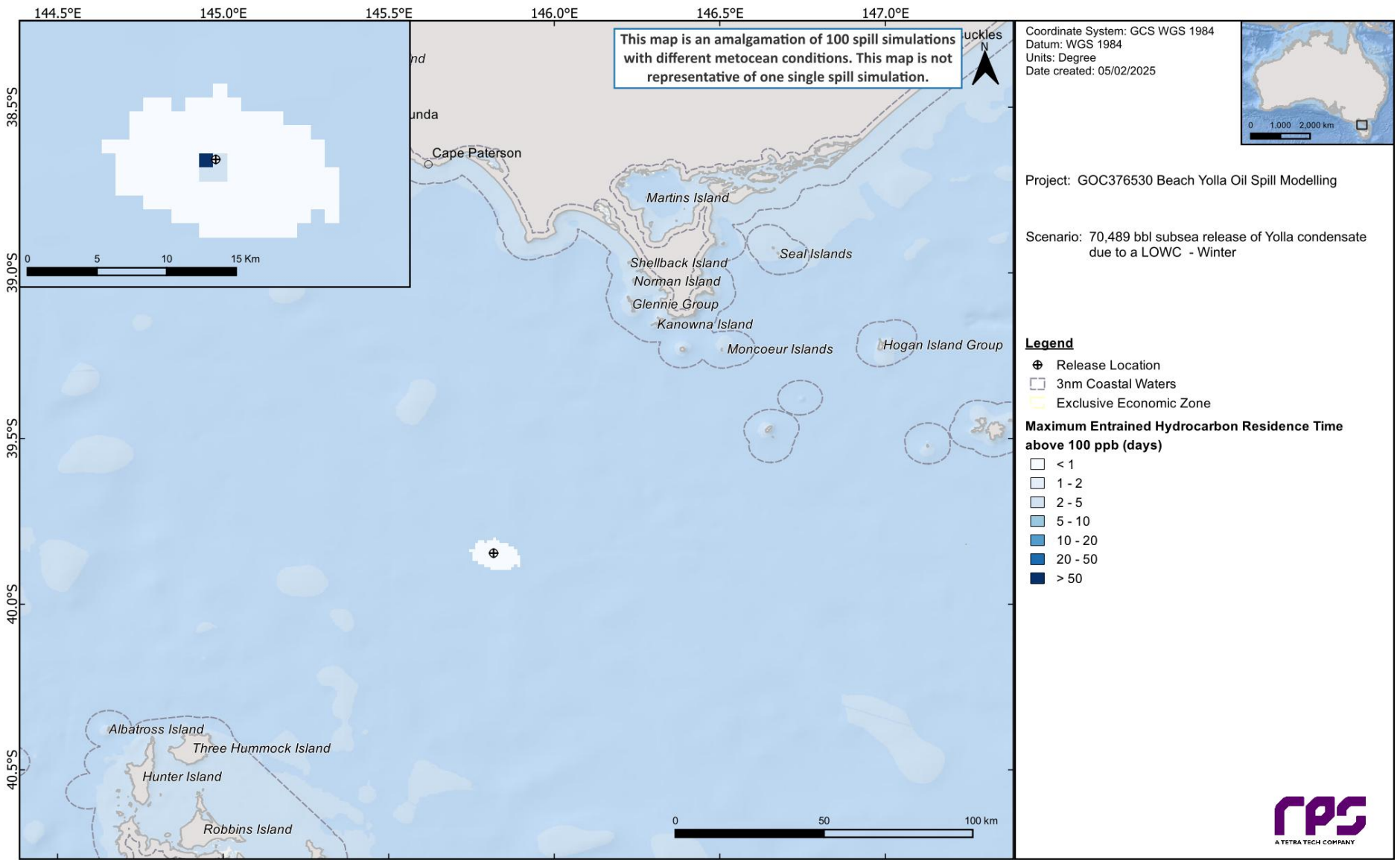


**Figure 13-28 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.**

# 14 RESULTS – SUBSEA RELEASE OF CONDENSATE 3NM FROM SHORE DUE TO PIPELINE RUPTURE

This scenario examined a 14,500 bbl (~2,305 $m^3$) subsea release of Yolla condensate over 36 minutes at a location 3 nm away from the shore. A total of 200 spill simulations were run (i.e., 100 spills per season) and tracked for 100 days. The results for all 100 simulations per season were combined and are presented on a seasonal basis (i.e., summer and winter).

## 14.1 Stochastic Analysis

### 14.1.1 Area of Exposure

Figure 14-1 and Figure 14-2 present the combined area of potential exposure for surface, shoreline, entrained and dissolved, by overlaying the results from all 200 simulations (i.e., 100 per season) during summer and winter conditions. Note that, when generating the EMBAs, a filter has been applied to remove numerical artifacts introduced by the model.

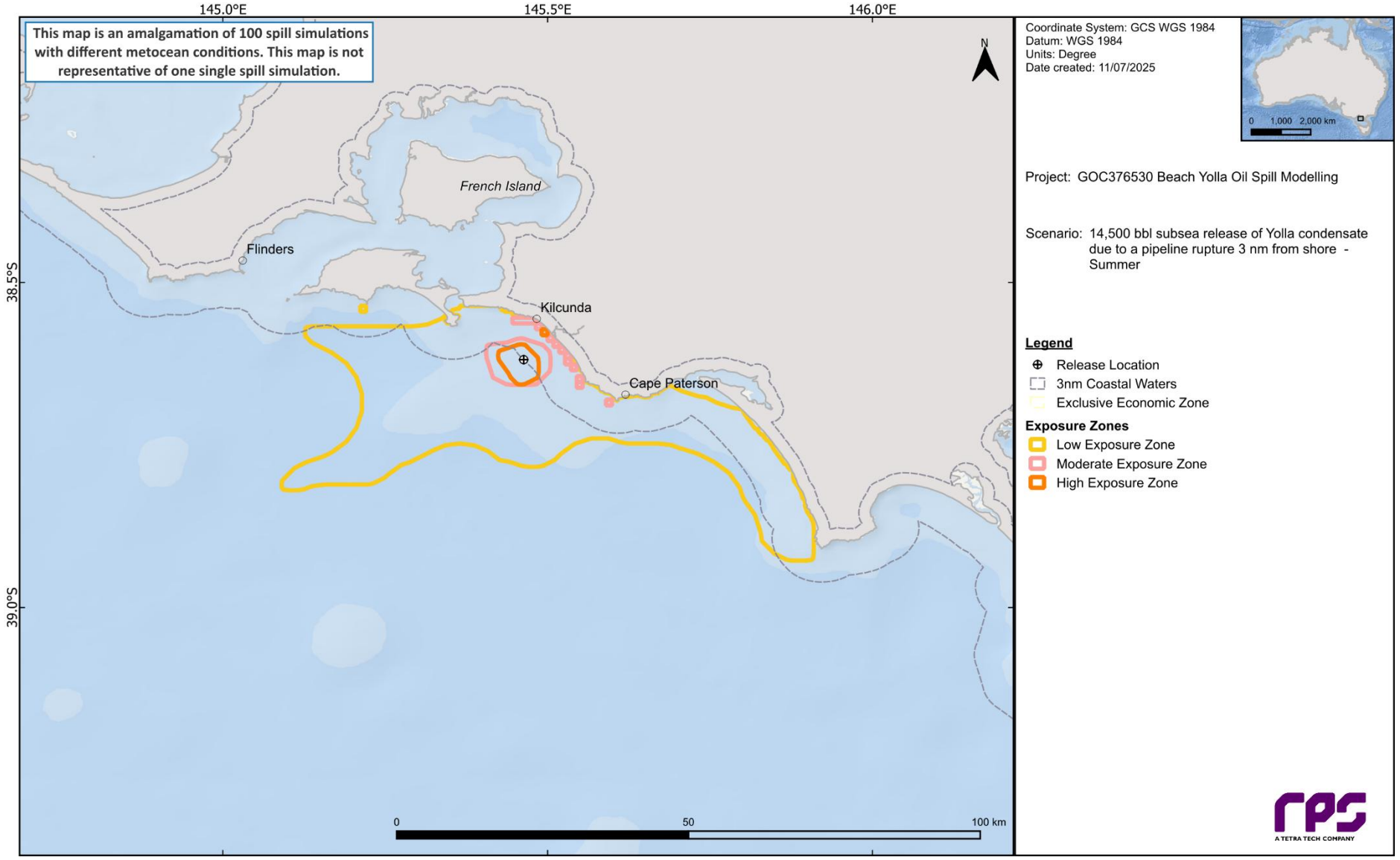


**Figure 14-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore during summer conditions.**

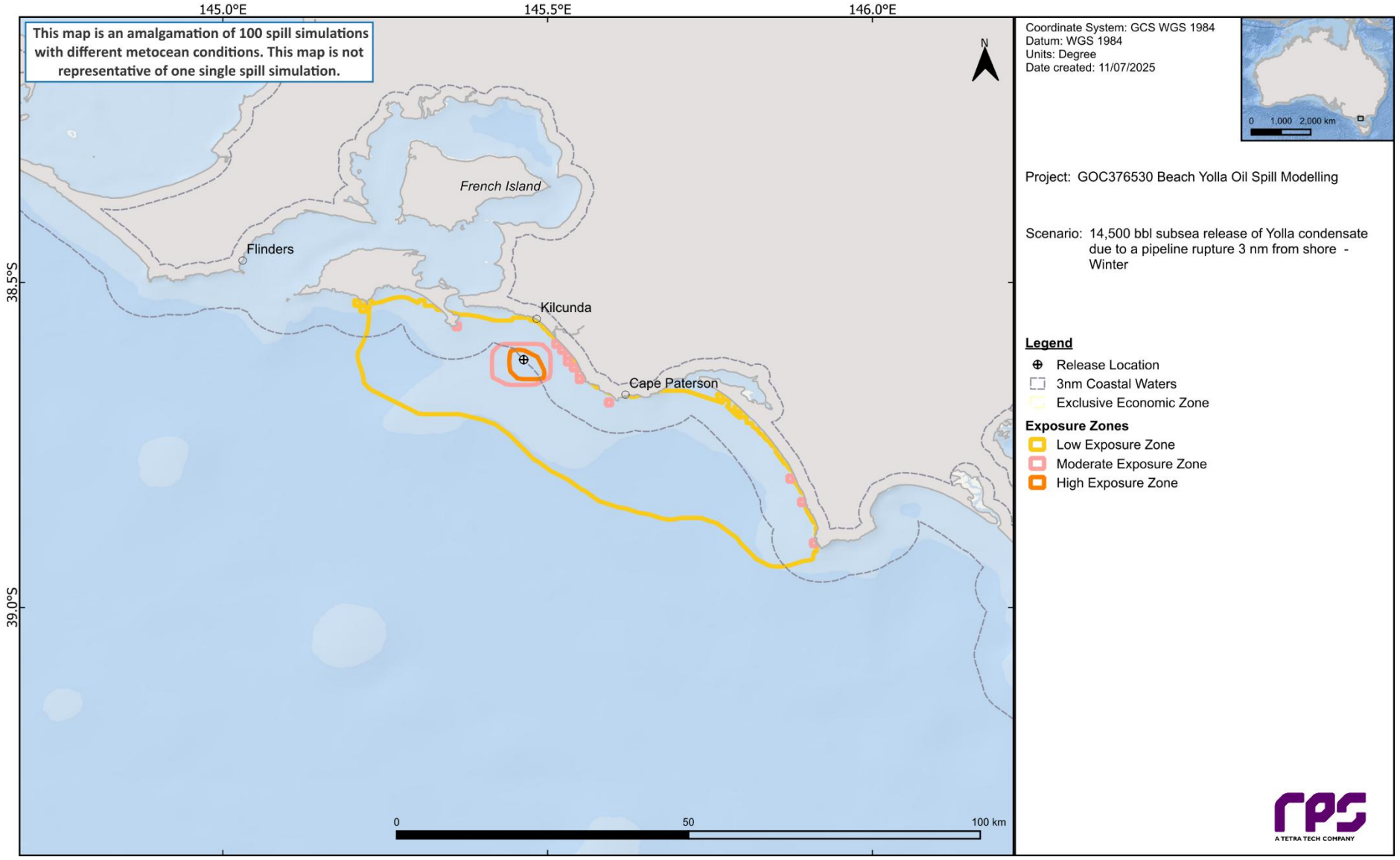


**Figure 14-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore during winter conditions.**

### 14.1.2 Floating Oil Exposure

Table 14-1 summarises the maximum distance travelled by floating oil on the sea surface at each threshold. The maximum distances from the release location to the low (1–10 g/m$^2$), moderate (10–50 g/m$^2$) and high (> 50 g/m$^2$) exposure zones were 13.03 km (south-southwest, summer) and 4.58 km (west-northwest, summer) and 0.46 km (southwest, both seasons).

Table 14-2 and Table 14-3 summarise the potential floating oil exposure to individual receptors during the summer and winter conditions. In addition to the receptors that the release location resides within, floating oil exposure above the low threshold was predicted with 100% probability at a few receptors, including Kilcunda nearshore waters and South-east (Marine).

Figure 14-3 and Figure 14-4 present the zones of potential floating oil exposure for all thresholds under summer and winter conditions, respectively.

Figure 14-5 to Figure 14-16 present the probability maps and minimum time before floating oil exposure for the NOPSEMA thresholds during summer and winter.

**Table 14-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential floating oil exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Maximum distance (km) from release location | 13.03 | 4.58 | 0.46 |
| | Direction | South-Southwest | West-Northwest | Southwest |
| Winter | Maximum distance (km) from release location | 8.67 | 4.17 | 0.46 |
| | Direction | Southeast | West-Southwest | Southwest |

**Table 14-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Probability of floating oil exposure (%) | | | Minimum time before floating oil exposure (days) | | | Maximum residence time for floating oil exposure (hours) | | |
| | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 14.5 | 6.25 | 1 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 14.5 | 6.25 | 1 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 14.5 | 6.25 | 1 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 14.5 | 6.25 | 1 |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 100 | 100 | - | 0.01 | 0.01 | - | 13.75 | 4.5 | - |
| | Pygmy Blue Whale - Distribution (None)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 14.5 | 6.25 | 1 |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 14.5 | 6.25 | 1 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 100 | 100 | - | 0.01 | 0.01 | - | 10.75 | 4.25 | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 14.5 | 6.25 | 1 |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| IMCRA-MESO | Central Bass Strait | 1 | - | - | 1.68 | - | - | 1.25 | - | - |
| | Central Victoria** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| IMCRA-PROV | Bass Strait Shelf Province** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 6.25 | 1 |
| MR | South-east (Marine) | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 14.5 | 6.25 | 1 |
| NRMR | West Gippsland (VIC)** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 5 | 1 |
| SHORE-VIC-MPRA | Kilcunda | 100 | - | - | 0.01 | - | - | 17.75 | - | - |
| State Waters | Victoria** | 100 | 100 | 2 | 0.01 | 0.01 | 0.06 | 19.75 | 5 | 1 |

**The release location resides within the receptor boundaries.

**Table 14-3 Summary of the potential floating oil exposure to individual receptors. Results are based on 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Probability of floating oil exposure (%) | | | Minimum time before floating oil exposure (days) | | | Maximum residence time for floating oil exposure (hours) | | |
| | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region) | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 12 | 5.75 | 0.75 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 12 | 5.75 | 0.75 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 12 | 5.75 | 0.75 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)*** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 12 | 5.75 | 0.75 |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 100 | 100 | - | 0.01 | 0.01 | - | 8.5 | 3.5 | - |
| | Pygmy Blue Whale - Distribution (None)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 12 | 5.75 | 0.75 |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 12 | 5.75 | 0.75 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 100 | 100 | - | 0.01 | 0.01 | - | 8.5 | 3.5 | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 12 | 5.75 | 0.75 |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| IMCRA-MESO | Central Victoria** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| IMCRA-PROV | Bass Strait Shelf Province** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| MR | South-east (Marine) | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 12 | 5.75 | 0.75 |
| NRMR | West Gippsland (VIC)** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |
| SHORE-VIC-MPRA | Kilcunda | 100 | - | - | 0.01 | - | - | 10.5 | - | - |
| State Waters | Victoria** | 100 | 100 | 1 | 0.01 | 0.01 | 0.05 | 17.25 | 5.75 | 0.75 |

**The release location resides within the receptor boundaries.

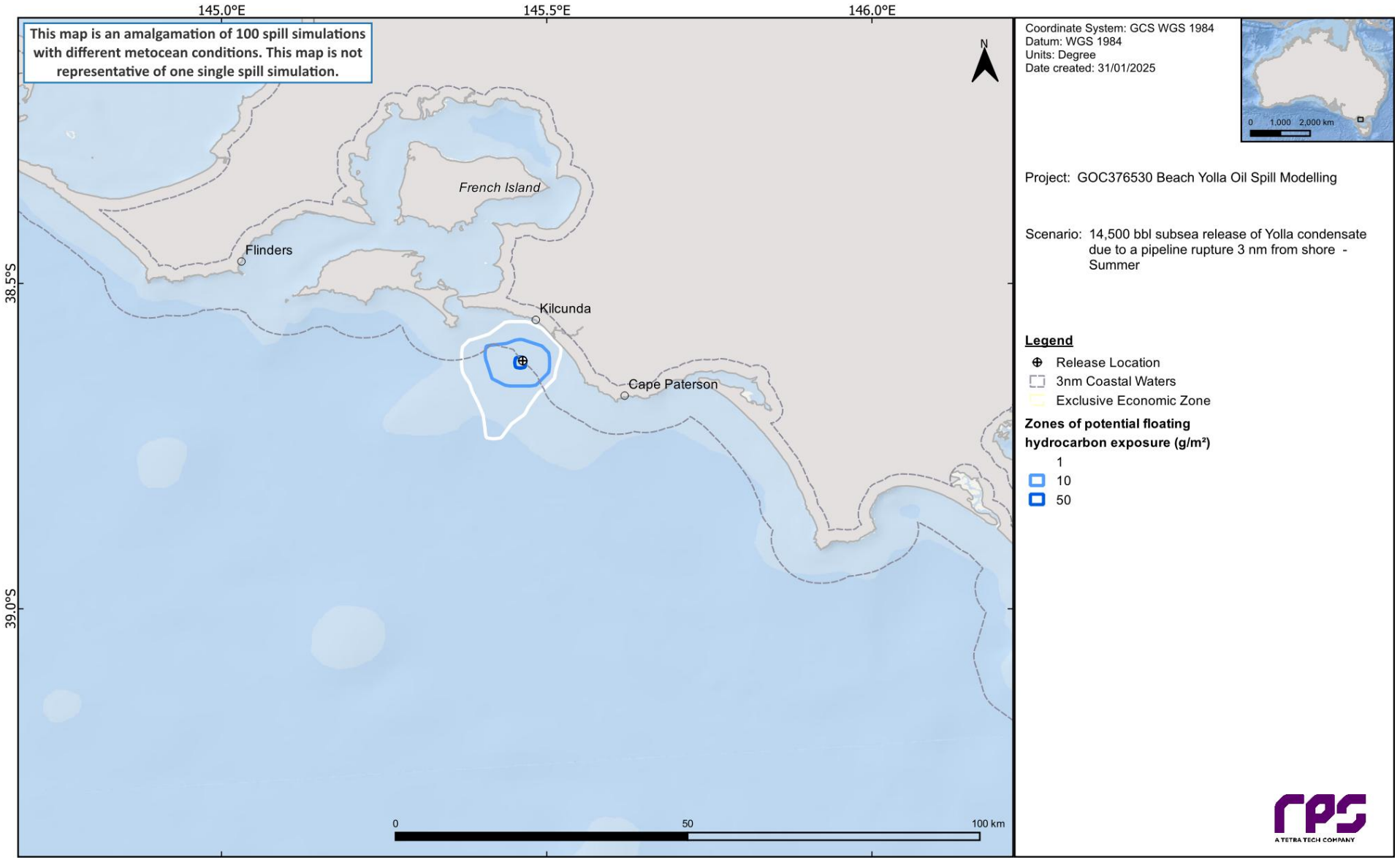


**Figure 14-3 Zones of potential floating oil exposure in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

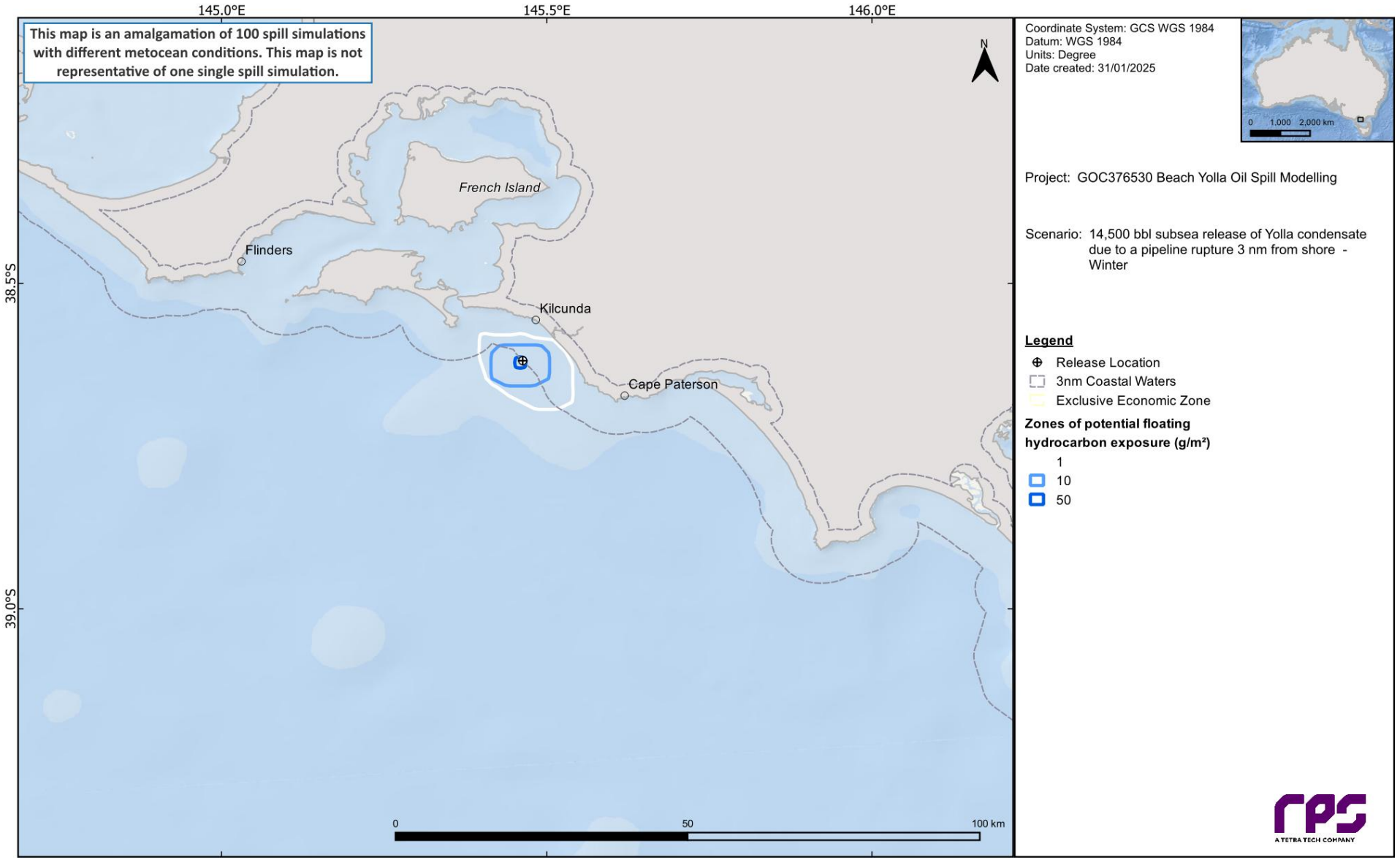


**Figure 14-4 Zones of potential floating oil exposure in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

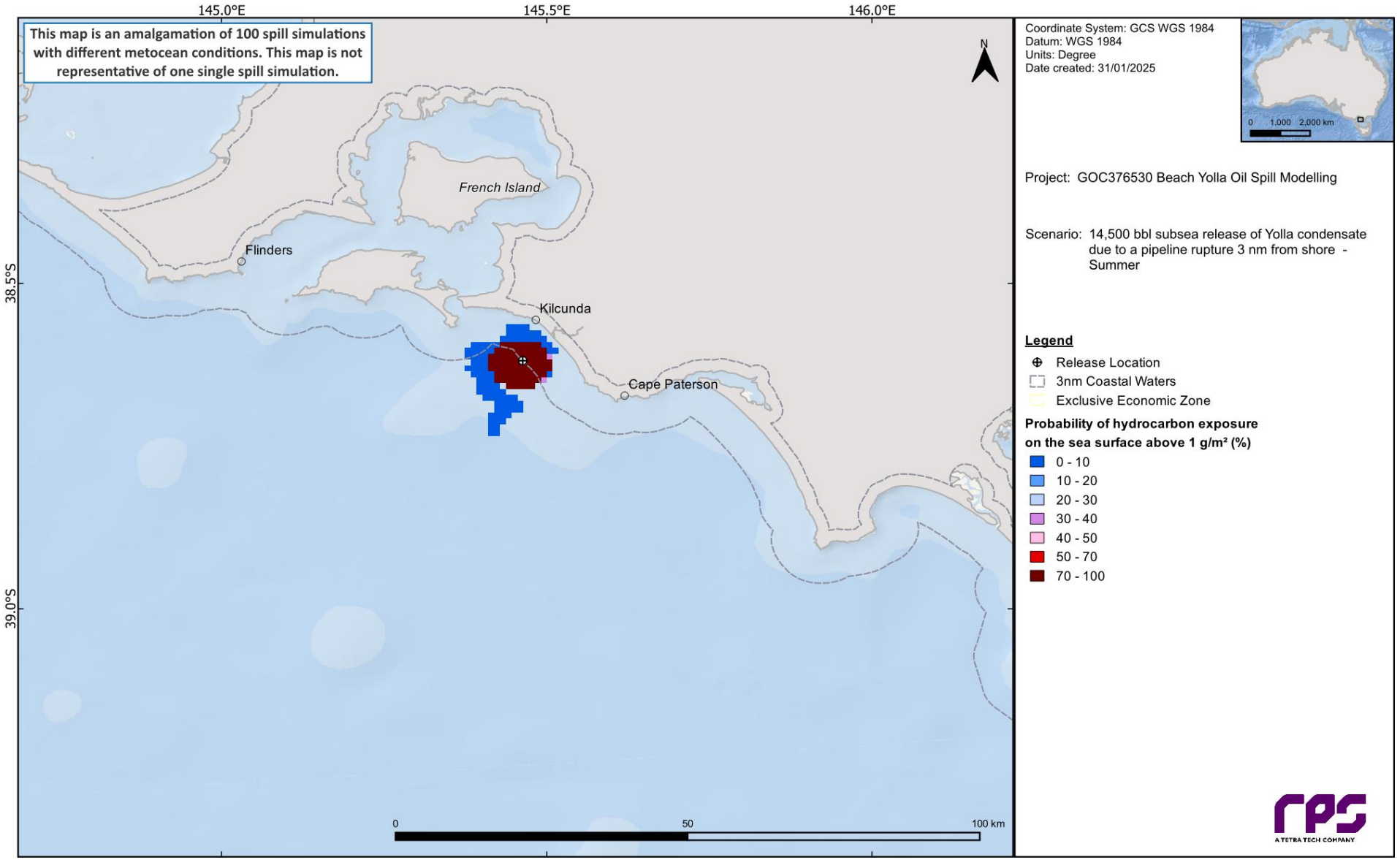


**Figure 14-5 Probability of floating oil exposure above 1 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

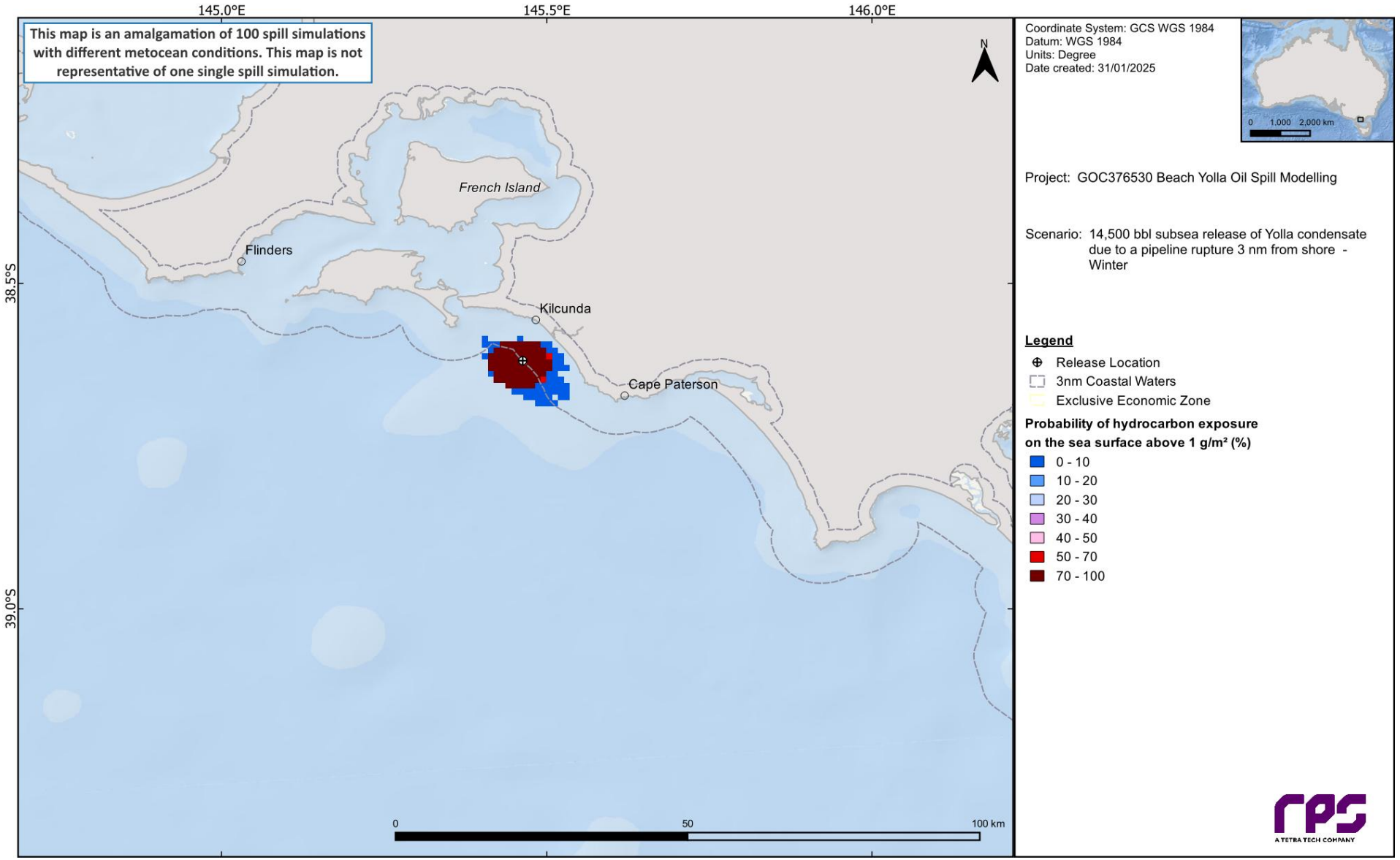


**Figure 14-6 Probability of floating oil exposure above 1 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

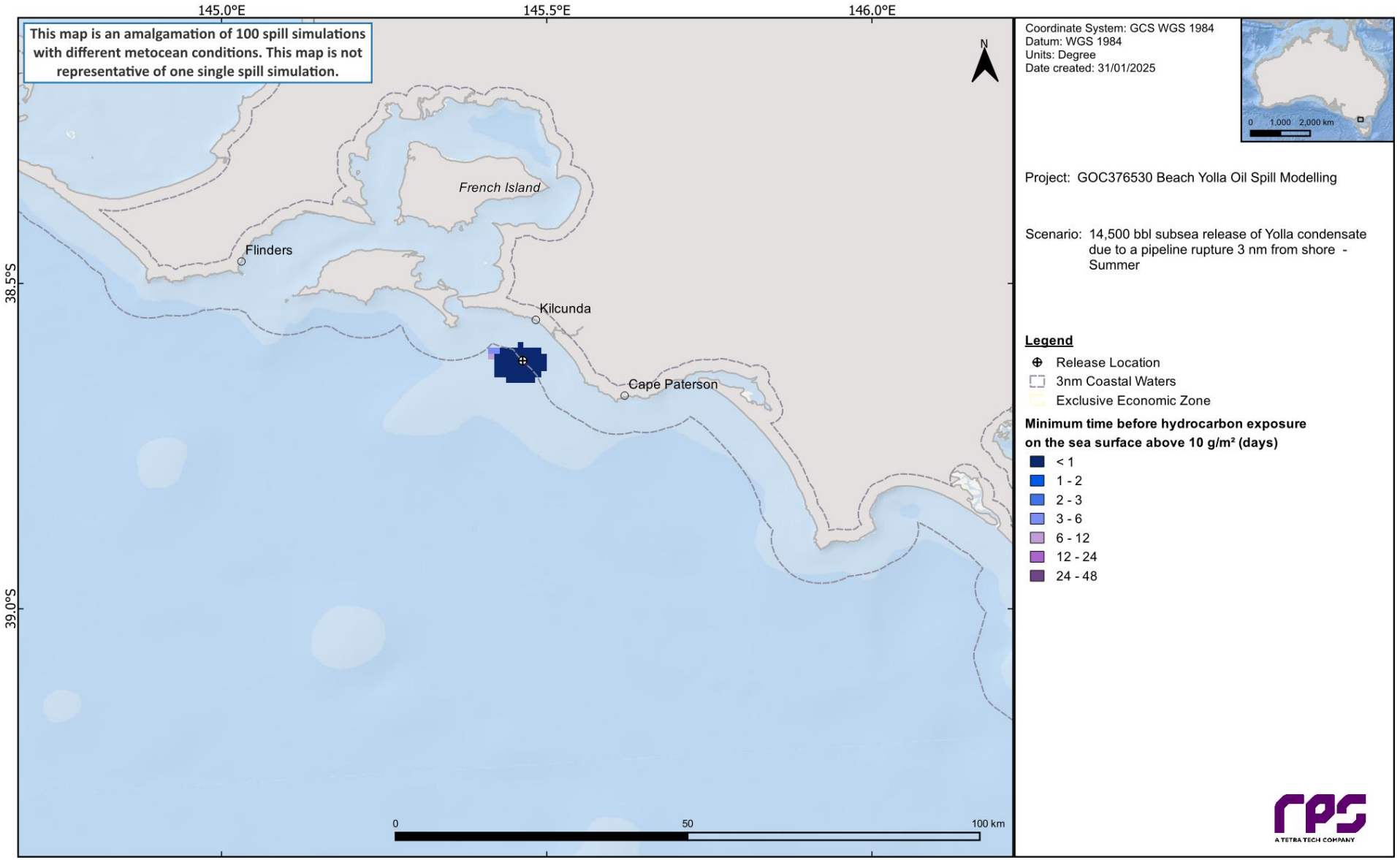


**Figure 14-7 Probability of floating oil exposure above 10 g/m², in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

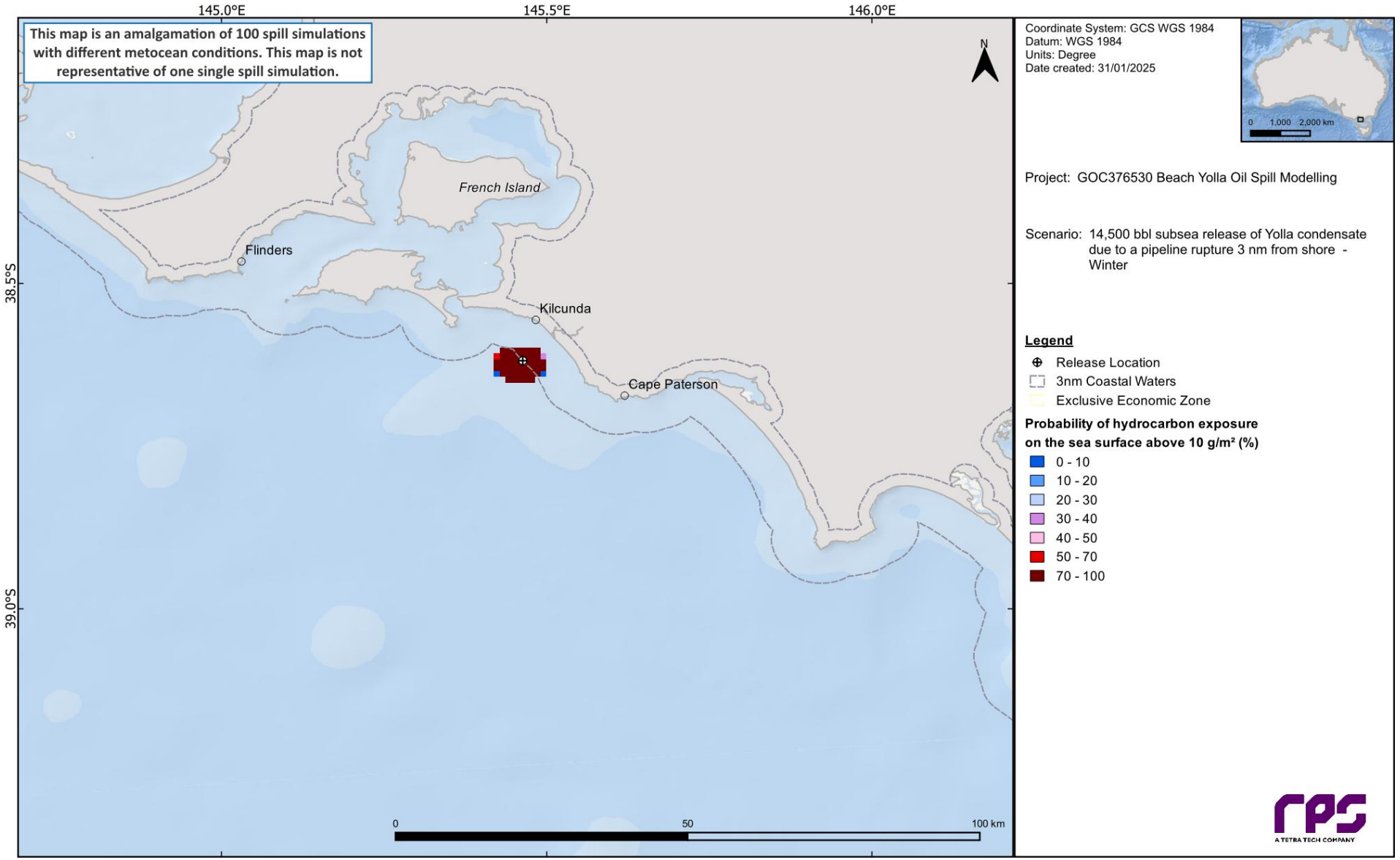


**Figure 14-8 Probability of floating oil exposure above 10 g/m², in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

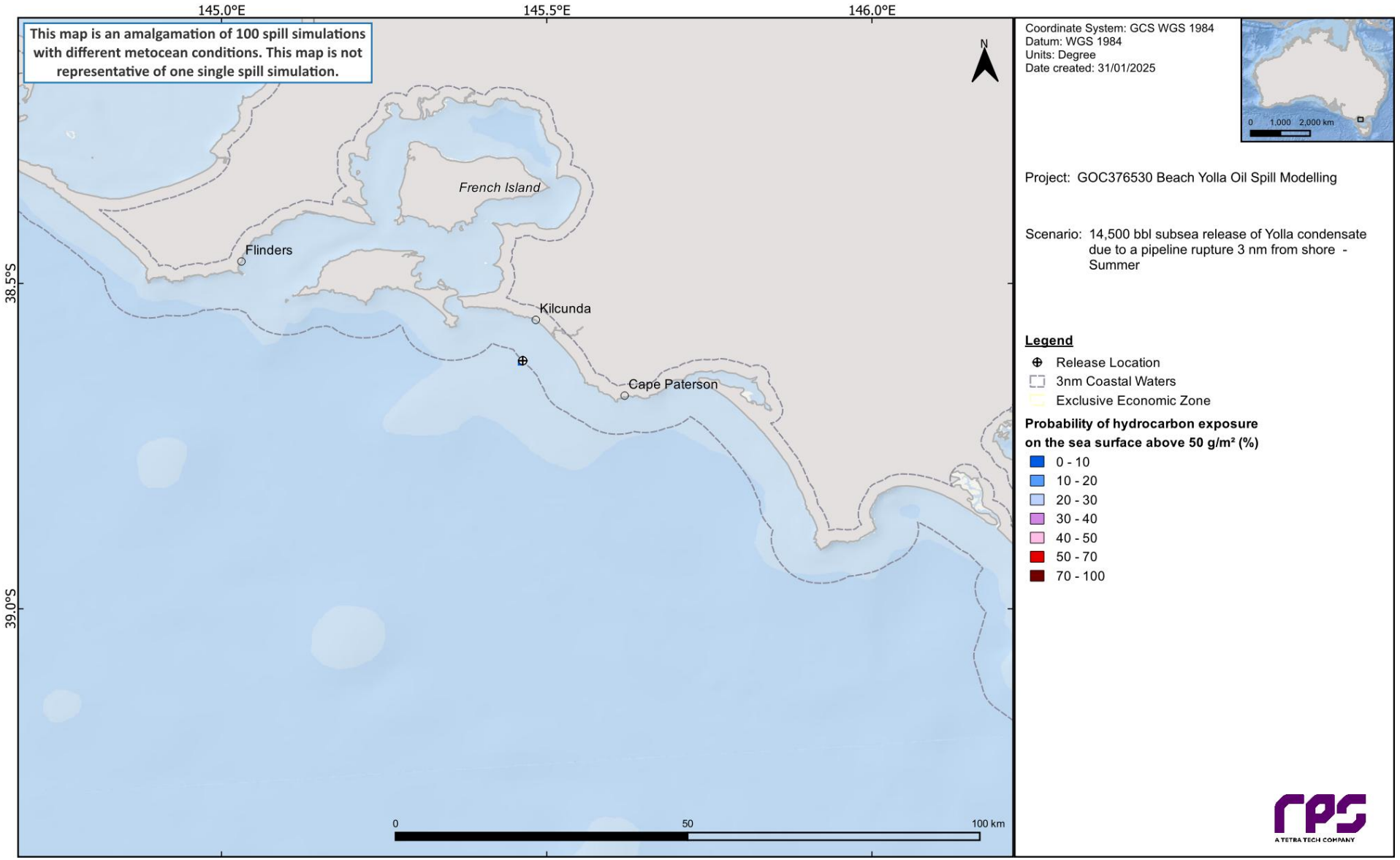


**Figure 14-9 Probability of floating oil exposure above 50 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

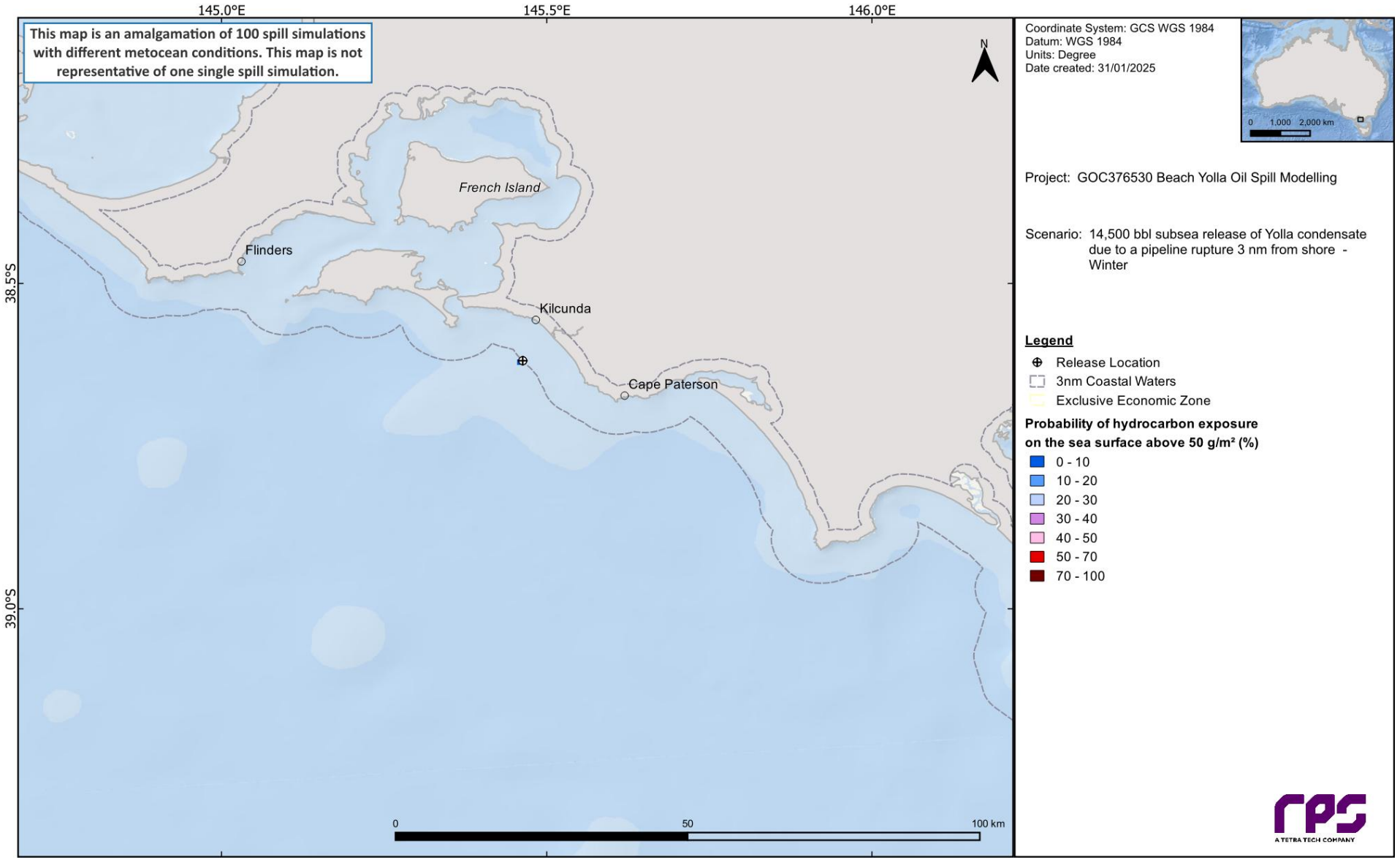


**Figure 14-10 Probability of floating oil exposure above 50 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

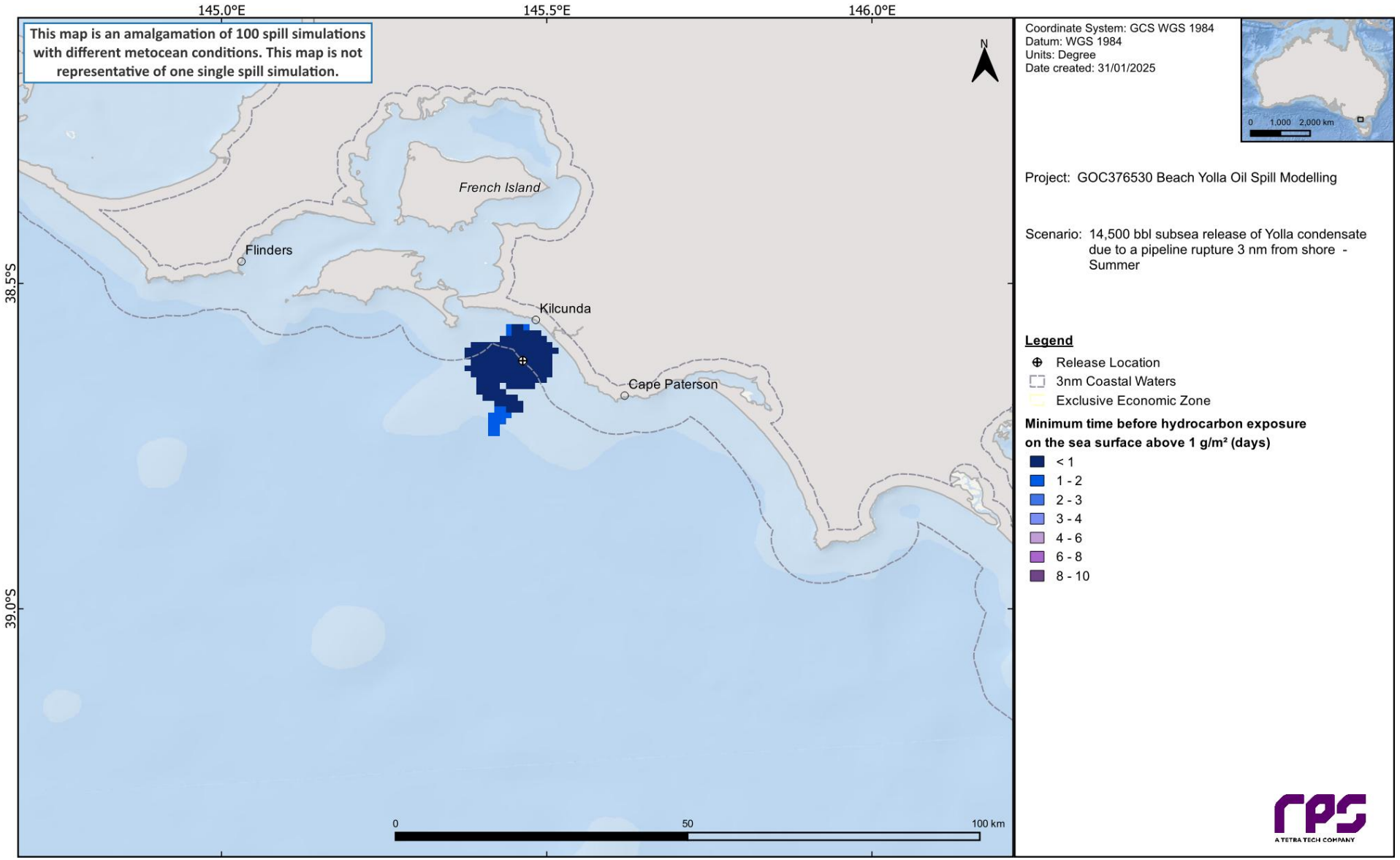


**Figure 14-11 Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

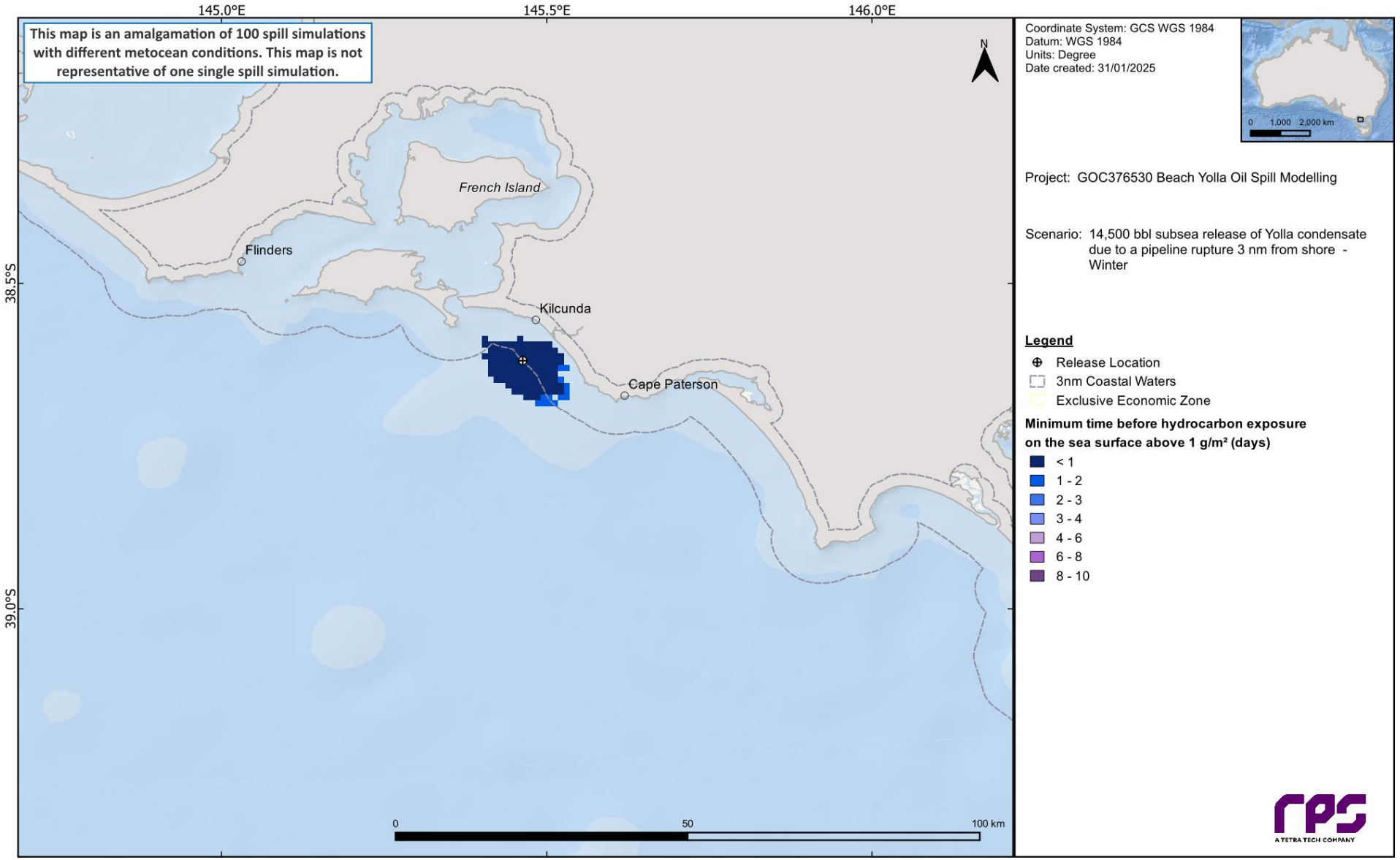


**Figure 14-12 Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

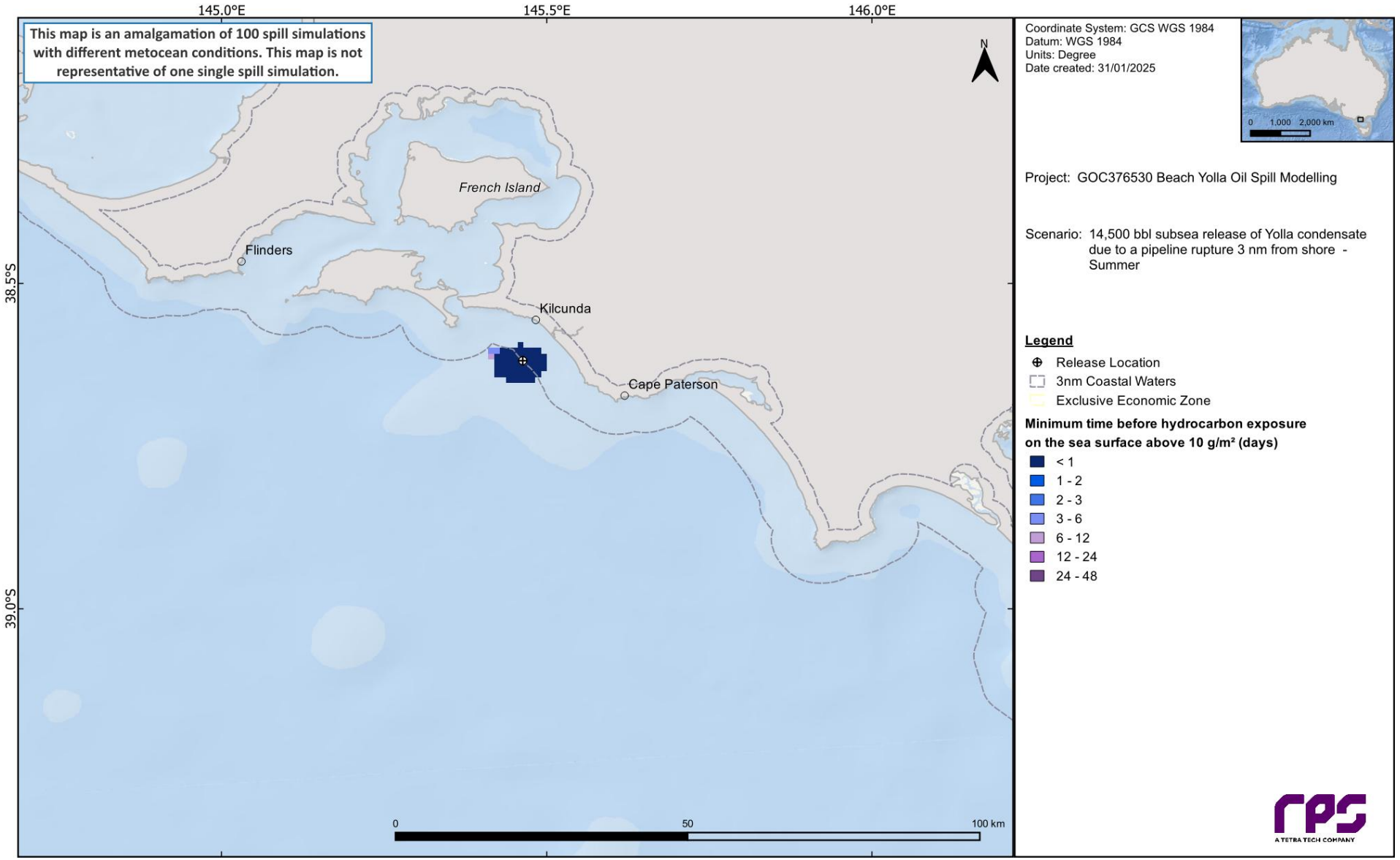


**Figure 14-13 Minimum time before floating oil exposure above 10 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

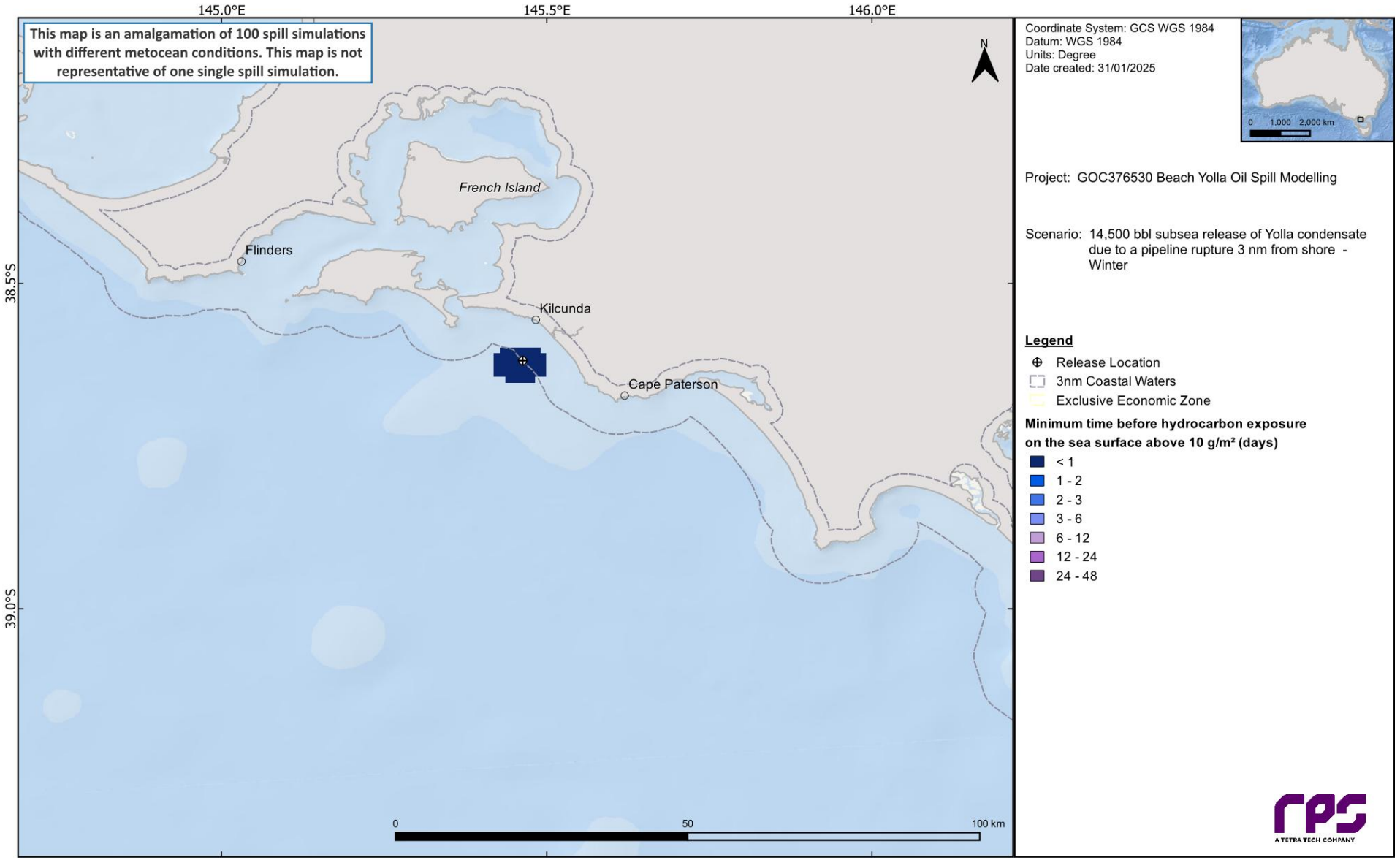


**Figure 14-14 Minimum time before floating oil exposure above 10 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

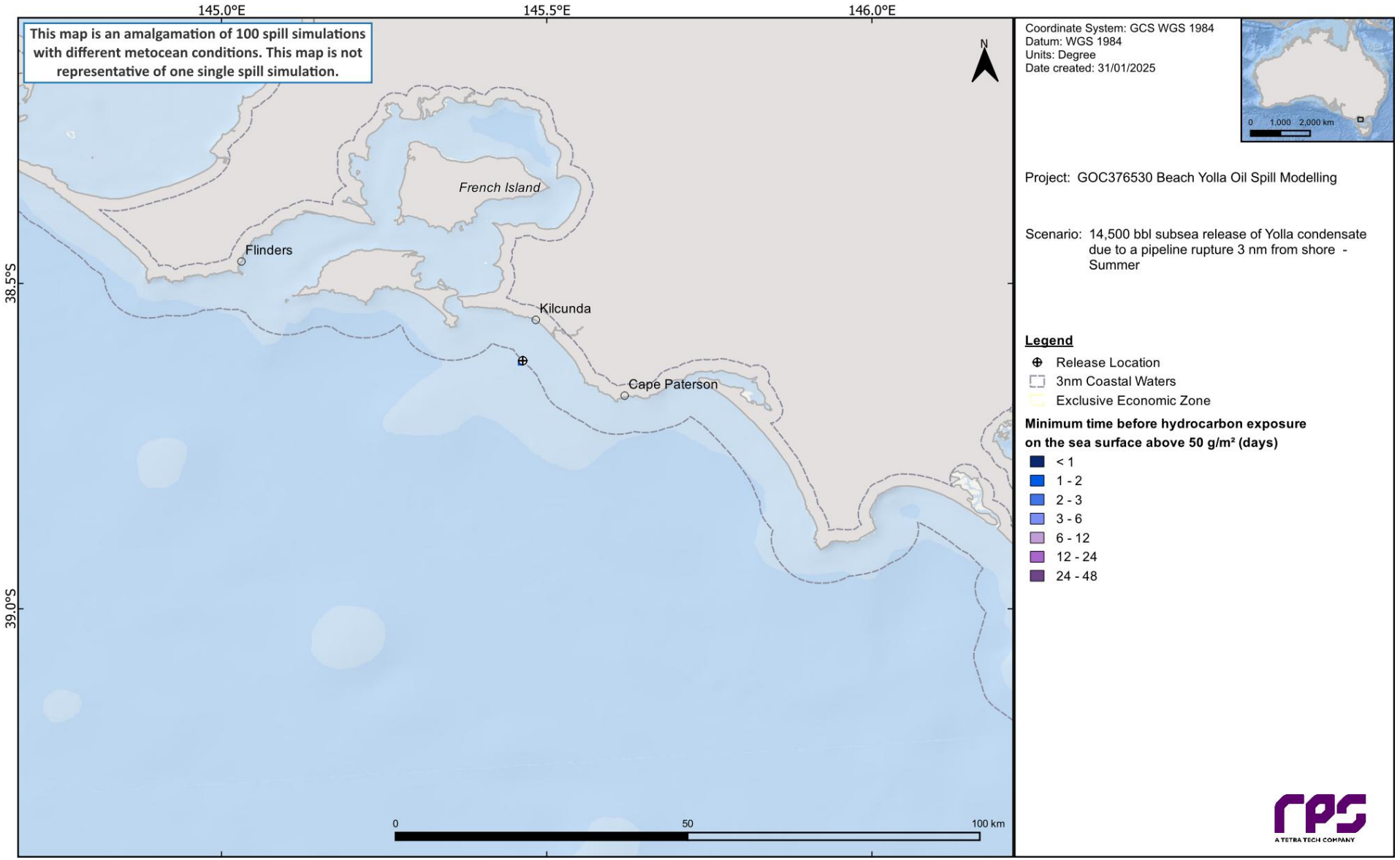


**Figure 14-15 Minimum time before floating oil exposure above 50 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

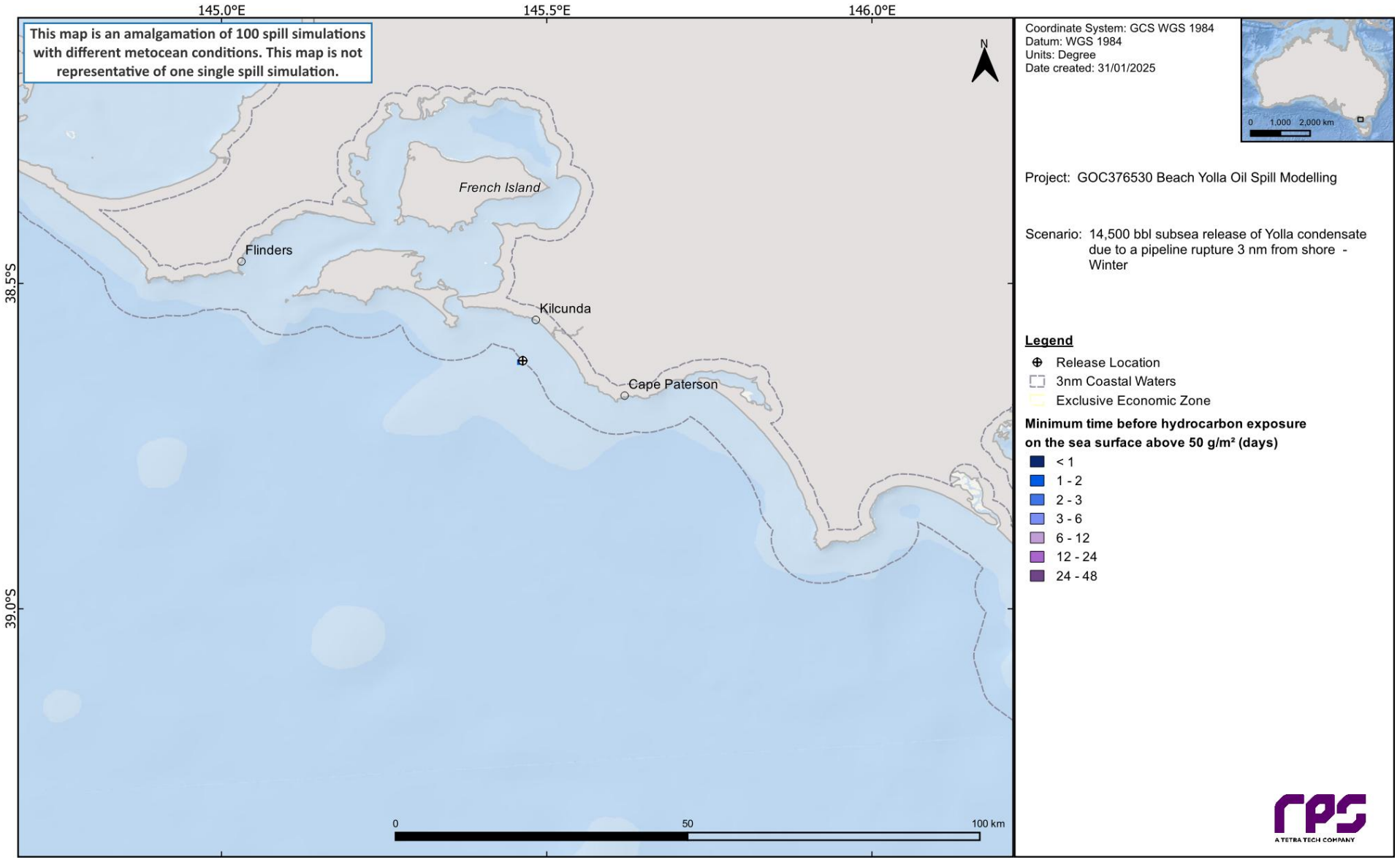


**Figure 14-16 Minimum time before floating oil exposure above 50 g/m$^2$, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

### 14.1.3 Shoreline Accumulation

Table 14-4 presents a summary of the predicted potential shoreline accumulation during the summer and winter conditions. The probability of accumulation to any shoreline at, or above, the low level (10 g/m$^2$) threshold was 66% during summer conditions and 84% during winter conditions. The minimum time before oil accumulation at, or above, the low threshold was 0.52 days during summer conditions, and 0.59 days during winter conditions. The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 24.70 m$^3$ and 23.71 m$^3$, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 13.98 km and 24.14 km, respectively.

Table 14-5 and Table 14-6 summarise the shoreline accumulation on individual receptors during the summer and winter conditions. Kilkunda shoreline recorded the highest probability of shoreline accumulation at the low threshold during summer conditions, being 53%, whilst in winter the highest probability was forecast to Venus Bay (60%). The minimum time before shoreline accumulation above the low threshold was forecast for Kilcunda (0.52 and 0.59 day during summer and winter respectively).

The summer and winter conditions maximum potential shoreline loading above the low and moderate shoreline thresholds are presented in Figure 14-17 and Figure 14-18, respectively.

**Table 14-4 Summary of oil accumulation across all shorelines. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations per season.**

| Shoreline Statistics | Summer | Winter |
|---|---|---|
| Probability of accumulation on any shoreline (%) | 66 | 84 |
| Absolute minimum time for visible oil to shore (days) | 0.52 | 0.59 |
| Maximum total volume of hydrocarbons ashore (m3) | 24.70 | 23.71 |
| Average volume of hydrocarbons ashore (m3) | 2.1 | 2.66 |
| Maximum length of the shoreline at 10 g/m2 (km) | 13.98 | 24.14 |
| Average shoreline length (km) at 10 g/m2 (km) | 4.41 | 6.82 |
| Maximum length of the shoreline at 100 g/m2 (km) | 5.09 | 6.36 |
| Average shoreline length (km) at 100 g/m2 (km) | 0.28 | 0.25 |
| Maximum length of the shoreline at 1,000 g/m2 (km) | 1.27 | - |
| Average shoreline length (km) at 1,000 g/m2 (km) | 0.01 | - |

**Table 14-5** **Summary of oil accumulation on individual shoreline receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Shoreline Receptor | | Summer (November through to March) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum probability of shoreline loading (%) | | | Minimum time before shoreline accumulation (days) | | | Load on shoreline ($g/m^2$) | | Volume on shoreline ($m^3$) | | Maximum total volume of oil arriving ashore ($m^3$) | | | Average total volume of oil arriving ashore ($m^3$) | | | Maximum total length of shoreline contacted (km) | | | Average total length of shoreline contacted (km) | | |
| | | Low | Mod | High | Low | Mod | High | Peak | Mean | Peak | Mean | Low | Mod | High | Low | Mod | High | Low | Mod | High | Low | Mod | High |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 3 | - | - | 3.67 | - | - | 75.61 | 1.38 | 2.12 | 0.07 | 1.89 | - | - | 0.04 | - | - | 7.62 | - | - | 0.18 | - | - |
| | French Island / San Remo | 2 | - | - | 3.43 | - | - | 16.76 | 0.87 | 0.53 | 0.02 | 0.5 | - | - | 0.01 | - | - | 3.81 | - | - | 0.05 | - | - |
| | Kilcunda | 53 | 10 | 1 | 0.52 | 0.69 | 1.08 | 1,041.64 | 44.42 | 24.7 | 1.58 | 24.42 | 22.71 | 11.98 | 1.35 | 0.63 | 0.12 | 12.71 | 5.09 | 1.27 | 3.06 | 0.27 | 0.01 |
| | Venus Bay | 32 | 3 | - | 1.41 | 3.79 | - | 164.44 | 14.81 | 6.26 | 0.55 | 6.07 | 3.17 | - | 0.42 | 0.06 | - | 8.9 | 2.54 | - | 1.46 | 0.05 | - |

**Table 14-6** **Summary of oil accumulation on individual shoreline receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Shoreline Receptor | | Winter (April through to October) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum probability of shoreline loading (%) | | | Minimum time before shoreline accumulation (days) | | | Load on shoreline ($g/m^2$) | | Volume on shoreline ($m^3$) | | Maximum total volume of oil arriving ashore ($m^3$) | | | Average total volume of oil arriving ashore ($m^3$) | | | Maximum total length of shoreline contacted (km) | | | Average total length of shoreline contacted (km) | | |
| | | Low | Mod | High | Low | Mod | High | Peak | Mean | Peak | Mean | Low | Mod | High | Low | Mod | High | Low | Mod | High | Low | Mod | High |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 42 | 3 | - | 3.32 | 7.9 | - | 128.55 | 18.04 | 8.67 | 0.9 | 7.88 | 2.42 | - | 0.68 | 0.05 | - | 16.5 | 2.54 | - | 2.7 | 0.05 | - |
| | French Island / San Remo | 1 | - | - | 2.19 | - | - | 69.44 | 0.78 | 1.1 | 0.01 | 0.8 | - | - | 0.01 | - | - | 1.27 | - | - | 0.01 | - | - |
| | Kilcunda | 40 | 5 | - | 0.59 | 0.82 | - | 779.14 | 26.94 | 23.36 | 0.88 | 23.32 | 21.33 | - | 0.77 | 0.28 | - | 11.44 | 6.36 | - | 1.82 | 0.13 | - |
| | Venus Bay | 60 | 7 | - | 1.09 | 2.11 | - | 165.67 | 32.89 | 4.87 | 1.11 | 4.61 | 1.9 | - | 0.92 | 0.1 | - | 12.71 | 1.27 | - | 2.94 | 0.09 | - |
| | Waratah Bay | 24 | 2 | - | 3.32 | 9.22 | - | 128.55 | 13.26 | 3.88 | 0.35 | 3.87 | 1.47 | - | 0.3 | 0.03 | - | 5.08 | 1.27 | - | 0.9 | 0.03 | - |

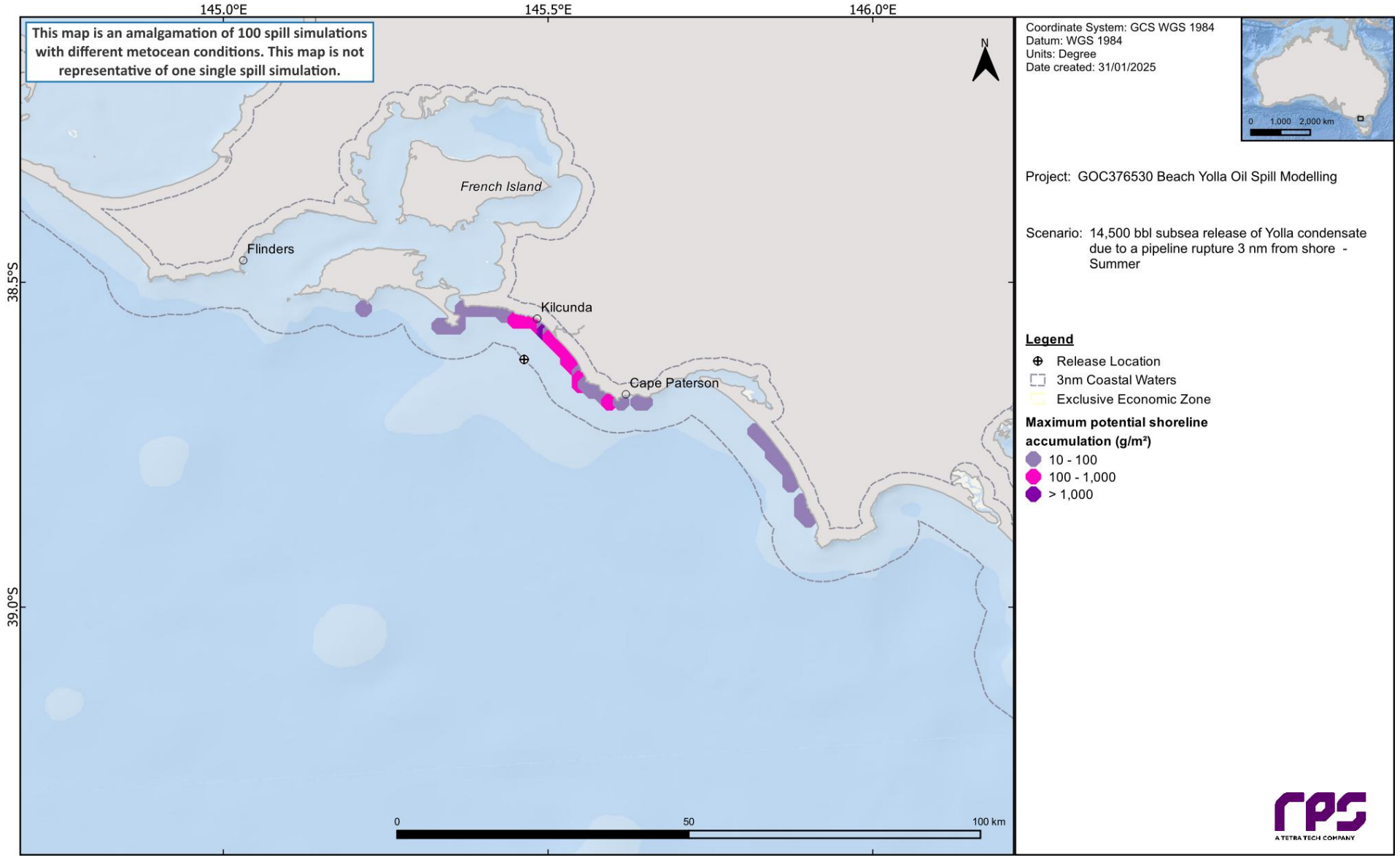


**Figure 14-17 Maximum potential shoreline loading in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

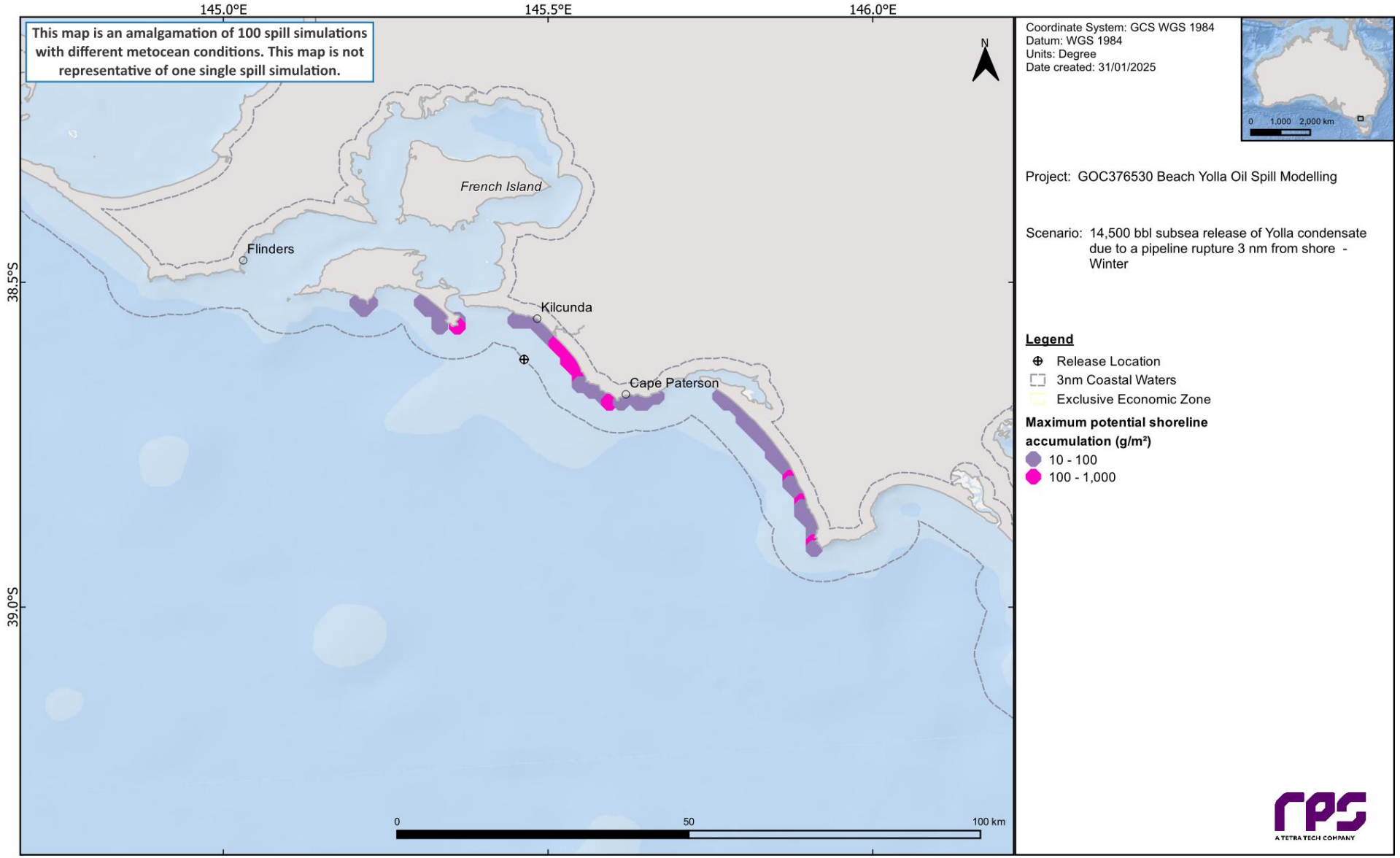


**Figure 14-18 Maximum potential shoreline loading in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

## 14.1.4 In-water exposure

### 14.1.4.1 Dissolved Hydrocarbons

Table 14-7 reveals the maximum distances to dissolved oil exposure during summer and winter conditions. Maximum distances to the low (10 ppb) and moderate (50 ppb) thresholds may reach 8.16 km (southeast, winter) and 2.77 km (west-northwest) respectively.

Table 14-8 and Table 14-9 summarise the exposure to individual receptors to dissolved hydrocarbons during the summer and winter conditions.

Outside of the receptors that the release location resides within, the highest concentration of dissolved hydrocarbon was predicted for Little Penguin - Foraging (Buffer around Phillip Island) and White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) BIAs during summer (63.19 ppb), with 2% probability, and Little Penguin - Foraging (Buffer around Phillip Island) BIA during winter (10.05 ppb), with 1% probability.

Figure 14-19 and Figure 14-20 present the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 14-21 to Figure 14-28 present the probability maps and the maximum residence time of dissolved hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

**Table 14-7 Maximum distance and direction from the release location to the edge of dissolved oil exposure. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential dissolve oil exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Maximum distance (km) from release location | 5.05 | 2.77 | - |
| | Direction | West | West-Northwest | - |
| Winter | Maximum distance (km) from release location | 8.16 | 1.16 | - |
| | Direction | Southeast | West-Southwest | - |

**Table 14-8 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 63.19 | 2 | 1 | - | 0.18 | 0.22 | - | 23 | 2.25 | - |
| | Pygmy Blue Whale - Distribution (None)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |

| Receptor | | Summer (November through to March) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 63.19 | 2 | 1 | - | 0.22 | 0.26 | - | 10.75 | 2.25 | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| IMCRA-MESO | Central Victoria** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| MR | South-east (Marine) | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 23 | 3.5 | - |
| NRMR | West Gippsland (VIC)** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 13.75 | 3.5 | - |
| State Waters | Victoria** | 113.28 | 6 | 4 | - | 0.02 | 0.03 | - | 13.75 | 3.5 | - |

**The release location resides within the receptor boundaries.

**Table 14-9 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region) | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region) | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island) | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region) | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 10.05 | 1 | - | - | 0.74 | - | - | 0.25 | - | - |
| | Pygmy Blue Whale - Distribution (None)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |

| Receptor | | Winter (April through to October) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| | Wandering Albatross - Foraging (The whole South-east Marine Region) | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld) | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour) | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| IMCRA-MESO | Central Victoria** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| MR | South-east (Marine) | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 20.5 | 7.5 | - |
| NRMR | West Gippsland (VIC)** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 19 | 6.25 | - |
| State Waters | Victoria** | 190.72 | 5 | 3 | - | 0.02 | 0.02 | - | 19 | 6.25 | - |

**The release location resides within the receptor boundaries.

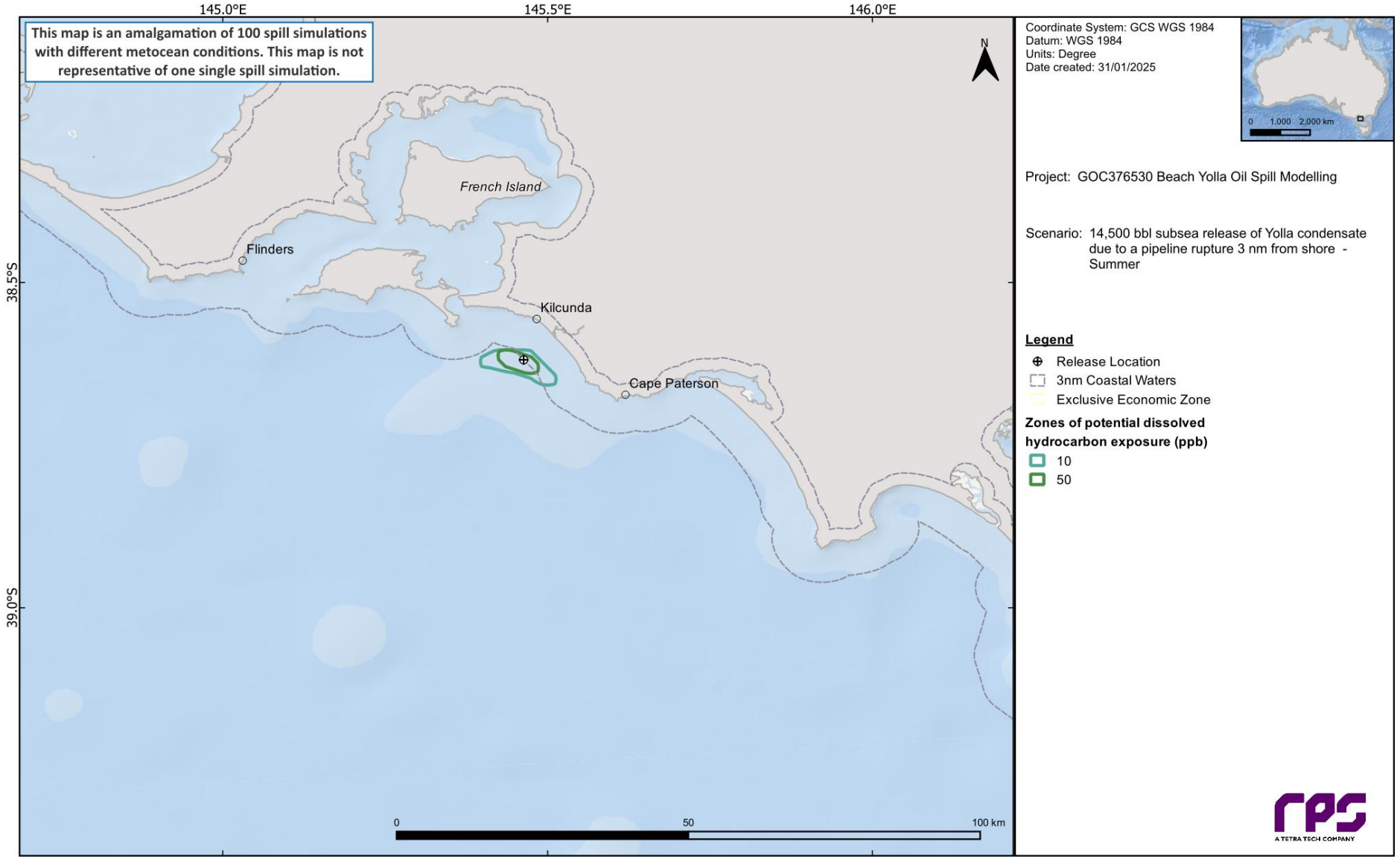


**Figure 14-19 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

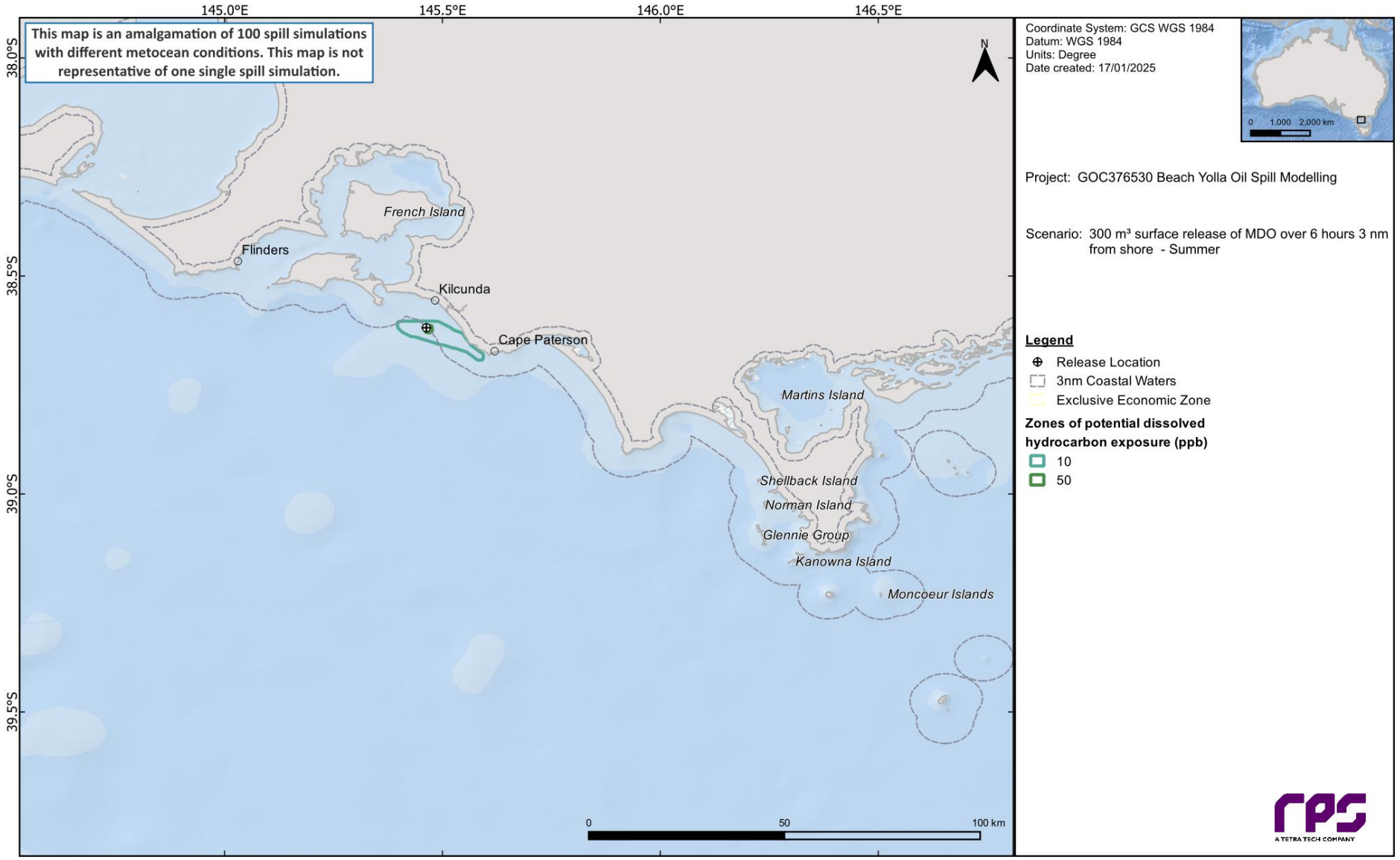


**Figure 14-20 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

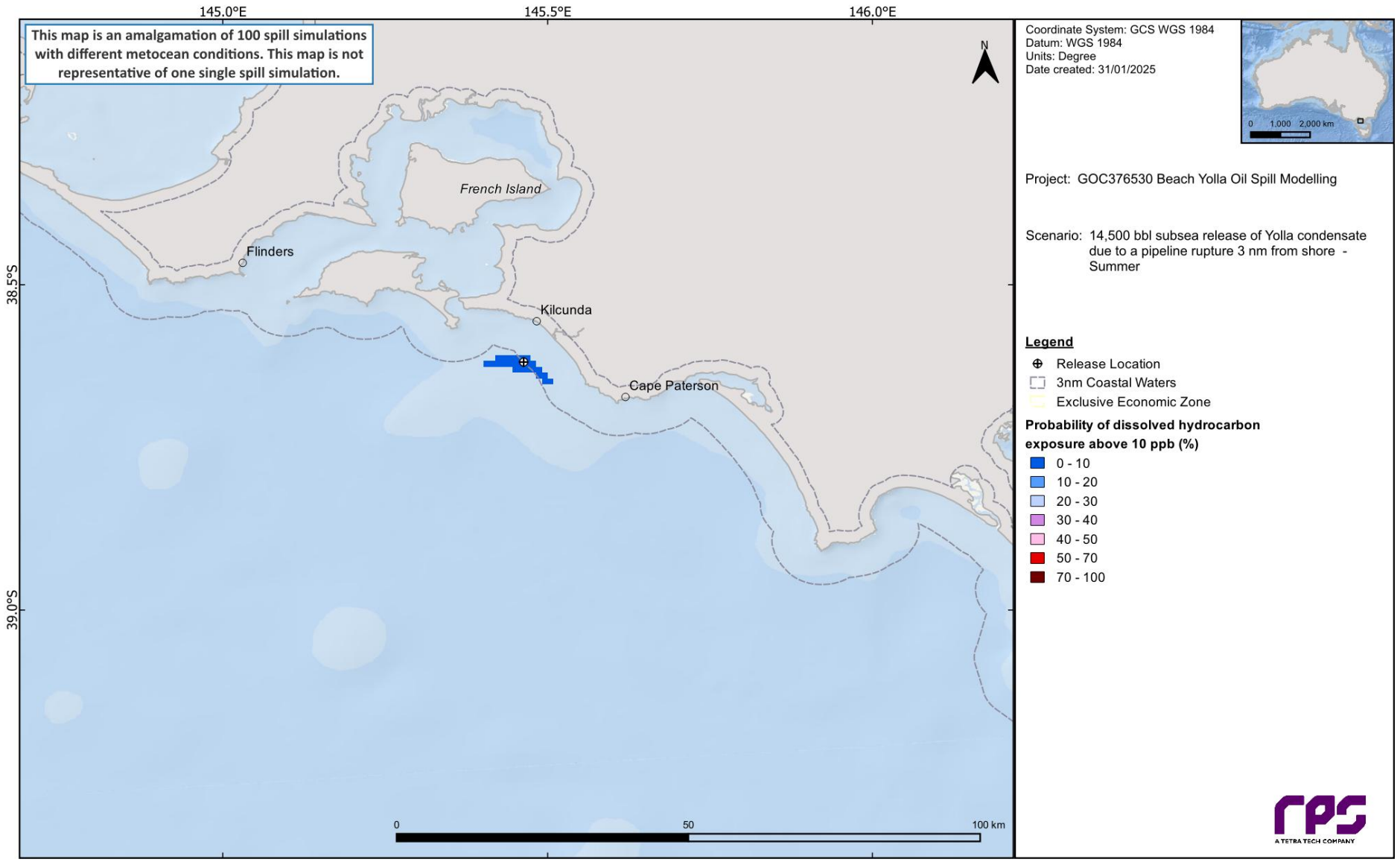


**Figure 14-21 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

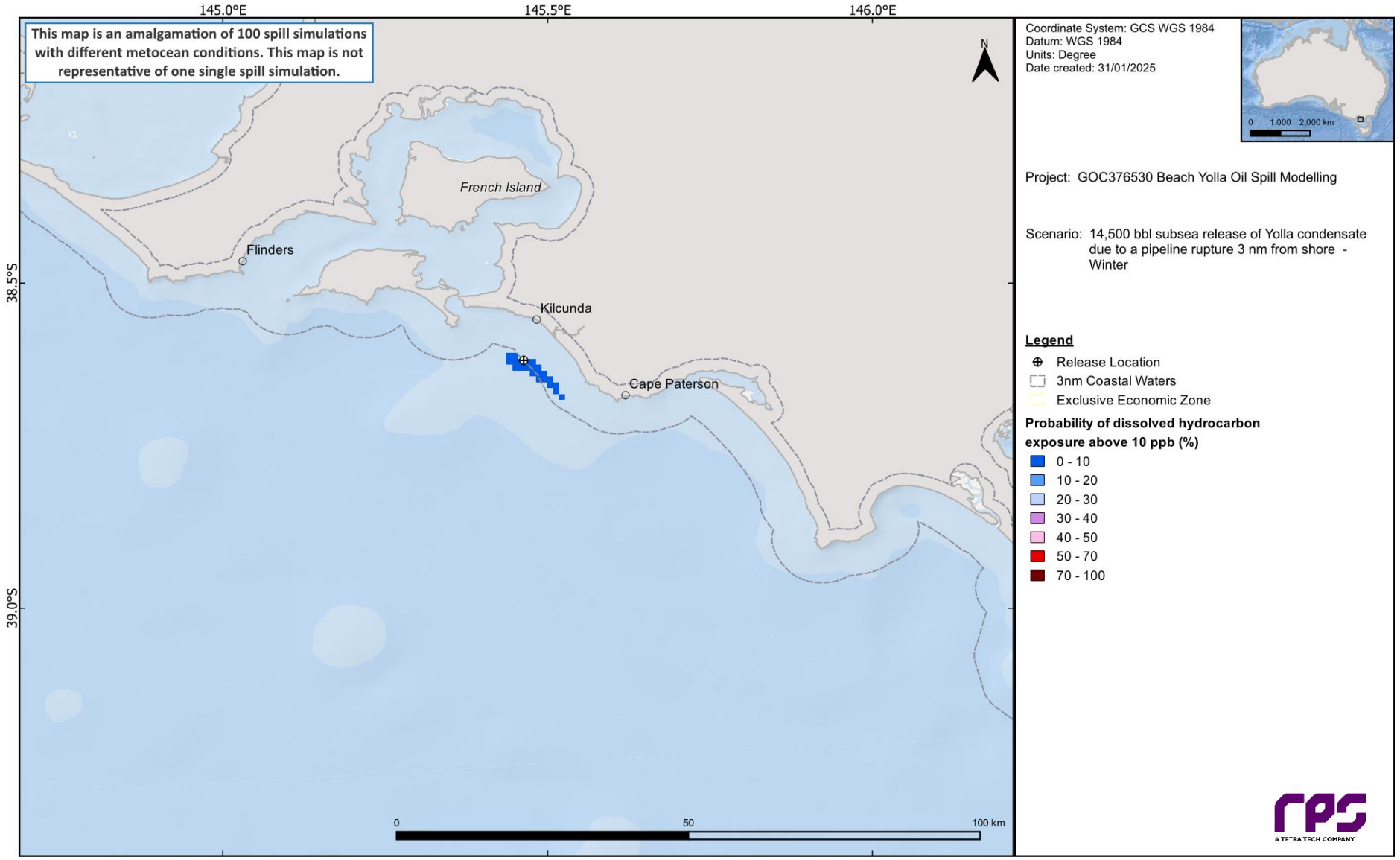


**Figure 14-22 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

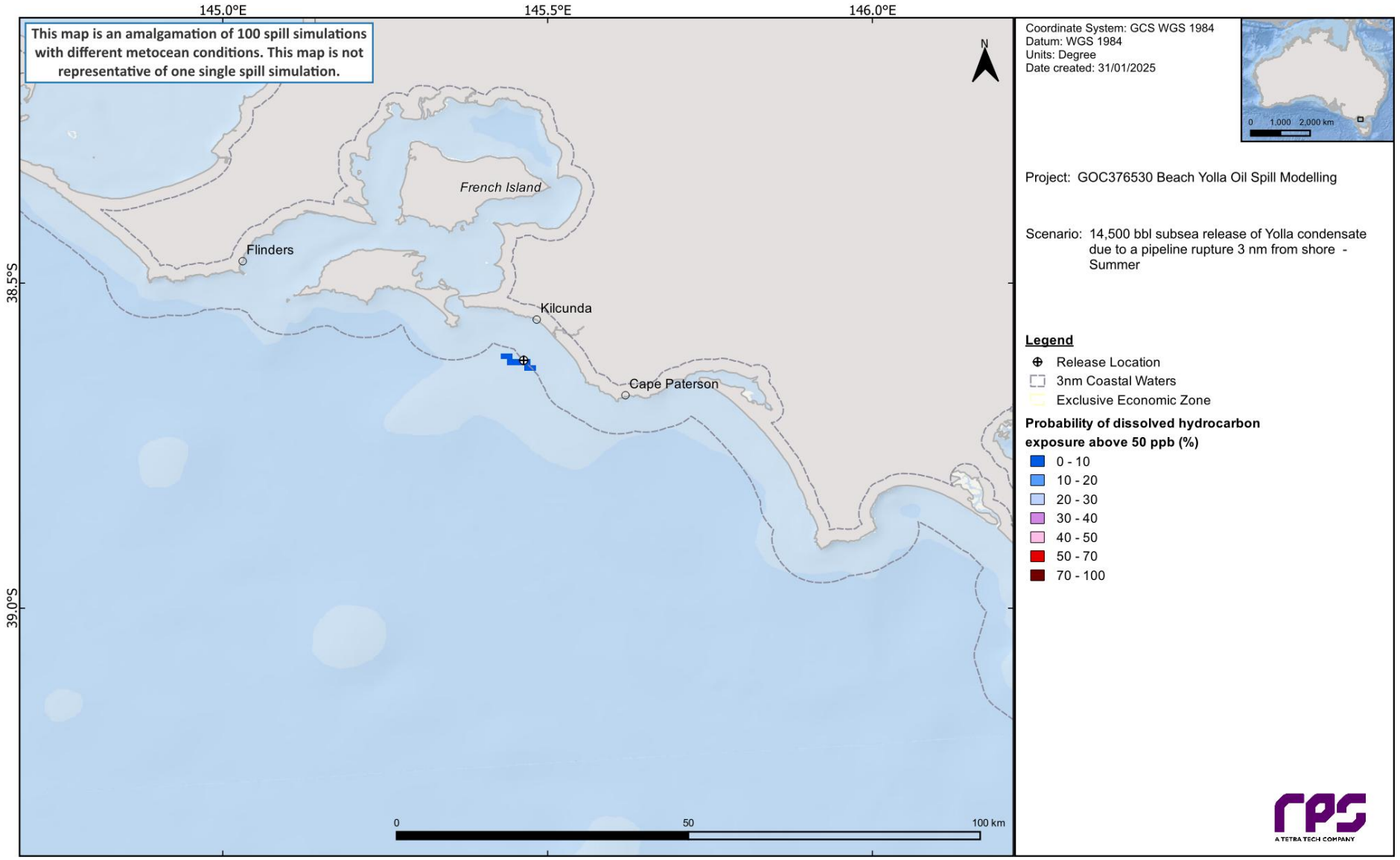


**Figure 14-23 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

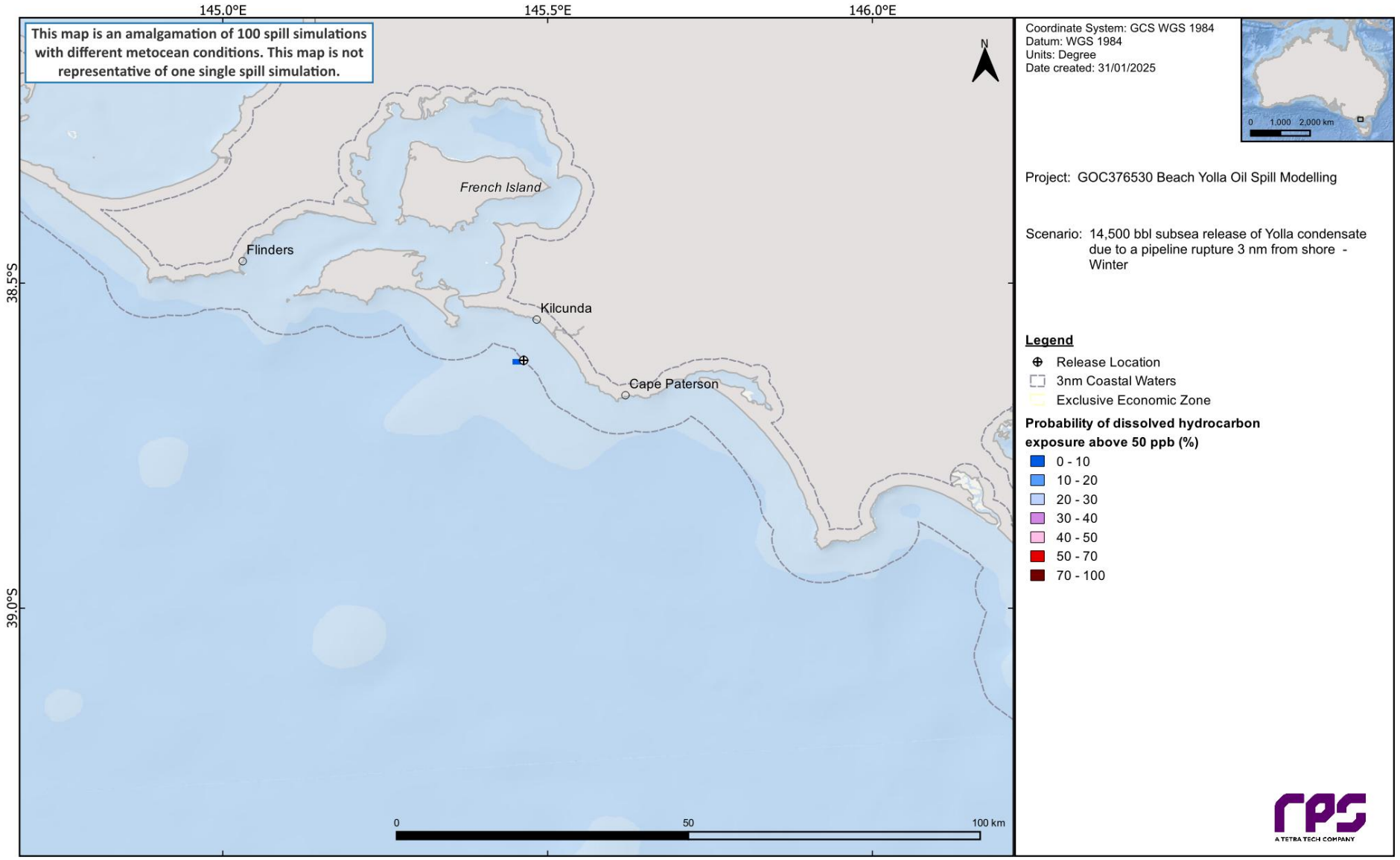


**Figure 14-24 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

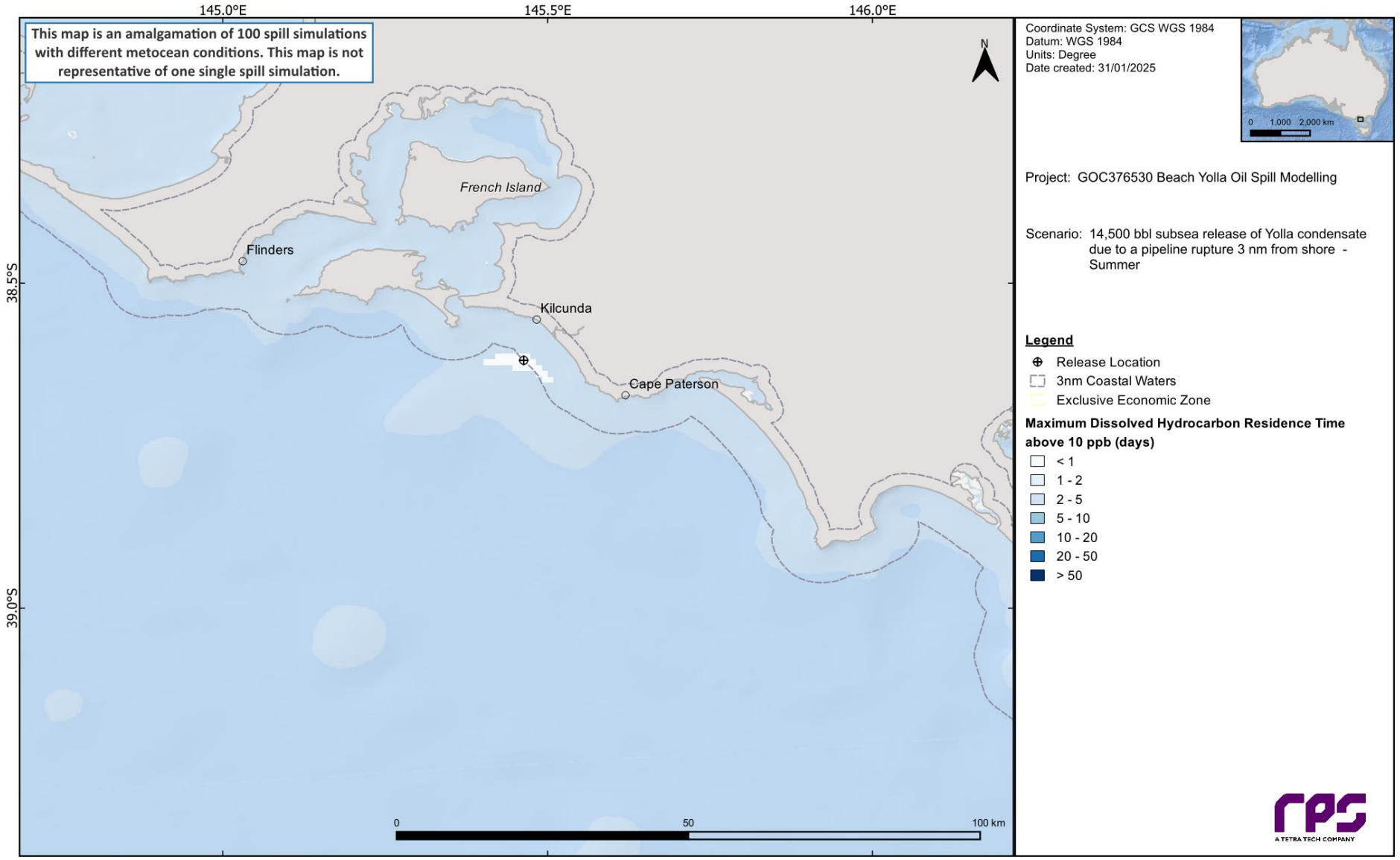


**Figure 14-25 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

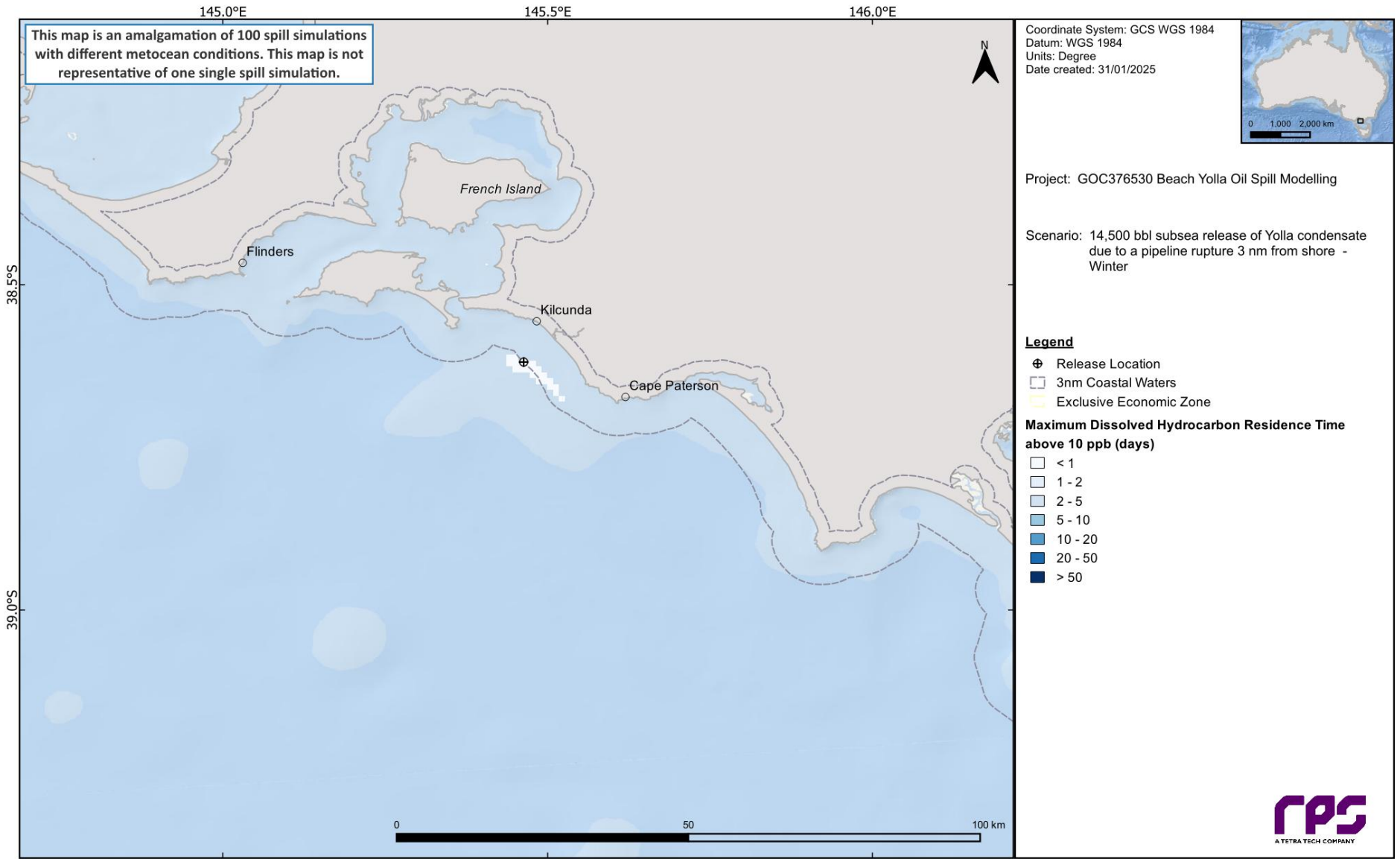


**Figure 14-26 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

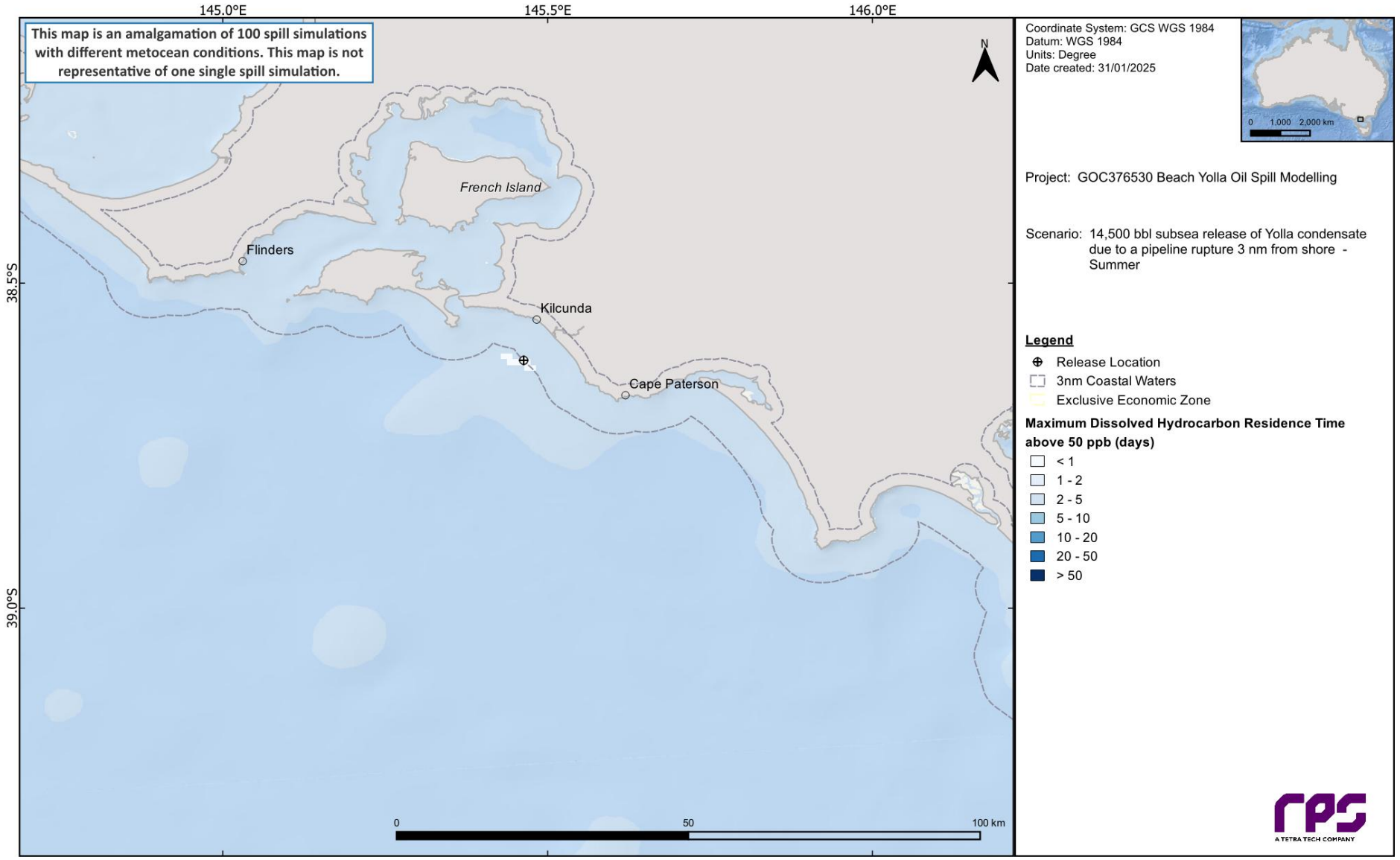


**Figure 14-27 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

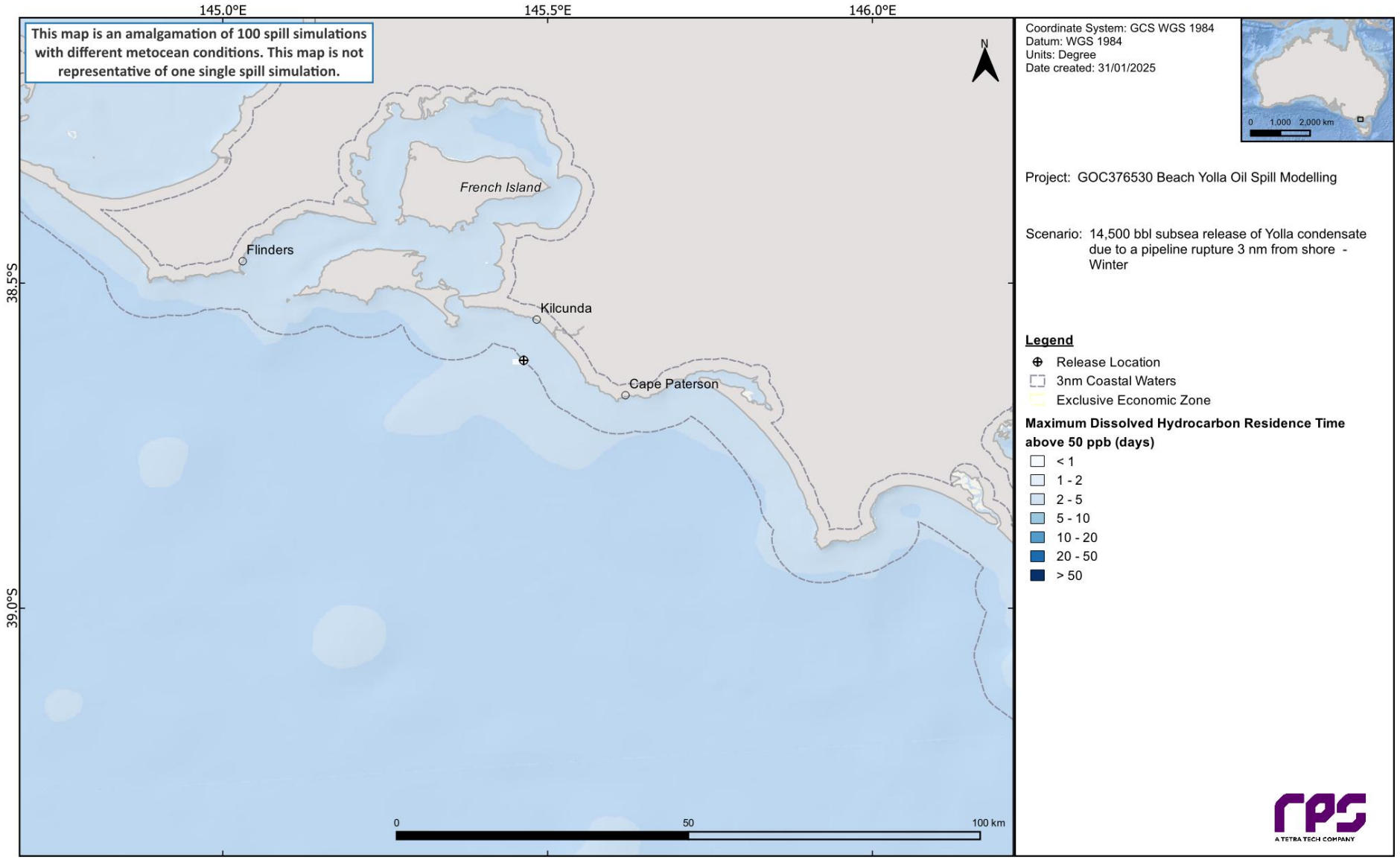


**Figure 14-28 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

### 14.1.4.2 Entrained Hydrocarbons

Table 14-10 reveals the maximum distances to entrained oil exposure during summer and winter conditions. Maximum distances to the 10 ppb and 100 ppb thresholds may reach 80.2 km (east-southeast, winter) and 47.43 km (east-southeast, summer) respectively.

Table 14-11 and Table 14-12 present a summary of exposure to individual receptors from entrained hydrocarbons for the summer and winter conditions.

Except for the receptors that the Yolla Well Head resides within, the highest probabilities of entrained hydrocarbons at, or above, 10 ppb with probabilities were 86% for the White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) BIA during summer and 88% for the Kilcunda nearshore waters in winter. The minimum time before exposure was 0.05 days and 0.06 days for the Little Penguin - Foraging (Buffer around Phillip Island) BIA in summer and winter respectively.

Figure 14-29 and Figure 14-30 present the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 14-31 to Figure 14-38 present the probability maps and the maximum residence time of entrained hydrocarbon exposure for the 10 ppb and 100 ppb thresholds in summer and winter.

**Table 14-10 Maximum distance and direction from the release location to the edge of entrained oil exposure. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential entrained oil exposure | |
|---|---|---|---|
| | | 10 ppb | 100 ppb |
| Summer | Maximum distance (km) from release location | 50.56 | 47.43 |
| | Direction | Southeast | East-Southeast |
| Winter | Maximum distance (km) from release location | 80.2 | 43.31 |
| | Direction | East-Southeast | East-Southeast |

**Table 14-11 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| BAS | Gippsland Basin - Gippsland | 24.58 | 1 | - | 2.17 | - | 25.5 | - |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region) | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 34.75 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region) | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 34.75 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island) | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 34.75 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region) | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 34.75 |
| | Little Penguin - Breeding (Phillip Island) | 12.26 | 1 | - | 9.78 | - | 5.25 | - |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 1,047.64 | 90 | 52 | 0.02 | 0.05 | 233.75 | 25.5 |
| | Pygmy Blue Whale - Distribution (None)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| | Short-tailed Shearwater - Breeding (Phillip Island) | 12.26 | 1 | - | 9.78 | - | 5.25 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | waters anywhere between Sydney and Perth, including off Tasmania)** | | | | | | | |
| | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promotory) | 230.5 | 43 | 9 | 0.22 | 0.73 | 184.75 | 31.5 |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| | Wandering Albatross - Foraging (The whole South-east Marine Region) | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 34.75 |
| | White Shark - Distribution (Between the 60-120m depth contour) | 248.54 | 40 | 1 | 0.59 | 0.89 | 91.5 | 6 |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld) | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 34.75 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 1,042.07 | 86 | 45 | 0.03 | 0.09 | 232 | 25.5 |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour) | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 34.75 |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| CP | Cape Liptrap Coastal Park | - | - | - | - | - | - | - |
| IBRA | South East Coastal Plain | 12.26 | 2 | - | 2.7 | - | 5.25 | - |
| IMCRA-MESO | Central Bass Strait | 81.17 | 1 | - | 1.63 | - | 9 | - |
| | Central Victoria** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| | Victorian Embayments | 16.95 | 3 | - | 5.93 | - | 79.25 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| MNP | Bunurong | 92.29 | 16 | - | 1.04 | - | 69.5 | - |
| MR | South-east (Marine) | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 34.75 |

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| NIW | Western Port | 18.94 | 7 | - | 3.78 | - | 106 | - |
| NPS4 | Bunurong Marine Park | 198.79 | 39 | 8 | 0.91 | 1.14 | 101.25 | 9.25 |
| NRMR | Port Phillip and Western Port (VIC) | 239.72 | 43 | 5 | 0.24 | 0.65 | 162.25 | 6 |
| | West Gippsland (VIC)** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |
| OP | Phillip Island Nature Park | 12.26 | 1 | - | 9.78 | - | 5.25 | - |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 175.89 | 7 | 1 | 1.85 | 2.61 | 184.75 | 31.5 |
| | French Island / San Remo | 19.68 | 9 | - | 3.51 | - | 109.25 | - |
| | Kilcunda | 710.04 | 80 | 19 | 0.03 | 0.51 | 227.75 | 58 |
| | Venus Bay | 230.5 | 49 | 9 | 0.13 | 0.96 | 153 | 15 |
| State Waters | Victoria** | 86,652.20 | 100 | 100 | 0.01 | 0.01 | 240 | 58 |

**The release location resides within the receptor boundaries.

**Table 14-12 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| BAS | Gippsland Basin - Gippsland | 12.87 | 5 | - | 2 | - | 5.5 | - |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region) | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 203.5 | 26.5 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region) | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 203.5 | 26.5 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island) | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 203.5 | 26.5 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region) | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 203.5 | 26.5 |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 898.46 | 81 | 28 | 0.03 | 0.06 | 137.5 | 24 |
| | Pygmy Blue Whale - Distribution (None)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 27.5 |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promotory) | 241.57 | 84 | 15 | 0.16 | 0.75 | 166 | 45.25 |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 27.5 |
| | Wandering Albatross - Foraging (The whole South-east Marine Region) | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 203.5 | 26.5 |
| | White Shark - Distribution (Between the 60-120m depth contour) | 92.07 | 45 | - | 0.78 | - | 132.5 | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld) | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 203.5 | 26.5 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 790.49 | 75 | 21 | 0.03 | 0.09 | 126 | 22.25 |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour) | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 203.5 | 26.5 |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| IMCRA-MESO | Central Bass Strait | 12.35 | 1 | - | 3.51 | - | 3.75 | - |
| | Central Victoria** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| | Flinders | 11.96 | 2 | - | 7.86 | - | 3.5 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| | Southeast Shelf Transition | 11.96 | 2 | - | 7.86 | - | 3.5 | - |
| MNP | Bunurong | 71.05 | 73 | - | 0.67 | - | 99.25 | - |
| MR | South-east (Marine) | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 203.5 | 26.5 |
| NIW | Western Port | 11.03 | 1 | - | 2.96 | - | 9 | - |
| NPS4 | Bunurong Marine Park | 200.91 | 81 | 14 | 0.39 | 0.79 | 125.5 | 18.5 |
| | Wilsons Promontory Marine Park | 11.11 | 1 | - | 9.9 | - | 2.75 | - |

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| NRMR | Port Phillip and Western Port (VIC) | 68.42 | 12 | - | 0.69 | - | 76.5 | - |
| | West Gippsland (VIC)** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |
| RSB | Cody Bank | 14.89 | 2 | - | 2.69 | - | 3.75 | - |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 235.38 | 58 | 1 | 2.05 | 3.35 | 165.75 | 45.25 |
| | French Island / San Remo | 11.44 | 1 | - | 2.96 | - | 9 | - |
| | Kilcunda | 211.53 | 88 | 19 | 0.03 | 0.53 | 218 | 20.5 |
| | Venus Bay | 200.91 | 84 | 14 | 0.08 | 0.75 | 130.25 | 18.5 |
| | Waratah Bay | 23.29 | 20 | - | 2.86 | - | 83.25 | - |
| | Wilsons Promontory - West | 11.11 | 1 | - | 9.9 | - | 2.75 | - |
| State Waters | Victoria** | 86,657.97 | 100 | 100 | 0.01 | 0.01 | 239.5 | 45.25 |

**The release location resides within the receptor boundaries.

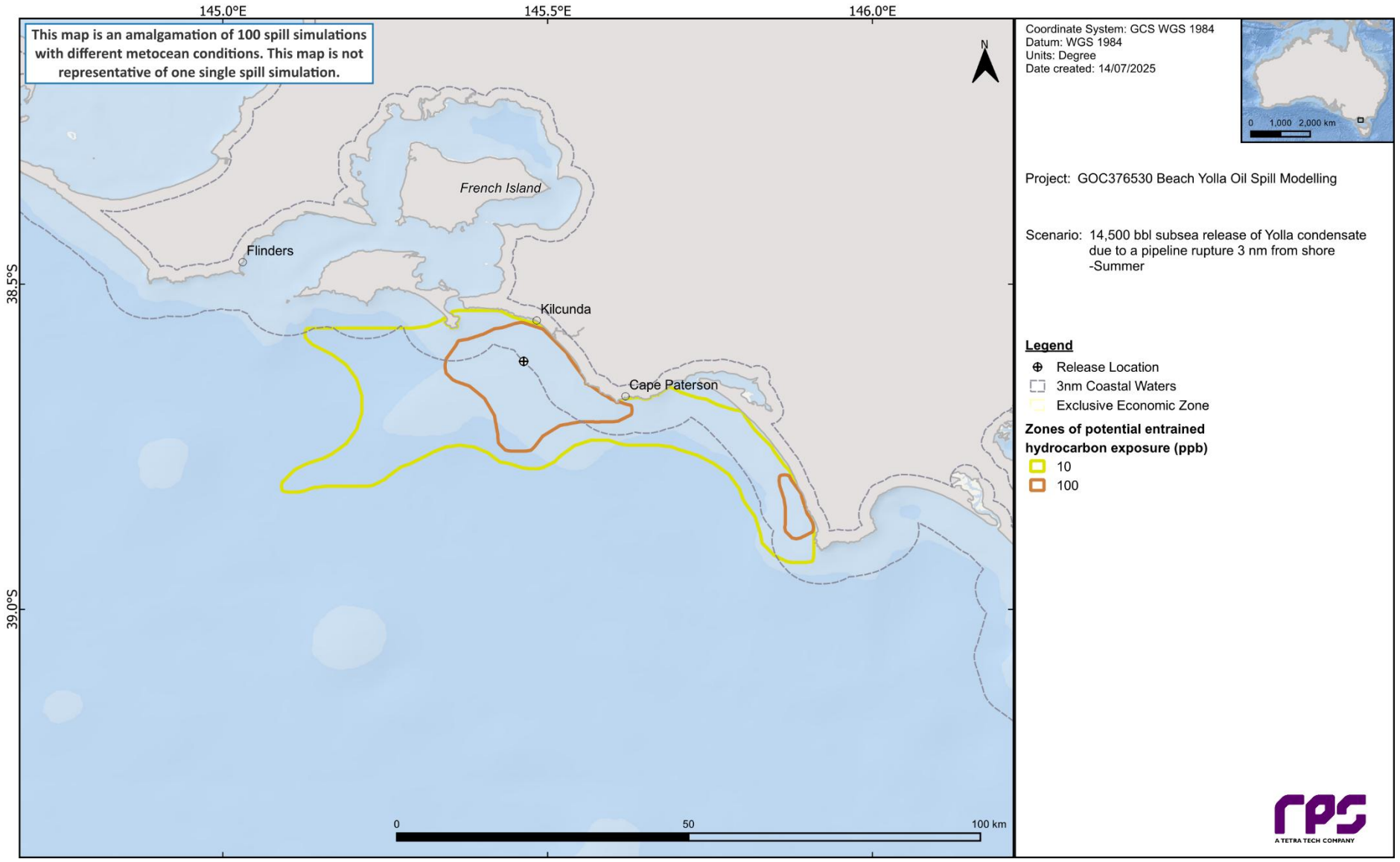


**Figure 14-29 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

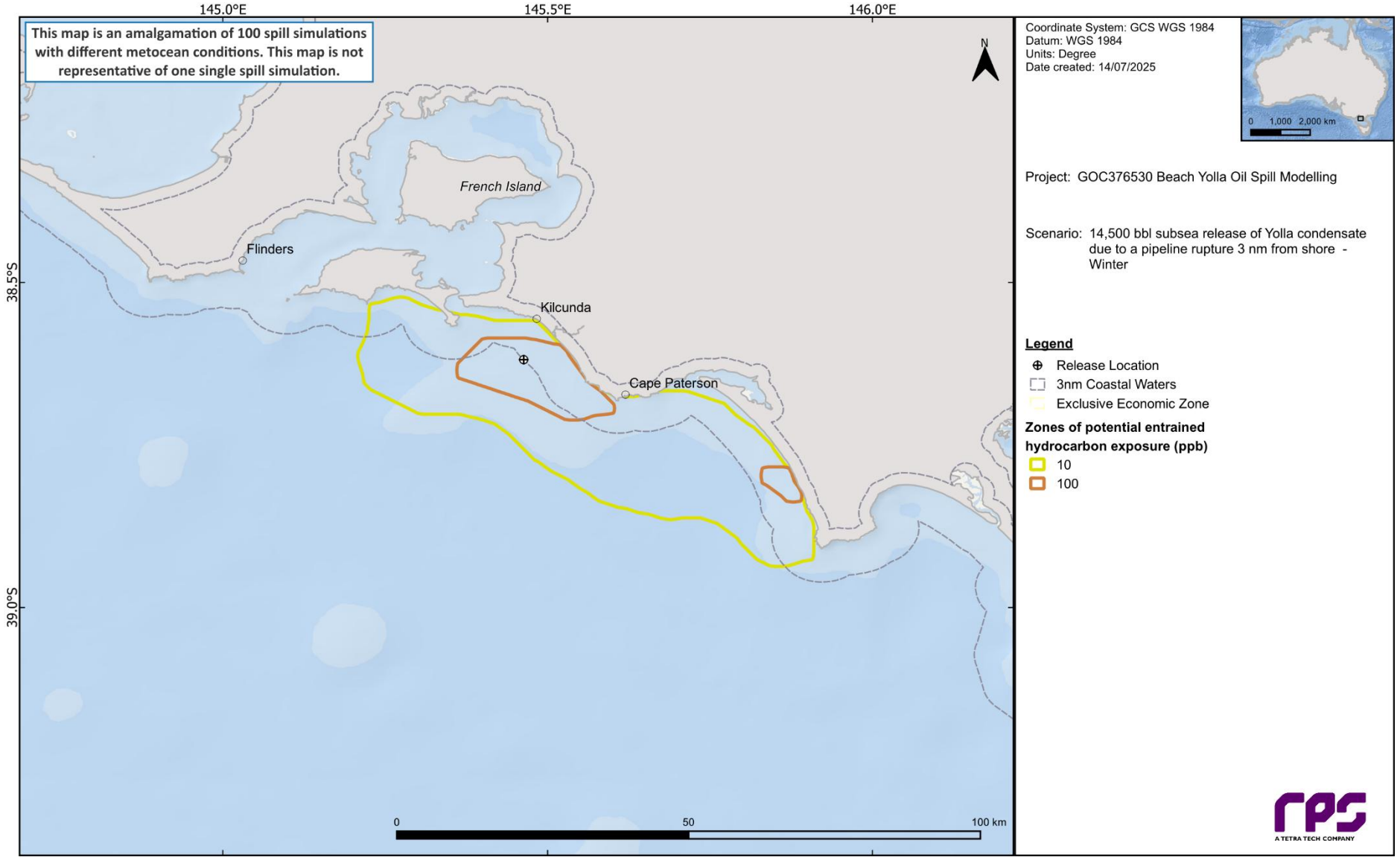


**Figure 14-30 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

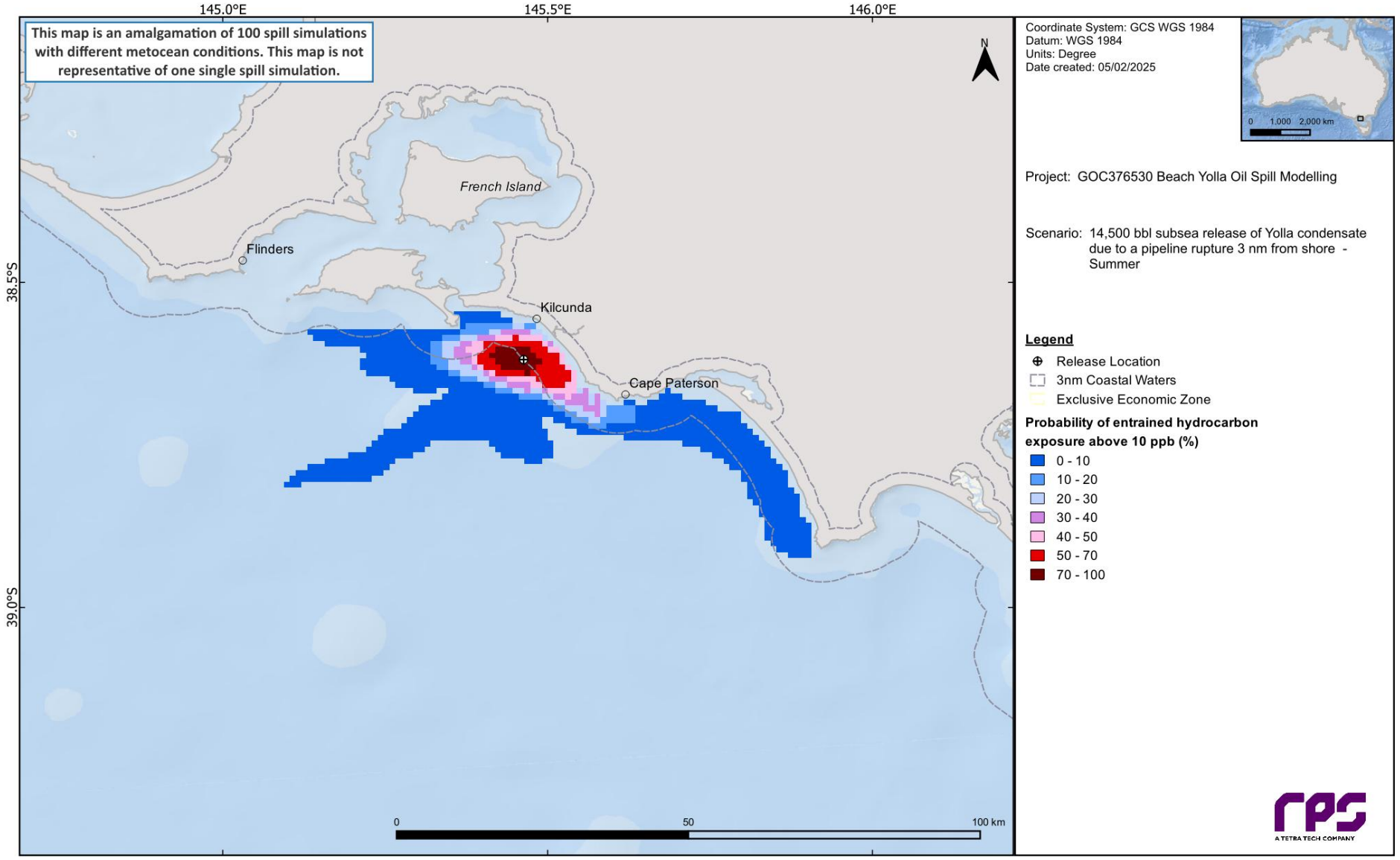


**Figure 14-31 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

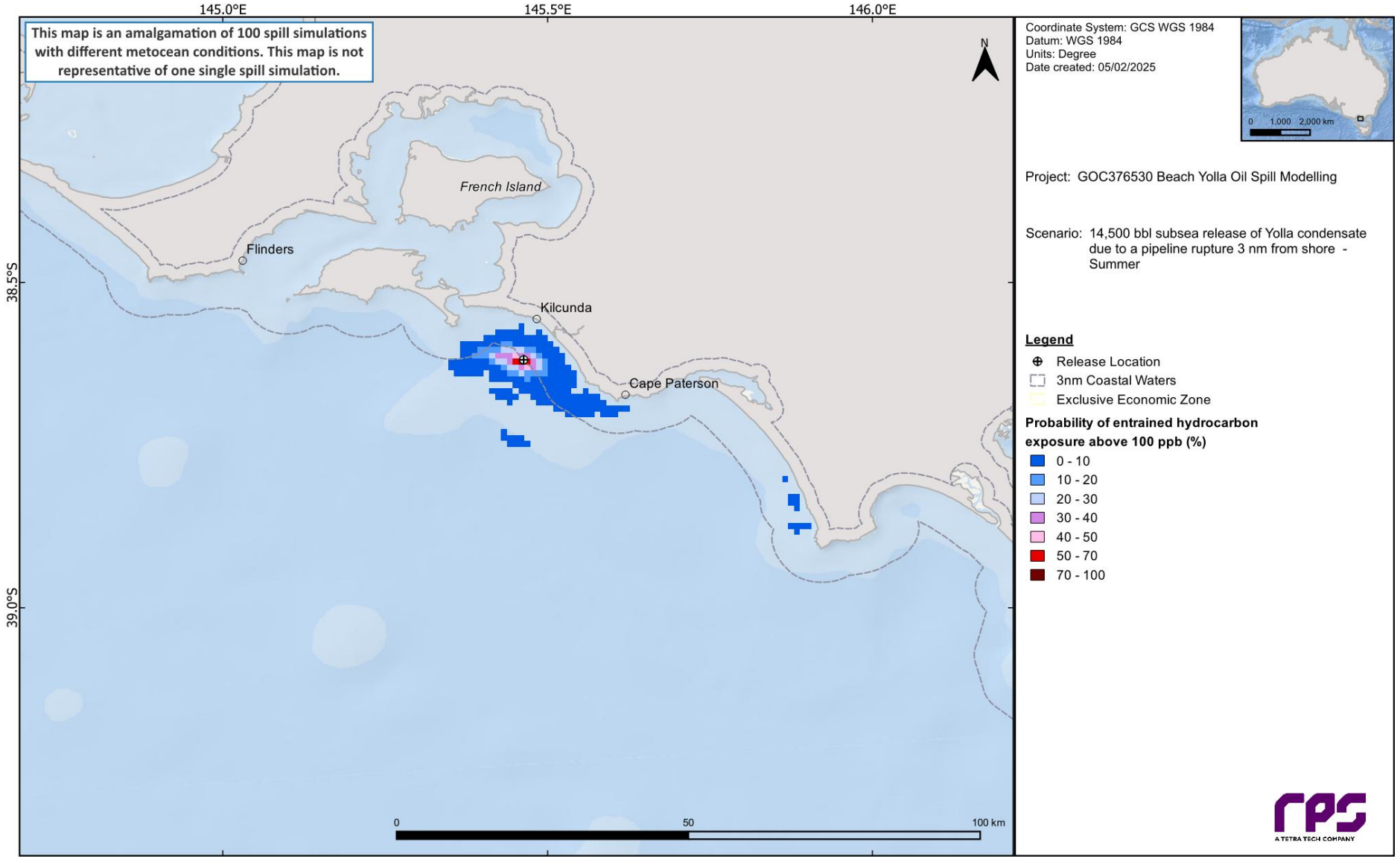


**Figure 14-32 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

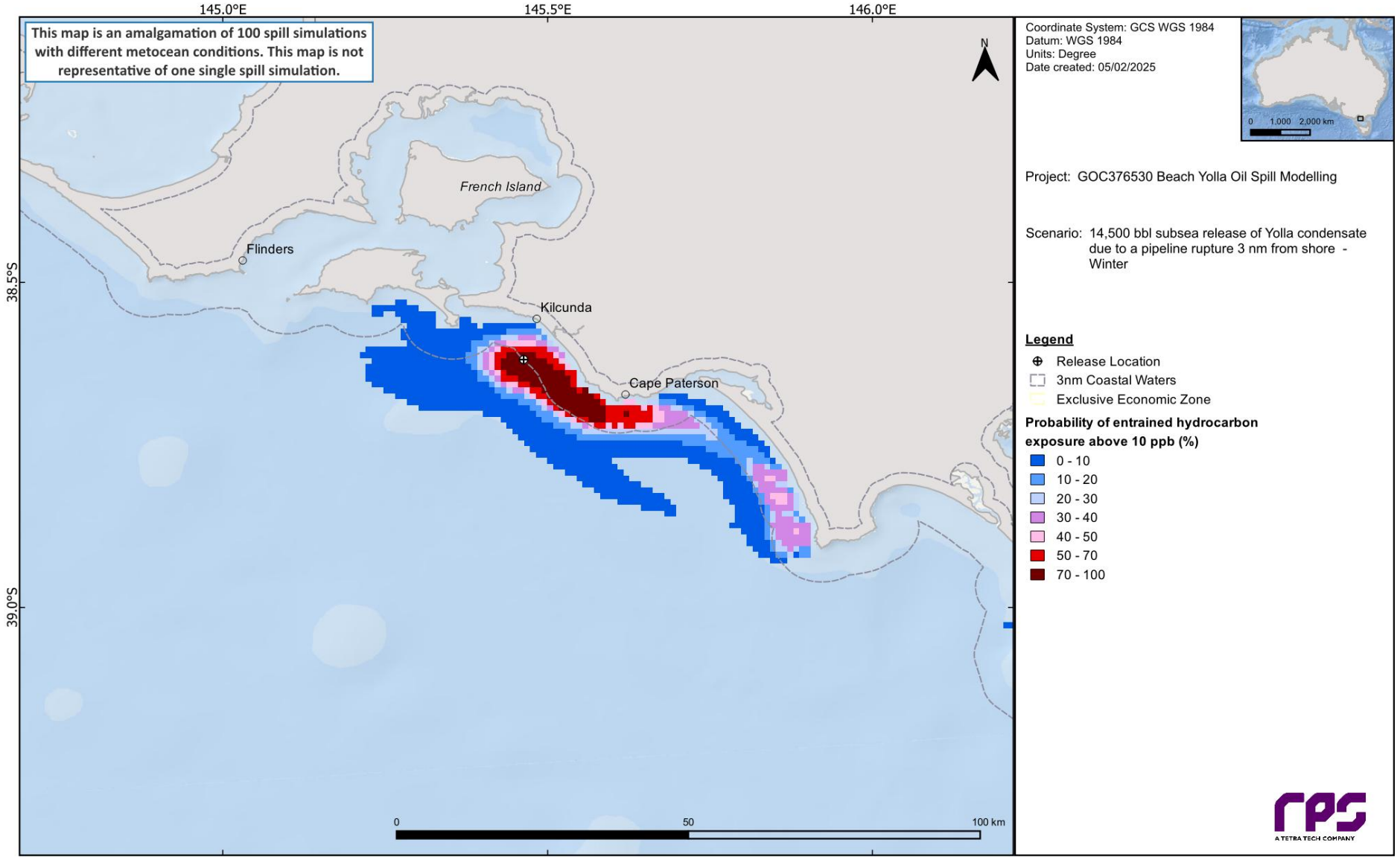


**Figure 14-33 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

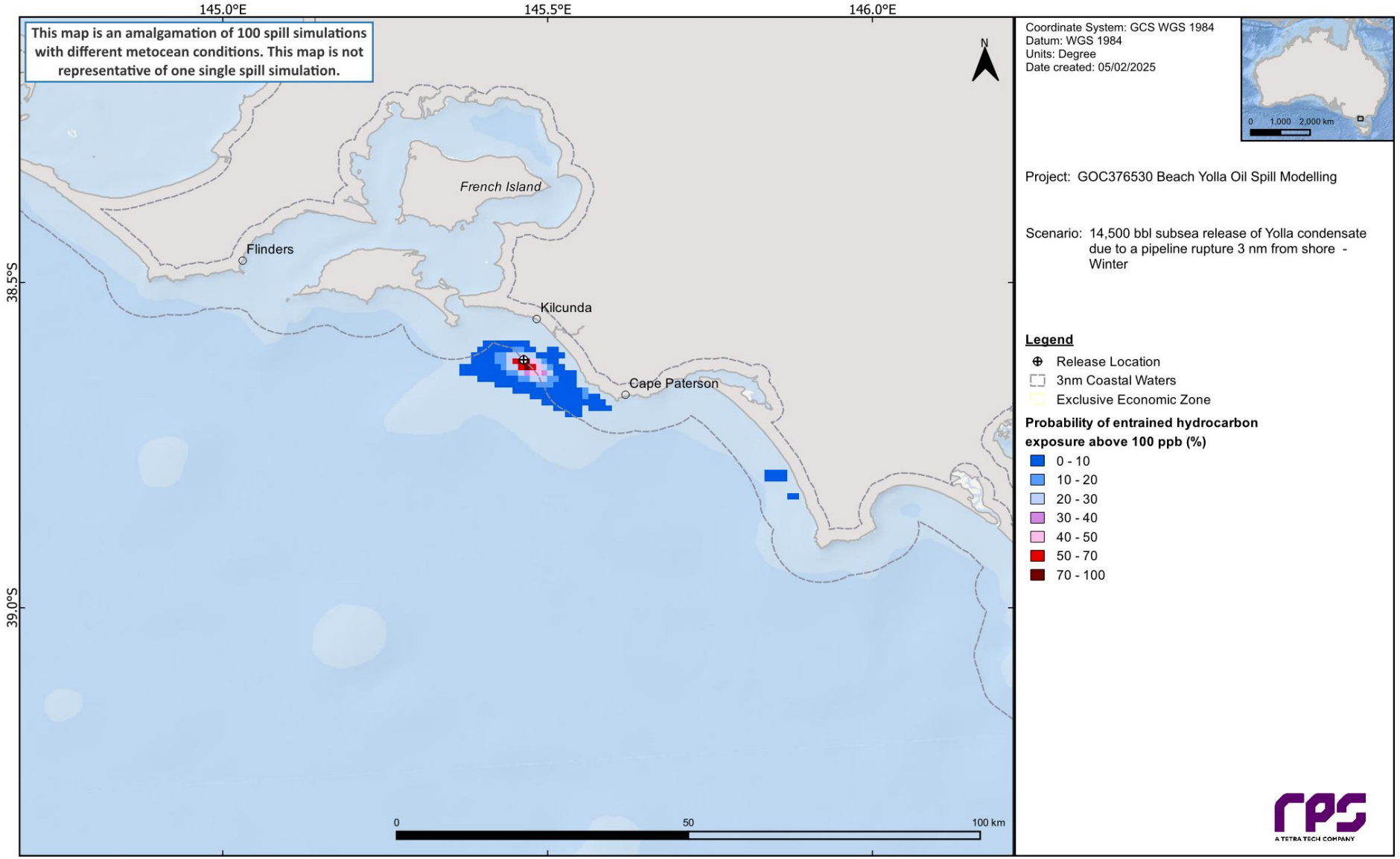


**Figure 14-34 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

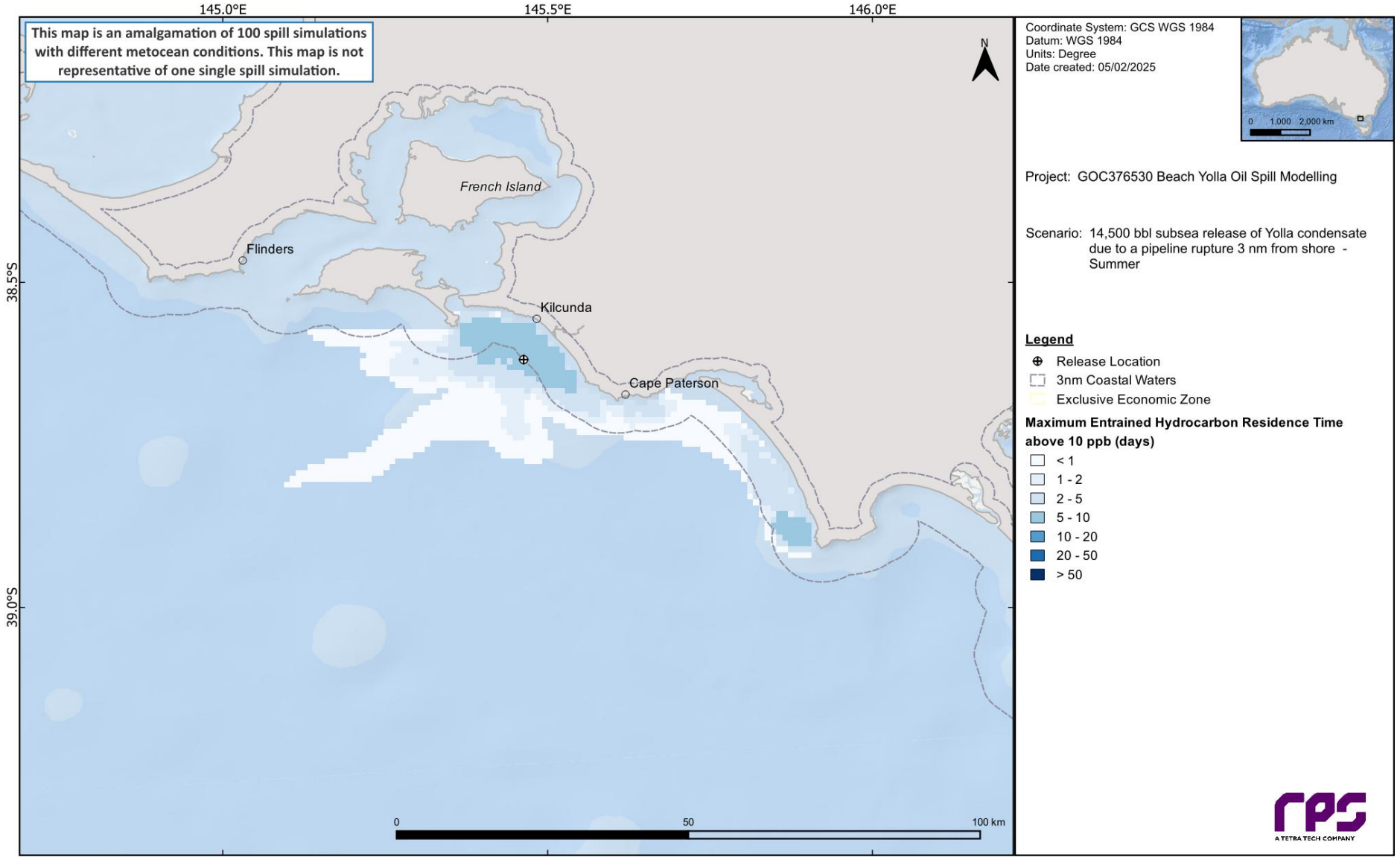


**Figure 14-35 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

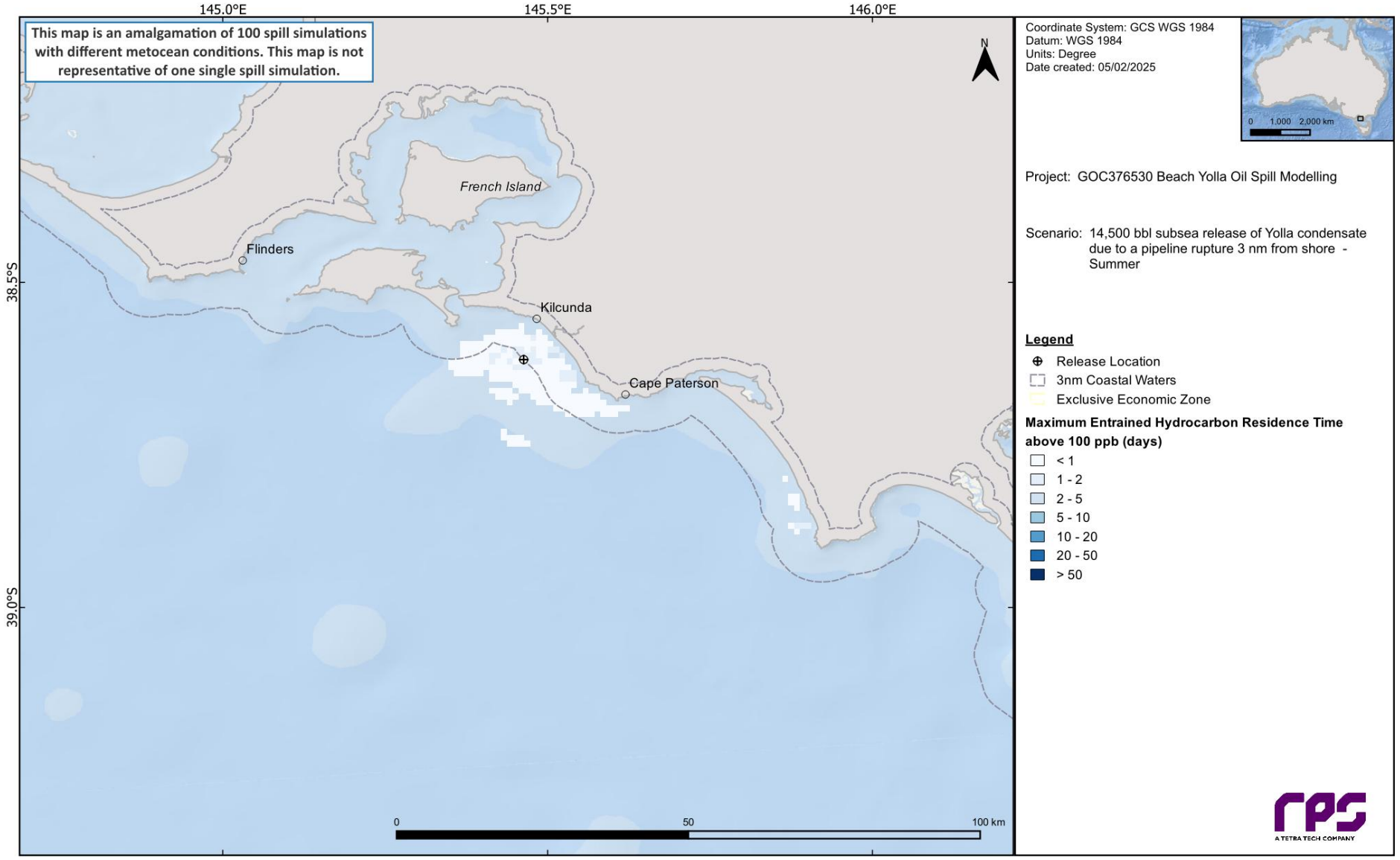


**Figure 14-36 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions.**

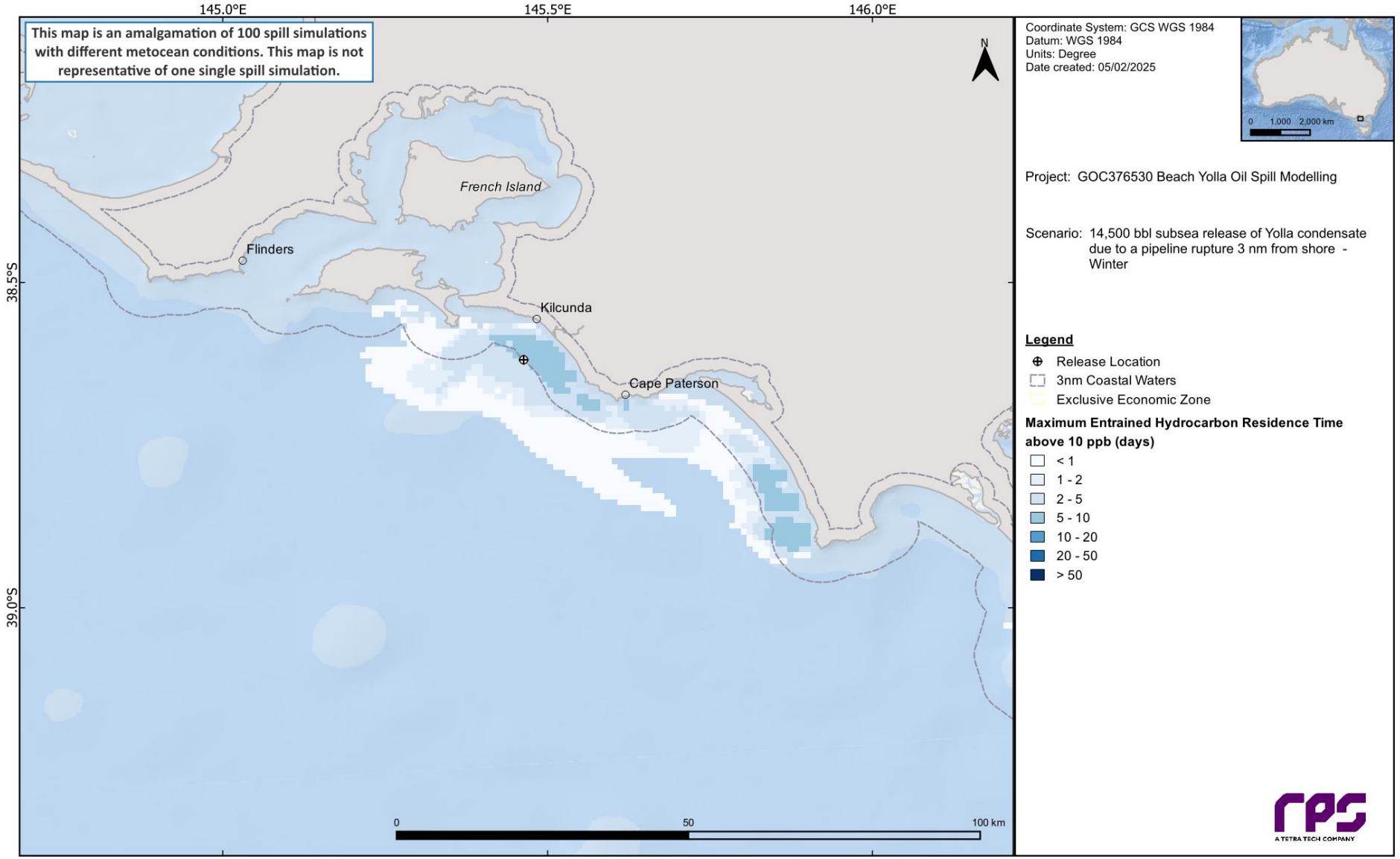


**Figure 14-37 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

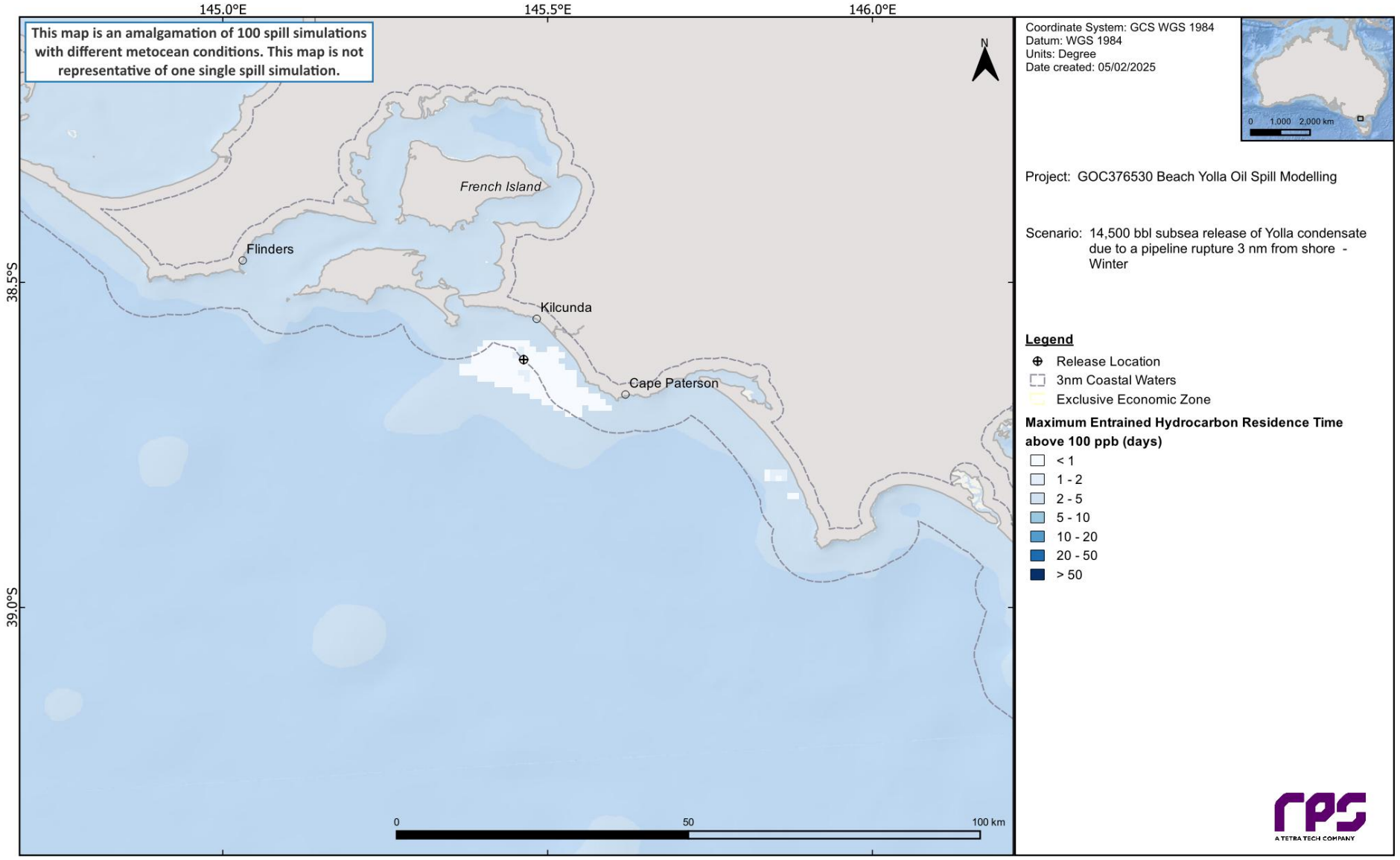


**Figure 14-38 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter conditions.**

# 15 RESULTS – SURFACE RELEASE OF MDO 3NM FROM SHORE

This scenario examined a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. A total of 200 spill simulations were run (i.e., 100 spills per season) and tracked for 100 days. The results for all 100 simulations per season were combined and are presented on a seasonal basis (i.e., summer and winter).

## 15.1 Stochastic Analysis

### 15.1.1 Area of Exposure

Figure 15-1 and Figure 15-2 presents the combined area of potential exposure for surface, shoreline, entrained and dissolved, by overlaying the results from all 200 simulations (i.e., 100 per season) during summer and winter conditions. Note that, when generating the EMBAs, a filter has been applied to remove numerical artifacts introduced by the model.

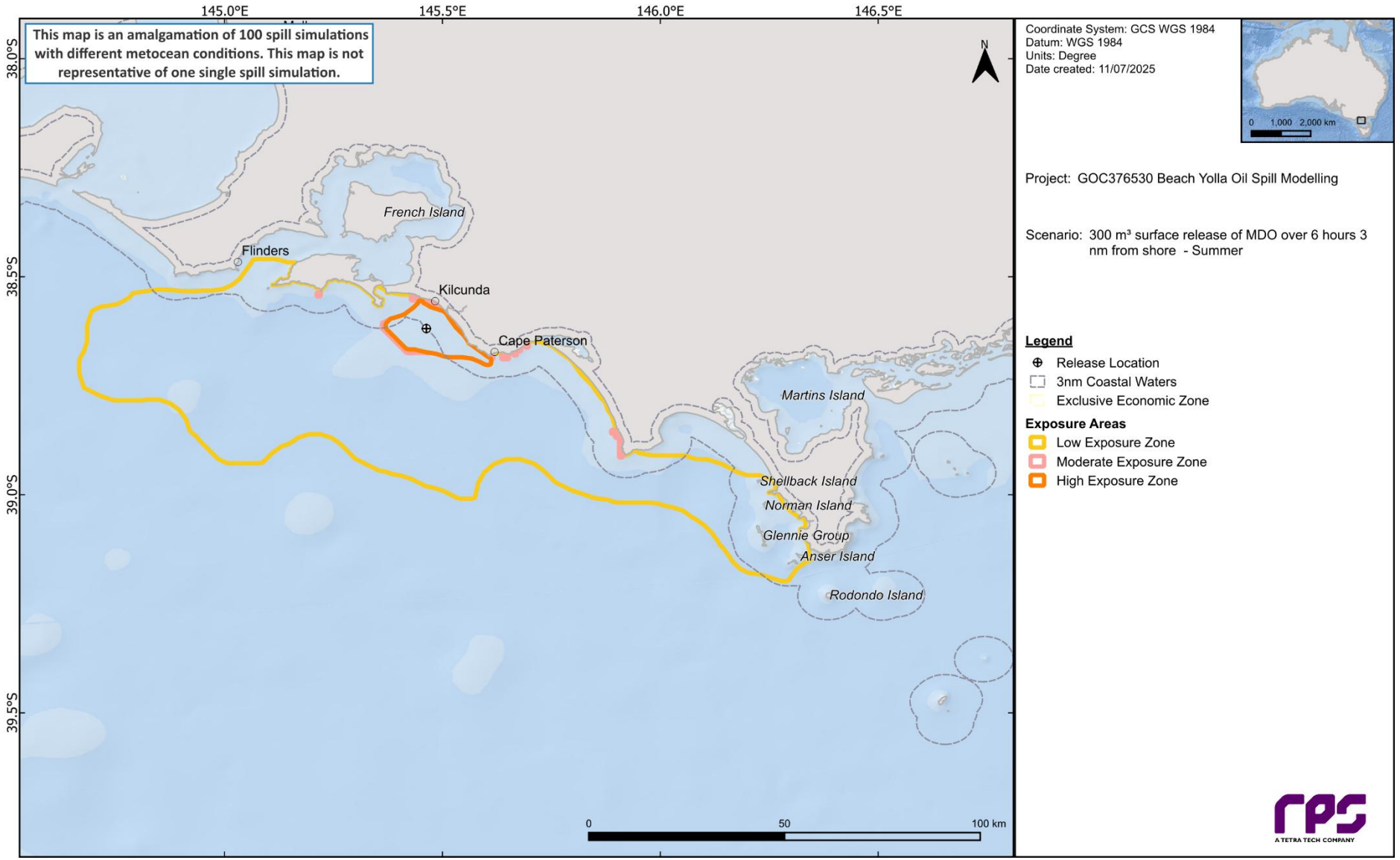


**Figure 15-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore during summer conditions.**

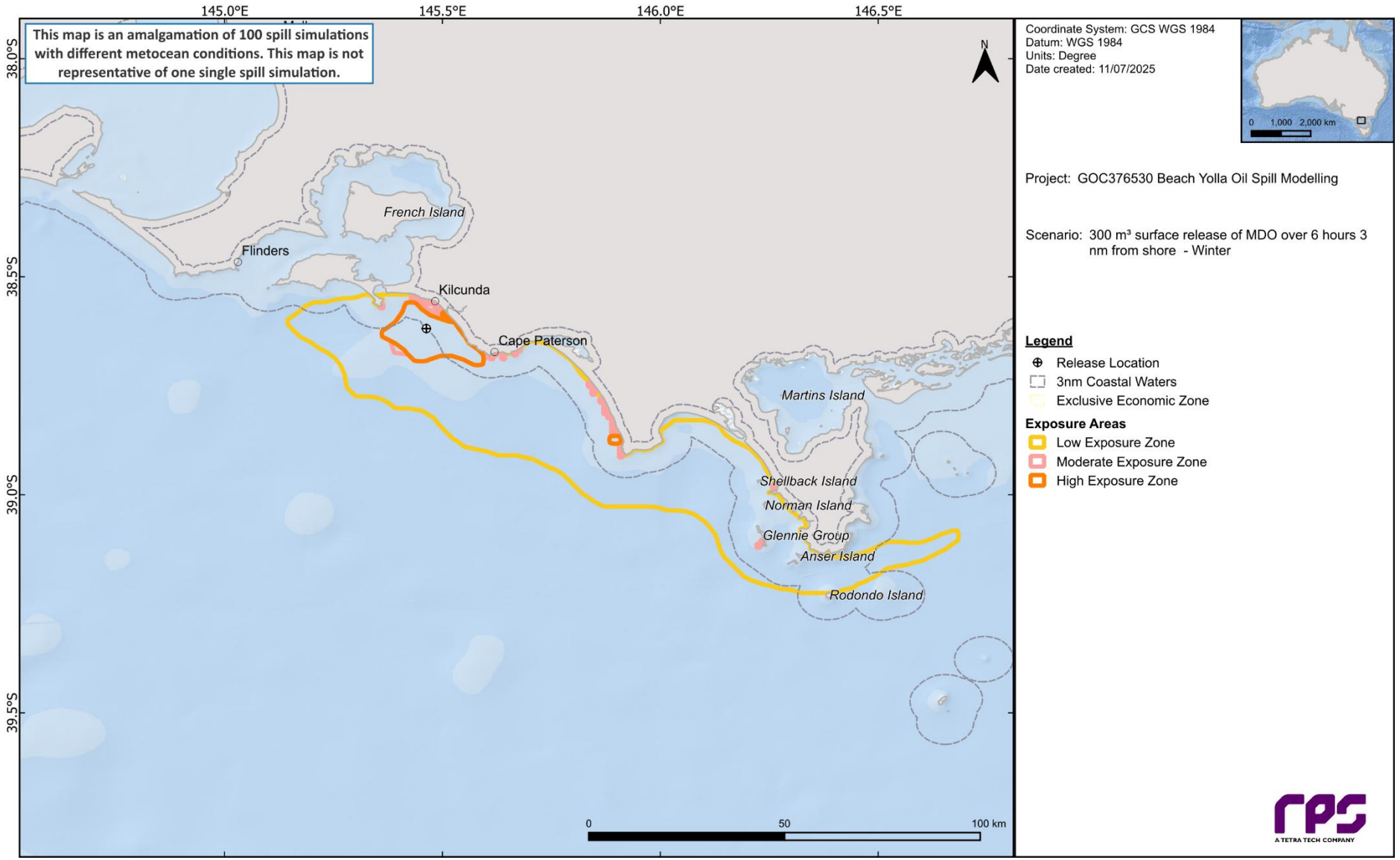


**Figure 15-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore during winter conditions.**

### 15.1.2 Floating Oil Exposure

Table 15-1 summarises the maximum distance travelled by floating oil on the sea surface at each threshold. The maximum distances from the release location to the low (1–10 g/m$^2$), moderate (10–50 g/m$^2$) and high (> 50 g/m$^2$) exposure zones were 49.27 km (east-southeast, winter), 8.21 km (west, summer) and 4.45 km (west-southwest, winter).

Table 15-2 and Table 15-3 summarise the potential floating oil exposure to individual receptors during the summer and winter conditions. Outside of the receptors that the release location resides within, the highest probability of floating oil exposure above the low threshold was predicted at the Little Penguin - Foraging (Buffer around Phillip Island) BIA (69% - summer, 38% - winter).

Figure 15-3 and Figure 15-4 present the zones of potential floating oil exposure for all thresholds under summer and winter conditions, respectively.

Figure 15-5 to Figure 15-16 present the minimum time before floating oil exposure for the NOPSEMA thresholds during summer and winter.

**Table 15-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential floating oil exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Maximum distance (km) from release location | 13.51 | 8.21 | 4.27 |
| | Direction | East-Southeast | West | West |
| Winter | Maximum distance (km) from release location | 49.27 | 7.88 | 4.45 |
| | Direction | East-Southeast | Southwest | West-Southwest |

**Table 15-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Probability of floating oil exposure (%) | | | Minimum time before floating oil exposure (days) | | | Maximum residence time for floating oil exposure (hours) | | |
| | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 69 | 24 | 3 | 0.06 | 0.08 | 0.31 | 36.5 | 16 | 2.75 |
| | Pygmy Blue Whale - Distribution (None)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promontory) | 3 | - | - | 0.63 | - | - | 2.75 | - | - |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | Wandering Albatross - Foraging (The whole South-east Marine Region) | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | White Shark - Distribution (Between the 60-120 m depth contour) | 3 | - | - | 0.92 | - | - | 4.25 | - | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 63 | 16 | 3 | 0.1 | 0.15 | 0.36 | 36.5 | 9 | 2.75 |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| IMCRA-MESO | Central Victoria** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| IMCRA-PROV | Bass Strait Shelf Province** | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| MR | South-east (Marine) | 100 | 100 | 44 | 0.01 | 0.01 | 0.04 | 36.5 | 21.5 | 7.25 |
| NRMR | Port Phillip and Western Port (VIC) | 5 | 1 | - | 0.84 | 0.91 | - | 13 | 2.5 | - |
| NRMR | West Gippsland (VIC)** | 100 | 100 | 43 | 0.01 | 0.01 | 0.04 | 32.5 | 21.5 | 7.25 |
| SHORE-VIC-MPRA | Kilcunda | 48 | 2 | - | 0.25 | 0.55 | - | 20.5 | 3.25 | - |
| SHORE-VIC-MPRA | Venus Bay | 6 | - | - | 0.6 | - | - | 6 | - | - |
| State Waters | Victoria** | 100 | 100 | 43 | 0.01 | 0.01 | 0.04 | 32.5 | 21.5 | 7.25 |

**The release location resides within the receptor boundaries.

**Table 15-3 Summary of the potential floating oil exposure to individual receptors. Results are based on 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Probability of floating oil exposure (%) | | | Minimum time before floating oil exposure (days) | | | Maximum residence time for floating oil exposure (hours) | | |
| | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 38 | 16 | 4 | 0.05 | 0.13 | 0.41 | 40 | 16.25 | 1.75 |
| | Pygmy Blue Whale - Distribution (None)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promontory) | 17 | - | - | 0.65 | - | - | 20 | - | - |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | White Shark - Distribution (Between the 60-120 m depth contour) | 3 | - | - | 1.02 | - | - | 28.75 | - | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 33 | 10 | 3 | 0.07 | 0.17 | 0.45 | 40 | 16.25 | 1.5 |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| IMCRA-MESO | Central Bass Strait | 1 | - | - | 1.74 | - | - | 28.75 | - | - |
| | Central Victoria** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| IMCRA-PROV | Bass Strait Shelf Province** | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| MNP | Bunurong | 1 | - | - | 2.28 | - | - | 0.5 | - | - |
| MR | South-east (Marine) | 100 | 100 | 26 | 0.01 | 0.01 | 0.04 | 44.5 | 24 | 9.75 |
| NPS4 | Bunurong Marine Park | 5 | - | - | 2.2 | - | - | 20 | - | - |
| NRMR | Port Phillip and Western Port (VIC) | 2 | - | - | 0.85 | - | - | 5.25 | - | - |
| NRMR | West Gippsland (VIC)** | 100 | 100 | 25 | 0.01 | 0.01 | 0.04 | 42.75 | 24 | 9.75 |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 3 | - | - | 5.32 | - | - | 4 | - | - |
| | Kilcunda | 34 | 3 | - | 0.31 | 0.7 | - | 23.75 | 3.5 | - |
| | Venus Bay | 19 | - | - | 1.63 | - | - | 20 | - | - |
| State Waters | Victoria** | 100 | 100 | 25 | 0.01 | 0.01 | 0.04 | 42.75 | 24 | 9.75 |

**The release location resides within the receptor boundaries.

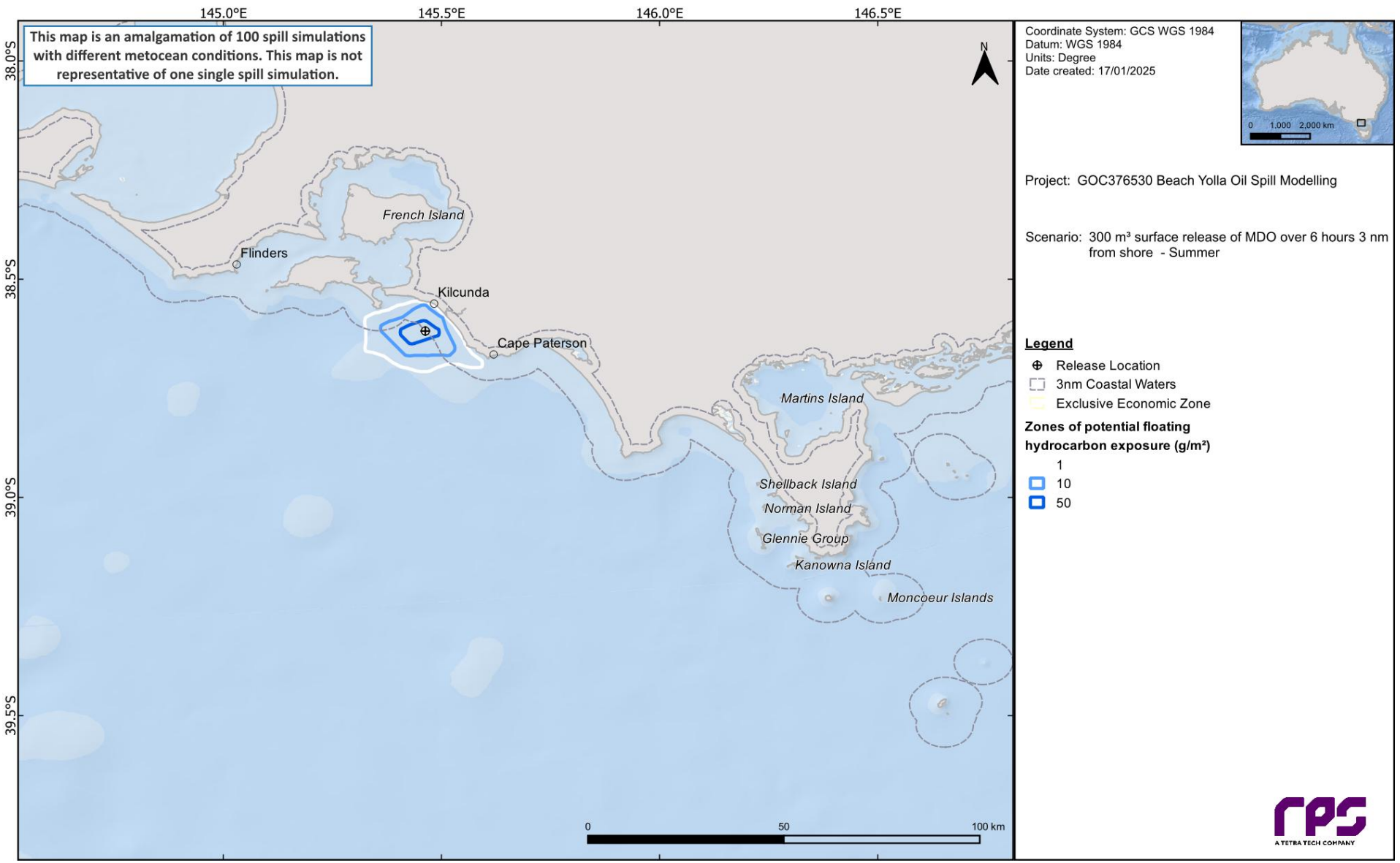


**Figure 15-3 Zones of potential floating oil exposure in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

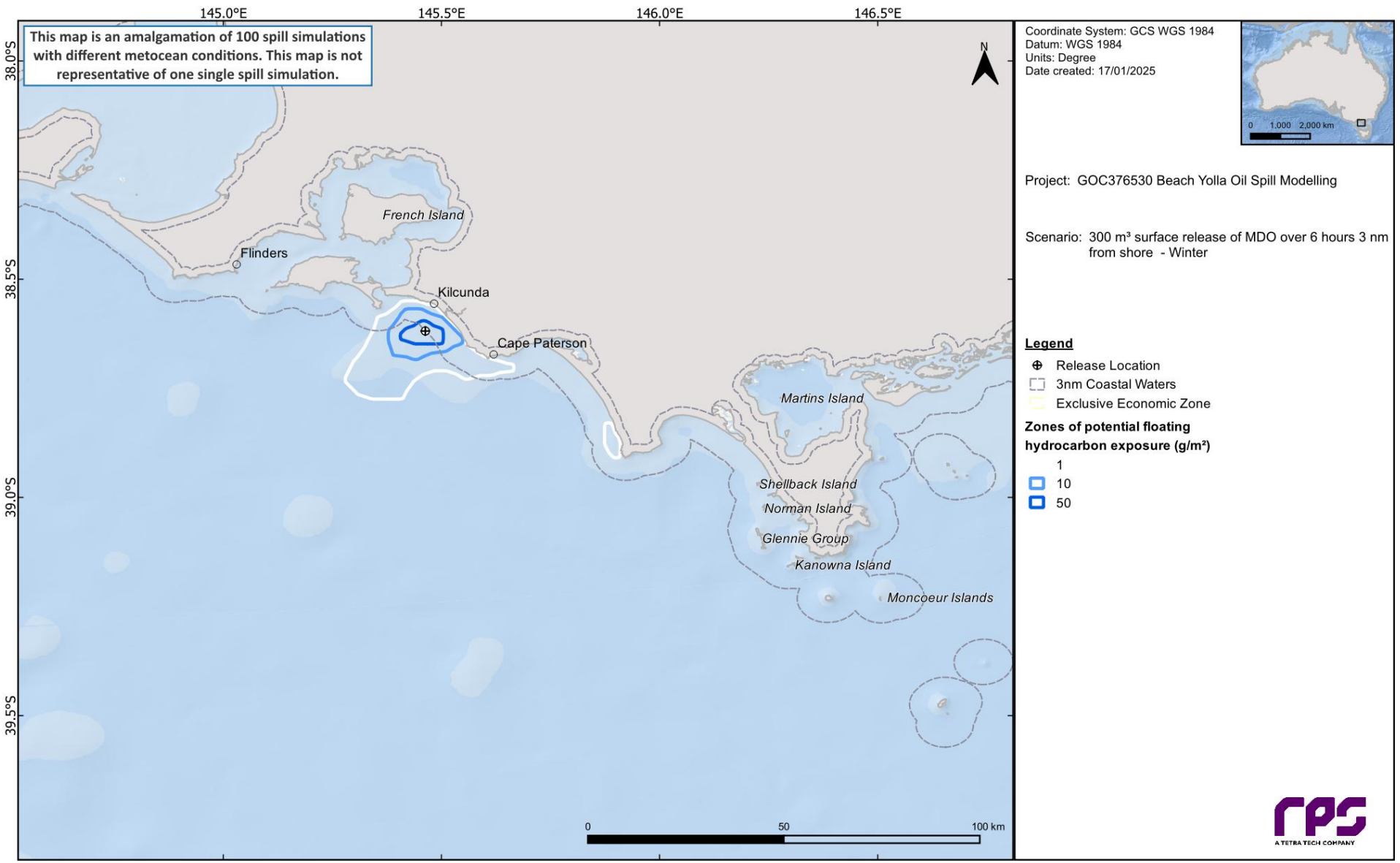


**Figure 15-4 Zones of potential floating oil exposure in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

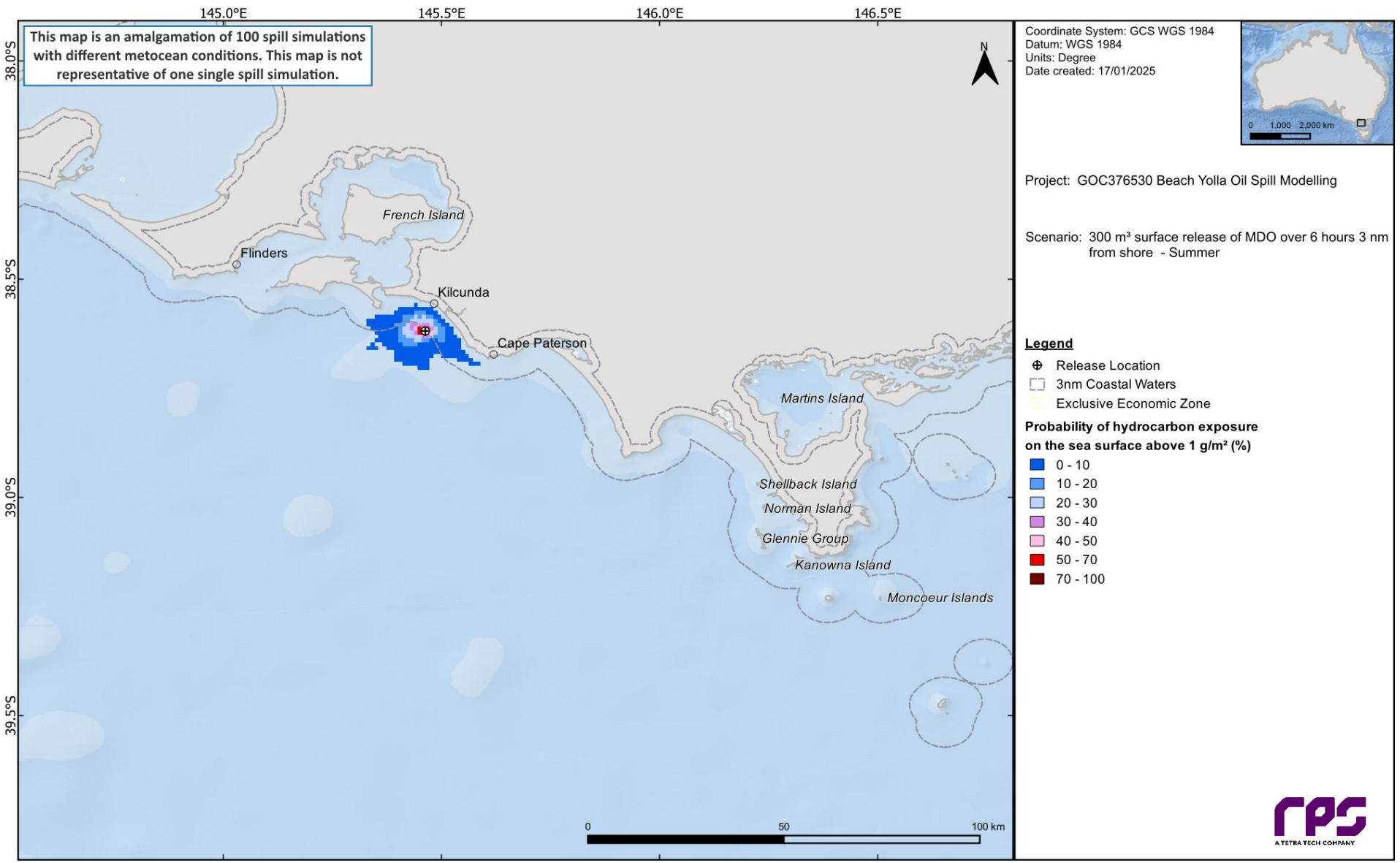


**Figure 15-5 Probability of floating oil exposure above 1 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

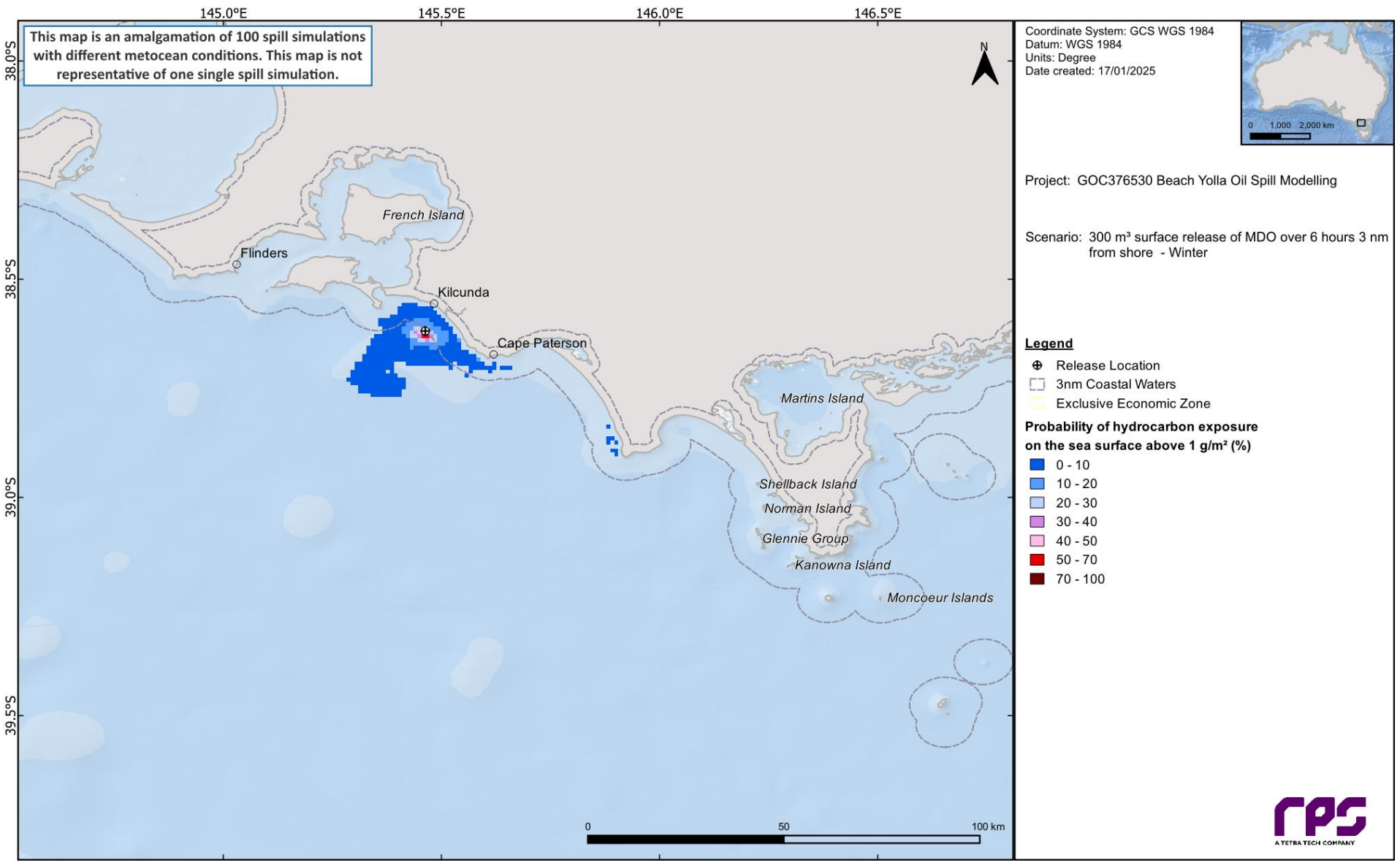


**Figure 15-6 Probability of floating oil exposure above 1 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

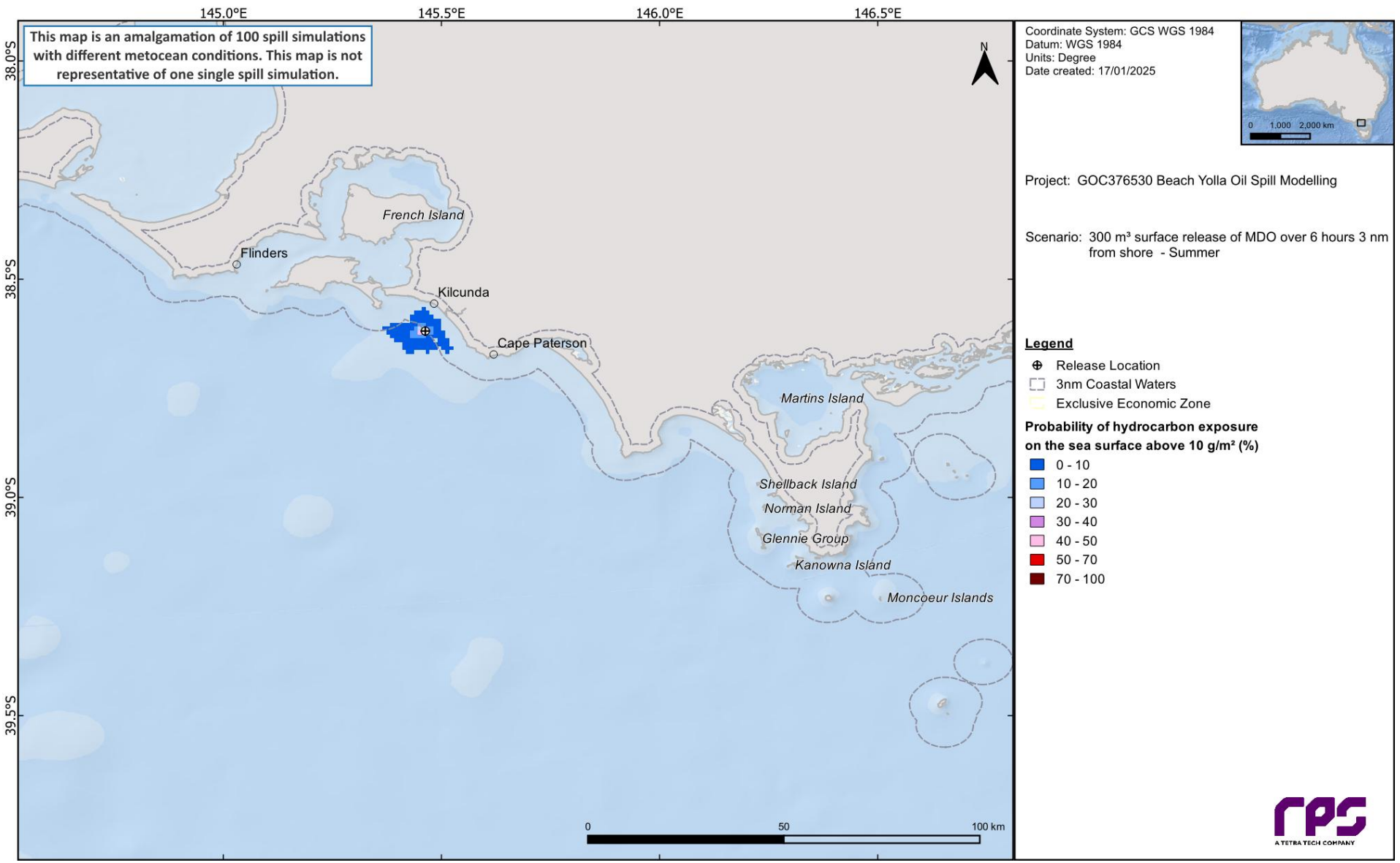


**Figure 15-7 Probability of floating oil exposure above 10 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

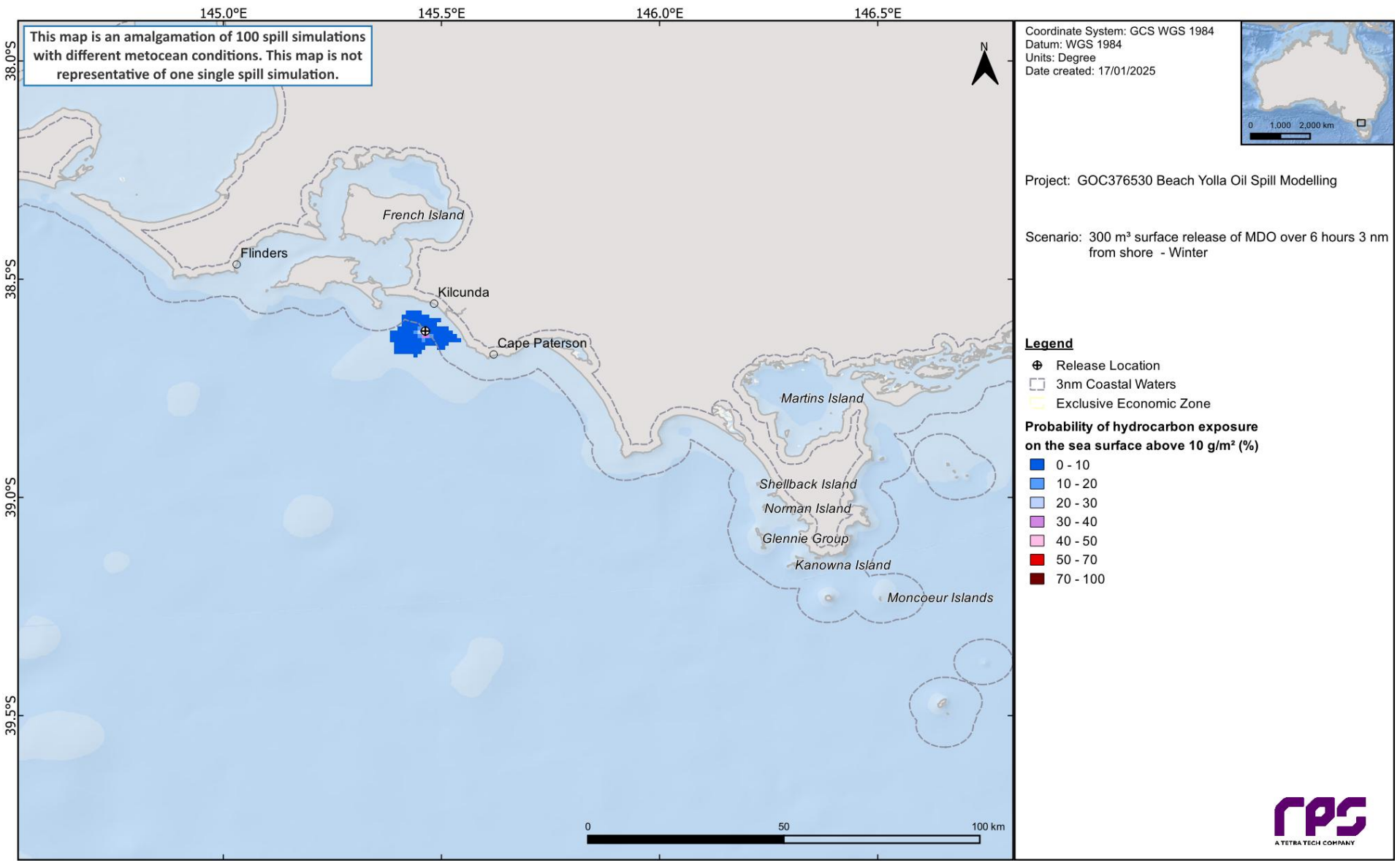


**Figure 15-8 Probability of floating oil exposure above 10 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

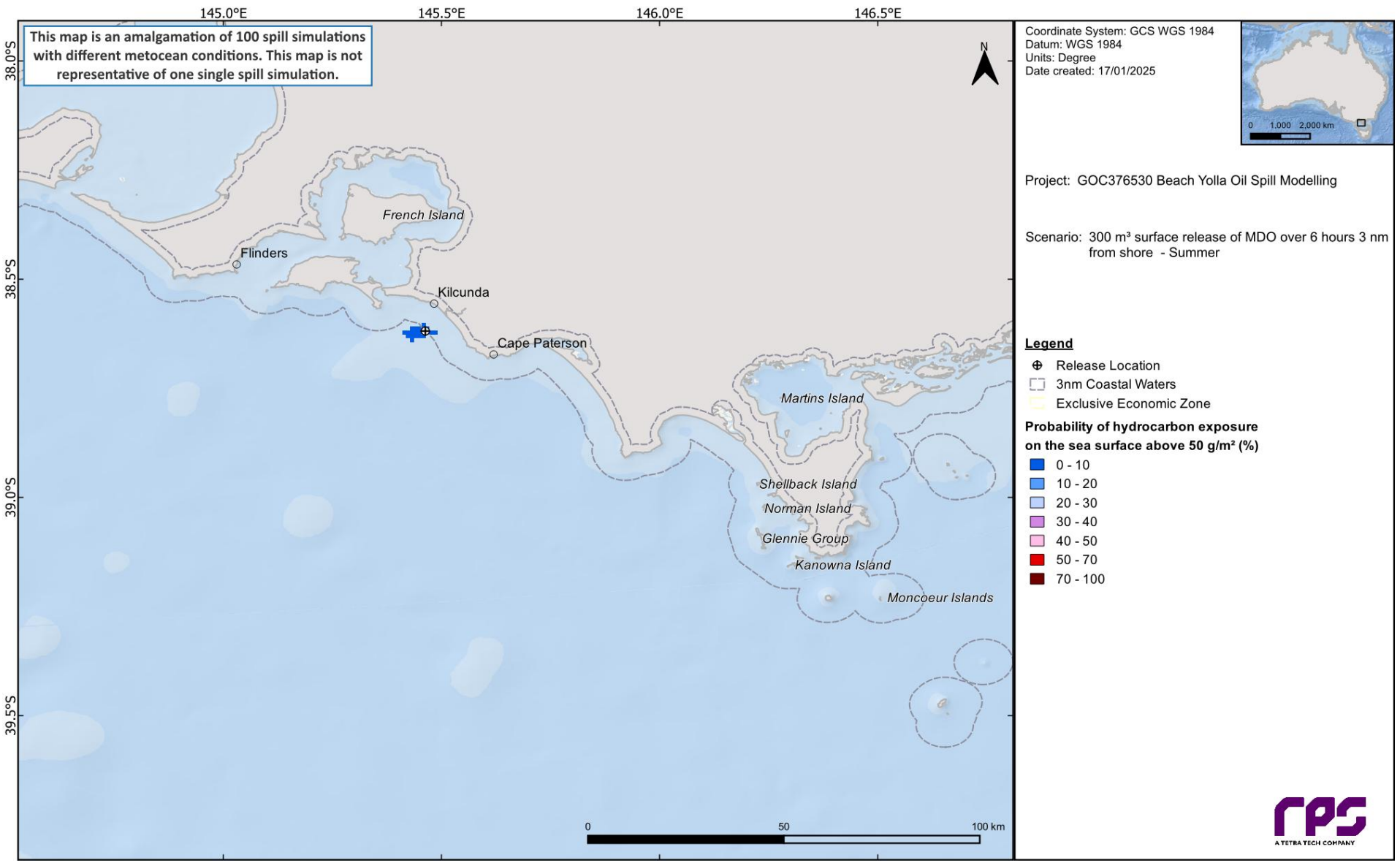


**Figure 15-9 Probability of floating oil exposure above 50 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

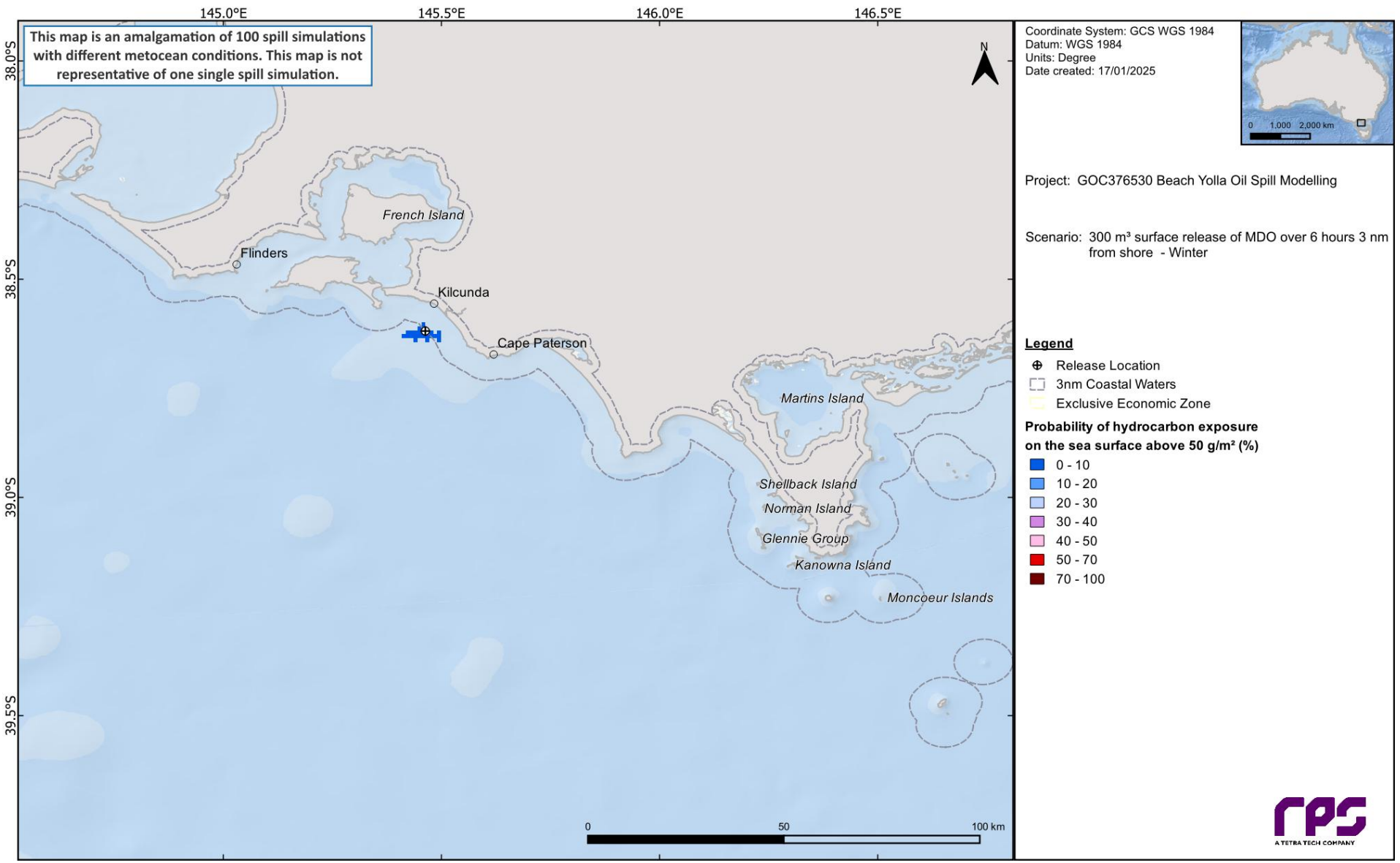


**Figure 15-10 Probability of floating oil exposure above 50 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

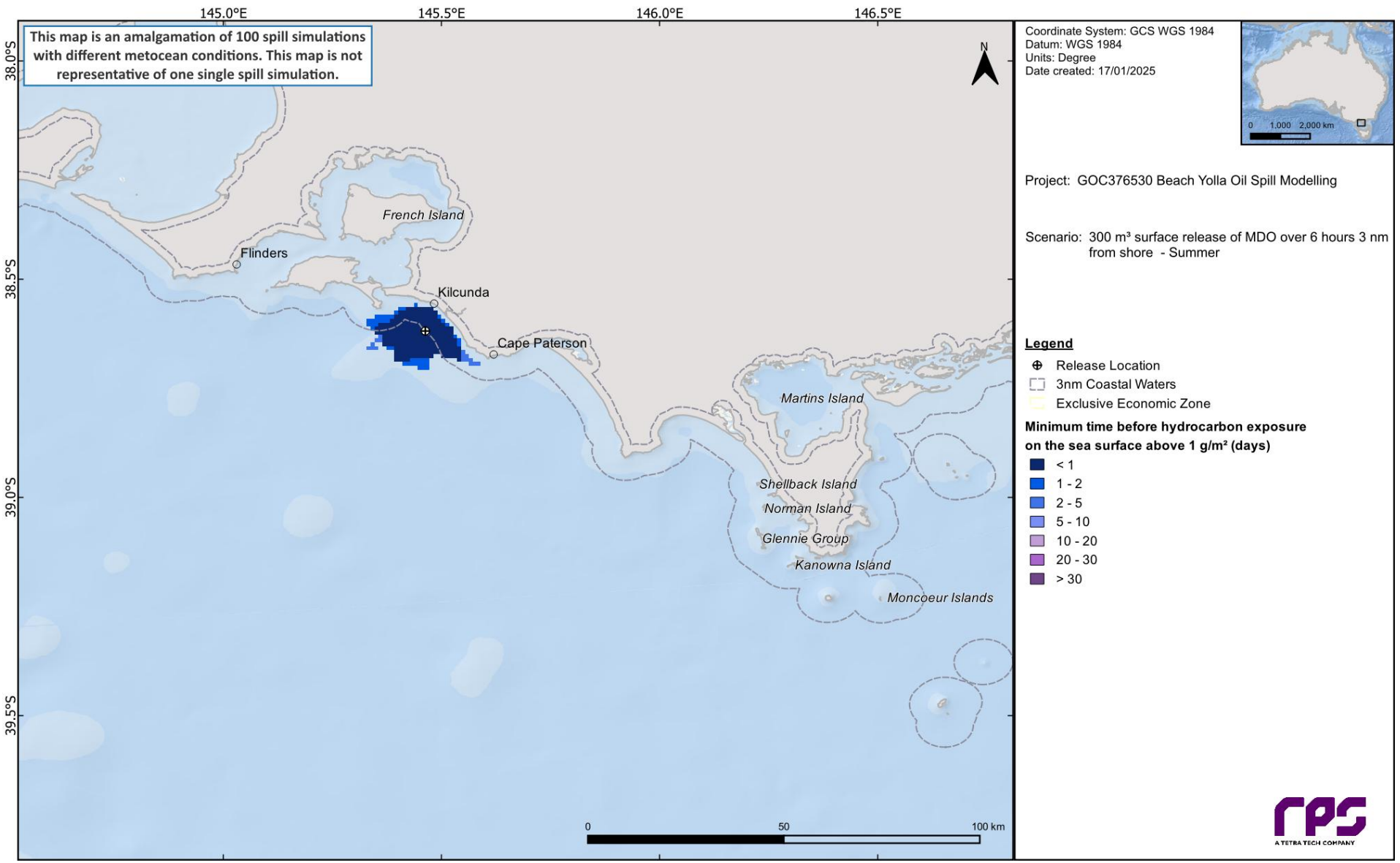


**Figure 15-11 Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

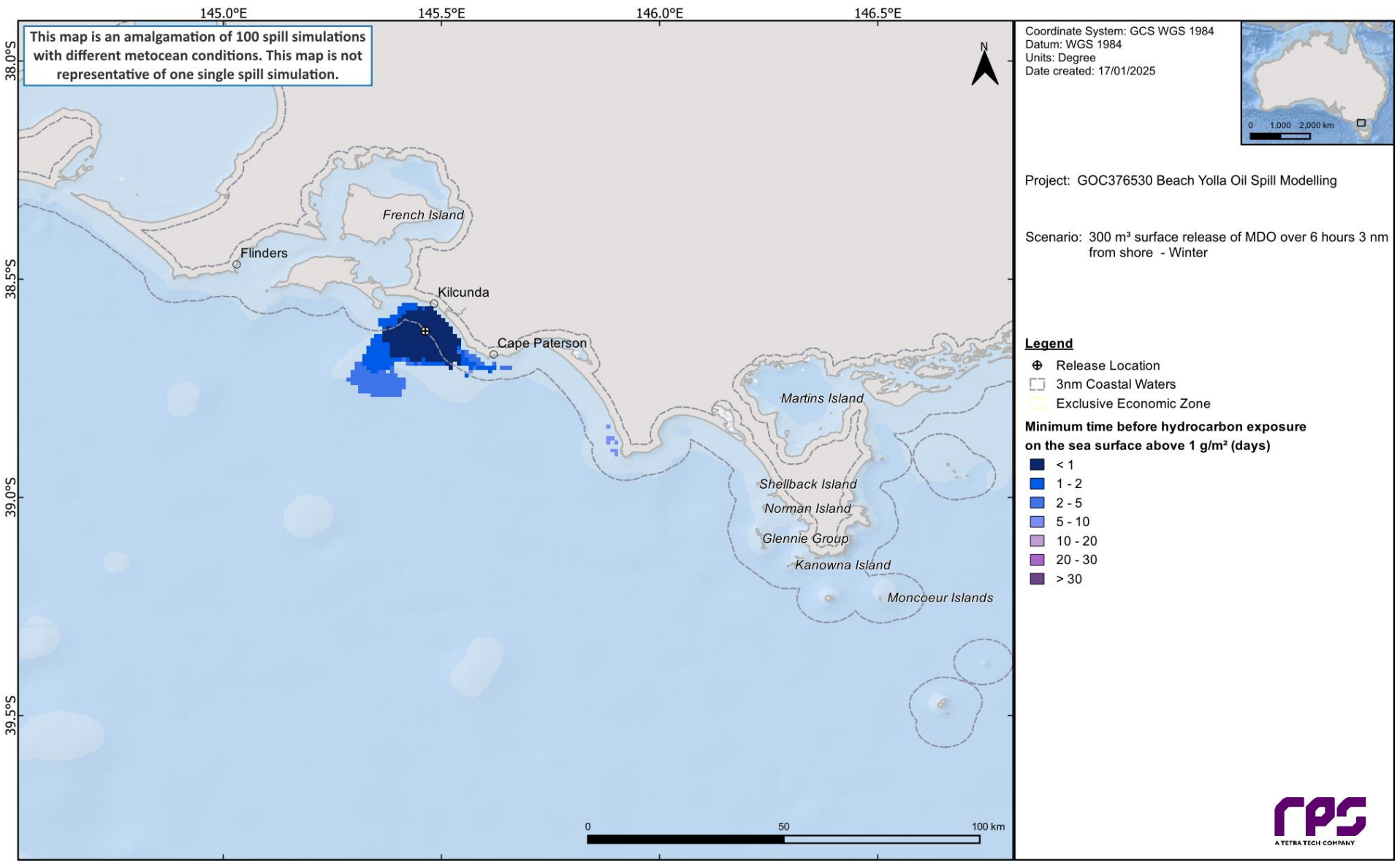


**Figure 15-12 Minimum time before floating oil exposure above 1 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

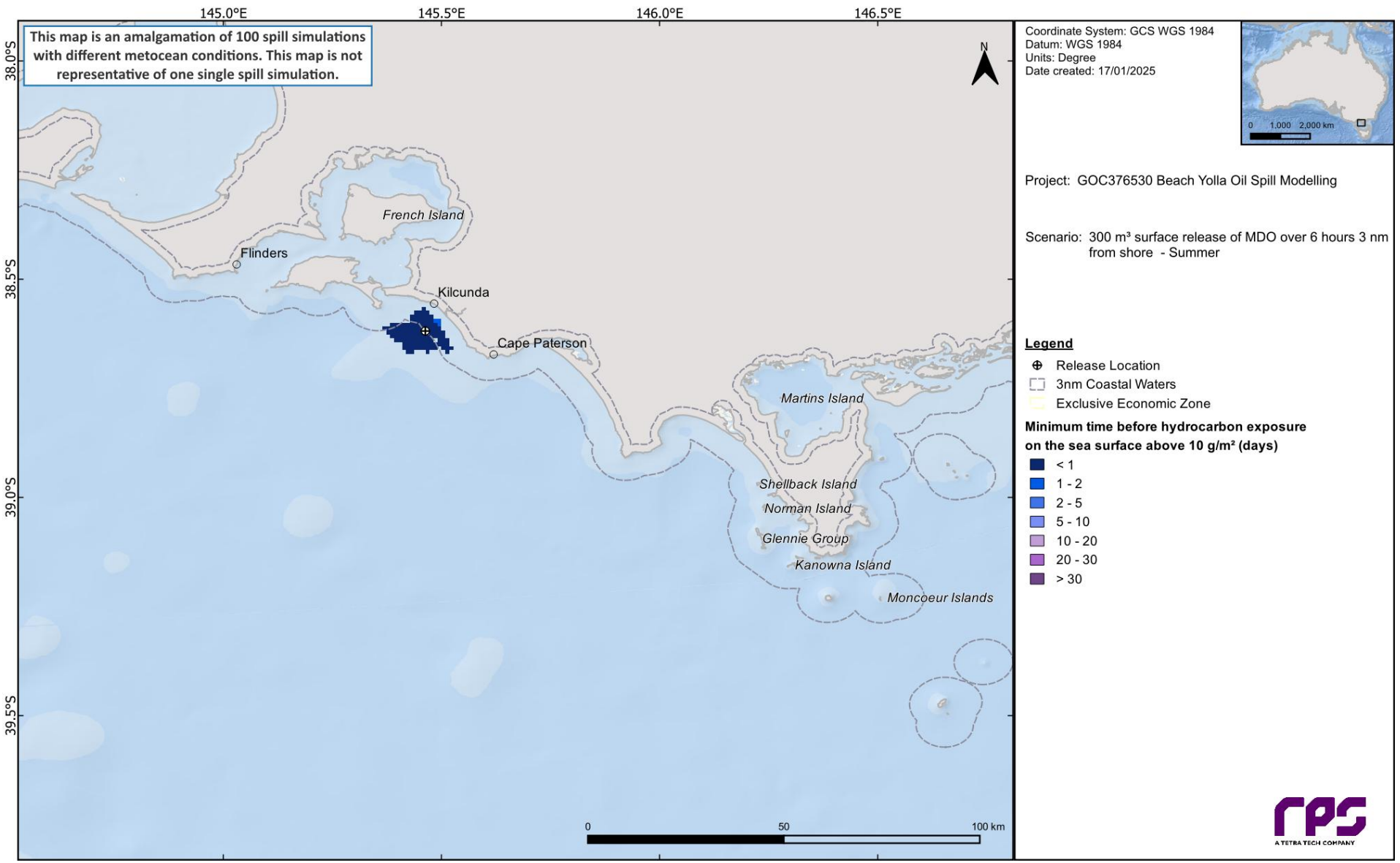


**Figure 15-13 Minimum time before floating oil exposure above 10 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

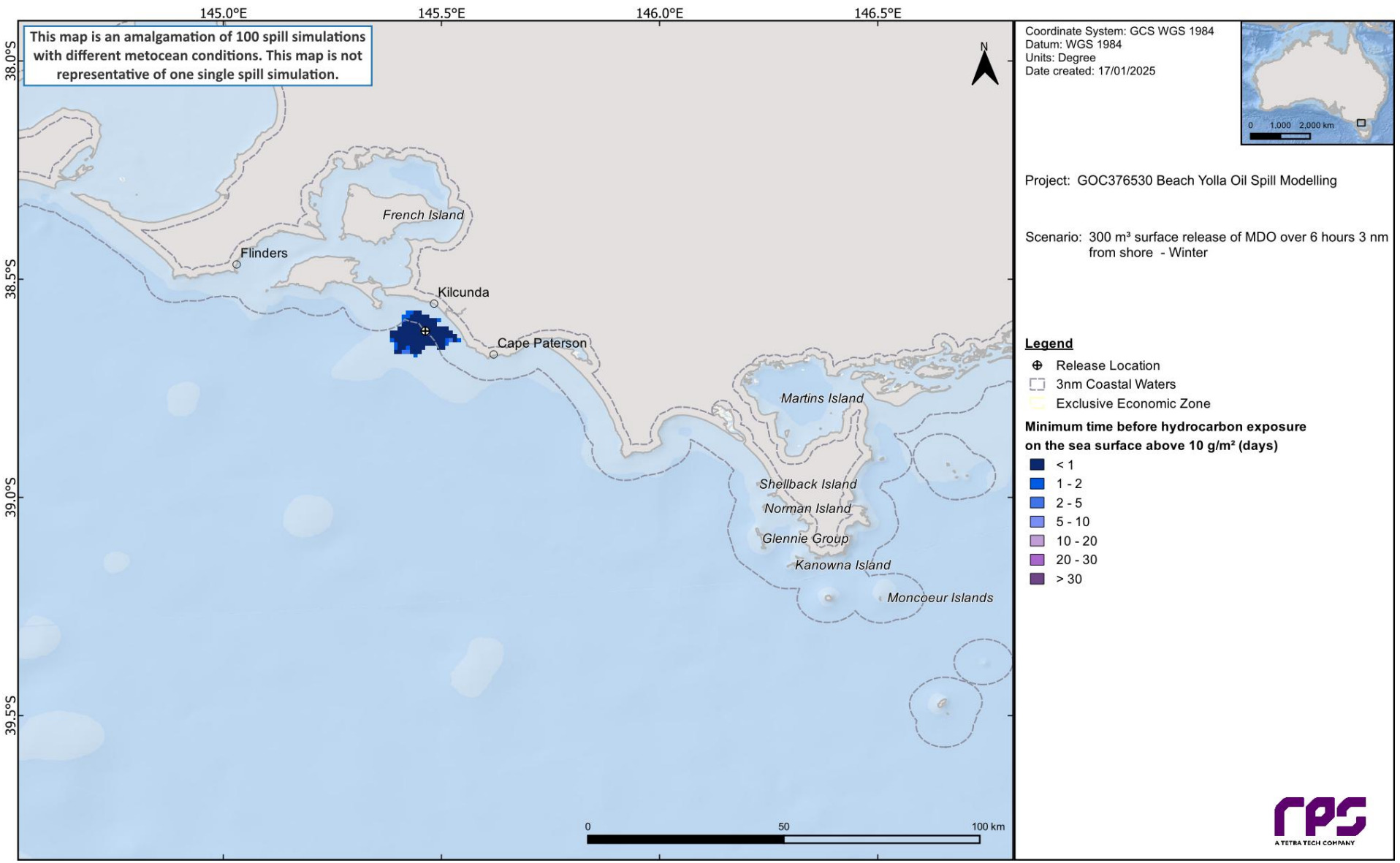


**Figure 15-14 Minimum time before floating oil exposure above 10 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

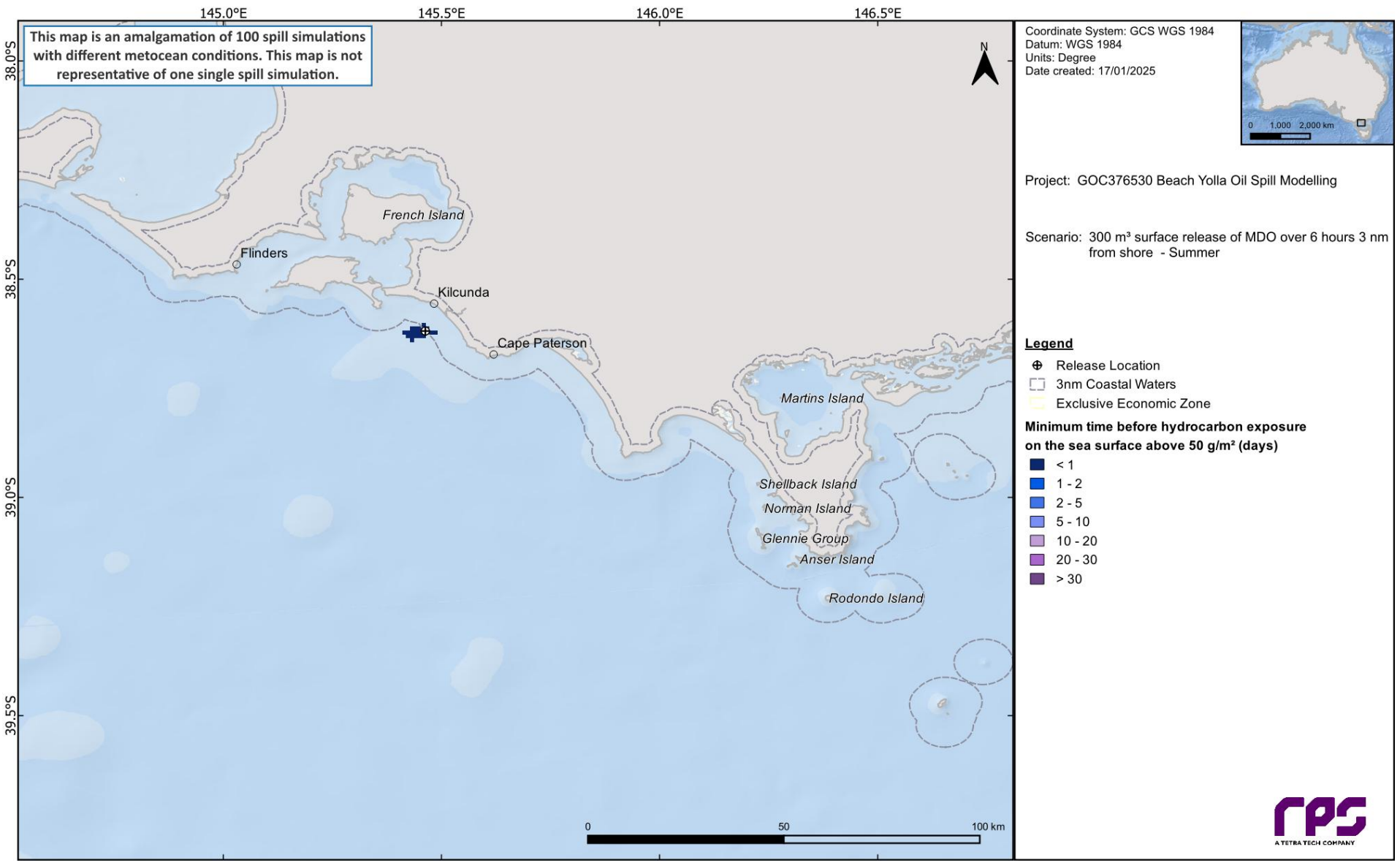


**Figure 15-15 Minimum time before floating oil exposure above 50 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

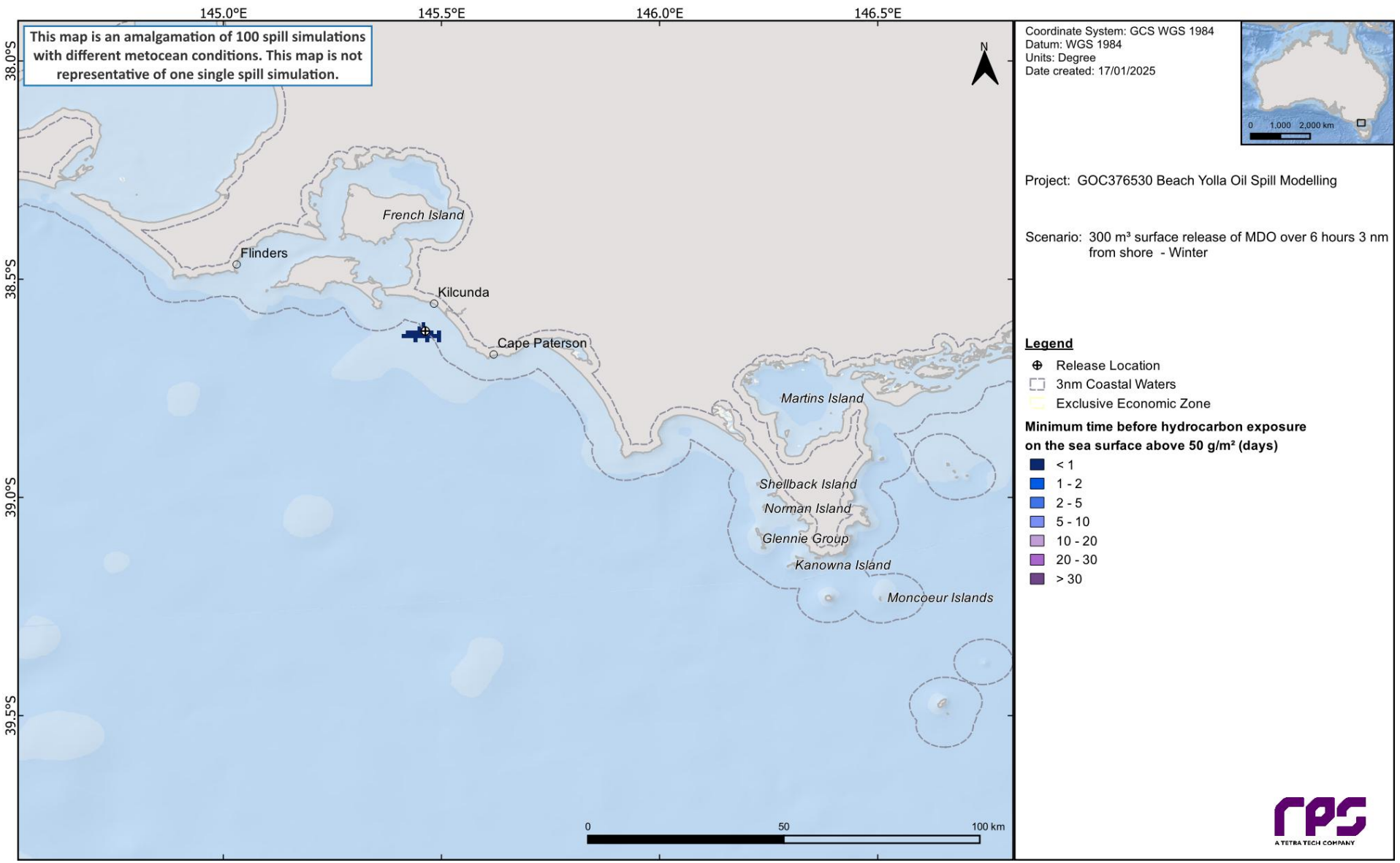


**Figure 15-16 Minimum time before floating oil exposure above 50 g/m$^2$, in the event of a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

### 15.1.3 Shoreline Accumulation

Table 15-4 presents a summary of the predicted potential shoreline accumulation during the summer and winter conditions. The probability of accumulation to any shoreline at, or above, the low level (10 g/m$^2$) threshold was 94% during summer conditions and 100% during winter conditions. The minimum time before oil accumulation at, or above, the low threshold was 0.51 days during summer conditions, and 0.48 days during winter conditions. The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 51.64 m$^3$ and 98.73 m$^3$, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 50.81 km and 58.41 km, respectively. For the moderate threshold (100 g/m$^2$), the maximum length of shoreline accumulation predicted was 16.52 km (summer) and 15.24 km (winter). For the high (1,000 g/m$^2$) threshold, maximum lengths were 1.27 km (summer) and 3.81 km (winter).

Table 15-5 and Table 15-6 summarises the shoreline accumulation on individual receptors during the summer and winter conditions. Kilkunda shoreline recorded the highest probability of shoreline accumulation at the low threshold during summer conditions, being 82%, whilst in winter the highest probability was forecast to Venus Bay (84%). The minimum time before shoreline accumulation above the low threshold was forecast for Kilcunda (0.51 and 0.48 day during summer and winter respectively).

The summer and winter conditions maximum potential shoreline loading above the low and moderate shoreline thresholds are presented in Figure 15-17 and Figure 15-18, respectively.

**Table 15-4 Summary of oil accumulation across all shorelines. Results are based on a 300 m$^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations per season.**

| Shoreline Statistics | Summer | Winter |
|---|---|---|
| Probability of accumulation on any shoreline (%) | 94 | 100 |
| Absolute minimum time for visible oil to shore (days) | 0.51 | 0.48 |
| Maximum total volume of hydrocarbons ashore (m3) | 51.64 | 98.73 |
| Average volume of hydrocarbons ashore (m3) | 13.56 | 20.17 |
| Maximum length of the shoreline at 10 g/m2 (km) | 50.81 | 58.41 |
| Average shoreline length (km) at 10 g/m2 (km) | 19.17 | 28.47 |
| Maximum length of the shoreline at 100 g/m2 (km) | 16.52 | 15.24 |
| Average shoreline length (km) at 100 g/m2 (km) | 3.93 | 5.31 |
| Maximum length of the shoreline at 1,000 g/m2 (km) | 1.27 | 3.81 |
| Average shoreline length (km) at 1,000 g/m2 (km) | 0.03 | 0.14 |

**Table 15-5** **Summary of oil accumulation on individual shoreline receptors. Results are based on a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill and refer to summer conditions.**

| Shoreline Receptor | | Summer (November through to March) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum probability of shoreline loading (%) | | | Minimum time before shoreline accumulation (days) | | | Load on shoreline (g/m²) | | Volume on shoreline (m³) | | Maximum total volume of oil arriving ashore (m³) | | | Average total volume of oil arriving ashore (m³) | | | Maximum total length of shoreline contacted (km) | | | Average total length of shoreline contacted (km) | | |
| | | Low | Mod | High | Low | Mod | High | Peak | Mean | Peak | Mean | Low | Mod | High | Low | Mod | High | Low | Mod | High | Low | Mod | High |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 34 | 5 | - | 3.68 | 11.84 | - | 193.72 | 16.34 | 12.4 | 1.02 | 11.93 | 11.64 | - | 0.8 | 0.19 | - | 25.4 | 8.88 | - | 3.05 | 0.16 | - |
| | French Island / San Remo | 28 | - | - | 1.69 | - | - | 70.99 | 9.24 | 3.31 | 0.42 | 3.11 | - | - | 0.28 | - | - | 10.18 | - | - | 1.42 | - | - |
| | Kilcunda | 82 | 52 | 2 | 0.51 | 0.67 | 1.38 | 1,190.77 | 226.33 | 38.44 | 9.01 | 38.09 | 36.11 | 12.61 | 8.61 | 6.54 | 0.25 | 25.44 | 10.17 | 1.27 | 10.02 | 2.81 | 0.03 |
| | Mornington Peninsula - South | 1 | - | - | 12.03 | - | - | 13.28 | 0.48 | 0.62 | 0.03 | 0.14 | - | - | - | - | - | 1.27 | - | - | 0.01 | - | - |
| | Venus Bay | 54 | 29 | - | 0.7 | 1.63 | - | 965.94 | 111.06 | 39.65 | 4.15 | 38.97 | 34.09 | - | 3.83 | 2.6 | - | 33.04 | 12.71 | - | 6.09 | 1.33 | - |
| | Waratah Bay | 22 | 4 | - | 7.14 | 11.84 | - | 193.72 | 10.99 | 7.83 | 0.31 | 7.49 | 7.49 | - | 0.28 | 0.14 | - | 5.08 | 5.08 | - | 0.65 | 0.11 | - |
| | Wilsons Promontory - West | 4 | - | - | 20.36 | - | - | 24.35 | 1.13 | 0.86 | 0.05 | 0.46 | - | - | 0.01 | - | - | 3.8 | - | - | 0.1 | - | - |

**Table 15-6** **Summary of oil accumulation on individual shoreline receptors. Results are based on a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Shoreline Receptor | | Winter (April through to October) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum probability of shoreline loading (%) | | | Minimum time before shoreline accumulation (days) | | | Load on shoreline (g/m²) | | Volume on shoreline (m³) | | Maximum total volume of oil arriving ashore (m³) | | | Average total volume of oil arriving ashore (m³) | | | Maximum total length of shoreline contacted (km) | | | Average total length of shoreline contacted (km) | | |
| | | Low | Mod | High | Low | Mod | High | Peak | Mean | Peak | Mean | Low | Mod | High | Low | Mod | High | Low | Mod | High | Low | Mod | High |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 82 | 39 | - | 2.66 | 4.76 | - | 777.88 | 124.11 | 30.5 | 5.26 | 30.14 | 28.06 | - | 4.89 | 2.54 | - | 29.21 | 13.96 | - | 9.61 | 1.37 | - |
| | Kilcunda | 74 | 47 | 6 | 0.48 | 0.6 | 0.92 | 3,161.24 | 236.14 | 93.02 | 8.41 | 92.9 | 92.24 | 74.61 | 8.24 | 6.84 | 1.69 | 22.89 | 11.44 | 3.81 | 7.03 | 2.5 | 0.14 |
| | Venus Bay | 84 | 54 | - | 0.9 | 1.01 | - | 812.44 | 203.89 | 33.21 | 6.59 | 33.04 | 30.83 | - | 6.3 | 4.66 | - | 33.04 | 10.17 | - | 7.83 | 2.17 | - |
| | Waratah Bay | 76 | 36 | - | 3.67 | 5.18 | - | 777.88 | 118.17 | 23.94 | 3.09 | 23.74 | 23.74 | - | 2.94 | 2.1 | - | 11.42 | 5.08 | - | 3.34 | 1 | - |
| | Wilsons Promontory - West | 34 | 1 | - | 9.06 | 29.31 | - | 109.63 | 14.21 | 7.07 | 0.86 | 6.59 | 1.16 | - | 0.5 | 0.01 | - | 21.56 | 1.27 | - | 2.56 | 0.01 | - |

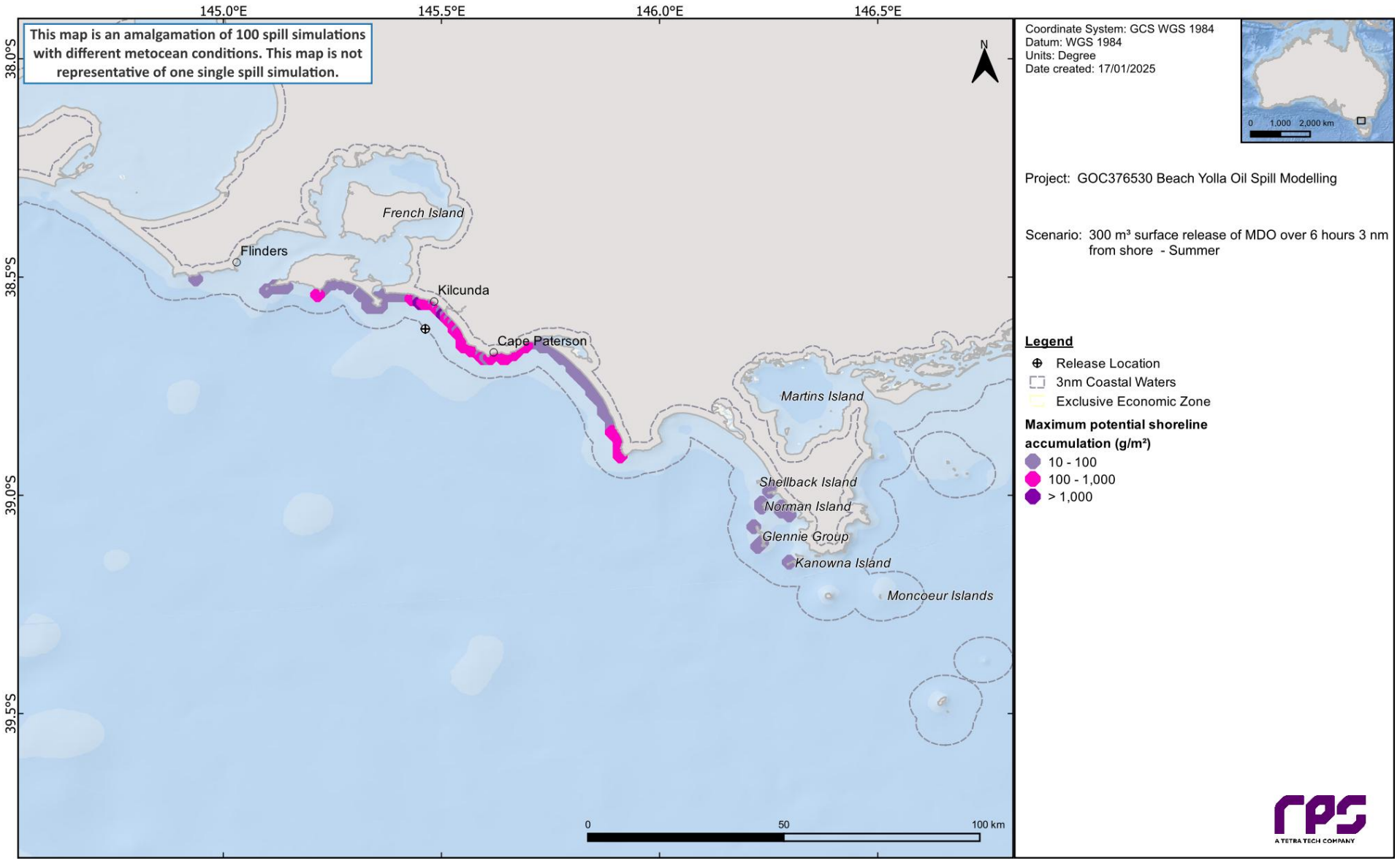


**Figure 15-17 Maximum potential shoreline loading in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

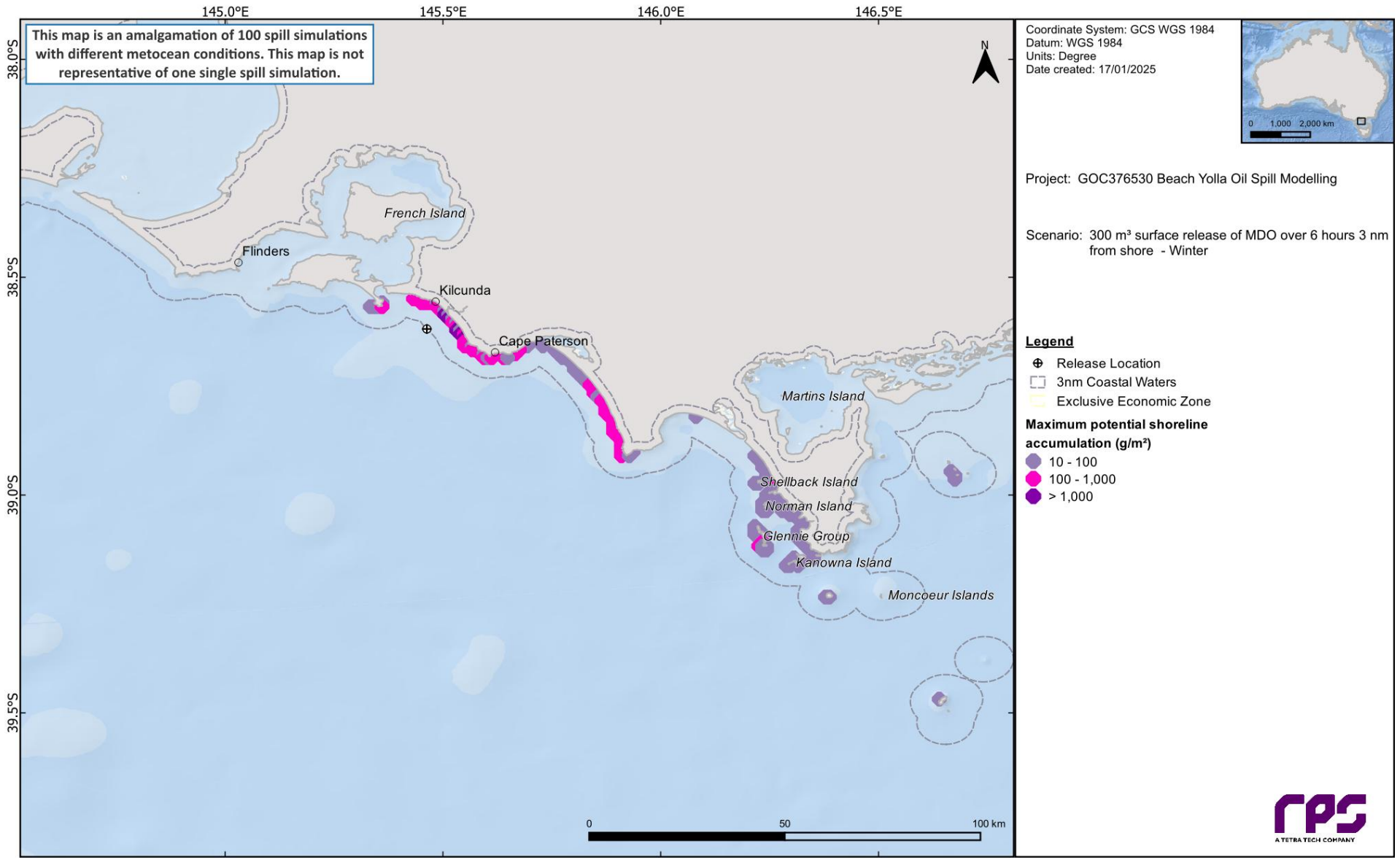


**Figure 15-18 Maximum potential shoreline loading in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

## 15.1.4 In-water exposure

### 15.1.4.1 Dissolved Hydrocarbons

Table 15-7 reveals the maximum distances to dissolved oil exposure during summer and winter conditions. Maximum distances to the low (10 ppb) and moderate (50 ppb) thresholds may reach 12.92 km (east-southeast, both seasons) and 1.39 km (south-southeast, winter) respectively.

Table 15-8 and Table 15-9 summarise the probability of exposure to individual receptors from dissolved hydrocarbons during the summer and winter conditions.

Outside of the receptors that the release location resides within, the highest concentration of dissolved hydrocarbon was predicted for the Little Penguin - Foraging (Buffer around Phillip Island) BIA (25.96 ppb – summer, 25.95 ppb - winter), with probabilities of 21% and 16% respectively.

Figure 15-19 and Figure 15-20 present the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 15-21 to Figure 15-28 present the maximum residence time of dissolved hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

**Table 15-7 Maximum distance and direction from the release location to the edge of dissolved oil exposure. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential dissolve oil exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Maximum distance (km) from release location | 12.92 | 0.55 | - |
| | Direction | East-Southeast | East-Southeast | - |
| Winter | Maximum distance (km) from release location | 12.92 | 1.39 | - |
| | Direction | East-Southeast | South-Southeast | - |

**Table 15-8 Summary of dissolved hydrocarbons exposure to marine based receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 52.38 | 75 | 1 | - | 0.03 | 0.24 | - | 27 | 0.5 | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 52.38 | 75 | 1 | - | 0.03 | 0.24 | - | 27 | 0.5 | - |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 52.38 | 75 | 1 | - | 0.03 | 0.24 | - | 27 | 0.5 | - |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 52.38 | 75 | 1 | - | 0.03 | 0.24 | - | 27 | 0.5 | - |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 25.96 | 21 | - | - | 0.18 | - | - | 10.5 | - | - |
| | Pygmy Blue Whale - Distribution (None)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 34.25 | 0.5 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |

| Receptor | | Summer (November through to March) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promontory) | 11.89 | 1 | - | - | 2.64 | - | - | 39 | - | - |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 52.38 | 75 | 1 | - | 0.03 | 0.24 | - | 27 | 0.5 | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 52.38 | 75 | 1 | - | 0.03 | 0.24 | - | 27 | 0.5 | - |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 20.52 | 8 | - | - | 0.27 | - | - | 7.25 | - | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 52.38 | 75 | 1 | - | 0.03 | 0.24 | - | 27 | 0.5 | - |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| IMCRA-MESO | Central Victoria** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 52.38 | 76 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| MR | South-east (Marine)** | 52.38 | 75 | 1 | - | 0.03 | 0.24 | - | 27 | 0.5 | - |
| NRMR | West Gippsland (VIC)** | 52.38 | 74 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |
| SHORE-VIC-MPRA | Kilcunda | 32.02 | 3 | - | - | 0.6 | - | - | 41.75 | - | - |
| | Venus Bay | 18.74 | 2 | - | - | 0.7 | - | - | 39 | - | - |
| State Waters | Victoria** | 52.38 | 74 | 1 | - | 0.03 | 0.24 | - | 41.75 | 0.5 | - |

**The release location resides within the receptor boundaries.

**Table 15-9 Summary of dissolved hydrocarbons exposure to marine based receptors in the 0–10 m dept. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.25 | 0.75 | - |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.25 | 0.75 | - |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquarie Island)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.25 | 0.75 | - |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.25 | 0.75 | - |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 25.95 | 16 | - | - | 0.11 | - | - | 11.5 | - | - |
| | Pygmy Blue Whale - Distribution (None)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.5 | 0.75 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |

| Receptor | | Winter (April through to October) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum dissolved hydrocarbon exposure | Probability of dissolved hydrocarbon exposure | | | Minimum time before instantaneous dissolved hydrocarbon exposure (days) | | | Maximum residence time for dissolved hydrocarbon exposure (hours) | | |
| | | | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promontory) | 21.44 | 9 | - | - | 0.67 | - | - | 91.5 | - | - |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 29 | 0.75 | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.25 | 0.75 | - |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.25 | 0.75 | - |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 22.63 | 8 | - | - | 0.17 | - | - | 10.25 | - | - |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000 m depth contour)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.25 | 0.75 | - |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| IMCRA-MESO | Central Victoria** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| MR | South-east (Marine) | 52.96 | 81 | 1 | - | 0.03 | 0.27 | - | 21.25 | 0.75 | - |
| NPS4 | Bunurong Marine Park | 18.79 | 4 | - | - | 0.95 | - | - | 37.75 | - | - |
| NRMR | West Gippsland (VIC)** | 52.96 | 78 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |
| SHORE-VIC-MPRA | Kilcunda | 18.48 | 10 | - | - | 0.65 | - | - | 29 | - | - |
| | Venus Bay | 21.44 | 11 | - | - | 0.67 | - | - | 91.5 | - | - |
| State Waters | Victoria** | 52.96 | 78 | 1 | - | 0.03 | 0.27 | - | 91.5 | 0.75 | - |

**The release location resides within the receptor boundaries.

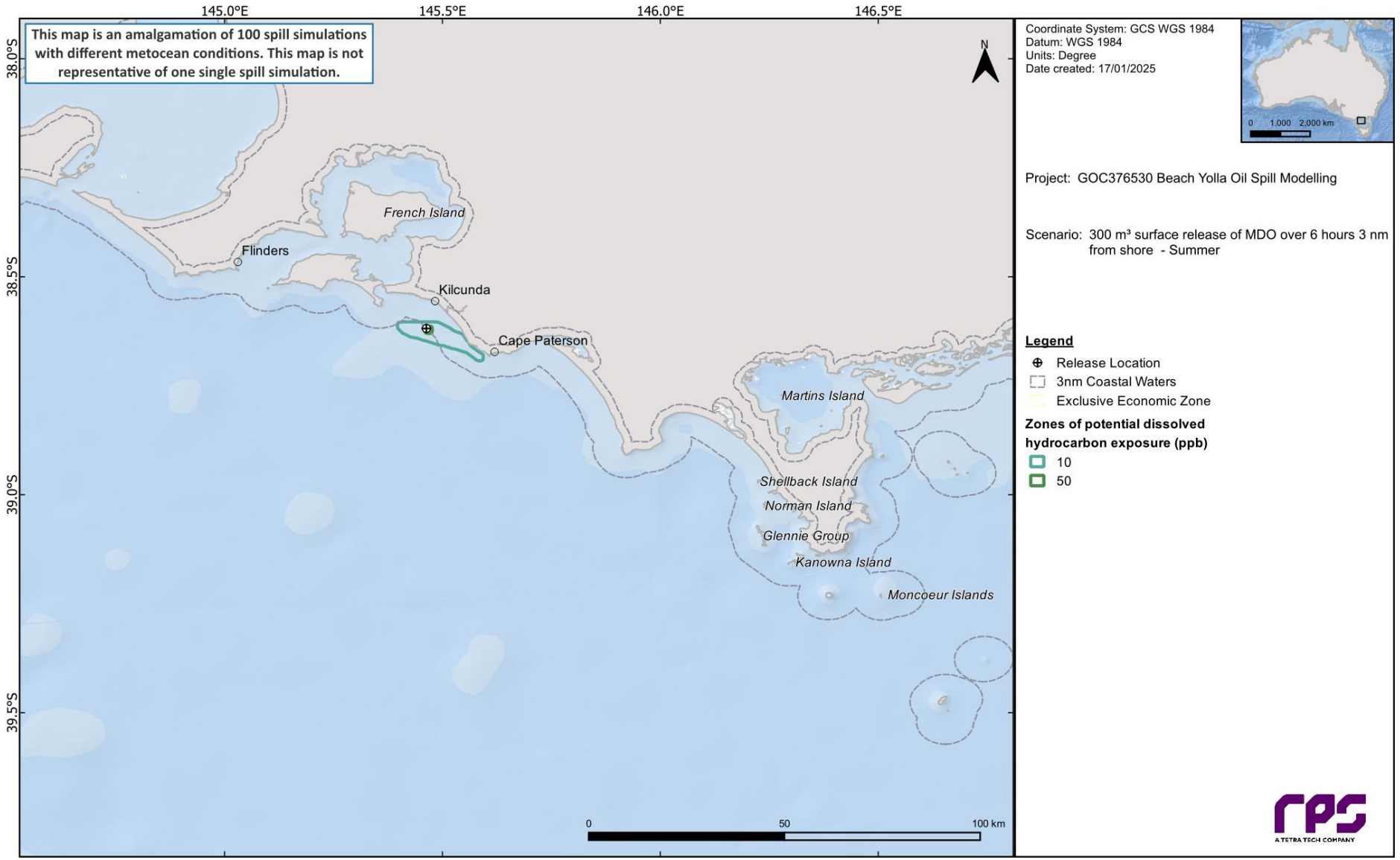


**Figure 15-19 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

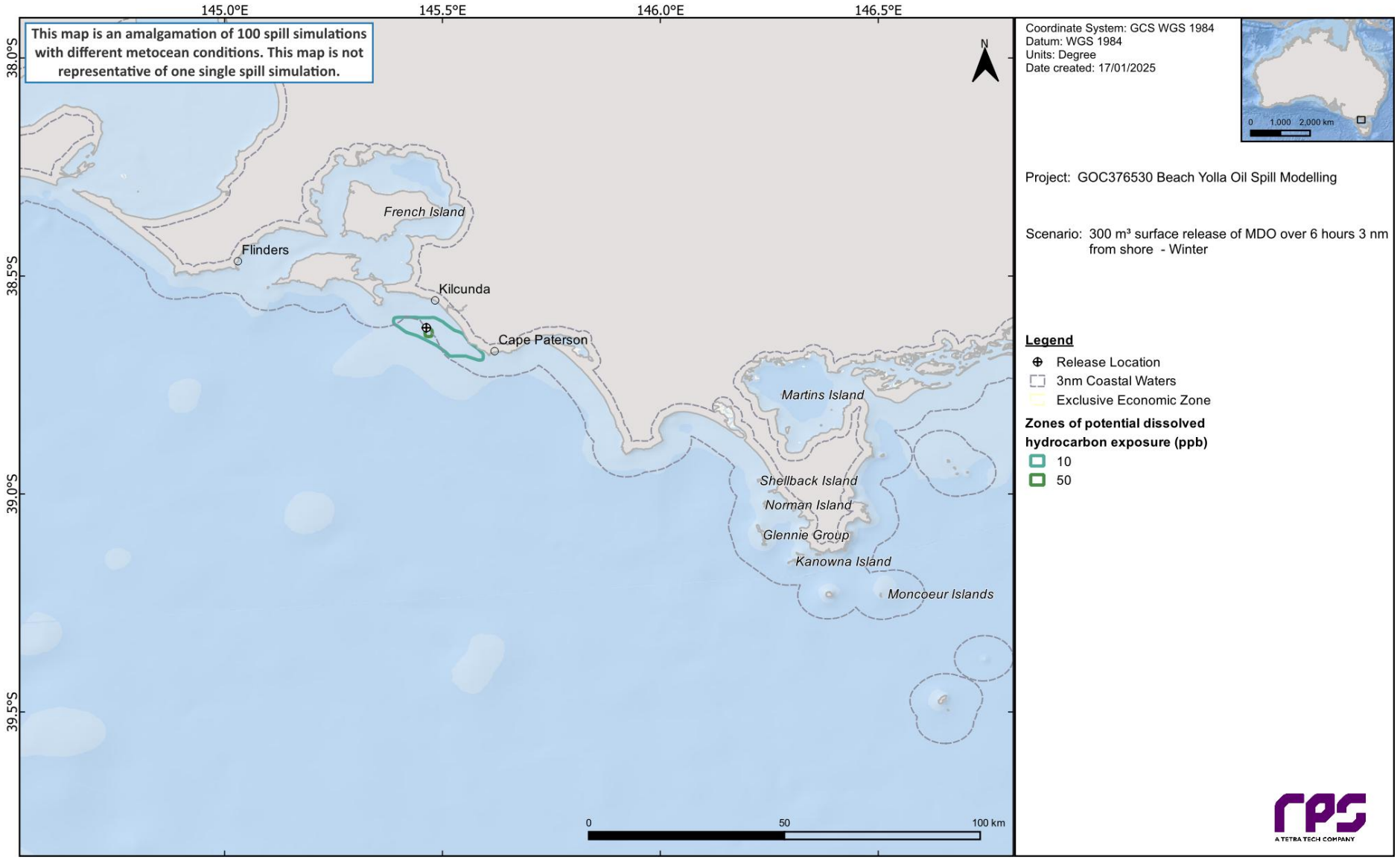


**Figure 15-20 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

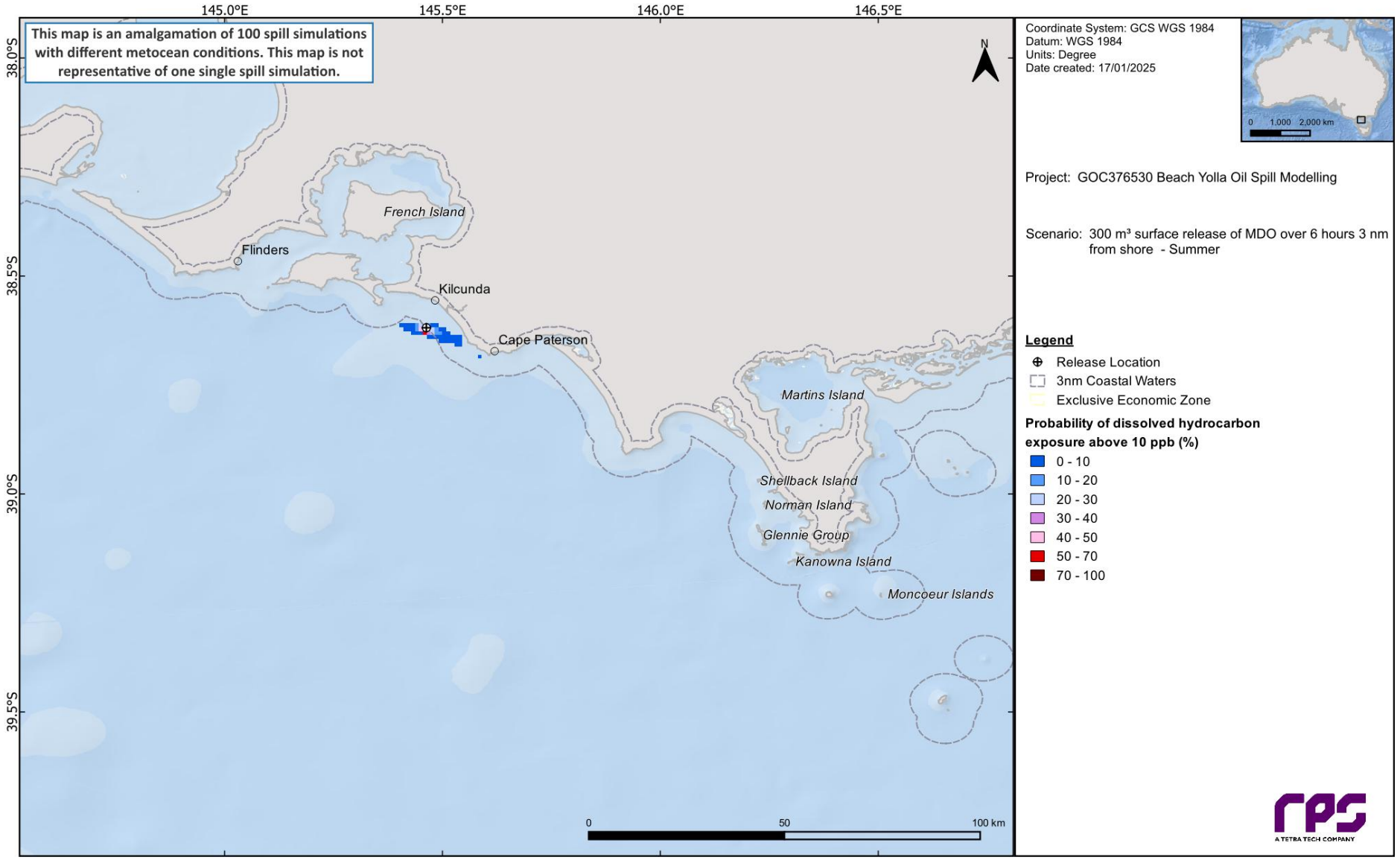


**Figure 15-21 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

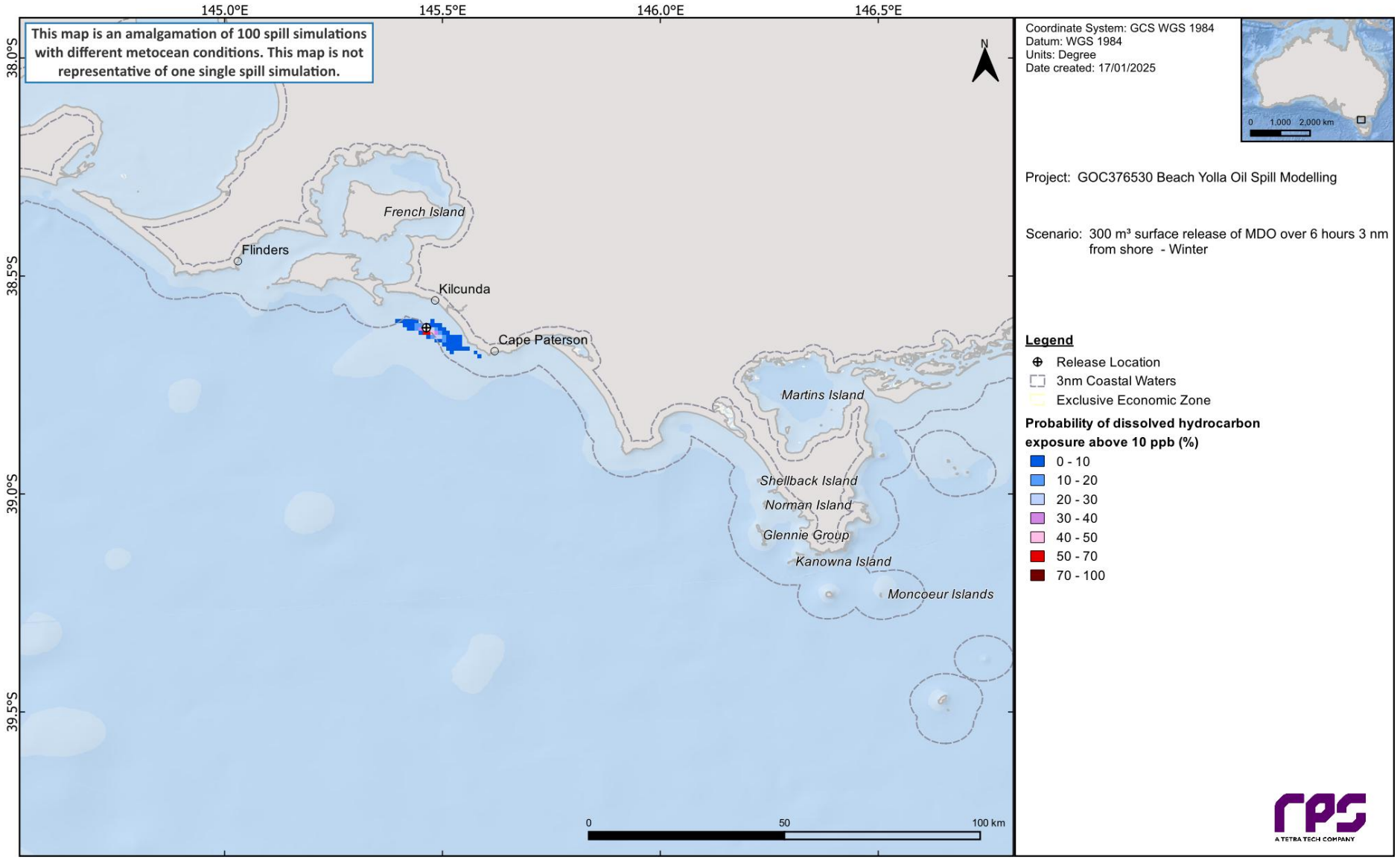


**Figure 15-22 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

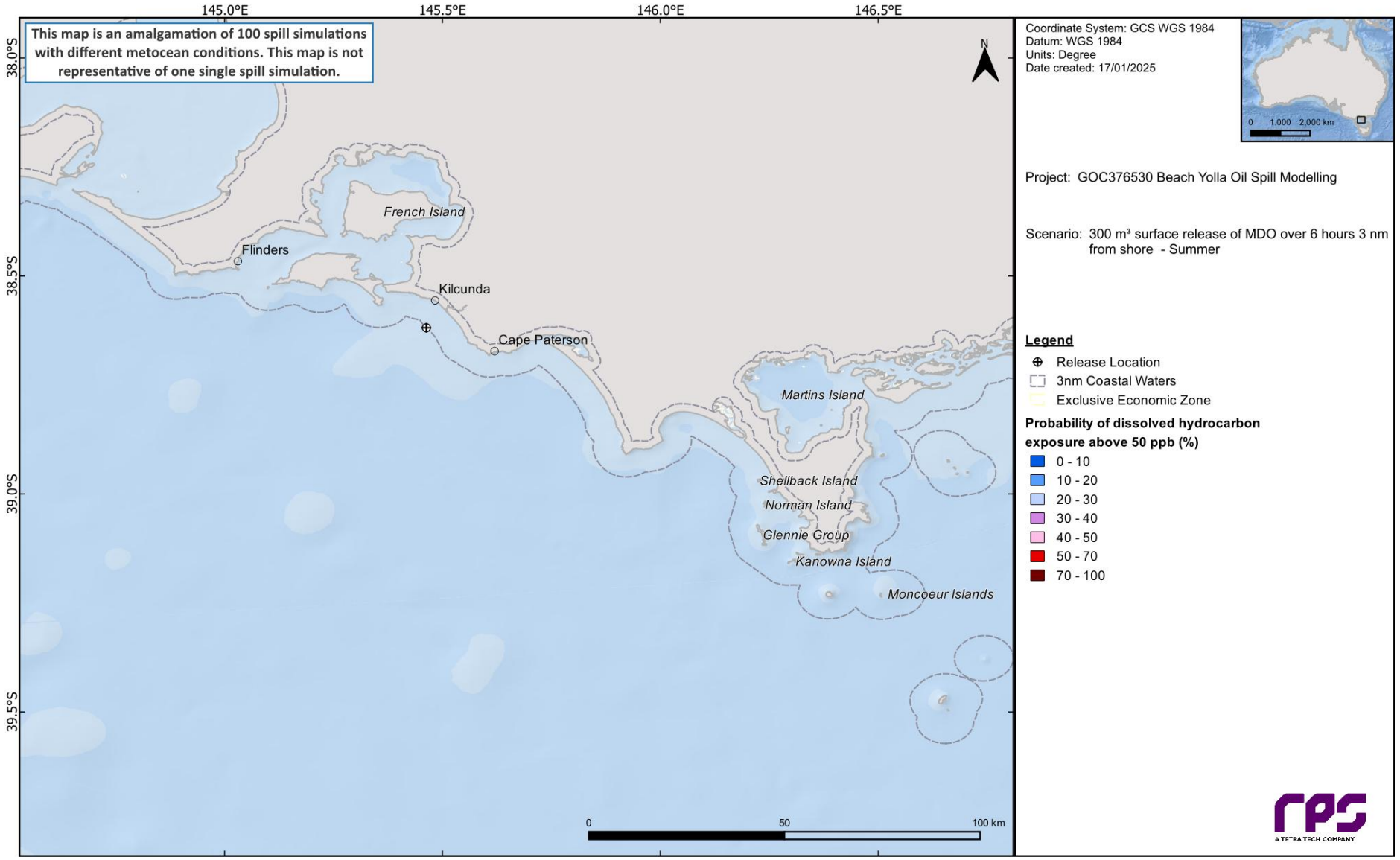


**Figure 15-23 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

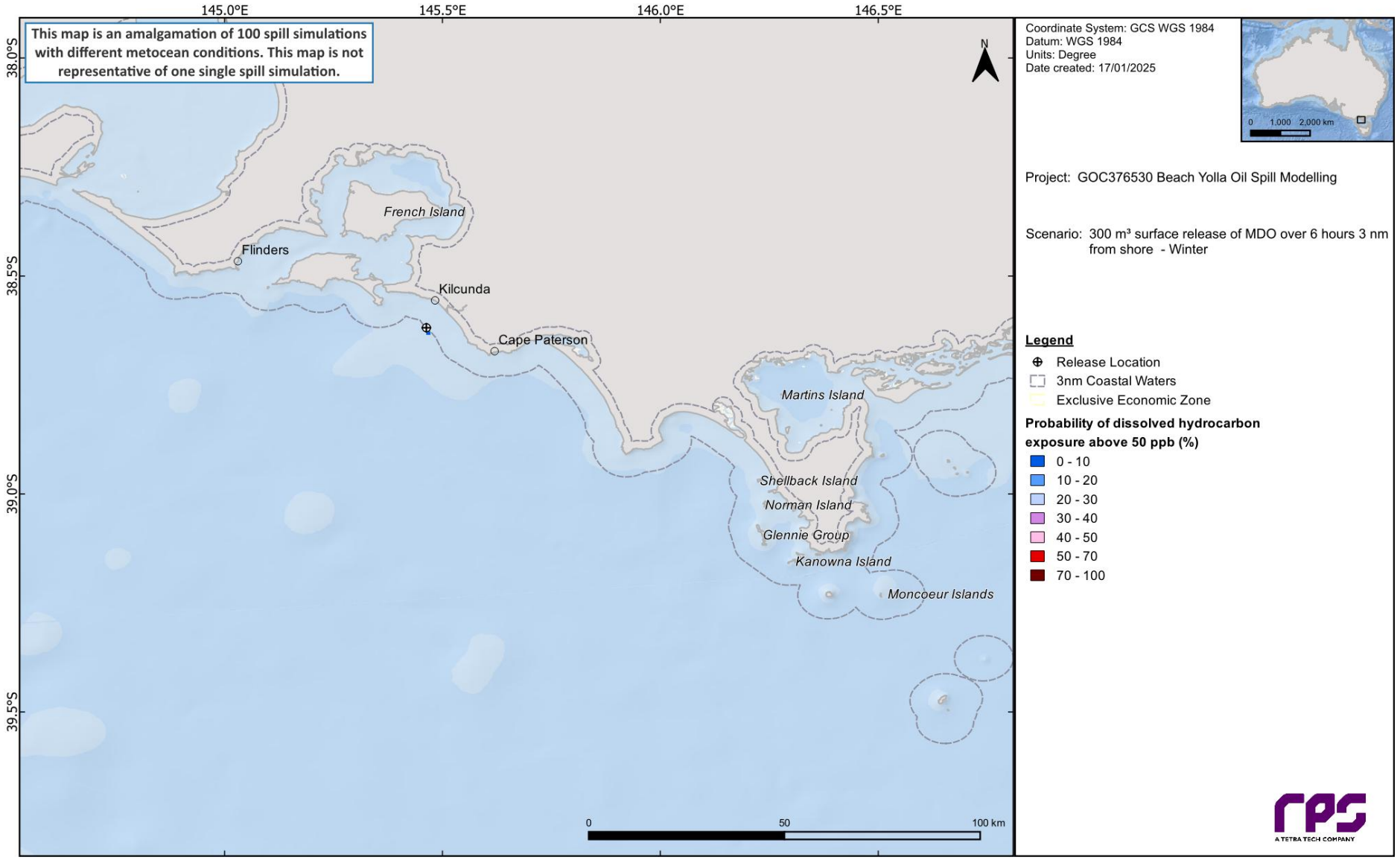


**Figure 15-24 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

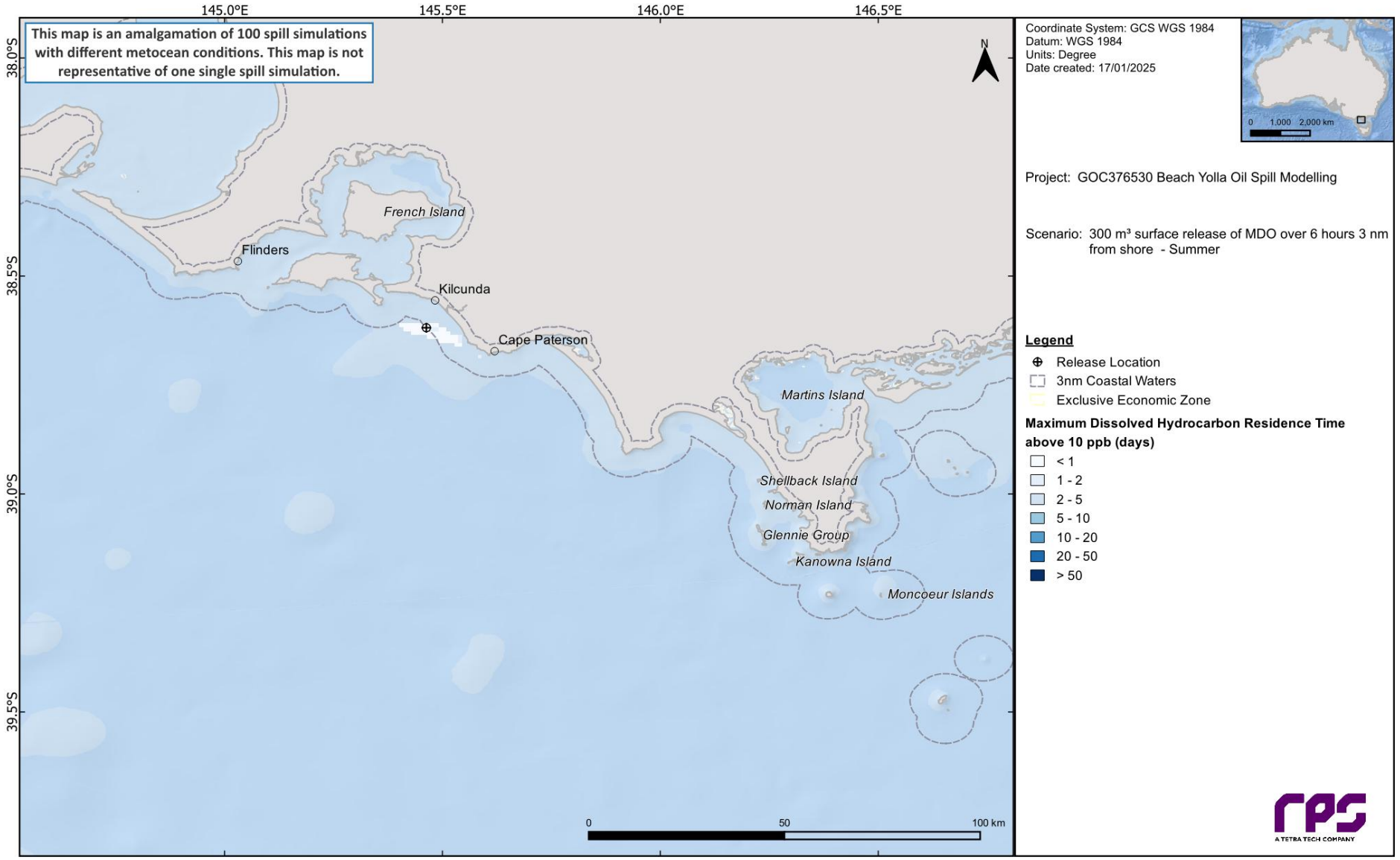


**Figure 15-25 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

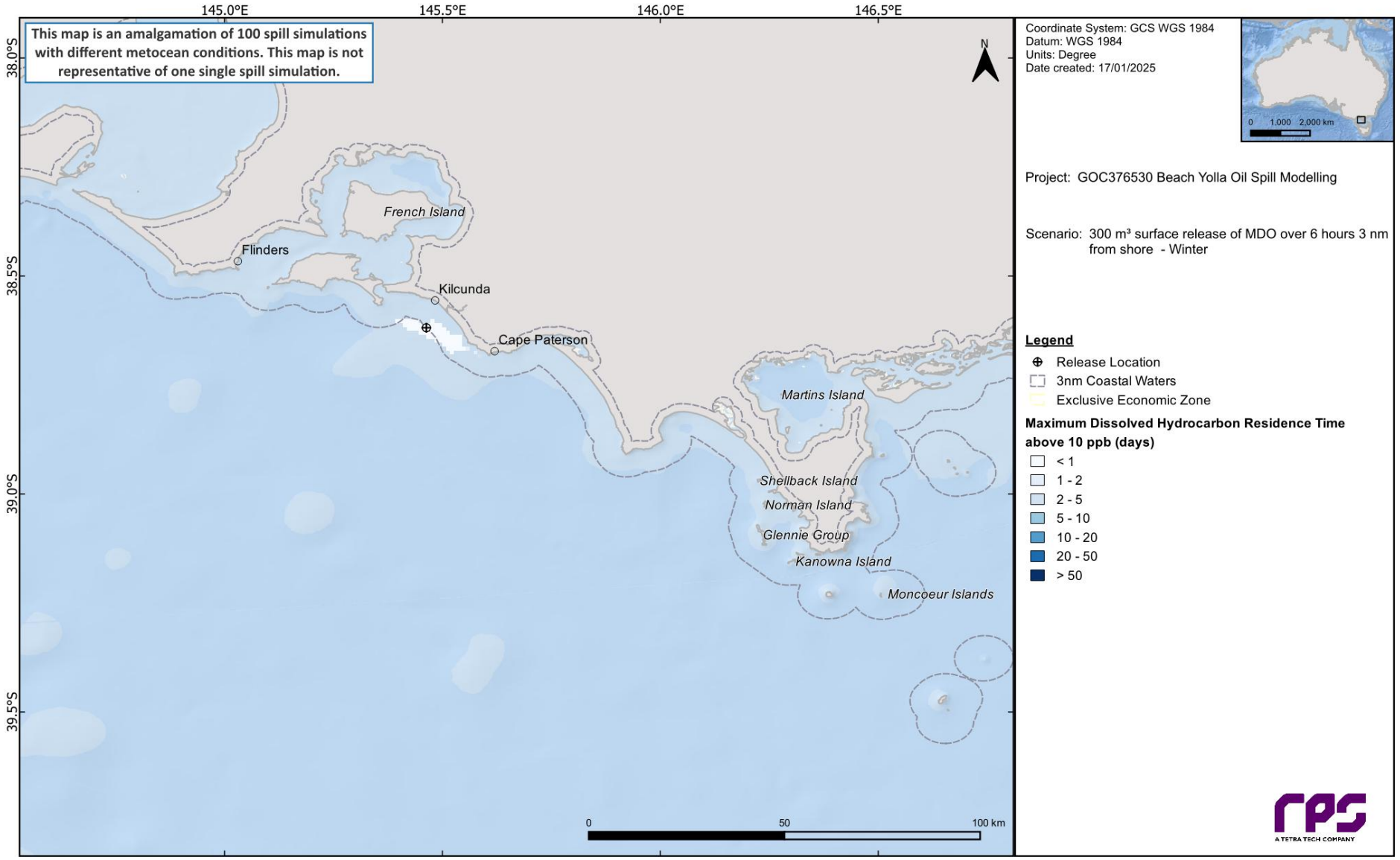


**Figure 15-26 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

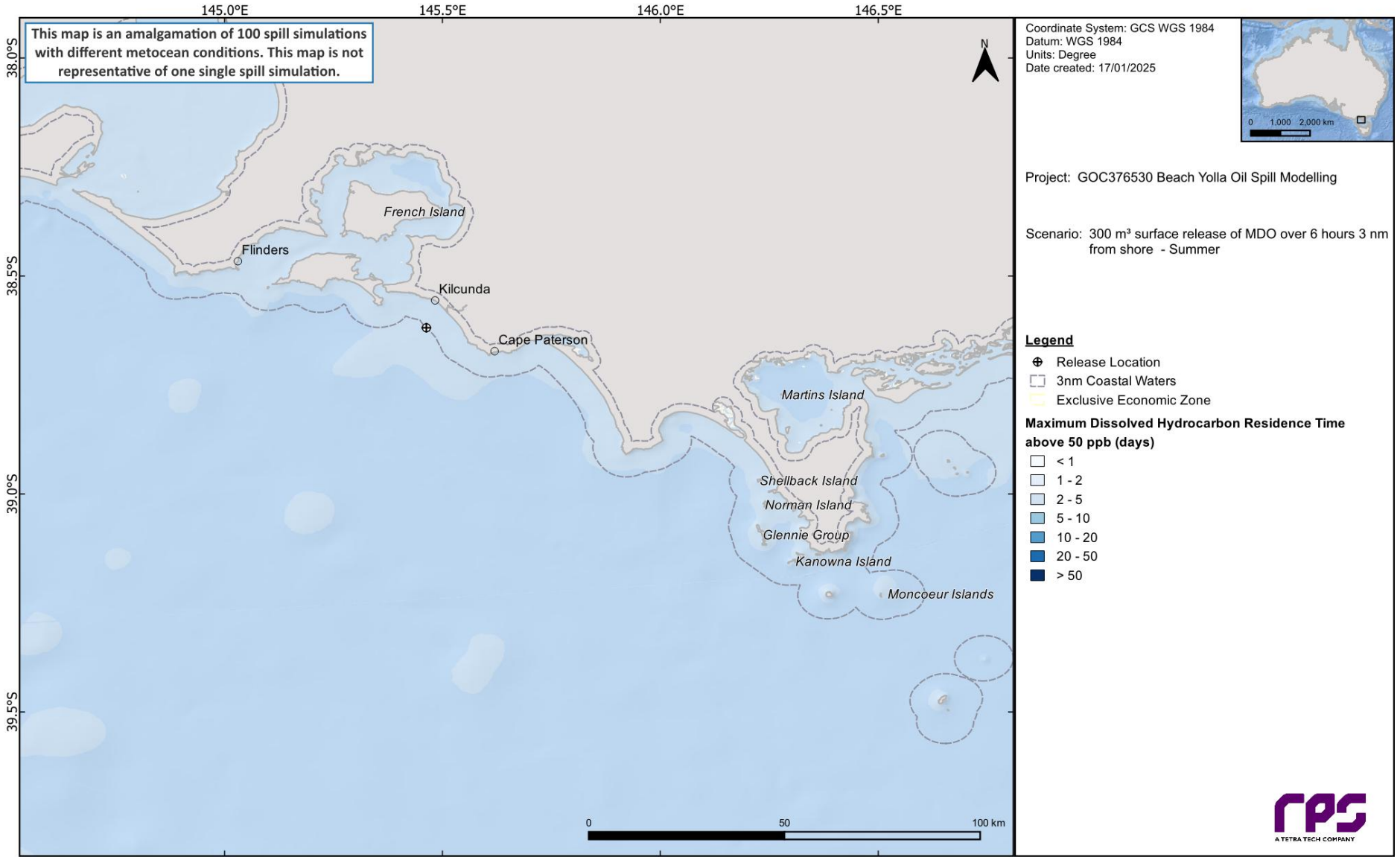


**Figure 15-27 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

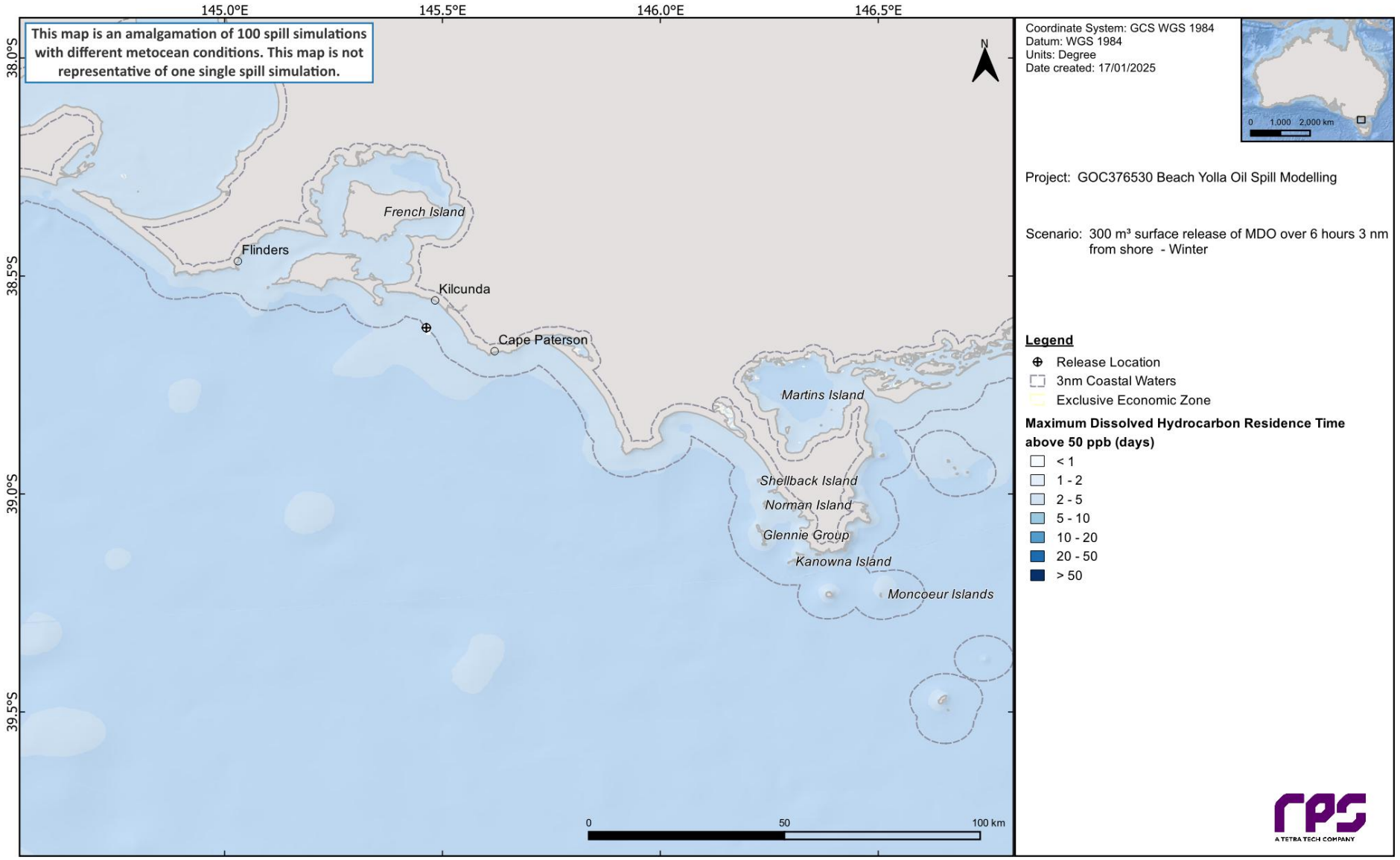


**Figure 15-28 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

### 15.1.4.2 Entrained Hydrocarbons

Table 15-10 reveals the maximum distances to entrained oil exposure during summer and winter conditions. Maximum distances to the 10 ppb and 100 ppb thresholds may reach 117.97 km (east-southeast, winter) and 90.11 km (east-southeast, winter) respectively.

Table 15-11 and Table 15-12 present the probability of exposure to individual receptors from entrained hydrocarbons for the summer and winter conditions.

Except for the receptors that the Yolla Well Head resides within, the highest probabilities of entrained hydrocarbons at, or above, 10 ppb with probabilities were 98% for the White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) BIA during summer and 99% for the Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promotory) and White Shark - Distribution (Between the 60-120m depth contour) BIAs and the Kilcunda nearshore waters in winter. The minimum time before exposure was 0.05 days and 0.04 days for the Little Penguin - Foraging (Buffer around Phillip Island) BIA in summer and winter respectively.

Figure 15-29 and Figure 15-30 present the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 15-31 to Figure 15-38 present the probability maps and the maximum residence time of entrained hydrocarbon exposure for the 10 ppb and 100 ppb thresholds in summer and winter.

**Table 15-10 Maximum distance and direction from the release location to the edge of entrained oil exposure. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential entrained oil exposure | |
|---|---|---|---|
| | | 10 ppb | 100 ppb |
| Summer | Maximum distance (km) from release location | 114.52 | 49.91 |
| | Direction | East-Southeast | East-Southeast |
| Winter | Maximum distance (km) from release location | 117.97 | 90.11 |
| | Direction | East-Southeast | East-Southeast |

**Table 15-11 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to summer conditions.**

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| BAS | Gippsland Basin - Gippsland | 284.55 | 31 | 2 | 1.56 | 5.49 | 530.75 | 75.75 |
| BIA | Australasian Gannet - Foraging (Port Phillip Bay) | 35.71 | 4 | - | 3.78 | - | 51.5 | - |
| | Black-browed Albatross - Foraging (The whole South-east Marine Region) | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 150.25 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region) | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 150.25 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island) | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 150.25 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region) | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 150.25 |
| | Little Penguin - Breeding (Phillip Island) | 152.73 | 22 | 1 | 4.78 | 25.81 | 563.75 | 20 |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 5,682.58 | 96 | 84 | 0.05 | 0.06 | 717.5 | 276.5 |
| | Pygmy Blue Whale - Distribution (None)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Short-tailed Shearwater - Breeding (Phillip Island) | 152.73 | 22 | 1 | 4.78 | 25.81 | 563.75 | 20 |
| | Short-tailed Shearwater - Breeding (Wilsons Promontory Islands) | 27.87 | 8 | - | 8.35 | - | 94.5 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area) | 13.1 | 2 | - | 24.2 | - | 5 | - |
| | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promotory) | 1,506.25 | 77 | 38 | 0.56 | 0.6 | 672.25 | 227.75 |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Southern Right Whale - Migration and resting on migration (Wilsons Promotory area) | 11 | 1 | - | 8.76 | - | 4.25 | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region) | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 150.25 |
| | White Shark - Distribution (Between the 60-120m depth contour) | 546.86 | 81 | 21 | 0.6 | 0.68 | 595 | 49.25 |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld) | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 150.25 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 3,971.14 | 98 | 79 | 0.07 | 0.08 | 714.75 | 181.75 |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour) | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 181.75 |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| IBRA | Furneaux | 27.87 | 8 | - | 8.35 | - | 94.5 | - |

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | South East Coastal Plain | 284.55 | 51 | 3 | 2.07 | 5.59 | 563.75 | 75.75 |
| IMCRA-MESO | Central Bass Strait | 125 | 21 | 1 | 1.76 | 2.68 | 72.75 | 7.5 |
| | Central Victoria** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Flinders | 65.81 | 12 | - | 7.16 | - | 239 | - |
| | Victorian Embayments | 152.73 | 24 | 1 | 3.75 | 25.81 | 630.25 | 20 |
| IMCRA-PROV | Bass Strait Shelf Province** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| | Southeast Shelf Transition | 65.81 | 12 | - | 7.16 | - | 239 | - |
| MNP | Bunurong | 597.27 | 53 | 18 | 1.08 | 1.14 | 671.75 | 142.25 |
| | Port Phillip Heads | 11.23 | 1 | - | 25.66 | - | 1.25 | - |
| | Wilsons Promontory | 42.49 | 5 | - | 8.01 | - | 239 | - |
| MR | South-east (Marine) | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 150.25 |
| NHPN | Summerland Peninsula | 12.37 | 4 | - | 9.66 | - | 31.25 | - |
| NIW | Western Port | 152.73 | 32 | 1 | 2.94 | 25.81 | 641.25 | 20 |
| NP | Wilsons Promontory | 37.98 | 7 | - | 8.35 | - | 134 | - |
| NPS4 | Bunurong Marine Park | 1,506.25 | 70 | 35 | 0.56 | 0.61 | 644 | 121.5 |
| | Wilsons Promontory Marine Park | 61.79 | 10 | - | 14.36 | - | 215.75 | - |
| | Wilsons Promontory Marine Reserve | 37.98 | 2 | - | 8.15 | - | 134 | - |
| NRMR | North NRM Region (TAS) | 14.4 | 1 | - | 8.68 | - | 7.5 | - |
| | Port Phillip and Western Port (VIC) | 980.03 | 72 | 28 | 0.42 | 0.59 | 646 | 52 |
| | West Gippsland (VIC)** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |
| OP | Phillip Island Nature Park | 152.73 | 22 | 1 | 4.78 | 25.81 | 563.75 | 20 |
| RA | Anser Island | 14.18 | 1 | - | 11.67 | - | 30.5 | - |
| RAMSAR | Western Port | 23.4 | 3 | - | 18.97 | - | 3.25 | - |
| RNAS6 | Wilsons Promontory Islands | 37.98 | 7 | - | 8.35 | - | 134 | - |
| RSB | Cody Bank | 57.42 | 8 | - | 3.13 | - | 28 | - |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 590.19 | 40 | 7 | 2.91 | 5.05 | 599.25 | 147 |
| | French Island / Crib Point | 10.17 | 1 | - | 22.78 | - | 0.25 | - |
| | French Island / San Remo | 152.73 | 37 | 1 | 1.41 | 25.81 | 649.25 | 20 |

| Receptor | | Summer (November through to March) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | Kilcunda | 3,463.23 | 95 | 75 | 0.22 | 0.3 | 711.25 | 294.5 |
| | Mornington Peninsula - South | 10.22 | 1 | - | 21.53 | - | 2.5 | - |
| | Mornington Peninsula - Southwest | 13.1 | 2 | - | 24.2 | - | 5 | - |
| | Port Phillip - Sorrento Shore | 11.44 | 1 | - | 25.66 | - | 1.25 | - |
| | Venus Bay | 1,506.25 | 75 | 42 | 0.46 | 0.55 | 671.75 | 227.75 |
| | Waratah Bay | 126.05 | 21 | 1 | 5.25 | 7.1 | 451.5 | 12.75 |
| | Westernport | 10.17 | 1 | - | 22.78 | - | 0.25 | - |
| | Wilsons Promontory - West | 61.79 | 11 | - | 9.71 | - | 215.75 | - |
| State Waters | Tasmania | 14.4 | 1 | - | 8.68 | - | 7.5 | - |
| | Victoria** | 9,485.99 | 100 | 100 | 0.01 | 0.01 | 720 | 298.5 |

**The release location resides within the receptor boundaries.

**Table 15-12 Summary of entrained hydrocarbons exposure to marine based receptors. Results are based on a 300 $m^3$ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations and refer to winter conditions.**

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| AMP | Beagle | 11.81 | 2 | - | 10.83 | - | 11 | - |
| BAS | Gippsland Basin - Gippsland | 177.21 | 59 | 2 | 1.07 | 1.93 | 181.75 | 68.75 |
| BIA | Black-browed Albatross - Foraging (The whole South-east Marine Region) | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 129 |
| | Bullers Albatross - Foraging (Most of the South-east Marine Region) | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 129 |
| | Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island) | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 129 |
| | Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region) | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 129 |
| | Little Penguin - Foraging (Buffer around Phillip Island) | 5,443.27 | 64 | 52 | 0.04 | 0.05 | 705.25 | 237.75 |
| | Pygmy Blue Whale - Distribution (None)** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Short-tailed Shearwater - Breeding (Wilsons Promontory Islands) | 69.07 | 48 | - | 4.77 | - | 596.25 | - |
| | Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Shy Albatross - Foraging likely (The whole South-east Marine Region)** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Southern Right Whale - Known core range (Southern Right Whales occur in coastal | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | waters anywhere between Sydney and Perth, including off Tasmania)** | | | | | | | |
| | Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promotory) | 2,226.53 | 99 | 83 | 0.29 | 0.32 | 616.5 | 254.75 |
| | Southern Right Whale - Migration and resting on migration (Philip Island area)** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Southern Right Whale - Migration and resting on migration (Wilsons Promotory area) | 13.54 | 2 | - | 10.71 | - | 25.75 | - |
| | Wandering Albatross - Foraging (The whole South-east Marine Region) | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 129 |
| | White Shark - Breeding (nursery area) (Corner Inlet) | 11.97 | 1 | - | 16.83 | - | 1.25 | - |
| | White Shark - Distribution (Between the 60-120m depth contour) | 930.86 | 99 | 30 | 0.83 | 0.88 | 534.5 | 129 |
| | White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld) | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 129 |
| | White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region) | 4,449.23 | 96 | 53 | 0.06 | 0.07 | 703.25 | 237.75 |
| | White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour) | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 237.75 |
| | White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| IBRA | Furneaux | 69.07 | 48 | - | 4.77 | - | 596.25 | - |
| | South East Coastal Plain | 169.37 | 37 | 1 | 1.38 | 3.57 | 181.75 | 68.75 |
| IMCRA-MESO | Central Bass Strait | 242.92 | 19 | 2 | 1.33 | 2.1 | 57 | 6.25 |
| | Central Victoria** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Flinders | 303.81 | 68 | 11 | 3.47 | 5.2 | 608.5 | 198 |

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | Victorian Embayments | 11.97 | 1 | - | 16.83 | - | 1.25 | - |
| IMCRA-PROV | Bass Strait Shelf Province** | 10,466.22 | 100 | 100 | 0.01 | 0.01 | 709.75 | 272.25 |
| | Southeast Shelf Transition | 303.81 | 68 | 11 | 3.47 | 5.2 | 608.5 | 198 |
| MNP | Bunurong | 735.11 | 94 | 44 | 0.63 | 0.9 | 260.75 | 84.75 |
| | Wilsons Promontory | 114.35 | 48 | 1 | 4.48 | 23.41 | 608.5 | 5.5 |
| MR | South-east (Marine) | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 129 |
| NIW | Corner Inlet | 11.97 | 1 | - | 16.83 | - | 1.25 | - |
| | Western Port | 29.57 | 6 | - | 3 | - | 334.75 | - |
| NP | Wilsons Promontory | 69.7 | 40 | - | 4.77 | - | 573 | - |
| NPS4 | Bunurong Marine Park | 2,226.53 | 98 | 70 | 0.34 | 0.45 | 251.5 | 119.25 |
| | Nooramunga Marine & Coastal Park | 11.97 | 1 | - | 16.83 | - | 1.25 | - |
| | Wilsons Promontory Marine Park | 303.81 | 58 | 9 | 5.26 | 12.52 | 510 | 198 |
| | Wilsons Promontory Marine Reserve | 81.47 | 40 | - | 4.58 | - | 597.5 | - |
| NRMR | North NRM Region (TAS) | 13.35 | 2 | - | 10.66 | - | 22.5 | - |
| | Port Phillip and Western Port (VIC) | 815.46 | 27 | 7 | 0.61 | 0.88 | 383.25 | 19.25 |
| | West Gippsland (VIC)** | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 272.25 |
| RA | Anser Island | 24.36 | 12 | - | 8.36 | - | 114 | - |
| RAMSAR | Corner Inlet | 11.97 | 1 | - | 16.83 | - | 1.25 | - |
| RNAS6 | Wilsons Promontory Islands | 69.7 | 40 | - | 4.77 | - | 573 | - |
| RSB | Cody Bank | 183.92 | 11 | 1 | 1.64 | 1.77 | 61 | 3 |
| SHORE-LGA | Flinders Council (TAS) | 10.49 | 1 | - | 12.08 | - | 1.5 | - |
| SHORE-VIC-MPRA | Cape Liptrap - Northwest | 1,061.44 | 96 | 49 | 1.75 | 1.92 | 541.25 | 254.75 |
| | Clonmel Island | 11.97 | 1 | - | 16.83 | - | 1.25 | - |
| | Kilcunda | 2,607.67 | 99 | 83 | 0.19 | 0.26 | 698.5 | 266.75 |
| | Snake Island | 11.97 | 1 | - | 16.94 | - | 0.25 | - |
| | Venus Bay | 2,226.53 | 98 | 77 | 0.25 | 0.32 | 338.5 | 119.25 |
| | Waratah Bay | 173.57 | 76 | 5 | 3 | 3.57 | 297.75 | 22 |

| Receptor | | Winter (April through to October) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Maximum entrained hydrocarbon exposure | Probability of instantaneous entrained hydrocarbon exposure (%) | | Minimum time before instantaneous entrained hydrocarbon exposure (days) | | Maximum residence time for entrained hydrocarbon exposure (hours) | |
| | | | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb | ≥ 10 ppb | ≥ 100 ppb |
| | Wilsons Promontory - East | 10.31 | 2 | - | 10.83 | - | 2.25 | - |
| | Wilsons Promontory - West | 303.81 | 66 | 10 | 4.77 | 12.52 | 561.75 | 198 |
| State Waters | Tasmania | 13.35 | 2 | - | 10.66 | - | 22.5 | - |
| | Victoria** | 10,466.22 | 100 | 99 | 0.01 | 0.01 | 709.75 | 272.25 |

**The release location resides within the receptor boundaries.

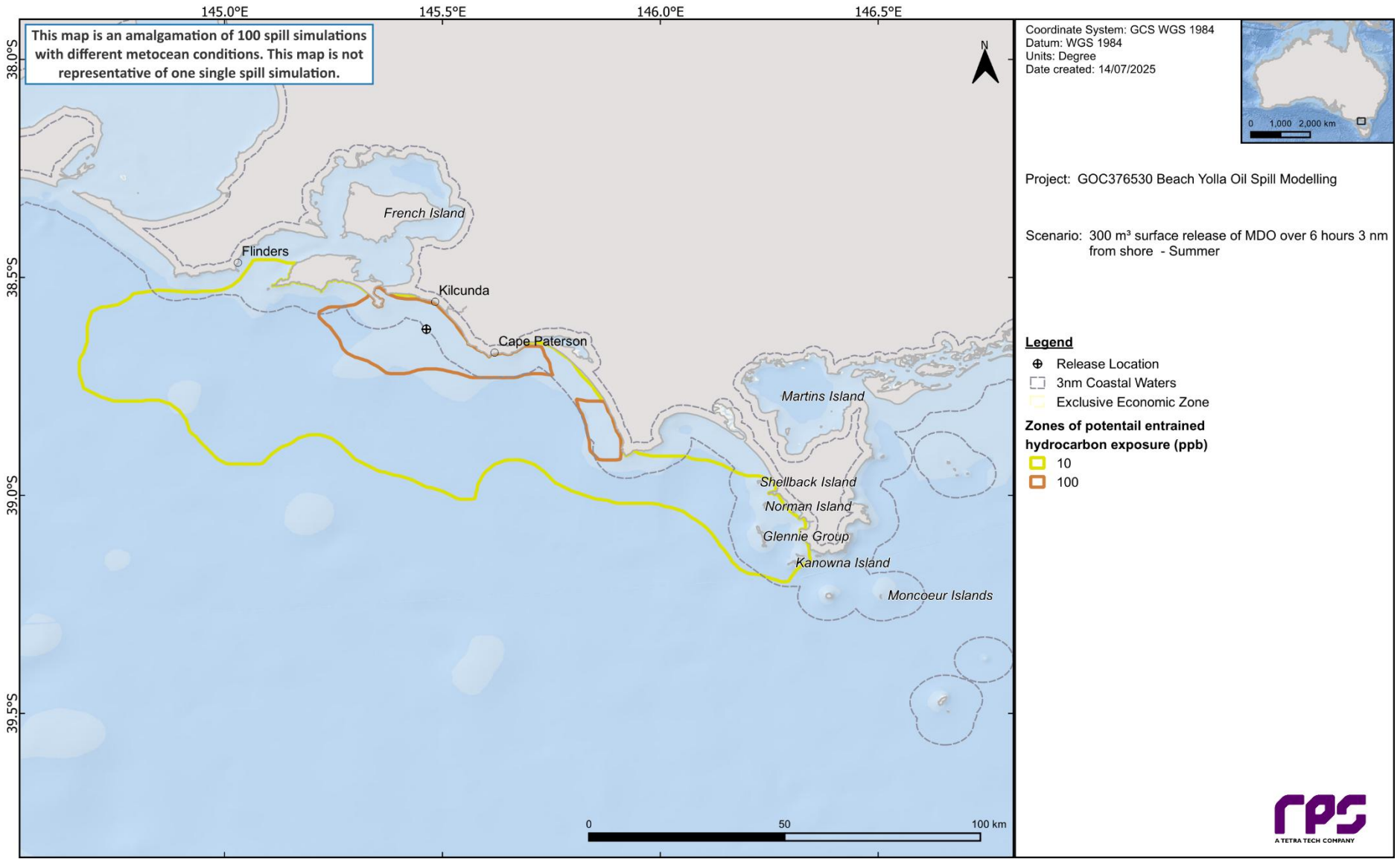


**Figure 15-29 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

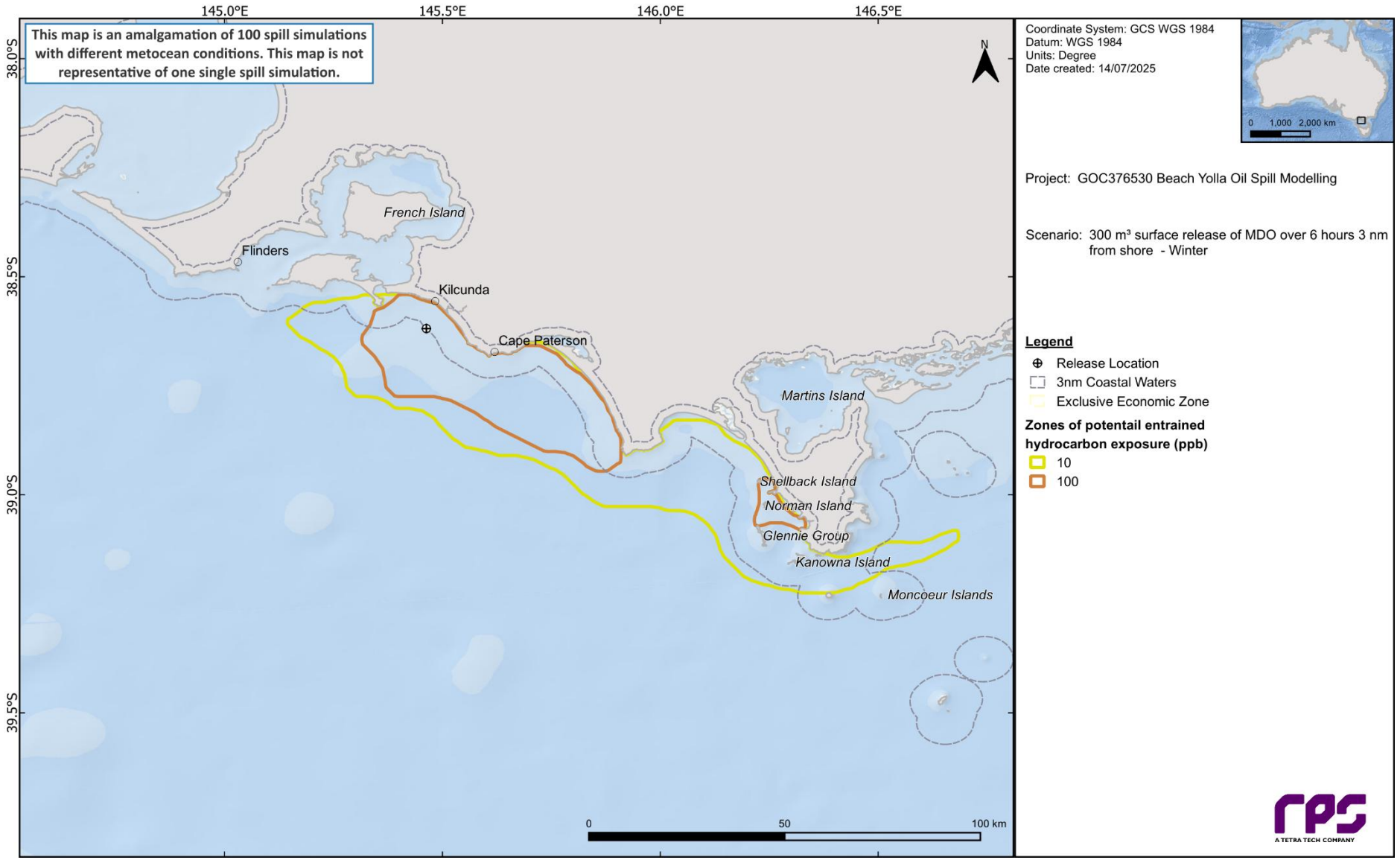


**Figure 15-30 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

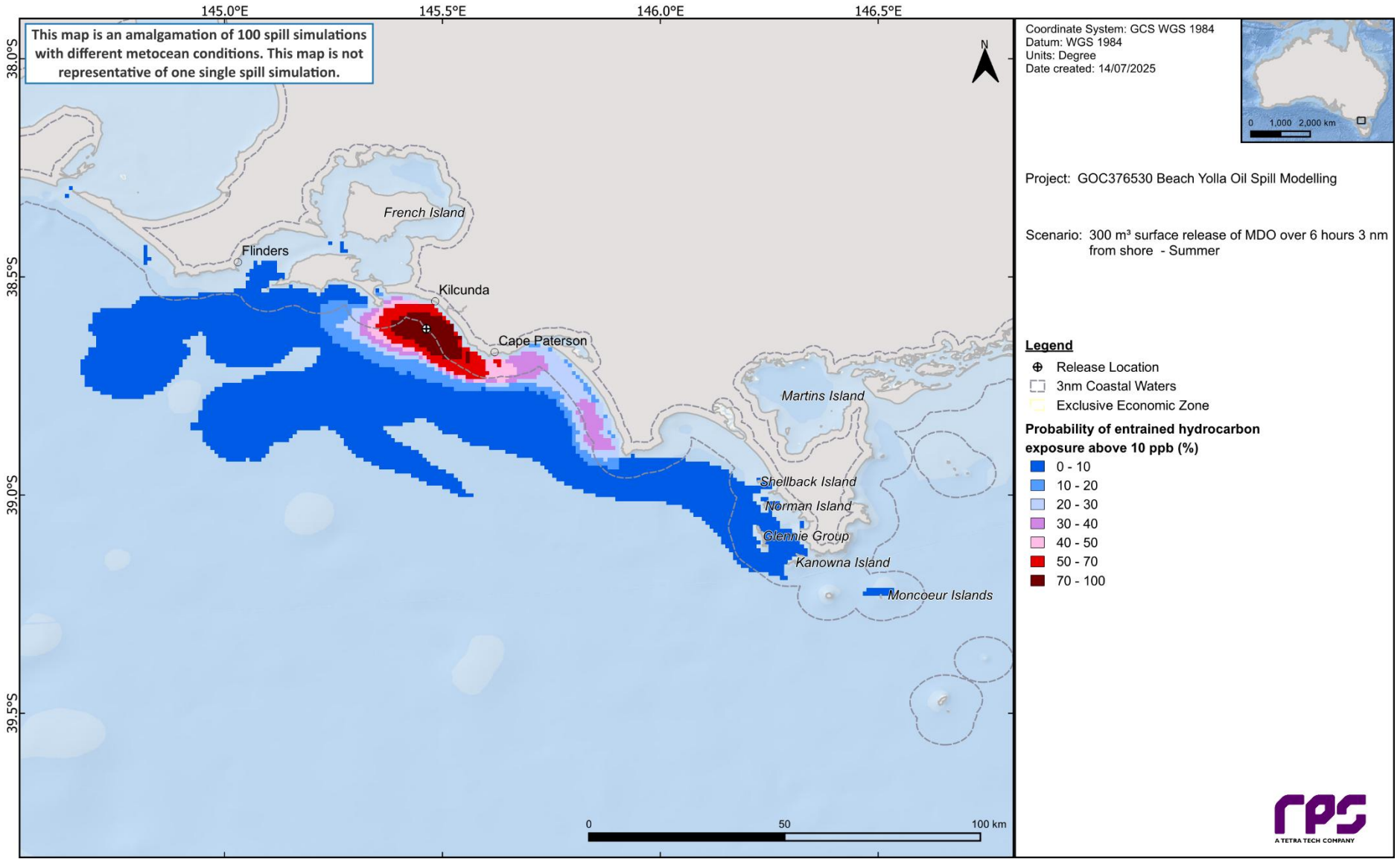


**Figure 15-31 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

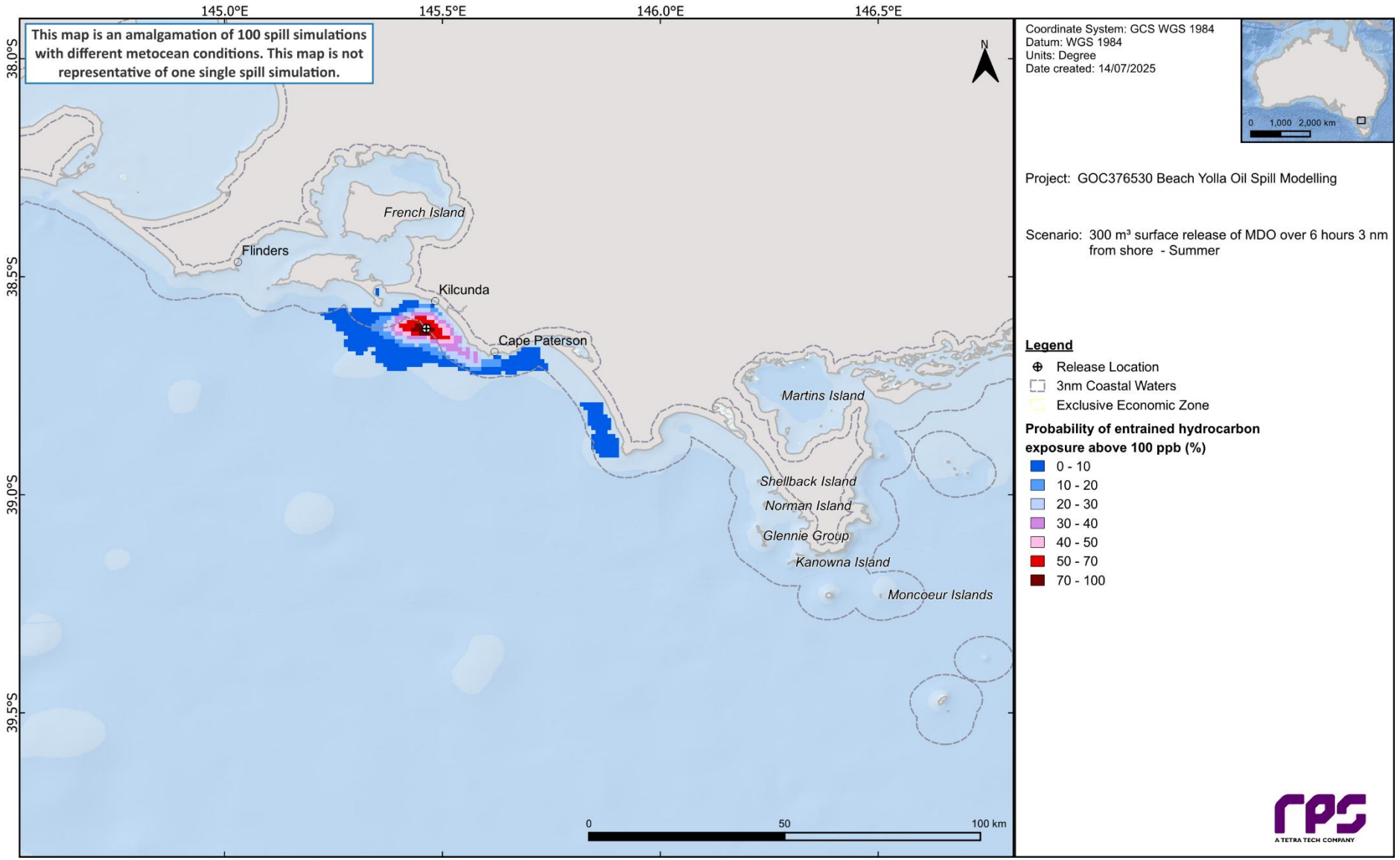


**Figure 15-32 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

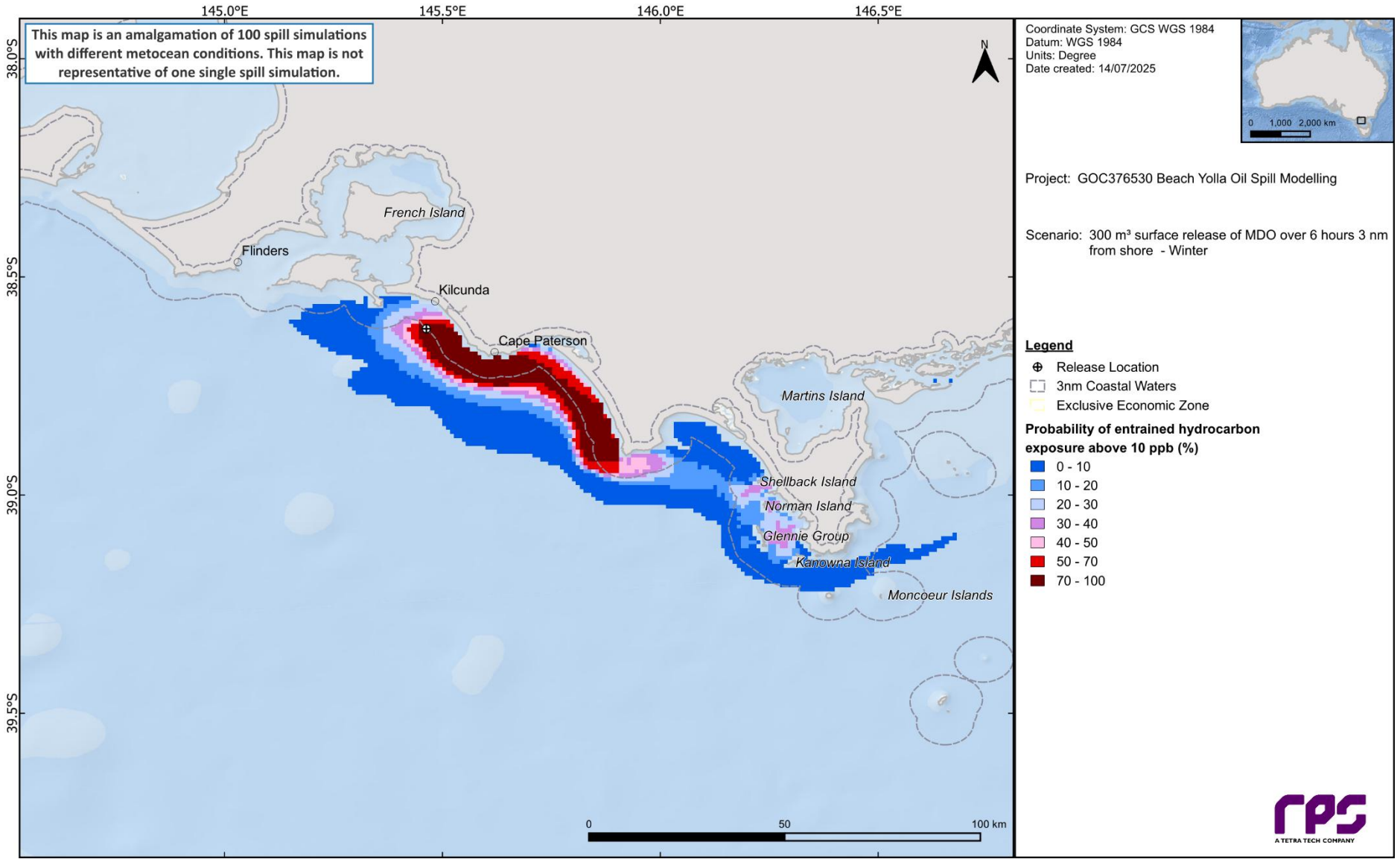


**Figure 15-33 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

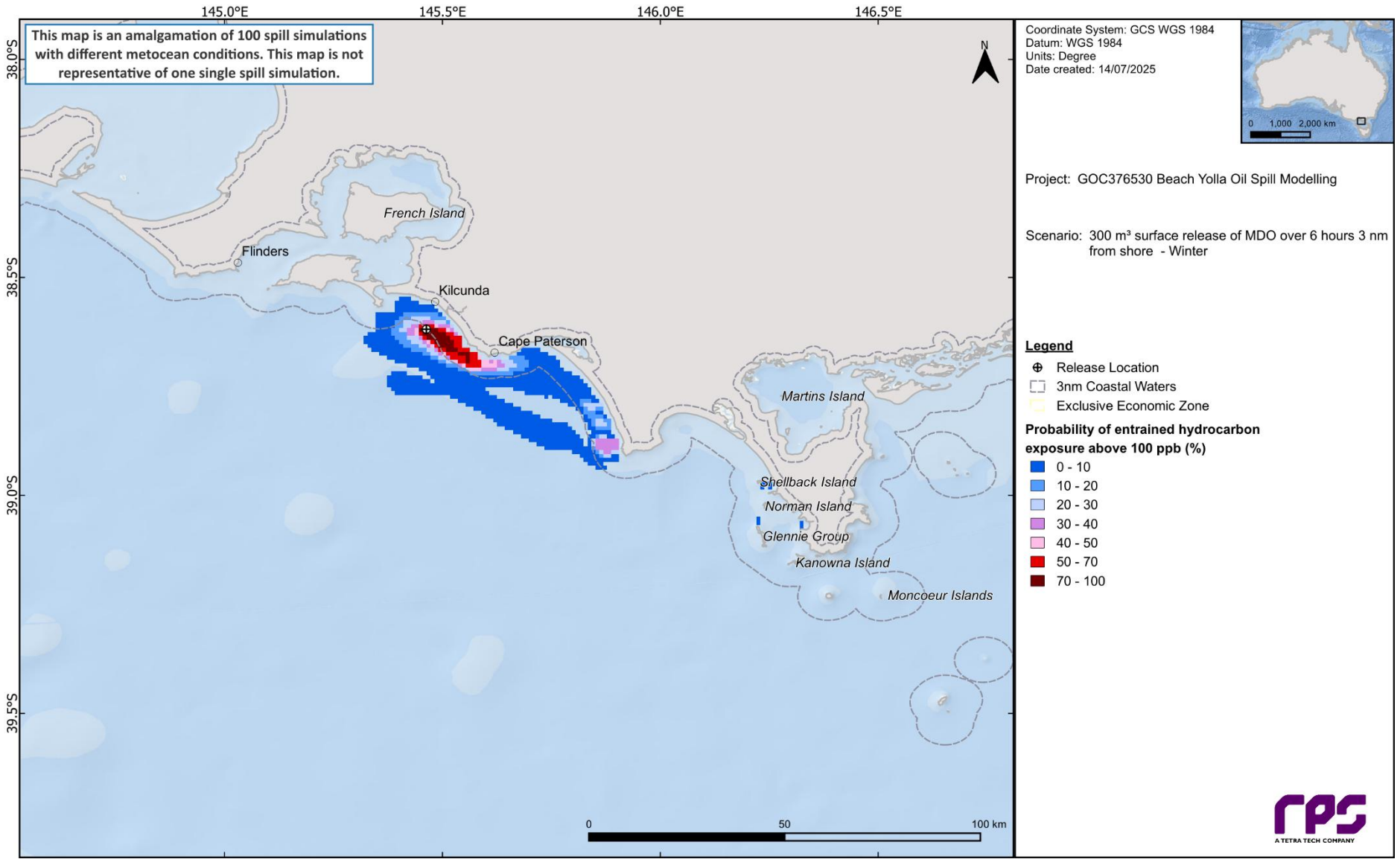


**Figure 15-34 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

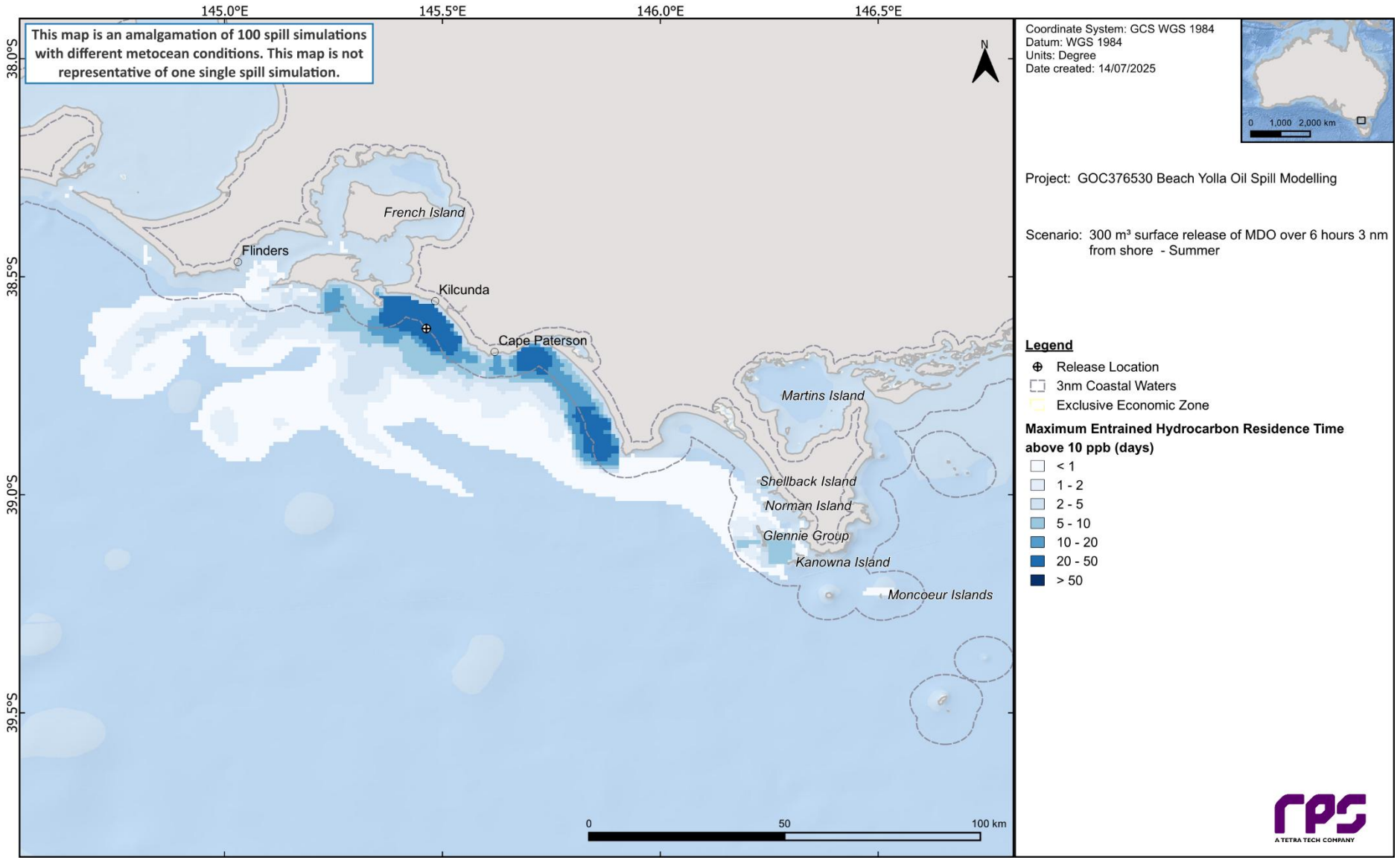


**Figure 15-35 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

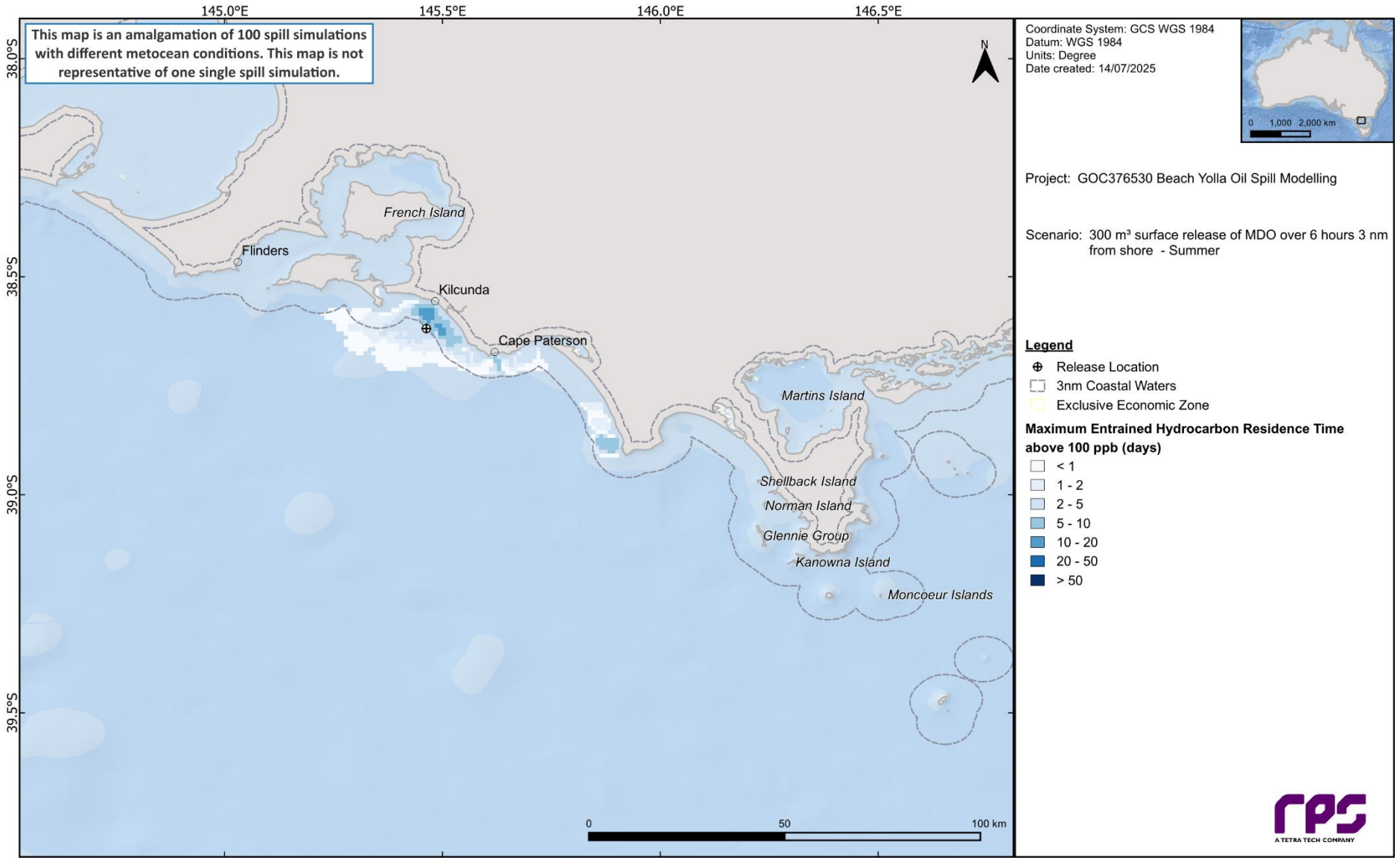


**Figure 15-36 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.**

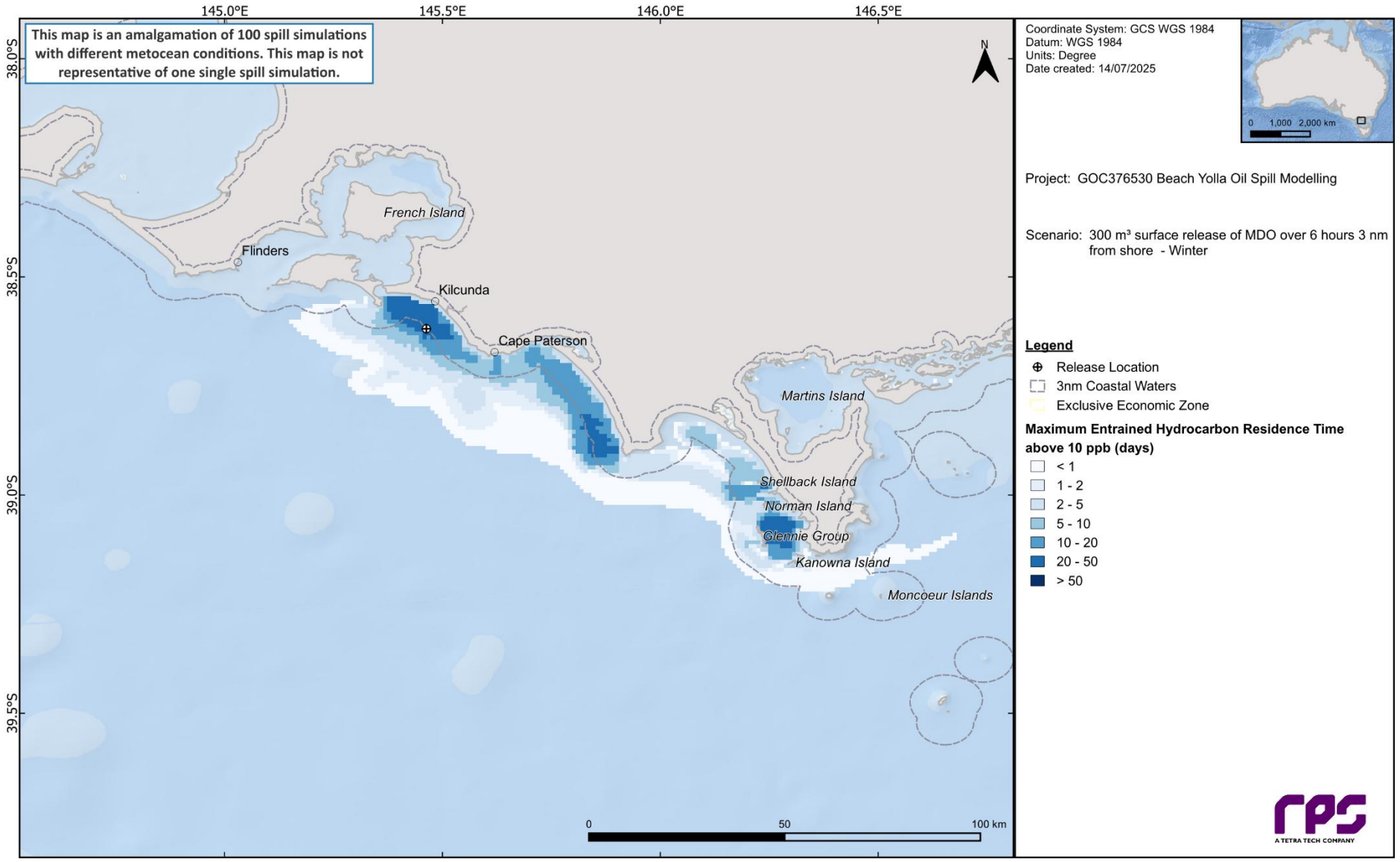


**Figure 15-37 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.**

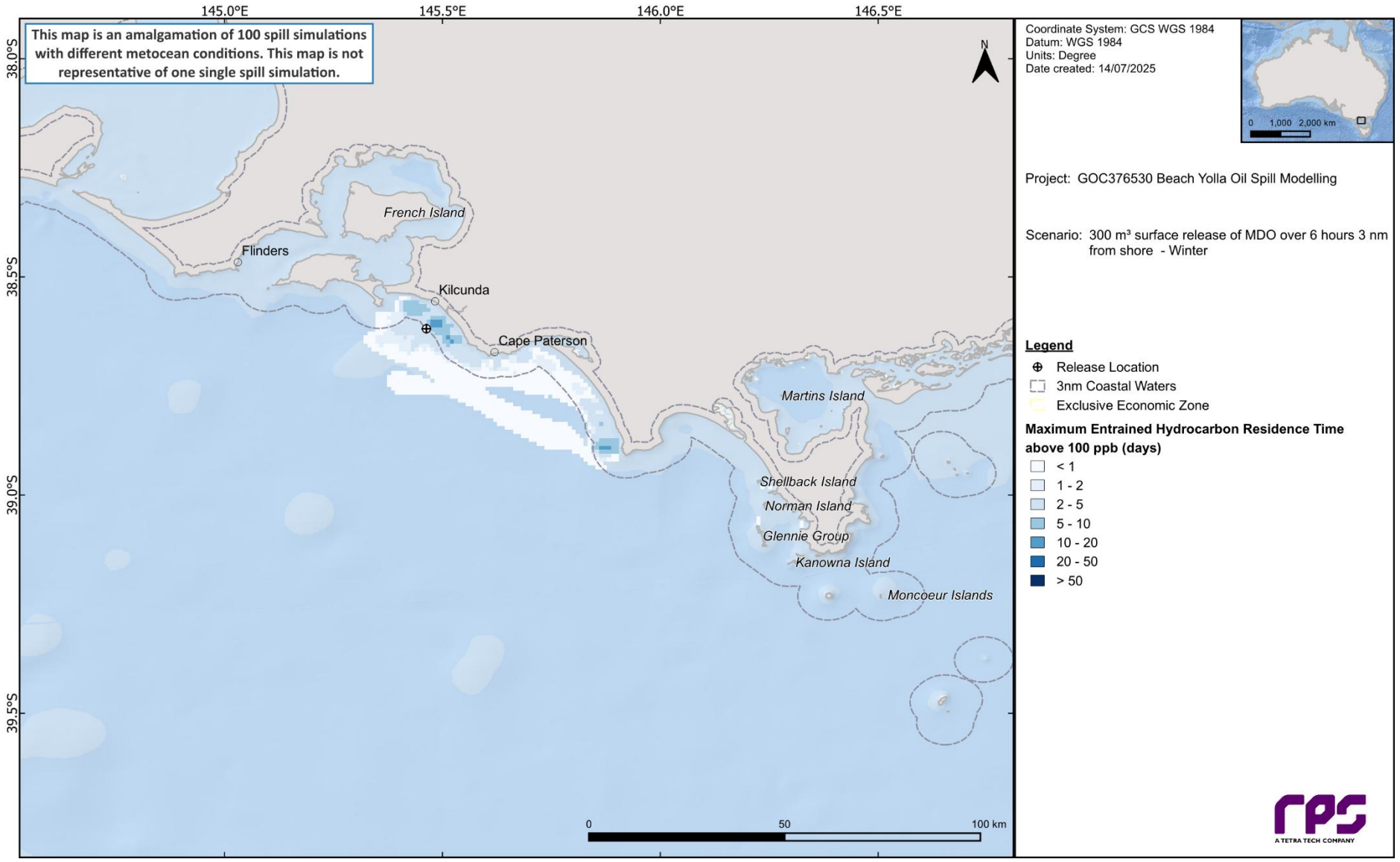


**Figure 15-38 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions**

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# YOLLA PLATFORM

## Produced Water Dispersion Modelling

GOC384054
2 December 2025
Rev 3

rpsgroup.com

## Document status

| Version | Purpose of document | Authored by | Reviewed by | Approved by | Review date |
|---|---|---|---|---|---|
| Rev A | Internal Draft | L. Perez | N. Benfer | N. Benfer | 4/04/2025 |
| Rev 0 | Draft issued to client | | | N. Benfer | 4/04/2025 |
| Rev 1 | Additional scenario added | L. Perez<br>N. Benfer | L. Perez | N. Benfer | 30/04/2025 |
| Rev 2 | Assessed new thresholds | L. Perez | | N. Benfer | 23/05/2025 |
| Rev 3 | Issued to client | | | N. Benfer | 2/12/2025 |

## Approval for issue

Nathan Benfer 2 December 2025

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# Contents

**EXECUTIVE SUMMARY** ..... **V**
Near-Field Modelling ..... v
Far-Field Modelling ..... v

**1 INTRODUCTION** ..... **1**
1.1 Background ..... 1

**2 SCOPE OF WORK** ..... **3**

**3 DESCALING ACTIVITIES DISCHARGE IMPACT** ..... **4**

**4 MODELLING METHODOLOGY** ..... **5**
4.1 Near-Field Modelling ..... 5
4.1.1 Overview ..... 5
4.1.2 Description of Near-Field Model: CORMIX ..... 5
4.1.3 Setup of Near-Field Model ..... 6
4.2 Far-Field Modelling ..... 9
4.2.1 Overview ..... 9
4.2.2 Description of Far-Field Model: MUDMAP ..... 9
4.2.3 Stochastic Modelling ..... 9
4.2.4 Setup of Far-Field Model ..... 10
4.2.5 Regional Ocean Currents ..... 12

**5 MODELLING RESULTS** ..... **19**
5.1 Near-Field Modelling ..... 19
5.1.1 Overview ..... 19
5.2 Far-Field Modelling ..... 27
5.2.1 Overview ..... 27
5.2.2 Stochastic Analysis ..... 27

**6 REFERENCES** ..... **1**

# Tables

Table 1-1 Location of the Yolla Platform used as the release site for the PFW dispersion modelling assessment. ....1
Table 4-1 CORMIX mixing zones. ....5
Table 4-2 Summary of the PFW discharge characteristics. ....7
Table 4-3 Average seasonal temperature and salinity levels adjacent to the Yolla Platform location. ....7
Table 4-4 Adopted ambient current conditions adjacent to the Yolla Platform location. ....8
Table 4-5 Summary of PFW discharge modelling assumed for far-field modelling. ....10
Table 4-6 Predicted monthly average and maximum surface current speeds close to the release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2010-2019. ....16
Table 5-3 Maximum distance from the PFW discharge location to achieve threshold dilutions. ....27

# Figures

Figure 1-1 Location of the Yolla Platform. ....2
Figure 3-1 Time-series of density and oil in water measurements taken in the PFW outlet during normal and descaling activities. Image provided by Beach. ....4
Figure 4-1 Conceptual diagram showing the general behaviour of a positively buoyant discharge discharged vertically into receiving water moving due to current. ....6
Figure 4-2 Monthly salinity and temperature profiles at the Yolla Platform ....8
Figure 4-3 Example HYCOM averaged seasonal surface drift currents during summer (top) and winter (bottom). ....13
Figure 4-4 Zoomed in view of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh. ....14
Figure 4-5 Bathymetry defined throughout the tidal model domain. ....15
Figure 4-6 Monthly surface current rose distributions at the release location derived from the 2010 to 2019 modelled dataset. ....17
Figure 4-7 Total surface current rose plot at the release location derived from the 2010 to 2019 modelled dataset. ....18
Figure 5-1 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....21
Figure 5-2 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....21
Figure 5-3 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....22
Figure 5-4 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....22
Figure 5-5 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....23
Figure 5-6 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....23
Figure 5-7 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....24
Figure 5-8 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....24
Figure 5-9 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....25
Figure 5-10 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....25
Figure 5-11 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....26

Figure 5-12 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....26
Figure 5-13 95$^{th}$ percentile dilution for a PFW discharge at 200 $m^3$/d. Results refer to annual conditions. ....28
Figure 5-14 95$^{th}$ percentile dilution for a PFW discharge at 300 $m^3$/d. Results refer to annual conditions. ....29

# EXECUTIVE SUMMARY

Beach Energy (Beach) is updating their Environment Plan (EP) for operations in the Yolla field. This field is situated within production licence T/L1, located 147 km south of Kilcunda (Victoria) in Bass Strait.

As part of their operations Beach is discharging produced formation water (PFW) continuously into the ocean. The PFW is water from the reservoir that is intimately mixed with oil and various organic and inorganic compounds such as heavy metals and minerals from the geological formations. Additionally, Beach will be periodically injecting a descaling agent (GLDA) into the reservoir to reduce resistance in the flowlines.

Whole effluent toxicity testing was carried for the PFW stream both with and without the presence of the GLDA, and the 99% species protection dilution thresholds were determined to be 1,961 and 19,608 dilutions, respectively. In order to achieve 95% species protection dilution thresholds decreased to 526 and 7,143 respectively.

RPS was commissioned to conduct a dispersion modelling study considering both the base case (200 $m^3$/day) and future case (300 $m^3$/day) discharge of PFW at a depth of 45 m below mean sea level.

To accurately determine the dilution of the PFW discharge and the total potential area of influence the effect of initial mixing generated by the discharge jet and buoyancy effects (near-field mixing) must be considered first. Subsequent dispersion of the remnant plume by ambient currents and turbulent forces in the water column (far-field dispersion) must then be considered where near-field mixing is inadequate to meet required dilutions. Different modelling approaches are required for calculating near-field and far-field dilutions due to the differing time and space scales that are involved. Rates of both near-field mixing and far-field dispersion will vary with prevailing currents. Hence, calculations must assess for variability in prevailing currents around the discharge site.

The potential area that may be influenced by the PFW discharge stream was assessed on an annual basis. The following details summarise the findings of this study.

## Near-Field Modelling

- Under strong currents, the distance where the lower dilution threshold of 526 was reached ranged from 55 m to 62 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 850 m to 1,230 m.
- Under moderate currents, the distance where the lower dilution threshold of 526 was reached ranged from 27 m to 30 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 475 m to 1,400 m.
- Under low currents, the distance where the lower dilution threshold of 526 was reached ranged from 11 m to 12 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 580 m to 1,600 m.

## Far-Field Modelling

- The lower dilution threshold (526) was observed within approximately 10 m and 12 m for the Base Case and Future Case, respectively.
- The dilution threshold of 7,143 was observed within approximately 29 m and 37 m for the Base Case and Future Case, respectively.
- The dilution threshold of 1,961 was observed within approximately 41 m and 61 m for the Base Case and Future Case, respectively.
- The upper dilution threshold (19,608) was observed within approximately 163 m and 247 m for the Base Case and Future Case, respectively.

# 1 INTRODUCTION

## 1.1 Background

Beach Energy (Beach) is updating their Environment Plan (EP) for operations in the Yolla field. This field is situated within production licence T/L1, located 147 km south of Kilcunda (Victoria) in Bass Strait.

As part of their operations Beach is discharging produced formation water (PFW) continuously into the ocean. The PFW is water from the reservoir that is intimately mixed with oil and various organic and inorganic compounds such as heavy metals and minerals from the geological formations. Additionally, Beach will be periodically injecting a descaling agent (GLDA) into the reservoir to reduce resistance in the flowlines.

Whole effluent toxicity testing was carried for the PFW stream both with and without the presence of the GLDA, and the 99% species protection dilution thresholds were determined to be 1,961 and 19,608 dilutions, respectively. In order to achieve 95% species protection dilution thresholds decreased to 526 and 7,143 respectively.

RPS was commissioned to conduct a dispersion modelling study considering both the base case (200 $m^3$/day) and future case (300 $m^3$/day) discharge of PFW at a depth of 45 m below mean sea level.

**Table 1-1 Location of the Yolla Platform used as the release site for the PFW dispersion modelling assessment.**

| Release Site | Latitude (S) | Longitude (E) | Water Depth (m) |
|---|---|---|---|
| Yolla Platform | 39° 50’ 39.5” | 145° 49’ 5.9” | 80 |

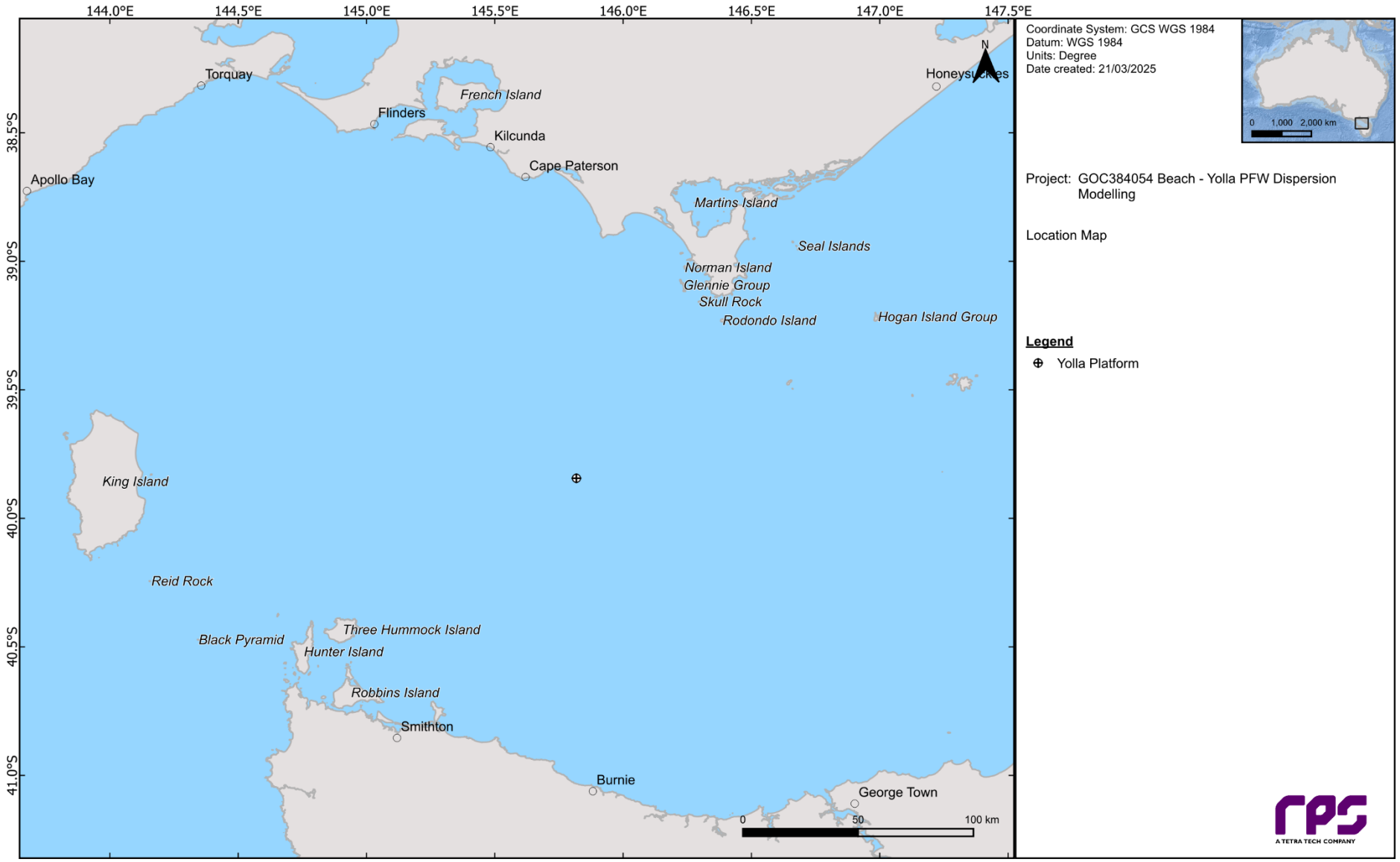


**Figure 1-1 Location of the Yolla Platform.**

# 2 SCOPE OF WORK

The physical mixing and dilution of PFW with receiving waters occur through a series of processes. Initial mixing is generated during what is referred to as the “near-field” mixing zone, which occurs within metres of the discharge and within seconds to minutes. The near-field mixing is strongly affected by characteristics of the discharge configuration. Initial mixing is generated by turbulence generated as the discharge, ejected vertically and downwards, plunges due to momentum. As the plume descends, momentum will be lost due to the energy required to displace receiving water. If there is a lateral current, the centreline of the plume will bend in the direction of the current flow. Once downward momentum is lost, the fate of the plume will depend upon the plume density. If the plume remains buoyant relative to receiving water (i.e. warmer and/or at lower salinity than the receiving water), the plume will rise, undergoing further mixing by entrainment of ambient water, until either neutral density is reached or the plume collapses into a layer below the water surface. At this point, the plume is considered to enter the far-field mixing zone, where subsequent mixing is generated by water currents and turbulence in the water column.

The following scope of work was completed to assess dilution through near-field and far-field dilution phases:

- Collation of three-dimensional, spatially varying, current data for the waters surrounding the release location. Data spanning ten-years (2010-2019) was compiled by combining a hindcast from an ocean circulation model (HYCOM) with a high-resolution tidal model (HYDROMAP). The current dataset included the combined influence of drift and tidal currents and was suitably long as to be indicative of interannual variability in ocean currents.

- Derivation of statistical distributions for the current speed and directions for use in the near-field modelling. Analyses included percentile distributions and development of current roses. This analysis was important to ensure that current data samples applied in the dispersion model were statistically representative.

- Collation of vertical water density profiles at the Yolla Platform location for use as input to the dispersion models.

- Near-field modelling conducted for each unique discharge to assess the initial mixing of the discharge due to turbulence and subsequent entrainment of ambient water. This modelling was conducted at high spatial and temporal resolution (scales of metres and seconds, respectively).

- Outcomes from the near-field modelling included estimates of the width, shape and orientation of the plumes, and resulting contaminant concentrations and dilutions, for each discharge at a range of incident current speeds.

- Establishment of a far-field dispersion model to calculate dispersive mixing and dilution under currents and turbulence.

- Calculations for the transport and dispersive mixing of the remnant plume (remaining beyond the near-field zone) under a wide range of local current conditions by stochastic modelling (i.e. repeated simulations with each simulation using a unique time-sequence of current flow, chosen at random from the 10-year time series of current data).

- Analysis and mapping of areas that might be exposed to different levels of dilution.

# 3 DESCALING ACTIVITIES DISCHARGE IMPACT

Descaling involves the use of a chemical for the removal of scale deposits that accumulate in the wellbore and production equipment and pipelines due to the high mineral content of the PFW. Whilst the flowback of descaling activities is an isolated non-continuous discharge, contrasting with the PFW discharge, its impact on the surrounding waters was initially assessed through in-situ measurements taken at the PFW outlet. Even though the descaling chemical is not a hydrocarbon, it has a fluorescence which triggers the oil in water (OIW) instrumentation.

Measurements taken during activities conducted in November 2024 revealed changes in both density and OIW measurements, which were validated by samples of the stream. Density and OIW time-series showed a peak occurring immediately after the discharge, followed by a decay back to baseline readings approximately 13 hours later. WET tests performed to the samples collected in the same period also align with the peak OIW and density in-situ measurements. The density and OIW time-series are depicted in Figure 3-1.

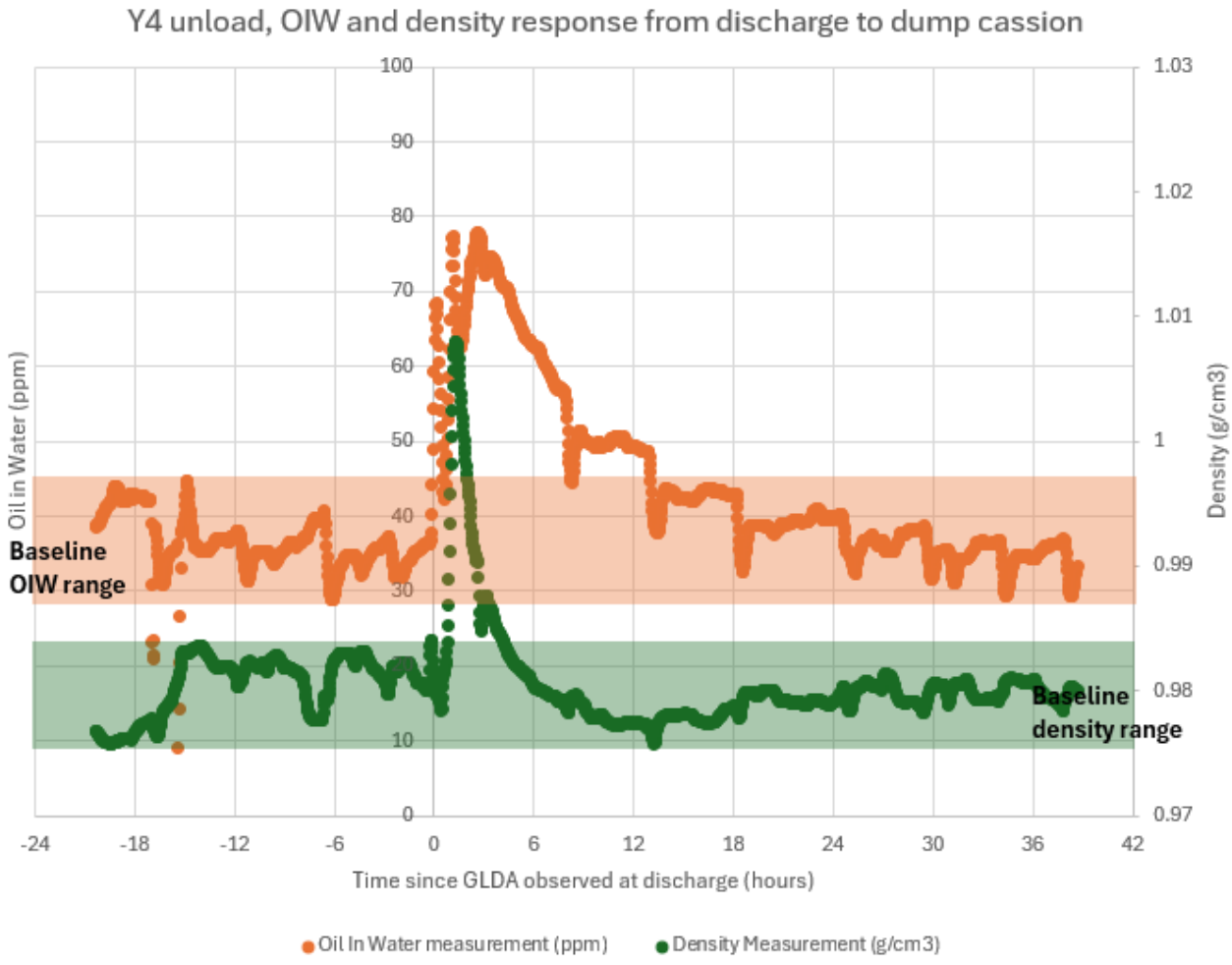


**Figure 3-1 Time-series of density and oil in water measurements taken in the PFW outlet during normal and descaling activities. Image provided by Beach.**

# 4 MODELLING METHODOLOGY

## 4.1 Near-Field Modelling

### 4.1.1 Overview

Numerical modelling was applied to quantify the area of influence of PFW discharges, in terms of the distribution of the minimum dilutions that might occur with distance from the source given defined discharge configurations, source concentrations, and the range of metocean conditions that affect the discharge location.

The dispersion of the PFW discharge will depend, initially, on the geometry and hydrodynamics of the discharges themselves, where the induced momentum and buoyancy effects dominate over background processes. This region is generally referred to as the near-field zone and is characterised by variations over short time and space scales. As the discharges mix with the ambient waters, the momentum and buoyancy signatures are eroded, and the background – or ambient – processes become dominant.

The shape and orientation of the discharged water plumes, and hence the distribution and dilution rate of the plume, will vary significantly with natural variation in prevailing water currents. Therefore, to best calculate the likely outcomes of the discharges, it is necessary to simulate discharge under a range of current speeds statistically representative of the Yolla Platform location.

### 4.1.2 Description of Near-Field Model: CORMIX

The near-field mixing and dispersion of the outfall was simulated using the three-dimensional flow model, CORMIX. CORMIX is a mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones. CORMIX contains a series of elements for the analysis and design of single or multi-port discharges. Discharges may be submerged or above surface, buoyant or denser than receiving water and the receiving water may be stratified or unstratified. The emphasis of the model is the influence of the geometry and dilution characteristics on the initial mixing zone (Doneker and Jirka, 1990; Jirka et al., 1991). CORMIX is widely applied worldwide and has been validated in many independent studies (http://www.cormix.info/validations.php).

CORMIX is a collection of analytic solutions to simplified forms of the mathematical equations describing transport and dispersion of water borne constituents. The simplifications come about through a range of assumptions about the source configuration, source characteristics (discharge and buoyancy) and the ambient environment. These assumptions effectively limit the domain within which the analytic solutions apply. For the typical outfall source flow, two main zones can be defined as described in Table 4-1.

Although CORMIX does calculate far-field dispersion, the assumptions of the algorithms limit application to homogeneous environments with no eddies in the ambient flow and little recirculation. For this reason, the CORMIX component of the calculations for this study were limited to the near-field zone.

**Table 4-1 CORMIX mixing zones.**

| Zone | Description |
|---|---|
| Near-field | Jet characteristics, momentum flux, buoyancy flux and outfall geometry influence the plume's trajectory and mixing. |
| Far-field | Ambient conditions control the plume's trajectory and dilution due to density current buoyant spreading and ambient turbulence. |

CORMIX specifies the average dilution or bulk dilution (flux averaged) as 1.7 times the centreline dilution. The centreline is defined by the points of maximum concentration (maximum temperature, minimum dilution etc) at each vertical section along the longitudinal axis. Accordingly, centreline depth is defined as the depth of the maximum concentration point (maximum temperature, minimum dilution) along the longitudinal axis.

Figure 4-1 shows a conceptual diagram of the dispersion and fates of a positively buoyant discharge and the idealised representation of the discharge phases.

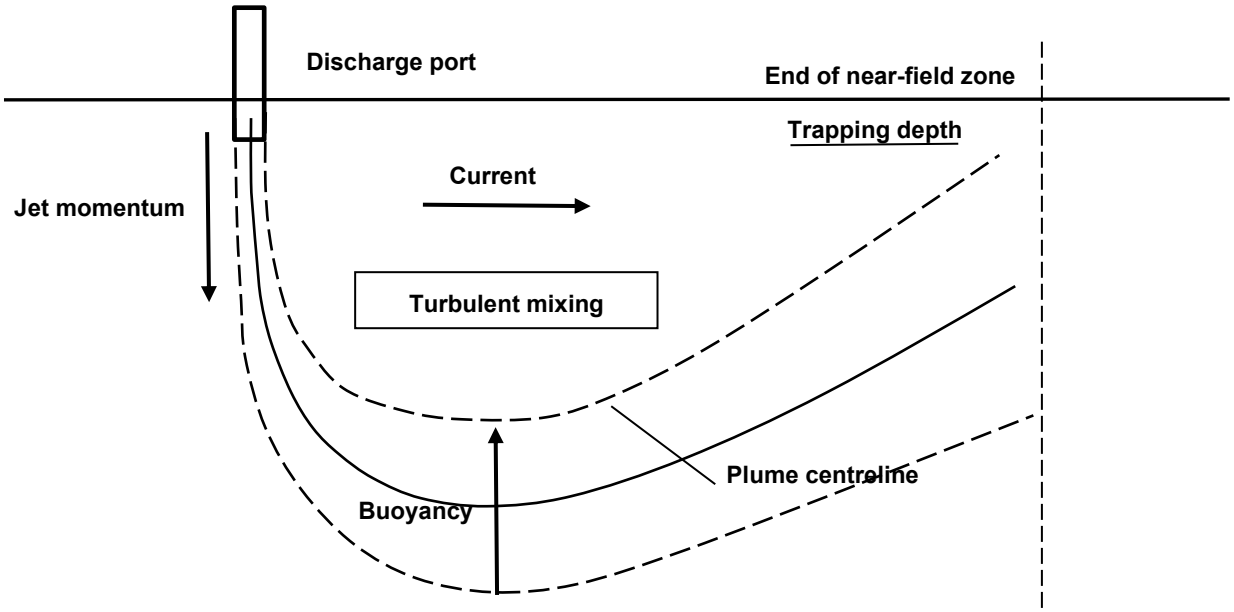


**Figure 4-1 Conceptual diagram showing the general behaviour of a positively buoyant discharge discharged vertically into receiving water moving due to current.**

### 4.1.3 Setup of Near-Field Model

#### 4.1.3.1 Discharge Characteristics

The PFW discharge characteristics for the discharge case are summarised in Table 4-2. The discharge is assumed to occur from the Yolla Platform at a discharge rate of either 200 $m^3$/day or 300 $m^3$/day. The PFW is discharged from a 0.73 m diameter pipe pointed vertically downwards and ending 45 m below the water surface. The discharge was assumed to have an average temperature and salinity of 15.3°C and 14.7 parts per thousand (ppt), respectively.

**Table 4-2 Summary of the PFW discharge characteristics.**

| Parameter | Base Case | Maximum Case |
|---|---|---|
| Flow rate ($m^3/d$) | 200 | 300 |
| Location | Yolla Platform | Yolla Platform |
| Duration (min) | Continuous | Continuous |
| Outlet pipe internal diameter (m) | 0.73 | 0.73 |
| Number of Ports | 1 | 1 |
| Outlet pipe orientation | Vertical (downwards) | Vertical (downwards) |
| Discharge Depth (m) | 45 (below MSL) | 45 (below MSL) |
| Discharge salinity (ppt) | 14.7 | 14.7 |
| Discharge temperature (°C) | 15.3 (average) | 15.3 (average) |

### 4.1.3.2 Ambient Environmental Conditions

Inputs of ambient environmental conditions to the CORMIX model included vertical profiles of temperature and salinity for winter (April to October) and summer (November to March) seasons, along with constant current speeds and general direction (per simulation). The temperature and salinity profiles are required to accurately account for the relative buoyancy of the diluting plume, while the current speeds control the intensity of initial mixing and the deflection of the PFW plume. These inputs are described in the following sections.

#### 4.1.3.2.1 Ambient Temperature and Salinity

Temperature and salinity data applied to the near-field modelling were sourced from the World Ocean Atlas 2018 (WOA18) database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration, NOAA) and its co-located World Data Center for Oceanography (Levitus *et al.*, 2013).

Figure 4-2 shows the vertical profiles of temperature and salinity for each month at Yolla Platform. Table 4-3 shows the average water temperature and salinity near surface and seabed at the Yolla Platform location for summer and winter.

**Table 4-3 Average seasonal temperature and salinity levels adjacent to the Yolla Platform location.**

| Season | Depth | Temperature (°C) | Salinity (PSU) |
|---|---|---|---|
| Summer | Near surface | 17.3 | 35.4 |
| | Near seabed | 15.8 | 35.3 |
| Winter | Near surface | 14.4 | 35.4 |
| | Near seabed | 14.4 | 35.4 |

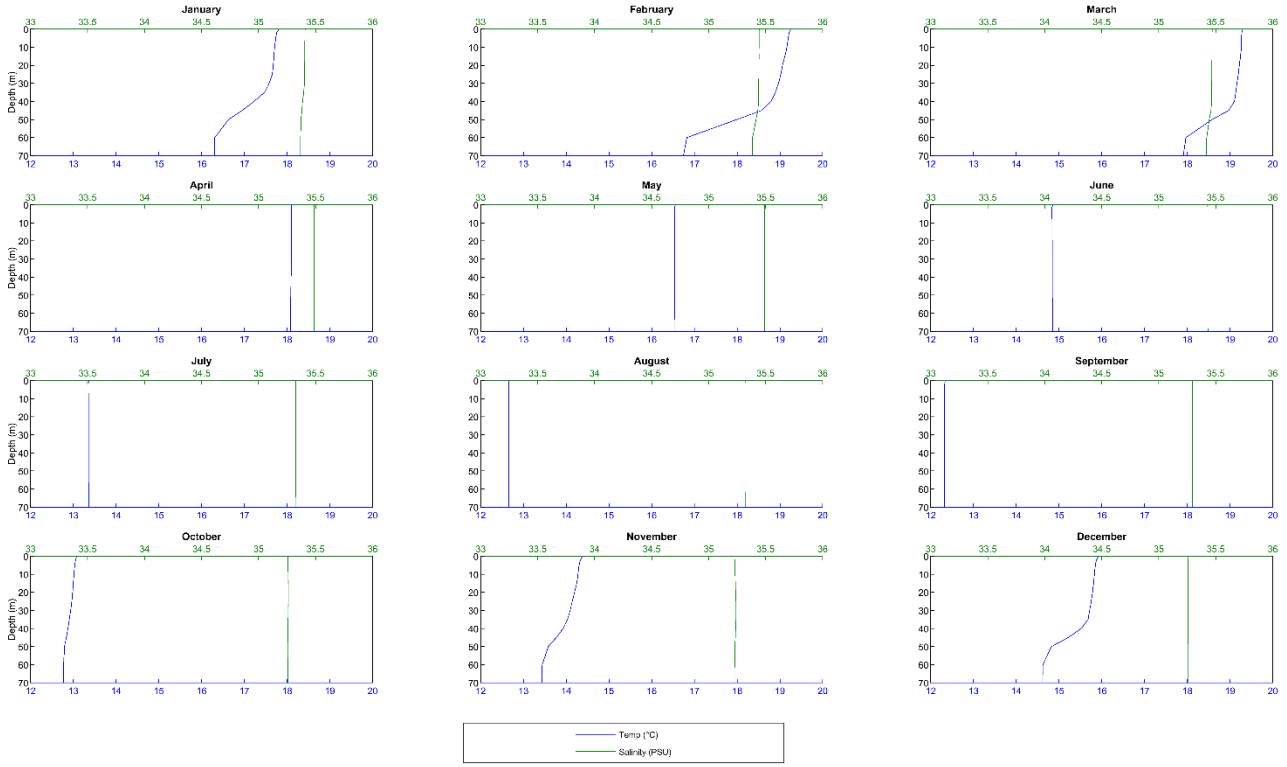


**Figure 4-2 Monthly salinity and temperature profiles at the Yolla Platform**

### 4.1.3.2.2 Ambient Current

Ocean current data was sourced from a ten-year hindcast data set of combined large-scale ocean (HYCOM) and tidal currents. The data was statistically analysed to determine the 5$^{th}$, 50$^{th}$ and 95$^{th}$ percentile current speeds. These statistical current speeds can be considered representative of annual conditions at the location as current speeds did not reveal to be substantially sensitive to seasonality.

Table 4-4 presents the annual steady-state, unidirectional, current speeds at varying depths used as input to the near-field model as forcing for each discharge case:

- 5$^{th}$ percentile current speed: weak currents, low dilution and slow advection.
- 50$^{th}$ percentile (median) current speed: average currents, moderate dilution and advection.
- 95$^{th}$ percentile current speed: strong currents, high dilution and rapid advection to nearby areas.

The 5$^{th}$, 50$^{th}$ and 95$^{th}$ percentile values are referenced as weak, medium and strong current speeds, respectively.

**Table 4-4 Adopted ambient current conditions adjacent to the Yolla Platform location.**

| Season | 5$^{th}$ Percentile (Weak) Current Speed (m/s) | 50$^{th}$ Percentile (Medium) Current Speed (m/s) | 95$^{th}$ Percentile (Strong) Current Speed (m/s) |
|---|---|---|---|
| Annual | 0.04 | 0.17 | 0.42 |

## 4.2 Far-Field Modelling

### 4.2.1 Overview

The far-field modelling expands on the near-field work by allowing the time-varying nature of currents to be included, with the potential for localised build-up when current speeds are low (e.g. at the turning of the tide) and recirculation of the plume back to the discharge location might occur. In this case, concentrations near the discharge point can be increased due to the discharge plume mixing with the remnant plume from an earlier time. This may be a potential source of episodic increases in pollutant concentrations in the receiving waters.

### 4.2.2 Description of Far-Field Model: MUDMAP

The mixing and dispersion of the produced formation water discharges beyond the near-field zone was predicted using the three-dimensional discharge and plume behaviour model, MUDMAP (Koh & Chang, 1973; Khondaker, 2000). MUDMAP predicts the transport and passive dispersion of the discharged material due to the local currents and dispersive forces in the water column. Dispersion of the discharged material will be enhanced with increased current speeds, greater variation in current direction over time and increased wave energy.

The passive dispersion stage employs a particle-based, random walk, procedure. Constituents within the discharge stream are represented by a sample of Lagrangian particles. These particles are moved in three dimensions over each subsequent time step according to the prevailing local current data as well as horizontal and vertical mixing coefficients. Seabed deposition patterns are calculated for particulate sinking material, with sinking rates varying by particle size.

MUDMAP treats the Lagrangian particles as conservative tracers (i.e. they are not removed over time to account for chemical interactions, decay or precipitation). Predicted concentrations will therefore be conservative overestimates where these processes do occur. Each particle represents a proportion of the discharge, by mass, and particles are released at a given rate to represent the rate of the discharge (mass per unit time). Concentrations of constituents are predicted over time by counting the number of particles that occur within a given depth level and grid square and converting this value to mass per unit volume.

The system has been extensively validated and applied for discharge operations in Australian waters for other PFW discharges (e.g. Burns et al., 1999; King & McAllister, 1997, 1998).

### 4.2.3 Stochastic Modelling

A stochastic modelling procedure was applied in the far-field modelling to sample a representative set of conditions that could affect the distribution of constituents. This approach involves 100 simulations of a given discharge, with each simulation representing discharge for 5 days under a different, randomly selected, sequence of current speed and direction data. These sequences were selected at random from the 10-year database of current data for the site. The initial dilution and shape of the discharge was set by the results of the near-field results described in Section 4.1. This methodology ensures that the calculated movement and fate of each discharge is representative of the passive dispersive forces for the range of prevailing currents that occur at the discharge location. Assumed PFW characteristics are summarised in Table 4-5.

Once the stochastic modelling was complete, all simulations were statistically analysed to map distributions of possible outcomes based on likelihood. The stochastic simulations were jointly processed annually (100 replicate simulations). The analysis calculated the frequency of occurrence of a given dilution level, by horizontal location, at surrounding locations. Results were summarised for the 95$^{th}$ percentile dilution over time.

The 95$^{th}$ percentile dilution values do not represent the instantaneous spatial extent of the plume at any single point in time. Instead, they provide a spatially aggregated statistical summary across all model simulations. Specifically, the 95$^{th}$ percentile dilution map shows the minimum dilution level that is met or exceeded 95% of the time during the simulations. In other words, dilution is lower than the mapped values for only 5% of the simulation periods.

This percentile-based approach is particularly relevant for environmental impact assessments. Instantaneous worst-case dilution values can be misleading, as they capture only brief (i.e. less than 1 hr), potentially rare events that are not representative of sustained environmental conditions. Since ecotoxicological studies—such as those used to establish safe concentration thresholds—are based on time-averaged exposure scenarios, a

percentile-based metric like the 95th percentile provides a more meaningful and conservative estimate of potential environmental harm. It aligns more closely with chronic exposure levels rather than transient extremes, making it more suitable for regulatory comparison and ecological risk evaluation.

### 4.2.4 Setup of Far-Field Model

#### 4.2.4.1 Discharge Characteristics

The MUDMAP model simulated the discharge into a time-varying current field with the initial dilution and shape of the discharge set by the near-field results described in Section 4.1. The PFW discharge scenario was modelled as a continuous discharge under time-varying current assuming the initial dilution and density change imposed by the near-field mixing (detailed in Section 5.1).

Table 4-5 presents a summary of the far-field model inputs used to calculate the transport and mixing of the chemical treatment by the ambient currents. As previously mentioned, 100 simulations were run as a representation on annual conditions and each simulation had a different start time, which ensured a range of current conditions were sampled.

**Table 4-5 Summary of PFW discharge modelling assumed for far-field modelling.**

| Parameter | Base Case | Future Case |
|---|---|---|
| Hindcast modelling period | 2010-2019 | 2010-2019 |
| Seasons | Annual | Annual |
| Flow rate ($m^3/d$) | 200 | 300 |
| Initial depth of centreline (m) | 45 | 45 |
| Number of simulations | 100 | 100 |
| Simulated discharge type | Continuous | Continuous |
| Simulated discharge period (days) | 5 | 5 |

#### 4.2.4.2 Mixing Parameters

Horizontal and vertical dispersion coefficients in dispersion modelling represent turbulence-driven mixing and diffusion, which occur at sub-grid scales relative to the model's hydrodynamics. These coefficients, expressed in m²/s, govern the rate of area change per second. Increasing the horizontal dispersion coefficient enhances lateral plume spread, reducing centreline concentrations, while increasing the vertical coefficient accelerates downward mixing into the water column.

Horizontal turbulent diffusion depends on metocean conditions (wind, waves and currents) and the plume's scale relative to oceanic dispersion processes. For plumes 10–100 m wide, small-scale swirling motions and vertical mixing dominate, with horizontal dispersion rates near 0.1 m²/s. As the plume's width expands to 1–10 km, mesoscale eddies drive dispersion rates of a few to tens of m²/s. At scales exceeding mesoscale eddies, eddy mixing dominates with dispersion rates of 100–1,000 m²/s.

A spatially uniform and conservative dispersion coefficient of 0.2 m²/s (horizontal) and 0.0001 m²/s (vertical) was applied to control produced water plume spreading. These values were selected through extensive sensitivity testing, ensuring conservative concentration estimates, as in-situ mixing under average and high-energy conditions is expected to be at least an order of magnitude greater (King & McAllister, 1997, 1998).

#### 4.2.4.3 Grid Configuration

MUDMAP uses a three-dimensional grid to represent the geographic region under study (water depth and bathymetric profiles). The model was setup, and analysed and mapped on two grid scales, representing the aqueous and particulates components, respectively. Due to the rapid mixing and small-scale effect of the effluent discharge, it was necessary to use a fine grid with a resolution of 5 m x 5 m to track the movement and fate of the aqueous PFW discharge plume. The extent of the grid region measured approximately 5 km (longitude or x-axis) by 5 km (latitude or y-axis), which was subdivided horizontally into approximately 1,000 x 1,000 cells. The vertical resolution was set to 5 m.

### 4.2.5 Regional Ocean Currents

#### 4.2.5.1 Background

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area off the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the strait are driven by tides, winds, incident continental shelf waves and density driven flows. High winds and strong tidal currents are frequent within the area (Jones, 1980).

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 4-3 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with surface tidal currents developed by RPS. The following sections provide a summary of the hybrid regional data set.

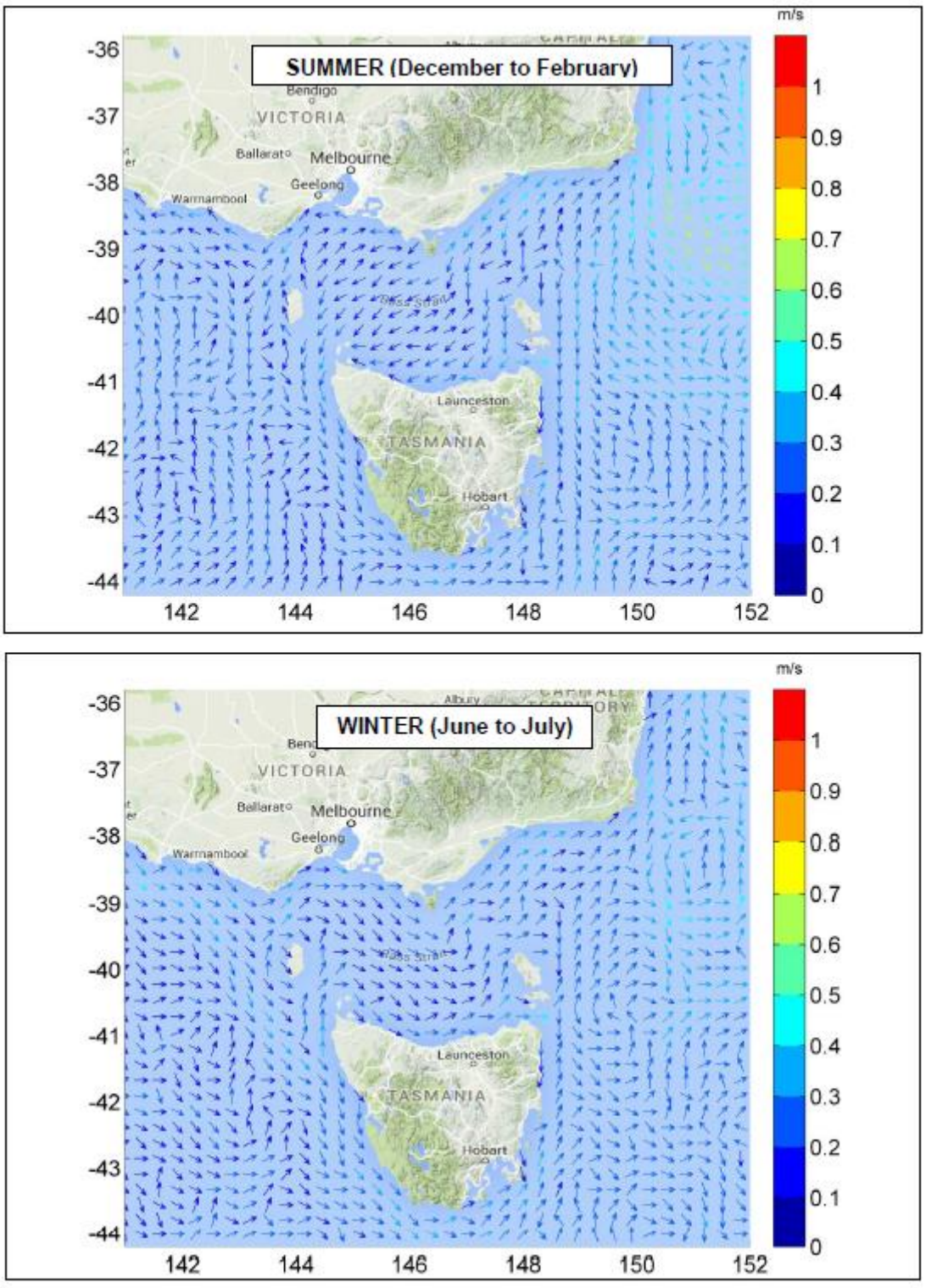


**Figure 4-3 Example HYCOM averaged seasonal surface drift currents during summer (top) and winter (bottom).**

### 4.2.5.1 Tidal Currents

Tidal current data were generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world over the past 38 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data have been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

### 4.2.5.2 Grid Setup

The tidal model domain has been sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids were allocated in a step-wise fashion to resolve flows more accurately along the coastline, around islands and over regions with more complex bathymetry. Figure 4-4 shows the tidal model grid resolutions.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 4-5). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

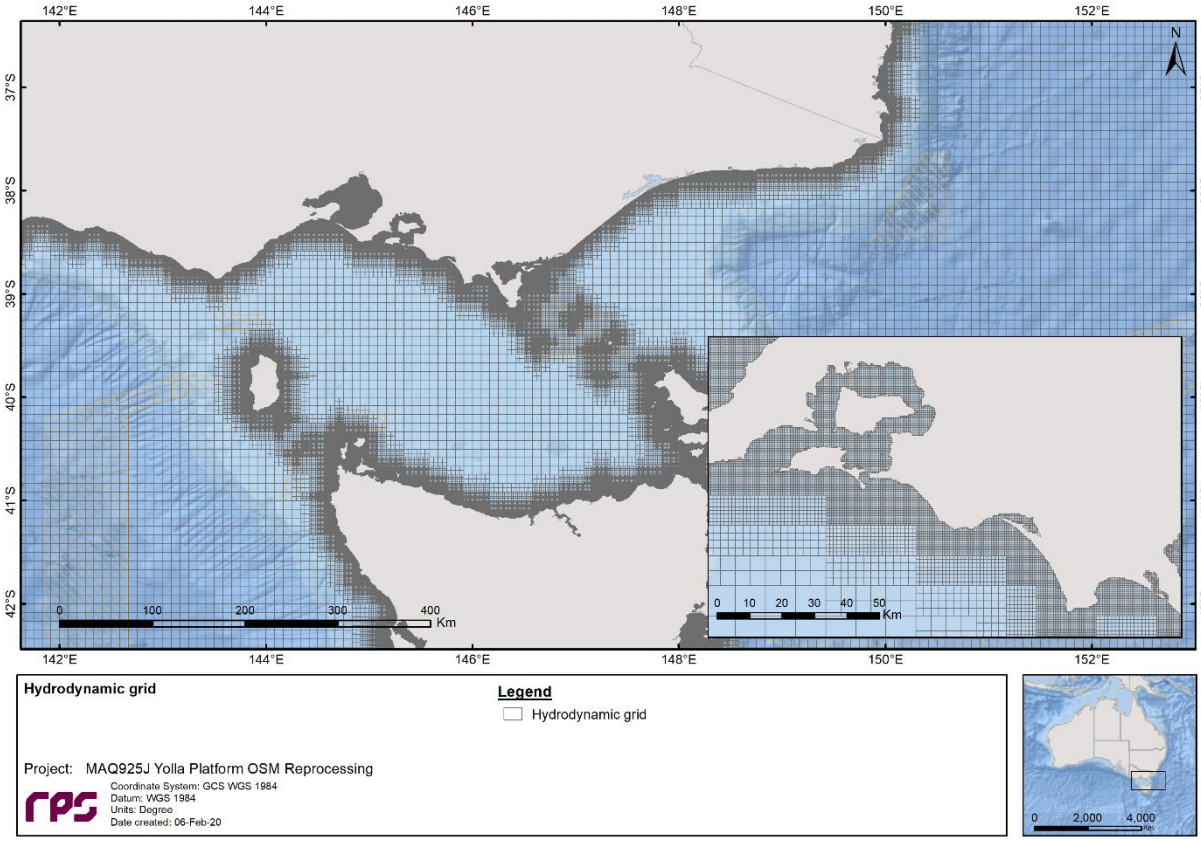


**Figure 4-4 Zoomed in view of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.**

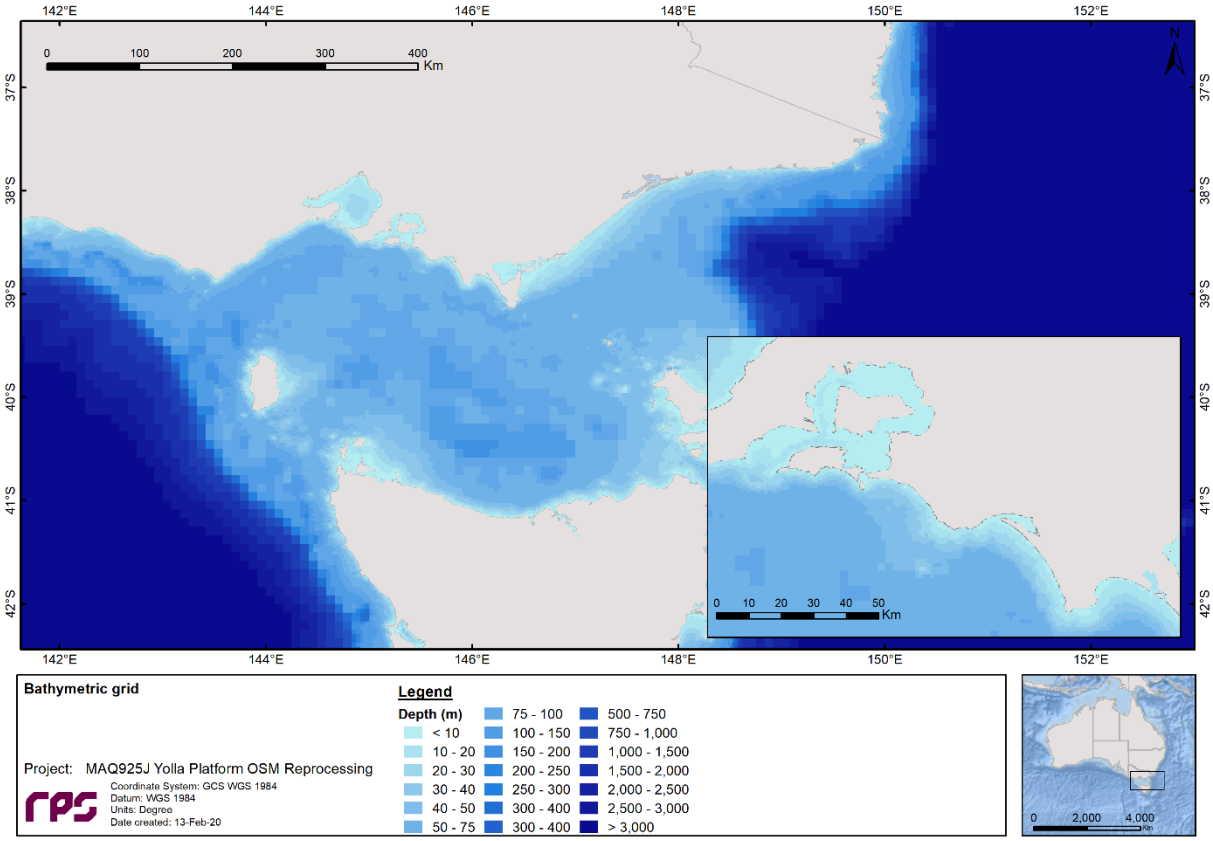


**Figure 4-5 Bathymetry defined throughout the tidal model domain.**

### 4.2.5.3 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 7.2) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were $K_2$, $S_2$, $M_2$, $N_2$, $K_1$, $P_1$, $O_1$ and $Q_1$. Using the tidal data, surface heights were firstly calculated along the open boundaries, at each time step in the model.

The TOPEX/Poseidon satellite data have a global resolution of 0.25 degrees and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The satellites equipped with two highly accurate altimeters and capable of taking sea level measurements with an accuracy of ± 5 cm measured oceanic surface elevations (and the resultant tides) for over 13 years (1992–2005). In total, these satellites carried out 62,000 orbits of the planet.

The TOPEX/Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk and Tangdong, 2004; Qiu and Chen 2010). As such the TOPEX/Poseidon tidal data is considered suitably accurate for this study.

### 4.2.5.4 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the National Ocean Partnership Program (NOPP), as part of the U.S. Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12$^{th}$ of a degree) over the region, at a frequency of every 3 hours. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

For this study, the HYCOM hindcast currents were obtained for the years 2010 to 2019 (inclusive).

Note the convention for defining current direction throughout this report is the direction the current flows towards. Each branch of the current rose distribution represents the currents flowing to that direction, with north to the top of the diagram. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.1 m/s are typically used in these current roses. The length of each coloured segment within a branch is proportional to the frequency of currents flowing within the corresponding speed and direction.

### 4.2.5.5 Surface Currents

Table 4-6 presents the predicted average and maximum monthly surface current speeds at the release location.

Current speeds near the Yolla Platform varied throughout the year with monthly maximum current speeds ranging between 0.61 m/s (January) and 0.98 m/s (July). The dominant surface current directions throughout the year were identified as (towards) the east and east-southeast.

Figure 4-6 and Figure 4-7 present the monthly and total current rose distributions, respectively.

**Table 4-6 Predicted monthly average and maximum surface current speeds close to the release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2010-2019.**

| Month | Average current speed (m/s) | Maximum current speed (m/s) | General direction (towards) |
|---|---|---|---|
| January | 0.18 | 0.61 | Varied |
| February | 0.18 | 0.65 | East-west axis |
| March | 0.17 | 0.75 | East |
| April | 0.17 | 0.75 | East-southeast |
| May | 0.20 | 0.96 | East |
| June | 0.19 | 0.80 | East-southeast |
| July | 0.23 | 0.98 | East-southeast |
| August | 0.21 | 0.91 | East |
| September | 0.20 | 0.78 | East |
| October | 0.18 | 0.70 | East |
| November | 0.18 | 0.67 | East-northeast |
| December | 0.19 | 0.63 | East-northeast |
| **Minimum** | **0.17** | **0.61** | - |
| **Maximum** | **0.23** | **0.98** | - |

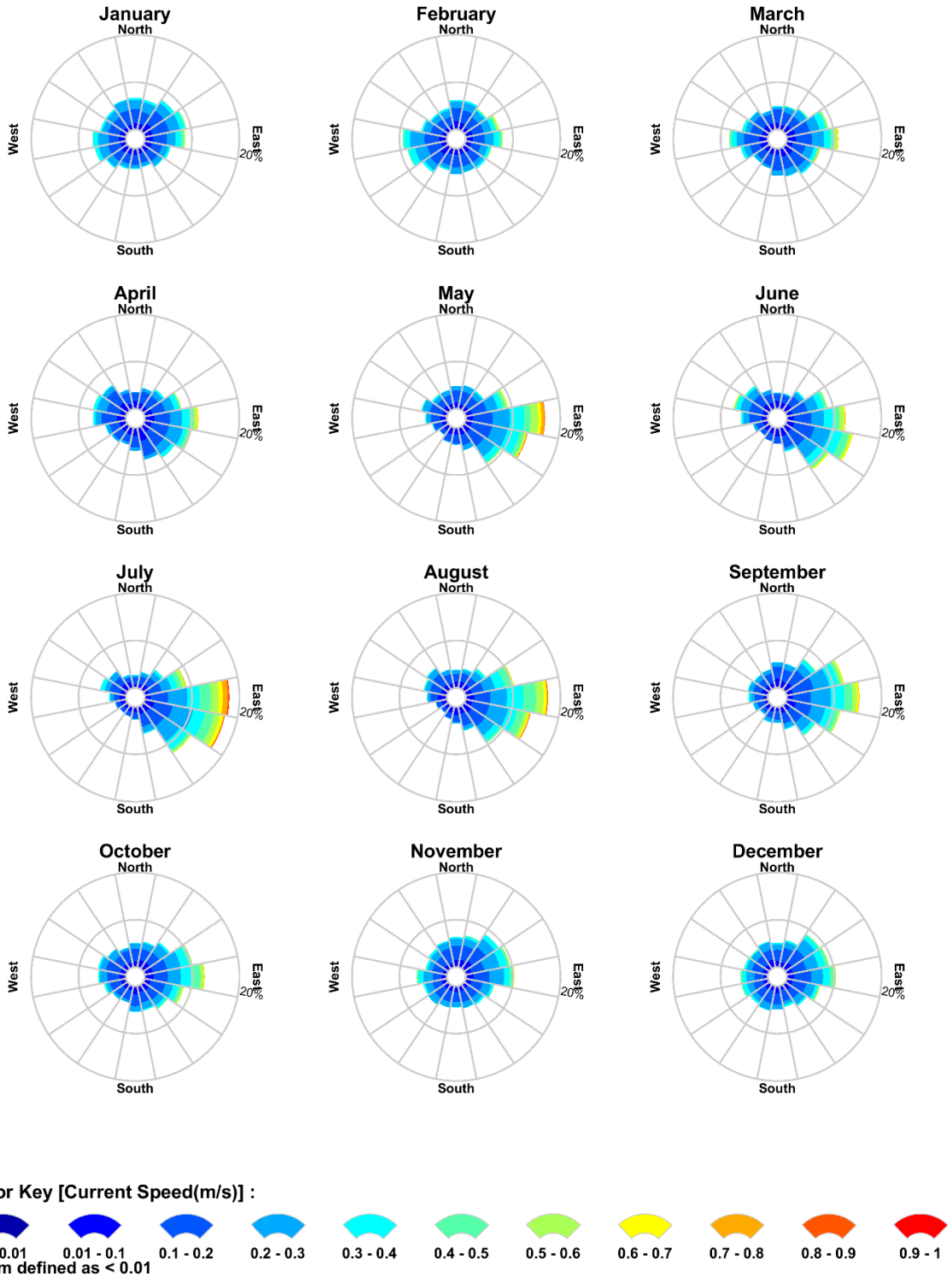


**Figure 4-6 Monthly surface current rose distributions at the release location derived from the 2010 to 2019 modelled dataset.**

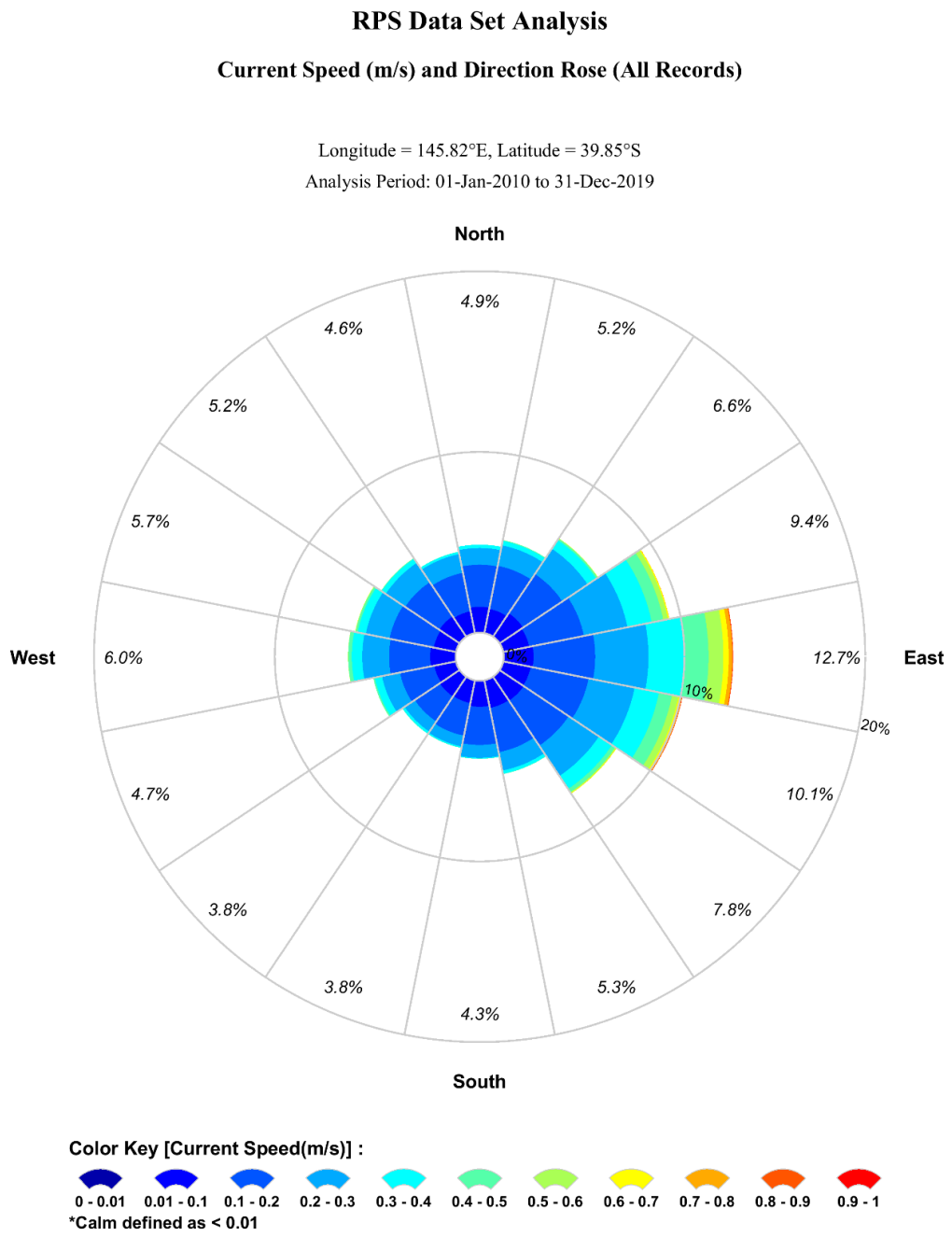


**Figure 4-7 Total surface current rose plot at the release location derived from the 2010 to 2019 modelled dataset.**

# 5 MODELLING RESULTS

## 5.1 Near-Field Modelling

### 5.1.1 Overview

Figure 5-1 to Figure 5-12show the change in minimum dilution of the plume under varying seasons and current speeds (weak, medium and strong). The figures show the predicted horizontal distance travelled by the plume before the trapping depth is reached (i.e. before the plume becomes neutrally buoyant). Please note the differing x-axis and y-axis aspect ratios between the cases to best highlight details for each case.

The plots show the general shape expected for the plume given the discharge characteristics and different current speeds. The downward directed jet is forecasted to briefly plunge and rapidly dilute due to the initial momentum of the discharge, then rise to the water surface.

The plots also show the expected bending of the plume to align with the current direction over the plunge and rise phase. Faster currents speeds are forecasted to result in the plume aligning to the current direction more quickly, commencing during the plunge phase and continuing during the buoyant rise phase.

Under strong currents, the distance where the lower dilution threshold of 526 was reached ranged from 55 m to 62 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 850 m to 1,230 m.

Under moderate currents, the distance where the lower dilution threshold of 526 was reached ranged from 27 m to 30 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 475 m to 1,400 m.

Under low currents, the distance where the lower dilution threshold of 526 was reached ranged from 11 m to 12 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 580 m to 1,600 m.

Table 5-1 and Table 5-2 summarise the distances from the release location for the threshold dilutions to be reached under high, medium and low currents for each season and flow case.

**Table 5-1 Distances from release location to reach threshold dilutions for the 200 $m^3$/day base case.**

| Current speed condition | Summer | | | | Winter | | | |
|---|---|---|---|---|---|---|---|---|
| | 526 dilutions | 1,961 dilutions | 7,143 dilutions | 19,608 dilutions | 526 dilutions | 1,961 dilutions | 7,143 dilutions | 19,608 dilutions |
| High | 55 | 161 | 400 | 1,230 | 55 | 145 | 400 | 900 |
| Medium | 28 | 83 | 400 | 1,100 | 27 | 73 | 198 | 475 |
| Low | 11 | 27 | 500 | 1,220 | 11 | 27 | 65 | 580 |

**Table 5-2 Distances from release location to reach threshold dilutions for the 300 $m^3$/day future case.**

| Current speed condition | Summer | | | | Winter | | | |
|---|---|---|---|---|---|---|---|---|
| | 526 dilutions | 1,961 dilutions | 7,143 dilutions | 19,608 dilutions | 526 dilutions | 1,961 dilutions | 7,143 dilutions | 19,608 dilutions |
| High | 62 | 182 | 410 | 850 | 58 | 162 | 446 | 1.030 |
| Medium | 30 | 95 | 560 | 1,400 | 29 | 80 | 220 | 503 |
| Low | 12 | 32 | 675 | 1,600 | 12 | 30 | 100 | 981 |

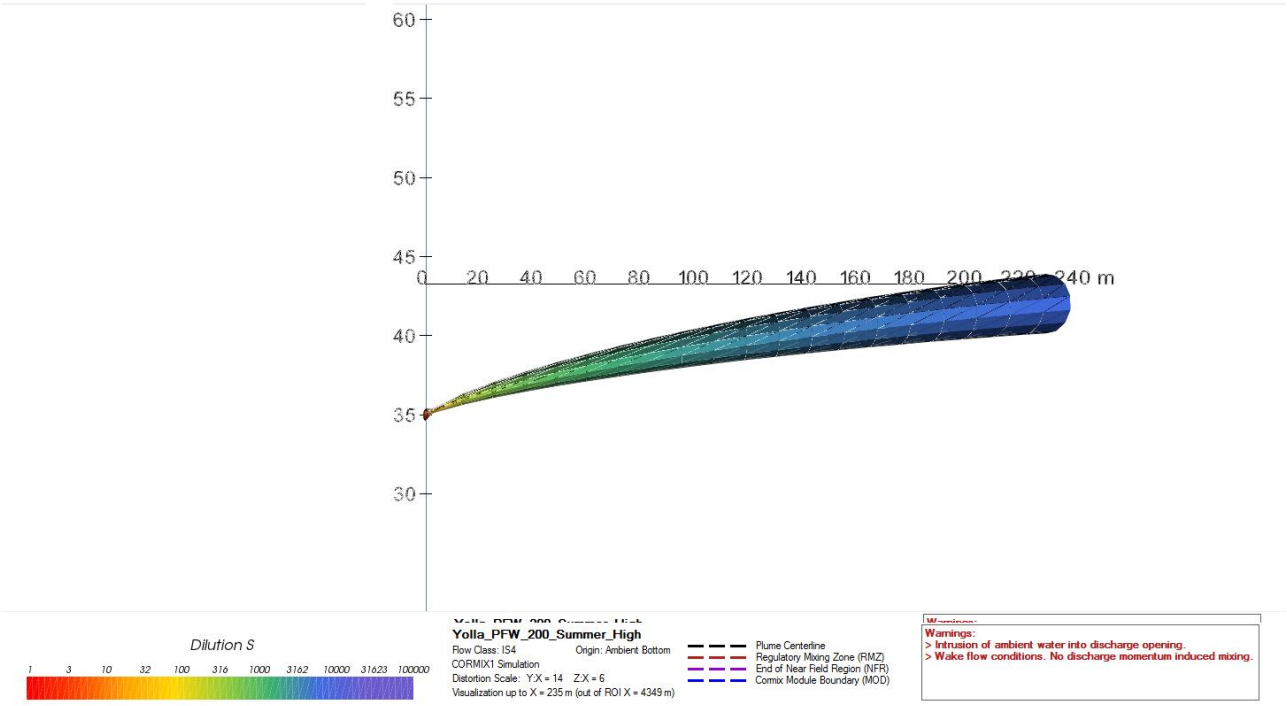


**Figure 5-1 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

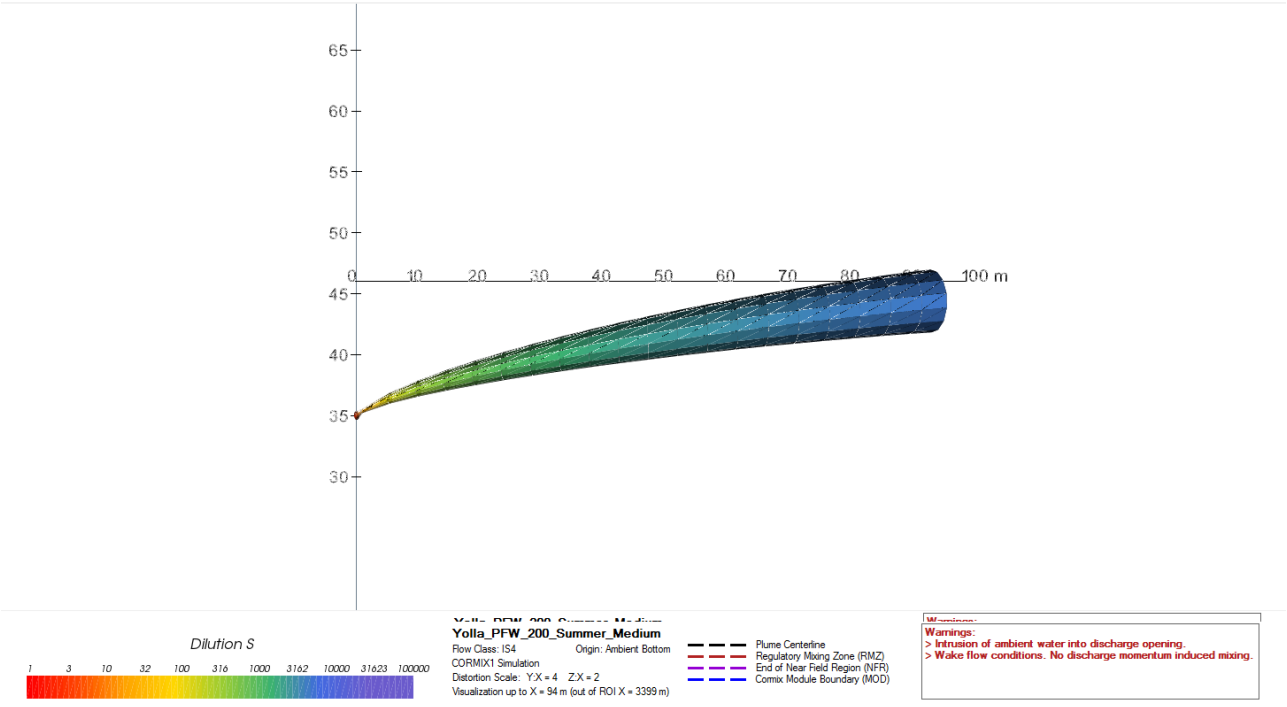


**Figure 5-2 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

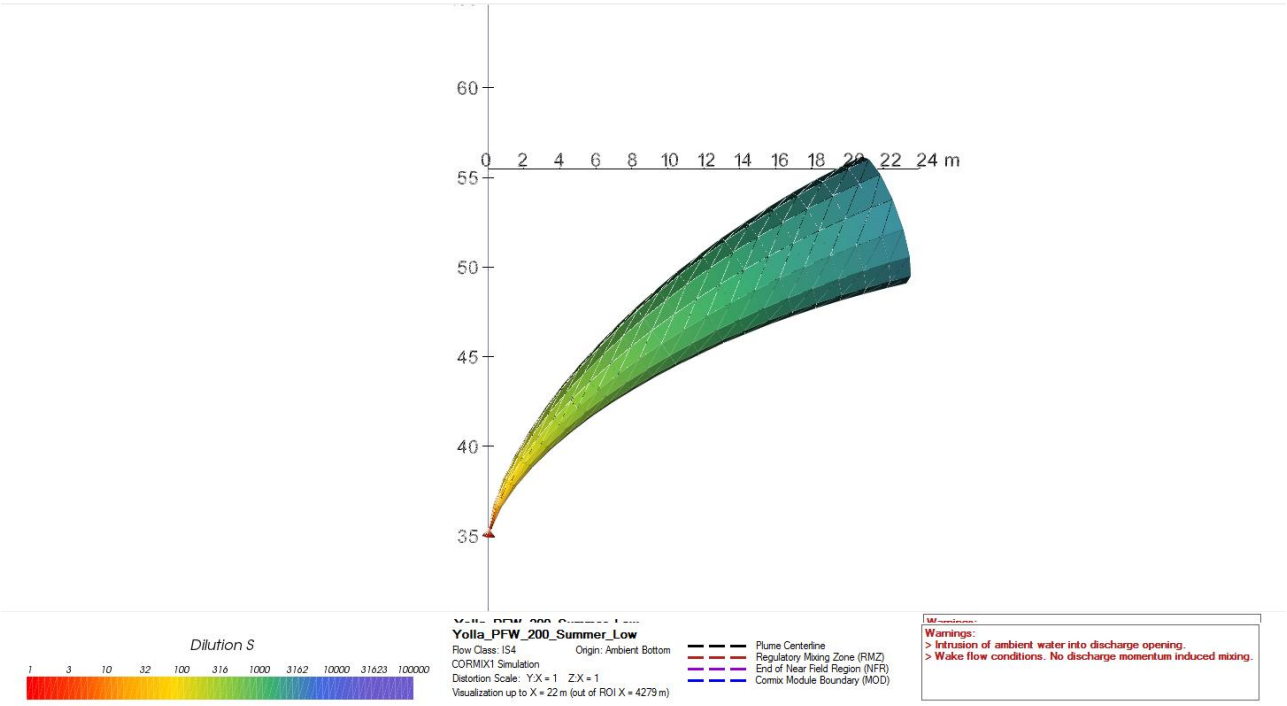


**Figure 5-3 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

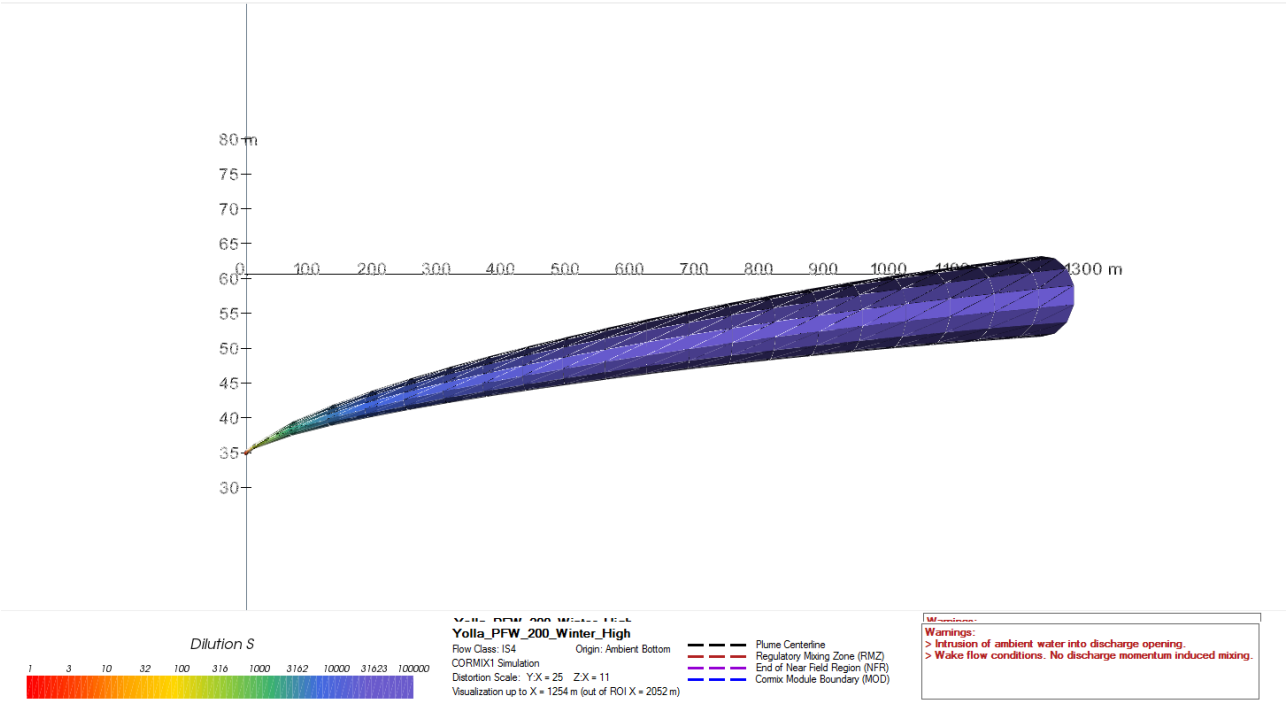


**Figure 5-4 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

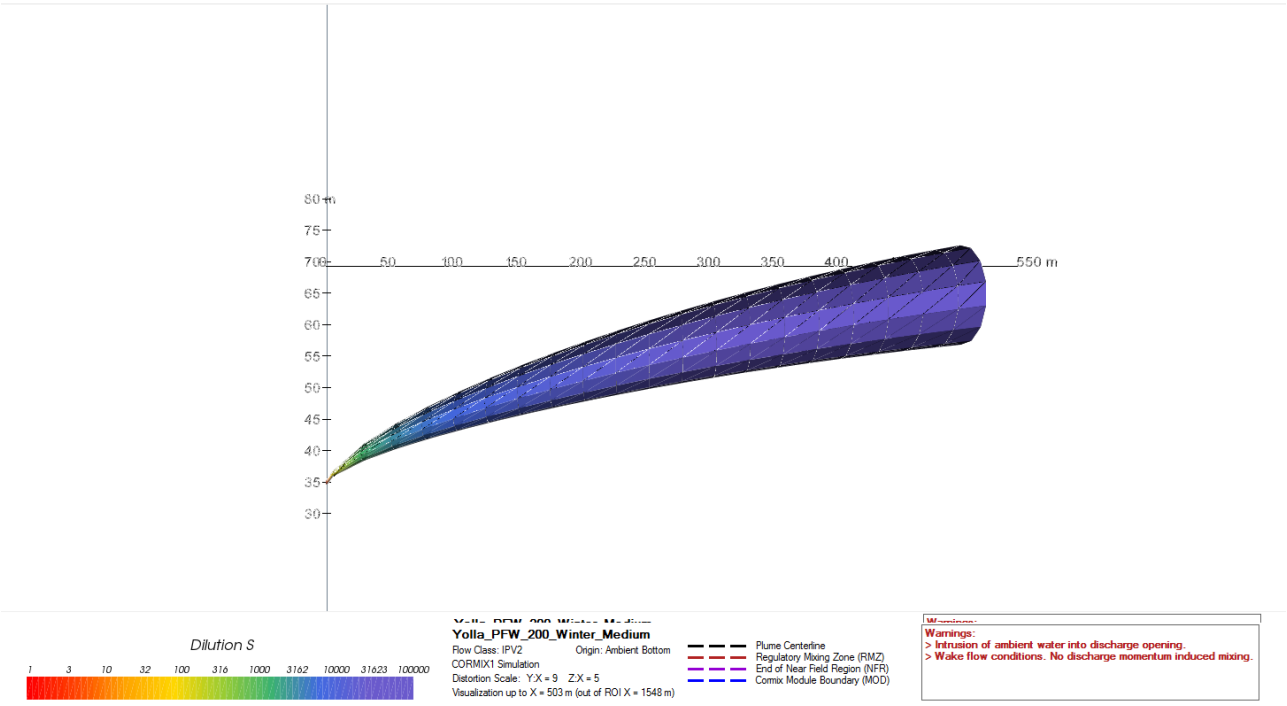


**Figure 5-5 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

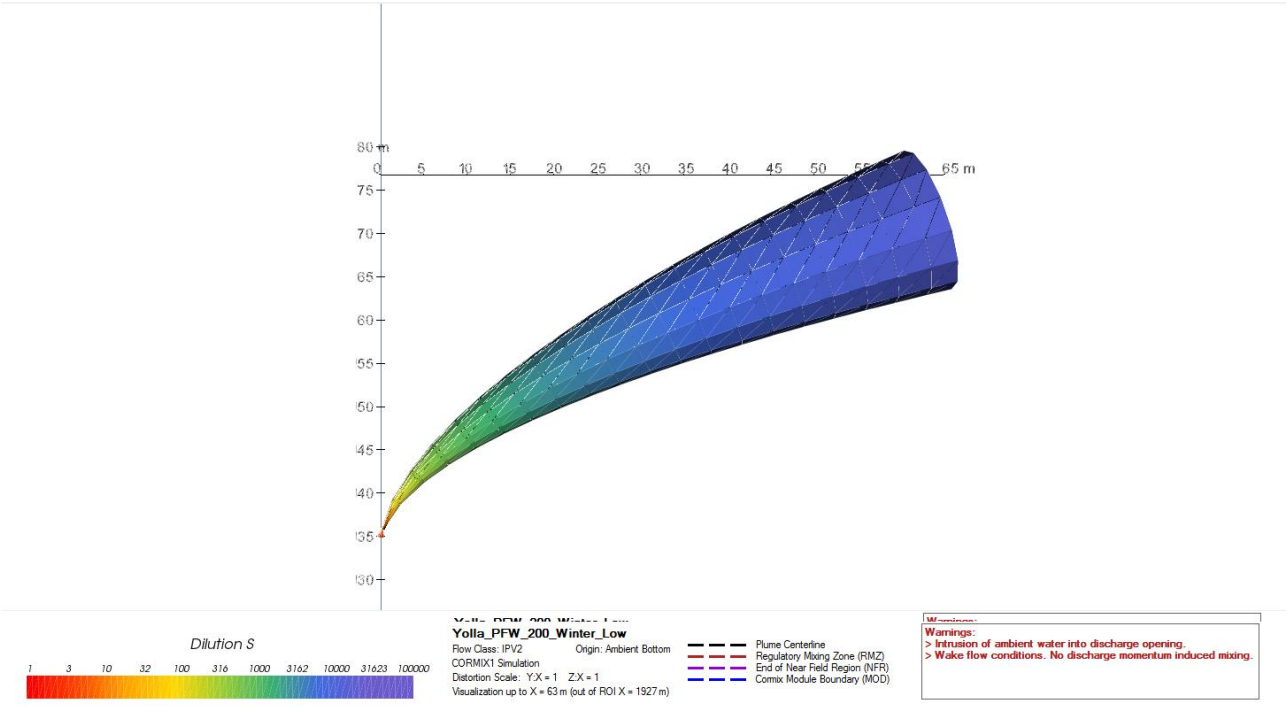


**Figure 5-6 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

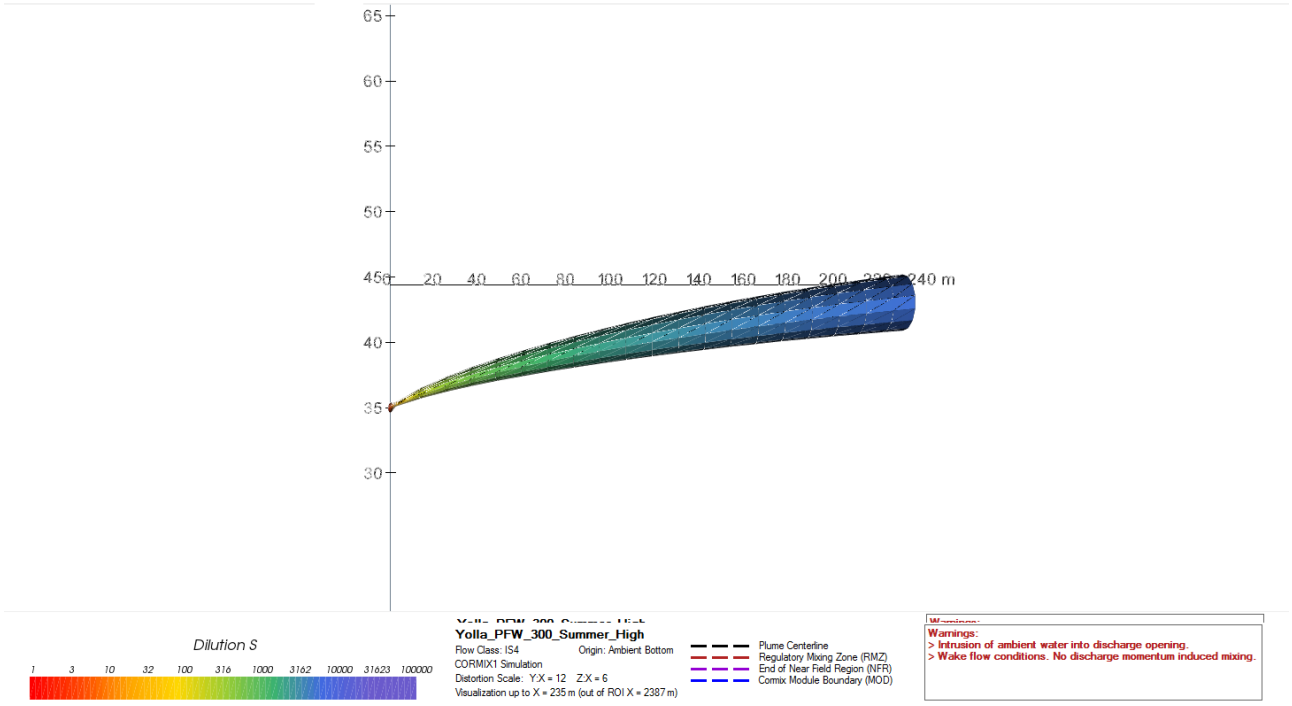


**Figure 5-7 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

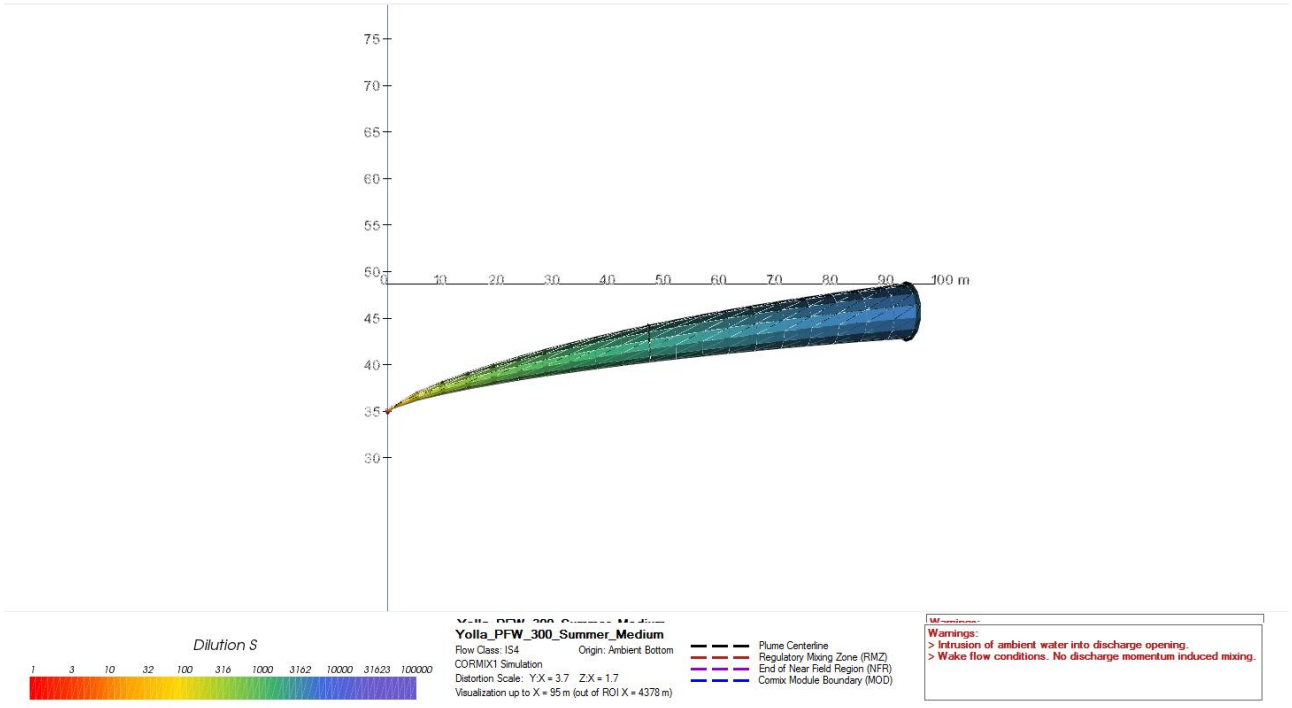


**Figure 5-8 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

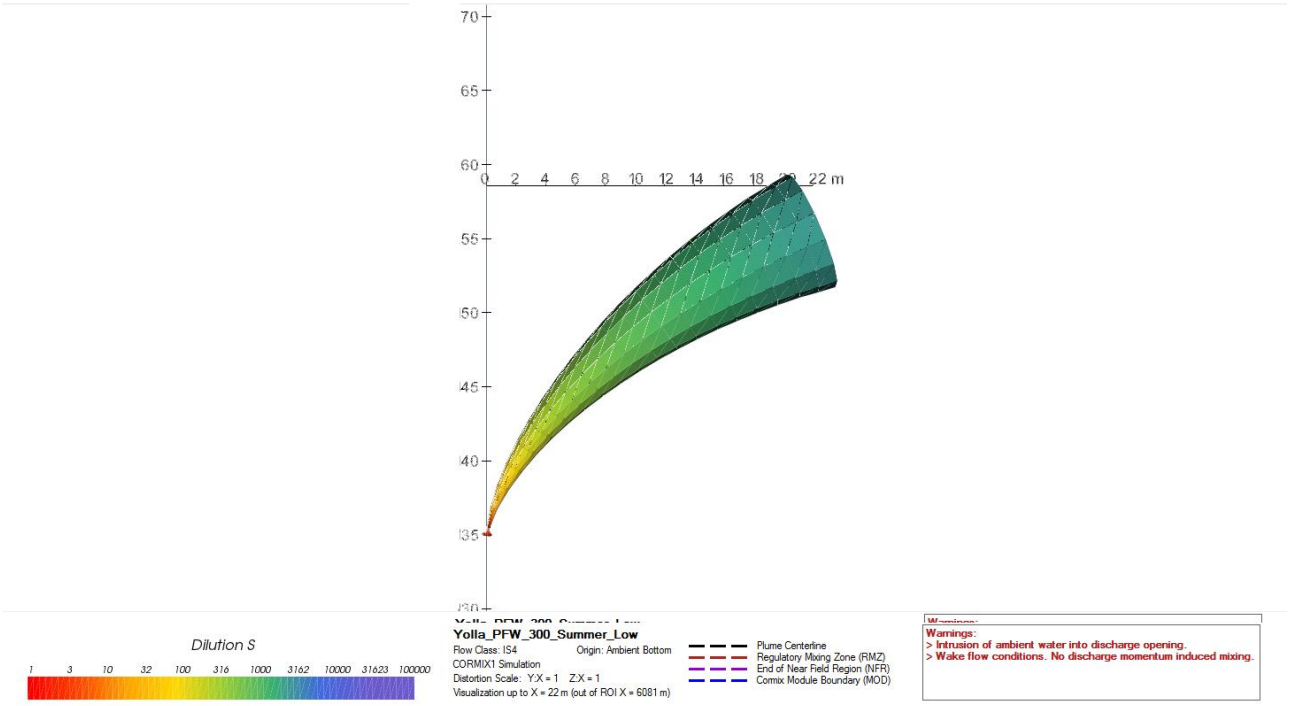


**Figure 5-9 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

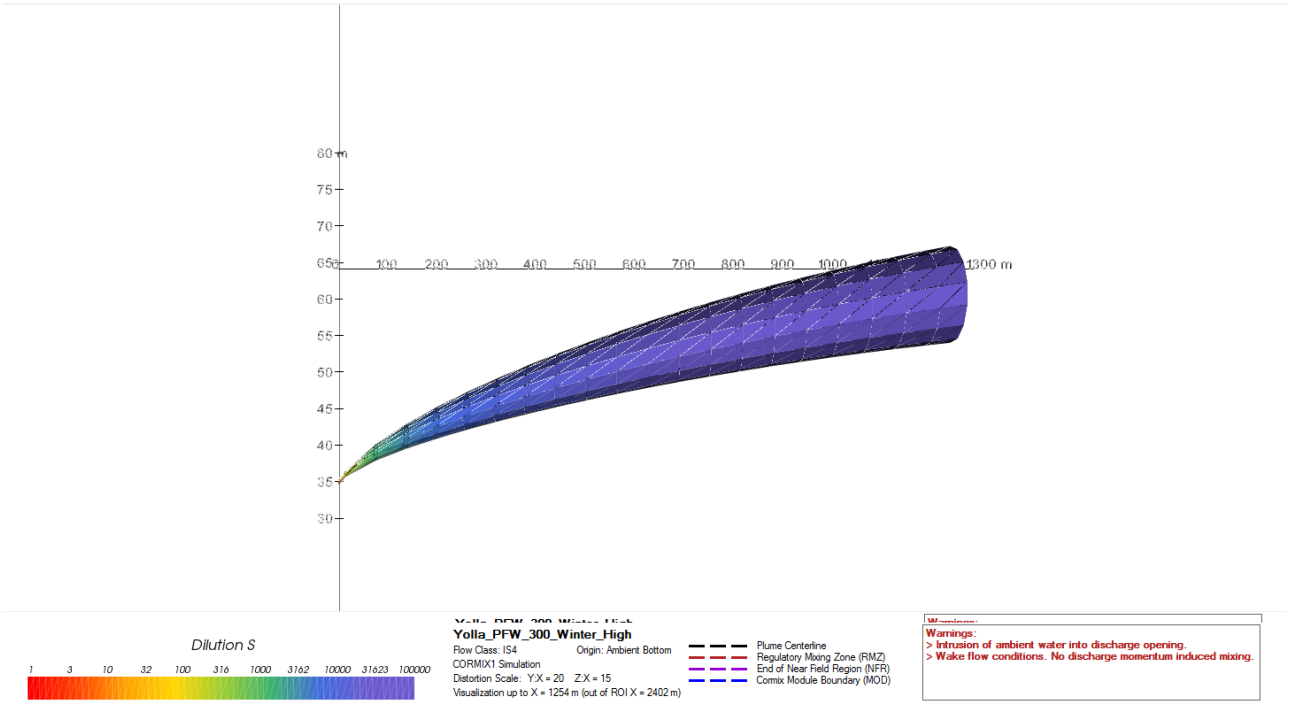


**Figure 5-10 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

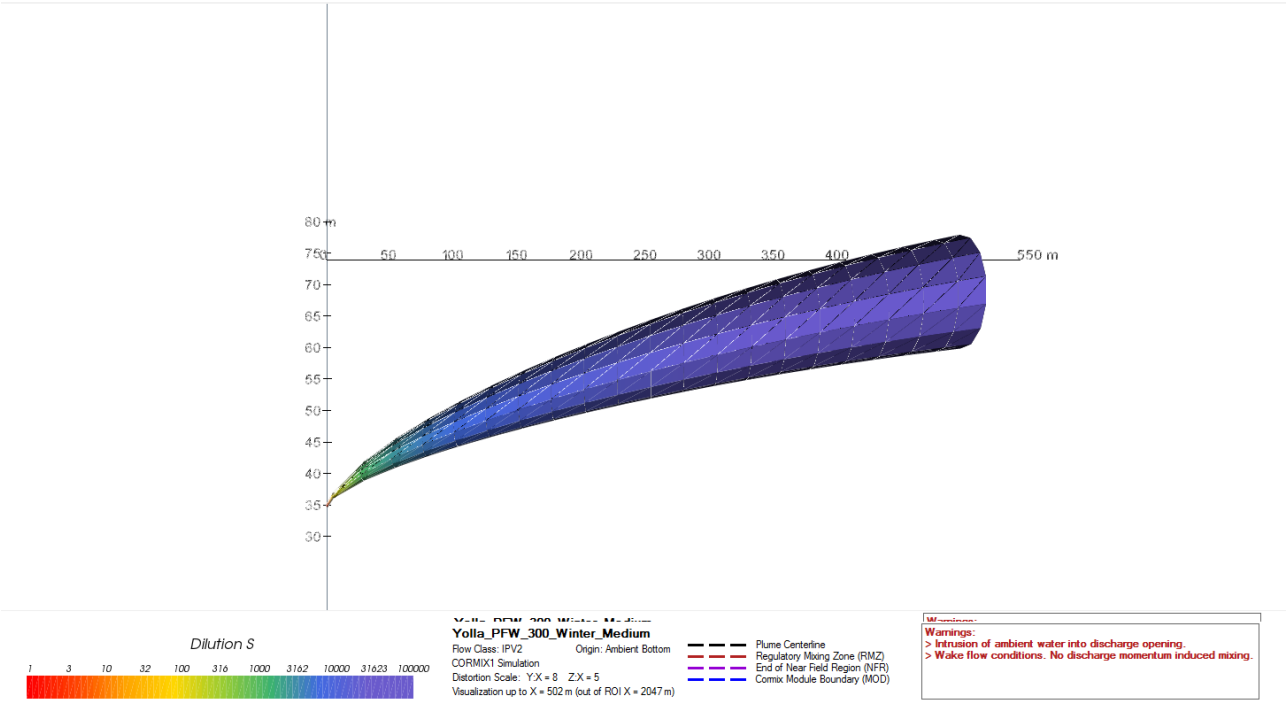


**Figure 5-11 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

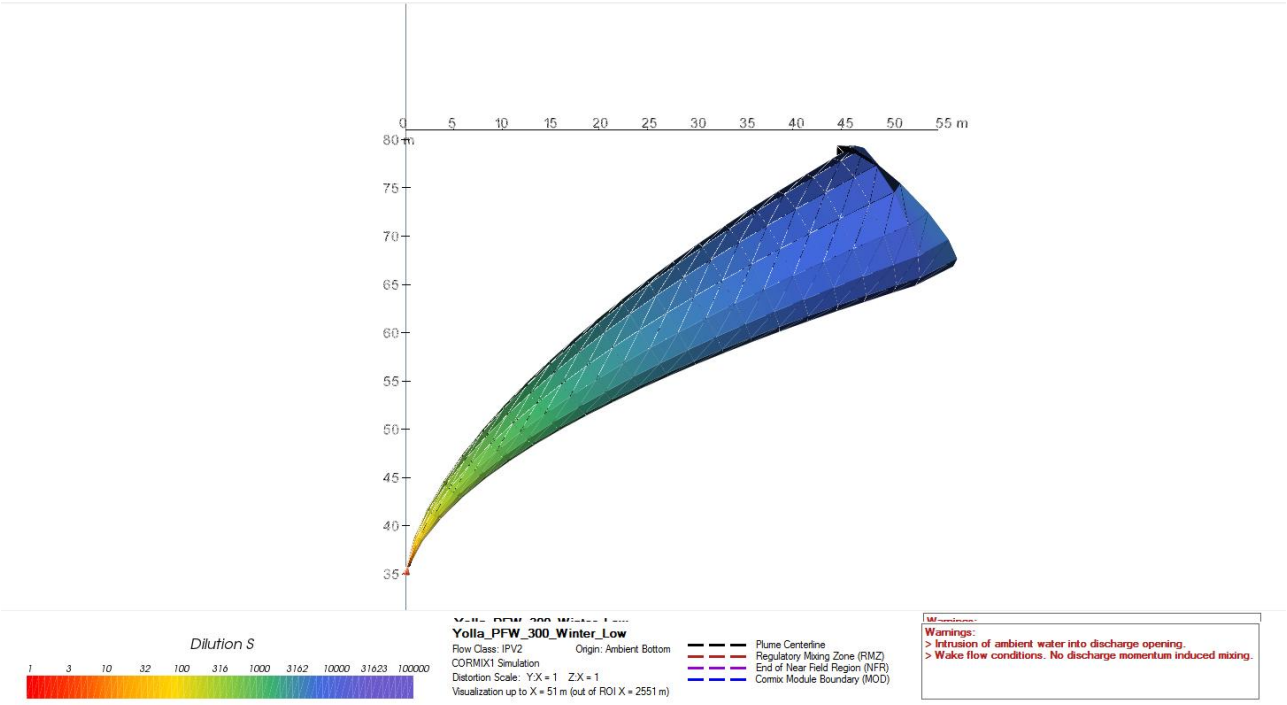


**Figure 5-12 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

## 5.2 Far-Field Modelling

### 5.2.1 Overview

Near-field and far-field modelling describe different processes at different scales, so their results may not always align where the two overlap near the discharge location. Far-field modelling accounts for time-varying currents, which can sometimes lead to plume pooling at the release site under weak currents. When this pooled plume is later carried away, it can result in lower dilutions (higher concentrations) migrating farther from the discharge point.

### 5.2.2 Stochastic Analysis

The model outputs over the ten-year hindcast period (2010-2019) were combined and analysed on an annual basis.

Table 5-3 summarises the maximum distances from the discharge location to achieve various dilution levels, ranging between 500 and 20,000 dilutions, for the 95$^{th}$ percentile.

The lower dilution threshold (526) was observed within approximately 10 m and 12 m for the Base Case and Future Case, respectively.

The dilution threshold of 1,961 was observed within approximately 29 m and 37 m for the Base Case and Future Case, respectively.

The dilution threshold of 7,143 was observed within approximately 41 m and 61 m for the Base Case and Future Case, respectively.

The upper dilution threshold (19,608) was observed within approximately 163 m and 247 m for the Base Case and Future Case, respectively.

The dilution maps for the 95$^{th}$ percentile for each discharge case is depicted in Figure 5-13 and Figure 5-14, along with contours illustrating the lower and upper dilution thresholds.

**Table 5-3 Maximum distance from the PFW discharge location to achieve threshold dilutions.**

| Statistic | Dilutions (1:X) | Maximum distance (m) from discharge location to achieve given dilution for the Base Case (200 m$^3$/day) | Maximum distance (m) from discharge location to achieve given dilution for the Future Case (300 m$^3$/day) |
|---|---|---|---|
| 95$^{th}$ Percentile | 500 | 10 | 12 |
| | **526** | **10** | **12** |
| | **1,961** | **29** | **37** |
| | 2,000 | 29 | 36 |
| | 4,000 | 30 | 38 |
| | **7,143** | **41** | **61** |
| | 8,000 | 43 | 74 |
| | 10,000 | 64 | 125 |
| | 12,500 | 100 | 152 |
| | 15,000 | 126 | 182 |
| | 17,500 | 160 | 232 |
| | **19,608** | **163** | **247** |
| | 20,000 | 165 | 253 |

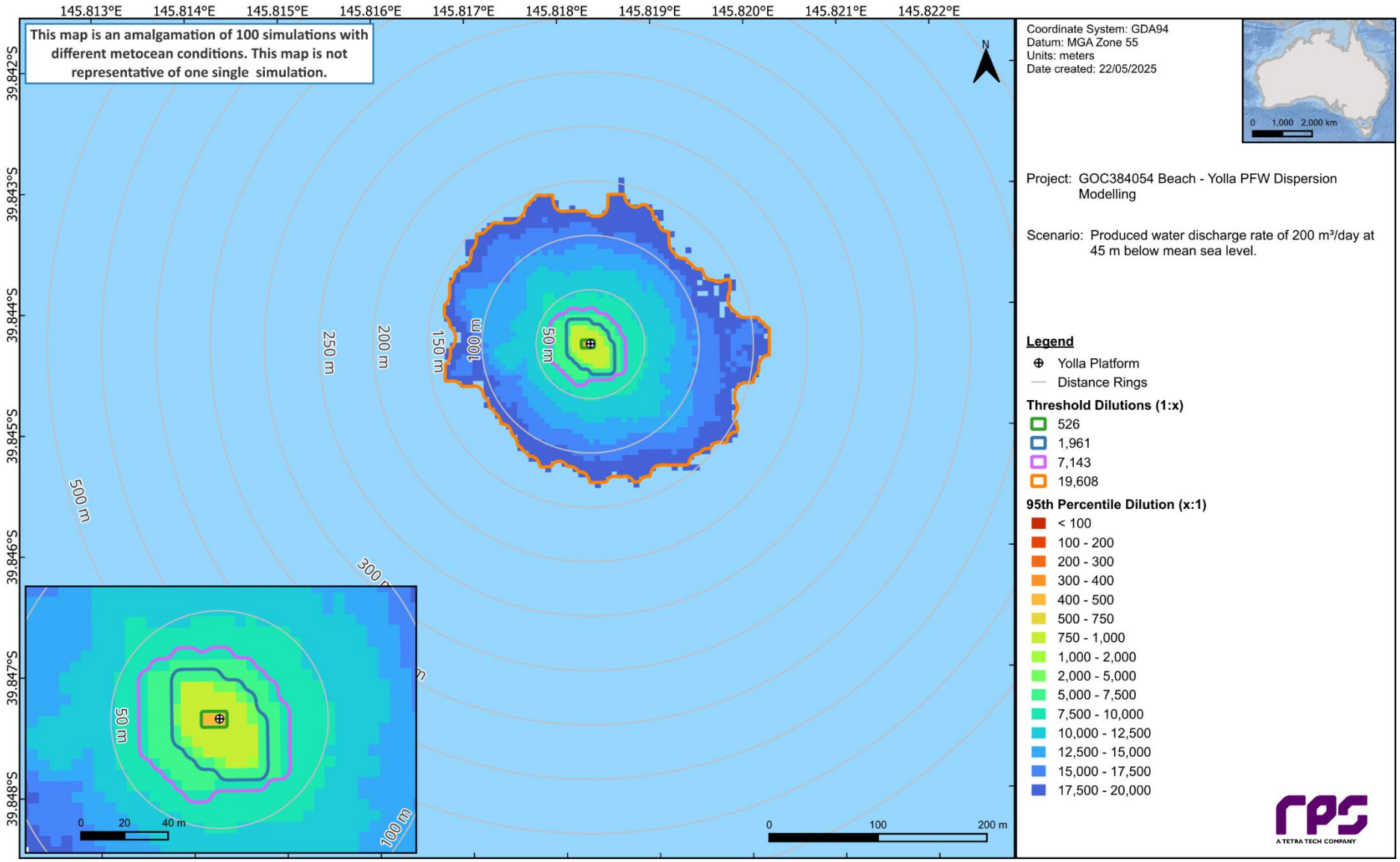


**Figure 5-13 95th percentile dilution for a PFW discharge at 200 m³/d. Results refer to annual conditions.**

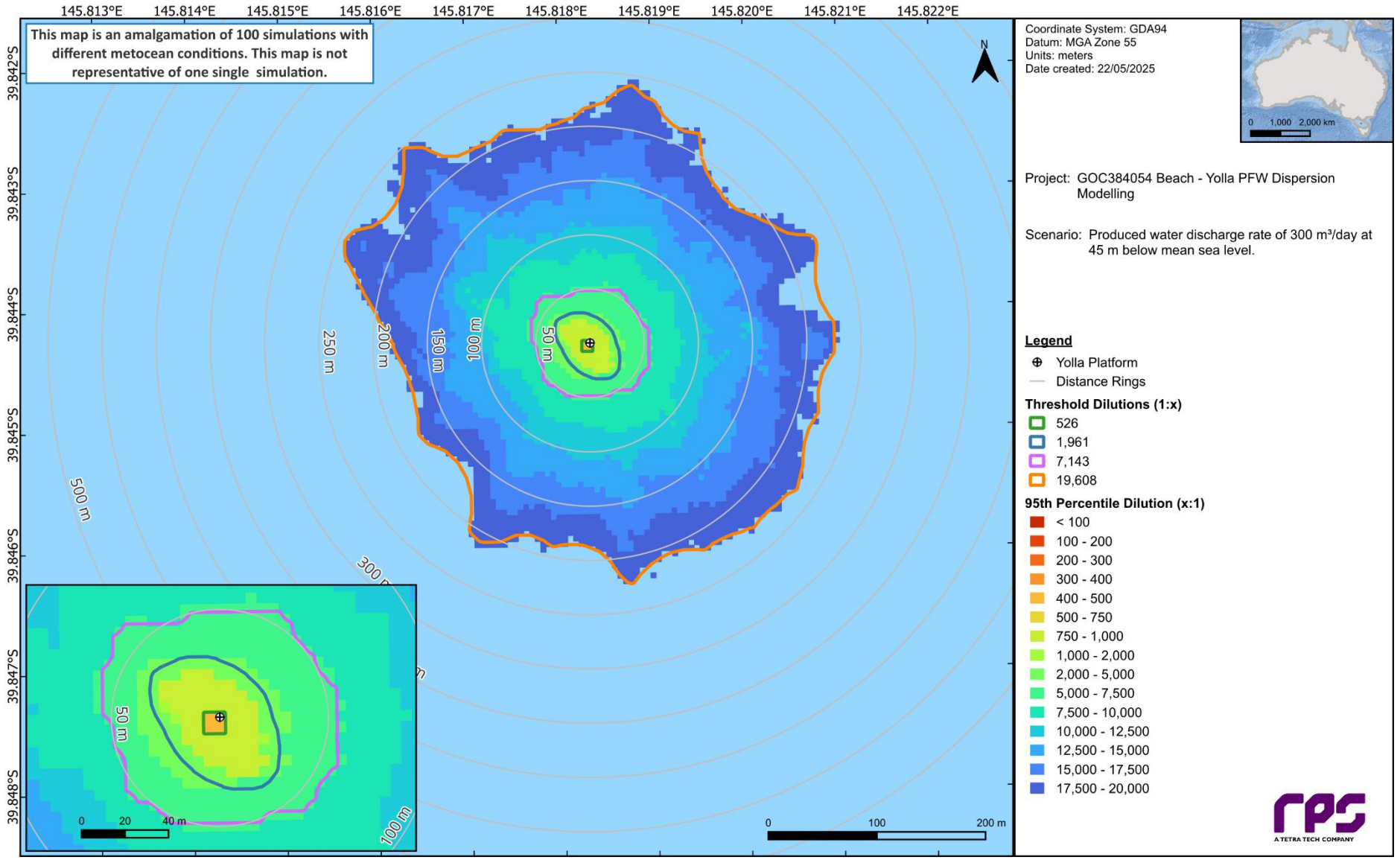


**Figure 5-14 95th percentile dilution for a PFW discharge at 300 m³/d. Results refer to annual conditions.**

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Prepared for
Beach Energy Limited
ABN: 30007617969

AECOM

# Yolla Produced Formation Water Plume Model Verification Study

## Results Report

22-May-2023
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# Yolla Produced Formation Water Plume Model Verification Study

Results Report

Client: Beach Energy Limited

ABN: 30007617969

Prepared by

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# Quality Information

| | |
|---|---|
| Document | Yolla Produced Formation Water Plume Model Verification Study |
| Ref | 60649604 |
| Date | 22-May-2023 |
| Originator | Marthin Slabber |
| Checker/s | Ian Baxter |
| Verifier/s | Peter Young |

**Revision History**

| Rev | Revision Date | Details | Approved | |
|---|---|---|---|---|
| | | | Name/Position | Signature |
| A | 06-Apr-2023 | For Client Comments | Marthin Slabber<br>Senior Marine Scientist | |
| 0 | 22-May-2023 | Final | Marthin Slabber<br>Senior Marine Scientist | |

# Table of Contents

Executive Summary i
1.0 Introduction 1
1.1 Background 1
1.2 NOPSEMA Inspection of BassGas Operations 1
1.3 Study Objectives 2
1.4 Location and PFW Discharge Structure 2
1.5 Plume Dispersal Modelling 4
2.0 Methods 6
2.1 Study Design Overview 6
2.2 RWT Tracer Dye Injection 6
2.3 Sampling Methods and Equipment 7
2.3.1 Sampling Overview 7
2.3.2 Samples Collected 9
2.3.3 Sample Analysis 14
2.4 Model Verification 15
3.0 Results 17
3.1 Field Observations and Plume Behaviour 17
3.2 Sampling Analytical Results and Comparison Against Model Dilutions 17
3.2.1 Total Barium 17
3.2.2 Total Petroleum Hydrocarbons and Total Recoverable Hydrocarbons 19
3.2.3 BTEX Results 23
3.2.4 Polynuclear Aromatic Hydrocarbon Results 26
3.2.5 RWT Results 27
3.3 Physico-chemical Results 28
3.4 Insitu ROV RWT Dilution and vs. Model Dilution Results 31
4.0 Model Verification Discussion 34
4.1 Relevance of the Field Study to the Modelling 34
4.2 Observed Versus Predicted Dilutions – Insitu Hydrocarbon Concentrations 34
4.3 Observed Versus Predicted Dilutions – Insitu RWT Concentrations 35
4.4 Model Verification Outcome 35
5.0 References 36

Appendix A
Laboratory Reports A

## List of Plates

Plate 1 Yolla-A dump caisson subsea outlet (Source- Aventus 2020) 3
Plate 2 ROV used for insitu sampling and monitoring 10
Plate 3 Platform deployed Niskin bottle and sonde 13

## List of Tables

Table 1 Tide times and RWT injection timing and duration 7
Table 2 RWT injection rates across Day 1 and Day 2 injection events 7
Table 3 Summary of sampling undertaken 8
Table 4 Collection times for samples collected during Day 1 injection event 9
Table 5 Collection times for samples collected during Day 2 injection event 9
Table 6 Deployment and retrieval times for the ROV 12
Table 7 Field sample analysis parameters 14
Table 8 Total barium results in pre discharge and insitu samples from Day 1 18
Table 9 Total barium results in predischarge and insitu samples from Day 2 19
Table 10 TPH and TRH results in predischarge and insitu samples from Day 1 21
Table 11 TPH and TRH results in predischarge and insitu samples from Day 2 22
Table 12 BTEX results in predischarge and insitu samples from Day 1 24

Table 13 BTEX results in predischarge and insitu samples from Day 2 25
Table 14 PAH results in predischarge and insitu samples from Day 1 26
Table 15 RWT results in predischarge and insitu samples from Day 1 27
Table 16 RWT results in predischarge and insitu samples from Day 2 28

## List of Figures

Figure 1 Yolla Platform location 3
Figure 2 Modelled outcomes for the Yolla-A PFW discharge regime near field mixing under three discharge scenarios (RPS 2017). 5
Figure 3 Modelled outcomes for the Yolla-A PFW discharge regime far field mixing under three discharge scenarios (RPS 2020) 5
Figure 4 Screenshot of the sonar data alongside the ROV video feed used to determine distance from the caisson 11
Figure 5 Timings for high and low water during the sample dates with the time points of when insitu samples were collected 14
Figure 6 PFW discharge rate during Day 1 (9 October 2022) 16
Figure 7 PFW discharge rate during Day 2 (10 October 2022) 16
Figure 8 Day 2 Temperature, salinity and turbidity data (top) along with Day 2 ROV dive profile with measured insitu RWT concentrations (bottom) 29
Figure 9 Day 2 insitu RWT concentrations and pH measurements 30
Figure 10 Day 1 Insitu RWT dilutions and 2017 and 2020 modelled dilutions, across horizontal distance from caisson 32
Figure 11 Day 2 Insitu RWT dilutions and 2017 and 2020 modelled dilutions, across horizontal distance from caisson 33

# Executive Summary

Beach Energy (Operations) Ltd (Beach Energy) is the Operator of the BassGas Development. The BassGas Development consists of gas and liquids produced from the Yolla gas field, via the Yolla-A platform, located 147 km south of Kilcunda (Victoria) in Bass Strait.

In 2017 RPS was commissioned to conduct near field hydrodynamic modelling of the produced formation water discharge (PFW) plume for the Yolla-A platform, to assess the extent of plume dispersal and the dilution factors for PFW. Three scenarios of daily discharge volume were modelled (100 $m^3$, 200 $m^3$ and 300 $m^3$ per day) under both low and high current speeds. Subsequent modelling by RPS for the same three discharge volume scenarios was undertaken in 2020, to assess the far field plume dispersal of PFW discharged from the Yolla-A platform. For conservatism the far field model produced predictions for the three discharge volume scenarios based a 31 day average current speed from the least energetic month from a hindcast four year data set.

The dilution factors and extent of plume dispersal predicted by the modelling studies have been used to derive the extent of the mixing zone boundary around the point of discharge. The mixing zone boundary defines the predicted extent of potential impacts from PFW to the receiving environment.

As one of its commitments in their existing Environment Plan, Beach Energy committed to conduct a field based plume model verification study for Yolla-A to verify the outcomes from the hydrodynamic modelling, which informed the mixing zone boundary determined in their ALARP assessment.

Beach Energy engaged AECOM to undertake the PFW plume model verification study to verify the predictions made in the near field and far field modelling with respect to the number of dilutions the plume undergoes in the receiving environment over horizontal distance from the point of discharge.

The field survey was completed on 8-11 October 2022, with ERIAS Consulting executing the field component based on the sampling design by AECOM, with remote support from AECOM. The field study targeted neap tides as current speed and water movement is less than during spring tides, thus increasing the likelihood of detecting the plume in the receiving environment. It was also expected that the plume would likely dilute slower during neap tides, thus providing a conservative assessment of the dilution rate of the PFW.

To aid in the detection of the PFW plume in the receiving environment, and to act as a ‘tracer’, the study involved injection of rhodamine WT dye (RWT) into the PFW stream prior do discharge from the platform. Two injection events were completed, one on October 9 and a second on October 10.

To assess the dilution factors of the plume in the receiving environment, the concentration of tracer dye was measured using an ROV mounted fluorometer, supplemented with discrete water samples which were analysed for RWT and a range of contaminants on completion of the survey. The data collected allowed comparison of the modelled plume dilutions with the tracer dye concentrations measured during the field survey.

The PFW flow rate across the two sampling days ranged between 230 and 280 $m^3$ per day. Therefore the field data were compared against the 200 $m^3$ and 300 $m^3$ per day model scenarios.

The field study data revealed both the near and far field models under predict the dilution of the plume across horizontal distance from the point of discharge. Under high current conditions the near field model predicted fewer dilutions for both the 200 $m^3$ and 300 $m^3$ per day scenarios compared to the field data, while under low current conditions it predicted similar or fewer dilutions than the 300 $m^3$ per day scenario. The far field model predicted fewer dilutions for both the 200 $m^3$ and 300 $m^3$ per day scenarios.

Hence, the models applied to predicting the PFW discharge mixing zone boundary were shown to be conservative in their predictions of dilutions. Adding to this, the conditions under which the field survey was undertaken were considered to provide further conservatism due to the weak ambient currents during the neap tide phase. The field study results therefore indicate that the modelling completed for the Yolla-A PFW discharge is suitably conservative in predicting the rate of PFW dispersion and dilution and is a suitable basis upon which the mixing zone boundary can be determined.

# 1.0 Introduction

## 1.1 Background

Beach Energy (Operations) Ltd (Beach Energy) is the Operator of the BassGas Development. The BassGas Development consists of gas and liquids produced from the Yolla gas field, via the Yolla-A Platform, located 147 km south of Kilcunda (Victoria) in Bass Strait (Figure 1).

In 2017 RPS were commissioned to conduct near field hydrodynamic modelling of the produced formation water (PFW) discharge plume for the Yolla-A platform to assess the extent of the plume dispersal and the dilution factors for PFW. Subsequent modelling by RPS in 2020 was undertaken to assess the far field plume dispersal of PFW discharged from the Yolla-A platform.

The dilutions factors and extent of plume dispersal predicted by the modelling studies are used to derive the extent of the mixing zone boundary around the point of discharge. The mixing zone boundary defines the extent of potential impacts from PFW to the receiving environment.

Using the hydrodynamic modelling data in combination with whole of effluent testing (WET) using PFW contaminant data from Yolla-A, Beach Energy commissioned AECOM in 2019 to undertake an ALARP risk assessment to establish the dilutions required and thus mixing zone boundary for PFW to be below levels predicted to impact the receiving environment (Beach Energy 2020).

The outcomes of the ALARP report (AECOM 2019) were incorporated into the Environment Plan (EP) for BassGas Offshore Operations (Beach Energy 2020). As one of its commitments in the EP, Beach Energy committed to conduct a field based plume model verification study for Yolla-A to verify the outcomes from the hydrodynamic modelling, which informed the mixing zone boundary determined in the ALARP assessment.

Informed by the 2017 modelling, the ALARP assessment determined a mixing boundary of less than 10 m horizontally from the point of discharge under the maximum discharge rate of 300 $m^3$ per day, across all conditions. This boundary estimation was derived using the highest no effect concentration (NOEC) from the existing Yolla-A WET data. Following the ALARP assessment, Beach Energy engaged AECOM to undertake the field study to verify the model predictions. Given the ALARP report determined a very small mixing zone boundary, a platform based field survey was developed to assess the dilution factors upon which the mixing zone boundary would be based.

## 1.2 NOPSEMA Inspection of BassGas Operations

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) conducted an inspection of the BassGas Operations including the Yolla Platform operations on 24 and 25 August 2021. Of relevance to this report, NOPSEMA made the following observations and findings:

*Conclusion (2448-C2)*

*The inspectors conclude that the PFW mixing zone boundary has not been adequately predicted in the EP, or verified insitu via a PFW plume dispersion verification study for continuously managing impacts from the PFW discharge to the receiving environment to levels which are acceptable and ALARP.*

NOPSEMA made the following recommendations:

*Recommendation [2448-C2-R2]*

*Ensure that both the predicted and verified PFW mixing zone boundary has been derived using:*

1. *A safe dilution factor determined with representative biological effects data from the existing suite of WET tests, and a statistically based species sensitivity distribution in accordance with ANZG (2018); and,*
2. *An insitu plume dispersion verification study as described in the in-force EP.*

Following the inspection outcomes released by NOPSEMA, Beach Energy commissioned AECOM to derive a site specific dilution factor (SSDF) for Yolla-A using a statistically based species sensitivity distribution (in accordance with ANZG [2018]) based on existing and more recent contaminant and WET data from Yolla-A. The SSDF was applied to modelling data to derive the revised mixing zone boundary for Yolla-A. This study was recently completed by AECOM and has been submitted to Beach Energy for review in early 2023.

In October 2022, prior to the completion of the SSDF report, AECOM and ERIAS Consulting on behalf of Beach Energy, undertook the insitu plume dispersion verification study to verify the modelled dilutions as predicted in the modelling undertaken by RPS. The purpose of this report is to describe the methodologies and outcomes of the field study.

## 1.3 Study Objectives

The study objectives were to:

- Develop a methodology to identify and sample the PFW discharge plume from the Yolla-A platform.
- Sample and collect insitu field data of the PFW discharge plume from the Yolla-A Platform to describe the plume dispersal and dilution factors with the aim of verifying current PFW plume dispersion modelling for the platform.
- Verify the modelled PFW plume dilutions upon which the mixing zone boundary is based.

## 1.4 Location and PFW Discharge Structure

The Yolla-A Platform is a manned platform that stands in approximately 80 m water depth and is located in Production Licence T/L1, approximately 93 km south-west of Wilson's Promontory in Victoria and 109 km north-west of the Tasmanian mainland (Figure 1). The facility was installed in 2004 and has been in production since 2006. Product produced at the platform is transported via a 147 km subsea pipeline extending from the platform to the mainland shore crossing near Kilcunda in Victoria from where it is pumped further inland to the gas processing facility at Lang in Victoria (Aventus 2020).

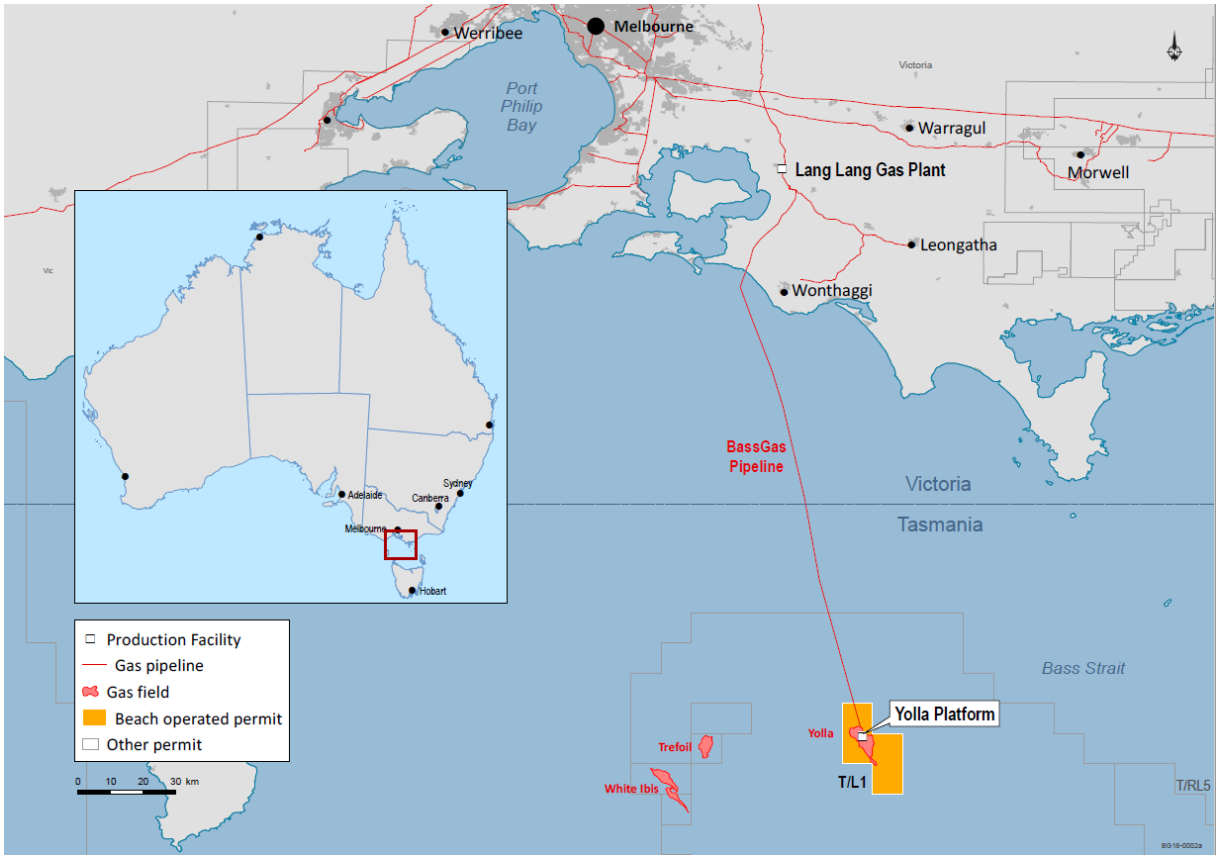


**Figure 1 Yolla Platform location**

The Yolla-A platform is four-legged tubular steel jacket, integrated into a gravity base structure that has a footprint of approximately 50 m x 50 m. Following treatment onboard to remove gas and traces of condensate and oil the PFW is discharged overboard through the dump caisson. The caisson consists of a downward facing 730 mm diameter discharge pipe with the outflow opening situated 45 m below sea level (Plate 1). The caisson is constructed as part of the platform jacket and is situated 3 m east of the north-west jacket corner (Aventus 2020).

**Plate 1 Yolla-A dump caisson subsea outlet (Source- Aventus 2020)**

## 1.5 Plume Dispersal Modelling

In 2017, RPS were commissioned to conduct near field hydrodynamic modelling of the PFW discharge plume for the Yolla-A platform to assess the extent of the plume dispersion and the dilution factors for PFW. Modelling was completed for three discharge scenarios: Case 1- Design (100 $m^3$/day); Case 2 - Typical (200 $m^3$/day); and Case 3- Worst Case (300 $m^3$/day). Dispersal distances were provided for low current (5$^{th}$ percentile) and high current (95$^{th}$ percentile) speeds in both summer and winter (RPS 2017). The cases and in turn discharge rates are based on the original PFW design flow rate, expected operation post-debottlenecking and end of field life, respectively.

To inform the 2017 modelling, chemical testing by Beach Energy identified a list of contaminants within the PFW discharged from Yolla-A for which guideline and trigger values are listed within the ANZECC (2000) guidelines (now ANZG [2018]). The required modelled dilution factors were based upon concentrations of contaminants within the Yolla-A PFW, and the dilutions factors required to achieve the 99% species protection trigger concentration for each contaminant. Oil and petroleum hydrocarbons required the greatest number of dilutions, which were 428; however, for conservatism the discharge was assessed to a maximum of 1000 dilutions.

The outcomes from the 2017 modelling conducted by RPS are shown in Figure 2.

Using the findings from the 2017 modelling, subsequent modelling by RPS of the Yolla-A PFW plume was undertaken in 2020, to assess far field dispersion of the plume beyond 1:1000 dilutions, and in particular, greater dilutions for total recoverable hydrocarbon (TRH) average (1:3,482) and maximum (1:5,400) concentrations determined from WET results to meet a low reliability 99% sp. protection ANZECC (2000) guideline value for TRH concentrations. To provide the most conservative estimate for the plume dispersal the modelling utilised the hindcast current data from 2008 – 2012 to determine the least energetic month of current movement (May 2011) against which to predict far field plume dispersal. As with the 2017 modelling, plume dispersal was modelled for the same three discharge rate scenarios: 100 $m^3$, 200 $m^3$ and 300 $m^3$ per day. As the modelling was based on the month of the slowest current speed (May 2011), low and high current dilutions were not calculated and instead just an average current speed and subsequent dilutions based on 31 days during May 2011.

The outcomes from the 2020 modelling conducted by RPS are shown in Figure 3.

Table 7 Maximum horizontal distance from the discharge point that centreline dilution (X:1) was predicted to travel.

| Case | Season | Current Speed (%ile) | Maximum Distance from Discharge Point to Centreline Dilution X:1 (m) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
| Case 1 Design Operation | Summer | 5th | 0.2 | 0.4 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 2.7 | 3.7 | 4.6 | 5.4 | 6.2 | 7.0 | 7.8 | 8.5 | 9.2 |
| | | 95th | 1.2 | 2.2 | 3.0 | 3.6 | 4.2 | 4.8 | 5.3 | 5.8 | 6.3 | 6.7 | 11.0 | 14.9 | 18.4 | 21.8 | 25.1 | 28.4 | 31.6 | 34.8 | 38.0 |
| | Winter | 5th | 0.2 | 0.4 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.2 | 1.4 | 1.5 | 2.6 | 3.6 | 4.5 | 5.3 | 6.1 | 6.8 | 7.6 | 8.3 | 9.0 |
| | | 95th | 1.2 | 2.2 | 3.0 | 3.6 | 4.2 | 4.7 | 5.2 | 5.7 | 6.2 | 6.7 | 10.9 | 14.6 | 18.0 | 21.2 | 24.3 | 27.3 | 30.1 | 32.9 | 35.6 |
| Case 2 Typical Operation | Summer | 5th | 0.3 | 0.5 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 3.8 | 5.3 | 6.6 | 7.9 | 9.1 | 10.2 | 11.2 | 12.3 | 13.3 |
| | | 95th | 1.4 | 2.6 | 3.6 | 4.5 | 5.4 | 6.2 | 6.9 | 7.7 | 8.4 | 9.1 | 15.4 | 21.1 | 26.5 | 31.8 | 37.1 | 42.5 | 48.1 | 53.9 | 59.9 |
| | Winter | 5th | 0.3 | 0.5 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.1 | 3.7 | 5.2 | 6.5 | 7.7 | 8.9 | 10.0 | 11.1 | 12.2 | 13.2 |
| | | 95th | 1.4 | 2.6 | 3.6 | 4.5 | 5.3 | 6.1 | 6.8 | 7.6 | 8.3 | 9.0 | 15.1 | 20.5 | 25.5 | 30.2 | 34.7 | 39.0 | 43.2 | 47.2 | 51.2 |
| Case 3 Worst Case Operation | Summer | 5th | 0.3 | 0.6 | 0.9 | 1.1 | 1.4 | 1.6 | 1.8 | 2.1 | 2.3 | 2.5 | 4.4 | 6.1 | 7.6 | 9.0 | 10.4 | 11.6 | 12.9 | 14.0 | 15.1 |
| | | 95th | 1.5 | 2.9 | 4.0 | 5.0 | 6.0 | 6.9 | 7.7 | 8.6 | 9.4 | 10.2 | 17.5 | 24.1 | 30.5 | 36.8 | 43.3 | 49.9 | 56.7 | 63.5 | 70.3 |
| | Winter | 5th | 0.3 | 0.6 | 0.9 | 1.1 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 4.3 | 5.9 | 7.4 | 8.9 | 10.2 | 11.5 | 12.8 | 14.1 | 15.4 |
| | | 95th | 1.5 | 2.8 | 3.9 | 4.9 | 5.9 | 6.8 | 7.6 | 8.5 | 9.3 | 10.1 | 17.1 | 23.2 | 28.9 | 34.4 | 39.5 | 44.5 | 49.3 | 54.0 | 58.6 |

**Figure 2 Modelled outcomes for the Yolla-A PFW discharge regime near field mixing under three discharge scenarios (RPS 2017).**

**Table 7.1 Maximum horizontal distance from the discharge point to varying dilutions (1:x) for each case.**

| Dilution (1:x) | Maximum horizontal distance (m) | | |
|---|---|---|---|
| | Case 1 Design Operation | Case 2 Typical Operation | Case 3 Worst Case Operation |
| 60 | <5 m | <5 m | <5 m |
| 62.5 | <5 m | <5 m | <5 m |
| 70 | <5 m | <5 m | 26 |
| 80 | <5 m | <5 m | 26 |
| 90 | <5 m | <5 m | 26 |
| 100 | <5 m | 26 | 26 |
| 200 | 39 | 64 | 64 |
| 300 | 39 | 64 | 64 |
| 400 | 64 | 64 | 64 |
| 500 | 69 | 64 | 64 |
| 600 | 69 | 64 | 64 |
| 700 | 69 | 64 | 114 |
| 800 | 69 | 64 | 114 |
| 900 | 69 | 64 | 118 |
| 1,000 | 69 | 73 | 121 |
| 3,482.4 | 133 | 295 | 485 |
| 5,400 | 292 | 490 | 693 |

**Figure 3 Modelled outcomes for the Yolla-A PFW discharge regime far field mixing under three discharge scenarios (RPS 2020)**

# 2.0 Methods

## 2.1 Study Design Overview

The in-field study methodology and sampling and analysis plan were developed by AECOM, incorporating input from Beach Energy with respect to operational details for the Yolla-A platform.

The field component of the study was undertaken by ERIAS Consulting with remote support from AECOM during the field study.

The field study was implemented from 8-11 October 2022. These dates fell within the neap tide phase of the tidal cycle. Neap tides were targeted to aid in the detection and tracking of the plume.

The study comprised injection of Rhodamine WT (RWT) dye, to act as a visual tracer, into the PFW discharge stream to assist in detection and sampling of the discharge plumes. Subsequent sampling and measurements were obtained by:

- Sampling of the dye spiked PFW stream prior to discharge into the dump caisson, for laboratory analysis, with analytical results also compared with fluorometry conducted on sampled waters.
- Measurement of the dye fluorescence (as a surrogate for dye concentration) and physico-chemical parameters (temperature, conductivity, salinity, pH, and depth) in receiving waters using a multiparameter sonde mounted on a remotely operated vehicle (ROV) and a hand deployed multiparameter sonde, both equipped with dye fluorescence sensors.
- Collection of insitu water samples in the receiving waters using ROV mounted and hand deployed Niskin water samplers, for laboratory analysis, with analytical results also compared with fluorometry conducted on sampled waters.

The field survey was centred on the execution of two RWT dye release events over two days. The survey design aimed to provide multiple data streams to meet the objectives of the project with the use of RWT as a tracer dye allowing the dilution of the plume to be measured. The measurement of other water chemistry parameters was undertaken to investigate how chemical constituents in the PFW were diluted in the receiving environment and to provide additional tracer data of the actual plume.

## 2.2 RWT Tracer Dye Injection

To aid in identifying the plume and determining the PFW dilution factors, liquid RWT dye was used to ‘spike’ the PFW stream prior discharge. RWT was injected into the PFW stream upstream of a sampling tap but prior to its discharge into the dump caisson. A pneumatic pump with adjustable flow control pumped the liquid RWT dye from an intermediate bulk container containing 1000 L of premixed dye, into the PFW stream.

Per the Yolla-A EP, the residence time for PFW in the caisson is approximately two hours. Thus the timing of the dye injection was aligned to commence at least two hours prior to high tide (and thus slack water) on the respective sampling dates, and then continue for as long possible into the ebbing tide phase with the aim of capturing data during periods of both slow and faster moving current speeds.

Should the RWT spiked plume not be visible, the sampling plan allowed for flexibility to raise the injection rate thus increasing the injected dye concentration in the PFW stream and in turn the dye visibility.

During the Day 1 injection event, dye injection commenced initially at a low rate before being gradually increased as the injection progressed, up to a fourfold increase by the end of end of injection, which was once all the dye in the mixing tank had been injected. During Day 2, the injection started at a high rate before being lowered slightly before getting raised again towards the end of the injection.

Table 1 provides the tide times across the two injection days and the start and end times of each injection event. Table 2 lists the injection rates across each injection event.

**Table 1 Tide times and RWT injection timing and duration**

| Tide Times / Injection Timing | Day 1 9 October 2022 | Day 2 10 October 2022 |
|---|---|---|
| High tide | H – 11:40 | H – 12:40 |
| Low tide | L – 17:50 | L – 19:00 |
| RWT Injection start time | 08:58 | 11:02 |
| RWT Injection finish time | 13:58 | 16:45 |
| Injection duration (minutes) | 290 | 306 |

**Table 2 RWT injection rates across Day 1 and Day 2 injection events**

| Day 1 9 October 2022 | | Day 2 10 October 2022 | |
|---|---|---|---|
| Time | Injection Rate (L/min) | Time | Injection Rate (L/min) |
| 8:58 | 1.5 | 11:02 | 5.8 |
| 10:30 | 1.7 | 11:14 | 3.8 |
| 10:42 | 2.8 | 11:22 | 3.8 |
| 11:02 | 2.4 | 11:43 | 3.4 |
| 11:35 | 3.6 | 14:20 | 3.1 |
| 12:00 | 5.6 | 15:13 | 2.4 |
| 12:35 | 6.1 | 15:30 | 3.5 |
| 13:58 | 1.5 | 16:45 | 5.8 |

## 2.3 Sampling Methods and Equipment

### 2.3.1 Sampling Overview

During the dye injection, sampling involved the collection of water samples for laboratory analysis and collection of insitu water quality profile data using a multiparameter sonde. The sonde measured physico-chemical indicators of the PFW plume through the water column, including electrical conductivity (EC), salinity, temperature, depth, pH, turbidity and RWT concentration.

Water samples underwent laboratory analysis for detection of PFW constituents including TRH and BTEX (which were identified as contaminants of concern in the ALARP assessment), and barium which has been shown to be present and potentially detectable after release to the receiving environment. Samples were also analysed for RWT concentration to provide verification of the insitu sonde measurement for RWT.

Sample collection consisted of:

- Samples collected of the dye mixture in the mixing tank prior to injection.
- Samples of the PFW stream downstream of the injection point, prior to its discharge into the dump caisson.
- Samples collected of the PFW and RWT dye plume in the ocean (insitu samples).
- Samples up current from the dump/discharge caisson position.
- Field blank and rinsate samples.

Insitu samples were collected through a combination of a platform deployed ROV with a mounted Niskin bottle water sampler, and via a Niskin bottle lowered overboard from the platform into the ocean.

Table 3 provides a summary of the sampling undertaken.

**Table 3 Summary of sampling undertaken**

| Sample Type | Sample ID Code | Timing | Analytes | Purpose |
|---|---|---|---|---|
| RWT Dye Mixing Tank | MXT | Pre-injection, during and post injection | RWT dye concentration | Determine the concentration of RWT within the mixing tank for the duration of injection. |
| PFW Stream | PFWS | Pre-injection, during (approx. every 90 mins), post injection | Barium, TRH, BTEX, PAH and RWT | Determine the concentration of RWT and other constituents in PFW stream prior to entry into discharge caisson. |
| Receiving environment – insitu plume sample by ROV | ROV | During injection once per dive, within the densest section of the plume, at increasing distances from the caisson | Barium, TRH, BTEX, PAH and RWT | Determine insitu concentrations of PFW constituents post discharge and verify RWT concentrations recorded by the sonde |
| Receiving environment – insitu plume sample by hand deployed Niskin bottle | NK | During injection within the densest section of the plume visible from the platform, post injection up current of caisson | Barium, TRH, BTEX, PAH and RWT | Provide additional insitu concentrations of PFW constituents post-discharge and verify RWT concentrations recorded by platform deployed sonde |
| Sonde calibration sample for RWT – ROV sonde and platform sonde | ROV-CB<br>NK-CB | Sample collected from bucket of premixed RWT in water using Niskin bottle, following RWT reading taken by sonde from bucket. One sample collected using ROV Niskin and platform Niskin, each injection day, prior to injection. | RWT | To test calibration of both ROV and platform sondes by comparing sonde readings to laboratory analysed samples |
| Rinsate/method blank for ROV Niskin and Platform Niskin | RS | At the completion of all insitu sampling, following cleaning and decontamination of equipment | Barium, TRH, BTEX and PAH | To assess potential sources of contamination during sampling and sample transport |

### 2.3.2 Samples Collected

Sampling to inform the assessment of the modelled dilution factors comprised the collection of the samples listed in Table 4 and Table 5:

**Table 4 Collection times for samples collected during Day 1 injection event**

| Day 1<br>9 October 2022 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Sample** | **Time** | **Sample** | **Time** | **Horizontal distance from caisson (m)** | **Sample** | **Time** | **Horizontal distance from caisson (m)** |
| PFWS 1-1 | 7:34 AM | NK 1-1 | 1:46 PM | 5 | ROV 1-1 | 11:56 AM | 3 |
| PFWS 1-2 | 9:08 AM | NK 1-2 | 3:12 PM | 15 | ROV 1-2 | 4:20 PM | 15 |
| PFWS 1-3 | 10:12 AM | NK 1-3 | 3:25 PM | 15 | | | |
| PFWS 1-4 | 11:40 AM | NK 1-4 | 4:10 PM | 20 | | | |
| PFWS 1-5 | 12:50 PM | NK 1-5 | 5:10 PM | 10 | | | |
| PFWS 1-6 | 2:23 PM | NK 1-6 | 5:10 PM | 10 | | | |

**Table 5 Collection times for samples collected during Day 2 injection event**

| Day 2<br>10 October 2022 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Sample** | **Time** | **Sample** | **Time** | **Horizontal distance from caisson (m)** | **Sample** | **Time** | **Horizontal distance from caisson (m)** |
| PFWS 2-1 | 8:20 AM | NK 2-1 | 4:19 PM | 20 | ROV 2-1 | 1:37 PM | 6 |
| PFWS 2-2 | 11:25 AM | NK 2-2 | 4:40 PM | 18 | ROV 2-2 | 3:49 PM | 1 |
| PFWS 2-3 | 12:14 PM | NK 2-3 | 5:19 PM | 35 | ROV 2-3 | 4:51 PM | 65 |
| PFWS 2-4 | 1:15 PM | | | | | | |
| PFWS 2-5 | 2:43 PM | | | | | | |
| PFWS 2-6 | 4:29 PM | | | | | | |
| PFWS 2-7 | 5:40 PM | | | | | | |
| PFWS 2-8 | 5:40 PM | | | | | | |

#### 2.3.2.1 PFW Stream Sampling

To allow the calculation of the plume dilution factors post discharge into the receiving environment, the concentration of dye within the PFW stream following injection, but prior to discharge into the dump caisson, needed to be determined. Before, during and following injection, samples were collected from a sampling tap in the PFW line downstream of the injection point but before the PFW entry into the dump caisson. These samples were then sent to the relevant laboratories and analysed for barium, TRH, PAH and RWT concentrations.

Samples were collected prior to injection and then approximately every 90 minutes during injection (Table 4 and Table 5).

#### 2.3.2.2 Insitu Plume Sampling and Monitoring by ROV

The primary means of sampling and monitoring the plume insitu was via a platform deployed Falcon 12366 ROV with a mounted Niskin bottle to collect water samples. A YSI multiparameter sonde equipped with temperature, salinity, depth, pH, turbidity and RWT sensors to collect physico-chemical profile data of the plume was also mounted to the ROV (Plate 2).

**Plate 2 ROV used for insitu sampling and monitoring**

Prior to each injection event, the ROV was launched and was positioned in view of the discharge caisson opening in order to observe the dye spiked plume exiting the caisson. As the plume became evident, the ROV would fly into the plume and aim to conduct vertical profiles from below, through and beyond the densest sections of the plume. RWT concentrations measured insitu by the sonde was relayed live through the ROV umbilical, which assisted the ROV operator and field scientist to discern the densest sections of the plume in addition to the live video feed vision.

Initially, during and following slack water, the visible plume moved slowly toward the south and underneath the platform through the jacket legs. Due to the risk of entanglement the ROV was not able to fly vertical profiles through the plume during this period. As the plume developed and started moving away from the caisson, the ROV would aim to fly further vertical profiles through the plume but moving with increasing distances away from the caisson for each profile, in the direction of the plume.

Physico-chemical data were collected for the duration of each dive. The horizontal distance from the caisson was determined through a sonar system on the ROV. Prior to each day's operations, the ROV, sonar and sonde clocks were synchronised to align the data sets and ensure that the horizontal distance away from caisson could be accurately determined for any physico-chemical data point recorded by the ROV sonde (Figure 4).

Worth noting is that the depth gauge on the ROV understated the depth by approximately 5 – 12 m depending on the actual depth at the time. This was confirmed by the ROV operator and is evident in Figure 4 where the depth is stated as 33 m even though the ROV was in front of the caisson opening, which is at 45 m depth.

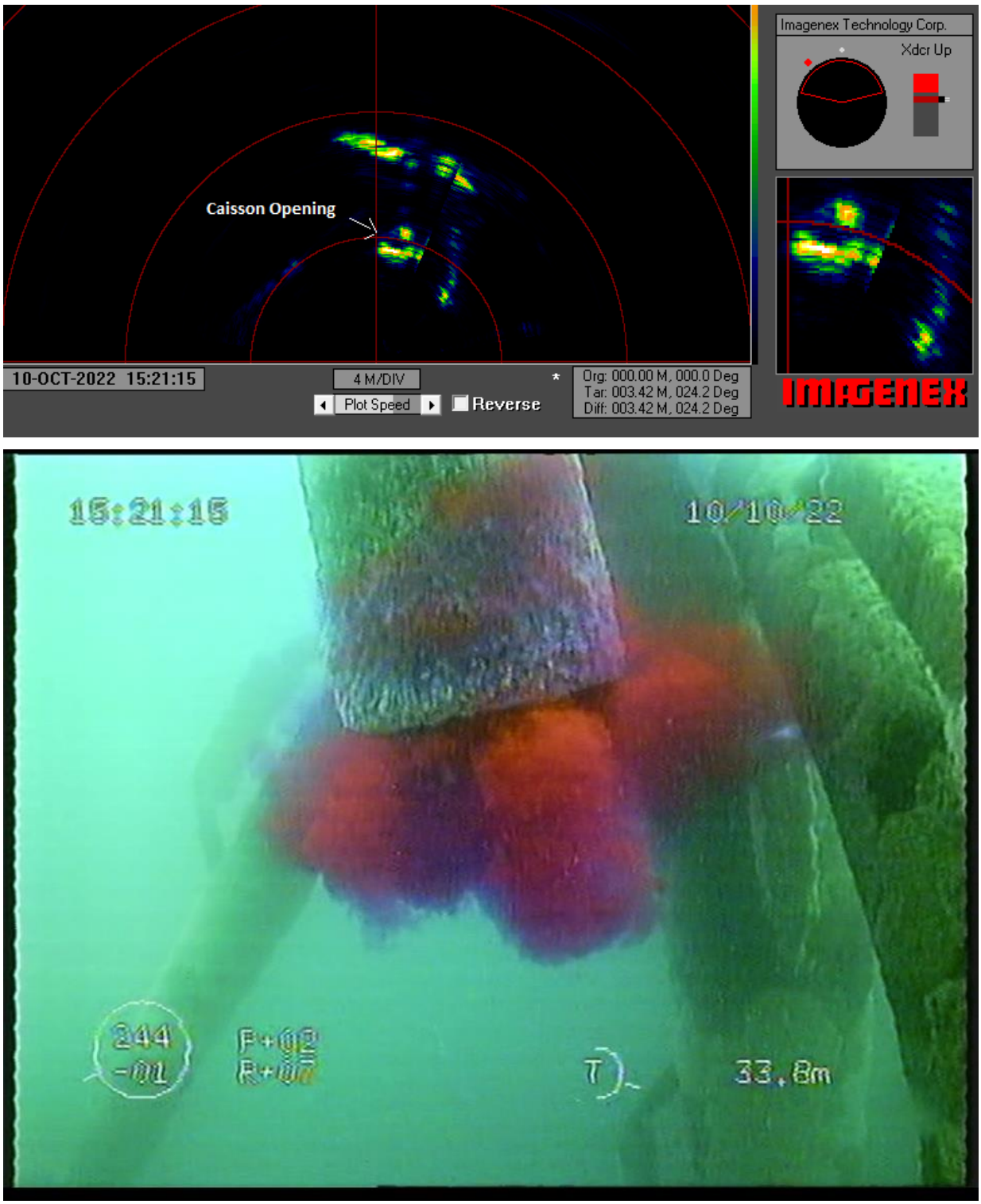


**Figure 4 Screenshot of the sonar data alongside the ROV video feed used to determine distance from the caisson**

Five insitu samples were collected (two on Day 1 [Table 4] and three on Day 2 [Table 5]) across the two injection events. Samples were collected within the plume at distances ranging from 1 m from the caisson out to 65 m away from the caisson within the direction of the plume, which was the limit of the sonar range.

As the ROV could only collect one sample per dive, and retrieval and redeployment of the ROV to decant a sample was generally quite time consuming, priority was given to keep the ROV deployed for as much as possible during each injection event to continue to collect physico-chemical and RWT profile data. Gaps in the physico-chemical data are those periods when the ROV was retrieved to decant a collected sample; with the exception of two notable instances.

During Day 1, the ROV sonde was initially set to record data on to the sonde handheld controller. However, at 11:04, the handheld controller unexpectedly went into standby mode resulting in no data being recorded for approximately 24 minutes. Upon realising this, the field team changed the sonde settings to record internally.

During Day 2, the ROV experienced a thruster malfunction requiring it to be retrieved at 11:51. It was able to be redeployed at 13:26, following repairs.

Table 6 lists the ROV deployment times.

**Table 6 Deployment and retrieval times for the ROV**

| | Deployment Time | Retrieval Time |
|---|---|---|
| **Day 1** | 8:55 | 14:28 |
| **9 October 2022** | 15:56 | 16:37 |
| **Day 2** | 10:41 | 11:51 |
| **10 October 2022** | 13:26 | 14:24 |
| | 14:33 | 15:56 |
| | 16:01 | 17:28 |

#### 2.3.2.3 Insitu Plume Sampling and Monitoring by Platform Deployed Niskin Bottle and Sonde

During both injection events, opportunistic insitu samples and profiles of the visible dye plume were collected using a Niskin bottle and multiparameter sonde deployed on a single line by hand from the platform. On both sampling days, however, upon review of the sonde data it appeared the sonde encountered data recording problems causing it to record abnormal readings such as elevated RWT readings out of the water, and frequently no measurements for up to 90 seconds. Following the survey, an investigation by the sonde supplier confirmed it was an issue related to a sensor wiper drawing too much current thus causing the system to momentarily turn off.

Nonetheless, where data were recorded the parameters such as depth and salinity appeared to be unaffected so in the absence of another sonde, the sonde was still used and, along with the Niskin bottle, was lowered on the same line so depth data could be captured for each sample as well as the insitu measured RWT concentration at the time of collection, however, due to the aforementioned issues the RWT data was deemed unreliable and discounted from subsequent data analysis in this report.

The Niskin bottle and sonde were deployed, where possible and accessible from the platform, into the densest section of the plume visible from the platform. The horizontal distance of the Niskin bottle and sonde away from the caisson was estimated based on the position on the platform from where it was lowered.

Given the aforementioned concerns around the sonde data, these data and the Niskin bottle samples are considered of lower accuracy compared to the data collected by the ROV with respect to the calculation of dilution factors across distance from the caisson.

**Plate 3 Platform deployed Niskin bottle and sonde**

#### 2.3.2.4 Sample Timing

Samples of the dye spiked PFW stream prior to entry into the dump caisson were collected approximately every 60-90 minutes during injection (Table 4 and Table 5). This provided data on the RWT concentration in the PFW stream prior to discharge and how it evolved. These data were required to calculate the dilution factor of the plume across horizontal distance away from the discharge point.

Insitu samples collected via the platform deployed Niskin bottle were collected when there was a plume visible from the platform, near or on the surface. Figure 5 shows the timing of those samples (Table 4 and Table 5) against the evolving tidal phase. It can be seen that the majority of the samples were collected once the tide was in full ebb phase and therefore when the tidal current speed was at its greatest for this stage of the tidal cycle. This is an important consideration in the context of the dilution across distance and with respect to the modelled dilution distances across different current speeds, particularly in the 2017 modelling as described in Section 1.5, which provides for dilutions over distance under low and high current speeds. This is discussed further in Section 3.4.

As can be seen in Figure 5, ROV collected samples were collected at both slower and higher current phases of the ebb tide, with the aim of capturing this variation.

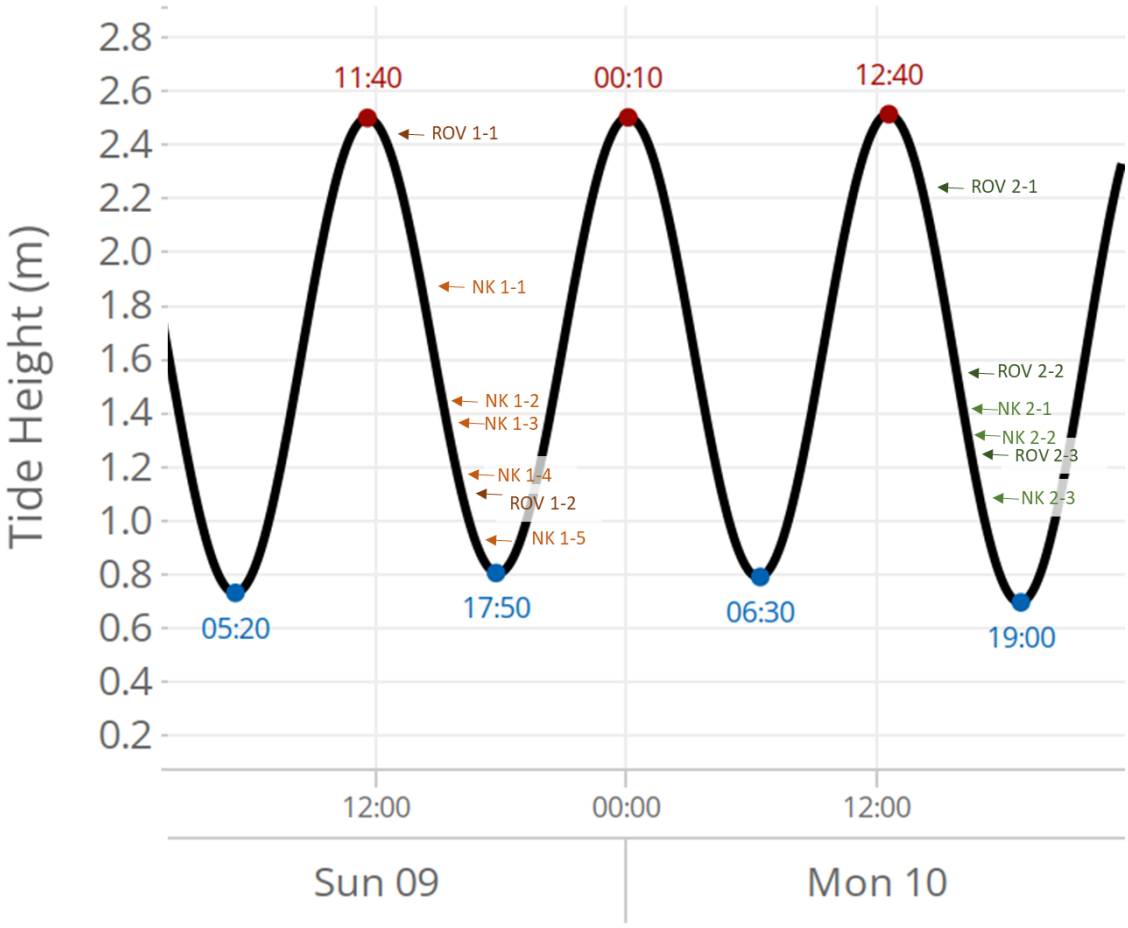


**Figure 5 Timings for high and low water during the sample dates with the time points of when insitu samples were collected**

### 2.3.3 Sample Analysis

On completion of the survey, all samples were delivered to the relevant laboratories for analysis of the parameters listed in Table 7.

The analysing laboratories were ALS Melbourne for the TRH (and TPH), PAH and barium analysis, and Marine and Freshwater Research Laboratories (MAFRL) in Perth who completed the rhodamine and also barium testing.

**Table 7 Field sample analysis parameters**

| Analyte | | Unit | LOR | Analysing Laboratory |
|---|---|---|---|---|
| TPH | C6 - C9 Fraction | µg/L | 20 | ALS |
| | C10 - C14 Fraction | µg/L | 50 | |
| | C15 - C28 Fraction | µg/L | 100 | |
| | C29 - C36 Fraction | µg/L | 50 | |
| | C10 - C36 Fraction (sum) | µg/L | 50 | |
| TRH | C6 - C10 Fraction | µg/L | 20 | |
| | C6 - C10 Fraction minus BTEX | µg/L | 20 | |
| | >C10 - C16 Fraction | µg/L | 100 | |
| | >C16 - C34 Fraction | µg/L | 100 | |
| | >C34 - C40 Fraction | µg/L | 100 | |
| | >C10 - C40 Fraction (sum) | µg/L | 100 | |
| | >C10 - C16 Fraction minus Naphthalene | µg/L | 100 | |

| Analyte | | Unit | LOR | Analysing Laboratory |
|---|---|---|---|---|
| BTEX | Benzene | µg/L | 1 | |
| | Toluene | µg/L | 2 | |
| | Ethylbenzene | µg/L | 2 | |
| | meta- & para-Xylene | µg/L | 2 | |
| | ortho-Xylene | µg/L | 2 | |
| | Total Xylenes | µg/L | 2 | |
| | Sum of BTEX | µg/L | 1 | |
| | Naphthalene | µg/L | 5 | |
| PAH | Naphthalene | µg/L | 0.02 | |
| | Acenaphthylene | µg/L | 0.02 | |
| | Acenaphthene | µg/L | 0.02 | |
| | Fluorene | µg/L | 0.02 | |
| | Phenanthrene | µg/L | 0.02 | |
| | Anthracene | µg/L | 0.02 | |
| | Fluoranthene | µg/L | 0.02 | |
| | Pyrene | µg/L | 0.02 | |
| | Benz(a)anthracene | µg/L | 0.02 | |
| | Chrysene | µg/L | 0.02 | |
| | Benzo(b+j)fluoranthene | µg/L | 0.02 | |
| | Benzo(k)fluoranthene | µg/L | 0.02 | |
| | Benzo(a)pyrene | µg/L | 0.005 | |
| | Indeno(1.2.3.cd)pyrene | µg/L | 0.02 | |
| | Dibenz(a.h)anthracene | µg/L | 0.02 | |
| | Benzo(g.h.i)perylene | µg/L | 0.02 | |
| | Total PAH | µg/L | 0.005 | |
| | Benzo(a)pyrene TEQ (zero) | µg/L | 0.005 | |
| Total Barium | - | µg/L | 1 | ALS and MAFRL |
| Rhodamine | High range | µg/L | 1 | MAFRL |
| | Low range | µg/L | 0.1 | |

## 2.4 Model Verification

To allow the calculation of the measured PFW dilution factors for comparison against modelled dilutions, the mean concentration of the predischarge (PFWS) samples was divided by the insitu collected sample concentrations and measurements. In the case of RWT, dilutions were then plotted against the horizontal distance from the discharge caisson. Horizontal distance was determined via the ROV sonar (for the ROV samples and measurements) and the location on the platform relative to the caisson topside opening, for the platform collected samples.

The primary data set by which the modelled dilution factors were assessed against are the insitu RWT concentrations as measured by the ROV mounted sonde data. This data set (from each day) provides the most reliable and broadest data capture of the plume across various current speeds and distances from the point of discharge as the tide and plume evolves.

The analytical chemical results of the insitu samples provide supporting data to characterise the plume dilutions and also verify that the plume is indeed sampled (given the sondes do not measure water chemistry such as hydrocarbon concentrations).

The analytical results of the insitu samples are presented in Section 3.0 along with their dilutions relative to the mean predischarge concentrations and the distance from the caisson that the samples were collected.

After the RWT dilutions were calculated and the distance from the caisson determined, they were then plotted against the modelled dilutions across distance. Comparisons of the field study data were made against both the near field (2017 [Figure 2]) and far field (2020 [Figure 3]) modelling results to ascertain over or under prediction of the plume dilution across horizontal distance from the caisson.

Across the two sampling days the PFW discharge rate ranged between 230 $m^3$ and 280 $m^3$ per day but remained relatively stable through most of each injection period (Figure 6 and Figure 7). On Day 1 the average rate was 255 $m^3$ per day and on Day 2 the average was 252 $m^3$ per day.

Comparisons of field study data are therefore made against the model outcomes from the 200 $m^3$ and 300 $m^3$ per day discharge scenarios, including all seasonal low (5$^{th}$ percentile) and high (95$^{th}$ percentile) current speed scenarios as presented in the 2017 near field modelling (Figure 2).

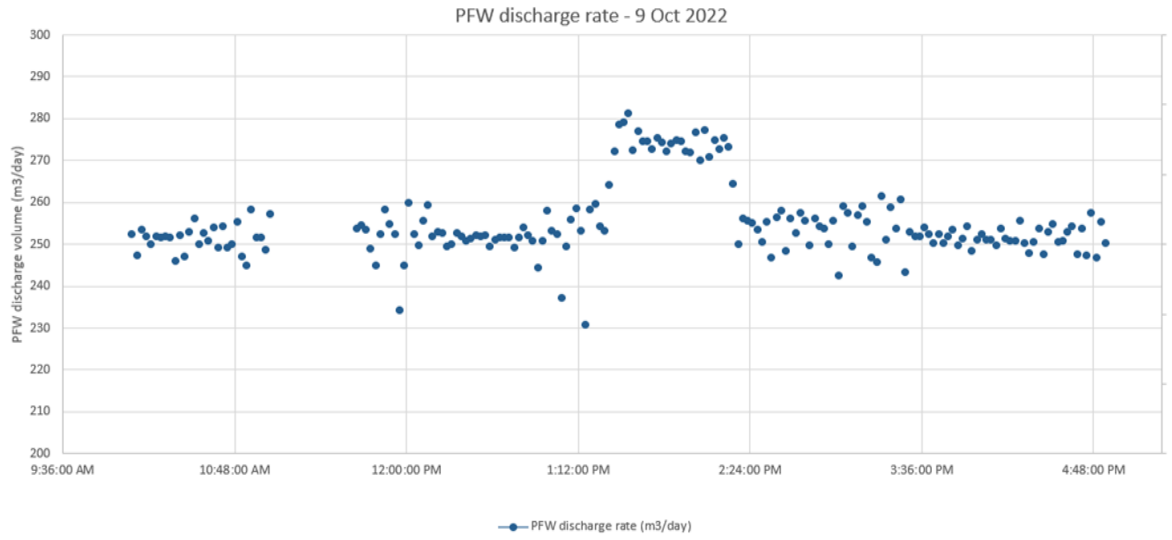


**Figure 6 PFW discharge rate during Day 1 (9 October 2022)**

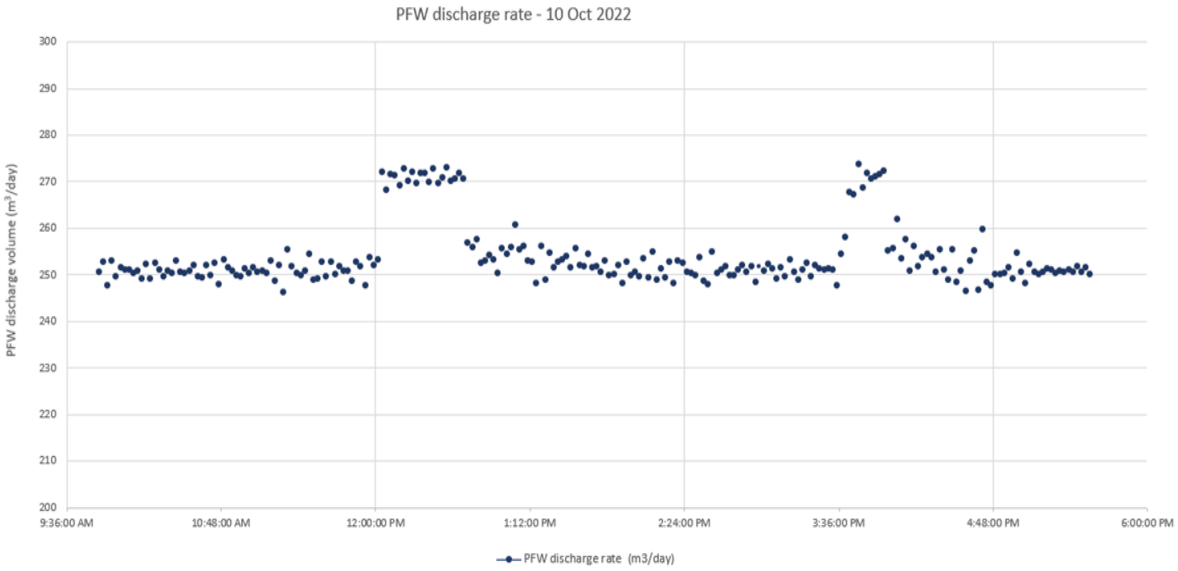


**Figure 7 PFW discharge rate during Day 2 (10 October 2022)**

# 3.0 Results

## 3.1 Field Observations and Plume Behaviour

Observations of the plume and currents were made by the field team during the injection dates.

ROV footage of the caisson revealed that the PFW does not discharge from the caisson at a steady rate but rather comes out in pulses. This was visibly evident for both the undyed and dyed PFW. During slack water on both sampling days the ROV observed the current to be initially flowing at low speed in a southerly direction and under the platform away from the caisson, which is located in the north-western corner of the platform jacket.

Through slack water and for a couple of hours following slack water, the plume displayed minimal movement away from the platform and instead would rise almost directly vertical and would dissipate quickly as it slowly rose without visibly reaching the surface. Due to the risk of entanglement within the jacket structure the ROV was not able to complete a vertical profile during this period.

After approximately two hours following slack water, the current direction gradually changed to westerly and by the completion of ROV activities, was flowing in a north-north westerly direction. During both sampling days the plume did not reach the surface for the majority of the injection time. Dye eventually reached the surface only towards the end of the day, close to the completion of the injection or after it, and once the current had changed to a north-westerly direction. Once it reached the surface it was highly visible and moved in a north-west to northerly direction.

## 3.2 Sampling Analytical Results and Comparison Against Model Dilutions

The results from the laboratory analysis of chemical constituents in the predischarge and insitu collected samples are provided in the following sections. A dilution factor is also calculated for each analyte in each sample by comparing the insitu sample concentrations against the mean of the predischarge sample concentrations. The calculated dilutions are compared, where possible, to the modelled dilutions (RPS 2017 and 2020) shown in Section 1.5.

The discharge rate during both days was on average between 252 and 255 $m^3$ per day. As the model dilutions do not provide specifically for this rate, the results are conservatively compared against the worst case scenario of 300 $m^3$ discharge rate per day.

It is also worth noting that, as discussed in Section 2.3.2.4, all the platform Niskin bottle samples (NK samples) on both days were collected during the peak current speed of the ebbing tide. This is an important consideration given that, with respect to the modelled dilutions, the modelling provides for both low current and high current conditions. The ROV samples were collected during both lower and faster stages of the ebbing tidal current.

The issued laboratory reports can be viewed in Appendix x

### 3.2.1 Total Barium

Results for total barium in all predischarge samples (PFWS samples) and insitu samples (NK and ROV samples) are presented in Table 8 and Table 9, along with the horizontal distances from the caisson where each sample was collected and the collection depth.

Dilution calculations for barium in the insitu samples relative to the predischarge concentrations are also listed. As it is not possible to link an insitu sample to any single predischarge sample, dilutions have been calculated based on the mean barium concentration across all the predischarge samples for each respective sampling day.

**Day 1 Samples**

The mean concentration in PFWS samples was 23,633 µg/L on Day 1 while the highest insitu concentration for total barium was 62 µg/L; reported in sample NK 1-5. The concentration reported by the laboratory ALS in sample NK 1-5, however, is considered unreliable for several reasons. The sample was collected up current and 10.5 m from the caisson, after the visible plume had disappeared. Sample NK 1-6, which was a duplicate of NK 1-5, reported a barium concentration of only 7 µg/L.

Finally, both samples were also tested for total barium by a second laboratory (MAFRL) who reported concentrations of only 7.5 µg/L and 6.5 µg/L, respectively. Therefore the result of 62 µg/L reported by ALS is considered to be an erroneous value.

The second highest reported concentration of total barium in insitu samples from Day 1, was 12 µg/L in sample NK 1-2. This concentration constitutes 1969 dilutions relative to the mean of the predischarge samples. NK 1-2 was collected at 10 m depth within the visible plume, and 15 m west of the caisson.

By comparison to the modelled dilutions relative to distance in the near field modelling (RPS 2017 report), under the 'worst case' discharge scenario of 300 $m^3$ per day (Section 1.5 and Figure 2), at 15 m from the caisson and under the lowest current speed ($5^{th}$ percentile) , the plume had reached only 1000 dilutions compared to the 1969 dilutions determined for barium in NK 1-2. Under the same 300 $m^3$ per day discharge scenario but under high current speed ($95^{th}$ percentile), the modelled plume had achieved only 200 dilutions at 17 m.

### Day 2 Samples

The mean total barium concentration of PFWS samples on Day 2 was 23,950 µg/L, while the highest insitu concentration was 14 µg/L reported in sample NK 2-2, which was collected 18 m from the caisson and at 10 m depth during higher current ebbing tide. This concentration constitutes a dilution factor of 1711 dilutions relative to the mean of the predischarge samples, which was the fewest dilutions observed from all Day 2 insitu samples.

In comparison to the near field modelled dilutions over horizontal distance, under the 300 $m^3$ per day discharge scenario for low current speed the maximum distance modelled was only 15.1 m, at which distance the plume was predicted to achieve 1000 dilutions, thus making it difficult to compare to the 18 m distance where NK 2-2 was collected. For the high current speed scenario under the same discharge volume, at 23 m from the caisson the plume was predicted to reach only 300 dilutions; far less than the 1711 dilutions determined for barium in NK 2-2 at 18 m away. Furthermore in the far field model outcomes (RPS 2020), which were informed by the near field outcomes, for the 300 $m^3$ per day discharge volume, the plume had only reached 70 – 100 dilutions at 26 m from the caisson.

**Table 8 Total barium results in pre discharge and insitu samples from Day 1**

| Sample date | Sample ID | Distance from caisson (m) | Depth (m) | | Barium | |
|---|---|---|---|---|---|---|
| | | | | | ALS Results | MAFRL Results |
| | | | | Units | µg/L | µg/L |
| | | | | LOR | 1 | 0.5 |
| 9/10/2022 | PFWS 1-1 | | | | 23800 | - |
| 9/10/2022 | PFWS 1-2 | | | | 23700 | - |
| 9/10/2022 | PFWS 1-3 | | | | 23700 | - |
| 9/10/2022 | PFWS 1-4 | | | | 24100 | - |
| 9/10/2022 | PFWS 1-5 | | | | 23100 | - |
| 9/10/2022 | PFWS 1-6 | | | | 23400 | - |
| | Mean (PFWS 1-1 – 1-6) | | | | 23633 | |
| 9/10/2022 | NK 1-1 | 5 | 40 | | 7 | 6.7 |
| | Number of dilutions# | | | | 3376 | 3527 |
| 9/10/2022 | NK 1-2 | 15 | 10 | | 12 | 10 |
| | Number of dilutions# | | | | 1969 | 2363 |
| 9/10/2022 | NK 1-3 | 15 | 5 | | 11 | 10 |
| | Number of dilutions# | | | | 2148 | 2363 |
| 9/10/2022 | NK 1-4 | 20 | 5 | | 11 | 9.8 |
| | Number of dilutions# | | | | 2148 | 2412 |
| 9/10/2022 | NK 1-5 | 10.5 | 5 | | 62 | 7.5 |
| | Number of dilutions# | | | | 381 | 3151 |
| 9/10/2022 | NK 1-6 | 10.5 | 5 | | 7 | 6.5 |

| | | Distance from caisson (m) | Depth (m) | | Barium | |
|---|---|---|---|---|---|---|
| | | | | | ALS Results | MAFRL Results |
| | Number of dilutions# | | | | 3376 | 3636 |
| 9/10/2022 | ROV 1-1 | 3 | 45 | | 6 | 8.1 |
| | Number of dilutions# | | | | 3939 | 2918 |
| 9/10/2022 | ROV 1-2 | 15 | 3 | | 9 | 7.4 |
| | Number of dilutions# | | | | 2626 | 3194 |

# Number of dilutions relative to the mean of PFWS 1-1 – PFWS 1-6

**Table 9 Total barium results in predischarge and insitu samples from Day 2**

| Sample date | Sample ID | Distance from Caisson (m) | Depth (m) | | Barium | |
|---|---|---|---|---|---|---|
| | | | | | ALS Results | MAFRL Results |
| | | | | Units | µg/L | µg/L |
| | | | | LOR | 1 | 0.5 |
| 10/10/2022 | PFWS 2-1 | | | | 22900 | |
| 10/10/2022 | PFWS 2-2 | | | | 24200 | |
| 10/10/2022 | PFWS 2-3 | | | | 23000 | |
| 10/10/2022 | PFWS 2-4 | | | | 24500 | |
| 10/10/2022 | PFWS 2-5 | | | | 23600 | |
| 10/10/2022 | PFWS 2-6 | | | | 23300 | |
| 10/10/2022 | PFWS 2-7 | | | | 25500 | |
| 10/10/2022 | PFWS 2-8 | | | | 24600 | |
| | Mean (PFWS 2-1 - 2-8) | | | | 23950 | |
| 10/10/2022 | NK 2-1 | 20 | 2 | | 7 | 6.4 |
| | Number of dilutions# | | | | 3421 | 3693 |
| 10/10/2022 | NK 2-2 | 18 | 10 | | 14 | 13 |
| | Number of dilutions# | | | | 1711 | 1818 |
| 10/10/2022 | NK 2-3 | 35 | 5 | | 7 | 6.2 |
| | Number of dilutions# | | | | 3421 | 3812 |
| 10/10/2022 | ROV 2-1 | 6 | 40 | | 7 | 6.4 |
| | Number of dilutions# | | | | 3421 | 3693 |
| 10/10/2022 | ROV 2-2 | 1 | 35 | | 7 | 6.5 |
| | Number of dilutions# | | | | 3421 | 3636 |
| 10/10/2022 | ROV 2-3 | 65 | 2 | | 10 | 6.4 |
| | Number of dilutions# | | | | 2395 | 3693 |

# Number of dilutions relative to the mean of PFWS 2-1 – PFWS 2-8

### 3.2.2 Total Petroleum Hydrocarbons and Total Recoverable Hydrocarbons

The analytical results for TPH and TRH from the predischarge and insitu samples from Day 1 and Day 2 are presented in Table 10 and Table 11.

Across the hydrocarbon fractions, the highest concentrations in the predischarge samples were reported for the short carbon chain fractions, namely C6-C9 and C6-C10. Within the insitu samples, concentrations of TPH and TRH above the LOR were reported only for the C6-C9 and C6-C10 range in both Day 1 and Day 2 samples.

### Day 1 Samples

From the Day 1 samples, NK 1-2 reported the concentrations of both the TPH and TRH fractions that underwent the fewest dilutions relative to the mean predischarge concentrations for those respective fractions of TPH and TRH.

NK 1-2 reported a TPH concentration of 100 µg/L for the C6-C9 fraction, constituting the TPH component that underwent the fewest dilutions, 957 relative to the mean predischarge concentration of 95,683 µg/L for that fraction. NK1-2 also reported a TRH concentration of 40 µg/L for the C6-C10 minus BTEX fraction, constituting a dilution factor of 693:1 compared to the predischarge mean of 27,700 µg/L, which was the lowest diluted fraction of the all the TRH results from Day 1. Sample NK 1-2 was collected 15 m from the caisson in 10 m depth.

In comparison to the modelled dilutions in the near field (RPS 2017) and far field modelling (RPS 2020), under the modelled low current speed for 300 $m^3$ per day, the plume had reached 1000 dilutions at 15 m. However, under the high current scenario the plume had only reached 200 dilutions at 17 m from the caisson compared to the 957 dilutions for TPH and 693 dilutions for TRH, measured in sample NK 1-2 at 15 m from the caisson.

For comparison with respect to the sample collected at the furthest horizontal distance away from the caisson on Day 1, sample NK 1-4 was collected at 20 m away and reported a TPH fraction C6-C9 concentration of 70 µg/L and TRH C6-C10 concentration of 80 µg/L, constituting 1367 and 1242 dilutions relative to the respective predischarge mean concentrations for those fractions.

### Day 2 Samples

From Day 2, sample NK 2-2, which was collected 18 m from the caisson and at 10 m depth, reported concentrations that constituted the fewest dilutions relative to the predischarge mean for both TPH and TRH. NK 2-2 reported a concentration of the TPH C6-C9 fraction of 160 µg/L and TRH C6-C10 concentration of 180 µg/L, constituting 591 and 551 dilutions respectively, relative to the respective predischarge means.

In comparing dilutions of sample NK 2-2 from Day 2 (collected at 18 m from the caisson) to the modelled dilutions, under the modelled low current speed for 300 $m^3$ per day, the plume had reached 1000 dilutions at 15 m. However, under the high current scenario the plume had only reached 300 dilutions at 23 m from the caisson compared to the 591 dilutions for TPH and 551 dilutions for TRH, measured in sample NK 2-2 at 18 m from the caisson under ebbing higher current speed and less than 300 $m^3$ per day discharge rate.

For comparison with respect to the furthest sampled distance from the caisson, sample ROV 2-3, which was collected 65 m away from the caisson at 2 m depth and in the direction of the visible plume, reported no detections of TPH or TRH above the respective LORs.

**Table 10 TPH and TRH results in predischarge and insitu samples from Day 1**

| | | | | | TPH | | | | | TRH | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample date | Sample ID | Distance from caisson (m) | Depth (m) | | C6 - C9 Fraction | C10 - C14 Fraction | C15 - C28 Fraction | C29 - C36 Fraction | C10 - C36 Fraction (sum) | C6 - C10 Fraction | C6 - C10 Fraction minus BTEX | >C10 - C16 Fraction | >C16 - C34 Fraction | >C34 - C40 Fraction | >C10 - C40 Fraction (sum) | >C10 - C16 Fraction minus Naphthalene |
| | | | | Units | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| | | | | LOR | 20 | 50 | 100 | 50 | 50 | 20 | 20 | 100 | 100 | 100 | 100 | 100 |
| 9/10/2022 | PFWS 1-1 | | | | 102000 | 56800 | 3280 | 60 | 60100 | 108000 | 31300 | 46900 | 2280 | <100 | 49200 | 45900 |
| 9/10/2022 | PFWS 1-2 | | | | 105000 | 83200 | 4870 | 110 | 88200 | 110000 | 31300 | 69900 | 3440 | <100 | 73300 | 69200 |
| 9/10/2022 | PFWS 1-3 | | | | 96500 | 62200 | 3500 | 80 | 65800 | 99300 | 27000 | 51800 | 2500 | <100 | 54300 | 50900 |
| 9/10/2022 | PFWS 1-4 | | | | 92900 | 65300 | 3550 | 80 | 68900 | 96000 | 26900 | 54700 | 2560 | <100 | 57300 | 53800 |
| 9/10/2022 | PFWS 1-5 | | | | 84800 | 76500 | 4660 | 120 | 81300 | 87200 | 24000 | 64600 | 3320 | <100 | 67900 | 63700 |
| 9/10/2022 | PFWS 1-6 | | | | 92900 | 85200 | 4200 | 100 | 89500 | 95600 | 25700 | 71400 | 3000 | <100 | 74400 | 70500 |
| | Mean (PFWS 1-1 – 1-6) | | | | 95683 | 71533 | 4010 | 92 | 75633 | 99350 | 27700 | 59883 | 2850 | <100 | 62733 | 59000 |
| 9/10/2022 | NK 1-1 | 5 | 40 | | <20 | <50 | <100 | <50 | <50 | <20 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| 9/10/2022 | NK 1-2 | 15 | 10 | | 100 | <50 | <100 | <50 | <50 | 110 | 40 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | 957 | - | - | - | - | 903 | 693 | - | - | - | - | - |
| 9/10/2022 | NK 1-3 | 15 | 5 | | 90 | <50 | <100 | <50 | <50 | 100 | 30 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | 1063 | - | - | - | - | 994 | 923 | - | - | - | - | - |
| 9/10/2022 | NK 1-4 | 20 | 5 | | 70 | <50 | <100 | <50 | <50 | 80 | 20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | 1367 | - | - | - | - | 1242 | 1385 | - | - | - | - | - |
| 9/10/2022 | NK 1-5 | 10.5 | 5 | | <20 | <50 | <100 | <50 | <50 | <20 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| 9/10/2022 | NK 1-6 | 10.5 | 5 | | <20 | <50 | <100 | <50 | <50 | <20 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| 9/10/2022 | ROV 1-1 | 3 | 45 | | <30 | <50 | <100 | <50 | <50 | <30 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| 9/10/2022 | ROV 1-2 | 15 | 3 | | <20 | <50 | <100 | <50 | <50 | <20 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |

# Number of dilutions relative to the mean of PFWS 1-1 – PFWS 1-6

**Table 11 TPH and TRH results in predischarge and insitu samples from Day 2**

| | | | | | TPH | | | | | TRH | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample date | Sample ID | Distance from Caisson (m) | Depth (m) | Units | C6 - C9 Fraction | C10 - C14 Fraction | C15 - C28 Fraction | C29 - C36 Fraction | C10 - C36 Fraction (sum) | C6 - C10 Fraction | C6 - C10 Fraction minus BTEX (F1) | >C10 - C16 Fraction | >C16 - C34 Fraction | >C34 - C40 Fraction | >C10 - C40 Fraction (sum) | >C10 - C16 Fraction minus Naphthalene (F2) |
| | | | | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| | | | | LOR | 20 | 50 | 100 | 50 | 50 | 20 | 20 | 100 | 100 | 100 | 100 | 100 |
| 10/10/2022 | PFWS 2-1 | | | | 107000 | 63500 | 4700 | 80 | 68300 | 119000 | 44800 | 52800 | 2990 | <100 | 55800 | 51500 |
| 10/10/2022 | PFWS 2-2 | | | | 84500 | 71800 | 4340 | 130 | 76300 | 87000 | 23900 | 60200 | 3120 | <100 | 63300 | 59400 |
| 10/10/2022 | PFWS 2-3 | | | | 85700 | 69700 | 3750 | 90 | 73500 | 88100 | 23500 | 58600 | 2720 | <100 | 61300 | 57700 |
| 10/10/2022 | PFWS 2-4 | | | | 92300 | 61700 | 3350 | 90 | 65100 | 94800 | 25100 | 51300 | 2450 | <100 | 53800 | 50500 |
| 10/10/2022 | PFWS 2-5 | | | | 89600 | 59300 | 3730 | 200 | 63200 | 92000 | 24500 | 49300 | 2860 | <100 | 52200 | 48500 |
| 10/10/2022 | PFWS 2-6 | | | | 99800 | 39000 | 1740 | 50 | 40800 | 104000 | 29700 | 32300 | 1440 | <100 | 33700 | 31500 |
| 10/10/2022 | PFWS 2-7 | | | | 101000 | 54000 | 2140 | <50 | 56100 | 106000 | 32000 | 44400 | 1650 | <100 | 46000 | 43500 |
| 10/10/2022 | PFWS 2-8 | | | | 96900 | 57900 | 2190 | <50 | 60100 | 102000 | 30700 | 47300 | 1690 | <100 | 49000 | 46400 |
| | Mean (PFWS 2-1 - 2-8) | | | | 94600 | 59612.5 | 3242.5 | 106.67 | 62925 | 99112.5 | 29275 | 49525 | 2365 | - | 51887.5 | 48625 |
| 10/10/2022 | NK 2-1 | 20 | 2 | | <20 | <50 | <100 | <50 | <50 | <20 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| 10/10/2022 | NK 2-2 | 18 | 10 | | 160 | <50 | <100 | <50 | <50 | 180 | 50 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | 591 | - | - | - | - | 551 | 586 | - | - | - | - | - |
| 10/10/2022 | NK 2-3 | 35 | 5 | | <20 | <50 | <100 | <50 | <50 | <20 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| 10/10/2022 | ROV 2-1 | 6 | 40 | | <20 | <50 | <100 | <50 | <50 | <20 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |
| 10/10/2022 | ROV 2-2 | 1 | 35 | | 60 | <50 | <100 | <50 | <50 | 60 | 20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | 1577 | - | - | - | - | 1652 | 1464 | - | - | - | - | - |
| 10/10/2022 | ROV 2-3 | 65 | 2 | | <20 | <50 | <100 | <50 | <50 | <20 | <20 | <100 | <100 | <100 | <100 | <100 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - | - | - | - | - |

# Number of dilutions relative to the mean of PFWS 2-1 – PFWS 2-8

### 3.2.3 BTEX Results

The analytical results for BTEX from the predischarge and insitu samples from Day 1 and Day 2 are presented in Table 12 and Table 13.

Amongst the BTEX species, benzene and toluene reported concentrations that were the least diluted relative to the mean predischarge concentration.

**Day 1 Samples**

Out of all the insitu samples collected on Day 1, sample NK 1-2 reported concentrations of benzene and toluene which constituted the fewest dilutions relative to the predischarge samples.

NK 1-2, which was collected 15 m from the caisson and at 10 m depth, reported a benzene concentration of 30 µg/L and a toluene concentration of 35 µg/L, constituting dilutions of 675 and 964, respectively, relative to the mean predischarge concentration.

In comparing these results to the modelling, in the near field modelling for 300 $m^3$ per day under low current speed, the plume had achieved 1000 dilutions at 15 m from the caisson compared to the 675 and 964 dilutions observed for benzene and toluene, respectively, at 15 m from the caisson. Under high current speeds, the modelled plume only achieved 200 dilutions at 17 m from the caisson compared to the aforementioned dilutions for benzene and toluene at 15 m from the caisson. Compared to the far field modelling results, which predicted dilutions during the month of slowest currents speeds (May), the dilutions determined for benzene and toluene in sample NK 1-2 were greater than the model prediction of only 100 dilutions at 26 m from the caisson.

By reference, sample NK 1-4, which was collected 20 m from the caisson and 5 m depth, reported a benzene concentration of 27 µg/L and a toluene concentration of 32 µg/L, constituting dilutions of 750 and 1055, respectively, relative to the mean predischarge concentration.

**Day 2 Samples**

Out of all the insitu samples collected on Day 2, sample NK 2-2 reported concentrations of benzene and toluene which constituted the fewest dilutions relative to the predischarge samples.

Sample NK 2-2, which was collected 18 m from the caisson and at 10 m depth, reported a benzene concentration of 51 µg/L and a toluene concentration of 59 µg/L, constituting dilutions of 385 and 560, respectively, relative to the mean predischarge concentration.

In comparison to the modelled dilutions for the low current speed, benzene and toluene in sample NK 2-2 had undergone fewer dilutions compared to the same distance in the modelling (1000 dilutions at 15 m). However, under high current speed the modelled plume had only undergone 300 dilutions at 23 m from the caisson. Compared to the far field modelling results the dilutions determined for benzene and toluene in sample NK 2-2 were greater than the model prediction of only 100 dilutions at 26 m from the caisson.

By reference, sample ROV 2-3, which was collected 65 m from the caisson in the direction of the plume and at 2 m depth, reported no detections of any BTEX species above the LORs.

**Table 12 BTEX results in predischarge and insitu samples from Day 1**

| Sample date | Sample ID | Distance from caisson (m) | Depth (m) | Units | BTEX | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Benzene | Toluene | Ethylbenzene | meta- & para-Xylene | ortho-Xylene | Total Xylenes | Sum of BTEX | Naphthalene |
| | | | | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| | | | | LOR | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 5 |
| 9/10/2022 | PFWS 1-1 | | | | 23700 | 36000 | 1160 | 12600 | 3270 | 15900 | 76700 | 970 |
| 9/10/2022 | PFWS 1-2 | | | | 22700 | 37200 | 1300 | 13900 | 3630 | 17500 | 78700 | 732 |
| 9/10/2022 | PFWS 1-3 | | | | 19700 | 34500 | 1200 | 13400 | 3530 | 16900 | 72300 | 928 |
| 9/10/2022 | PFWS 1-4 | | | | 18800 | 32600 | 1170 | 13100 | 3440 | 16500 | 69100 | 928 |
| 9/10/2022 | PFWS 1-5 | | | | 17100 | 29800 | 1050 | 12000 | 3220 | 15200 | 63200 | 892 |
| 9/10/2022 | PFWS 1-6 | | | | 19500 | 32400 | 1180 | 13300 | 3520 | 16800 | 69900 | 879 |
| | Mean (PFWS 1-1 – 1-6) | | | | 20250 | 33750 | 1177 | 13050 | 3435 | 16467 | 71650 | 888 |
| 9/10/2022 | NK 1-1 | 5 | 40 | | 1 | <2 | <2 | <2 | <2 | <2 | 1 | <5 |
| | Number of dilutions# | | | | 20250 | - | - | - | - | - | 71650 | - |
| 9/10/2022 | NK 1-2 | 15 | 10 | | 30 | 35 | <2 | 8 | 2 | 10 | 75 | <5 |
| | Number of dilutions# | | | | 675 | 964 | - | 1631 | 1718 | 1647 | 955 | - |
| 9/10/2022 | NK 1-3 | 15 | 5 | | 27 | 32 | <2 | 7 | <2 | 7 | 66 | <5 |
| | Number of dilutions# | | | | 750 | 1055 | - | 1864 | - | 2352 | 1086 | - |
| 9/10/2022 | NK 1-4 | 20 | 5 | | 23 | 26 | <2 | 6 | <2 | 6 | 55 | <5 |
| | Number of dilutions# | | | | 880 | 1298 | - | 2175 | - | 2744 | 1303 | - |
| 9/10/2022 | NK 1-5 | 10.5 | 5 | | 2 | 2 | <2 | <2 | <2 | <2 | 4 | <5 |
| | Number of dilutions# | | | | 10125 | 16875 | - | - | - | - | 17913 | - |
| 9/10/2022 | NK 1-6 | 10.5 | 5 | | 2 | <2 | <2 | <2 | <2 | <2 | 2 | <5 |
| | Number of dilutions# | | | | 10125 | - | - | - | - | - | 35825 | - |
| 9/10/2022 | ROV 1-1 | 3 | 45 | | <5 | <8 | <2 | <4 | <2 | <2 | <1 | <5 |
| | Number of dilutions# | | | | - | - | - | - | - | - | - | - |
| 9/10/2022 | ROV 1-2 | 15 | 3 | | 4 | 5 | <2 | <2 | <2 | <2 | 9 | <5 |
| | Number of dilutions# | | | | 5063 | 6750 | - | - | - | - | 7961 | - |

# Number of dilutions relative to the mean of PFWS 1-1 – PFWS 1-6

**Table 13 BTEX results in predischarge and insitu samples from Day 2**

| Sample date | Sample ID | Distance from Caisson (m) | Depth (m) | | BTEX | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Benzene | Toluene | Ethylbenzene | meta- & para-Xylene | ortho-Xylene | Total Xylenes | Sum of BTEX | Naphthalene |
| | | | | Units | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| | | | | LOR | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 5 |
| 10/10/2022 | PFWS 2-1 | | | | 20700 | 34600 | 1240 | 14000 | 3680 | 17700 | 74200 | 1260 |
| 10/10/2022 | PFWS 2-2 | | | | 17100 | 30000 | 1050 | 11800 | 3160 | 15000 | 63100 | 846 |
| 10/10/2022 | PFWS 2-3 | | | | 18100 | 30600 | 1050 | 11700 | 3140 | 14800 | 64600 | 907 |
| 10/10/2022 | PFWS 2-4 | | | | 20400 | 32700 | 1090 | 12200 | 3290 | 15500 | 69700 | 840 |
| 10/10/2022 | PFWS 2-5 | | | | 18900 | 32300 | 1080 | 12000 | 3250 | 15200 | 67500 | 789 |
| 10/10/2022 | PFWS 2-6 | | | | 21800 | 35000 | 1180 | 12900 | 3390 | 16300 | 74300 | 760 |
| 10/10/2022 | PFWS 2-7 | | | | 20200 | 35300 | 1240 | 13600 | 3610 | 17200 | 74000 | 867 |
| 10/10/2022 | PFWS 2-8 | | | | 19700 | 33800 | 1190 | 13100 | 3520 | 16600 | 71300 | 846 |
| | Mean (PFWS 2-1 - 2-8) | | | | 19612.5 | 33037.5 | 1140 | 12662.5 | 3380 | 16037.5 | 69837.5 | 889.375 |
| 10/10/2022 | NK 2-1 | 20 | 2 | | <1 | <2 | <2 | <2 | <2 | <2 | <1 | <5 |
| | Number of dilutions[#] | | | | - | - | - | - | - | - | - | - |
| 10/10/2022 | NK 2-2 | 18 | 10 | | 51 | 59 | <2 | 14 | 3 | 17 | 127 | <5 |
| | Number of dilutions[#] | | | | 385 | 560 | - | 904 | 1127 | 943 | 550 | - |
| 10/10/2022 | NK 2-3 | 35 | 5 | | <1 | <2 | <2 | <2 | <2 | <2 | <1 | <5 |
| | Number of dilutions[#] | | | | - | - | - | - | - | - | - | - |
| 10/10/2022 | ROV 2-1 | 6 | 40 | | <1 | <5 | <2 | <4 | <2 | <2 | <1 | <5 |
| | Number of dilutions[#] | | | | - | - | - | - | - | - | - | - |
| 10/10/2022 | ROV 2-2 | 1 | 35 | | 5 | 18 | <2 | 11 | 2 | 13 | 36 | <5 |
| | Number of dilutions[#] | | | | 3923 | 1835 | - | 1151 | 1690 | 1234 | 1940 | - |
| 10/10/2022 | ROV 2-3 | 65 | 2 | | <1 | <2 | <2 | <2 | <2 | <2 | <1 | <5 |
| | Number of dilutions[#] | | | | - | - | - | - | - | - | - | - |

# Number of dilutions relative to the mean of samples PFWS 2-1 – PFWS 2-8

### 3.2.4 Polynuclear Aromatic Hydrocarbon Results

Of the PAH species tested for, only naphthalene was detected above the LOR in insitu samples, and only on Day 1 (Table 14).

As with the other chemical results, sample NK 1-2, which was collected 15 m from the caisson at 10 m depth, reported the highest naphthalene concentration (0.08 µg/L) and thus the lowest dilution factor (10,788:1) relative to the predischarge mean.

For reference, , sample NK 1-4, which was collected 20 m from the caisson at 5 m depth, reported a concentration of 0.06 µg/L which constitutes 14,383 dilutions relative to the predischarge mean.

Both the aforementioned samples reported concentrations of naphthalene that, relative to the predischarge mean concentration, had undergone substantially more dilutions at the sampled distances from the caisson compared to the modelled dilutions for those same or greater distances.

**Table 14 PAH results in predischarge and insitu samples from Day 1**

| Sample date | Sample ID | Distance from caisson (m) | Depth (m) | Units | Naphthalene µg/L | Total PAH µg/L |
|---|---|---|---|---|---|---|
| | | | | LOR | 0.02 | 0.005 |
| 9/10/2022 | PFWS 1-1 | | | | 981 | 1030 |
| 9/10/2022 | PFWS 1-2 | | | | 730 | 775 |
| 9/10/2022 | PFWS 1-3 | | | | 853 | 891 |
| 9/10/2022 | PFWS 1-4 | | | | 948 | 982 |
| 9/10/2022 | PFWS 1-5 | | | | 888 | 922 |
| 9/10/2022 | PFWS 1-6 | | | | 778 | 809 |
| | Mean (PFWS 1-1 – 1-6) | | | | 863 | 901.5 |
| 9/10/2022 | NK 1-1 | 5 | 40 | | <0.02 | <0.005 |
| | Number of dilutions# | | | | - | - |
| 9/10/2022 | NK 1-2 | 15 | 10 | | 0.08 | 0.08 |
| | Number of dilutions# | | | | 10788 | 11269 |
| 9/10/2022 | NK 1-3 | 15 | 5 | | 0.06 | 0.06 |
| | Number of dilutions# | | | | 14383 | 15025 |
| 9/10/2022 | NK 1-4 | 20 | 5 | | 0.06 | 0.06 |
| | Number of dilutions# | | | | 14383 | 15025 |
| 9/10/2022 | NK 1-5 | 10.5 | 5 | | <0.02 | <0.005 |
| | Number of dilutions# | | | | - | - |
| 9/10/2022 | NK 1-6 | 10.5 | 5 | | <0.02 | <0.005 |
| | Number of dilutions# | | | | - | - |
| 9/10/2022 | ROV 1-1 | 3 | 45 | | 0.2 | 0.2 |
| | Number of dilutions# | | | | 4315 | 4508 |
| 9/10/2022 | ROV 1-2 | 15 | 3 | | 0.07 | 0.07 |
| | Number of dilutions# | | | | 12329 | 12879 |

# Number of dilutions relative to the mean of PFWS 1-1 – PFWS 1-6

### 3.2.5 RWT Results

Table 15 and Table 16 presents the results of the sample analysis for RWT for predischarge (PFWS samples) and insitu samples (NK and ROV samples). The number of dilutions of insitu samples relative to the mean predischarge concentration is also provided. It is worth noting that the mean has been calculated only from those samples collected during active injection. For injection times and rates refer to Section 2.2

**Day 1 Samples**

The variance in the RWT concentrations in the predischarge samples are as a result of the injection rate changes (Section 2.2). On Day 1 the injection rate started low but was gradually raised through the injection period. As a result, the RWT concentration increased from an initial concentration of 3590 µg/L shortly following injection commencing to a peak of 23,500 µg/L when the injection rate was highest at the end of the injection period.

Sample NK 1-5¸ which was collected 15 m from the caisson and at 10 m depth, reported the highest RWT concentration of all the insitu samples at 5.5 µg/L and thus the lowest dilution factor of 2107 dilutions relative to the mean predischarge concentration. This dilution factor was greater than the modelled number of dilutions for the plume of 1000 at 15 m under low current conditions, and 200 dilutions at 17 m under high current conditions.

**Day 2 Samples**

On day 2, the injection initially commenced at a high rate but was reduced slightly through the middle injection period before being raised again towards the end of the injection period. Sample PFWS 2-2 was the first sample collected after injection had commenced, while sample PFWS 2-6 was the last sample collected before injection finished. Therefore the mean predischarge concentrations has been calculated from the samples PFWS 2-2 to 2-6 only.

Sample NK 2-2, which was collected 18 m from the caisson in 5 m depth, reported the RWT concentration of the insitu samples at 7.6 µg/L and thus the lowest dilution factor of 2916 dilutions relative to the mean predischarge concentration. This dilution factor was greater than the modelled number of dilutions for the plume of 1000 at 15 m under low current conditions, 300 dilutions at 17 m under high current conditions, and 100 dilutions at 26 m under the lowest monthly current conditions as determined in the 2020 far field modelling.

**Table 15 RWT results in predischarge and insitu samples from Day 1**

| Sample ID | Sample Date | Distance from Caisson | Unit | RWT |
|---|---|---|---|---|
| | | | LOR | µg/L |
| | | | | <0.1 / <1 |
| | | | Sample Time | | Number of dilutions[#] |
| PFWS 1-2 | 9/10/2022 | - | 9:08 AM | 3590 | |
| PFWS 1-3 | 9/10/2022 | - | 10:12 AM | 5670 | |
| PFWS 1-4 | 9/10/2022 | - | 11:40 AM | 13600 | |
| PFWS 1-5 | 9/10/2022 | - | 12:50 PM | 23500 | |
| PFWS 1-6 | 9/10/2022 | - | 2:23 PM | 12 | |
| Mean (PFWS 1-2 - 1-5) | | | | 11590 | |
| NK 1-1 | 9/10/2022 | 5 | 1:46 PM | <0.1 | - |
| NK 1-2 | 9/10/2022 | 15 | 3:12 PM | 5.5 | 2107 |
| NK 1-3 | 9/10/2022 | 15 | 3:25 PM | 1.2 | 9658 |
| NK 1-4 | 9/10/2022 | 20 | 4:10 PM | 1.6 | 7244 |
| NK 1-5 | 9/10/2022 | 10.5 | 5:10 PM | <0.1 | - |
| NK 1-6 | 9/10/2022 | 10.5 | 5:10 PM | <0.1 | - |
| ROV 1-1 | 9/10/2022 | 3 | 11:56 AM | 0.3 | 38633 |
| ROV 1-2 | 9/10/2022 | 15 | 4:20 PM | 0.2 | 57950 |

# Number of dilutions relative to the mean of PFWS 1-1 – PFWS 1-5

**Table 16 RWT results in predischarge and insitu samples from Day 2**

| Sample ID | Sample Date | Distance from Caisson | Unit | RWT µg/L | Number of dilutions[#] |
|---|---|---|---|---|---|
| | | | LOR | <0.1 / <1 | |
| | | | Sample Time | | |
| PFWS 2-1 | 10/10/2022 | - | 8:20 AM | <1 | |
| PFWS 2-2 | 10/10/2022 | - | 11:25 AM | 25200 | |
| PFWS 2-3 | 10/10/2022 | - | 12:14 PM | 18400 | |
| PFWS 2-4 | 10/10/2022 | - | 1:15 PM | 17800 | |
| PFWS 2-5 | 10/10/2022 | - | 2:43 PM | 22600 | |
| PFWS 2-6 | 10/10/2022 | - | 4:29 PM | 26800 | |
| PFWS 2-7 | 10/10/2022 | - | 5:40 PM | 7 | |
| PFWS 2-8 | 10/10/2022 | - | 5:40 PM | 7 | |
| Mean (PFWS 2-2 - 2-6) | | | | 22160 | |
| NK 2-1 | 10/10/2022 | 20 | 4:19 PM | <0.1 | - |
| NK 2-2 | 10/10/2022 | 18 | 4:40 PM | 7.6 | 2916 |
| NK 2-3 | 10/10/2022 | 35 | 5:19 PM | <0.1 | - |
| ROV 2-1 | 10/10/2022 | 6 | 1:37 PM | <0.1 | |
| ROV 2-2 | 10/10/2022 | 1 | 3:49 PM | 0.2 | 110800 |
| ROV 2-3 | 10/10/2022 | 65 | 4:51 PM | <0.1 | - |

# Number of dilutions relative to the mean of PFWS 2-2 – PFWS 2-6

## 3.3 Physico-chemical Results

Temperature, salinity and turbidity on both days varied very little across depth, and in the presence of the visible plume, with none of those three parameters appearing to be indicative of a signature for the plume. Figure 8 provides a snapshot of the data from the Day 2 ROV dive profiles to illustrate this.

pH, however, did appear to be an indicator for the plume and, as illustrated in Figure 9, the insitu pH would experience a distinctive drop in level whenever the ROV encountered elevated RWT concentrations.

Of note is the distinctive spike in RWT concentration at 11:14 am on Day 2, which can be seen in Figure 8 and Figure 9. This spike is, however, considered erroneous (or at least not due to actual RWT insitu) for several reasons; there is no corresponding dip in pH at the time of the spike (Figure 9), no dye was visible in the ROV video at any time around this spike, and finally, injection of dye had commenced only 12 minutes prior to this reading (Table 1), which is not enough time for the dye to have made its way to the bottom of the caisson. Upon consultation with the sonde supplier, this spike is likely as a result of chlorophyll fluorescence from blue green algae floating across the sensor. Lots of floating particles can be seen in the ROV footage at this time, which does support this possibility.

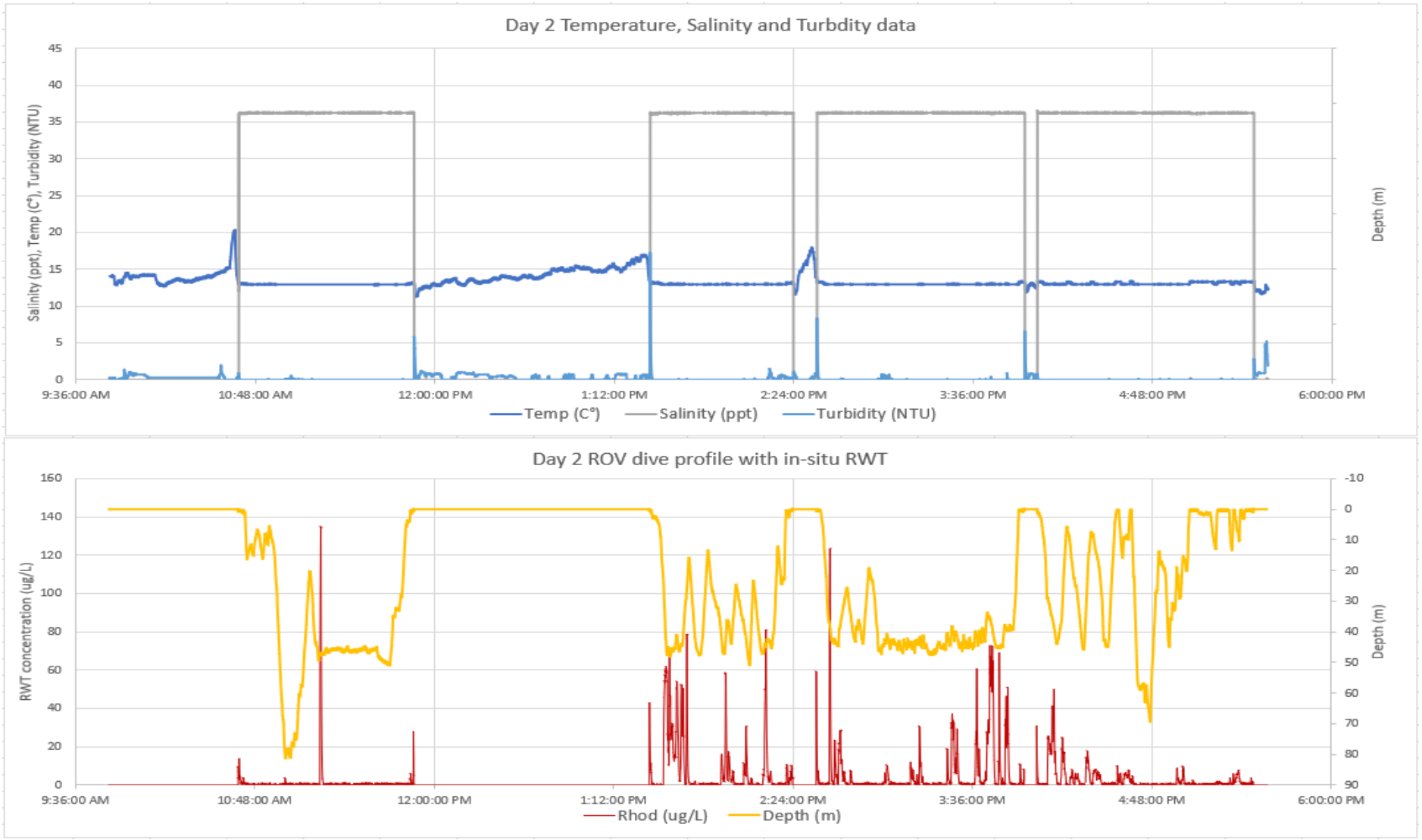


**Figure 8 Day 2 Temperature, salinity and turbidity data (top) along with Day 2 ROV dive profile with measured insitu RWT concentrations (bottom)**

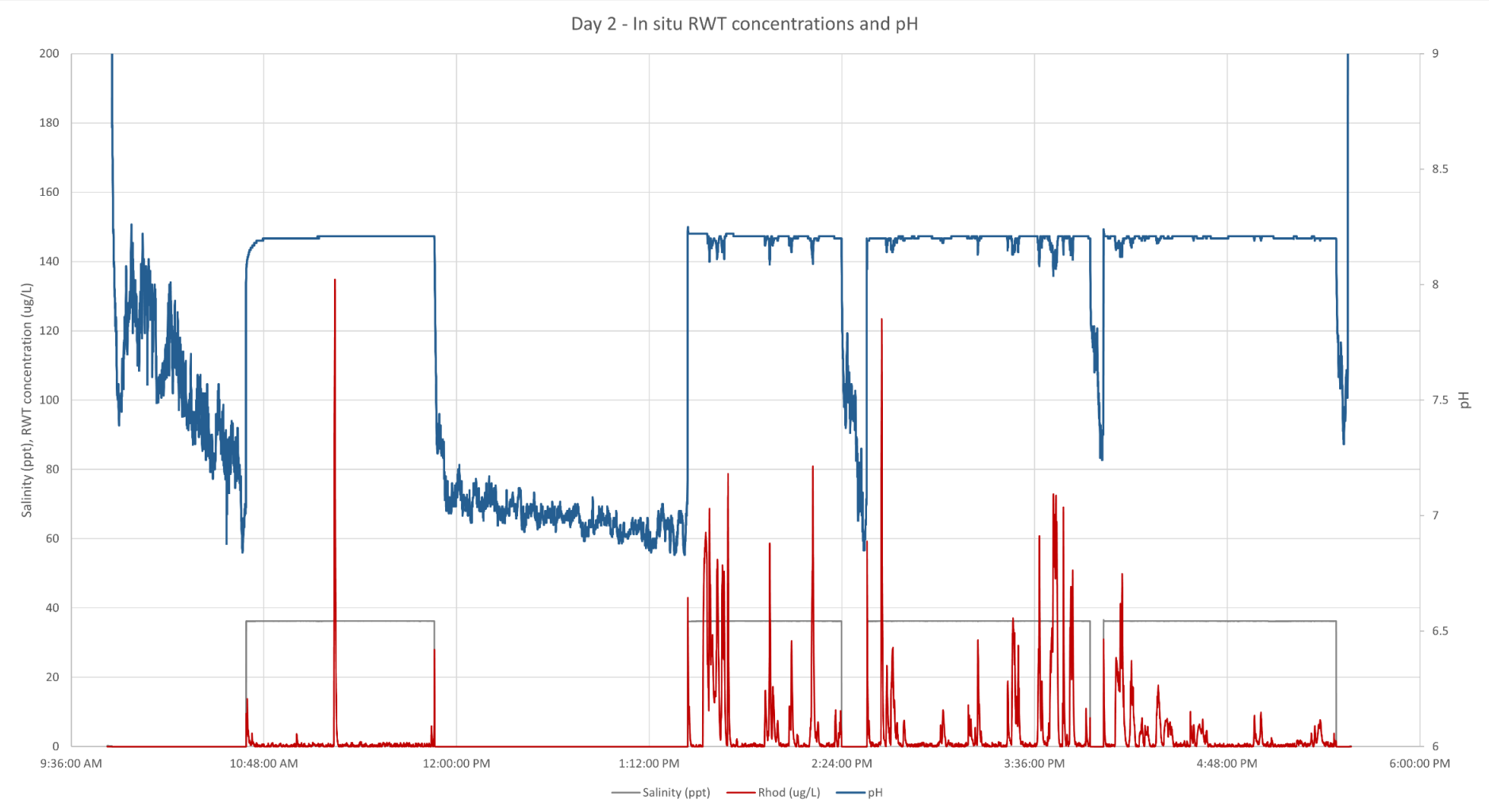


**Figure 9 Day 2 insitu RWT concentrations and pH measurements**

## 3.4 Insitu ROV RWT Dilution and vs. Model Dilution Results

Dilutions of the insitu RWT concentrations relative to the predischarge concentrations were calculated by dividing the mean of the predischarge sample concentrations (Table 15 and Table 16) by the insitu concentrations measured by the ROV sonde. RWT dilutions were then plotted against horizontal distance from the caisson for each measured data point.

Figure 10 and Figure 11 presents a visual comparison between the as measured dilutions and the modelled dilutions for each sample day. The figure shows the results of the insitu RWT dilutions plotted against horizontal distance from the caisson along with the modelled dilutions across distance from the near field modelling (2017) and far field modelling (2020). From the near field modelling, both the low current (5$^{th}$ percentile) and high current (95$^{th}$ percentile) results are shown along with a calculated 'average' curve based on the average of the 5$^{th}$ and 95$^{th}$ percentile current speed distances. As the discharge volume during the two sampling days ranged between 230 m$^3$ and 280 m$^3$ per day, only the model outcomes from the 200 m$^3$ and 300 m$^3$ per day discharge scenarios are presented.

As the data in Figure 10 and Figure 11 illustrate, the RWT concentration measured insitu by the ROV sonde indicates that the RWT spiked plume dispersed and diluted at a similar or greater rate than predicted by the modelling. All recorded insitu RWT concentrations were lower, and therefore more dilute, than the model concentrations across the same distance, for all high current (95$^{th}$ percentile) and 'average' current speeds scenarios, for both the 200 m$^3$ and 300 m$^3$ per day scenarios. Two brief data points are worth noting, however.

During Day 1 (Figure 10), the measured insitu dilutions were fewer than the modelled dilutions in the 2017 modelling for the 5$^{th}$ percentile (lowest modelled) current speed for both the 200 m$^3$ and 300 m$^3$ per day discharge scenarios. This concentration was measured at 8 m from the caisson at 39 m depth and occurred at 1:11 pm, which is approximately one and a half hours following slack water (Section 2.3.2.4)

On Day 2 (Figure 11), at 1:41 pm the measured dilutions were also recorded lower than the 2017 modelled dilutions for the 5$^{th}$ percentile current speed for both the 200 m$^3$ and 300 m$^3$ per day discharge scenarios. The reading was made at 7 m from the caisson and in 29 m water depth. As with the Day 1 occurrence this also occurred approximately one hour after slack water. However, at the time of this spike in RWT, no dye was visible in the water and nor did the sonde record a corresponding dip in pH value as was evident in all other instances when an elevated RWT concentration was recorded. As such, this data point is likely not RWT and possibly, a result of chlorophyll fluorescence from blue green algae floating across the sensor. Lots of floating particles can be seen in the ROV footage at this time, which does support this possibility.

Both events occurred not long after slack water. It was observed by the ROV that the current during, and for a period following, slack water flowed very slowly and the dye plume also rose very slowly. It is likely that the Day 1 occurrence can be attributed to a dense pulse of PFW during a period of very slow water movement and thus minimal dilution. However, as the current speed increased the plume would have dispersed and diluted more quickly. This is supported by the measurements taken during the subsequent stages of the tidal cycle where the recorded dilutions were greater than the modelled dilutions for all data points across all distances measured.

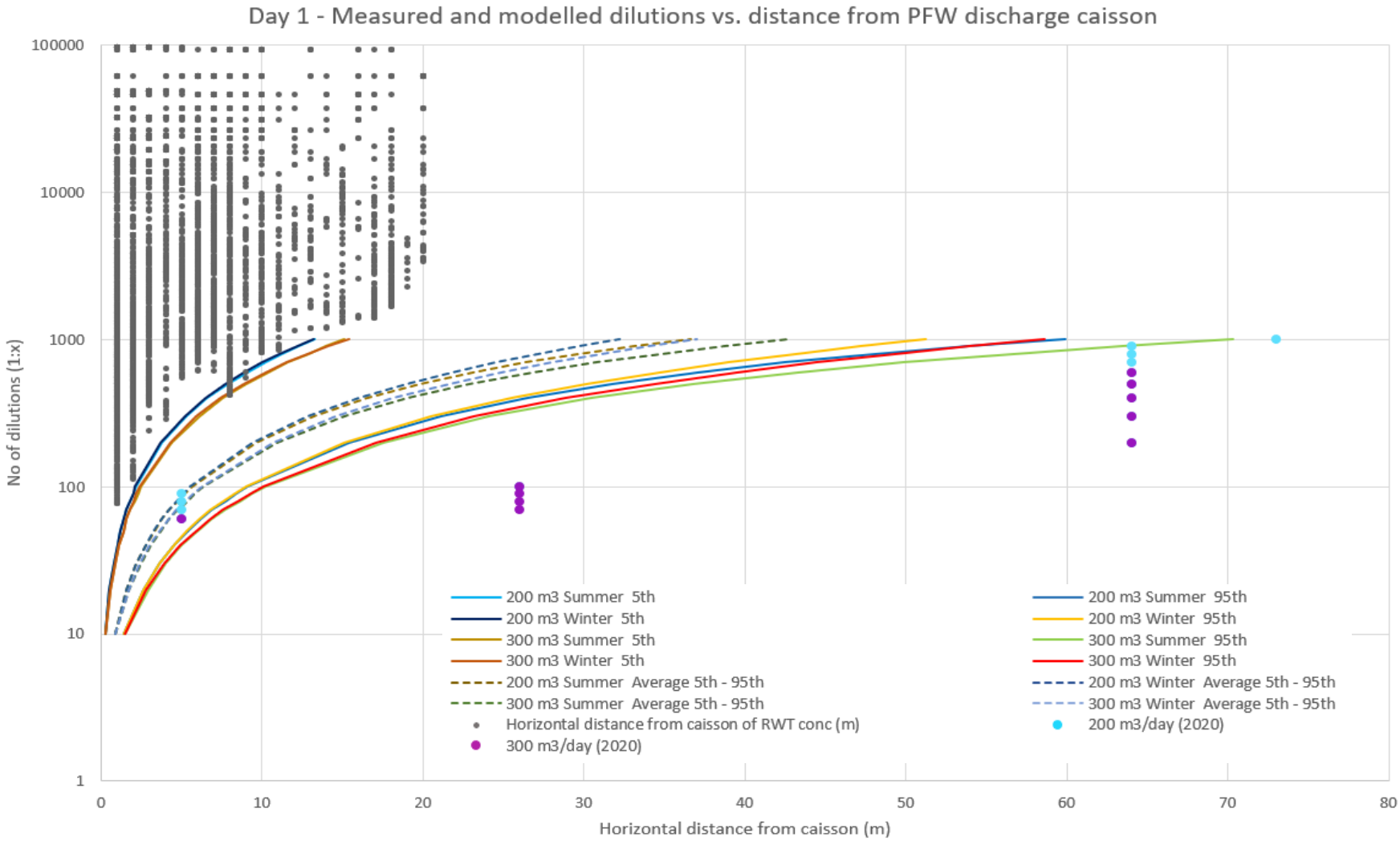


**Figure 10 Day 1 Insitu RWT dilutions and 2017 and 2020 modelled dilutions, across horizontal distance from caisson**

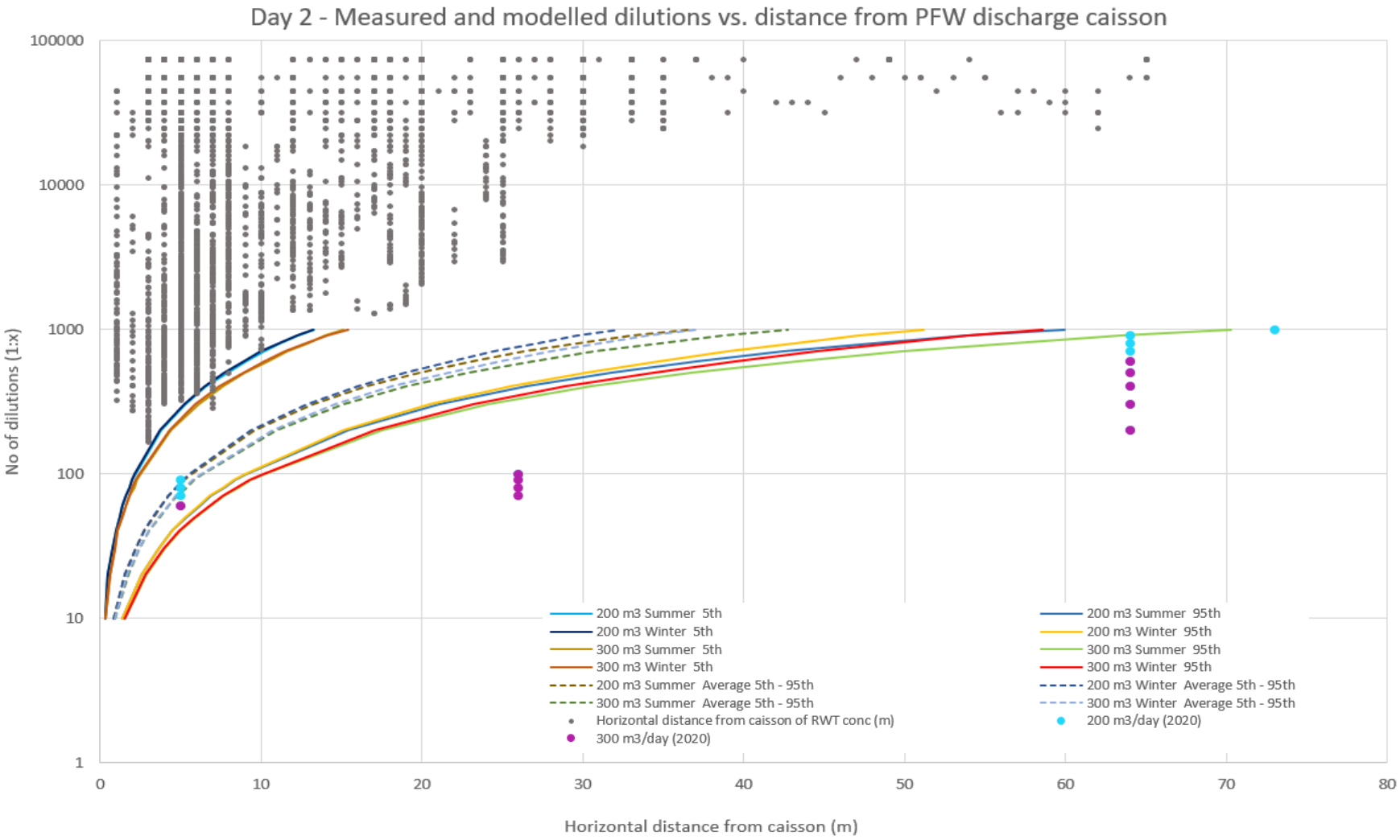


**Figure 11 Day 2 Insitu RWT dilutions and 2017 and 2020 modelled dilutions, across horizontal distance from caisson**

# 4.0 Model Verification Discussion

## 4.1 Relevance of the Field Study to the Modelling

The 2017 near field modelling presented modelled outcomes of dilutions (up to 1000:x) over distance achieved by the PFW plume upon discharge into the receiving environment, for a range of daily discharge volumes and seasonal scenarios including predictions for low and high current scenarios. Of relevance to the current study, the 2017 modelling presented modelled outcomes for:

- 200 $m^3$/day discharge rate during winter with low (5$^{th}$ percentile) current speed
- 200 $m^3$/day discharge rate during winter with high (95$^{th}$ percentile) current speed
- 200 $m^3$/day discharge rate during summer with low (5$^{th}$ percentile) current speed
- 200 $m^3$/day discharge rate during summer with high (95$^{th}$ percentile) current speed
- 300 $m^3$/day discharge rate during winter with low (5$^{th}$ percentile) current speed
- 300 $m^3$/day discharge rate during winter with high (95$^{th}$ percentile) current speed
- 300 $m^3$/day discharge rate during summer with low (5$^{th}$ percentile) current speed
- 300 $m^3$/day discharge rate during summer with high (95$^{th}$ percentile) current speed.

The 2020 far field modelling was informed by the near field modelling, to provide dilution over distance predictions further afield for up to 5,400 dilutions of the PFW plume. Like the near field modelling, the far field modelling also presented predictions for 200 $m^3$ and 300 $m^3$ per day discharge scenarios .For conservatism the model outcomes were based on simulations of the least energetic month, that being May in the hindcast model. Worth noting is the average current speeds for May and October in the 2020 study were the same.

The daily PFW discharge rate during the two days of the study ranged between 230 $m^3$ and 280 $m^3$ per day, therefore it was deemed appropriate to compare the field results to the modelled outcomes for the 200 $m^3$ and 300 $m^3$ per day scenarios. Additionally, the study was undertaken during neap tides to provide further conservatism in the data due to the weaker ambient currents and therefore reduced dilution force on the plume.

More specifically the field study focused on collecting data around slack water (low current speed), and throughout an ebbing tide (higher current speeds), to provide a comparison against the modelled scenarios across different conditions.

Of the results presented in section 3.0, the concentrations for particular hydrocarbons in the insitu samples, and RWT concentrations recorded by the ROV sonde, indicate dilutions across distance fewer than those predicted by the modelling for the corresponding distances. These results are discussed in the following sections 4.2.and 4.3

As discussed in section 2.3.2.3, the data collected by the platform deployed sonde, revealed numerous data gaps and abnormal readings, and consequently this data was not considered reliable for comparison against the model dilutions.

## 4.2 Observed Versus Predicted Dilutions – Insitu Hydrocarbon Concentrations

In review of the insitu sample results (Section 3.2), concentrations of TPH, TRH and BTEX were reported in the platform Niskin bottle samples NK 1-2 and NK 2-2 which indicated dilutions were fewer than those predicted by the near field modelling at similar horizontal distances from the point of discharge, for the low current and 300 $m^3$ per day scenario. For the high current and 300 $m^3$ scenario, however, all the reported insitu concentrations for TPH, TRH and BTEX were substantially more dilute than the model prediction for a similar distance from the discharge point.

Given all the insitu platform Niskin samples were collected well into the ebb stage of the tidal cycle (section 2.3.2.4, Figure 5) and therefore during faster current speeds, a comparison to the higher current modelled scenario is appropriate. Furthermore, as the actual discharge rate on both sampling days was less (average of approximately 260 $m^3$/day) than the modelled scenario of 300 $m^3$ per day, it is appropriate to conclude that the observed dilutions in the insitu samples were similar to, or greater than, the predicted model dilutions at similar distances under insitu conditions of comparable nature.

## 4.3 Observed Versus Predicted Dilutions – Insitu RWT Concentrations

The insitu ROV sonde measured RWT concentrations and calculated dilutions from both injection dates, provide the most comprehensive data set against which to compare the model outcomes. The data from each day captured insitu concentrations of the RWT in the receiving environment across lower and high current speeds and variable depths.

The results from the insitu RWT data indicates that the modelled plume dilutions for the near field high current and far field predictions for both the 200 $m^3$ and 300 $m^3$ per day discharge scenarios are substantially more conservative than dilutions observed in the field data (Figure 10 and Figure 11).

In field dilutions were also greater than the modelled dilutions for the low current speed from the near field modelling 300 $m^3$ per day discharge scenario, for all measurements with the exception of two data points across the two days, as discussed in Section 3.4.

The PFW plume generated by the inconsistent flow of the PFW from the caisson was affected to varying degrees by the ambient currents. During both days of sampling the plume remained subsurface until approximately the midpoint of the ebbing tide. This would indicate that, at the time of this study, the near field dispersal of the plume was predominantly influenced by currents and water movement rather than temperature or other buoyancy-increasing physical parameters of the plume itself. It is also likely that, as seen during the initial stages of the dye discharge with the plume flowing south through the jacket legs without reaching the surface, the plume is subject to swirling and eddying effects of water flowing through the jacket legs, which contribute to the plume dispersal prior to reaching the surface.

Once the plume did reach the surface, it coincided with the change in current direction to a north-west to north flowing current. The surface plume was observed to disperse quickly, and this was confirmed with the insitu sample ROV 2-3 and sonde RWT measurement, taken 65 m from the caisson just below the surface in the direction of the plume, where no RWT or chemical trace of the plume was detected. In comparing this measurement to the modelling, in the near field modelling for the high current speed and the 300 $m^3$ per day scenario, the model predicted 1000 dilutions of the plume would only be reached at 70 m from the discharge point, further indicating that the modelling outcomes under predict the rate of dilution over distance.

## 4.4 Model Verification Outcome

In summarising the results from the field study, the modelled dilutions from both the near field and far field results generally under predicted the plume dilution factor compared to measured insitu dilutions. Only the modelled low current speed scenario from the near field modelling was comparable to the field data. The higher current speed scenarios from the near field modelling were all more conservative than the observed dilutions and, in most cases, this was the case for the 200 $m^3$ and 300 $m^3$ per day discharge scenarios. When compared to the dilutions from the far field modelling, for both the 200 $m^3$ and 300 $m^3$ per day discharge scenarios, the insitu concentrations were more dilute in all measurements.

The field study therefore verifies that both the near and far field modelling outcomes are reliably conservative in predicting the plume dispersal and dilution across distance from the Yolla -A platform, and consequently can reliably be used to define the mixing zone boundary for PFW discharge from the Yolla-A platform.

# 5.0 References

AECOM 2020 Yolla Platform ALARP Assessment. A report prepared for Beach Energy Ltd by AECOM Australia Pty Ltd.

ANZG 2018 *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand* Governments and Australian state and territory governments, Canberra ACT, Australia.

Beach Energy 2020 *BassGas Offshore Operation Environment Plan CDN/ID 3972814.* Prepared by Aventus Consulting for Beach Energy Ltd, November 2020.

RPS 2017 *Yolla Platform – Bass Strait Produced Water Dispersion Near-Field Modelling Study.* Report prepared for Lattice Energy Ltd, November 2017.

RPS 2020 *Beach Yolla Platform Produced Water Dispersion Far-Field Modelling Study.* Report prepared for Beach Energy Ltd, September 2020.

# Appendix A

## Laboratory Reports

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Murdoch UNIVERSITY

# WATER QUALITY DATA

Contact: Marthin Slabber
Customer: AECOM
Address: 181 Adelaide Terrace, Perth, WA 6004

Date of Issue: 26/10/2022
Date Received: 13/10/2022
Our Reference: AEC22-18
Your Reference: 60672064. 1.4

| METHOD<br>SAMPLE CODE | Sampling Date | Sampling Time | Low Range/Marine Water Rhodamine<br>µg/L | High Range/Wastewater Rhodamine<br>µg/L |
|---|---|---|---|---|
| **Reporting Limit** | | | **<0.1** | **<1** |
| **Analysis Date** | | | **14,17,21/10/2022** | **14/10/2022** |
| **File** | | | **221014** | **221014** |
| NK 1-1 | 9/10/2022 | 1:46 PM | <0.1 | |
| NK 1-2 | 9/10/2022 | 3:12 PM | 5.5 | |
| NK 1-3 | 9/10/2022 | 3:25 PM | 1.2 | |
| NK 1-4 | 9/10/2022 | 4:10 PM | 1.6 | |
| NK 1-5 | 9/10/2022 | 5:10 PM | <0.1 | |
| NK 1-6 | 9/10/2022 | 5:10 PM | <0.1 | |
| NK 2-1 | 10/10/2022 | 4:19 PM | <0.1 | |
| NK 2-2 | 10/10/2022 | 4:40 PM | 7.6 | |
| NK 2-3 | 10/10/2022 | 5:19 PM | <0.1 | |
| PFWS 1-2 | 9/10/2022 | 9:08 AM | | 3590 |
| PFWS 1-3 | 9/10/2022 | 10:12 AM | | 5670 |
| PFWS 1-4 | 9/10/2022 | 11:40 AM | | 13600 |
| PFWS 1-5 | 9/10/2022 | 12:50 PM | | 23500 |
| PFWS 1-6 | 9/10/2022 | 2:23 PM | | 12 |
| PFWS 2-1 | 10/10/2022 | 8:20 AM | | <1 |
| PFWS 2-2 | 10/10/2022 | 11:25 AM | | 25200 |
| PFWS 2-3 | 10/10/2022 | 12:14 PM | | 18400 |
| PFWS 2-4 | 10/10/2022 | 1:15 PM | | 17800 |
| PFWS 2-5 | 10/10/2022 | 2:43 PM | | 22600 |

Signatory: Jamie Woodward
Date: 26/10/2022

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

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Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Murdoch UNIVERSITY

## WATER QUALITY DATA

Contact: Marthin Slabber
Customer: AECOM
Address: 181 Adelaide Terrace, Perth, WA 6004

Date of Issue: 26/10/2022
Date Received: 13/10/2022
Our Reference: AEC22-18
Your Reference: 60672064. 1.4

| METHOD<br>SAMPLE CODE | Sampling Date | Sampling Time | Low Range/Marine Water Rhodamine<br>µg/L | High Range/Wastewater Rhodamine<br>µg/L |
|---|---|---|---|---|
| **Reporting Limit** | | | **<0.1** | **<1** |
| **Analysis Date** | | | **14,17,21/10/2022** | **14/10/2022** |
| **File** | | | **221014** | **221014** |
| PFWS 2-6 | 10/10/2022 | 4:29 PM | | 26800 |
| PFWS 2-7 | 10/10/2022 | 5:40 PM | | 7 |
| PFWS 2-8 | 10/10/2022 | 5:40 PM | | 7 |
| ROV 1-1 | 9/10/2022 | 11:56 AM | 0.3 | |
| ROV 1-2 | 9/10/2022 | 4:20 PM | 0.2 | |
| ROV 2-1 | 10/10/2022 | 1:37 PM | <0.1 | |
| ROV 2-2 | 10/10/2022 | 3:49 PM | 0.2 | |
| ROV 2-3 | 10/10/2022 | 4:51 PM | <0.1 | |
| MXT 1-1 | 9/10/2022 | 7:31 AM | | 668000 |
| MXT 1-2 | 9/10/2022 | 9:58 AM | | 665000 |
| MXT 1-3 | 9/10/2022 | 1:40 PM | | 407000 |
| MXT 2-1 | 10/10/2022 | 9:20 AM | | 761000 |
| MXT 2-2 | 10/10/2022 | 11:33 AM | | 1170000 |
| MXT 2-3 | 10/10/2022 | 1:12 PM | | 1110000 |
| NK-CB | 10/10/2022 | 9:54 AM | | 84 |
| ROV-CB | 10/10/2022 | 9:52 AM | | 77 |
| NK-CB2 | 11/10/2022 | 9:53 AM | | 89 |
| ROV-CB2 | 11/10/2022 | 9:53 AM | | 93 |

Signatory: Jamie Woodward
Date: 26/10/2022

The results only apply to the sample tested.
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Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

Murdoch UNIVERSITY

# WATER QUALITY DATA

Contact: Marthin Slabber
Customer: AECOM
Address: Level 3, 181 Adelaide Tce, East Perth WA 6004

Date of Issue: 1/11/2022
Date Received: 21/10/2022
Our Reference: AEC22-19
Your Reference: 60672064. 1.4

| METHOD<br>SAMPLE CODE | Sampling Date | MS001<br>Unfiltered Ba<br>µg/L |
|---|---|---|
| **Reporting Limit** | | **<0.5** |
| **Analysis Date** | | **31/10/2022** |
| **File** | | **22103103** |
| NK 1-1 | 9/10/2022 | 6.7 |
| NK 1-2 | 9/10/2022 | 10 |
| NK 1-3 | 9/10/2022 | 10 |
| NK 1-4 | 9/10/2022 | 9.8 |
| NK 1-5 | 9/10/2022 | 7.5 |
| NK 1-6 | 9/10/2022 | 6.5 |
| NK 2-1 | 10/10/2022 | 6.4 |
| NK 2-2 | 10/10/2022 | 13 |
| NK 2-3 | 10/10/2022 | 6.2 |
| ROV 1-1 | 9/10/2022 | 8.1 |
| ROV 1-2 | 9/10/2022 | 7.4 |
| ROV 2-1 | 10/10/2022 | 6.4 |
| ROV 2-2 | 10/10/2022 | 6.5 |
| ROV 2-3 | 10/10/2022 | 6.4 |

Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Jamie Woodward
Date: 1/11/2022

The results only apply to the sample as received and to the sample tested.
Spare test items will be held for two months unless otherwise requested.

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ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EM2219948** | Page | : 1 of 16 |
| **Amendment** | : **1** | | |
| Client | : **AECOM AUSTRALIA PTY LTD** | Laboratory | : Environmental Division Melbourne |
| Contact | : MARTHIN SLABBER | Contact | : Peter Ravlic |
| Address | : LEVEL 2 181 ADELAIDE TERRACE PERTH WA, AUSTRALIA | Address | : 4 Westall Rd Springvale VIC Australia 3171 |
| Telephone | : ---- | Telephone | : +6138549 9645 |
| Project | : Yolla PFW Plume Verification 60672064. 1.4 | Date Samples Received | : 11-Oct-2022 14:38 |
| Order number | : 60649604 | Date Analysis Commenced | : 12-Oct-2022 |
| C-O-C number | : ---- | Issue Date | : 31-Oct-2022 10:01 |
| Sampler | : JT | | |
| Site | : ---- | | |
| Quote number | : EN/004/21 | | |
| No. of samples received | : 31 | | |
| No. of samples analysed | : 31 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

**Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.**

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Arenie Vijayaratnam | Senior Inorganic Chemist | Melbourne Inorganics, Springvale, VIC |
| Edwandy Fadjar | Organic Coordinator | Sydney Organics, Smithfield, NSW |
| Jarwis Nheu | Non-Metals Team Leader | Melbourne Inorganics, Springvale, VIC |
| Xing Lin | Senior Organic Chemist | Melbourne Organics, Springvale, VIC |

## General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP132-LL: Where reported, Total PAH is the sum of the reported concentrations of all PAHs at or above the LOR.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EP080: Particular compounds in sample EM2219948_24 and 26 have LOR raised due to possible background.
- EP080: Samples EM2219948_001, 005 and 006 have been confirmed by re-analysis.
- EG020F: EM2219948#29 has been confirmed for barium by re-preparation and re-analysis.
- Amendment 29/10/2022): This report has been amended following a change to the EP071 result reported for sample EM2219948_013 due to a transcription error. All details are recorded in client query 22MEC462 and a full investigation will be detailed in corrective action request 22MEC171
- RECORD TIME SORTING COMMENCED: 10:45 AM RECORD TIME PLACED IN FRIDGE: 11:30 AM
- EP132-LL : Particular samples required dilution due to sample matrix . LOR values have been adjusted accordingly.

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Sample ID | NK 1-1 | NK 1-2 | NK 1-3 | NK 1-4 | NK 1-5 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Sampling date / time | 09-Oct-2022 10:46 | 09-Oct-2022 12:12 | 09-Oct-2022 12:25 | 09-Oct-2022 13:10 | 09-Oct-2022 14:10 |
| Compound | CAS Number | LOR | Unit | | EM2219948-001 | EM2219948-002 | EM2219948-003 | EM2219948-004 | EM2219948-005 |
| | | | | | Result | Result | Result | Result | Result |
| **EG020T: Total Metals by ICP-MS** | | | | | | | | | |
| **Barium** | 7440-39-3 | 1 | ug/L | | **7** | **12** | **11** | **11** | **62** |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | | |
| **C6 - C9 Fraction** | ---- | 20 | µg/L | | <20 | **100** | **90** | **70** | <20 |
| **C10 - C14 Fraction** | ---- | 50 | µg/L | | <50 | <50 | <50 | <50 | <50 |
| **C15 - C28 Fraction** | ---- | 100 | µg/L | | <100 | <100 | <100 | <100 | <100 |
| **C29 - C36 Fraction** | ---- | 50 | µg/L | | <50 | <50 | <50 | <50 | <50 |
| ^ **C10 - C36 Fraction (sum)** | ---- | 50 | µg/L | | <50 | <50 | <50 | <50 | <50 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | | | |
| **C6 - C10 Fraction** | C6_C10 | 20 | µg/L | | <20 | **110** | **100** | **80** | <20 |
| ^ **C6 - C10 Fraction minus BTEX (F1)** | C6_C10-BTEX | 20 | µg/L | | <20 | **40** | **30** | **20** | <20 |
| **>C10 - C16 Fraction** | ---- | 100 | µg/L | | <100 | <100 | <100 | <100 | <100 |
| **>C16 - C34 Fraction** | ---- | 100 | µg/L | | <100 | <100 | <100 | <100 | <100 |
| **>C34 - C40 Fraction** | ---- | 100 | µg/L | | <100 | <100 | <100 | <100 | <100 |
| ^ **>C10 - C40 Fraction (sum)** | ---- | 100 | µg/L | | <100 | <100 | <100 | <100 | <100 |
| ^ **>C10 - C16 Fraction minus Naphthalene (F2)** | ---- | 100 | µg/L | | <100 | <100 | <100 | <100 | <100 |
| **EP080: BTEXN** | | | | | | | | | |
| **Benzene** | 71-43-2 | 1 | µg/L | | **1** | **30** | **27** | **23** | **2** |
| **Toluene** | 108-88-3 | 2 | µg/L | | <2 | **35** | **32** | **26** | **2** |
| **Ethylbenzene** | 100-41-4 | 2 | µg/L | | <2 | <2 | <2 | <2 | <2 |
| **meta- & para-Xylene** | 108-38-3 106-42-3 | 2 | µg/L | | <2 | **8** | **7** | **6** | <2 |
| **ortho-Xylene** | 95-47-6 | 2 | µg/L | | <2 | **2** | <2 | <2 | <2 |
| ^ **Total Xylenes** | ---- | 2 | µg/L | | <2 | **10** | **7** | **6** | <2 |
| ^ **Sum of BTEX** | ---- | 1 | µg/L | | **1** | **75** | **66** | **55** | **4** |
| **Naphthalene** | 91-20-3 | 5 | µg/L | | <5 | <5 | <5 | <5 | <5 |
| **EP132B: Polynuclear Aromatic Hydrocarbons** | | | | | | | | | |
| **Naphthalene** | 91-20-3 | 0.02 | µg/L | | <0.02 | **0.08** | **0.06** | **0.06** | <0.02 |
| **Acenaphthylene** | 208-96-8 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Acenaphthene** | 83-32-9 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Fluorene** | 86-73-7 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Phenanthrene** | 85-01-8 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Anthracene** | 120-12-7 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Fluoranthene** | 206-44-0 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Sample ID | NK 1-1 | NK 1-2 | NK 1-3 | NK 1-4 | NK 1-5 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Sampling date / time | 09-Oct-2022 10:46 | 09-Oct-2022 12:12 | 09-Oct-2022 12:25 | 09-Oct-2022 13:10 | 09-Oct-2022 14:10 |
| Compound | CAS Number | LOR | Unit | | EM2219948-001 | EM2219948-002 | EM2219948-003 | EM2219948-004 | EM2219948-005 |
| | | | | | Result | Result | Result | Result | Result |
| **EP132B: Polynuclear Aromatic Hydrocarbons - Continued** | | | | | | | | | |
| Pyrene | 129-00-0 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Benz(a)anthracene | 56-55-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Chrysene | 218-01-9 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(b+j)fluoranthene | 205-99-2 205-82-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(k)fluoranthene | 207-08-9 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(a)pyrene | 50-32-8 | 0.005 | µg/L | | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Indeno(1.2.3.cd)pyrene | 193-39-5 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Dibenz(a.h)anthracene | 53-70-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(g.h.i)perylene | 191-24-2 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| ^ Total PAH | ---- | 0.005 | µg/L | | <0.005 | **0.080** | **0.060** | **0.060** | <0.005 |
| ^ Benzo(a)pyrene TEQ (zero) | ---- | 0.005 | µg/L | | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | | |
| 1.2-Dichloroethane-D4 | 17060-07-0 | 2 | % | | **109** | **112** | **124** | **112** | **108** |
| Toluene-D8 | 2037-26-5 | 2 | % | | **93.7** | **95.8** | **107** | **95.3** | **93.0** |
| 4-Bromofluorobenzene | 460-00-4 | 2 | % | | **104** | **105** | **113** | **110** | **103** |
| **EP132T: Base/Neutral Extractable Surrogates (Low-Level)** | | | | | | | | | |
| 2-Fluorobiphenyl | 321-60-8 | 0.02 | % | | **75.2** | **88.9** | **79.2** | **85.7** | **81.7** |
| Anthracene-d10 | 1719-06-8 | 0.02 | % | | **104** | **110** | **119** | **102** | **112** |
| 4-Terphenyl-d14 | 1718-51-0 | 0.02 | % | | **87.4** | **95.3** | **98.6** | **92.7** | **93.2** |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Sample ID | NK 1-6 | NK 2-1 | NK 2-2 | NK 2-3 | PFWS 1-1 |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-Oct-2022 14:10 | 10-Oct-2022 13:19 | 10-Oct-2022 13:40 | 10-Oct-2022 14:19 | 09-Oct-2022 04:34 |
| Compound | CAS Number | LOR | Unit | EM2219948-006 | EM2219948-007 | EM2219948-008 | EM2219948-009 | EM2219948-010 |
| | | | | Result | Result | Result | Result | Result |
| **EG020T: Total Metals by ICP-MS** | | | | | | | | |
| Barium | 7440-39-3 | 1 | ug/L | 7 | 7 | 14 | 7 | 23800 |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | |
| C6 - C9 Fraction | ---- | 20 | µg/L | <20 | <20 | 160 | <20 | 102000 |
| C10 - C14 Fraction | ---- | 50 | µg/L | <50 | <50 | <50 | <50 | 56800 |
| C15 - C28 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | 3280 |
| C29 - C36 Fraction | ---- | 50 | µg/L | <50 | <50 | <50 | <50 | 60 |
| ^ C10 - C36 Fraction (sum) | ---- | 50 | µg/L | <50 | <50 | <50 | <50 | 60100 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | | |
| C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | <20 | 180 | <20 | 108000 |
| ^ C6 - C10 Fraction minus BTEX (F1) | C6_C10-BTEX | 20 | µg/L | <20 | <20 | 50 | <20 | 31300 |
| >C10 - C16 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | 46900 |
| >C16 - C34 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | 2280 |
| >C34 - C40 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| ^ >C10 - C40 Fraction (sum) | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | 49200 |
| ^ >C10 - C16 Fraction minus Naphthalene (F2) | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | 45900 |
| **EP080: BTEXN** | | | | | | | | |
| Benzene | 71-43-2 | 1 | µg/L | 2 | <1 | 51 | <1 | 23700 |
| Toluene | 108-88-3 | 2 | µg/L | <2 | <2 | 59 | <2 | 36000 |
| Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | <2 | <2 | <2 | 1160 |
| meta- & para-Xylene | 108-38-3 106-42-3 | 2 | µg/L | <2 | <2 | 14 | <2 | 12600 |
| ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | <2 | 3 | <2 | 3270 |
| ^ Total Xylenes | ---- | 2 | µg/L | <2 | <2 | 17 | <2 | 15900 |
| ^ Sum of BTEX | ---- | 1 | µg/L | 2 | <1 | 127 | <1 | 76700 |
| Naphthalene | 91-20-3 | 5 | µg/L | <5 | <5 | <5 | <5 | 970 |
| **EP132B: Polynuclear Aromatic Hydrocarbons** | | | | | | | | |
| Naphthalene | 91-20-3 | 0.02 | µg/L | <0.02 | <0.02 | 0.11 | 0.02 | 981 |
| Acenaphthylene | 208-96-8 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | 4.80 |
| Acenaphthene | 83-32-9 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | 2.40 |
| Fluorene | 86-73-7 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | 17.7 |
| Phenanthrene | 85-01-8 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | 13.2 |
| Anthracene | 120-12-7 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | 1.66 |
| Fluoranthene | 206-44-0 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | 3.65 |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Sample ID | NK 1-6 | NK 2-1 | NK 2-2 | NK 2-3 | PFWS 1-1 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Sampling date / time | 09-Oct-2022 14:10 | 10-Oct-2022 13:19 | 10-Oct-2022 13:40 | 10-Oct-2022 14:19 | 09-Oct-2022 04:34 |
| Compound | CAS Number | LOR | Unit | | EM2219948-006 | EM2219948-007 | EM2219948-008 | EM2219948-009 | EM2219948-010 |
| | | | | | Result | Result | Result | Result | Result |
| **EP132B: Polynuclear Aromatic Hydrocarbons - Continued** | | | | | | | | | |
| Pyrene | 129-00-0 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | **2.59** |
| Benz(a)anthracene | 56-55-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | **1.15** |
| Chrysene | 218-01-9 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | **0.97** |
| Benzo(b+j)fluoranthene | 205-99-2 205-82-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | **0.94** |
| Benzo(k)fluoranthene | 207-08-9 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | **0.48** |
| Benzo(a)pyrene | 50-32-8 | 0.005 | µg/L | | <0.005 | <0.005 | <0.005 | <0.005 | **0.846** |
| Indeno(1.2.3.cd)pyrene | 193-39-5 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | **0.50** |
| Dibenz(a.h)anthracene | 53-70-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | **0.32** |
| Benzo(g.h.i)perylene | 191-24-2 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | **0.52** |
| ^ Total PAH | ---- | 0.005 | µg/L | | <0.005 | <0.005 | **0.110** | **0.020** | **1030** |
| ^ Benzo(a)pyrene TEQ (zero) | ---- | 0.005 | µg/L | | <0.005 | <0.005 | <0.005 | <0.005 | **1.49** |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | | |
| 1.2-Dichloroethane-D4 | 17060-07-0 | 2 | % | | **103** | **107** | **115** | **106** | **107** |
| Toluene-D8 | 2037-26-5 | 2 | % | | **88.9** | **90.6** | **97.4** | **87.8** | **99.1** |
| 4-Bromofluorobenzene | 460-00-4 | 2 | % | | **101** | **102** | **99.3** | **99.1** | **104** |
| **EP132T: Base/Neutral Extractable Surrogates (Low-Level)** | | | | | | | | | |
| 2-Fluorobiphenyl | 321-60-8 | 0.02 | % | | **72.0** | **89.0** | **80.4** | **86.9** | **75.4** |
| Anthracene-d10 | 1719-06-8 | 0.02 | % | | **103** | **107** | **104** | **109** | **98.9** |
| 4-Terphenyl-d14 | 1718-51-0 | 0.02 | % | | **87.3** | **90.6** | **92.3** | **97.7** | **103** |

## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

| Compound | CAS Number | LOR | Unit | Sample ID | PFWS 1-2 | PFWS 1-3 | PFWS 1-4 | PFWS 1-5 | PFWS 1-6 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Sampling date / time | 09-Oct-2022 06:08 | 09-Oct-2022 07:12 | 09-Oct-2022 08:40 | 09-Oct-2022 09:50 | 09-Oct-2022 11:23 |
| | | | | | EM2219948-011 | EM2219948-012 | EM2219948-013 | EM2219948-014 | EM2219948-015 |
| | | | | | Result | Result | Result | Result | Result |
| **EG020T: Total Metals by ICP-MS** | | | | | | | | | |
| **Barium** | 7440-39-3 | 1 | ug/L | | **23700** | **23700** | **24100** | **23100** | **23400** |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | | |
| **C6 - C9 Fraction** | ---- | 20 | µg/L | | **105000** | **96500** | **92900** | **84800** | **92900** |
| **C10 - C14 Fraction** | ---- | 50 | µg/L | | **83200** | **62200** | **65300** | **76500** | **85200** |
| **C15 - C28 Fraction** | ---- | 100 | µg/L | | **4870** | **3500** | **3550** | **4660** | **4200** |
| **C29 - C36 Fraction** | ---- | 50 | µg/L | | **110** | **80** | **80** | **120** | **100** |
| ^ **C10 - C36 Fraction (sum)** | ---- | 50 | µg/L | | **88200** | **65800** | **68900** | **81300** | **89500** |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | | | |
| **C6 - C10 Fraction** | C6_C10 | 20 | µg/L | | **110000** | **99300** | **96000** | **87200** | **95600** |
| ^ **C6 - C10 Fraction minus BTEX (F1)** | C6_C10-BTEX | 20 | µg/L | | **31300** | **27000** | **26900** | **24000** | **25700** |
| **>C10 - C16 Fraction** | ---- | 100 | µg/L | | **69900** | **51800** | **54700** | **64600** | **71400** |
| **>C16 - C34 Fraction** | ---- | 100 | µg/L | | **3440** | **2500** | **2560** | **3320** | **3000** |
| **>C34 - C40 Fraction** | ---- | 100 | µg/L | | <100 | <100 | <100 | <100 | <100 |
| ^ **>C10 - C40 Fraction (sum)** | ---- | 100 | µg/L | | **73300** | **54300** | **57300** | **67900** | **74400** |
| ^ **>C10 - C16 Fraction minus Naphthalene (F2)** | ---- | 100 | µg/L | | **69200** | **50900** | **53800** | **63700** | **70500** |
| **EP080: BTEXN** | | | | | | | | | |
| **Benzene** | 71-43-2 | 1 | µg/L | | **22700** | **19700** | **18800** | **17100** | **19500** |
| **Toluene** | 108-88-3 | 2 | µg/L | | **37200** | **34500** | **32600** | **29800** | **32400** |
| **Ethylbenzene** | 100-41-4 | 2 | µg/L | | **1300** | **1200** | **1170** | **1050** | **1180** |
| **meta- & para-Xylene** | 108-38-3 106-42-3 | 2 | µg/L | | **13900** | **13400** | **13100** | **12000** | **13300** |
| **ortho-Xylene** | 95-47-6 | 2 | µg/L | | **3630** | **3530** | **3440** | **3220** | **3520** |
| ^ **Total Xylenes** | ---- | 2 | µg/L | | **17500** | **16900** | **16500** | **15200** | **16800** |
| ^ **Sum of BTEX** | ---- | 1 | µg/L | | **78700** | **72300** | **69100** | **63200** | **69900** |
| **Naphthalene** | 91-20-3 | 5 | µg/L | | **732** | **928** | **928** | **892** | **879** |
| **EP132B: Polynuclear Aromatic Hydrocarbons** | | | | | | | | | |
| **Naphthalene** | 91-20-3 | 0.02 | µg/L | | **730** | **853** | **948** | **888** | **778** |
| **Acenaphthylene** | 208-96-8 | 0.02 | µg/L | | **4.17** | **3.31** | **2.68** | **2.43** | **2.37** |
| **Acenaphthene** | 83-32-9 | 0.02 | µg/L | | **2.20** | **2.09** | **2.04** | **1.84** | **1.76** |
| **Fluorene** | 86-73-7 | 0.02 | µg/L | | **15.7** | **15.0** | **14.4** | **13.8** | **13.2** |
| **Phenanthrene** | 85-01-8 | 0.02 | µg/L | | **11.7** | **9.45** | **8.54** | **8.45** | **7.37** |
| **Anthracene** | 120-12-7 | 0.02 | µg/L | | **1.40** | **0.99** | **0.75** | **0.90** | **0.71** |
| **Fluoranthene** | 206-44-0 | 0.02 | µg/L | | **3.18** | **2.19** | **1.80** | **2.21** | **1.69** |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Sample ID | PFWS 1-2 | PFWS 1-3 | PFWS 1-4 | PFWS 1-5 | PFWS 1-6 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Sampling date / time | 09-Oct-2022 06:08 | 09-Oct-2022 07:12 | 09-Oct-2022 08:40 | 09-Oct-2022 09:50 | 09-Oct-2022 11:23 |
| Compound | CAS Number | LOR | Unit | | EM2219948-011 | EM2219948-012 | EM2219948-013 | EM2219948-014 | EM2219948-015 |
| | | | | | Result | Result | Result | Result | Result |
| **EP132B: Polynuclear Aromatic Hydrocarbons - Continued** | | | | | | | | | |
| Pyrene | 129-00-0 | 0.02 | µg/L | | 2.15 | 1.54 | 1.22 | 1.51 | 1.19 |
| Benz(a)anthracene | 56-55-3 | 0.02 | µg/L | | 0.99 | 0.64 | 0.53 | 0.61 | 0.54 |
| Chrysene | 218-01-9 | 0.02 | µg/L | | 0.87 | 0.59 | 0.48 | 0.56 | 0.40 |
| Benzo(b+j)fluoranthene | 205-99-2 205-82-3 | 0.02 | µg/L | | 0.77 | 0.55 | 0.43 | 0.52 | 0.43 |
| Benzo(k)fluoranthene | 207-08-9 | 0.02 | µg/L | | 0.40 | 0.32 | 0.26 | 0.29 | 0.23 |
| Benzo(a)pyrene | 50-32-8 | 0.005 | µg/L | | 0.720 | 0.489 | 0.332 | 0.406 | 0.315 |
| Indeno(1.2.3.cd)pyrene | 193-39-5 | 0.02 | µg/L | | 0.42 | 0.29 | 0.22 | 0.27 | 0.21 |
| Dibenz(a.h)anthracene | 53-70-3 | 0.02 | µg/L | | 0.28 | 0.19 | 0.14 | 0.18 | 0.14 |
| Benzo(g.h.i)perylene | 191-24-2 | 0.02 | µg/L | | 0.45 | 0.31 | 0.24 | 0.31 | 0.24 |
| ^ Total PAH | ---- | 0.005 | µg/L | | 775 | 891 | 982 | 922 | 809 |
| ^ Benzo(a)pyrene TEQ (zero) | ---- | 0.005 | µg/L | | 1.27 | 0.868 | 0.623 | 0.764 | 0.602 |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | | |
| 1.2-Dichloroethane-D4 | 17060-07-0 | 2 | % | | 108 | 111 | 112 | 106 | 112 |
| Toluene-D8 | 2037-26-5 | 2 | % | | 92.4 | 104 | 101 | 99.7 | 102 |
| 4-Bromofluorobenzene | 460-00-4 | 2 | % | | 100.0 | 109 | 104 | 105 | 106 |
| **EP132T: Base/Neutral Extractable Surrogates (Low-Level)** | | | | | | | | | |
| 2-Fluorobiphenyl | 321-60-8 | 0.02 | % | | 87.6 | 107 | 101 | 105 | 87.7 |
| Anthracene-d10 | 1719-06-8 | 0.02 | % | | 95.6 | 83.4 | 102 | 106 | 101 |
| 4-Terphenyl-d14 | 1718-51-0 | 0.02 | % | | 94.0 | 96.3 | 91.5 | 95.6 | 92.5 |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Sample ID | PFWS 2-1 | PFWS 2-2 | PFWS 2-3 | PFWS 2-4 | PFWS 2-5 |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 10-Oct-2022 05:20 | 10-Oct-2022 08:25 | 10-Oct-2022 09:14 | 10-Oct-2022 10:15 | 10-Oct-2022 11:43 |
| Compound | CAS Number | LOR | Unit | EM2219948-016 | EM2219948-017 | EM2219948-018 | EM2219948-019 | EM2219948-020 |
| | | | | Result | Result | Result | Result | Result |
| **EG020T: Total Metals by ICP-MS** | | | | | | | | |
| Barium | 7440-39-3 | 1 | ug/L | 22900 | 24200 | 23000 | 24500 | 23600 |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | |
| C6 - C9 Fraction | ---- | 20 | µg/L | 107000 | 84500 | 85700 | 92300 | 89600 |
| C10 - C14 Fraction | ---- | 50 | µg/L | 63500 | 71800 | 69700 | 61700 | 59300 |
| C15 - C28 Fraction | ---- | 100 | µg/L | 4700 | 4340 | 3750 | 3350 | 3730 |
| C29 - C36 Fraction | ---- | 50 | µg/L | 80 | 130 | 90 | 90 | 200 |
| ^ C10 - C36 Fraction (sum) | ---- | 50 | µg/L | 68300 | 76300 | 73500 | 65100 | 63200 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | | |
| C6 - C10 Fraction | C6_C10 | 20 | µg/L | 119000 | 87000 | 88100 | 94800 | 92000 |
| ^ C6 - C10 Fraction minus BTEX (F1) | C6_C10-BTEX | 20 | µg/L | 44800 | 23900 | 23500 | 25100 | 24500 |
| >C10 - C16 Fraction | ---- | 100 | µg/L | 52800 | 60200 | 58600 | 51300 | 49300 |
| >C16 - C34 Fraction | ---- | 100 | µg/L | 2990 | 3120 | 2720 | 2450 | 2860 |
| >C34 - C40 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| ^ >C10 - C40 Fraction (sum) | ---- | 100 | µg/L | 55800 | 63300 | 61300 | 53800 | 52200 |
| ^ >C10 - C16 Fraction minus Naphthalene (F2) | ---- | 100 | µg/L | 51500 | 59400 | 57700 | 50500 | 48500 |
| **EP080: BTEXN** | | | | | | | | |
| Benzene | 71-43-2 | 1 | µg/L | 20700 | 17100 | 18100 | 20400 | 18900 |
| Toluene | 108-88-3 | 2 | µg/L | 34600 | 30000 | 30600 | 32700 | 32300 |
| Ethylbenzene | 100-41-4 | 2 | µg/L | 1240 | 1050 | 1050 | 1090 | 1080 |
| meta- & para-Xylene | 108-38-3 106-42-3 | 2 | µg/L | 14000 | 11800 | 11700 | 12200 | 12000 |
| ortho-Xylene | 95-47-6 | 2 | µg/L | 3680 | 3160 | 3140 | 3290 | 3250 |
| ^ Total Xylenes | ---- | 2 | µg/L | 17700 | 15000 | 14800 | 15500 | 15200 |
| ^ Sum of BTEX | ---- | 1 | µg/L | 74200 | 63100 | 64600 | 69700 | 67500 |
| Naphthalene | 91-20-3 | 5 | µg/L | 1260 | 846 | 907 | 840 | 789 |
| **EP132B: Polynuclear Aromatic Hydrocarbons** | | | | | | | | |
| Naphthalene | 91-20-3 | 0.02 | µg/L | 744 | 844 | 781 | 775 | 763 |
| Acenaphthylene | 208-96-8 | 0.02 | µg/L | 2.63 | 1.85 | 1.89 | 2.31 | 1.70 |
| Acenaphthene | 83-32-9 | 0.02 | µg/L | 2.38 | 1.96 | 1.78 | 1.84 | 1.82 |
| Fluorene | 86-73-7 | 0.02 | µg/L | 15.6 | 14.8 | 13.1 | 7.24 | 5.86 |
| Phenanthrene | 85-01-8 | 0.02 | µg/L | 9.45 | 7.76 | 7.28 | 7.34 | 7.10 |
| Anthracene | 120-12-7 | 0.02 | µg/L | 0.74 | 0.63 | 0.67 | 0.74 | 0.84 |
| Fluoranthene | 206-44-0 | 0.02 | µg/L | 1.76 | 1.47 | 1.64 | 1.72 | 1.51 |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Sample ID | PFWS 2-1 | PFWS 2-2 | PFWS 2-3 | PFWS 2-4 | PFWS 2-5 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Sampling date / time | 10-Oct-2022 05:20 | 10-Oct-2022 08:25 | 10-Oct-2022 09:14 | 10-Oct-2022 10:15 | 10-Oct-2022 11:43 |
| Compound | CAS Number | LOR | Unit | | EM2219948-016 | EM2219948-017 | EM2219948-018 | EM2219948-019 | EM2219948-020 |
| | | | | | Result | Result | Result | Result | Result |
| **EP132B: Polynuclear Aromatic Hydrocarbons - Continued** | | | | | | | | | |
| Pyrene | 129-00-0 | 0.02 | µg/L | | 1.25 | 1.04 | 1.30 | 1.30 | 1.12 |
| Benz(a)anthracene | 56-55-3 | 0.02 | µg/L | | 0.47 | 0.40 | 0.44 | 0.52 | 0.47 |
| Chrysene | 218-01-9 | 0.02 | µg/L | | 0.44 | 0.38 | 0.42 | 0.40 | 0.37 |
| Benzo(b+j)fluoranthene | 205-99-2 205-82-3 | 0.02 | µg/L | | 0.40 | 0.34 | 0.38 | 0.42 | 0.37 |
| Benzo(k)fluoranthene | 207-08-9 | 0.02 | µg/L | | 0.24 | 0.20 | 0.25 | 0.27 | 0.23 |
| Benzo(a)pyrene | 50-32-8 | 0.005 | µg/L | | 0.306 | 0.255 | 0.327 | 0.306 | 0.267 |
| Indeno(1.2.3.cd)pyrene | 193-39-5 | 0.02 | µg/L | | 0.20 | 0.17 | 0.20 | 0.21 | 0.19 |
| Dibenz(a.h)anthracene | 53-70-3 | 0.02 | µg/L | | 0.13 | 0.11 | 0.13 | 0.14 | 0.12 |
| Benzo(g.h.i)perylene | 191-24-2 | 0.02 | µg/L | | 0.23 | 0.20 | 0.22 | 0.23 | 0.21 |
| ^ Total PAH | ---- | 0.005 | µg/L | | 780 | 876 | 811 | 800 | 785 |
| ^ Benzo(a)pyrene TEQ (zero) | ---- | 0.005 | µg/L | | 0.574 | 0.482 | 0.590 | 0.594 | 0.519 |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | | |
| 1.2-Dichloroethane-D4 | 17060-07-0 | 2 | % | | 108 | 108 | 104 | 109 | 104 |
| Toluene-D8 | 2037-26-5 | 2 | % | | 100 | 105 | 99.4 | 98.7 | 99.9 |
| 4-Bromofluorobenzene | 460-00-4 | 2 | % | | 106 | 107 | 107 | 104 | 107 |
| **EP132T: Base/Neutral Extractable Surrogates (Low-Level)** | | | | | | | | | |
| 2-Fluorobiphenyl | 321-60-8 | 0.02 | % | | 115 | 104 | 104 | 96.4 | 113 |
| Anthracene-d10 | 1719-06-8 | 0.02 | % | | 104 | 102 | 119 | 87.0 | 110 |
| 4-Terphenyl-d14 | 1718-51-0 | 0.02 | % | | 98.6 | 99.5 | 92.2 | 93.9 | 93.2 |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Sample ID | PFWS 2-6 | PFWS 2-7 | PFWS 2-8 | ROV 1-1 | ROV 1-2 |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 10-Oct-2022 13:29 | 10-Oct-2022 14:40 | 10-Oct-2022 14:40 | 09-Oct-2022 08:56 | 12-Oct-2022 13:20 |
| Compound | CAS Number | LOR | Unit | EM2219948-021 | EM2219948-022 | EM2219948-023 | EM2219948-024 | EM2219948-025 |
| | | | | Result | Result | Result | Result | Result |
| **EG020T: Total Metals by ICP-MS** | | | | | | | | |
| Barium | 7440-39-3 | 1 | ug/L | 23300 | 25500 | 24600 | 6 | 9 |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | |
| C6 - C9 Fraction | ---- | 20 | µg/L | 99800 | 101000 | 96900 | <30 | <20 |
| C10 - C14 Fraction | ---- | 50 | µg/L | 39000 | 54000 | 57900 | <50 | <50 |
| C15 - C28 Fraction | ---- | 100 | µg/L | 1740 | 2140 | 2190 | <100 | <100 |
| C29 - C36 Fraction | ---- | 50 | µg/L | 50 | <50 | <50 | <50 | <50 |
| ^ C10 - C36 Fraction (sum) | ---- | 50 | µg/L | 40800 | 56100 | 60100 | <50 | <50 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | | |
| C6 - C10 Fraction | C6_C10 | 20 | µg/L | 104000 | 106000 | 102000 | <30 | <20 |
| ^ C6 - C10 Fraction minus BTEX (F1) | C6_C10-BTEX | 20 | µg/L | 29700 | 32000 | 30700 | <20 | <20 |
| >C10 - C16 Fraction | ---- | 100 | µg/L | 32300 | 44400 | 47300 | <100 | <100 |
| >C16 - C34 Fraction | ---- | 100 | µg/L | 1440 | 1650 | 1690 | <100 | <100 |
| >C34 - C40 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| ^ >C10 - C40 Fraction (sum) | ---- | 100 | µg/L | 33700 | 46000 | 49000 | <100 | <100 |
| ^ >C10 - C16 Fraction minus Naphthalene (F2) | ---- | 100 | µg/L | 31500 | 43500 | 46400 | <100 | <100 |
| **EP080: BTEXN** | | | | | | | | |
| Benzene | 71-43-2 | 1 | µg/L | 21800 | 20200 | 19700 | <5 | 4 |
| Toluene | 108-88-3 | 2 | µg/L | 35000 | 35300 | 33800 | <8 | 5 |
| Ethylbenzene | 100-41-4 | 2 | µg/L | 1180 | 1240 | 1190 | <2 | <2 |
| meta- & para-Xylene | 108-38-3 106-42-3 | 2 | µg/L | 12900 | 13600 | 13100 | <4 | <2 |
| ortho-Xylene | 95-47-6 | 2 | µg/L | 3390 | 3610 | 3520 | <2 | <2 |
| ^ Total Xylenes | ---- | 2 | µg/L | 16300 | 17200 | 16600 | <2 | <2 |
| ^ Sum of BTEX | ---- | 1 | µg/L | 74300 | 74000 | 71300 | <1 | 9 |
| Naphthalene | 91-20-3 | 5 | µg/L | 760 | 867 | 846 | <5 | <5 |
| **EP132B: Polynuclear Aromatic Hydrocarbons** | | | | | | | | |
| Naphthalene | 91-20-3 | 0.02 | µg/L | 781 | 822 | 835 | 0.20 | 0.07 |
| Acenaphthylene | 208-96-8 | 0.02 | µg/L | 3.26 | 3.98 | 4.48 | <0.02 | <0.02 |
| Acenaphthene | 83-32-9 | 0.02 | µg/L | 1.84 | 1.09 | 1.16 | <0.02 | <0.02 |
| Fluorene | 86-73-7 | 0.02 | µg/L | 13.5 | 7.49 | 8.27 | <0.02 | <0.02 |
| Phenanthrene | 85-01-8 | 0.02 | µg/L | 28.0 | 12.0 | 11.3 | <0.02 | <0.02 |
| Anthracene | 120-12-7 | 0.02 | µg/L | 4.86 | 1.49 | 1.39 | <0.02 | <0.02 |
| Fluoranthene | 206-44-0 | 0.02 | µg/L | 3.00 | 3.38 | 3.13 | <0.02 | <0.02 |

## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

| Compound | CAS Number | LOR | Unit | Sample ID | PFWS 2-6 | PFWS 2-7 | PFWS 2-8 | ROV 1-1 | ROV 1-2 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Sampling date / time | 10-Oct-2022 13:29 | 10-Oct-2022 14:40 | 10-Oct-2022 14:40 | 09-Oct-2022 08:56 | 12-Oct-2022 13:20 |
| | | | | | EM2219948-021 | EM2219948-022 | EM2219948-023 | EM2219948-024 | EM2219948-025 |
| | | | | | Result | Result | Result | Result | Result |
| **EP132B: Polynuclear Aromatic Hydrocarbons - Continued** | | | | | | | | | |
| **Pyrene** | 129-00-0 | 0.02 | µg/L | | **2.20** | **2.46** | **2.26** | <0.02 | <0.02 |
| **Benz(a)anthracene** | 56-55-3 | 0.02 | µg/L | | **0.84** | **0.94** | **0.84** | <0.02 | <0.02 |
| **Chrysene** | 218-01-9 | 0.02 | µg/L | | **0.75** | **0.85** | **0.79** | <0.02 | <0.02 |
| **Benzo(b+j)fluoranthene** | 205-99-2 205-82-3 | 0.02 | µg/L | | **0.74** | **0.88** | **0.76** | <0.02 | <0.02 |
| **Benzo(k)fluoranthene** | 207-08-9 | 0.02 | µg/L | | **0.38** | **0.46** | **0.45** | <0.02 | <0.02 |
| **Benzo(a)pyrene** | 50-32-8 | 0.005 | µg/L | | **0.591** | **0.722** | **0.650** | <0.005 | <0.005 |
| **Indeno(1.2.3.cd)pyrene** | 193-39-5 | 0.02 | µg/L | | **0.35** | **0.42** | **0.38** | <0.02 | <0.02 |
| **Dibenz(a.h)anthracene** | 53-70-3 | 0.02 | µg/L | | **0.22** | **0.27** | **0.24** | <0.02 | <0.02 |
| **Benzo(g.h.i)perylene** | 191-24-2 | 0.02 | µg/L | | **0.38** | **0.48** | **0.42** | <0.02 | <0.02 |
| ^ **Total PAH** | ---- | 0.005 | µg/L | | **842** | **859** | **872** | **0.200** | **0.070** |
| ^ **Benzo(a)pyrene TEQ (zero)** | ---- | 0.005 | µg/L | | **1.05** | **1.28** | **1.14** | <0.005 | <0.005 |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | | |
| **1.2-Dichloroethane-D4** | 17060-07-0 | 2 | % | | **103** | **104** | **100** | **105** | **112** |
| **Toluene-D8** | 2037-26-5 | 2 | % | | **99.9** | **102** | **99.2** | **95.4** | **85.4** |
| **4-Bromofluorobenzene** | 460-00-4 | 2 | % | | **103** | **99.6** | **99.0** | **101** | **94.8** |
| **EP132T: Base/Neutral Extractable Surrogates (Low-Level)** | | | | | | | | | |
| **2-Fluorobiphenyl** | 321-60-8 | 0.02 | % | | **115** | **122** | **70.7** | **97.9** | **88.8** |
| **Anthracene-d10** | 1719-06-8 | 0.02 | % | | **91.9** | **106** | **101** | **94.5** | **107** |
| **4-Terphenyl-d14** | 1718-51-0 | 0.02 | % | | **102** | **101** | **105** | **104** | **97.7** |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Sample ID | ROV 2-1 | ROV 2-2 | ROV 2-3 | Rinsate-ROV | Rinsate-NK |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 10-Oct-2022 10:37 | 10-Oct-2022 12:49 | 10-Oct-2022 13:51 | 11-Oct-2022 08:00 | 11-Oct-2022 08:00 |
| Compound | CAS Number | LOR | Unit | EM2219948-026 | EM2219948-027 | EM2219948-028 | EM2219948-029 | EM2219948-030 |
| | | | | Result | Result | Result | Result | Result |
| **EG020T: Total Metals by ICP-MS** | | | | | | | | |
| Barium | 7440-39-3 | 1 | ug/L | **7** | **7** | **10** | **2** | <1 |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | |
| C6 - C9 Fraction | ---- | 20 | µg/L | <20 | **60** | <20 | <20 | <20 |
| C10 - C14 Fraction | ---- | 50 | µg/L | <50 | <50 | <50 | <50 | <50 |
| C15 - C28 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| C29 - C36 Fraction | ---- | 50 | µg/L | <50 | <50 | <50 | <50 | <50 |
| ^ C10 - C36 Fraction (sum) | ---- | 50 | µg/L | <50 | <50 | <50 | <50 | <50 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | | |
| C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | **60** | <20 | <20 | <20 |
| ^ C6 - C10 Fraction minus BTEX (F1) | C6_C10-BTEX | 20 | µg/L | <20 | **20** | <20 | <20 | <20 |
| >C10 - C16 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| >C16 - C34 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| >C34 - C40 Fraction | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| ^ >C10 - C40 Fraction (sum) | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| ^ >C10 - C16 Fraction minus Naphthalene (F2) | ---- | 100 | µg/L | <100 | <100 | <100 | <100 | <100 |
| **EP080: BTEXN** | | | | | | | | |
| Benzene | 71-43-2 | 1 | µg/L | <1 | **5** | <1 | <1 | <1 |
| Toluene | 108-88-3 | 2 | µg/L | <5 | **18** | <2 | <2 | <2 |
| Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | <2 | <2 | <2 | <2 |
| meta- & para-Xylene | 108-38-3 106-42-3 | 2 | µg/L | <4 | **11** | <2 | <2 | <2 |
| ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | **2** | <2 | <2 | <2 |
| ^ Total Xylenes | ---- | 2 | µg/L | <2 | **13** | <2 | <2 | <2 |
| ^ Sum of BTEX | ---- | 1 | µg/L | <1 | **36** | <1 | <1 | <1 |
| Naphthalene | 91-20-3 | 5 | µg/L | <5 | <5 | <5 | <5 | <5 |
| **EP132B: Polynuclear Aromatic Hydrocarbons** | | | | | | | | |
| Naphthalene | 91-20-3 | 0.02 | µg/L | **0.23** | **0.09** | **0.04** | <0.02 | <0.02 |
| Acenaphthylene | 208-96-8 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Acenaphthene | 83-32-9 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Fluorene | 86-73-7 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Phenanthrene | 85-01-8 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Anthracene | 120-12-7 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Fluoranthene | 206-44-0 | 0.02 | µg/L | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |

## Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

| Compound | CAS Number | LOR | Unit | Sample ID | ROV 2-1 | ROV 2-2 | ROV 2-3 | Rinsate-ROV | Rinsate-NK |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Sampling date / time | 10-Oct-2022 10:37 | 10-Oct-2022 12:49 | 10-Oct-2022 13:51 | 11-Oct-2022 08:00 | 11-Oct-2022 08:00 |
| | | | | | EM2219948-026 | EM2219948-027 | EM2219948-028 | EM2219948-029 | EM2219948-030 |
| | | | | | Result | Result | Result | Result | Result |
| **EP132B: Polynuclear Aromatic Hydrocarbons - Continued** | | | | | | | | | |
| **Pyrene** | 129-00-0 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Benz(a)anthracene** | 56-55-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Chrysene** | 218-01-9 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Benzo(b+j)fluoranthene** | 205-99-2 205-82-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Benzo(k)fluoranthene** | 207-08-9 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Benzo(a)pyrene** | 50-32-8 | 0.005 | µg/L | | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| **Indeno(1.2.3.cd)pyrene** | 193-39-5 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Dibenz(a.h)anthracene** | 53-70-3 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Benzo(g.h.i)perylene** | 191-24-2 | 0.02 | µg/L | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| ^ **Total PAH** | ---- | 0.005 | µg/L | | **0.230** | **0.090** | **0.040** | <0.005 | <0.005 |
| ^ **Benzo(a)pyrene TEQ (zero)** | ---- | 0.005 | µg/L | | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | | |
| **1.2-Dichloroethane-D4** | 17060-07-0 | 2 | % | | **108** | **115** | **116** | **101** | **98.8** |
| **Toluene-D8** | 2037-26-5 | 2 | % | | **94.8** | **104** | **109** | **95.9** | **94.0** |
| **4-Bromofluorobenzene** | 460-00-4 | 2 | % | | **102** | **103** | **104** | **110** | **102** |
| **EP132T: Base/Neutral Extractable Surrogates (Low-Level)** | | | | | | | | | |
| **2-Fluorobiphenyl** | 321-60-8 | 0.02 | % | | **99.5** | **93.3** | **99.0** | **95.7** | **92.4** |
| **Anthracene-d10** | 1719-06-8 | 0.02 | % | | **111** | **118** | **120** | **119** | **107** |
| **4-Terphenyl-d14** | 1718-51-0 | 0.02 | % | | **101** | **103** | **102** | **98.5** | **101** |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Sample ID | Trip Blank | ---- | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 31-Aug-2022 00:00 | ---- | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | EM2219948-031 | -------- | -------- | -------- | -------- |
| | | | | Result | ---- | ---- | ---- | ---- |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | |
| **C6 - C9 Fraction** | ---- | 20 | µg/L | <20 | ---- | ---- | ---- | ---- |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | | |
| **C6 - C10 Fraction** | C6_C10 | 20 | µg/L | <20 | ---- | ---- | ---- | ---- |
| ^ **C6 - C10 Fraction minus BTEX (F1)** | C6_C10-BTEX | 20 | µg/L | <20 | ---- | ---- | ---- | ---- |
| **EP080: BTEXN** | | | | | | | | |
| **Benzene** | 71-43-2 | 1 | µg/L | <1 | ---- | ---- | ---- | ---- |
| **Toluene** | 108-88-3 | 2 | µg/L | <2 | ---- | ---- | ---- | ---- |
| **Ethylbenzene** | 100-41-4 | 2 | µg/L | <2 | ---- | ---- | ---- | ---- |
| **meta- & para-Xylene** | 108-38-3 106-42-3 | 2 | µg/L | <2 | ---- | ---- | ---- | ---- |
| **ortho-Xylene** | 95-47-6 | 2 | µg/L | <2 | ---- | ---- | ---- | ---- |
| ^ **Total Xylenes** | ---- | 2 | µg/L | <2 | ---- | ---- | ---- | ---- |
| ^ **Sum of BTEX** | ---- | 1 | µg/L | <1 | ---- | ---- | ---- | ---- |
| **Naphthalene** | 91-20-3 | 5 | µg/L | <5 | ---- | ---- | ---- | ---- |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | |
| **1.2-Dichloroethane-D4** | 17060-07-0 | 2 | % | **105** | ---- | ---- | ---- | ---- |
| **Toluene-D8** | 2037-26-5 | 2 | % | **106** | ---- | ---- | ---- | ---- |
| **4-Bromofluorobenzene** | 460-00-4 | 2 | % | **114** | ---- | ---- | ---- | ---- |

## Surrogate Control Limits

| Sub-Matrix: **WATER** | | Recovery Limits (%) | |
|---|---|---|---|
| *Compound* | *CAS Number* | *Low* | *High* |
| **EP080S: TPH(V)/BTEX Surrogates** | | | |
| **1.2-Dichloroethane-D4** | 17060-07-0 | 73 | 129 |
| **Toluene-D8** | 2037-26-5 | 70 | 125 |
| **4-Bromofluorobenzene** | 460-00-4 | 71 | 129 |
| **EP132T: Base/Neutral Extractable Surrogates (Low-Level)** | | | |
| **2-Fluorobiphenyl** | 321-60-8 | 54 | 136 |
| **Anthracene-d10** | 1719-06-8 | 66 | 134 |
| **4-Terphenyl-d14** | 1718-51-0 | 63 | 135 |

## Inter-Laboratory Testing

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry) 14913 (Biology).

(WATER) EP132B: Polynuclear Aromatic Hydrocarbons

(WATER) EP132T: Base/Neutral Extractable Surrogates (Low-Level)

ALS Environmental

# QUALITY CONTROL REPORT

| | | | |
|---|---|---|---|
| **Work Order** | : **EM2219948** | Page | : 1 of 8 |
| **Amendment** | : **1** | | |
| Client | : **AECOM AUSTRALIA PTY LTD** | Laboratory | : Environmental Division Melbourne |
| Contact | : MARTHIN SLABBER | Contact | : Peter Ravlic |
| Address | : LEVEL 2 181 ADELAIDE TERRACE PERTH WA, AUSTRALIA | Address | : 4 Westall Rd Springvale VIC Australia 3171 |
| Telephone | : ---- | Telephone | : +6138549 9645 |
| Project | : Yolla PFW Plume Verification 60672064. 1.4 | Date Samples Received | : 11-Oct-2022 |
| Order number | : 60649604 | Date Analysis Commenced | : 12-Oct-2022 |
| C-O-C number | : ---- | Issue Date | : 31-Oct-2022 |
| Sampler | : JT | | |
| Site | : ---- | | |
| Quote number | : EN/004/21 | | |
| No. of samples received | : 31 | | |
| No. of samples analysed | : 31 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Arenie Vijayaratnam | Senior Inorganic Chemist | Melbourne Inorganics, Springvale, VIC |
| Edwandy Fadjar | Organic Coordinator | Sydney Organics, Smithfield, NSW |
| Jarwis Nheu | Non-Metals Team Leader | Melbourne Inorganics, Springvale, VIC |
| Xing Lin | Senior Organic Chemist | Melbourne Organics, Springvale, VIC |

## General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

## Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

| | | | | Laboratory Duplicate (DUP) Report | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Laboratory sample ID | Sample ID | Method: Compound | CAS Number | LOR | Unit | Original Result | Duplicate Result | RPD (%) | Acceptable RPD (%) |
| **EG020T: Total Metals by ICP-MS (QC Lot: 4634960)** | | | | | | | | | |
| EM2219948-001 | NK 1-1 | EG020A-T: Barium | 7440-39-3 | 0.001 | mg/L | 7 ug/L | 0.006 | 0.0 | No Limit |
| EM2219948-010 | PFWS 1-1 | EG020A-T: Barium | 7440-39-3 | 0.001 | mg/L | 23800 ug/L | 24.1 | 1.4 | 0% - 20% |
| **EG020T: Total Metals by ICP-MS (QC Lot: 4634961)** | | | | | | | | | |
| EM2219948-021 | PFWS 2-6 | EG020A-T: Barium | 7440-39-3 | 0.001 | mg/L | 23300 ug/L | 23.6 | 1.0 | 0% - 20% |
| EM2219948-030 | Rinsate-NK | EG020A-T: Barium | 7440-39-3 | 0.001 | mg/L | <1 ug/L | <0.001 | 0.0 | No Limit |
| **EP080/071: Total Petroleum Hydrocarbons (QC Lot: 4632996)** | | | | | | | | | |
| EM2219948-030 | Rinsate-NK | EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| EB2229422-001 | Anonymous | EP080: C6 - C9 Fraction | ---- | 20 | µg/L | 40 | 40 | 0.0 | No Limit |
| **EP080/071: Total Petroleum Hydrocarbons (QC Lot: 4633000)** | | | | | | | | | |
| EM2219948-001 | NK 1-1 | EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| EM2219948-011 | PFWS 1-2 | EP080: C6 - C9 Fraction | ---- | 20 | µg/L | 105000 | 101000 | 4.3 | 0% - 20% |
| **EP080/071: Total Petroleum Hydrocarbons (QC Lot: 4634989)** | | | | | | | | | |
| EM2219942-001 | Anonymous | EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| EM2220026-001 | Anonymous | EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| **EP080/071: Total Petroleum Hydrocarbons (QC Lot: 4649897)** | | | | | | | | | |
| EM2219948-031 | Trip Blank | EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 4632996)** | | | | | | | | | |
| EM2219948-030 | Rinsate-NK | EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| EB2229422-001 | Anonymous | EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | 20 | 0.0 | No Limit |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 4633000)** | | | | | | | | | |
| EM2219948-001 | NK 1-1 | EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| EM2219948-011 | PFWS 1-2 | EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | 110000 | 105000 | 4.4 | 0% - 20% |

Sub-Matrix: **WATER**

| | | | | Laboratory Duplicate (DUP) Report | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Laboratory sample ID* | *Sample ID* | *Method: Compound* | *CAS Number* | *LOR* | *Unit* | *Original Result* | *Duplicate Result* | *RPD (%)* | *Acceptable RPD (%)* |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 4634989)** | | | | | | | | | |
| EM2219942-001 | Anonymous | EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| EM2220026-001 | Anonymous | EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 4649897)** | | | | | | | | | |
| EM2219948-031 | Trip Blank | EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | <20 | 0.0 | No Limit |
| **EP080: BTEXN (QC Lot: 4632996)** | | | | | | | | | |
| EM2219948-030 | Rinsate-NK | EP080: Benzene | 71-43-2 | 1 | µg/L | <1 | <1 | 0.0 | No Limit |
| | | EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | <5 | 0.0 | No Limit |
| EB2229422-001 | Anonymous | EP080: Benzene | 71-43-2 | 1 | µg/L | 2 | 2 | 0.0 | No Limit |
| | | EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | <5 | 0.0 | No Limit |
| **EP080: BTEXN (QC Lot: 4633000)** | | | | | | | | | |
| EM2219948-001 | NK 1-1 | EP080: Benzene | 71-43-2 | 1 | µg/L | 1 | 2 | 0.0 | No Limit |
| | | EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | <5 | 0.0 | No Limit |
| EM2219948-011 | PFWS 1-2 | EP080: Benzene | 71-43-2 | 1 | µg/L | 22700 | 20700 | 9.5 | 0% - 20% |
| | | EP080: Toluene | 108-88-3 | 2 | µg/L | 37200 | 35800 | 3.8 | 0% - 20% |
| | | EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | 1300 | 1190 | 8.3 | 0% - 50% |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | 13900 | 13200 | 5.3 | 0% - 20% |
| | | EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | 3630 | 3470 | 4.6 | 0% - 20% |
| | | EP080: Naphthalene | 91-20-3 | 5 | µg/L | 732 | 665 | 9.6 | No Limit |
| **EP080: BTEXN (QC Lot: 4634989)** | | | | | | | | | |
| EM2219942-001 | Anonymous | EP080: Benzene | 71-43-2 | 1 | µg/L | <1 | <1 | 0.0 | No Limit |
| | | EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |

Sub-Matrix: **WATER**

| | | | | Laboratory Duplicate (DUP) Report | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Laboratory sample ID* | *Sample ID* | *Method: Compound* | *CAS Number* | *LOR* | *Unit* | *Original Result* | *Duplicate Result* | *RPD (%)* | *Acceptable RPD (%)* |
| **EP080: BTEXN (QC Lot: 4634989) - continued** | | | | | | | | | |
| EM2219942-001 | Anonymous | EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | <5 | 0.0 | No Limit |
| EM2220026-001 | Anonymous | EP080: Benzene | 71-43-2 | 1 | µg/L | <1 | <1 | 0.0 | No Limit |
| | | EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | <5 | 0.0 | No Limit |
| **EP080: BTEXN (QC Lot: 4649897)** | | | | | | | | | |
| EM2219948-031 | Trip Blank | EP080: Benzene | 71-43-2 | 1 | µg/L | <1 | <1 | 0.0 | No Limit |
| | | EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | <2 | 0.0 | No Limit |
| | | EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | <5 | 0.0 | No Limit |

## Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

| | | | | Method Blank (MB) Report | Laboratory Control Spike (LCS) Report | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Spike | Spike Recovery (%) | Acceptable Limits (%) | |
| Method: Compound | CAS Number | LOR | Unit | Result | Concentration | LCS | Low | High |
| **EG020T: Total Metals by ICP-MS (QCLot: 4634960)** | | | | | | | | |
| EG020A-T: Barium | 7440-39-3 | 0.001 | mg/L | <0.001 | 0.1 mg/L | 106 | 87.2 | 117 |
| **EG020T: Total Metals by ICP-MS (QCLot: 4634961)** | | | | | | | | |
| EG020A-T: Barium | 7440-39-3 | 0.001 | mg/L | <0.001 | 0.1 mg/L | 104 | 87.2 | 117 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 4632996)** | | | | | | | | |
| EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | 360 µg/L | 106 | 66.2 | 134 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 4633000)** | | | | | | | | |
| EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | 360 µg/L | 98.8 | 66.2 | 134 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 4634559)** | | | | | | | | |
| EP071: C10 - C14 Fraction | ---- | 50 | µg/L | <50 | 4460 µg/L | 94.6 | 47.2 | 122 |
| EP071: C15 - C28 Fraction | ---- | 100 | µg/L | <100 | 14300 µg/L | 100 | 52.9 | 131 |
| EP071: C29 - C36 Fraction | ---- | 50 | µg/L | <50 | 7300 µg/L | 99.5 | 50.4 | 127 |
| EP071: C10 - C36 Fraction (sum) | ---- | 50 | µg/L | <50 | 26060 µg/L | 98.9 | 51.5 | 128 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 4634561)** | | | | | | | | |
| EP071: C10 - C14 Fraction | ---- | 50 | µg/L | <50 | 4460 µg/L | 90.1 | 47.2 | 122 |
| EP071: C15 - C28 Fraction | ---- | 100 | µg/L | <100 | 14300 µg/L | 92.5 | 52.9 | 131 |
| EP071: C29 - C36 Fraction | ---- | 50 | µg/L | <50 | 7300 µg/L | 91.0 | 50.4 | 127 |
| EP071: C10 - C36 Fraction (sum) | ---- | 50 | µg/L | <50 | 26060 µg/L | 91.6 | 51.5 | 128 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 4634989)** | | | | | | | | |
| EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | 360 µg/L | 90.1 | 66.2 | 134 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 4649897)** | | | | | | | | |
| EP080: C6 - C9 Fraction | ---- | 20 | µg/L | <20 | 360 µg/L | 106 | 66.2 | 134 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4632996)** | | | | | | | | |
| EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | 450 µg/L | 106 | 66.2 | 132 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4633000)** | | | | | | | | |
| EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | 450 µg/L | 96.1 | 66.2 | 132 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4634559)** | | | | | | | | |
| EP071: >C10 - C16 Fraction | ---- | 100 | µg/L | <100 | 6090 µg/L | 95.1 | 49.1 | 125 |
| EP071: >C16 - C34 Fraction | ---- | 100 | µg/L | <100 | 19400 µg/L | 101 | 51.6 | 128 |
| EP071: >C34 - C40 Fraction | ---- | 100 | µg/L | <100 | 1300 µg/L | 104 | 47.2 | 130 |
| EP071: >C10 - C40 Fraction (sum) | ---- | 100 | µg/L | <100 | 26790 µg/L | 99.5 | 51.2 | 127 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4634561)** | | | | | | | | |
| EP071: >C10 - C16 Fraction | ---- | 100 | µg/L | <100 | 6090 µg/L | 88.4 | 49.1 | 125 |
| EP071: >C16 - C34 Fraction | ---- | 100 | µg/L | <100 | 19400 µg/L | 93.0 | 51.6 | 128 |

Sub-Matrix: **WATER**

| Method: Compound | CAS Number | LOR | Unit | Method Blank (MB) Report | Laboratory Control Spike (LCS) Report | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Spike | Spike Recovery (%) | Acceptable Limits (%) | |
| | | | | Result | Concentration | LCS | Low | High |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4634561) - continued** | | | | | | | | |
| EP071: >C34 - C40 Fraction | ---- | 100 | µg/L | <100 | 1300 µg/L | 83.4 | 47.2 | 130 |
| EP071: >C10 - C40 Fraction (sum) | ---- | 100 | µg/L | <100 | 26790 µg/L | 91.3 | 51.2 | 127 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4634989)** | | | | | | | | |
| EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | 450 µg/L | 97.4 | 66.2 | 132 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4649897)** | | | | | | | | |
| EP080: C6 - C10 Fraction | C6_C10 | 20 | µg/L | <20 | 450 µg/L | 104 | 66.2 | 132 |
| **EP080: BTEXN (QCLot: 4632996)** | | | | | | | | |
| EP080: Benzene | 71-43-2 | 1 | µg/L | <1 | 20 µg/L | 109 | 68.8 | 127 |
| EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | 20 µg/L | 107 | 72.9 | 129 |
| EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | 20 µg/L | 108 | 71.7 | 130 |
| EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | 40 µg/L | 108 | 72.3 | 136 |
| EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | 20 µg/L | 112 | 75.9 | 134 |
| EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | 5 µg/L | 108 | 68.3 | 131 |
| **EP080: BTEXN (QCLot: 4633000)** | | | | | | | | |
| EP080: Benzene | 71-43-2 | 1 | µg/L | <1 | 20 µg/L | 99.5 | 68.8 | 127 |
| EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | 20 µg/L | 99.2 | 72.9 | 129 |
| EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | 20 µg/L | 96.6 | 71.7 | 130 |
| EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | 40 µg/L | 97.1 | 72.3 | 136 |
| EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | 20 µg/L | 103 | 75.9 | 134 |
| EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | 5 µg/L | 123 | 68.3 | 131 |
| **EP080: BTEXN (QCLot: 4634989)** | | | | | | | | |
| EP080: Benzene | 71-43-2 | 1 | µg/L | <1 | 20 µg/L | 92.6 | 68.8 | 127 |
| EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | 20 µg/L | 97.1 | 72.9 | 129 |
| EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | 20 µg/L | 97.7 | 71.7 | 130 |
| EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | 40 µg/L | 93.2 | 72.3 | 136 |
| EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | 20 µg/L | 99.0 | 75.9 | 134 |
| EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | 5 µg/L | 99.0 | 68.3 | 131 |
| **EP080: BTEXN (QCLot: 4649897)** | | | | | | | | |
| EP080: Benzene | 71-43-2 | 1 | µg/L | <1 | 20 µg/L | 103 | 68.8 | 127 |
| EP080: Toluene | 108-88-3 | 2 | µg/L | <2 | 20 µg/L | 107 | 72.9 | 129 |
| EP080: Ethylbenzene | 100-41-4 | 2 | µg/L | <2 | 20 µg/L | 106 | 71.7 | 130 |
| EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2 | µg/L | <2 | 40 µg/L | 106 | 72.3 | 136 |
| EP080: ortho-Xylene | 95-47-6 | 2 | µg/L | <2 | 20 µg/L | 107 | 75.9 | 134 |
| EP080: Naphthalene | 91-20-3 | 5 | µg/L | <5 | 5 µg/L | 105 | 68.3 | 131 |

Sub-Matrix: **WATER**

| Method: Compound | CAS Number | LOR | Unit | Method Blank (MB) Report | Laboratory Control Spike (LCS) Report | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Spike | Spike Recovery (%) | Acceptable Limits (%) | |
| | | | | Result | Concentration | LCS | Low | High |
| **EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 4635741)** | | | | | | | | |
| EP132-LL: Naphthalene | 91-20-3 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 90.3 | 62.0 | 136 |
| EP132-LL: Acenaphthylene | 208-96-8 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 101 | 68.0 | 128 |
| EP132-LL: Acenaphthene | 83-32-9 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 104 | 69.0 | 121 |
| EP132-LL: Fluorene | 86-73-7 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 97.1 | 69.0 | 131 |
| EP132-LL: Phenanthrene | 85-01-8 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 102 | 69.0 | 137 |
| EP132-LL: Anthracene | 120-12-7 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 93.8 | 64.0 | 120 |
| EP132-LL: Fluoranthene | 206-44-0 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 101 | 63.0 | 129 |
| EP132-LL: Pyrene | 129-00-0 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 104 | 67.0 | 127 |
| EP132-LL: Benz(a)anthracene | 56-55-3 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 108 | 72.0 | 132 |
| EP132-LL: Chrysene | 218-01-9 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 96.6 | 65.0 | 125 |
| EP132-LL: Benzo(b+j)fluoranthene | 205-99-2<br>205-82-3 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 117 | 66.0 | 130 |
| EP132-LL: Benzo(k)fluoranthene | 207-08-9 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 102 | 64.0 | 130 |
| EP132-LL: Benzo(a)pyrene | 50-32-8 | 0.005 | µg/L | <0.005 | 0.25 µg/L | 98.8 | 61.0 | 125 |
| EP132-LL: Indeno(1.2.3.cd)pyrene | 193-39-5 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 100.0 | 67.0 | 131 |
| EP132-LL: Dibenz(a.h)anthracene | 53-70-3 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 97.7 | 67.0 | 135 |
| EP132-LL: Benzo(g.h.i)perylene | 191-24-2 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 98.0 | 66.0 | 130 |
| EP132-LL: Total PAH | ---- | 0.005 | µg/L | <0.005 | ---- | ---- | ---- | ---- |
| **EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 4635742)** | | | | | | | | |
| EP132-LL: Naphthalene | 91-20-3 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 101 | 62.0 | 136 |
| EP132-LL: Acenaphthylene | 208-96-8 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 104 | 68.0 | 128 |
| EP132-LL: Acenaphthene | 83-32-9 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 110 | 69.0 | 121 |
| EP132-LL: Fluorene | 86-73-7 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 109 | 69.0 | 131 |
| EP132-LL: Phenanthrene | 85-01-8 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 105 | 69.0 | 137 |
| EP132-LL: Anthracene | 120-12-7 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 112 | 64.0 | 120 |
| EP132-LL: Fluoranthene | 206-44-0 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 113 | 63.0 | 129 |
| EP132-LL: Pyrene | 129-00-0 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 117 | 67.0 | 127 |
| EP132-LL: Benz(a)anthracene | 56-55-3 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 113 | 72.0 | 132 |
| EP132-LL: Chrysene | 218-01-9 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 106 | 65.0 | 125 |
| EP132-LL: Benzo(b+j)fluoranthene | 205-99-2<br>205-82-3 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 110 | 66.0 | 130 |
| EP132-LL: Benzo(k)fluoranthene | 207-08-9 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 105 | 64.0 | 130 |
| EP132-LL: Benzo(a)pyrene | 50-32-8 | 0.005 | µg/L | <0.005 | 0.25 µg/L | 110 | 61.0 | 125 |
| EP132-LL: Indeno(1.2.3.cd)pyrene | 193-39-5 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 107 | 67.0 | 131 |
| EP132-LL: Dibenz(a.h)anthracene | 53-70-3 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 107 | 67.0 | 135 |
| EP132-LL: Benzo(g.h.i)perylene | 191-24-2 | 0.02 | µg/L | <0.02 | 0.25 µg/L | 107 | 66.0 | 130 |
| EP132-LL: Total PAH | ---- | 0.005 | µg/L | <0.005 | ---- | ---- | ---- | ---- |

## Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

| | | | | Matrix Spike (MS) Report | | | |
|---|---|---|---|---|---|---|---|
| | | | | Spike | SpikeRecovery(%) | Acceptable Limits (%) | |
| Laboratory sample ID | Sample ID | Method: Compound | CAS Number | Concentration | MS | Low | High |
| **EG020T: Total Metals by ICP-MS (QCLot: 4634960)** | | | | | | | |
| EM2219948-001 | NK 1-1 | EG020A-T: Barium | 7440-39-3 | 1 mg/L | 115 | 80.0 | 120 |
| **EG020T: Total Metals by ICP-MS (QCLot: 4634961)** | | | | | | | |
| EM2219948-021 | PFWS 2-6 | EG020A-T: Barium | 7440-39-3 | 1 mg/L | # Not Determined | 80.0 | 120 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 4633000)** | | | | | | | |
| EM2219948-002 | NK 1-2 | EP080: C6 - C9 Fraction | ---- | 280 µg/L | 80.8 | 33.9 | 126 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 4634989)** | | | | | | | |
| EM2219942-002 | Anonymous | EP080: C6 - C9 Fraction | ---- | 280 µg/L | 68.0 | 33.9 | 126 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4633000)** | | | | | | | |
| EM2219948-002 | NK 1-2 | EP080: C6 - C10 Fraction | C6_C10 | 330 µg/L | 74.7 | 34.0 | 122 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4634989)** | | | | | | | |
| EM2219942-002 | Anonymous | EP080: C6 - C10 Fraction | C6_C10 | 330 µg/L | 64.1 | 34.0 | 122 |
| **EP080: BTEXN (QCLot: 4633000)** | | | | | | | |
| EM2219948-002 | NK 1-2 | EP080: Benzene | 71-43-2 | 20 µg/L | 100 | 56.3 | 133 |
| | | EP080: Toluene | 108-88-3 | 20 µg/L | 98.7 | 60.4 | 132 |
| **EP080: BTEXN (QCLot: 4634989)** | | | | | | | |
| EM2219942-002 | Anonymous | EP080: Benzene | 71-43-2 | 20 µg/L | 83.8 | 56.3 | 133 |
| | | EP080: Toluene | 108-88-3 | 20 µg/L | 87.7 | 60.4 | 132 |

ALS Environmental

# QA/QC Compliance Assessment to assist with Quality Review

| | | | |
|---|---|---|---|
| **Work Order** | : **EM2219948** | Page | : 1 of 10 |
| **Amendment** | : **1** | | |
| Client | : **AECOM AUSTRALIA PTY LTD** | Laboratory | : Environmental Division Melbourne |
| Contact | : MARTHIN SLABBER | Telephone | : +6138549 9645 |
| Project | : Yolla PFW Plume Verification 60672064. 1.4 | Date Samples Received | : 11-Oct-2022 |
| Site | : ---- | Issue Date | : 31-Oct-2022 |
| Sampler | : JT | No. of samples received | : 31 |
| Order number | : 60649604 | No. of samples analysed | : 31 |

**This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.**

Brief method summaries and references are also provided to assist in traceability.

## Summary of Outliers

### Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

### Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

### Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

## Outliers : Quality Control Samples

*Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes*

Matrix: **WATER**

| Compound Group Name | Laboratory Sample ID | Client Sample ID | Analyte | CAS Number | Data | Limits | Comment |
|---|---|---|---|---|---|---|---|
| **Matrix Spike (MS) Recoveries** | | | | | | | |
| EG020T: Total Metals by ICP-MS | EM2219948--021 | PFWS 2-6 | **Barium** | 7440-39-3 | Not Determined | ---- | **MS recovery not determined, background level greater than or equal to 4x spike level.** |

## Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

| Method / Container / Client Sample ID(s) | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|
| | Date extracted | Due for extraction | Days overdue | Date analysed | Due for analysis | Days overdue |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | |
| **Amber VOC Vial - Sulfuric Acid** | | | | | | |
| Trip Blank | 20-Oct-2022 | 14-Sep-2022 | **36** | 20-Oct-2022 | 14-Sep-2022 | **36** |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | |
| **Amber VOC Vial - Sulfuric Acid** | | | | | | |
| Trip Blank | 20-Oct-2022 | 14-Sep-2022 | **36** | 20-Oct-2022 | 14-Sep-2022 | **36** |
| **EP080: BTEXN** | | | | | | |
| **Amber VOC Vial - Sulfuric Acid** | | | | | | |
| Trip Blank | 20-Oct-2022 | 14-Sep-2022 | **36** | 20-Oct-2022 | 14-Sep-2022 | **36** |

## Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

| Quality Control Sample Type / Method | Count | | Rate (%) | | Quality Control Specification |
|---|---|---|---|---|---|
| | QC | Regular | Actual | Expected | |
| Laboratory Duplicates (DUP) | | | | | |
| PAH Compounds in Water | 0 | 30 | 0.00 | 10.00 | NEPM 2013 B3 & ALS QC Standard |
| TRH - Semivolatile Fraction | 0 | 39 | 0.00 | 10.00 | NEPM 2013 B3 & ALS QC Standard |
| Matrix Spikes (MS) | | | | | |
| PAH Compounds in Water | 0 | 30 | 0.00 | 5.00 | NEPM 2013 B3 & ALS QC Standard |
| TRH - Semivolatile Fraction | 0 | 39 | 0.00 | 5.00 | NEPM 2013 B3 & ALS QC Standard |
| TRH Volatiles/BTEX | 2 | 52 | 3.85 | 5.00 | NEPM 2013 B3 & ALS QC Standard |

# Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|
| | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EG020T: Total Metals by ICP-MS** | | | | | | | | |
| **Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T)** | | | | | | | | |
| NK 1-1, | NK 1-2, | **09-Oct-2022** | **13-Oct-2022** | 07-Apr-2023 | ✓ | **13-Oct-2022** | 07-Apr-2023 | ✓ |
| NK 1-3, | NK 1-4, | | | | | | | |
| NK 1-5, | NK 1-6, | | | | | | | |
| PFWS 1-1, | PFWS 1-2, | | | | | | | |
| PFWS 1-3, | PFWS 1-4, | | | | | | | |
| PFWS 1-5, | PFWS 1-6, | | | | | | | |
| ROV 1-1 | | | | | | | | |
| **Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T)** | | | | | | | | |
| NK 2-1, | NK 2-2, | **10-Oct-2022** | **13-Oct-2022** | 08-Apr-2023 | ✓ | **13-Oct-2022** | 08-Apr-2023 | ✓ |
| NK 2-3, | PFWS 2-1, | | | | | | | |
| PFWS 2-2, | PFWS 2-3, | | | | | | | |
| PFWS 2-4, | PFWS 2-5, | | | | | | | |
| PFWS 2-6, | PFWS 2-7, | | | | | | | |
| PFWS 2-8, | ROV 2-1, | | | | | | | |
| ROV 2-2, | ROV 2-3 | | | | | | | |
| **Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T)** | | | | | | | | |
| Rinsate-ROV, | Rinsate-NK | **11-Oct-2022** | **13-Oct-2022** | 09-Apr-2023 | ✓ | **13-Oct-2022** | 09-Apr-2023 | ✓ |
| **Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T)** | | | | | | | | |
| ROV 1-2 | | **12-Oct-2022** | **13-Oct-2022** | 10-Apr-2023 | ✓ | **13-Oct-2022** | 10-Apr-2023 | ✓ |

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|
| | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| NK 1-1, NK 1-2, NK 1-3, NK 1-4, NK 1-5, NK 1-6, PFWS 1-1, PFWS 1-2, PFWS 1-3, PFWS 1-4, PFWS 1-5, PFWS 1-6, ROV 1-1 | **09-Oct-2022** | **13-Oct-2022** | 16-Oct-2022 | ✓ | **15-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| PFWS 2-1, PFWS 2-2, PFWS 2-3, PFWS 2-4, PFWS 2-5, ROV 2-1, ROV 2-2 | **10-Oct-2022** | **13-Oct-2022** | 17-Oct-2022 | ✓ | **15-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| NK 2-1, NK 2-2, NK 2-3, PFWS 2-6, PFWS 2-7, PFWS 2-8, ROV 2-3 | **10-Oct-2022** | **13-Oct-2022** | 17-Oct-2022 | ✓ | **18-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| Rinsate-ROV, Rinsate-NK | **11-Oct-2022** | **13-Oct-2022** | 18-Oct-2022 | ✓ | **18-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| ROV 1-2 | **12-Oct-2022** | **13-Oct-2022** | 19-Oct-2022 | ✓ | **18-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| ROV 1-1 | **09-Oct-2022** | **12-Oct-2022** | 23-Oct-2022 | ✓ | **12-Oct-2022** | 23-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| NK 1-1, NK 1-2, NK 1-3, NK 1-4, NK 1-5, NK 1-6, PFWS 1-1, PFWS 1-2, PFWS 1-3, PFWS 1-4, PFWS 1-5, PFWS 1-6 | **09-Oct-2022** | **12-Oct-2022** | 23-Oct-2022 | ✓ | **13-Oct-2022** | 23-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| PFWS 2-6, PFWS 2-7, PFWS 2-8, ROV 2-1, ROV 2-2, ROV 2-3 | **10-Oct-2022** | **12-Oct-2022** | 24-Oct-2022 | ✓ | **12-Oct-2022** | 24-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| NK 2-1, NK 2-2, NK 2-3, PFWS 2-1, PFWS 2-2, PFWS 2-3, PFWS 2-4, PFWS 2-5 | **10-Oct-2022** | **12-Oct-2022** | 24-Oct-2022 | ✓ | **13-Oct-2022** | 24-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| Rinsate-ROV, Rinsate-NK | **11-Oct-2022** | **12-Oct-2022** | 25-Oct-2022 | ✓ | **12-Oct-2022** | 25-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|
| | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EP080/071: Total Petroleum Hydrocarbons - Continued** | | | | | | | |
| ROV 1-2 | **12-Oct-2022** | **13-Oct-2022** | 26-Oct-2022 | ✓ | **13-Oct-2022** | 26-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| Trip Blank | **31-Aug-2022** | **20-Oct-2022** | 14-Sep-2022 | × | **20-Oct-2022** | 14-Sep-2022 | × |

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|
| | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| NK 1-1, NK 1-2, NK 1-3, NK 1-4, NK 1-5, NK 1-6, PFWS 1-1, PFWS 1-2, PFWS 1-3, PFWS 1-4, PFWS 1-5, PFWS 1-6, ROV 1-1 | **09-Oct-2022** | **13-Oct-2022** | 16-Oct-2022 | ✓ | **15-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| PFWS 2-1, PFWS 2-2, PFWS 2-3, PFWS 2-4, PFWS 2-5, ROV 2-1, ROV 2-2 | **10-Oct-2022** | **13-Oct-2022** | 17-Oct-2022 | ✓ | **15-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| NK 2-1, NK 2-2, NK 2-3, PFWS 2-6, PFWS 2-7, PFWS 2-8, ROV 2-3 | **10-Oct-2022** | **13-Oct-2022** | 17-Oct-2022 | ✓ | **18-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| Rinsate-ROV, Rinsate-NK | **11-Oct-2022** | **13-Oct-2022** | 18-Oct-2022 | ✓ | **18-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP071)** | | | | | | | |
| ROV 1-2 | **12-Oct-2022** | **13-Oct-2022** | 19-Oct-2022 | ✓ | **18-Oct-2022** | 22-Nov-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| ROV 1-1 | **09-Oct-2022** | **12-Oct-2022** | 23-Oct-2022 | ✓ | **12-Oct-2022** | 23-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| NK 1-1, NK 1-2, NK 1-3, NK 1-4, NK 1-5, NK 1-6, PFWS 1-1, PFWS 1-2, PFWS 1-3, PFWS 1-4, PFWS 1-5, PFWS 1-6 | **09-Oct-2022** | **12-Oct-2022** | 23-Oct-2022 | ✓ | **13-Oct-2022** | 23-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| PFWS 2-6, PFWS 2-7, PFWS 2-8, ROV 2-1, ROV 2-2, ROV 2-3 | **10-Oct-2022** | **12-Oct-2022** | 24-Oct-2022 | ✓ | **12-Oct-2022** | 24-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| NK 2-1, NK 2-2, NK 2-3, PFWS 2-1, PFWS 2-2, PFWS 2-3, PFWS 2-4, PFWS 2-5 | **10-Oct-2022** | **12-Oct-2022** | 24-Oct-2022 | ✓ | **13-Oct-2022** | 24-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |
| Rinsate-ROV, Rinsate-NK | **11-Oct-2022** | **12-Oct-2022** | 25-Oct-2022 | ✓ | **12-Oct-2022** | 25-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** | | | | | | | |

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|
| | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued** | | | | | | | |
| ROV 1-2 | **12-Oct-2022** | **13-Oct-2022** | 26-Oct-2022 | ✓ | **13-Oct-2022** | 26-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** Trip Blank | **31-Aug-2022** | **20-Oct-2022** | 14-Sep-2022 | × | **20-Oct-2022** | 14-Sep-2022 | × |
| **EP080: BTEXN** | | | | | | | |
| **Amber VOC Vial - Sulfuric Acid (EP080)** ROV 1-1 | **09-Oct-2022** | **12-Oct-2022** | 23-Oct-2022 | ✓ | **12-Oct-2022** | 23-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** NK 1-1, NK 1-2, NK 1-3, NK 1-4, NK 1-5, NK 1-6, PFWS 1-1, PFWS 1-2, PFWS 1-3, PFWS 1-4, PFWS 1-5, PFWS 1-6 | **09-Oct-2022** | **12-Oct-2022** | 23-Oct-2022 | ✓ | **13-Oct-2022** | 23-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** PFWS 2-6, PFWS 2-7, PFWS 2-8, ROV 2-1, ROV 2-2, ROV 2-3 | **10-Oct-2022** | **12-Oct-2022** | 24-Oct-2022 | ✓ | **12-Oct-2022** | 24-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** NK 2-1, NK 2-2, NK 2-3, PFWS 2-1, PFWS 2-2, PFWS 2-3, PFWS 2-4, PFWS 2-5 | **10-Oct-2022** | **12-Oct-2022** | 24-Oct-2022 | ✓ | **13-Oct-2022** | 24-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** Rinsate-ROV, Rinsate-NK | **11-Oct-2022** | **12-Oct-2022** | 25-Oct-2022 | ✓ | **12-Oct-2022** | 25-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** ROV 1-2 | **12-Oct-2022** | **13-Oct-2022** | 26-Oct-2022 | ✓ | **13-Oct-2022** | 26-Oct-2022 | ✓ |
| **Amber VOC Vial - Sulfuric Acid (EP080)** Trip Blank | **31-Aug-2022** | **20-Oct-2022** | 14-Sep-2022 | × | **20-Oct-2022** | 14-Sep-2022 | × |

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|
| | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EP132B: Polynuclear Aromatic Hydrocarbons** | | | | | | | | |
| **Amber Glass Bottle - Unpreserved (EP132-LL)** | | | | | | | | |
| NK 1-1, | NK 1-2, | **09-Oct-2022** | **15-Oct-2022** | 16-Oct-2022 | ✓ | **15-Oct-2022** | 24-Nov-2022 | ✓ |
| NK 1-3, | NK 1-4, | | | | | | | |
| NK 1-5, | NK 1-6, | | | | | | | |
| PFWS 1-1, | PFWS 1-2, | | | | | | | |
| PFWS 1-3, | PFWS 1-4, | | | | | | | |
| PFWS 1-5, | PFWS 1-6, | | | | | | | |
| ROV 1-1 | | | | | | | | |
| **Amber Glass Bottle - Unpreserved (EP132-LL)** | | | | | | | | |
| NK 2-1, | NK 2-2, | **10-Oct-2022** | **15-Oct-2022** | 17-Oct-2022 | ✓ | **15-Oct-2022** | 24-Nov-2022 | ✓ |
| NK 2-3, | PFWS 2-1, | | | | | | | |
| PFWS 2-2, | PFWS 2-3, | | | | | | | |
| PFWS 2-4, | PFWS 2-5, | | | | | | | |
| PFWS 2-6, | PFWS 2-7, | | | | | | | |
| PFWS 2-8, | ROV 2-1, | | | | | | | |
| ROV 2-2, | ROV 2-3 | | | | | | | |
| **Amber Glass Bottle - Unpreserved (EP132-LL)** | | | | | | | | |
| Rinsate-ROV, | Rinsate-NK | **11-Oct-2022** | **15-Oct-2022** | 18-Oct-2022 | ✓ | **15-Oct-2022** | 24-Nov-2022 | ✓ |
| **Amber Glass Bottle - Unpreserved (EP132-LL)** | | | | | | | | |
| ROV 1-2 | | **12-Oct-2022** | **15-Oct-2022** | 19-Oct-2022 | ✓ | **15-Oct-2022** | 24-Nov-2022 | ✓ |

# Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

| Quality Control Sample Type | | Count | | Rate (%) | | | Quality Control Specification |
|---|---|---|---|---|---|---|---|
| *Analytical Methods* | *Method* | *QC* | *Regular* | ***Actual*** | ***Expected*** | *Evaluation* | |
| Laboratory Duplicates (DUP) | | | | | | | |
| PAH Compounds in Water | EP132-LL | 0 | 30 | **0.00** | **10.00** | × | NEPM 2013 B3 & ALS QC Standard |
| Total Metals by ICP-MS - Suite A | EG020A-T | 4 | 30 | **13.33** | **10.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| TRH - Semivolatile Fraction | EP071 | 0 | 39 | **0.00** | **10.00** | × | NEPM 2013 B3 & ALS QC Standard |
| TRH Volatiles/BTEX | EP080 | 7 | 52 | **13.46** | **10.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| Laboratory Control Samples (LCS) | | | | | | | |
| PAH Compounds in Water | EP132-LL | 2 | 30 | **6.67** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| Total Metals by ICP-MS - Suite A | EG020A-T | 2 | 30 | **6.67** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| TRH - Semivolatile Fraction | EP071 | 2 | 39 | **5.13** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| TRH Volatiles/BTEX | EP080 | 4 | 52 | **7.69** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| Method Blanks (MB) | | | | | | | |
| PAH Compounds in Water | EP132-LL | 2 | 30 | **6.67** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| Total Metals by ICP-MS - Suite A | EG020A-T | 2 | 30 | **6.67** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| TRH - Semivolatile Fraction | EP071 | 2 | 39 | **5.13** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| TRH Volatiles/BTEX | EP080 | 4 | 52 | **7.69** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| Matrix Spikes (MS) | | | | | | | |
| PAH Compounds in Water | EP132-LL | 0 | 30 | **0.00** | **5.00** | × | NEPM 2013 B3 & ALS QC Standard |
| Total Metals by ICP-MS - Suite A | EG020A-T | 2 | 30 | **6.67** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| TRH - Semivolatile Fraction | EP071 | 0 | 39 | **0.00** | **5.00** | × | NEPM 2013 B3 & ALS QC Standard |
| TRH Volatiles/BTEX | EP080 | 2 | 52 | **3.85** | **5.00** | × | NEPM 2013 B3 & ALS QC Standard |

## Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

| Analytical Methods | Method | Matrix | Method Descriptions |
|---|---|---|---|
| Total Metals by ICP-MS - Suite A | EG020A-T | WATER | In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector. |
| TRH - Semivolatile Fraction | EP071 | WATER | In house: Referenced to USEPA SW 846 - 8015 The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM Schedule B(3) |
| TRH Volatiles/BTEX | EP080 | WATER | In house: Referenced to USEPA SW 846 - 8260 Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM Schedule B(3) |
| PAH Compounds in Water | EP132-LL | WATER | In house, Samples are extracted into solvent in original containers. Determination by large volume injection GCMS in selected ion monitoring (SIM) mode. |

| Preparation Methods | Method | Matrix | Method Descriptions |
|---|---|---|---|
| Digestion for Total Recoverable Metals | EN25 | WATER | In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM Schedule B(3) |
| Separatory Funnel Extraction of Liquids | ORG14 | WATER | In house: Referenced to USEPA SW 846 - 3510 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM Schedule B(3) . ALS default excludes sediment which may be resident in the container. |
| Sep. Funnel Extraction /Acetylation of Phenolic Compounds | ORG14-AC | WATER | In house: Referenced to USEPA 3510 (Extraction) / In-house (Acetylation): A 1L sample is extracted into dichloromethane and concentrated to 1 mL with echange into cyclohexane. Phenolic compounds are reacted with acetic anhydride to yield phenyl acetates suitable for ultra-trace analysis. This method is compliant with NEPM Schedule B(3) . ALS default excludes sediment which may be resident in the container. |
| Volatiles Water Preparation | ORG16-W | WATER | A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for purging. |

# CHAIN OF CUSTODY

ALS Laboratory: **please tick →**


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WAGGA WAGGA 1/19-21 Pioneer Place Wagga Wagga NSW 2650 Ph: 02 6971 9696 E: wagga@alsglobal.com


| | | | |
|---|---|---|---|
| **CLIENT: AECOM** | **TURNAROUND REQUIREMENTS :** X Standard TAT (List due date): | **FOR LABORATORY USE ONLY (Circle)** | |
| **OFFICE: WA** | (Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date): | Custody Seal Intact? | Yes No N/A |
| **PROJECT: Yolla PFW Plume Verification** **PROJECT NO.: 60649604** | **ALS QUOTE NO.:** | Free ice / frozen ice bricks present upon receipt? | Yes No N/A |
| **ORDER NUMBER:** **PURCHASE ORDER NO.:** | **COUNTRY OF ORIGIN: Australia** | Random Sample Temperature on Receipt: | °C |
| **PROJECT MANAGER: Marthin Slabber** | **CONTACT PH: 0430 111 569** | Other comment: | |
| **SAMPLER: James Tanner** | **SAMPLER MOBILE: 0423 358 651** | | |
| **COC Emailed to ALS? ( YES )** | **EDD FORMAT (or default):** | | |
| **Email Reports to** (will default to PM if no other addresses are listed): **marthin.slabber1@aecom.com, james.tanner@eriasgroup.com** | | | |
| **Email Invoice to** (will default to PM if no other addresses are listed): **marthin.slabber1@aecom.com** | | | |

**COC SEQUENCE NUMBER (Circle)**

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

| RELINQUISHED BY: | RECEIVED BY: | RELINQUISHED BY: | RECEIVED BY: |
|---|---|---|---|
| DATE/TIME: | DATE/TIME: BL. (ALS) 11/10/22 17:38 | DATE/TIME: | DATE/TIME: |

**COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:**

| ALS USE ONLY | SAMPLE DETAILS MATRIX: Solid(S) Water(W) | | | | CONTAINER INFORMATION | | ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required). | | | | | | | | Additional Information |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB ID | SAMPLE ID | DATE / TIME | | MATRIX | TYPE & PRESERVATIVE (refer to codes below) | TOTAL BOTTLES | BTEX | TRH (C6-C10) | TRH (>C10–C40) | PAH | Total Barium | | | | Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. |
| | NK 1-1 | 1:46:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | NK 1-2 | 3:12:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | NK 1-3 | 3:25:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | NK 1-4 | 4:10:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | NK 1-5 | 5:10:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | NK 1-6 | 5:10:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | NK 2-1 | 4:19:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | NK 2-2 | 4:40:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | NK 2-3 | 5:19:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 1-1 | 7:34:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 1-2 | 9:08:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 1-3 | 10:12:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 1-4 | 11:40:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 1-5 | 12:50:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 1-6 | 2:23:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 2-1 | 8:20:00 AM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 2-2 | 11:25:00 AM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 2-3 | 12:14:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 2-4 | 1:15:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 2-5 | 2:43:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 2-6 | 4:29:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 2-7 | 5:40:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | PFWS 2-8 | 5:40:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | ROV 1-1 | 11:56:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | ROV 1-2 | 4:20:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | ROV 2-1 | 1:37:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | ROV 2-2 | 3:49:55 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | ROV 2-3 | 4:51:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | Rinsate-ROV | 11:00:00 AM | 11/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | Rinsate-NK | 11:00:00 AM | 11/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| | Trip blank | | | | | 3 | | | | | | | | | Samples may also contain traces of Rhodamine WT |
| | | | | | TOTAL | 153 | | | | | | | | | |

***Water Container Codes:*** P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Unpreserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulfate Soils; B = Unpreserved Bag; V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; F = Formaldehyde Preserved Glass;

Environmental Division
Melbourne
Work Order Reference
EM2219948

# CHAIN OF CUSTODY

ALS Laboratory: please tick →


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| | | | |
|---|---|---|---|
| **CLIENT:** AECOM | **TURNAROUND REQUIREMENTS :** X Standard TAT **(List due date):** | **FOR LABORATORY USE ONLY (Circle)** | |
| **OFFICE:** WA | (Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☐ Non Standard or urgent TAT **(List due date):** | Custody Seal Intact? | Yes No N/A |
| **PROJECT:** Yolla PFW Plume Verification 60672064. 1.4 **PROJECT NO.** 60649604 | **ALS QUOTE NO.:** EN/004/21 | Free ice / frozen ice bricks present upon receipt? | Yes No N/A |
| **ORDER NUMBER:** EN/004/21 **PURCHASE ORDER NO.:** | **COUNTRY OF ORIGIN:** Australia | Random Sample Temperature on Receipt: | °C |
| **PROJECT MANAGER:** Marthin Slabber **CONTACT PH:** 0430 111 569 | **COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7 | Other comment: | |
| **SAMPLER:** James Tanner **SAMPLER MOBILE:** 0423 358 651 | **RELINQUISHED BY:** | **RECEIVED BY:** | **RELINQUISHED BY:** | **RECEIVED BY:** |
| **COC Emailed to ALS?** ( YES ) **EDD FORMAT (or default):** | | | | |
| **Email Reports to** (will default to PM if no other addresses are listed): marthin.slabber1@aecom.com, james.tanner@eriasgroup.co | DATE/TIME: | DATE/TIME: | DATE/TIME: | DATE/TIME: |
| **Email Invoice to** (will default to PM if no other addresses are listed): marthin.slabber1@aecom.com | | | | |

**COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:**

| ALS USE ONLY | SAMPLE DETAILS MATRIX: Solid(S) Water(W) | | | | CONTAINER INFORMATION | | ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required). WA Suite | | | | | | | | Additional Information |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB ID | SAMPLE ID | DATE | TIME | MATRIX | TYPE & PRESERVATIVE *(refer to codes below)* | TOTAL BOTTLES | BTEX (standard LORs) | TRH (C6-C10) (100ug/L) | TRH (>C10-C40 (100ug/L) | PAH (<0.02 ug/L) EP132-LL | Total Barium (1 ug/L) EG020T | | | | Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. |
| 1 | NK 1-1 | 1:46:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 2 | NK 1-2 | 3:12:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 3 | NK 1-3 | 3:25:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 4 | NK 1-4 | 4:10:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 5 | NK 1-5 | 5:10:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 6 | NK 1-6 | 5:10:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 7 | NK 2-1 | 4:19:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 8 | NK 2-2 | 4:40:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 9 | NK 2-3 | 5:19:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 10 | PFWS 1-1 | 7:34:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 11 | PFWS 1-2 | 9:08:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 12 | PFWS 1-3 | 10:12:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 13 | PFWS 1-4 | 11:40:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 14 | PFWS 1-5 | 12:50:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 15 | PFWS 1-6 | 2:23:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 16 | PFWS 2-1 | 8:20:00 AM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 17 | PFWS 2-2 | 11:25:00 AM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 18 | PFWS 2-3 | 12:14:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 19 | PFWS 2-4 | 1:15:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 20 | PFWS 2-5 | 2:43:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 21 | PFWS 2-6 | 4:29:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 22 | PFWS 2-7 | 5:40:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 23 | PFWS 2-8 | 5:40:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 24 | ROV 1-1 | 11:56:00 AM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 25 | ROV 1-2 | 4:20:00 PM | 9/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 26 | ROV 2-1 | 1:37:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 27 | ROV 2-2 | 3:49:55 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 28 | ROV 2-3 | 4:51:00 PM | 10/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 29 | Rinsate-ROV | 11:00:00 AM | 11/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 30 | Rinsate-NK | 11:00:00 AM | 11/10/2022 | | | 5 | X | X | X | X | X | | | | Samples may also contain traces of Rhodamine WT |
| 31 | Trip blank | | | | | 3 | | | | | | | | | Samples may also contain traces of Rhodamine WT |
| | | | | | TOTAL | 153 | | | | | | | | | |

***Water Container Codes:*** P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;

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Prepared for
Beach Energy Limited
ABN: 20 007 617 969

AECOM

# Site Specific Dilution Factor and Revised Mixing Zone Report

## BassGas Operations, Yolla-A Platform

29-May-2025
Doc No. 60731020_1

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# Site Specific Dilution Factor and Revised Mixing Zone Report

BassGas Operations, Yolla-A Platform

Client: Beach Energy Limited

ABN: 20 007 617 969

Prepared by

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# Quality Information

| | |
|---|---|
| Document | Site Specific Dilution Factor and Revised Mixing Zone Report |
| Ref | 60731020 |
| Date | 29-May-2025 |
| Originator/s | Supriya Lath and Marthin Slabber |
| Checker/s | Bryant Gagliardi and Ian Baxter |
| Verifier/s | Roisin Smit |

**Revision History**

| Rev | Revision Date | Details | Approved | |
|---|---|---|---|---|
| | | | Name/Position | Signature |
| A | 20-Feb-2023 | Draft for Client Review | Marthin Slabber<br>Project Manager | |
| 0 | 22-May-2023 | Final | Marthin Slabber<br>Project Manager | |
| 1 | 15-May-2024 | Updated to incorporate additional chemistry and ecotoxicity data | Marthin Slabber<br>Project Manager | |
| 2 | 26-Feb-2025 | Draft for Review - update to incorporate additional chemistry and ecotoxicity data | Jason Crisp<br>Project Manager | |
| 3 | 29-May-2025 | Final Adjusted | Jason Crisp<br>Project Manager | |

# Table of Contents

Acronyms i
Executive Summary ii
1.0 Introduction 1
1.1 Background 1
1.2 Objective 3
1.3 Scope of Work 3
2.0 Environmental Setting 6
2.1 Yolla-A Platform 6
2.2 PFW Discharge and Mixing Conditions 6
2.3 Receiving Environment 6
2.4 Marine Communities in Receiving Environment 8
3.0 SSDF Derivation Methodology 10
3.1 Guidelines 10
3.2 Technical Approach Overview 10
3.3 Data Considered 10
3.3.1 Chemical Characterisation Data 11
3.3.2 Ecotoxicology Data 11
3.4 Ecotoxicity Testing Methodology 12
4.0 SSDF Calculation 14
4.1 Step 1: PFW and GLDA-PFW Chemical Characterisation 14
4.1.1 PFW Chemistry 17
4.1.2 GLDA-PFW Chemistry 17
4.1.3 Physico-Chemical Properties 18
4.2 Step 2: Data Quantity Assessment 18
4.3 Step 3: Data Quality Assessment 19
4.3.1 Assessment of Test Characteristics 19
4.3.2 Data Quality Scoring 20
4.4 Step 4: Classification of Acute and Chronic Tests 22
4.4.1 Conversion of Acute to Chronic Data 23
4.5 Step 5: Data Selection 24
4.6 Step 6: Species Sensitivity Distribution Analysis 25
4.6.1 Reliability of the SSDFs 27
5.0 2025 Mixing Zone Update 28
5.1 Current mixing zone boundary 28
5.2 Validation of GLDA-PFW Dispersion Characteristics 28
5.3 Mixing zone boundary 29
5.4 Updated mixing zone boundary – PFW only 29
5.5 Updated Mixing Zone Boundary – PFW + GLDA 29
6.0 Uncertainty Assessment and Limitations 31
7.0 Conclusions 33
8.0 References 35

Appendix A
Chemical Characterisation Data A

Appendix B
ESA Toxicity Test Reports B

Appendix C
ESA Toxicity Test Factsheets C

Appendix D
Ecotoxicity Data Information Summary D

Appendix E
Ecotoxicity Data Quality Scores E

Appendix F
Selection of Input Toxicity Data for Burrlioz 2.0 F

Appendix G
Burrlioz 2.0 Statistical Output - Species Sensitivity Distribution G

Appendix H
Beach Yolla Platform Produced Water Dispersion Far-Field Modelling Study (RPS, 2020) H

Appendix I
Beach Yolla Platform Produced Water Dispersion Modelling (RPS, 2025) I

## List of Figures

Figure 1 Yolla-A Platform location at the BassGas Development facility. 1
Figure 2 The BassGas Development 'Spill EMBA' (sourced from Aventus, 2020) 7
Figure 3 SSD plot generated by Burrlioz 2.0 for PFW (based on WET-testing of 12 samples collected between September 2019 to September 2024) 25
Figure 4 SSD plot generated by Burrlioz 2.0 for GLDA-PFW (based on WET-testing of one sample collected in November 2024) 26

## List of Tables

Table 1 Whole Effluent Toxicity (WET) test details 13
Table 2 Summary of PFW sample characterisation results, and comparison with GLDA-PFW characterisation 15
Table 3 Taxonomically different organism types 19
Table 4 Assessment of WET testing data suitability 19
Table 5 WET testing data quality scoring system 20
Table 6 Classification of acute and chronic WET tests 22
Table 7 Toxicity data used to generate the SSD curves for PFW and GLDA-PFW. 24
Table 8 SSDFs for PFW and GLDA-PFW – 99% spp. and 95% spp. 26
Table 9 Maximum distance from the PFW discharge location to achieve threshold dilutions (RPS, 2025) 29
Table 10 Mixing zone boundaries for Yolla-A for three discharge volume scenarios based on PFW only SSDF 29
Table 11 Mixing zone boundaries for Yolla-A for three discharge volume scenarios based on PFW and GLDA SSDF 30
Table 12 Summary of limitations and uncertainties 31

# Acronyms

| | |
|---|---|
| ACR | Acute to chronic ratio |
| AECOM | AECOM Australia Pty Ltd |
| ALARP | As low as reasonably practicable |
| ANZG | Australian and New Zealand Guidelines for Fresh and marine Water Quality |
| ASTM | American Society for Testing and Materials |
| Beach | Beach Energy Limited |
| BEC | Bounded effect concentration |
| ECx | x% Effect concentration |
| EP | Environment Plan |
| EPA | Environment Protection Authority |
| EPBC | Environment Protection and Biodiversity Conservation |
| ESA | Ecotox Services Australia |
| GLDA | Descaling chemical MC MX 2-5895, with active ingredient: glutamic acid-N,N-diacetic acid |
| GLDA-PFW | GLDA-containing PFW |
| ICx | x% Inhibition concentration |
| LCx | x% Lethal concentration |
| LOEC | Low observed effect concentration |
| NEC | No effect concentrations |
| NOEC | No observed effect concentration |
| NOPSEMA | National Offshore Petroleum Safety and Environmental Management Authority |
| OECD | Organisation for Economic Co-operation and Development |
| OPGGS | Victorian Offshore Petroleum and Greenhouse Gas Storage Regulations 2011 |
| OPGGS(E) | Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 |
| PAH | Polycyclic aromatic hydrocarbons |
| PFW | Produced formation water |
| PMST | Protected Matters Search Tool |
| ppt | Parts per thousand |
| spp. | Species protection |
| SD | Standard deviation |
| SSD | Species sensitivity distribution |
| SSDF | Site-specific dilution factor |
| TRH | Total recoverable hydrocarbons |
| USEPA | United States Environmental Protection Agency |
| VBA | Victorian Biodiversity Atlas |
| WET | Whole Effluent Toxicity |

# Executive Summary

AECOM Australia Pty Ltd (AECOM) was engaged by Beach Energy Limited (Beach) to determine site-specific dilution factors (SSDF) to inform mixing zone dimensions for produced formation water (PFW) discharge associated with the Yolla-A platform of the BassGas Development facility. This comprised an update of the previous *Site Specific Dilution Factor and Revised Mixing Zone Report, Rev 1* (AECOM, 2024a) report, based on review of additional data collected in 2024, including consideration of the impact of the introduction of a descaling chemical on the SSDF and mixing zone dimensions of the PFW discharge.

**Background**

In August 2021, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) conducted an inspection of the Yolla-A platform and recommended revision of the PFW mixing zone using whole effluent toxicity (WET) testing data in accordance with *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* [ANZG (2018)]. Beach conducted WET tests between 2019 – 2022 and AECOM derived a SSDF in 2023 to be protective of 99% of species in the marine receiving environment (AECOM, 2023a).

Further WET testing in 2023 and 2024 was undertaken, including the impact of the descaling chemical 'GLDA'. AECOM was engaged to undertake a review of these WET results to gain a preliminary understanding of the potential toxicity of PFW dosed with GLDA, the outcomes which were reported in the *Descaling Agent Ecotoxicology Review MC MX 2-5895 Report* (AECOM, 2024b), with findings indicating the toxicity of PFW increased when dosed with GLDA. Beach commissioned additional testing and engaged AECOM to update the SSDF and mixing zone dimensions based on the latest data.

In addition, Beach commissioned further analytical chemistry and WET testing on a sample of PFW collected immediately following a descaling event in November 2024 from Yolla-A, i.e. an end-of-pipe PFW sample incorporating GLDA (hereafter referred to as 'GLDA-PFW'). AECOM was again engaged by Beach to update the AECOM (2024a) report to incorporate the findings associated with these recent data collected in September (for PFW) and November 2024 (for GLDA-PFW).

**Objectives**

The objective of the current stage of works was to update the AECOM (2024a) report, including an assessment of recently collected data, comprising:

- Review and incorporate the findings of the most recent analytical chemistry and WET data of the PFW sample collected in September 2024 to derive an updated SSDF, protective of 99% of species for the Yolla-A PFW discharge regime, which can be used to inform a revised mixing zone boundary representative of the PFW.
- Review and assess the WET and analytical chemistry data of the GLDA-PFW sample collected in November 2024 following the introduction of GLDA into the PFW system; and derive a new SSDF from those data only, protective of 99% of species, which can be used to inform a revised mixing zone boundary representative of GLDA presence in the PFW.
- Provide discussion on how the introduction of GLDA into the production process may alter the toxicity of the PFW discharged from Yolla-A, and subsequently, alter the SSDF and mixing zone dimensions of PFW.

**Outcomes**

The conclusions of the assessment were as follows:

- The degree of variability in the PFW chemistry was acceptable, and that the samples of PFW that were used for WET testing were representative of the PFW discharge.

- Temporal data are not available for GLDA-PFW. Concentrations of analytes reported within the GLDA-PFW sample (from November 2024) were within the range reported in the historical PFW dataset, with the exception of conductivity, total nitrogen (as N), chromium, lead, nickel and zinc, concentrations of which exceeded those historically reported in PFW. These increases may be attributable to a combination of factors, such as the composition of GLDA itself (nitrogen), or due to chemical reactions occurring as part of the descaling process (metals). A potential contributor of GLDA-PFW variability in future may be variations in the injection rate of GLDA per BassGas operations, i.e. future injections may be at higher or lower rates than those applied in the generation of the current sample.
- The WET testing data were considered to be of suitable quality and quantity to derive the SSDFs in accordance with the ANZG (2018) species sensitivity distribution (SSD) statistical method on the basis of the following:
    - The minimum WET data requirements to derive the SSDF using SSD modelling techniques were exceeded, and the dataset was classified as 'adequate', including measurement of both chronic and acute endpoints.
    - Data quality complied with the conditions for test characteristics set out in Warne et al. (2018) relating to experimental design, duration of exposure and toxicological endpoints.
    - Data quality scores for 114 of 116 WET tests exceeded the requisite score of 80% to classified as 'acceptable' to 'high' quality. Data from the remaining two tests were excluded from the SSDF derivation due to them not passing internal laboratory quality assurance / quality control criteria.
- For PFW, a concentration (strength) of 0.051% based on an SSDF of 1:1,961 is estimated to be required to achieve 99% species protection (spp.) in the receiving environment. However, for GLDA-PFW, a concentration (strength) of 0.0051% based on an SSDF of 1:19,608 is estimated to be required to achieve 99% spp. Based on the available data, the SSDF of GLDA-PFW is 10 times greater than the SSDF of PFW, i.e. the introduction of GLDA into the PFW stream has resulted in a 10-fold increase in SSDF required for 99% spp. In other words, operational injection of GLDA at the volume used in this sample enhances effluent toxicity approximately 10-fold. These SSDFs are considered to be of 'moderate reliability', and hence suitable for application in environmental protection, in accordance with the classification process outlined in Batley et al. (2018).
- Mixing zone update based on modelling outputs provided by RPS 2025:
    - Under the maximum and 'worst case' PFW discharge scenario of 300 $m^3$ per day, a 'mixing zone' boundary of 37 m for PFW and 247 m for PFW+GLDA from the point of PFW discharge was identified outside of which 99% of species would be protected from chronic toxicity.
    - For comparison purposes, a mixing zone boundary for 99% spp. could not be determined in this report for GLDA-PFW for the same daily PFW discharge rate because the number of dilutions (19, 608) required to reach 99% spp. exceeds the existing maximum modelled dilutions (5,400) for PFW discharges from Yolla-A, however previous models did not incorporate a stochastic model for deriving metocean conditions used to assess plume dispersion.
    - Per ANZG (2018) and the EPA Victoria (2010) guidance, mixing zones should be as small as reasonably practicable and should account for any temporal, spatial, chemical, physical and biological variability of the effluent discharge. Consequently, the mixing zone boundary for Yolla-A needs to account for any and all potential variability in PFW discharges, including as a result of GLDA use. Notwithstanding updated dispersion modelling to account for the GLDA-PFW 99% SSDF, ALARP assessment may result in a mixing zone for Yolla-A substantially different to those previously determined for non-GLDA effect PFW discharges.
- Recommendations for future testing and assessment of PFW discharges from Yolla-A with respect to future use of GLDA in reference to the outcomes of the scope of work include:
    - Commissioning the interrogation of the existing RPS modelling to ascertain whether an estimate can be made of the distance from the discharge point where 20,000 dilutions of GLDA-PFW may be predicted to occur

- Testing a range of GLDA injection regimes and collecting the following data from each injection:
    - The change in yield from the injection (in order to characterise the minimum injection volume that confers acceptable productivity gains)
    - Full chemical analysis for the GLDA-PFW effluent from each injection (in order to characterise PFW chemical composition changes against a gradient of different GLDA injection volumes). It is recognised that the toxicity of the effluent may, at least in part, be due to the concentrations of metals therein. The elevated (above PFW-only) metals concentrations may arise from the scale removed from the production infrastructure - the metals that were elevated to the greatest degree were those that typically occur within such infrastructure. Therefore, the sources of toxicity within the GLDA-PFW effluent may be different from the toxicity sources within GLDA-only and PFW-only.
    - WET analysis for the GLDA-PFW effluent from each injection (in order to characterise the maximum GLDA injection volume that results in potentially ‘acceptably toxic’ PFW-GLDA effluent)
- Commissioning an ALARP assessment of GLDA use, informed by the outcomes of the test regime along with a cost-benefit analysis, which maps the benefits (productivity) of GLDA injections against the costs (GLDA purchase) of injecting GLDA
- An assessment of the chemical impact of GLDA on PFW and the drivers for increased toxicity with a review of potential treatment options to reduce GLDA-PFW toxicity to ALARP.

# 1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was engaged by Beach Energy Limited (Beach) to determine site-specific dilution factors (SSDF) to inform mixing zone dimensions for produced formation water (PFW) discharge associated with the Yolla-A platform of the BassGas Development facility. This comprised an update of the previous *Site Specific Dilution Factor and Revised Mixing Zone Report, Rev 1* (AECOM, 2024a) report, based on review of additional data collected in 2024, including consideration of the impact of the introduction of a descaling chemical on the SSDF and mixing zone dimensions of the PFW discharge.

## 1.1 Background

The BassGas Development facility is an offshore gas facility located in Bass Strait operated by Beach. The location of the Yolla-A platform is presented on **Figure 1** below.

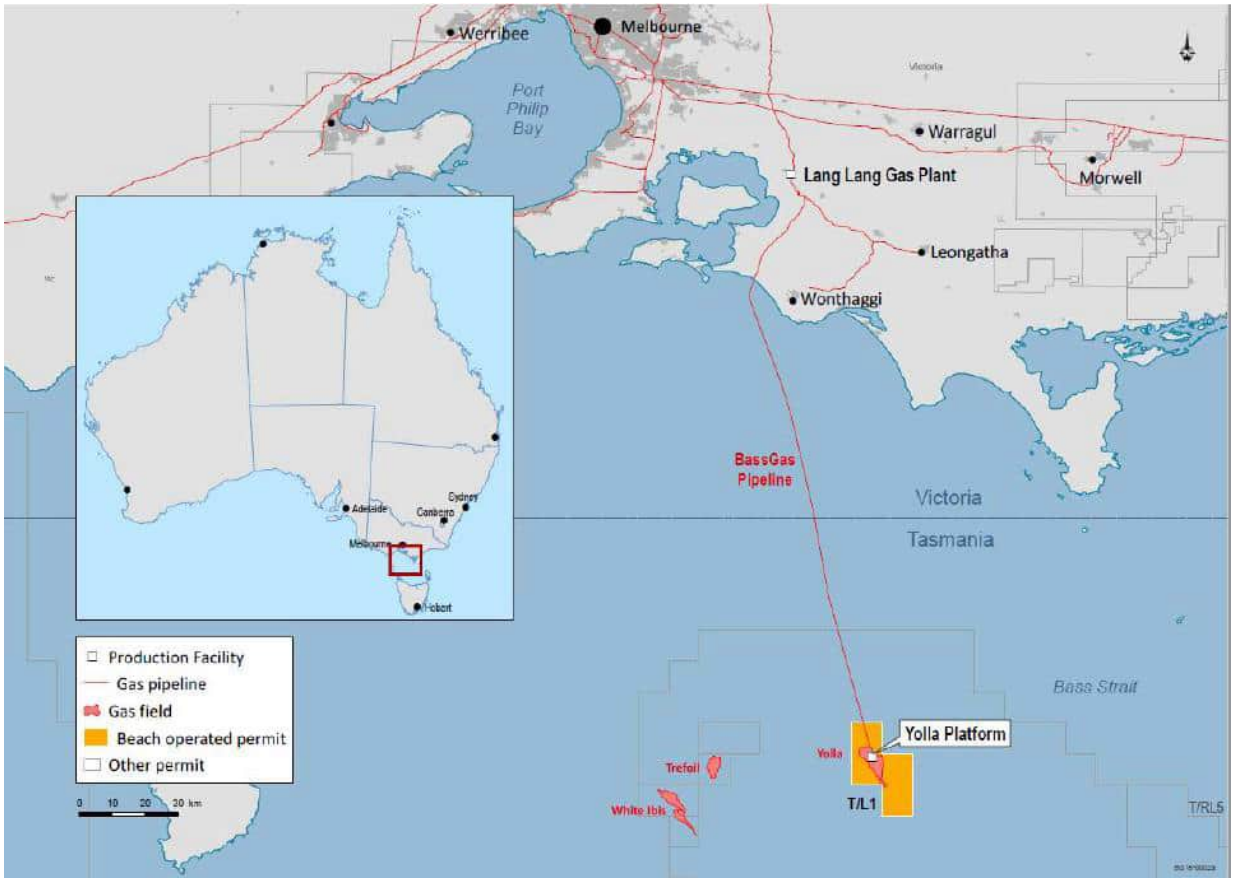


**Figure 1 Yolla-A Platform location at the BassGas Development facility.**

An Environment Plan (EP) is implemented to manage potential environmental impacts and risks associated with operation of the BassGas Development facility. In accordance with the *Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E))*, and the since revoked Victorian *Offshore Petroleum and Greenhouse Gas Storage (OPGGS) Regulations 2011*, a five-yearly update of the EP was undertaken, and the BassGas Offshore Operations EP [prepared by Aventus (2020)] was re-issued to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment on 30 November 2020.

Following acceptance of the revised EP (Aventus, 2020), NOPSEMA undertook an environmental compliance inspection of the BassGas Development facility between 24 and 25 August 2021. The conclusions and recommendations following NOPSEMA's inspection are presented in *NOPSEMA Inspection of BassGas Operations (Draft for discussion with duty holders), NOPSEMA Inspection Report, Inspection No. 2448, 13 September 2021* (NOPSEMA, 2021).

The inspection scope included determination of compliance with the systems, practices and procedures in the accepted EP (Aventus, 2020) associated with the management of PFW discharged from the Yolla-A platform.

Inspectors reviewed assumptions associated with the modelled mixing zone boundary described in the EP (Aventus, 2020) to ensure predictions were representative of the Yolla-A PFW discharge regime. The inspectors concluded that the PFW mixing zone boundary had not been adequately predicted in the EP (Aventus, 2020). It was therefore recommended by NOPSEMA that the predicted PFW mixing zone boundary be derived using:

- a safe dilution factor determined with representative biological effects data from the existing suite of whole effluent toxicity (WET) tests, and
- a statistically based species sensitivity distribution (SSD) in accordance with *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* [ANZG (2018)].

It was also recommended that a plume verification study be undertaken to confirm the predicted mixing zone boundary (which defines the extent of potential impacts from PFW to the receiving environment).

In response to NOPSEMA's recommendation, Beach engaged AECOM to derive an SSDF for Yolla-A platform PFW discharge and calculate mixing zone dimensions that would be protective of 99% of species in the marine receiving environment adjacent to the Yolla-A platform. The outcomes of this assessment, based on PFW WET data collected between October 2019 and September 2022, were presented in the *Site Specific Dilution Factor and Revised Mixing Zone Report, Rev 0* (AECOM, 2023a) report. It was estimated that a PFW concentration (strength) of 0.046%, based on a 'moderate reliability' SSDF of 1:2,174, would be required to achieve 99% species protection (spp.) in the receiving environment. The SSDF was subsequently used to calculate the mixing zone boundary from the point of PFW discharge using surface water mixing data provided in RPS (2020). Under the maximum and 'worst case' PFW discharge scenario of 300 $m^3$ per day, a mixing zone boundary of 290 m from the point of PFW discharge was estimated, outside of which 99% of species would be protected from chronic toxicity.

Since the submission of the AECOM (2023a) report, Beach undertook a further round of analytical chemistry and WET testing for the PFW produced by Yolla-A in September 2023. Beach engaged AECOM to update the AECOM (2023a) report to incorporate this additional WET and chemistry data and subsequently derive an updated SSDF for the Yolla-A PFW discharge regime. The updated assessment, presented in the *Site Specific Dilution Factor and Revised Mixing Zone Report, Rev 1* (AECOM, 2024a) report, estimated that a PFW concentration of 0.05%, based on a 'moderate reliability' SSDF of 1:2,000, would be required to achieve 99% spp. in the receiving environment. Important to note, following a request from Beach, a new mixing zone dimension was not calculated in the AECOM (2024a) revision, i.e. this revision focused only on updating the SSDF with the September 2023 WET testing and chemistry data. It was anticipated that Beach intended to undertake further WET testing in the future, upon which stage the SSDF would require further update, and that the mixing zone dimensions would be revised at such time.

Since submission of the AECOM (2024a) revised report, Beach has undertaken one further round of analytical chemistry and WET testing of PFW discharge collected from Yolla-A in September 2024. Additionally, Beach has recently trialled the usage of a descaling chemical, MC MX 2-5895 (also known as 'GLDA', which is an abbreviation for its active ingredient: glutamic acid-*N*,*N*-diacetic acid), , with the purpose of removing calcite buildup and enhancing well productivity of wells connected to the Yolla-A facility. As a result, Beach sought to understand how (if at all) the introduction of GLDA into the production process may alter the toxicity of the PFW discharged from Yolla-A and subsequently alter the SSDF upon which the mixing zone is based.

To help inform this understanding, Beach commissioned WET testing of GLDA and PFW samples and a mixture of GLDA and PFW (mixed together at various concentrations in the laboratory). Beach engaged AECOM to undertake a review of the WET results with the aim of gaining a preliminary understanding of the potential toxicity of the PFW when combined with GLDA following its introduction into the Yolla system. The outcomes of this review were reported in the *Descaling Agent Ecotoxicology Review MC MX 2-5895 Report* (AECOM, 2024b), with findings indicating a 1:1 dosing of GLDA in PFW is notably more toxic than PFW alone and calculated an indicative 99% spp. limit of 0.00039% concentration of neat GLDA.

Following the AECOM (2024b) report, Beach commissioned WET and analytical chemistry testing on a sample of PFW collected in November 2024 from Yolla-A, following the introduction of GLDA into the upstream industrial process, i.e. an end-of-pipe PFW sample incorporating GLDA (hereafter referred to as 'GLDA-PFW'), similar to previous testing undertaken for PFW samples. AECOM has been engaged by Beach to update the AECOM (2024a) report to incorporate the findings associated with these recent data collected in September 2024 (for PFW) and November 2024 (for GLDA-PFW).

It is noted that an in-field plume verification study (recommended by NOPSEMA) was undertaken by AECOM for Beach and the outcomes were reported separately in the *Yolla Produced Formation Water Plume Model Verification Study* report (AECOM, 2023b). The in-field study results indicated that the modelling completed for the Yolla-A PFW discharge is suitably conservative in predicting the rate of PFW dispersion and dilution and is a suitable basis upon which the mixing zone boundary can be determined.

## 1.2 Objective

The objective of the current stage of works is to update the AECOM (2024a) report, including an assessment of recently collected data, comprising:

- Review and incorporate the findings of the most recent WET data of the PFW sample collected in September 2024 to derive an updated SSDF, protective of 99% of species for the Yolla-A PFW discharge regime, which can be used to inform modelling of a revised mixing zone boundary representative of the PFW.
- Review and assess the WET and analytical chemistry data of the GLDA-PFW sample collected in November 2024 following the introduction of GLDA into the PFW system; and derive a new SSDF from those data only, protective of 99% of species, which can be used to inform modelling of a revised mixing zone boundary representative of GLDA presence in the PFW.
- Update and provide discussion on how the introduction of GLDA into the production process may alter the toxicity of the PFW discharged from Yolla-A, and subsequently alter the SSDF and mixing zone dimensions of PFW.

## 1.3 Scope of Work

The following scope of work was undertaken to achieve the study objective described in **Section 1.2**:

- Review the following project-specific reports:
  - NOPSEMA Inspection of BassGas Operations (Draft for discussion with duty holders), NOPSEMA Inspection Report, Inspection No. 2448, 13 September 2021 (NOPSEMA, 2021).
  - Environment Plan, BassGas Offshore Operations, Revision 3 (Doc No. CDN/ID 3972814), 30 November 2020 (Aventus, 2020).
  - Beach Yolla Platform – Produced Water Dispersion Far-Field Modelling Study, RPS Group, 23 September 2020 (RPS, 2020).
  - Yolla Platform – Produced Water Dispersion Modelling, Rev2, 23 May 2025 (RPS, 2025).
  - Yolla-A Platform ALARP[1] Assessment, 23 July 2020 (AECOM, 2020).
  - Yolla Produced Formation Water Plume Model Verification Study Results Report (AECOM, 2023b)
  - Site Specific Dilution Factor and Revised Mixing Zone Report, BassGas Operations, Yolla-A Platform, Rev 0, 22 May 2023 (AECOM, 2023a).
  - Site Specific Dilution Factor and Revised Mixing Zone Report, BassGas Operations, Yolla-A Platform, Rev 1, 15 May 2024 (AECOM, 2024a).

[1] 'ALARP' refers to 'as low as reasonably practicable'.

  - Descaling Agent Ecotoxicology Review MC MX 2-5895 Report, BassGas Operations, Yolla-A Platform, Rev 0, 29 November 2024 (AECOM, 2024b)

- Review of PFW analytical chemistry data (2019 – 2024) (provided by Beach) to assess temporal variability of the PFW quality with the aim of understanding how representative the PFW samples that underwent WET testing are of typical PFW discharge.
- Review of analytical chemistry data corresponding to the November 2024 sample of PFW-GLDA compared with PFW chemical characterisation (prior to introduction of GLDA).
- Update of SSDF for PFW, including:
  - Review of one additional round of WET data for Yolla-A PFW dated September 2024 (provided by Beach), including:
    - review of the quality and quantity of the data to assess its suitability and reliability for generating a SSDF, using SSD modelling approaches, and
    - assessment to identify whether the data are representative of chronic or acute exposure, followed by selection of data for SSD modelling
  - Generation of an updated SSD model using suitable ecotoxicity data through use of the software Burrlioz 2.0, incorporating existing WET results (AECOM, 2023a and 2024a) with the recent WET data (September 2024)
  - Derivation of an updated SSDF to achieve 99% spp. in the receiving environment, using the SSD model. SSDFs corresponding to 95% spp. are reported for comparative purposes only.
- Development of SSDF for GLDA-PFW, including:
  - Review of analytical chemistry data (provided by Beach) corresponding to the GLDA-PFW sample, for comparison with PFW chemical characterisation (prior to introduction of GLDA).
  - Review of one round of WET data for GLDA-PFW dated November 2024 (provided by Beach), including:
    - review of the quality and quantity of the data to assess its suitability and reliability for generating a SSDF, using SSD modelling approaches, and
    - assessment to identify whether the data are representative of chronic or acute exposure, followed by selection of data for SSD modelling
  - Generation of an SSD model using suitable ecotoxicity data through use of the software Burrlioz 2.0
  - Derivation of an SSDF for PFW that contains GLDA to achieve 99% spp. in the receiving environment, using the SSD model. SSDFs corresponding to 95% spp. are reported for comparative purposes only.
- Provision of updated PFW and GLDA-PFW SSDF values, to inform calculation of revised mixing zone dimensions for PFW and GLDA-PFW, from the point of discharge for assessment, noting that:
  - Mixing zone dimensions reported in previous revisions of this AECOM report (i.e. AECOM, 2023a and 2024a) were based on RPS (2020) dispersion modelling which considered PFW discharge parameters alone and did not account for any potential impact of introduction of other chemicals such as GLDA upon those discharge / dispersion parameters. The RPS (2025) model accounts for introduction of GLDA and is the basis for the mixing zone dimensions in this report.
  - mixing zone dimensions for PFW and GLDA-PFW in this report are subject to accuracy of the data provided by RPS (via Beach).

- Discussion of impact of introduction of GLDA on PFW SSDF and mixing zone dimensions, including:
  - Comparison of toxicities based on the Burrlioz 2.0 outputs for PFW versus GLDA-PFW.
  - Comparison of mixing zone dimensions of PFW versus GLDA-PFW using the RPS (2025) model outputs, noting that the RPS (2020) dispersion modelling was based on PFW discharge parameters alone, up to 5,400 dilutions, and did not account for any potential impact of introduction of other chemicals such as GLDA upon those discharge / dispersion parameters.

# 2.0 Environmental Setting

## 2.1 Yolla-A Platform

The Yolla-A platform is an offshore manned gas production platform located approximately 93 km south-west of Wilson's Promontory in Victoria and 109 km north-west of the Tasmanian mainland (refer to **Figure 1**). The facility was installed in 2004 and has been in production since 2006. Product produced at the platform is transported via a 147 km subsea pipeline extending from the platform to the mainland shore crossing near Kilcunda (Victoria). It is then pumped further inland to the Lang Lang Gas Plant (LLGP), a gas processing facility at Lang Lang (Victoria), where gas is processed prior to distribution to the Victorian gas network.

## 2.2 PFW Discharge and Mixing Conditions

The offshore Yolla-A platform stands in approximately 80 m water depth and supports wellheads and topside gas and condensate processing facilities. Hydrocarbon processing at the Yolla-A platform is designed to separate the raw gas into three streams: gas, condensate and PFW. The gas and condensate are comingled and exported to the LLGP. The PFW is treated to remove suspended condensate/oil droplets and then discharged to the sea through a discharge pipe.

PFW discharge rates from the platform are variable with daily discharge rates reported to have ranged between 29 $m^3$/day to 271 $m^3$/day between 2018 and 2020 (Aventus, 2020), averaging 186.4 $m^3$/day in 2019 and 238.8 $m^3$/day in 2018. Typical discharge rates are expected to be around 200 $m^3$/day with the maximum rate anticipated as 300 $m^3$/day (AECOM, 2020; Aventus, 2020).

The discharge of PFW into the seawater results in the PFW mixing in the water column. The degree of mixing depends on the sea currents (speed and direction of movement) at the time of discharge and relative densities and temperatures of the PFW and seawater. Details relating to the oceanography in the receiving environment including water temperature, water quality and salinity are provided in Section 5 of the EP (Aventus, 2020).

The mixture of PFW and seawater in the receiving environment may be considered as a plume, with the associated mixing zone considered as a mechanism for delineating the area of impact to the receiving environment from the point source of PFW discharge.

## 2.3 Receiving Environment

In accordance with 2009 OPGGS (Environment) Regulation 13(2) and the 2011 OPGGS Regulation 15(2), the 'environment that may be affected' (EMBA) by an activity or facility is described as the area where a change to ambient environmental conditions may potentially occur as a result of planned activities or unplanned events.

The 'spill EMBA' established for the BassGas Development facility, generated based on hydrocarbon spill modelling, is described in Section 5 of the EP (Aventus, 2020) and presented in **Figure 2** below. It illustrates EMBAs for multiple spill scenarios and includes consideration of sea surface (floating) hydrocarbons (floating oil), entrained hydrocarbons, dissolved hydrocarbons and shoreline hydrocarbons. The spill EMBA is generated from stochastic modelling and represents the compilation of possible outcomes and encompasses the area predicted to be affected from 100 simulations for each spill scenario under annualised weather conditions. Because of this, the spill EMBA is large, covering areas that may not be affected by any single spill event. Since the spill EMBA is generated with predictive tools it carries a degree of uncertainty (Aventus, 2020).

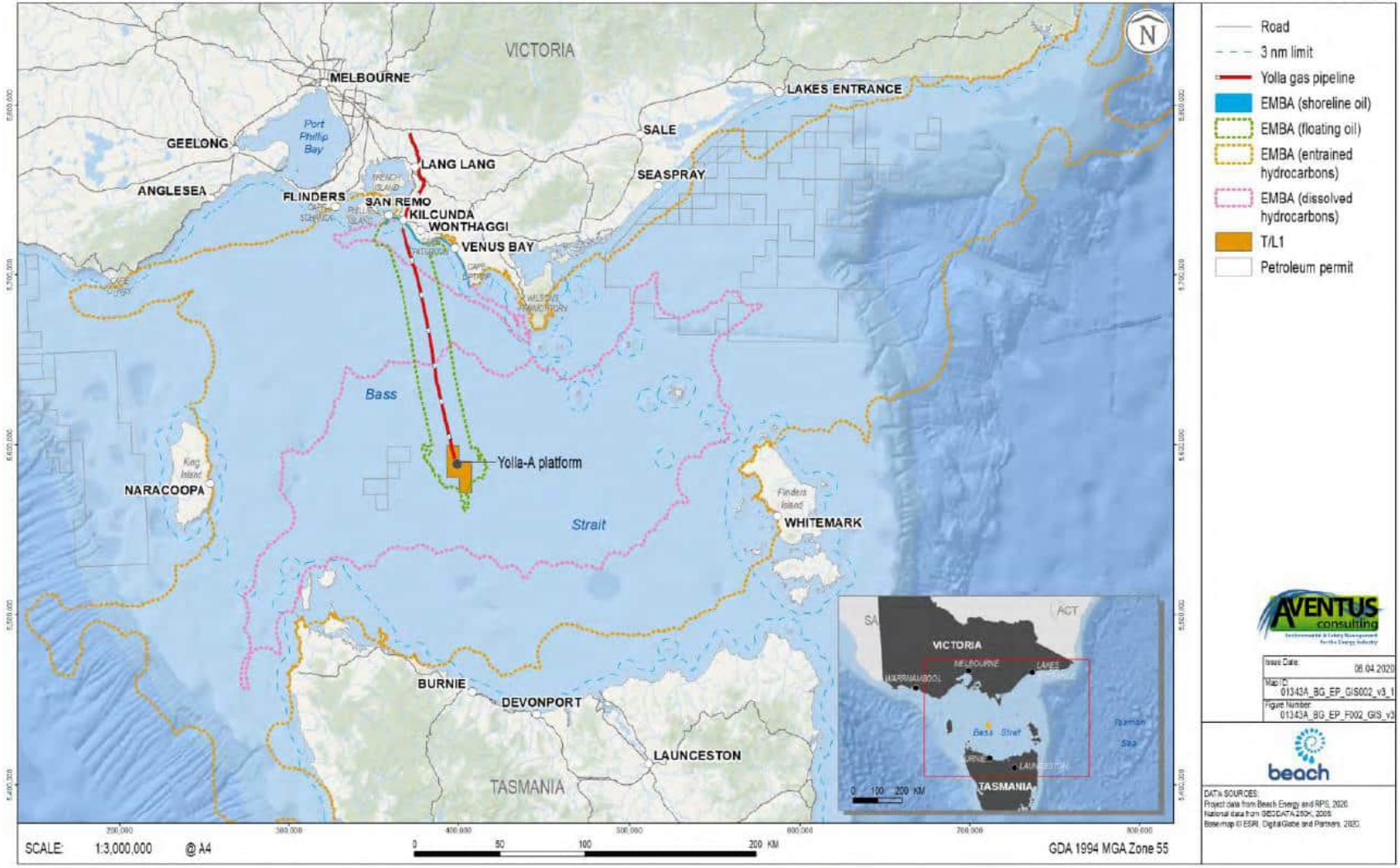


**Figure 2 The BassGas Development 'Spill EMBA' (sourced from Aventus, 2020)**

The spill EMBA has been considered as the broad marine receiving environment for the purpose of developing the SSDFs. The spill EMBA encompasses the operational area, which is considered to be the area within a 500 m radius around the BassGas Development facility (Aventus, 2020).

The Victorian Government (2021) *Environment Reference Standard* (ERS) considers water-dependent ecosystems and species from the coastal marine waters in Central Bass Strait as 'largely unmodified'. Hence, for the marine receiving waters relevant to the PFW discharge from the Yolla-A platform, ERS (Victorian Government, 2021) requires water quality objectives to be protective of 99% of species in an ecosystem.

## 2.4 Marine Communities in Receiving Environment

A detailed review of the species that may be present in the receiving environment (as defined in **Section 2.3**) based on information sourced from the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) and the Victorian Biodiversity Atlas (VBA) search tool is provided in Section 5.5 of the EP (Aventus, 2020). Information relating to the operational area and spill EMBA was relied upon where this information exists. In the absence of this information, where appropriate, information relating to the Bass Strait environment (beyond the spill EMBA) was considered.

Briefly, the EP (Aventus, 2020) identified the following types of receptors are likely to be present in the receiving environment:

- Benthic assemblages – According to the VBA the most common marine gastropod species recorded were the black-lip abalone, the common periwinkle and the common warrener. The most common crustaceans recorded were the cleft-fronted shore crab and the red rock lobster. Species of feather star, sea star, sea urchin, sea slug and scallop were also recorded. Previous surveys of the seabed near the Yolla-A platform prior to drilling and construction have identified sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and predatory snails (whelk).
- Plankton – Plankton is a key component in oceanic food chains. Both phytoplankton (e.g. diatoms, flagellates and cyanobacteria) and zooplankton (e.g. krill, polychaetes, fish eggs and fish larvae) commonly found in the Bass Strait may be present in the receiving environment.
- Marine Flora – The subtidal and intertidal rocky reefs of Bass Strait are understood to have a high diversity of plant species including kelp, seagrasses and macroalgae. The VBA indicated several species of algae comprising a mix of brown, red and green algae have been recorded, with the most frequently recorded species being the brown algae *Phyllospora comosa*.
- Birds – The PMST identified 69 bird species (seabirds and shorebirds) as threatened or migratory whose habitat or migratory path may occur within the receiving environment, of which six are listed as critically endangered, nine as endangered and 23 as vulnerable. These primarily comprise 17 albatross, six petrels, two parrots, three shearwaters, three godwits, six terns, one swift, two curlew, one prion, four snipes, three gulls, seven plovers, two tattlers and seven sandpipers. Many of these bird species are protected by international agreements (such as the Bonn Convention, Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement and Republic of Korea–Australia Migratory Birds Agreement) and periodically pass through the Bass Strait to and from the Bass Strait islands, mainland Victoria and Tasmania.
- Cetaceans – The PMST identified 22 whale species and eight dolphin species that may reside within or migrate through the receiving environment. The VBA database indicated the most common whales sighted in the receiving environment were the southern right and humpback whales, and the most common dolphins were short-beaked common dolphins.
- Pinnipeds – The PMST identified two pinniped species (the New Zealand fur seal and the Australian fur seal) as potentially occurring within the receiving environment. The VBA database identified four additional species - the southern elephant seal, the leopard seal, the subantarctic fur seal and the Australian sea lion.

- Fish – It is estimated that there are over 500 species of fish found in the waters of Bass Strait, including a number of species of importance to commercial and recreational fisheries. There were 39 fish species, 31 of which were signathids (seahorses and pipefish) identified in the PMST as potentially occurring in the receiving environment. The VBA records indicated a further 113 fish species have been recorded within the receiving environment, with the most commonly sighted fish species being wrasse, leatherjacket and perch.
- Reptiles – Four species of marine turtle are identified in the PMST and VBA as potentially migrating through the receiving environment - the loggerhead turtle, green turtle, leatherback turtle and hawksbill turtle.
- Marine Pests – Several introduced species have become pests either by displacing native species, dominating habitats or causing algal blooms. Marine pests known to occur in Bass Strait include the pacific oyster, northern pacific sea star, New Zealand screw shell, European shore crab, dead man's fingers (seaweed) and cord grass.

# 3.0 SSDF Derivation Methodology

## 3.1 Guidelines

The SSDF was derived in accordance with the following Australian endorsed guidelines and technical approaches:

- ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines
- Batley GE, van Dam R, Warne MStJ, Chapman JC, Fox DR, Hickey CW and Stauber JL. 2018. Technical Rationale for Changes to the Method for Deriving Australian and New Zealand Water Quality Guideline Values for Toxicants – update of 2014 version. Prepared for the revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.
- Warne MStJ, Batley GE, van Dam RA, Chapman JC, Fox DR, Hickey CW and Stauber J. 2018. Revised Method for Deriving Australian and New Zealand Water Quality Guideline Values for Toxicants – update of 2015 version. Prepared for the revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand.

## 3.2 Technical Approach Overview

A summary of the technical stepwise approach for deriving the PFW SSDF is presented below:

- *Step 1: PFW and GLDA-PFW Chemical Characterisation*. Review of the PFW analytical data to assess temporal variability of the PFW quality with the aim of understanding how representative the PFW samples that underwent WET testing are of typical PFW discharge; as well as comparison of the chemistry of the GLDA-PFW sample (from November 2024) with PFW chemistry. This assessment is presented in **Section 4.1**.
- *Step 2: Data Quantity Assessment*. Data quantity assessment identifies if the minimum data requirements specified by ANZG (2018) to use the SSD method to derive a SSDF is satisfied. This assessment is presented in **Section 4.2**.
- *Step 3: Data Quality Assessment*. Data quality assessment to ensure that only 'high' and 'acceptable' quality toxicity data as defined by ANZG (2018), and Warne et al. (2018) are used to derive the SSDFs. This assessment is presented in **Section 4.3**.
- *Step 4: Classification of Chronic or Acute Data*. Classification of the WET testing data as either representing chronic or acute exposure in accordance with guidance provided in Warne et al. (2018). This assessment is presented in **Section 4.4**.
- *Step 5: Data Selection*. Review and selection of the WET testing data so that a single toxicity value is selected to represent the sensitivity of each species in the SSD plots. This assessment is presented in **Section 4.5**.
- *Step 6: SSD Modelling*. Generation of the SSDFs via SSD modelling using the Burrlioz 2.0 software, including an assessment of the reliability of the SSDF. This assessment is presented in **Section 4.6**.

## 3.3 Data Considered

The data considered in this assessment includes analytical characterisation data and the WET testing data for PFW and GLDA-PFW discharge samples, described in **Section 3.3.1** and **Section 3.3.2**, respectively.

All PFW and GLDA-PFW samples were collected by Beach technicians from a designated sampling point in the PFW stream just prior to the PFW entering the discharge caisson. Samples were decanted from the PFW sampling tap directly into laboratory-supplied bottles for analytical chemistry testing, and four 2.5 litre bottles for WET testing. Most samples (all except one, dated 23 August 2023) collected for WET testing also underwent chemical characterisation. This means that all except one set of WET samples have 'paired' datasets of both ecotoxicology and chemical characterisation data. Additionally, for PFW, some chemical characterisation samples have been collected during routine compliance wastewater monitoring (i.e. not for the purpose of toxicity characterisation), which do not have corresponding WET data.

### 3.3.1 Chemical Characterisation Data

Analytical chemistry characterisation data provided by Beach to AECOM, in the form of laboratory certificates (where available) and tabulated data are provided in **Appendix A.**

The PFW and GLDA-PFW samples were analysed for a combination of chemicals, including inorganics, metals, metalloids, total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylenes, naphthalene (BTEXN), polycyclic aromatic hydrocarbons (PAHs), phenols and glycols as well as physico-chemical parameters including pH and conductivity.

#### 3.3.1.1 PFW

The following PFW analytical chemistry characterisation data (provided by Beach) were available for consideration in this assessment:

- One PFW sample collected in September 2024 analysed for the above-mentioned analytes (data available in Microsoft Excel™ format only, no laboratory certificates provided).
- Laboratory analytical certificates reporting concentrations of the above-mentioned analytes, measured in 15 PFW samples collected between September 2019 and February 2023. These 15 samples were analysed for all above-mentioned analytes, with the exception of phosphate and copper which were not analysed in two of the 15 samples; and glycols which were not analysed in two of the 15 samples.
- A further five PFW samples collected between December 2017 and August 2019 for chemical analysis of the above-mentioned analytes (data available in Microsoft Excel™ format only, no laboratory certificates provided). It is noted that not all samples were analysed for all analytes.

#### 3.3.1.2 GLDA-PFW

The following GLDA-PFW analytical chemistry characterisation data (provided by Beach) were available for consideration in this assessment:

- Laboratory analytical certificate reporting concentrations of the above-mentioned analytes, measured in one GLDA-PFW sample collected in November 2024.

### 3.3.2 Ecotoxicology Data

For PFW, the following eight WET testing reports (provided by Beach) generated by Ecotox Services Australia (ESA) for a total of 12 PFW samples collected from Yolla-A platform were available for consideration during derivation of the SSDF:

- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report, October 2019.
- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report – Round 2, October 2019.
- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report – Round 3, October 2019.
- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report, February – March 2021.
- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report, July – August 2021.

- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report, September 2022.
- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report, September 2023.
- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report, September 2024.

For GLDA-PFW, the following WET testing report (provided by Beach) generated by ESA for one GLDA-PFW sample collected from Yolla-A platform was available for consideration during derivation of the SSDF:

- Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility, Test Report, November 2024.

The WET testing reports provided by ESA are included as **Appendix B**. Further details regarding the WET tests are provided in the ESA toxicity test factsheets attached in **Appendix C.**

The above-mentioned test reports provide WET test results for up to seven marine aquatic species as described in **Section 3.4** and **Section 4.2**. A detailed summary of the data including PFW and GLDA-PFW sample details, test species, endpoints, exposure durations and toxicity estimates is presented in **Appendix D.**

The data were reviewed to identify whether they are of suitable quality and quantity to derive the SSDF in accordance with the ANZG (2018) SSD statistical method. The quantity and quality of the ecotoxicology data considered is described in **Section 4.2** and **Section 4.3**, respectively.

When selecting WET testing data for each test species, to input into the SSDF derivation, Warne et al. (2018) state that the preferred hierarchy of statistical estimates of chronic (and acute) toxicity to be used to calculate site-specific guideline values (in order of preference) is:

- No effect concentrations (NEC).
- x% effect/inhibition/lethal concentration (in order of preference: EC/IC/$LC_x$) where x ≤10.
- 10% bounded effect concentration ($BEC_{10}$).
- x% effect concentration (EC/IC/$LC_x$) where x >10 and ≤20.
- No observed effect concentration (NOEC).

The estimates of toxicity reported by ESA include the 10% and 50% effect concentration ($EC_{10}$ and $EC_{50}$) or inhibition concentration ($IC_{10}$ and $IC_{50}$) in addition to the NOEC and lowest observed effect concentration (LOEC) values. In accordance with Warne et al. (2018), preference was given $IC_{10}$/$EC_{10}$ values (where these were available alongside NOEC and $LC_{50}$ values) when selecting WET testing data to derive the SSDF.

## 3.4 Ecotoxicity Testing Methodology

A total of 12 PFW samples and one GLDA-PFW sample have been subject to WET analysis to assess the acute and chronic toxicity of the PFW and GLDA-PFW at the point of discharge. As discussed in **Section 3.3.2**, a suite of ecotoxicity tests were performed on these effluent samples, including a combination of chronic and acute endpoints for seven species (from four taxonomic groups) for PFW, and for six species (from four taxonomic groups) for GLDA-PFW, representative of those species present in the receiving environment.

The ecotoxicity laboratory tests were performed by ESA, using the effluent samples serially diluted with filtered seawater to achieve up to seven test concentrations for each test, designed to identify the dilution ratio required to achieve a range of ecotoxicity observations such as IC/EC10, EC50, NOEC and LOEC. The PFW test concentrations used for the WET tests were 100%, 50%, 25%, 12.5%, 6.3%, 3.1% and 1.6%. For GLDA-PFW, a significantly lower range of test concentrations were used for the WET tests, i.e. 3.1%, 1.6%, 0.8%, 0.4%, 0.2%, 0.1% and 0.05%.

Due to the 'marine' nature of the environment at the point of discharge, the listed ecotoxicity tests were selected for Australian marine species. Given that salinity of the PFW (refer **Section 4.1.3**) is relatively low compared to the receiving water, the laboratory adjusted the salinity in the PFW samples to approximately 35 parts per thousand (ppt), i.e., consistent with the salinity of seawater, to match the receiving environment. This aligns with the Warne et al. (2018) recommendations that marine guideline values should be derived using ecotoxicity data from tests where the salinity is between 25 and 36 ppt.

The types of ecotoxicity tests undertaken, including species tested and endpoints measured are summarised in **Table 1** .

**Table 1 Whole Effluent Toxicity (WET) test details**

| Marine Species | Taxonomic Group | Test Endpoint and Definition |
|---|---|---|
| *Heliocidaris tuberculata* (sea urchin) | Macroinvertebrate | Fertilisation success (% fertilised eggs) |
| | | Larval development (% normal larvae) |
| *Mytilus galloprovincialis* (mussel) | Macroinvertebrate | Larval development (% normal larvae) |
| *Allorchestes compressa* (amphipod) | Macroinvertebrate | Acute toxicity/survival (% unaffected) |
| *Nitzschia closterium* (marine microalgae) | Microalgae | Algal growth (cell yield; cells/mL) |
| *Hormosira banksii* (seaweed) | Macroalgae | Germination success (% germination) |
| *Macquaria novemaculeata* (Australian Bass) ^ | Fish | Fish imbalance* (% unaffected) |
| *Lates calcarifer* (Barramundi) | Fish | Fish imbalance* (% unaffected) |
| | Fish | Biomass (biomass; mg) |

*Notes: * Fish imbalance includes fish that have altered swimming ability (with signs of distress), those that are moribund (i.e., clearly alive but unable to swim and unlikely to ultimately survive) and those that are dead; ^ Macquaria novemaculeata (Australian Bass) was not used in the WET-testing of the GLDA-PFW sample, noting it was only used for the WET-testing of some PFW samples (in 2019).*

The WET testing reports provided by ESA are presented in **Appendix B**. A detailed summary of the data including PFW sample details, test species, endpoints, exposure durations, control testing, reference toxicant testing and toxicity estimates is tabulated in **Appendix D.**

# 4.0 SSDF Calculation

## 4.1 Step 1: PFW and GLDA-PFW Chemical Characterisation

Analytical chemistry data (provided by Beach) is available for 21 samples of PFW (between December 2017 and February 2023) collected from Yolla-A, which were analysed by a NATA-certified laboratory (Eurofins). Of the 21 PFW samples, 11 of the samples characterised between September 2019 and September 2024 were used for WET testing as described in **Section 3.3.2** and **Section 3.4**. An additional sample for WET analysis was collected 23 August 2023, however this sample did not undergo chemical analysis.

In addition, analytical chemistry data from Eurofins is also available for one GLDA-PFW sample collected from Yolla-A in November 2024, after the introduction of GLDA for a descaling event. This sample was also subject to WET testing.

These analytical data were provided to AECOM for consideration during derivation of the SSDF and are presented in **Appendix A**, including:

- a table presenting the analytical data for all 21 PFW samples analysed, and one PFW-GLDA sample.
- Eurofins' laboratory certificates for 15 (out of 21) PFW samples (noting laboratory certificates for all samples were not provided to AECOM), and one GLDA-PFW sample.

AECOM conducted a review of the PFW analytical data to assess whether the 12 (of 21) PFW samples that underwent WET testing were representative of typical Yolla-A PFW in terms of water quality (WQ) characteristics. Because the WET sample collected 23 August 2023 did not undergo chemical analysis, the assessment of representativeness of this sample was based only upon pH results (rather than a full analytical suite), reported by ESA upon sample receipt.

A summary of the PFW characterisation results is presented in **Table 2**, including maximum and minimum concentrations noted for analytes in all 21 samples. Statistical measures including average concentrations and standard deviation (SD) values are also presented. The GLDA-PFW chemical characterisation results, compared to PFW, are also presented in in **Table 2**. It is noted that for concision, assessment of 'total' concentrations for PAHs and phenolic chemicals is presented in **Table 2**. Refer to **Appendix A** for detailed data for the individual constituent PAH and phenolic chemicals.

**Table 2 Summary of PFW sample characterisation results, and comparison with GLDA-PFW characterisation**

| Chemical Group | Chemical Name | PFW Concentrations (mg/L unless specified) | | | | | GLDA-PFW Concentrations (mg/L unless specified) | Were GLDA-PFW concentrations within historical PFW range? |
|---|---|---|---|---|---|---|---|---|
| | | Minimum [1] | Maximum [1] | Mean [1] | SD [1] | Number of Data Points (Samples) [2] | | |
| Physico-chemical and inorganics | Conductivity (at 25°C, µS/cm) | 17,000 | 31,000 | 25,000 | 3,710 | 18 | 36,000 | No – exceeded range maximum |
| | pH (at 25°C, pH unit) | 6.1 | 7.1 | 6.7 | 0.33 | 18 | 6.50 | Yes |
| | Potassium | 33 | 74 | 55 | 10 | 19 | 56 | Yes |
| | Phosphate total (as P) | 0.01 | 0.5 | 0.09 | 0.13 | 16 | 0.14 | Yes |
| | Total Nitrogen (as N) | 21 | 52 | 33 | 9.6 | 18 | 1,600 | No – exceeded range maximum |
| | Total Suspended Solids | 2 | 29 | 7.7 | 6.0 | 18 | 5.8 | Yes |
| Metals / metalloids | Arsenic | 0.001 | 0.014 | 0.006 | 0.004 | 20 | <0.01 | Yes |
| | Cadmium | 0.0002 | 0.002 | 0.001 | 0.001 | 20 | <0.002 | Yes |
| | Chromium | 0.001 | 0.019 | 0.006 | 0.005 | 20 | 1.7 | No – exceeded range maximum |
| | Copper | 0.001 | 0.012 | 0.006 | 0.004 | 18 | <0.01 | Yes |
| | Lead | 0.001 | 0.02 | 0.005 | 0.005 | 20 | 0.27 | No – exceeded range maximum |
| | Mercury | 0.001 | 0.05 | 0.01 | 0.01 | 21 | 0.0023 | Yes |
| | Nickel | 0.001 | 0.1 | 0.01 | 0.02 | 20 | 0.65 | No – exceeded range maximum |
| | Zinc | 0.006 | 0.071 | 0.03 | 0.02 | 20 | 0.84 | No – exceeded range maximum |
| TRH | TRH C6-C10 | 4 | 130 | 70 | 29 | 19 | 85 | Yes |
| | TRH C10-C16 | 0.33 | 100 | 44 | 26 | 20 | 15 | Yes |
| | TRH C16-C34 | 0.1 | 120 | 6.9 | 27 | 20 | <1 | Yes |

| Chemical Group | Chemical Name | PFW Concentrations (mg/L unless specified) | | | | | GLDA-PFW Concentrations (mg/L unless specified) | Were GLDA-PFW concentrations within historical PFW range? |
|---|---|---|---|---|---|---|---|---|
| | | Minimum [1] | Maximum [1] | Mean [1] | SD [1] | Number of Data Points (Samples) [2] | | |
| | TRH C34-C40 | 0.1 | 1 | 0.31 | 0.38 | 20 | <1 | Yes |
| | TRH C10-C36 (Total) | 0.33 | 232.8 | 56 | 48 | 20 | 30 | Yes |
| BTEXN | Benzene | 0.8 | 36 | 14 | 6.9 | 20 | 11 | Yes |
| | Toluene | 0.27 | 30 | 19 | 8.9 | 20 | 21 | Yes |
| | Ethylbenzene | 0.27 | 9.5 | 1.9 | 2.7 | 20 | 0.8 | Yes |
| | Meta- and para-xylene | 1.4 | 16 | 8.0 | 3.5 | 20 | 8.9 | Yes |
| | Ortho-xylene | 0.5 | 27 | 3.6 | 5.6 | 20 | 2.2 | Yes |
| | Naphthalene | 0.002 | 0.86 | 0.45 | 0.29 | 20 | 0.73 | Yes |
| Glycols | Di-Ethylene Glycol* | 20 | 120 | 26 | 24 | 17 | <20 | Yes |
| | Ethylene glycol* | 20 | 20 | 20 | 0 | 17 | <20 | Yes |
| | Propylene glycol* | 20 | 20 | 20 | 0 | 17 | <20 | Yes |
| | Triethylene glycol* | 20 | 98 | 25 | 19 | 17 | <20 | Yes |
| PAH | Total PAH* | 0.002 | 0.86 | 0.45 | 0.29 | 20 | 0.43 | Yes |
| Phenols | Total Halogenated Phenol* | 0.01 | 1 | 0.06 | 0.22 | 20 | <0.01 | Yes |
| | Total Non-Halogenated Phenol* | 0.459 | 177 | 72 | 51 | 20 | 52 | Yes |

*Notes: * Indicates NATA accreditation does not cover the performance of this Eurofins analysis; 1 – Where a concentration was reported below the laboratory limit of reporting (LOR), the full LOR value has been adopted as a conservative measure for the purpose of calculations; 2 – Number of data points (samples) available for each chemical ranged from 16 to 21 samples.*

### 4.1.1 PFW Chemistry

The following is noted regarding the PFW chemical characterisation data for the entire set of 21 PFW samples analysed:

- Approximately 62% of the analytes analysed in the PFW samples were reported above the laboratory LORs in at least one sample. These included analytes across all chemical groups tested, including:
  - Inorganics, metals and metalloids (except cadmium).
  - TRH and BTEXN.
  - Select PAHs.
  - Select phenols and glycols.
- Approximately 38% of the analytes were reported below the laboratory LORs in all samples.
- Temporal variability in PFW composition was noted. This is expected due to chemical processes including transformation, volatilisation and dilution of analytes at the point of discharge, as well as changes to the PFW processing or discharge regime over time.
- No clear temporal trends were apparent in the PFW composition.
- 11 out of the 12 WET-tested PFW samples also underwent chemical analysis. Of these samples, approximately 96% of the analytes results (i.e. 767 of 798 reported analyte concentrations) were within two standard deviations of the mean analyte concentrations calculated for the entire PFW dataset.
- Although chemical analysis of the WET-tested PFW sample from 23 August 2023 was not undertaken, it has been considered, for the purpose of this assessment, that this sample is also likely to be within typical PFW discharge variability, on the basis of the following:
  - its laboratory-determined pH level (pH 6.0, see **Appendix B**) is comparable to the mean ± 2SD range for the PFW dataset (6.0 – 7.3, see **Table 2**); and
  - its pH, salinity and ammonia concentrations, as determined by ESA during ecotoxicological analyses (refer **Appendix B**, **Appendix D** and **Section 4.1.3**) are within the range determined by ESA for other WET-tested PFW samples.

The overall PFW monitoring regime included 21 PFW-sampling events across four seasons (including seven in summer, one in autumn, nine in winter, and four in spring months) and is considered to be adequately representative of the expected Yolla-A PFW temporal variability.

The PFW samples selected for WET testing were ‘real’ PFW samples collected from the Yolla-A operations, i.e., no artificial samples were used. On the basis of the PFW characteristics discussed herein, as well as the physico-chemical parameters of the PFW (refer to **Section 4.1.3**), it is considered that the samples of PFW used for WET testing are representative of the PFW discharge.

### 4.1.2 GLDA-PFW Chemistry

Concentrations of analytes reported within the GLDA-PFW sample from November 2024 were within the maximum and minimum concentrations of analytes reported in the historical PFW dataset, with the following exceptions (refer **Table 2**), where concentrations exceeded those reported in PFW:

- Conductivity (at 25°C, µS/cm) – concentration was a slight increase compared to in PFW
- Total Nitrogen (as N) – concentration was approximately 30 times greater than in PFW
- Chromium – concentration was approximately 100 times greater than in PFW
- Lead, nickel and zinc – concentration was approximately 10 times greater than in PFW

It is noted that concentrations of these analytes in GLDA-PFW were greater than two standard deviations of the mean analyte concentrations calculated for the entire PFW dataset. These increases may be attributable to a combination of factors, such as the composition of GLDA (i.e. nitrogen based compound) itself, or due to chemical reactions occurring as part of the descaling process e.g. reactions with scale deposits to dissolve and release their constituents into the PFW stream.

Temporal data are not available for GLDA-PFW. As only one round of WET and chemistry data are available for the GLDA-PFW sample, a statistical assessment of whether the sample of GLDA-PFW used for testing is representative of the typical GLDA-PFW discharge (expected during descaling events) cannot be made. Further testing is recommended to enable consideration of temporal variation.

### 4.1.3 Physico-Chemical Properties

The laboratory-measured physico-chemical parameters including pH and conductivity of the PFW samples analysed by Eurofins are presented in **Appendix A**. In addition, physico-chemical parameters of the samples recorded by the toxicity testing laboratory (ESA) on receipt of the samples for WET testing are reported in **Appendix B**.

The laboratory-measured parameters for 18 of the 21 samples analysed between December 2017 and September 2024 are summarised below:

- pH ranged between pH 6.1 and 7.1, i.e. slightly acidic to slightly alkaline. No excessively high or low pH values were recorded.
- Conductivity ranged between 17,000 and 31,000 µS/cm, which is approximately half the typical seawater conductivity of 50,000 µS/cm[2].

Laboratory-measured pH of 6.5 for the GLDA-PFW (November 2024) sample was comparable to the range reported for PFW, however, conductivity of 36,000 µS/cm slightly exceeded the range reported for PFW.

The physico-chemical parameters of the 12 PFW samples received by ESA for WET testing are summarised below:

- Temperature ranged between 8˚C and 14˚C.
- pH ranged between pH 5.9 and 6.9, i.e. slightly acidic, for 11 of the 12 WET-tested PFW samples and generally consistent with the Eurofins results. One sample, collected on 31 August 2022, received by ESA on 1 September 2022, was reported to have a higher pH of 8.3. It is generally recognised that pH of aqueous solutions can change as soon as a sample is placed in a container[3], due to a combination of factors including (but not limited to) temperature, microbial activity, or shift in chemical equilibrium.

  On this basis, the slightly alkaline pH recorded for this sample is not considered to impact the usability of the data for the purpose of generation of an SSD curve.
- Salinity ranged between 10 ppt and 18.5 ppt and was adjusted to a salinity of 35±1 ppt to match the salinity of seawater.
- Total ammonia ranged between 12.9 mg/L and 32.6 mg/L.

In comparison, the temperature (12˚C), pH (6.5) and ammonia (14.6 mg/L) reported by ESA for the WET-tested GLDA-PFW sample was similar to the PFW samples, however, the salinity (20.4 ppt) was slightly greater than the range reported for PFW, which is consistent with the conductivity results described above.

## 4.2 Step 2: Data Quantity Assessment

The minimum data requirements to use the SSD method to derive a SSDF includes at least five species that belong to at least four taxonomically different groups (i.e., generally different phyla) as described in **Table 3**. This requirement is consistent with the guidance documents listed in **Section 3.1**.

[2] https://mrccc.org.au/wp-content/uploads/2013/10/Water-Quality-Salinity-Standards.pdf
[3] https://www.epa.gov/hw-sw846/holding-time-preservation

Warne et al. (2018) classifies datasets that contain 5-7 species as 'adequate', datasets with 8-14 species that belong to at least four taxonomic groups are 'good' and datasets that contain at least 15 species belonging to at least four taxonomic groups are termed 'preferred'.

**Table 3 Taxonomically different organism types**

| Major Types of Organisms | Organisms Considered to be Taxonomically Different | AECOM Assessment |
|---|---|---|
| Vertebrates | Fish, amphibians | The toxicity data set includes seven species (from four taxonomic groups) for PFW, and six species (from four taxonomic groups) for GLDA-PFW (refer to **Table 1**) which meets and exceeds the minimum requirements. |
| Invertebrates | Crustaceans, insects, molluscs, annelids, echinoderms, rotifers, hydra | |
| Plants | Green algae, diatoms, brown algae, red algae, macrophytes | |
| Others | Blue-green algae (cyanobacteria), bacteria, protozoans, coral, fungi and others | |

Based on the Warne et al. (2018) classification, the dataset is classified as 'adequate' and meets the minimum data requirements to generate environmentally protective guidelines.

## 4.3 Step 3: Data Quality Assessment

The quality of the WET testing data was assessed in accordance with approaches described in Warne et al. (2018) to determine their suitability for use in SSDF derivation; and were screened against the following characteristics:

- Whether the test characteristics (such as experimental design, exposure concentrations) are in accordance with ANZG (2018) requirements. This assessment is presented in **Section 4.3.1**.
- The data quality 'score' which is generated by examining the reliability of each test underlying the marine toxicity data, with a maximum score of 100%. ANZG (2018) states that "*toxicity data with a quality score ≥80% are classed as 'high' quality, data with a quality score of ≥ 50% to < 80% are classed as 'acceptable' quality while data with a quality score of <50% are classed as 'unacceptable' quality. Only 'high' and 'acceptable' quality data can be used to derive GVs*." This assessment is presented in **Section 4.3.2**.

### 4.3.1 Assessment of Test Characteristics

The collated WET testing data were screened against the exclusion conditions set out in Table 2 of Warne et al. (2018) to determine their suitability for use in deriving the SSDF. An assessment of whether the test characteristics are in accordance with ANZG (2018) requirements is presented in **Table 4**.

**Table 4 Assessment of WET testing data suitability**

| Test Characteristic | Warne et al. (2018) Conditions for Exclusion of Data | AECOM's Assessment of Whether Data are Suitable for Calculating the SSDF |
|---|---|---|
| | | |
| Experimental design | Where the test concentrations differ by a large amount (for example > 10-fold differences such as 1, 10, 100, 1000 and 10,000 µg/L) | **Data complies**.<br>The PFW test concentrations were 100%, 50%, 25%, 12.5%, 6.3%, 3.1% and 1.6%. The GLDA-PFW test concentrations were 3.1%, 1.6%, 0.8%, 0.4%, 0.2%, 0.1% and 0.05%.<br>Concentrations differed from each other by a reasonable order of magnitude (i.e. approximately 2-fold differences). |

| Test Characteristic | Warne et al. (2018) Conditions for Exclusion of Data | AECOM's Assessment of Whether Data are Suitable for Calculating the SSDF |
|---|---|---|
| Duration of exposure | If not stated or does not conform with the definition of acute and chronic toxicity tests for temperate species (defined in Table 1 of Warne et al. (2018)). | **Data complies**.<br>Refer to AECOM's assessment presented in **Table 6.** |
| Toxicological endpoint | If not stated and/or endpoints other than lethality, immobilisation, growth, population growth or the equivalent unless the endpoint has been proven to be ecologically relevant. | **Data complies**.<br>Endpoints are stated in laboratory reports (refer to **Appendix B** and **Table 6**) as well as detailed in the ESA Toxicity Test Factsheets (refer to **Appendix C**). All endpoints are ecologically relevant. |
| Aqueous solubility | If toxicity values are greater than twice the aqueous solubility. | **Not applicable.**<br>Solubility for PFW or GLDA-PFW mixtures not determined. |

As the ecotoxicity data reviewed did not trigger the exclusion conditions described above, the data were considered to be suitable for use in the derivation of the SSDF.

### 4.3.2 Data Quality Scoring

The scoring system for assessing the quality of WET testing data for contaminants to marine/estuarine species to be used in the derivation of guideline values for toxicants (or derivation of a SSDF) is presented in **Table 5**.

**Table 5 WET testing data quality scoring system**

| No. | Question | Highest Possible ANZG (2018) Score | |
|---|---|---|---|
| | | Non-Plant Species | Plant Species |
| 1 | Was the duration of the exposure stated? (e.g. 48 or 96 h) | 10 | 10 |
| 2 | Was the biological endpoint (e.g. immobilisation or population growth) stated and defined (10 marks)? Award 5 marks if the biological endpoint is only stated. | 10 | 10 |
| 3 | Was the biological effect stated (e.g. LC or NOEC)? | 5 | 5 |
| 4 | Was the biological effect quantified (e.g. 50% effect, 25% effect)?<br>Note: The effect for NOEC and LOEC data must be quantified. | 5 | 5 |
| 5 | Were appropriate controls (e.g. a no-toxicant control and/or solvent control) used? | 5 | 5 |
| 6 | Were each control and contaminant concentration at least duplicated? | 5 | 5 |
| 7 | Were the test acceptability criteria stated (e.g. mortality in controls must not exceed a certain percentage) (5 marks)? OR Were test acceptability criteria inferred (e.g. test method used [United States Environmental Protection Agency (USEPA), Organisation for Economic Co-operation and Development (OECD), American Society for Testing and Materials (ASTM) etc.]) (award 2 marks)?<br>Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used | 5 | 5 |

| No. | Question | Highest Possible ANZG (2018) Score | |
|---|---|---|---|
| | | Non-Plant Species | Plant Species |
| 8 | Were the characteristics of the test organism (e.g. length, mass, age) stated? | 5 | 5 |
| 9 | Was the type of test media used stated? | 5 | 5 |
| 10 | Was the type of exposure (e.g. static, flow through) stated? | 4 | 4 |
| 11 | Were contaminant concentrations measured at the beginning and end of the exposure (4 marks)? Award two marks if they were measured only once during the test. Note: If concentrations were not measured then automatically the data cannot be high quality. | 4 | 4 |
| 12 | Were parallel reference toxicity tests conducted? | 4 | 4 |
| 13 | Was there a concentration-response relationship either observable or stated? | 4 | 4 |
| 14 | Was an appropriate statistical method or model used to determine the toxicity? Note: They should be accepted by a recognised national or international regulatory body (e.g. USEPA, OECD, ASTM) | 4 | 4 |
| 15 | For the LC/EC/BEC data, was an estimate of variability provided? OR For NOEC/LOEC data was the significance level 0.05 or less? | 4 | 4 |
| 16 | Was the conductivity / salinity measured and stated? (3 marks if measured and stated, 1 mark if just stated) | 3 | 3 |
| 17 | Was the dissolved oxygen measured and stated? (3 marks if measured and stated, 1 mark if just stated) | 3 | Not applicable |
| 18 | Was the pH measured and stated? (3 marks if measured and stated, 1 mark if just stated) | 3 | 3 |
| 19 | Was the temperature measured and stated (3 marks)? Award 1 mark if the temperature was measured but not stated, or if only the temperature settings of the room or chamber are stated. | 3 | 3 |
| 20 | Were test solutions, blanks and/or controls tested for contamination OR were analytical reagent grade chemicals used or the highest possible purity chemicals used for the experiment? | 3 | 3 |
| ***Total Highest Possible Score*** | | ***94*** | ***91*** |

In accordance with ANZG (2018), WET testing data with a quality score ≥80% are classed as ‘high’ quality, data with a quality score of ≥50 to <80% are classed as ‘acceptable’ quality, while data with a quality score of <50% are classed as ‘unacceptable’ quality. Only ‘high’ and ‘acceptable’ quality WET data can be used to derive the SSDF.

An assessment of the data quality for each WET test performed and determination of data quality scores undertaken by AECOM is presented in **Appendix E**. Data quality scores for all the WET tests considered ranged from 78% to 99%, and these data are considered to be of ‘acceptable’ to ‘high’ quality, as defined by Warne et al (2018), and therefore suitable for derivation of a SSDF. This is with the exception of two data points, discussed as follows, which are considered to be of ‘unacceptable’ quality, and thus excluded from the derivation of the SSDF:

- One datum from a 7-day fish biomass test (for Sample Name Y0021019, dated 2 October 2019, refer **Appendix B**) which failed the laboratory quality assurance / quality control criterion of control mean growth >20% of initial weight (refer **Appendix E**).
- One datum from a 7-day fish biomass test (for Sample Name Y0230823, dated 23 August 2023, refer **Appendix B**) for which a complete laboratory test report was not available (i.e. missing pages), thus it cannot be determined whether the quality control criterion was met.

## 4.4 Step 4: Classification of Acute and Chronic Tests

The WET data have been classified by AECOM as either acute or chronic ecotoxicity data in accordance with Table 1 of Warne et al. (2018) based on the following definitions:

- Acute toxicity: a lethal or adverse sub-lethal effect that occurs after exposure to a chemical for a short period relative to the organism's life span.
- Chronic toxicity: a lethal or adverse sub-lethal effect that occurs after exposure to a chemical for a period of time that is a substantial portion (typically greater than 10%) of the organism's life span or an adverse effect on a sensitive early life stage.

The acute and chronic classification is based on assessment against recommended test durations for different types of organisms from different life-stages, for a variety of test endpoints. It is noted that the recommended test durations in Table 1 of Warne et al. (2018) apply to tests on temperate species, typically undertaken in water temperatures ranging from 15–25˚C. As the ecotoxicity tests in this assessment were undertaken at temperatures ranging from 18–25˚C (refer to **Appendix B**), the Warne et al. (2018) classification is considered to be appropriate for the acute and chronic classification assessment.

The acute or chronic classification of the WET tests were assessed in accordance with Warne et al. (2018) and the results are summarised in **Table 6**.

**Table 6 Classification of acute and chronic WET tests**

| Marine Species | Taxonomic Group | Life Stage | Test Endpoint | Exposure Duration | AECOM Assessment and Classification [1] |
|---|---|---|---|---|---|
| *Heliocidaris tuberculata* (sea urchin) | Macro-invertebrate | Gametes (both sperm and eggs) | Fertilisation success | 1 hr | **Chronic**. Data complies with chronic classification for fertilisation tests with ≥1 hr exposure. |
| | | Developing embryo | Larval development | 72 hr | **Chronic**. Data complies with chronic classification for larval development with ≥48 hr exposure. |
| *Mytilus galloprovincialis* (mussel) | Macro-invertebrate | Developing embryo | Larval development | 48 - 72 hr | **Chronic**. Data complies with chronic classification for larval development with ≥48 hr exposure. |
| *Allorchestes compressa* (amphipod) | Macro-invertebrate | Juvenile | Acute toxicity (survival) | 96 hr | **Acute**. Data complies with acute classification for all endpoints with <14 days exposure. |
| *Nitzschia closterium* (marine microalgae) | Microalgae | Not applicable | Algal growth | 72 hr | **Chronic**. Data complies with chronic classification for all endpoints with >24 hr exposure. |

| Marine Species | Taxonomic Group | Life Stage | Test Endpoint | Exposure Duration | AECOM Assessment and Classification [1] |
|---|---|---|---|---|---|
| *Hormosira banksii* (seaweed) | Macroalgae | Zygotes or zoospores | Germination success | 72 hr | **Chronic**. Data complies with chronic classification for development endpoints with ≥48 hr exposure. |
| *Macquaria novemaculeata* (Australian Bass) ^ | Fish | Larvae | Fish imbalance | 96 hr | **Acute**. Data complies with acute classification for all endpoints with <7 days exposure. |
| *Lates calcarifer* (Barramundi) | Fish | Juvenile | Fish imbalance | 7 day | ***Acute**. Data complies with acute classification for all endpoints with <21 days exposure. |
| | Fish | Juvenile | Biomass | 7 day | ***Acute**. Data complies with acute classification for all endpoints with <21 days exposure. |
| | Fish | Larvae | Fish imbalance | 96 hr | **Acute**. Data complies with acute classification for all endpoints with <7 days exposure. |

*Notes: 1 – Assessment and classification of acute and chronic tests in accordance with Table 1 of Warne et al. (2018) guidance; * – The 7-day fish biomass and imbalance tests were considered as chronic tests by ESA in accordance with the ESA test factsheets (refer to **Appendix C**) tests, however, these tests have been conservatively classified by AECOM as acute tests on the basis of Warne et al. (2018) which recommends that all tests conducted on juvenile or adult fish for durations less than 21 days are considered as acute tests; ^ Macquaria novemaculeata (Australian Bass) was not used in the WET-testing of the GLDA-PFW sample, noting it was only used for the WET-testing of some PFW samples (in 2019).*

### 4.4.1 Conversion of Acute to Chronic Data

In accordance with Warne et al. (2018), when deriving water quality guidelines (or SSDF), the use of chronic toxicity data are preferred above acute toxicity data. However, in cases where there are insufficient chronic data, acute toxicity data can be converted to provide an estimate of chronic toxicity by applying a chemical-specific acute to chronic ratio (ACR). In such cases, chronic and converted acute toxicity data can be combined to derive a water quality guideline (or SSDF).

In this assessment, chronic data are only available for four marine species from three taxonomic groups. The acute data available for additional species and taxonomic groups, including the following, were converted to chronic toxicity estimates:

- *Allorchestes compressa* (amphipod) – survival.
- *Macquaria novemaculeata* (fish, Australian Bass) – imbalance.
- *Lates calcarifer* (fish, barramundi) – imbalance and biomass.

In accordance with Warne et al. (2018), a default ACR of 10 can be applied in the absence of a chemical-specific ACR. Thus, a default ACR of 10 was used for PFW and GLDA-PFW samples as the samples comprised a complex mixture of chemicals.

The chronic and converted chronic toxicity values for each combination of species, endpoint and duration are presented in **Appendix F**.

## 4.5 Step 5: Data Selection

Only a single toxicity value is used to represent the sensitivity of each species in a SSD (Warne et al., 2018). However, because there are often multiple toxicity values available for each species – including data for several endpoints and exposure durations – selection and processing of the toxicity data are required and undertaken in accordance with the Warne et al. (2018) guidance. Briefly, the rules for data processing applied to all toxicity data for each species are set out below:

- Determine the toxicity value for each combination of species, endpoint and duration. If there is a single value for a combination, it is adopted. If there are multiple values for a combination, the geometric mean of the values is calculated and adopted for that combination.
- Determine the lowest toxicity value for each combination of species and endpoint. This will be the lowest of the values for each combination of species, endpoint and duration. Generally, the longest duration will have the lowest toxicity values, but this is not always the case. If there is a single value for each combination of species, endpoint and duration, it is adopted. If there are multiple combinations of species, endpoint and duration, the lowest geometric mean value is adopted.
- Determine the lowest value for each species. The lowest value for all combinations of a species and endpoint is adopted as the toxicity value to represent the sensitivity of the species in the SSD calculations.

The detailed step-by-step application of these rules to the data considered in this assessment to determine a single toxicity value for each species for inclusion in the SSD, for PFA as well as for GLDA-PFW , is presented in **Appendix F**.

The lowest toxicity values for all combinations of a species and endpoint adopted as the single toxicity value to represent the sensitivity of each species in the SSD calculations are summarised in **Table 7**, for both PFW, and PFW-GLDA.

**Table 7 Toxicity data used to generate the SSD curves for PFW and GLDA-PFW.**

| Test Species | Toxicity Data Type | PFW – EC/IC10 (Concentration, %) | GLDA-PFW – EC/IC10/NOEC* (Concentration, %) |
|---|---|---|---|
| *Allorchestes compressa* (amphipod) | Converted Chronic | 0.927 | 0.030 |
| *Heliocidaris tuberculata* (sea urchin) | Chronic | 3.482 | 0.100 |
| *Hormosira banksii* (macroalgae seaweed) | Chronic | 9.475 | 0.300 |
| *Lates calcarifer* (fish, Barramundi) | Converted Chronic | 0.336 | 0.020 |
| *Macquaria novemaculeata* (fish, Australian Bass) ^ | Converted Chronic | 0.293 | - |
| *Mytilus galloprovincialis* (mussel) | Chronic | 3.432 | 0.100 |
| *Nitzschia closterium* (marine microalgae) | Chronic | 5.653 | 0.300 |

*Notes: ^ Macquaria novemaculeata (Australian Bass) was not used in the WET-testing of the GLDA-PFW sample, noting it was only used for the WET-testing of some PFW samples (in 2019); *EC/IC 10 values were adopted for all test, with the exception the 7-day fish imbalance test on Lates calcarifer (Barramundi) for the November 2024 GLDA-PFW sample as the laboratory was unable to report an EC/IC10 value, thus the NOEC was adopted as the toxicity estimate based on Warne et al. (2018) guidance on preferred hierarchy of estimates of toxicity.*

## 4.6 Step 6: Species Sensitivity Distribution Analysis

In accordance with recommendations provided in Warne et al. (2018), the SSDFs for PFW and GLDA-PFW were generated using the statistical software Burrlioz 2.0 (Barry and Henderson, 2014). The Burrlioz 2.0 software fits a statistical distribution to an empirical cumulative frequency distribution of the input WET test data to generate a SSD plot. Using the SSD plot, Burrlioz 2.0 has the ability to calculate a SSDF (or site-specific water quality guideline) that is protective of a nominated percent of species (level of protection) e.g., 99% or 95% species protection. The Burrlioz 2.0 software automatically uses a log-logistic distribution for datasets that comprise less than eight toxicity values.

The $IC_{10}$/$EC_{10}$ and NOEC data (concentration, %) presented in **Table 7** were used as Burrlioz 2.0 input toxicity data for generation of the SSD plots for PFW and GLDA-PFW. The Burrlioz 2.0 statistical outputs are provided in **Appendix G**.

The SSD plots generated using the Burrlioz 2.0 software are presented in **Figure 3** below for PFW, and **Figure 4** for GLDA-PFW. It is noted that the fitted curves are indicated in blue, and the 95% confidence intervals bounds are indicated by the grey dotted curves.

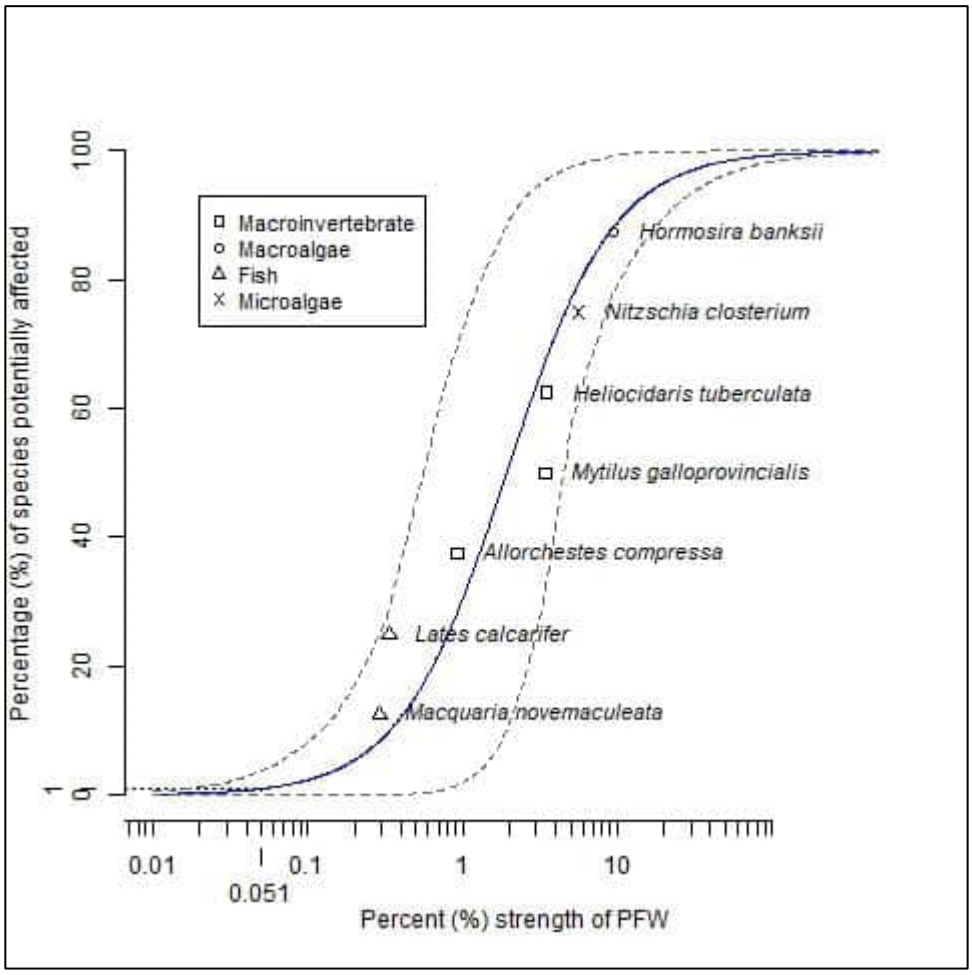


**Figure 3 SSD plot generated by Burrlioz 2.0 for PFW (based on WET-testing of 12 samples collected between September 2019 to September 2024)**

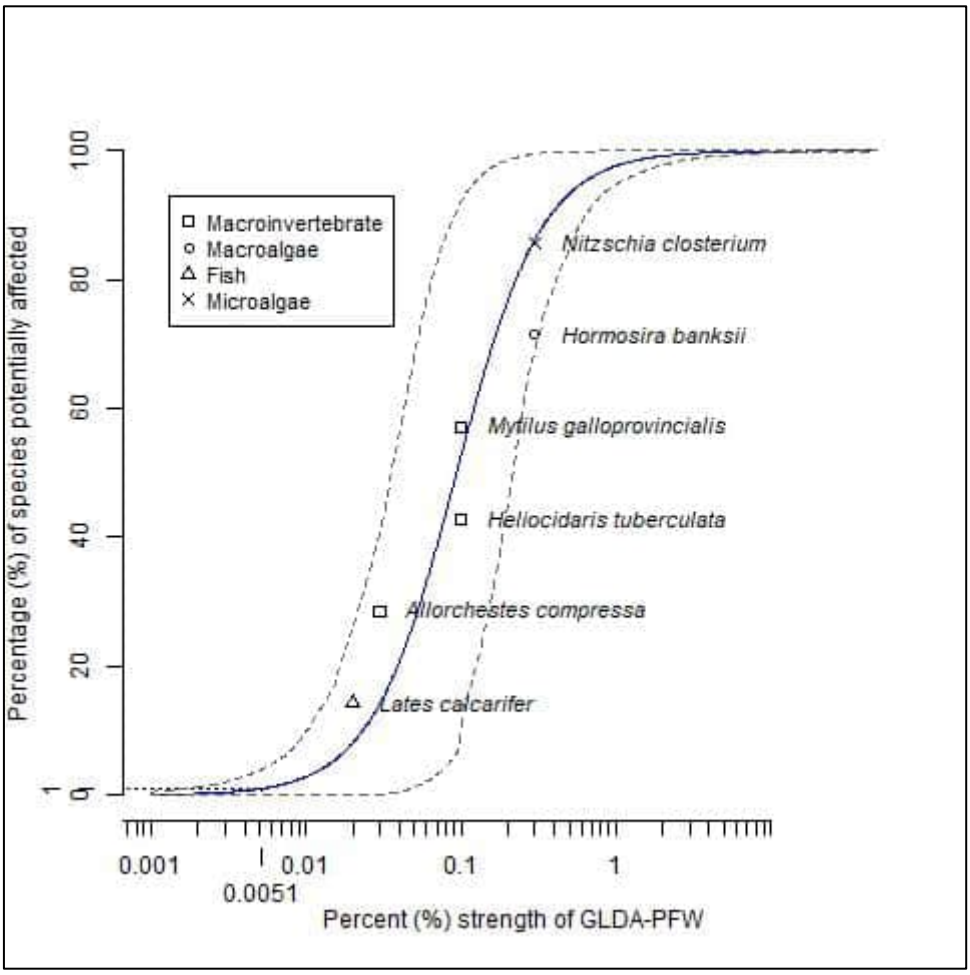


**Figure 4 SSD plot generated by Burrlioz 2.0 for GLDA-PFW (based on WET-testing of one sample collected in November 2024)**

The PFW and GLDA-PFW concentrations (i.e. 'guideline values') required for a range of species protection levels (99%, 95%, 90% and 80%) are presented in **Appendix G**.

For concision, the concentrations and dilutions required for PFW and GLDA-PFW for 99% spp. and 95% spp., are presented herein in the report, in **Table 8**.

**Table 8 SSDFs for PFW and GLDA-PFW – 99% spp. and 95% spp.**

| Species Protection Level (%) | PFW | GLDA-PFW |
|---|---|---|
| **99% Species Protection Level** | | |
| Concentration (%) | 0.051 | 0.0051 |
| Lower 95% Confidence Interval | 0.017 - 0.87 | 0.0017 - 0.053 |
| Site-Specific Dilution Factor | 1:1,961 | 1:19,608 |
| **95% Species Protection Level** | | |
| Concentration (%) | 0.19 | 0.014 |
| Lower 95% Confidence Interval | 0.067 - 1.6 | 0.0062 - 0.089 |
| Site-Specific Dilution Factor | 1:526 | 1:7,143 |

It is noted that the 99% spp. is recommended for Yolla-A platform given the required water quality objectives outlined by the Victorian Government (2021) ERS for the receiving environment relevant to the discharge from the Yolla-A platform (refer to **Section 2.3**). For PFW, a concentration of 0.051% (based on an SSDF of 1:1,961) is required to achieve 99% spp. in the receiving environment. However, for GLDA-PFW, a concentration (strength) of 0.0051% (based on an SSDF of 1:19,608) is required to achieve 99% spp. in the receiving environment.

Thus, the available data indicate that the SSDF of GLDA-PFW required to be protective of 99% of species in the ecosystem is 10 times greater than the SSDF of PFW, i.e. the introduction of GLDA into the PFW stream has resulted in a 10-fold increase in SSDF required to protect 99% of species in the receiving environment.

### 4.6.1 Reliability of the SSDFs

The reliability of the SSDFs was assessed in accordance with the classification process outlined in Batley et al. (2018) which considers:

- the sample size i.e., number of species used in the WET testing
- data type i.e., chronic and / or acute converted data
- visual fit of the data points on the SSD curve where data points located on or close to the SSD curve are considered to have a ‘good fit’ and data points further away from the SSD curve are considered to have a ‘poor fit’.

When considering the Batley et al. (2018) reliability classification process, the SSDF is considered to be ‘moderate reliability’ because:

- six to seven data points (i.e., toxicity data from six to seven species) were available for inclusion in the SSD plots for PFW and GLDA-PFW (refer to **Table 7**), hence both datasets were considered to be ‘adequate’.
- the toxicity data comprised a mixture of chronic and converted acute marine toxicity data (refer to **Table 7**), which are preferred ‘data types’ compared to acute toxicity data.
- a visual assessment of the SSD provided in **Figure 3** and **Figure 4** (GLDA-PFW) indicates a ‘good fit’ of the data on the SSD curves based on examples provided in **Figure 1** of Batley et al. (2018), and given five (out of seven) data points for PFW and four (out of six) data points for GLDA-PFW were on or close to the SSD curve. It is noted the nature of this visual assessment is subjective.

# 5.0 2025 Mixing Zone Update

## 5.1 Current mixing zone boundary

The current approved EP (Aventus, 2020) for BassGas' Yolla-A platform PFW discharge provides a mixing zone boundary range comprising a high reliability mixing zone boundary based on 2019 WET minimum NOEC concentration data, and a low reliability boundary based on a 'single' worst-case constituent ANZECC DGV 99% spp. value.

The horizontal distances from the point of discharge to attain the required dilution factors for Yolla-A PFW discharge plumes calculated in this report, to achieve 99% spp., were modelled using a stochastic hydrodynamic model to derive metocean conditions for assessment (RPS, 2025). Detailed description of this approach can be found in **Appendix I**, however briefly, RPS noted that this model used a probabilistic method, incorporating one hundred potential metocean scenarios into a dilution spread model representative of likely natural conditions at site to achieve high and low reliability mixing zone boundaries. This approach differs from previous models produced by RPS in 2017 and 2020 for previous EP's incorporating the Yolla-A PFW discharge plume, for a range of conditions and discharge scenarios. In those reports, three discharge scenarios modelled were 100 $m^3$, 200 $m^3$ and a 'worst case' operations scenario, and maximum allowable discharge rate, of 300 $m^3$ per day, however these scenarios did not include natural tidal profiles.

Under the previous modelled 'worst case' scenario of 300 $m^3$ per day PFW discharge, the high reliability mixing zone boundary based on a minimum NOEC derived dilution factor of 62:1, was determined to be 7.3 m from the point of discharge (Aventus, 2020). The lower reliability mixing zone boundary based on a 5,400:1 dilution factor, derived from a single constituent 99% spp. protection value, was determined as 693 m from the point of discharge, under the 'worst case' scenario discharge rate (Aventus, 2020).

As part of NOPSEMA's environmental compliance inspection of the BassGas Development facility between 24 and 25 August 2021, NOPSEMA inspectors reviewed assumptions associated with the modelled mixing zone boundaries described in the EP (Aventus, 2020) to ensure predictions were representative of the Yolla-A PFW discharge regime. The inspectors concluded that the PFW mixing zone boundary had not been adequately predicted in the EP (Aventus, 2020). It was recommended by NOPSEMA that the predicted PFW mixing zone boundary be derived using a SSDF determined with representative biological effects data from the existing suite of WET tests, and a statistically based SSD in accordance with ANZG (2018).

As described in **Section 1.1**, in order to address this shortcoming as noted by NOPSEMA, an SSD was applied to Yolla-A WET data from 2019, 2021 and 2022, and a SSDF was derived for a range of spp. levels by AECOM in 2023 (AECOM, 2023a) and a mixing zone boundary of 290 m determined based on the RPS (2020) model, beyond which 99% of species would be expected to be protected from chronic toxicity from PFW discharges from Yolla-A. The SSDF was updated in May 2024 (AECOM, 2024a) to incorporate further Yolla-A WET data from September 2023. At the request from Beach a new mixing zone boundary was not calculated in the 2024 (AECOM, 2024a) revision.

In the current report (this report)**,** the SSDF has been updated again to incorporate September 2024 PFW only WET data, as described in **Section 4.0.** Additionally, following the introduction of GLDA, a SSDF has also been calculated for PFW discharge following GLDA injection (GLDA-PFW SSDF).

## 5.2 Validation of GLDA-PFW Dispersion Characteristics

As part of the most recent dispersion model produced by RPS (2025), a comparison of the specific density and Oil-in-Water (OIW) characteristics was done to determine if the addition of GLDA into PFW would change the dispersion conditions being assessed from PFW-only modelling to date. Measurements taken during activities conducted in November 2024 revealed changes in both density and OIW measurements, which were validated by samples of the stream. RPS 2025 reported density and OIW time-series data which showed a peak occurring immediately after the discharge, followed by a decay back to baseline readings approximately 13 hours later. Given that the model assesses dispersion effects up to five days after release, this validation study determined that the existing model was suitable for re-use as the GLDA-PFW predictive model tool.

## 5.3 Mixing Zone Boundary Stochastics

**Table 9** summarises the maximum distances from the discharge point to achieve various dilution levels, ranging between 500 and 20,000 dilutions, as determined by the RPS (2025) stochastic dilution model described in **Section 5.1** and **Appendix I**.

**Table 9 Maximum distance from the PFW discharge location to achieve threshold dilutions (RPS, 2025)**

| Dilutions (1:X) | Maximum distance in metres from the PFW discharge location to achieve threshold dilutions for two discharge scenarios | |
|---|---|---|
| Dilutions | Base Case (200 $m^3$/day) | Future Case (300 $m^3$/day) |
| 500 | 10 | 12 |
| **526** | **10** | **12** |
| **1961** | **29** | **37** |
| 2000 | 29 | 36 |
| 4000 | 30 | 38 |
| **7143** | **41** | **61** |
| 8000 | 43 | 74 |
| 10000 | 64 | 125 |
| 12500 | 100 | 152 |
| 15000 | 126 | 182 |
| 17500 | 160 | 232 |
| **19608** | **163** | **247** |
| 20000 | 165 | 253 |

## 5.4 Updated Mixing Zone Boundary – PFW only

For PFW discharges, where GLDA has not been used, based on the 99% spp. SSDF, a mixing zone boundary from the point of PFW discharge was calculated using surface water mixing data provided in RPS (2020). Two discharge scenarios were assessed, including the 'Base Case' scenario of 200 $m^3$ PFW per day and a 'worst case' scenario of 300 $m^3$ PFW per day (**Table 10**). Under the worst-case scenario, a mixing zone boundary of 37 m from the point of discharge was calculated, outside of which 99% of species would be expected to be protected from chronic toxicity. For comparison purposes, a mixing zone boundary of 12 m was identified for 95% spp.

**Table 10 Mixing zone boundaries for Yolla-A for three discharge volume scenarios based on PFW only SSDF**

| Daily PFW Discharge Rate | 95 % spp. Protection Level SSDF | 99 % spp. Protection Level SSDF |
|---|---|---|
| | 1:526 | 1:1,961 |
| 200 $m^3$/day | 10 m | 29 m |
| 300 $m^3$/day | 12 m | 37 m |

## 5.5 Updated Mixing Zone Boundary – PFW + GLDA

Using the SSDF derived for GLDA-PFW in **Table 8**, and the RPS 2025 model (refer to **Table 9**) for 99% spp. under the scenario of 300 $m^3$ / day PFW produced a dilution value of 1:19,608 dilutions and a mixing zone boundary of 247 m. Interestingly, these boundary conditions fall well within the maximum distance modelled (693 m) by the RPS (2020) dispersion modelling, but th 2025 model includes a nearly four-fold increase in dilution rate (1:5,400) compared to what was previously described.

However, as mentioned in **Section 5.1**, this RPS 2020 report did not use a stochastic approach, rather it assumed a single tidal speed as part of the model calculation and did not account for tidal cycles.

Under the current base case scenario, the RPS 2025 model predicts a mixing zone boundary of 163 m, well within the current accepted boundary distance for PFW discharged at Yolla A Platform.

**Table 11 Mixing zone boundaries for Yolla-A for three discharge volume scenarios based on PFW and GLDA SSDF**

| Daily PFW Discharge Rate | 95 % spp. Protection Level SSDF | 99 % spp. Protection Level SSDF |
|---|---|---|
| | 1:7,143 | 1:19,608 |
| 200 $m^3$/day | 41 | 163 |
| 300 $m^3$/day | 61 | 247 |

By comparison, the GLDA-PFW SSDF for 95% spp requires 7,143 dilutions of the GLDA-PFW plume to become acceptably protective. This is also greater than the modelled maximum number of dilutions of 5,400 modelled in RPS 2020. Therefore, using the 2020 model this would have resulted in a mixing zone extending beyond 693 m (at 300 $m^3$/day discharge rate) from the discharge point before reaching a concentration below what is protective of 95% of species, however the stochastic model (RPS 2025) derived a mixing zone boundary of 61 m in the ‘worst case’ scenario.

# 6.0 Uncertainty Assessment and Limitations

The data and information upon which the assessment has been based have limitations which has the potential to introduce uncertainty in the derivation of the SSDF and mixing zone boundaries. **Table 12** provides a summary of the limitations and uncertainties inherent in the assessment.

**Table 12 Summary of limitations and uncertainties**

| Limitations/ Uncertainties | Effect | Assessment |
|---|---|---|
| Ecotoxicity studies did not necessarily adopt species specific to the marine receiving environment geographically associated with the Yolla-A platform | Generic species adopted for ecotoxicity studies. | **Low uncertainty.**<br>The ecotoxicity test species were chosen to reflect the types of aquatic flora and fauna receptor groups likely to be found in the marine receiving environment and are considered to be suitably protective of potential receptors at the point of PFW discharge at the Yolla-A platform. These species were representative of seven species from four different taxonomic groups (refer to **Section 4.2**).<br>Often species used in ecotoxicity studies are limited to those that are commonly available, are able to be easily bred in laboratories and/or have successfully been used in other ecotoxicity studies that are used to derive ecotoxicity methodology guidelines. Additionally, Warne et al. (2018) stipulates a preference for test methodologies endorsed by reputable agencies or laboratories, which further necessitates use of standard test species. Finally, the available evidence indicates that geographical differences in test species' native ranges are unlikely to impact toxicity test applicability (Rico et al, 2011; Peters et al, 2019), further suggesting the current WET results as likely protective of the surrounding Yolla-A receiving environment. |
| Limitations in the SSD approach | Uncertainties associated with calculated SSDF | **Low uncertainty.**<br>The quantity and quality of the data used to generate the SSD was verified in accordance with the requirements outlined in ANZG (2018) and Warne et al. (2018), as presented in **Section 4.2** and **Section 4.3**, respectively. These assessments concluded that the dataset was 'adequate', with data quality ranging from 'acceptable' to 'high', suitable for SSDF derivation. Data deemed to be of unacceptable quality were not considered in the derivation of SSDFs. Visual assessment of 'goodness of fit' suggested the data points on the SSD curve were considered to be of 'good' fit (refer to **Section 4.6.1**).<br>Overall, the SSDF generated is considered to be of 'moderate reliability', which is permissible for SSDF purposes under the Warne et al. (2018) framework. |
| Ability of the WET data to be representative of PFW discharge | The WET data may over or under predict potential ecotoxicity associated with the PFW | **Low uncertainty.**<br>Following an empirical statistical review of the PFW analytical data collected over a comprehensive regime of 21 sampling events, it was considered that the samples of PFW used for WET testing are representative of the PFW discharge (refer to **Section 4.1**). |

| Limitations/ Uncertainties | Effect | Assessment |
|---|---|---|
| Ability of the WET data to be representative of GLDA-PFW discharge | The WET data may over or under predict potential ecotoxicity associated with the GLDA-PFW | **Moderate uncertainty.**<br>Only one round of WET and chemistry data are available for the GLDA-PFW sample. The concentration and injection rate of GLDA used during future descaling events may differ from that used when samples were collected during the current study. An assessment of whether the sample of GLDA-PFW used for WET testing is representative of the typical GLDA-PFW discharge (expected during descaling events) cannot be made. Further testing is recommended to enable consideration of temporal variation. |
| Limitations of modelling used to determine mixing zone boundary distances | PFW plume mixing modelling is a predictive tool that relies on specific data inputs and assumptions, and thus has inherent limitations which may not account for every possible discharge scenario. | **Low uncertainty.**<br>Hydrodynamic modelling for the BassGas Yolla-A operations PFW discharge was undertaken by RPS, a reputable specialist modelling consultant. The 2020 modelling report is provided in **Appendix H** and the 2025 model in Appendix **I.**<br><br>An in-field plume model verification study was undertaken by AECOM for Beach in 2022 to verify the projected dilutions derived from the modelling. The study concluded that the modelling is conservative in its' prediction of the plume dilutions over distance and that the plume undergoes greater dilutions across distance upon discharge than was predicted in the modelling. |
| Applicability of existing PFW plume mixing modelling tool to GLDA-PFW discharges | The tool may not be directly applicable to modelling of GLDA-PFW discharges. | **Moderate uncertainty.**<br>The RPS (2020) dispersion modelling was based on PFW discharge parameters alone and does not account for any potential impact of introduction of other chemicals such as GLDA upon those discharge / dispersion parameters. The most recent RPS (2025) report assessed the likelihood that GLDA-PFW discharges would have similar dispersion characters to PFW alone after a period of 13 hours. This report determined that they were sufficiently similar to model dispersion rates as one entity. |

# 7.0 Conclusions

The SSDFs for PFW and GLDA-PFW were derived following a review of WET testing data and analytical chemistry data of PFW and GLDA-PFW discharge samples collected from Yolla-A platform, in accordance with ANZG (2018) and the revised Australian methodology for deriving water quality guidelines (and SSDF) using the SSD approach (Warne et al., 2018; Batley et al., 2018).

The conclusions of this assessment are as follows:

- A review of PFW analytical data to assess temporal variability of the PFW identified that the degree of variability in the PFW chemistry was acceptable, and that the samples of PFW that were used for WET testing were representative of the PFW discharge.
- Temporal data are not available for GLDA-PFW. Concentrations of analytes reported within the GLDA-PFW sample (from November 2024) were within the range reported in the historical PFW dataset, with the exception of conductivity, total nitrogen (as N), chromium, lead, nickel and zinc, concentrations of which exceeded those historically reported in PFW. These increases may be attributable to a combination of factors, such as the composition of GLDA itself (nitrogen), or due to chemical reactions occurring as part of the descaling process (metals). A potential contributor of GLDA-PFW variability in future may be variations in the injection rate of GLDA per BassGas operations, i.e. future injections may be at higher or lower rates than those applied in the generation of the current sample.
- The WET testing data were considered to be of suitable quality and quantity to derive the SSDFs in accordance with the ANZG (2018) SSD statistical method on the basis of the following:
    - A suite of ecotoxicity tests was performed on PFW and GLDA-PFW samples, including measurement of both chronic and acute endpoints for seven marine species (from four taxonomic groups) for PFW and six marine species (from four taxonomic groups) for GLDA-PFW. These exceeded the minimum data requirements (of at least five species from at least four taxonomically different groups) to derive the SSDF using SSD modelling techniques. The dataset was classified as ‘adequate’ on account of toxicity estimates being available for greater than five species.
    - Data quality complied with the conditions for test characteristics set out in Warne et al. (2018) relating to experimental design, duration of exposure and toxicological endpoints.
    - Data quality scores for all WET tests assessed against the ANZG (2018) scoring system for marine species ranged from 78% to 99%. Because of these scores being greater than the requisite 80%, the 114 of 116 WET testing data are considered to be of ‘acceptable’ to ‘high’ quality, as defined by ANZG (2018). Data from two 7-day fish biomass tests for two PFW samples were excluded from the SSDF derivation due to them not passing internal laboratory quality assurance / quality control criteria.
- For PFW, a concentration (strength) of 0.051% based on an SSDF of 1:1,961 is estimated to be required to achieve 99% spp. in the receiving environment. However, for GLDA-PFW, a concentration (strength) of 0.0051% based on an SSDF of 1:19,608 is estimated to be required to achieve 99% spp. in the receiving environment. Based on the available data, the SSDF of GLDA-PFW is 10 times greater than the SSDF of PFW, i.e. the introduction of GLDA into the PFW stream has resulted in a 10-fold increase in SSDF required to protect 99% of species in the receiving environment. In other words, operational injection of GLDA at the volume used in this sample enhances effluent toxicity approximately 10-fold. These SSDFs are considered to be of ‘moderate reliability’, and hence suitable for application in environmental protection, in accordance with the classification process outlined in Batley et al. (2018).
- Mixing zone update:
    - Under the maximum and ‘worst case’ PFW discharge scenario of 300 $m^3$ per day, a ‘mixing zone’ boundary of 247 m from the point of PFW discharge was identified outside of which 99% of species would be protected from chronic toxicity.

  - For comparison purposes, a mixing zone boundary for 99% spp. could not be determined in this report for GLDA-PFW for the same daily PFW discharge rate because the number of dilutions (19, 608) required to reach 99% spp. exceeds the existing maximum modelled dilutions (5,400) for PFW discharges from Yolla-A, however stochastic models of metocean conditions were not applied in previous reports.
  - Per ANZG (2018) and the EPA Victoria (2010) guidance, mixing zones should be as small as reasonably practicable and should account for any temporal, spatial, chemical, physical and biological variability of the effluent discharge. Consequently, the mixing zone boundary for Yolla-A needs to account for any and all potential variability in PFW discharges, including as a result of GLDA use. Notwithstanding as yet updated modelling to account for the GLDA-PFW 99% SSDF, this may result in a mixing zone for Yolla-A substantially larger than that previously determined for non GLDA effect PFW discharges.

- Recommendations for future testing and assessment of PFW discharges from Yolla-A with respect to future use of GLDA in reference to the outcomes of the scope of work include:
  - Commissioning the interrogation of the existing RPS modelling to ascertain whether an estimate can be made of the distance from the discharge point where 20,000 dilutions of GLDA-PFW may be predicted to occur
  - Testing a range of GLDA injection regimes and collecting the following data from each injection:
    - The change in yield from the injection (in order to characterise the minimum injection volume that confers acceptable productivity gains)
    - Full chemical analysis for the GLDA-PFW effluent from each injection (in order to characterise PFW chemical composition changes against a gradient of different GLDA injection volumes). It is recognised that the toxicity of the effluent may, at least in part, be due to the concentrations of metals therein. The elevated (above PFW-only) metals concentrations may arise from the scale removed from the production infrastructure - the metals that were elevated to the greatest degree were those that typically occur within such infrastructure. Therefore, the sources of toxicity within the GLDA-PFW effluent may be different from the toxicity sources within GLDA-only and PFW-only.
    - WET analysis for the GLDA-PFW effluent from each injection (in order to characterise the maximum GLDA injection volume that results in potentially ‘acceptably toxic’ PFW-GLDA effluent)
  - Commissioning an ALARP assessment of GLDA use, informed by the outcomes of the test regime along with a cost-benefit analysis, which maps the benefits (productivity) of GLDA injections against the costs (GLDA purchase) of injecting GLDA.
  - An assessment of the chemical impact of GLDA on PFW and the drivers for increased toxicity with a review of potential treatment options to reduce GLDA-PFW toxicity to ALARP.

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# Appendix A

## Chemical Characterisation Data

| | Date Sampled | 10/12/2017 | 12/06/2018 | 11/12/2018 | 22/06/2019 | 5/08/2019 | 27/09/2019 | 3/10/2019 | 10/10/2019 | 18/062020 | 16/02/2021 | 23/02/2021 | 3/03/2021 | 28/07/2021 | 3/08/2021 | 18/08/2021 | 2/02/2022 | 12/06/2022 | 31/08/2022 | 21/02/2023 | 21/02/2023 | 11/09/2024 | 7/11/2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lab Ref No. | 5474094 | M18-Jn24771 | M18-De25704 | M19-Jl16077 | M19-Au23295 | S19-Se42146 | S19-Oc07916 | S19-Oc15765 | M20-Jn35649 | S21-Fe39076 | S21-Ma00783 | S21-Ma13815 | S21-Au13187 | S21-Au13187 | S21-Au44428 | M22-Fe01471 | M22-Jn0052501 | S22-Se0004153 | M23-Fe0051761 | M23-Fe0051762 | S24-Se0035426 | S24-N00075654 |
| | Lab Certificates available? | No | No | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes |
| | WET-Tests Undertaken? | No | No | No | No | No | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes |
| **Chemical Group** | **Chemical Name** | | | | | | | | | | | | | | | | | | | | | | |
| Physico-chemical Parameters and Inorganics | Conductivity (at 25°C, µS/cm) | 20000 | - | - | - | 21000 | 29000 | 29000 | 31000 | 25000 | 30000 | 25000 | 27000 | 25000 | 24000 | 26000 | 28000 | 23000 | 21000 | 24000 | 25000 | 17000 | 36000 |
| | pH (at 25°C, pH unit) | 6.1 | - | - | - | 6.2 | 6.7 | 6.9 | 7.1 | 6.3 | 6.6 | 7 | 6.8 | 6.7 | 6.7 | 7 | 7.1 | 6.4 | 6.9 | 6.8 | 6.8 | 6.1 | 6.5 |
| | Potassium (K) | - | 52 | 66 | - | 40 | 60 | 67 | 74 | 55 | 56 | 68 | 54 | 58 | 58 | 53 | 51 | 51 | 42 | 51 | 47 | 33 | 56 |
| | Phosphate total (as P) | <0.5 | - | - | - | 0.03 | - | - | 0.03 | 0.03 | 0.03 | 0.02 | 0.06 | <0.05 | <0.05 | <0.05 | 0.09 | 0.18 | 0.3 | <0.01 | <0.01 | 0.01 | 0.14 |
| | Total Nitrogen (as N)* | 26 | - | - | - | 30 | 27 | 51 | 34 | 28 | 23 | 43 | 31 | 21 | 29 | 30 | 32 | 27 | 25 | 52 | 50 | 36 | 1600 |
| | Total Suspended Solids | 4 | - | - | - | 29 | 2 | 4.7 | 5.1 | 6.4 | 11 | 9.7 | 5.3 | <5 | <5 | 7.4 | <5 | 6.3 | <5 | 10 | 13 | <5 | 5.8 |
| Metals and Metalloids | Arsenic | 0.002 | <0.01 | <0.005 | - | 0.001 | 0.003 | 0.002 | 0.003 | <0.01 | <0.01 | <0.01 | <0.01 | 0.004 | 0.004 | 0.003 | 0.002 | <0.01 | 0.013 | 0.011 | 0.014 | 0.002 | <0.01 |
| | Cadmium | <0.0002 | <0.002 | <0.001 | - | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.001 | <0.0002 | <0.002 | <0.002 | <0.002 | <0.002 |
| | Chromium | <0.001 | <0.01 | <0.005 | - | 0.019 | <0.001 | 0.001 | <0.001 | 0.01 | <0.01 | <0.01 | <0.01 | 0.002 | <0.001 | <0.001 | <0.001 | <0.01 | <0.001 | <0.01 | <0.01 | 0.006 | 1.7 |
| | Copper | <0.001 | <0.01 | <0.005 | - | < 0.001 | - | - | 0.005 | 0.012 | <0.01 | <0.01 | <0.01 | <0.001 | <0.001 | <0.001 | 0.003 | 0.011 | <0.001 | <0.01 | <0.01 | <0.001 | <0.01 |
| | Lead | <0.001 | <0.01 | <0.005 | - | < 0.001 | <0.001 | <0.001 | <0.001 | 0.02 | <0.01 | <0.01 | <0.01 | <0.001 | <0.001 | <0.001 | <0.001 | <0.01 | <0.001 | <0.01 | <0.01 | <0.001 | 0.27 |
| | Mercury | 0.01 | 0.0052 | 0.0055 | 0.0069 | 0.05 | <0.005 | <0.005 | <0.005 | <0.001 | 0.0078 | 0.0053 | <0.001 | 0.011 | 0.0089 | 0.0031 | 0.0086 | 0.013 | 0.014 | 0.0054 | 0.0069 | 0.038 | 0.0023 |
| | Nickel | <0.001 | <0.01 | <0.005 | - | 0.039 | <0.001 | <0.001 | <0.001 | 0.011 | <0.1 | <0.01 | <0.01 | <0.001 | <0.001 | <0.001 | <0.001 | <0.01 | <0.001 | <0.01 | 0.039 | 0.002 | 0.65 |
| | Zinc | 0.016 | <0.05 | <0.025 | - | 0.013 | 0.017 | 0.011 | 0.019 | 0.066 | 0.071 | <0.05 | <0.05 | 0.007 | 0.008 | 0.008 | 0.016 | <0.05 | 0.006 | <0.05 | <0.05 | 0.008 | 0.84 |
| Total Recoverable Hydrocarbons (TRH, 1999 NEPM) | TRH $C_6$-$C_9$ | 40 | 73 | 92 | - | 59 | 71 | 82 | 80 | 81 | 84 | <4 | 18 | 76 | 73 | 44 | 47 | 22 | 68 | 44 | 45 | 120 | 77 |
| | TRH $C_{10}$-$C_{14}$ | 54 | 69 | 44 | - | 74 | 0.33 | 32 | 32 | 37 | 29 | 88 | 47 | 6.3 | 5.3 | 64 | 120 | 41 | 65 | 74 | 67 | 44 | 30 |
| | TRH $C_{15}$-$C_{28}$ | 4 | 0.5 | 0.8 | - | 1.1 | <0.1 | 0.2 | 1 | 0.8 | 0.5 | 1.8 | <0.1 | <1 | <0.1 | <1 | 110 | 1.5 | 2.8 | 2.2 | 1.9 | <0.1 | <1 |
| | TRH $C_{29}$-$C_{36}$ | <1 | <0.1 | <0.1 | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <0.1 | <1 | 2.8 | <0.1 | <1 | <0.1 | <0.1 | <0.1 | <1 |
| | TRH $C_{10}$-$C_{36}$ (Total) | 58 | 69.5 | 44.8 | - | 75.1 | 0.33 | 32.2 | 33 | 37.8 | 29.5 | 89.8 | 47 | 6.3 | 5.3 | 64 | 232.8 | 42.5 | 67.8 | 76.2 | 68.9 | 44 | 30 |
| Total Recoverable Hydrocarbons (TRH, 2013 NEPM) | Napthalene | 1 | 0.99 | 1.2 | - | 0.63 | 0.63 | 0.36 | <5 | <4 | 1.1 | 0.79 | <5 | 0.68 | <1 | <2.5 | 0.47 | <5 | <1 | <2 | <1 | <2 | 0.73 |
| | TRH $C_6$-$C_{10}$ less BTEX | - | 22 | 42 | - | 14 | 27 | 29 | 34 | 35 | 42 | <4 | 7.7 | 28 | 26 | 15 | 21 | 40 | 31 | 0.90 | 0.80 | 56.00 | 41.00 |
| | TRH $C_6$-$C_{10}$ | - | 74 | 98 | - | 68 | 80 | 92 | 90 | 90 | 89 | <4 | 18 | 80 | 77 | 48 | 53 | 65 | 76 | 48 | 49 | 130 | 85 |
| | TRH $C_{10}$-$C_{16}$ | 48 | 50 | 63 | - | 59 | 0.33 | 35 | 37 | 34 | 22 | 86 | 44 | 5.5 | 3.8 | 51 | 100 | 23 | 62 | 63 | 59 | 41 | 15 |
| | TRH $C_{>10}$-$C_{16}$ less Naphthalene | - | 49 | 62 | - | 58.37 | - | 35 | 37 | 34 | 20.9 | 85.21 | 44 | 5.5 | 3.8 | 51 | 99.53 | 40 | 62 | 63 | 59 | 41 | 14.27 |
| | TRH $C_{16}$-$C_{34}$ | 3.1 | 0.4 | 0.7 | - | 0.6 | <0.1 | <0.1 | 0.8 | 0.5 | 0.5 | 1.5 | <0.1 | <1 | <0.1 | <1 | 120 | 1.2 | 2.2 | 1.8 | 1.5 | <0.1 | <1 |
| | TRH $C_{34}$-$C_{40}$ | <1 | <0.1 | <0.1 | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <0.1 | <1 | 0.7 | <0.1 | <1 | <0.1 | <0.1 | <0.1 | <1 |
| BTEX | Benzene | 10 | - | 17 | 36 | 14 | 14 | 17 | 15 | 19 | 9.9 | 0.8 | 5.2 | 15 | 14 | 9.1 | 12 | 12 | 13 | 11 | 11 | 20 | 11 |
| | Toluene | 13 | 24 | 25 | - | 0.97 | 25 | 30 | 27 | 25 | 20 | 0.27 | 3.7 | 24 | 25 | 15 | 14 | 20 | 21 | 19 | 19 | 30 | 21 |
| | Ethylbenzene | 0.52 | 0.81 | 0.9 | - | 9.5 | 0.94 | 1.1 | 0.93 | 0.74 | 0.98 | 0.27 | <0.5 | 0.88 | 0.83 | 0.59 | 0.33 | 1 | 0.73 | 7.1 | 7.6 | 1.3 | 0.78 |
| | m&p-Xylene | 5.6 | 9.6 | 9.6 | - | 2.8 | 10 | 12 | 10 | 8 | 13 | 3.3 | 1.4 | 9.1 | 8.4 | 6.2 | 4.1 | 7.4 | 8 | 7.4 | 7.9 | 16 | 8.9 |
| | o-Xylene | 1.7 | 2.4 | 3.1 | - | 27 | 2.7 | 3.2 | 2.7 | 2.2 | 3.2 | 1 | <0.5 | 2.6 | 2.4 | 1.8 | 1.2 | 2.1 | 2.2 | 2.6 | 2.7 | 4 | 2.2 |
| | Xylenes - Total | 7.3 | 12 | 13 | - | 12 | 13 | 15 | 13 | 10 | 16 | 4.4 | 1.4 | 12 | 11 | 8 | 5.3 | 9.5 | 10 | 10 | 11 | 20 | 11 |
| Glycols | Di-Ethylene Glycol* | - | < 20 | 120 | - | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | - | - | < 20 | < 20 |
| | Ethylene glycol* | - | < 20 | <20 | - | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | - | - | < 20 | < 20 |
| | Propylene glycol* | - | < 20 | <20 | - | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | - | - | < 20 | < 20 |
| | Triethylene glycol* | - | < 20 | 98 | - | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | - | - | < 20 | < 20 |
| Polycyclic Aromatic Hydrocarbons (PAH) | Acenaphthene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Acenaphthylene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | 0.004 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Anthracene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Benz(a)anthracene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Benzo(a)pyrene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Benzo(b&j)fluoranthene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Benzo(g,h,i)perylene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Benzo(k)fluoranthene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Chrysene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Dibenz(a,h)anthracene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Fluoranthene | <0.01 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Fluorene | <0.01 | 0.002 | 0.003 | - | < 0.001 | < 0.001 | 0.001 | 0.001 | 0.001 | <0.03 | 0.003 | 0.002 | 0.003 | 0.002 | <0.005 | < 0.001 | 0.003 | 0.004 | <0.001 | <0.001 | 0.003 | 0.002 |
| | Indeno(1,2,3-cd)pyrene | <0.01 | <0.001 | < 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Naphthalene | <0.01 | 0.4 | 0.37 | - | 0.097 | 0.002 | 0.36 | 0.14 | 0.25 | 0.049 | 0.29 | 0.62 | 0.68 | 0.85 | 0.63 | 0.51 | 0.63 | 0.8 | 0.86 | 0.76 | 0.62 | 0.43 |
| | Phenanthrene | <0.01 | < 0.001 | 0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | < 0.001 | 0.001 | 0.003 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Pyrene | <0.01 | < 0.001 | <0.001 | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.03 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | < 0.001 |
| | Total PAH* | <0.01 | 0.402 | 0.374 | - | 0.097 | 0.002 | 0.361 | 0.14 | 0.25 | 0.049 | 0.294 | 0.627 | 0.684 | 0.853 | 0.631 | 0.51 | 0.63 | 0.81 | 0.86 | 0.76 | 0.62 | 0.43 |
| Phenols (Halogenated) | 2.4.5-Trichlorophenol | <1 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.01 | <0.01 | < 0.01 | < 0.01 |
| | 2.4.6-Trichlorophenol | <1 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.01 | <0.01 | < 0.01 | < 0.01 |
| | 2.4-Dichlorophenol | <1 | < 0.003 | < 0.003 | - | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | <0.03 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | <0.003 | <0.003 | < 0.003 | < 0.003 |
| | 2.6-Dichlorophenol | <1 | < 0.003 | < 0.003 | - | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | <0.03 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | <0.003 | <0.003 | < 0.003 | < 0.003 |
| | 2-Chlorophenol | <1 | < 0.003 | < 0.003 | - | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | <0.03 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 | <0.003 | <0.003 | < 0.003 | < 0.003 |
| | 4-Chloro-3-methylphenol | <1 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.01 | <0.01 | < 0.01 | < 0.01 |
| | Pentachlorophenol | <1 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.01 | <0.01 | < 0.01 | < 0.01 |
| | Tetrachlorophenols - Total | <1 | < 0.03 | < 0.03 | - | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | <0.3 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | <0.03 | <0.03 | < 0.03 | < 0.03 |
| | Total Halogenated Phenol* | <1 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.01 | <0.01 | < 0.01 | < 0.01 |
| Phenols (non-Halogenated) | 2.4-Dimethylphenol | 9.1 | 6.4 | 11 | - | 1.9 | 0.049 | 5.3 | 4.3 | 8.5 | 0.63 | 4.6 | 3.7 | 7.2 | 12 | 11 | 3.2 | 8.9 | 14 | 23 | 18 | 9.9 | 8 |
| | 2.4-Dinitrophenol | - | <0.03 | <0.03 | - | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.3 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |
| | 2-Cyclohexyl-4,6-dinitrophenol | - | <0.1 | <0.1 | - | < 0.1 | < 0.1 | < 0.1 | <0.1 | <0.1 | <1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | 2-Methyl-4,6-dinitrophenol | - | <0.03 | <0.03 | - | < 0.03 | < 0.03 | < 0.03 | < 0.03 | <0.03 | <0.3 | <0.03 | <0.003 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |
| | 2-Methylphenol (o-Cresol) | 41 | 16 | 34 | - | 4.2 | 0.12 | 14 | 13 | 17 | 1.8 | 8.8 | 8.6 | 19 | 26 | 26 | 11 | 24 | 22 | 34 | 22 | 25 | 16 |
| | 2-Nitrophenol | <1 | <0.01 | <0.01 | - | < 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | 3&4-Methylphenol (m&p-Cresol) | 50 | 17 | 33 | - | 4 | 0.1 | 10 | 12 | 13 | 1.6 | 6.3 | 6.3 | 18 | 21 | 24 | 4.9 | 21 | 24 | 32 | 19 | 22 | 17 |
| | 4-Nitrophenol | <1 | <0.03 | <0.03 | - | < 0.03 | < 0.03 | < 0.03 | < 0.03 | <0.03 | <0.3 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |
| | Dinoseb | - | <0.1 | 32 | - | < 0.1 | < 0.1 | < 0.1 | < 0.1 | <0.1 | <1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | Phenol | 61 | 17 | 32 | - | 2.8 | 0.19 | 7.7 | 8.4 | 8.3 | 1.6 | 3.9 | 3.7 | <20 | <20 | 12 | 5.7 | 13 | 13 | 22 | 12 | 14 | 11 |
| | Total Non-Halogenated Phenol* | 150 | 56.4 | 110 | - | 12.9 | 0.459 | 37 | 37.7 | 46.8 | 5.63 | 23.6 | 22.3 | 81.2 | 106 | 123 | 40.8 | 111.9 | 119 | 177 | 112 | 71 | 52 |

**Notes:**
Units mg/L unless specified
* Indicates NATA accreditation does not cover the performance of this analysis by Eurofin Laboratory
Grey font: value below laboratory limits of reporting
Grey highlighted cells indicate Produced Formation Water (PFW) samples which were subjected to Whole Effluent Toxicity (WET) Testing
Orange highlighted cells indicate analyte concentrations in the 10 WET-tested PFW samples which differed from the mean analyte concentration (calculated from all PFW samples) by more than two standard deviations. Note that where a concentration was reported below the laboratory limit of reporting (LOR), the full LOR value has been adopted as a conservative measure for the purpose of calculations
"-" = analyte not measured in this sample

# Appendix B

## ESA Toxicity Test Reports

# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report

**October 2019**

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ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR1858/1



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 25 September 2019 |
| | | **Date Received:** | 26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3*, salinity 17.3 ‰*, total ammonia 32.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 27 September 2019 at 1810h |

| Sample 9252*: Y0250919* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control 92.0 ± 1.8 | | |
| ASW Control 92.5 ± 1.7 | | |
| 1.6 87.8 ± 5.6 | | |
| 3.1 12.8 ± 9.5 * | | |
| 6.3 2.0 ± 1.4 * | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **EC10 = 1.6%**** | | |
| **EC50 = 2.4% **** | | |
| **NOEC = 1.6%** | | |
| **LOEC = 3.1%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)
** The 95% Confidence limits are not reliable.

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ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 92.0% | Yes |
| Reference Toxicant within cusum chart limits | 48.7-66.6µg Cu/L | 56.9µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR1858/2



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3*, salinity 17.3 ‰*, total ammonia 32.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 27 September 2019 at 1730h |

| Sample: **Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 95.3 ± 2.2 | | |
| ASW Control | 96.0 ± 2.6 | | |
| 1.6 | 96.3 ± 1.7 | | |
| 3.1 | 84.0 ± 4.7 * | | |
| 6.3 | 25.5 ± 10.3 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |

**72-hr EC10 = 3.0 (2.78-3.22)%**
**72-hr EC50 = 4.9 (4.66-5.08)%**
**NOEC = 1.6%**
**LOEC = 3.1%**

*Significantly lower percentage of normally developed larvae compared with the FSW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/2



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 95.3% | Yes |
| Reference Toxicant within cusum chart limits | 9.6-13.6µg Cu/L | 11.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR1858/3



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 25 September 2019 |
| | | **Date Received:** | 26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3*, salinity 17.3 ‰*, total ammonia 32.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | The test was extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 27 September 2019 at 1830 h |

| Sample 9252: *Y0250919* **Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 78.3 ± 4.0 | | |
| ASW Control | 76.5 ± 3.4 | | |
| 1.6 | 80.3 ± 4.4 | | |
| 3.1 | 48.0 ± 8.8 * | | |
| 6.3 | 0.0 ± 0.0 | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 =2.0 (1.87-2.21)%**<br>**72-hr EC50 =3.4 (3.28-3.50)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/3



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 78.3% | Yes |
| Reference Toxicant within cusum chart limits | 7.5-15.3µg Cu/L | 9.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.



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# Toxicity Test Report: TR1858/4



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3 ‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 27 September 2019 at 1630h |

| Sample 9252: Y0250919<br>**Concentration (%)** | **% Unaffected (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 90.0 ± 20.0 | | |
| 6.3 | 60.0 ± 16.3 * | | |
| 12.5 | 10.0 ± 11.6 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr EC10 = 3.4(2.27-4.39)%**<br>**96-hr EC50 = 6.6 (5.41-8.19)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/4



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.6-8.4mg SDS/L | 3.6mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR1858/5



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3 ‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 27 September 2019 at 1930h |

| Sample 9252: *Y0250919*<br>**Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 18.1 ± 1.0 | | |
| ASW Control | 16.7 ± 0.6 | | |
| 1.6 | 19.0 ± 1.3 | | |
| 3.1 | 18.3 ± 1.8 | | |
| 6.3 | 8.2 ± 1.8 * | | |
| 12.5 | 2.6 ± 1.4 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr IC10 = 3.7 (3.33-3.80)%**<br>**72-hr IC50 = 6.0 (5.43-6.93)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/5



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean cell density | ≥16.0x10$^4$ cells/mL | 19.1x10$^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 5.5% | Yes |
| Reference Toxicant within cusum chart limits | 3.0-9.3µg Cu/L | 4.8µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR1858/6



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 25 September 2019 |
| | | **Date Received:** | 26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 27 September 2019 at 1930h |

| Sample 9252: *Y0250919* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control: 95.5 ± 2.7 | | |
| ASW Control: 95.8 ± 2.5 | | |
| 1.6: 94.8 ± 3.0 | | |
| 3.1: 95.5 ± 2.1 | | |
| 6.3: 93.5 ± 2.1 | | |
| 12.5: 57.5 ± 11.8 * | | |
| 25: 24.0 ± 11.5 * | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr EC10 = 7.9 (5.58-9.79)%** | | |
| **72-hr EC50 = 15.6 (13.3-18.1)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/6



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 95.5% | Yes |
| Reference Toxicant within cusum chart limits | 104.9-276.5µg Cu/L | 181.7µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR1858/7



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 25 September 2019 |
| | | **Date Received:** | 26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using the Bass *Macqauria novemaculeata.* |
| **Test Protocol:** | ESA SOP 117 (ESA 2016), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample |
| **Source of Test Organisms:** | In-house cultures |
| **Test Initiated:** | 27 September 2019 at 1900h |

| Sample 9252: *Y0250919* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control — 90.0 ± 11.6 | | |
| ASW Control — 90.0 ± 11.6 | | |
| 1.6 — 90.0 ± 11.6 | | |
| 3.1 — 60.0 ± 16.3 * | | |
| 6.3 — 0.0 ± 0.0 | | |
| 12.5 — 0.0 ± 0.0 | | |
| 25 — 0.0 ± 0.0 | | |
| 50 — 0.0 ± 0.0 | | |
| 100 — 0.0 ± 0.0 | | |
| **96-hr IC10 = 2.1%**** | | |
| **96-hr EC50 = 3.5 (3.04-4.06)%** | | |
| **NOEC = 1.6%** | | |
| **LOEC = 3.1%** | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)
** The 95% Confidence Limits are not reliable.

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# Toxicity Test Report: TR1858/7



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 90.0% | Yes |
| Reference Toxicant within cusum chart limits | 76.3-2555.9µg Cu/L | 607.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 12. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR1858/8



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Size of Test Organisms:** | 23mm |
| **Test Initiated:** | 27 September 2019 at 1930h |

Sample 9252: *Y0250919*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** | |
|---|---|---|
| FSW Control | 100 ± 0.0 | |
| ASW Control | 100 ± 0.0 | |
| 1.6 | 100 ± 0.0 | |
| 3.1 | 55.0 ± 10.0 | * |
| 6.3 | 0.0 ± 0.0 | |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day EC10 (unaffected) = 2.7 (2.62-2.76)%**
**7 day EC50 (unaffected) = 3.2 (2.79-3.78)%**
**NOEC = 1.6%**
**LOEC = 3.1%**

Sample 9252: *Y0250919*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** | |
|---|---|---|
| FSW Control | 22.4 ± 1.9 | |
| ASW Control | 22.1 ± 2.5 | |
| 1.6 | 20.6 ± 1.6 | |
| 3.1 | 10.8 ± 1.8 | ** |
| 6.3 | 0.0 ± 0.0 | |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day IC10 (biomass) = 1.7%*****
**7 day IC50 (biomass) =3.1 (2.69-3.67) %**
**NOEC = 1.6%**
**LOEC = 3.1%**

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)
**Significantly lower fish biomass compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)
***The 95% Confidence Limits are not reliable

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# Toxicity Test Report: TR1858/8



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | - | No* |
| Reference Toxicant within cusum chart limits | 10.7-114.8mg $NH_4^+$/L | 46.3mg $NH_4^+$/L | Yes |

*fish available for testing at 27 September were older and at a relatively lower growth phase than with younger fish

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

NATA WORLD RECOGNISED ACCREDITATION

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www.ecotox.com.au
ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Chain-of-Custody Documentation

Datasheet ID: 601.2

Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Peter Young

**Client** : AECOM Australia Pty Ltd
Level 6, 3 Forrest Place
Perth WA 6849

**Email** : peter.young@aecom.com
**Telephone** : 08 6208 0000
**Facsimile** :

**Date** : 2/10/2019

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR1858 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 26/10/2019
**Time samples received** : 8:45
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 11-15°C

**Comments** : 4 x 2.5L sample received at 12oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

ecotox SERVICES AUSTRALIA

Customer | Ship To
Contact Name | Attention
Phone | Email (please provide an email address for sample receipt notification)
Sampled by: D MCLACHLAN

12°C

G25+

| Sample Date (day/month/year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | Comments / Instructions |
|---|---|---|---|---|---|---|
| | | | | | | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 1858 |
| 25/09/2014 | 08:30 | YO250919-1 | | 1 x 2 SL | | |
| " | " | YO250919-2 | | 1 x 2 SL | | |
| " | " | YO250919-3 | | 1 x 2 SL | | |
| " | " | YO250919-4 | | 1 x 2 L | | |

| 1) Released By | Date | 2) Received By | Date | 3) Released By | Date | 4) Received By | Date |
|---|---|---|---|---|---|---|---|
| D MCLACHLAN | 25/9/14 | | 26/9/14 | | | | |
| Of | Time 08:30 | Of ESP | Time 0845 | Of | Time | Of | Time |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9300 | 0.9800 | 0.9600 |
| ASW Control | 0.9500 | 0.9300 | 0.9900 | 0.9700 |
| 1.6 | 0.9400 | 0.9700 | 0.9600 | 0.9800 |
| 3.1 | 0.7900 | 0.8500 | 0.9000 | 0.8200 |
| 6.3 | 0.3600 | 0.1200 | 0.3000 | 0.2400 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3789 | 1.3030 | 1.4706 | 5.232 | 4 | * | | | 16 | 400 |
| 1.6 | 0.9625 | 1.0026 | 1.3796 | 1.3233 | 1.4289 | 3.240 | 4 | -0.012 | 2.290 | 0.1332 | 15 | 400 |
| *3.1 | 0.8400 | 0.8750 | 1.1624 | 1.0948 | 1.2490 | 5.681 | 4 | 3.723 | 2.290 | 0.1332 | 64 | 400 |
| *6.3 | 0.2550 | 0.2656 | 0.5222 | 0.3537 | 0.6435 | 23.840 | 4 | 14.729 | 2.290 | 0.1332 | 298 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

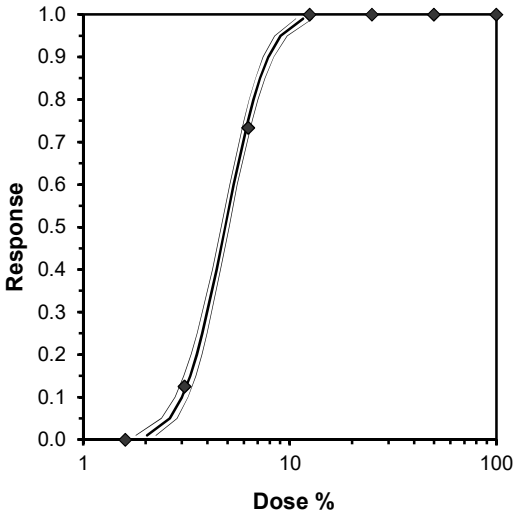
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.975273 | 0.887 | -0.42954 | 0.482187 |
| Bartlett's Test indicates equal variances (p = 0.41) | 2.877388 | 11.34487 | | |
| The control means are not significantly different (p = 0.64) | 0.498347 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.065634 | 0.068111 | 0.657642 | 0.006766 | 1.1E-08 | 3, 12 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 6.149576 | 0.334514 | 5.493928 | 6.805223 | 0.04 | 3.589738 | 11.0705 | 0.61 | 0.687311 | 0.162613 | 4 |
| Intercept | 0.773331 | 0.245685 | 0.291789 | 1.254874 | | | | | | | |
| TSCR | 0.039185 | 0.007027 | 0.025411 | 0.052959 | | | | | | | |

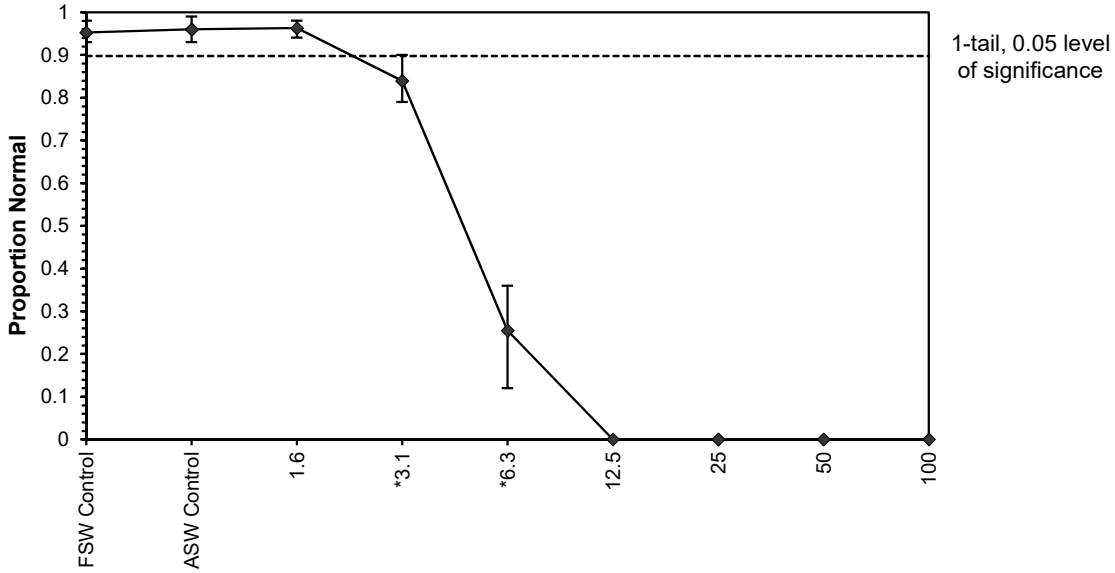
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.03712 | 1.801262 | 2.253447 |
| EC05 | 3.355 | 2.629277 | 2.390429 | 2.845354 |
| EC10 | 3.718 | 3.012408 | 2.777552 | 3.224509 |
| EC15 | 3.964 | 3.301971 | 3.07203 | 3.51023 |
| EC20 | 4.158 | 3.55183 | 3.326811 | 3.756811 |
| EC25 | 4.326 | 3.781202 | 3.560788 | 3.983656 |
| EC40 | 4.747 | 4.427037 | 4.216199 | 4.628583 |
| EC50 | 5.000 | 4.867552 | 4.656595 | 5.077419 |
| EC60 | 5.253 | 5.351901 | 5.131327 | 5.582442 |
| EC75 | 5.674 | 6.266013 | 5.997911 | 6.570449 |
| EC80 | 5.842 | 6.670664 | 6.370831 | 7.020684 |
| EC85 | 6.036 | 7.175431 | 6.828854 | 7.591264 |
| EC90 | 6.282 | 7.865156 | 7.444511 | 8.384187 |
| EC95 | 6.645 | 9.011248 | 8.448203 | 9.728514 |
| EC99 | 7.326 | 11.63067 | 10.68178 | 12.89303 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.25 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| ASW Control | | 96.00 | 93.00 | 99.00 | 2.58 | 1.67 | 4 |
| 1.6 | | 96.25 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 3.1 | | 84.00 | 79.00 | 90.00 | 4.69 | 2.58 | 4 |
| 6.3 | | 25.50 | 12.00 | 36.00 | 10.25 | 12.55 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9300 | 0.9800 | 0.9600 |
| ASW Control | 0.9500 | 0.9300 | 0.9900 | 0.9700 |
| 1.6 | 0.9400 | 0.9700 | 0.9600 | 0.9800 |
| 3.1 | 0.7900 | 0.8500 | 0.9000 | 0.8200 |
| 6.3 | 0.3600 | 0.1200 | 0.3000 | 0.2400 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3789 | 1.3030 | 1.4706 | 5.232 | 4 | * | | | 16 | 400 |
| 1.6 | 0.9625 | 1.0026 | 1.3796 | 1.3233 | 1.4289 | 3.240 | 4 | -0.012 | 2.290 | 0.1332 | 15 | 400 |
| *3.1 | 0.8400 | 0.8750 | 1.1624 | 1.0948 | 1.2490 | 5.681 | 4 | 3.723 | 2.290 | 0.1332 | 64 | 400 |
| *6.3 | 0.2550 | 0.2656 | 0.5222 | 0.3537 | 0.6435 | 23.840 | 4 | 14.729 | 2.290 | 0.1332 | 298 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

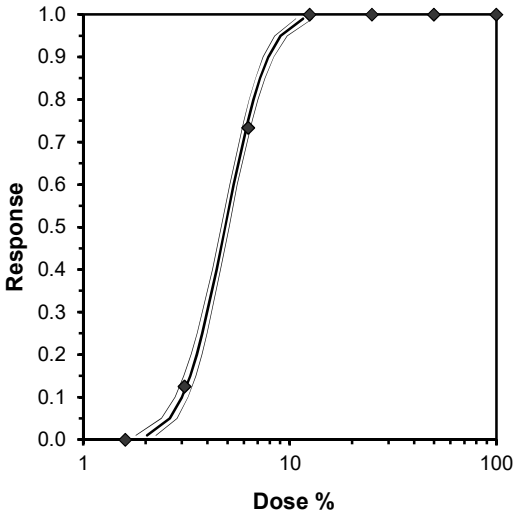
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.975273 | 0.887 | -0.42954 | 0.482187 |
| Bartlett's Test indicates equal variances (p = 0.41) | 2.877388 | 11.34487 | | |
| The control means are not significantly different (p = 0.64) | 0.498347 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.065634 | 0.068111 | 0.657642 | 0.006766 | 1.1E-08 | 3, 12 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 6.149576 | 0.334514 | 5.493928 | 6.805223 | 0.04 | 3.589738 | 11.0705 | 0.61 | 0.687311 | 0.162613 | 4 |
| Intercept | 0.773331 | 0.245685 | 0.291789 | 1.254874 | | | | | | | |
| TSCR | 0.039185 | 0.007027 | 0.025411 | 0.052959 | | | | | | | |

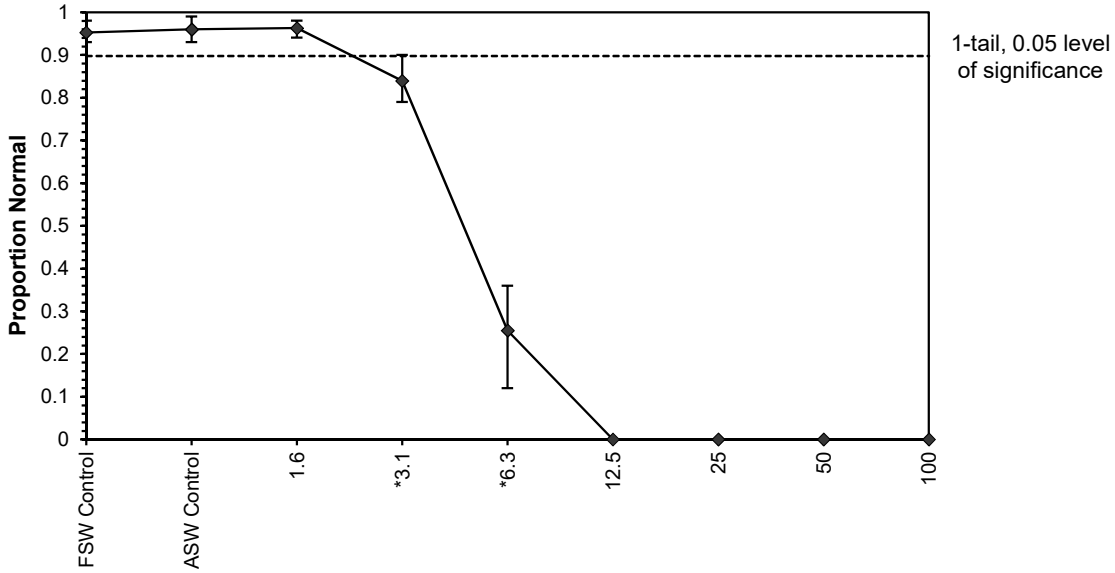
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.03712 | 1.801262 | 2.253447 |
| EC05 | 3.355 | 2.629277 | 2.390429 | 2.845354 |
| EC10 | 3.718 | 3.012408 | 2.777552 | 3.224509 |
| EC15 | 3.964 | 3.301971 | 3.07203 | 3.51023 |
| EC20 | 4.158 | 3.55183 | 3.326811 | 3.756811 |
| EC25 | 4.326 | 3.781202 | 3.560788 | 3.983656 |
| EC40 | 4.747 | 4.427037 | 4.216199 | 4.628583 |
| EC50 | 5.000 | 4.867552 | 4.656595 | 5.077419 |
| EC60 | 5.253 | 5.351901 | 5.131327 | 5.582442 |
| EC75 | 5.674 | 6.266013 | 5.997911 | 6.570449 |
| EC80 | 5.842 | 6.670664 | 6.370831 | 7.020684 |
| EC85 | 6.036 | 7.175431 | 6.828854 | 7.591264 |
| EC90 | 6.282 | 7.865156 | 7.444511 | 8.384187 |
| EC95 | 6.645 | 9.011248 | 8.448203 | 9.728514 |
| EC99 | 7.326 | 11.63067 | 10.68178 | 12.89303 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.25 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| ASW Control | | 96.00 | 93.00 | 99.00 | 2.58 | 1.67 | 4 |
| 1.6 | | 96.25 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 3.1 | | 84.00 | 79.00 | 90.00 | 4.69 | 2.58 | 4 |
| 6.3 | | 25.50 | 12.00 | 36.00 | 10.25 | 12.55 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 18:30 | Test ID: | PR1858/15 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 18:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7400 | 0.8300 | 0.8000 | 0.7600 |
| ASW Control | 0.7500 | 0.8100 | 0.7300 | 0.7700 |
| 1.6 | 0.7400 | 0.8400 | 0.8100 | 0.8200 |
| 3.1 | 0.4600 | 0.3900 | 0.4700 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

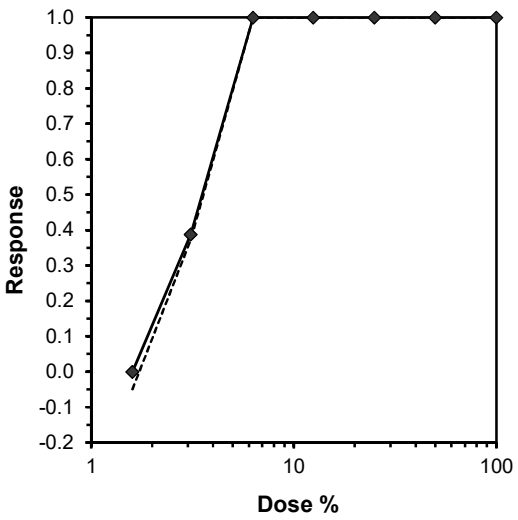
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7825 | 1.0229 | 1.0869 | 1.0357 | 1.1458 | 4.535 | 4 | | | | | |
| ASW Control | 0.7650 | 1.0000 | 1.0655 | 1.0244 | 1.1198 | 3.830 | 4 | * | | | 94 | 400 |
| 1.6 | 0.8025 | 1.0490 | 1.1119 | 1.0357 | 1.1593 | 4.799 | 4 | -1.024 | 2.180 | 0.0987 | 79 | 400 |
| *3.1 | 0.4800 | 0.6275 | 0.7653 | 0.6745 | 0.8861 | 11.522 | 4 | 6.633 | 2.180 | 0.0987 | 208 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.97222 | 0.859 | 0.428236 | 0.615081 |
| Bartlett's Test indicates equal variances (p = 0.44) | 1.627575 | 9.21034 | | |
| The control means are not significantly different (p = 0.53) | 0.668304 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.088191 | 0.115181 | 0.141556 | 0.004096 | 6.0E-05 | 2, 9 |

### Trimmed Spearman-Karber

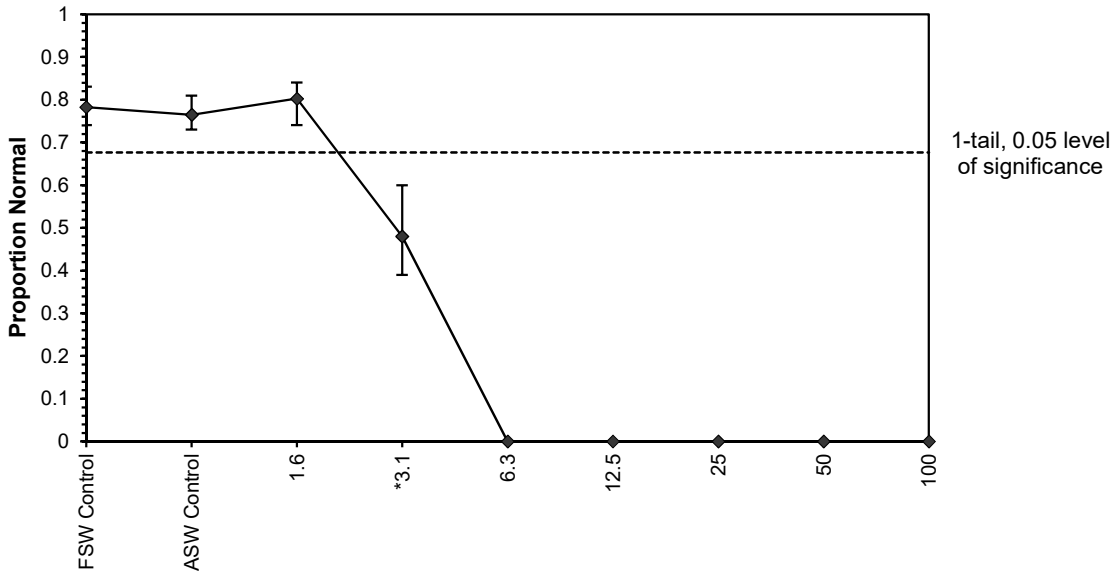
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.3885 | 3.2773 | 3.5036 |
| 5.0% | 3.4105 | 3.2858 | 3.5400 |
| 10.0% | 3.4323 | 3.2895 | 3.5813 |
| 20.0% | 3.4747 | 3.2733 | 3.6886 |
| Auto-0.0% | 3.3885 | 3.2773 | 3.5036 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 18:30 | Test ID: | PR1858/15 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 18:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 18:30 | Test ID: | PR1858/15 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 18:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 78.25 | 74.00 | 83.00 | 4.03 | 2.57 | 4 |
| ASW Control | | 76.50 | 73.00 | 81.00 | 3.42 | 2.42 | 4 |
| 1.6 | | 80.25 | 74.00 | 84.00 | 4.35 | 2.60 | 4 |
| 3.1 | | 48.00 | 39.00 | 60.00 | 8.76 | 6.16 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 18:30 | Test ID: | PR1858/15 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 18:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7400 | 0.8300 | 0.8000 | 0.7600 |
| ASW Control | 0.7500 | 0.8100 | 0.7300 | 0.7700 |
| 1.6 | 0.7400 | 0.8400 | 0.8100 | 0.8200 |
| 3.1 | 0.4600 | 0.3900 | 0.4700 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

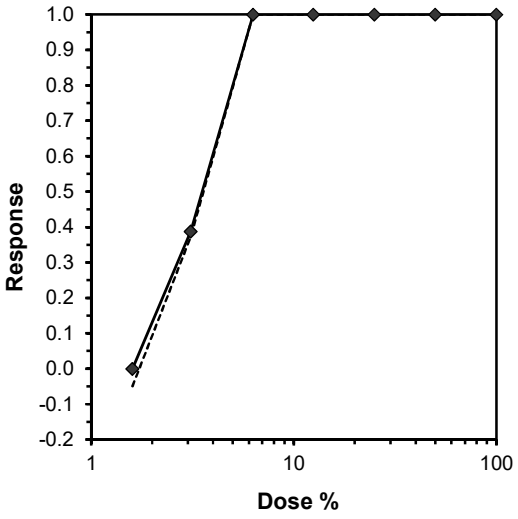
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7825 | 1.0229 | 1.0869 | 1.0357 | 1.1458 | 4.535 | 4 | | | | | |
| ASW Control | 0.7650 | 1.0000 | 1.0655 | 1.0244 | 1.1198 | 3.830 | 4 | * | | | 0.7838 | 1.0000 |
| 1.6 | 0.8025 | 1.0490 | 1.1119 | 1.0357 | 1.1593 | 4.799 | 4 | -1.024 | 2.180 | 0.0987 | 0.7838 | 1.0000 |
| *3.1 | 0.4800 | 0.6275 | 0.7653 | 0.6745 | 0.8861 | 11.522 | 4 | 6.633 | 2.180 | 0.0987 | 0.4800 | 0.6124 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.97222 | 0.859 | 0.428236 | 0.615081 |
| Bartlett's Test indicates equal variances (p = 0.44) | 1.627575 | 9.21034 | | |
| The control means are not significantly different (p = 0.53) | 0.668304 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.088191 | 0.115181 | 0.141556 | 0.004096 | 6.0E-05 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.7956 | 0.0668 | 1.7268 | 1.9051 | -10.9184 |
| IC10 | 1.9850 | 0.0560 | 1.8688 | 2.2077 | 0.3615 |
| IC15 | 2.1715 | 0.0825 | 1.9964 | 2.5128 | 0.9785 |
| IC20 | 2.3581 | 0.1116 | 2.1214 | 2.8245 | 1.1568 |
| IC25 | 2.5471 | 0.1401 | 2.2395 | 3.1471 | 1.0250 |
| IC40 | 3.1101 | 0.1053 | 2.6353 | 3.2456 | -1.0027 |
| IC50 | 3.1942 | 0.0411 | 3.0657 | 3.3281 | 0.1532 |



# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 16:30 | Test ID: | PR1858/02 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 16:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 0.6000 |
| 6.3 | 0.6000 | 0.8000 | 0.6000 | 0.4000 |
| 12.5 | 0.0000 | 0.2000 | 0.2000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 0.9000 | 0.9000 | 1.2305 | 0.8861 | 1.3453 | 18.660 | 4 | 16.00 | 10.00 | 2 | 20 |
| *6.3 | 0.6000 | 0.6000 | 0.8910 | 0.6847 | 1.1071 | 19.366 | 4 | 10.00 | 10.00 | 8 | 20 |
| *12.5 | 0.1000 | 0.1000 | 0.3446 | 0.2255 | 0.4636 | 39.900 | 4 | 10.00 | 10.00 | 18 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

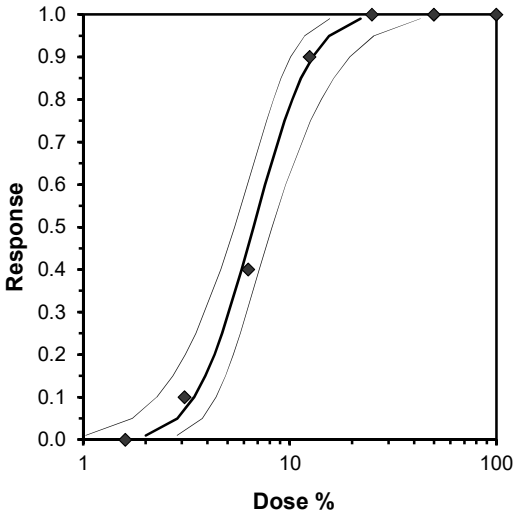
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.874764 | 0.905 | -1.01023 | 1.925233 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 4.476347 | 0.779411 | 2.948702 | 6.003993 | 0 | 0.752017 | 11.0705 | 0.98 | 0.823407 | 0.223396 | 3 |
| Intercept | 1.314144 | 0.671174 | -0.00136 | 2.629645 | | | | | | | |
| TSCR | | | | | | | | | | | |

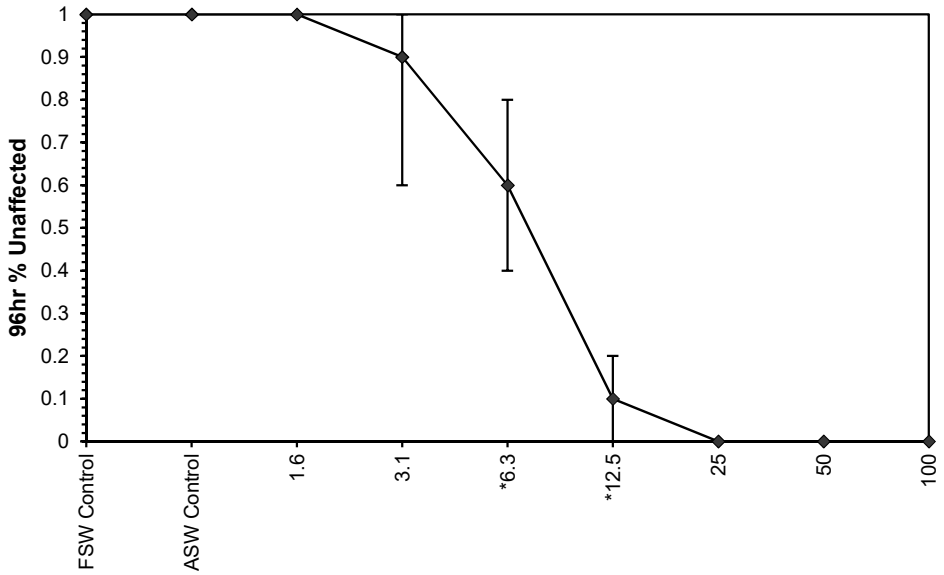
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.012376 | 1.034186 | 2.85415 |
| EC05 | 3.355 | 2.857278 | 1.733282 | 3.765561 |
| EC10 | 3.718 | 3.444395 | 2.271134 | 4.387061 |
| EC15 | 3.964 | 3.907252 | 2.716143 | 4.87997 |
| EC20 | 4.158 | 4.319085 | 3.122326 | 5.326055 |
| EC25 | 4.326 | 4.706828 | 3.509488 | 5.756475 |
| EC40 | 4.747 | 5.845344 | 4.639124 | 7.111008 |
| EC50 | 5.000 | 6.658968 | 5.410339 | 8.189498 |
| EC60 | 5.253 | 7.585842 | 6.234193 | 9.545884 |
| EC75 | 5.674 | 9.420751 | 7.706435 | 12.60984 |
| EC80 | 5.842 | 10.26649 | 8.330809 | 14.17074 |
| EC85 | 6.036 | 11.3486 | 9.093906 | 16.28708 |
| EC90 | 6.282 | 12.87363 | 10.11726 | 19.4753 |
| EC95 | 6.645 | 15.51891 | 11.78891 | 25.51472 |
| EC99 | 7.326 | 22.03458 | 15.55582 | 42.75583 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 16:30 | Test ID: | PR1858/02 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 16:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 16:30 | Test ID: | PR1858/02 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 16:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 90.00 | 60.00 | 100.00 | 20.00 | 4.97 | 4 |
| 6.3 | | 60.00 | 40.00 | 80.00 | 16.33 | 6.74 | 4 |
| 12.5 | | 10.00 | 0.00 | 20.00 | 11.55 | 33.98 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/07 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 18.314 | 17.014 | 19.514 | 17.614 | 16.614 | 19.014 | 17.814 | 18.614 |
| ASW Control | 17.314 | 16.614 | 16.814 | 15.914 | | | | |
| 1.6 | 18.614 | 19.014 | 17.714 | 20.714 | | | | |
| 3.1 | 21.014 | 17.314 | 17.814 | 17.114 | | | | |
| 6.3 | 8.114 | 5.914 | 10.114 | 8.714 | | | | |
| 12.5 | 2.214 | 4.314 | 2.914 | 1.014 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

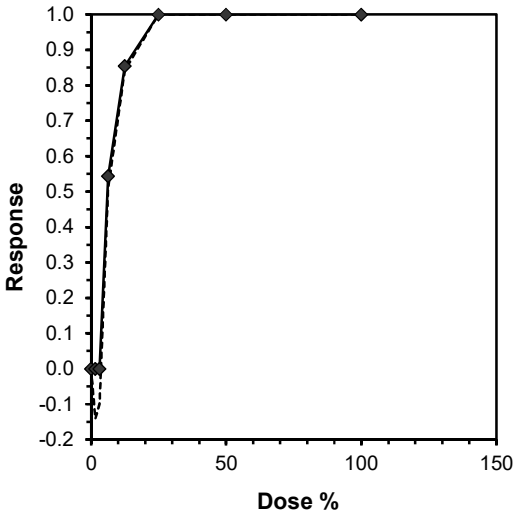
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 18.064 | 1.0840 | 18.064 | 16.614 | 19.514 | 5.472 | 8 | | | | | |
| ASW Control | 16.664 | 1.0000 | 16.664 | 15.914 | 17.314 | 3.482 | 4 | * | | | 17.997 | 1.0000 |
| 1.6 | 19.014 | 1.1410 | 19.014 | 17.714 | 20.714 | 6.611 | 4 | -2.327 | 2.360 | 2.383 | 17.997 | 1.0000 |
| 3.1 | 18.314 | 1.0990 | 18.314 | 17.114 | 21.014 | 9.959 | 4 | -1.634 | 2.360 | 2.383 | 17.997 | 1.0000 |
| *6.3 | 8.214 | 0.4929 | 8.214 | 5.914 | 10.114 | 21.273 | 4 | 8.368 | 2.360 | 2.383 | 8.214 | 0.4564 |
| *12.5 | 2.614 | 0.1569 | 2.614 | 1.014 | 4.314 | 52.734 | 4 | 13.914 | 2.360 | 2.383 | 2.614 | 0.1452 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.970155 | 0.905 | 0.427505 | -0.08268 |
| Bartlett's Test indicates equal variances (p = 0.51) | 3.267247 | 13.2767 | | |
| The control means are significantly different (p = 0.03) | 2.580344 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 2.383094 | 0.143009 | 208.6 | 2.039333 | 1.1E-10 | 4, 15 |

### Linear Interpolation (200 Resamples)

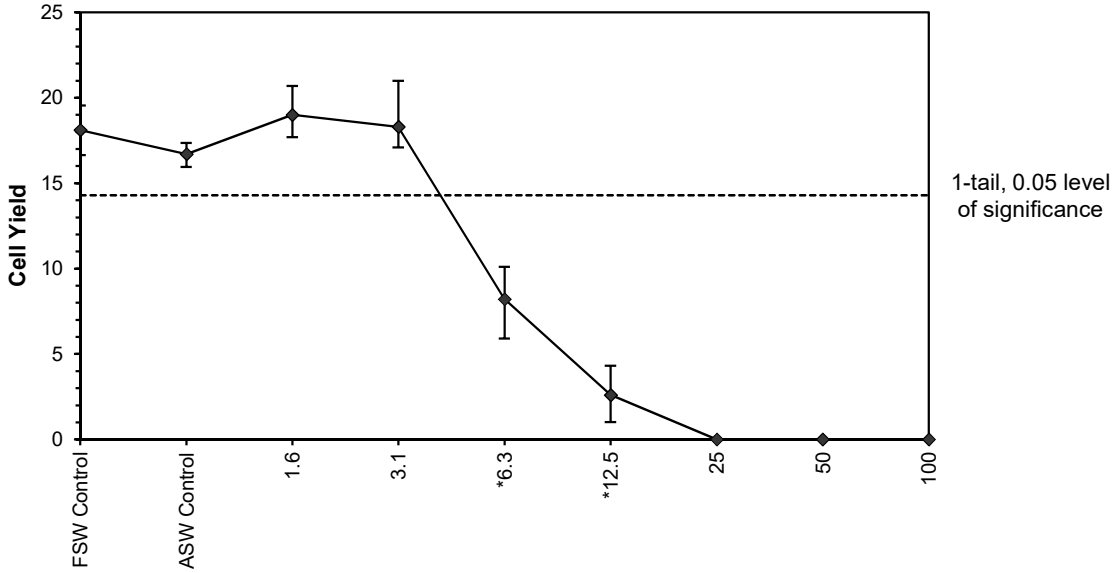
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.3943 | 0.0843 | 2.9935 | 3.4479 | -1.8951 |
| IC10 | 3.6887 | 0.0779 | 3.3296 | 3.8001 | -1.1331 |
| IC15 | 3.9830 | 0.0832 | 3.6401 | 4.1536 | -0.6121 |
| IC20 | 4.2773 | 0.0953 | 3.9400 | 4.5055 | -0.2673 |
| IC25 | 4.5717 | 0.1121 | 4.2001 | 4.8608 | -0.0793 |
| IC40 | 5.4547 | 0.1757 | 4.9306 | 5.9203 | 0.1581 |
| IC50 | 6.0433 | 0.2582 | 5.4339 | 6.9275 | 0.8476 |



**Microalgal Cell Yield-Cell Yield**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/07 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/07 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 18.06 | 16.61 | 19.51 | 0.99 | 5.50 | 8 |
| ASW Control | | 16.66 | 15.91 | 17.31 | 0.58 | 4.57 | 4 |
| 1.6 | | 19.01 | 17.71 | 20.71 | 1.26 | 5.90 | 4 |
| 3.1 | | 18.31 | 17.11 | 21.01 | 1.82 | 7.37 | 4 |
| 6.3 | | 8.21 | 5.91 | 10.11 | 1.75 | 16.09 | 4 |
| 12.5 | | 2.61 | 1.01 | 4.31 | 1.38 | 44.92 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/03 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9800 | 0.9200 | 0.9700 |
| ASW Control | 0.9600 | 0.9500 | 0.9300 | 0.9900 |
| 1.6 | 0.9600 | 0.9100 | 0.9400 | 0.9800 |
| 3.1 | 0.9600 | 0.9300 | 0.9800 | 0.9500 |
| 6.3 | 0.9400 | 0.9100 | 0.9600 | 0.9300 |
| 12.5 | 0.6500 | 0.4100 | 0.6700 | 0.5700 |
| 25 | 0.3900 | 0.1200 | 0.1900 | 0.2600 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9550 | 0.9974 | 1.3637 | 1.2840 | 1.4289 | 4.643 | 4 | | | | | |
| ASW Control | 0.9575 | 1.0000 | 1.3721 | 1.3030 | 1.4706 | 5.188 | 4 | * | | | 17 | 400 |
| 1.6 | 0.9475 | 0.9896 | 1.3469 | 1.2661 | 1.4289 | 5.129 | 4 | 0.401 | 2.410 | 0.1513 | 21 | 400 |
| 3.1 | 0.9550 | 0.9974 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | 0.166 | 2.410 | 0.1513 | 18 | 400 |
| 6.3 | 0.9350 | 0.9765 | 1.3155 | 1.2661 | 1.3694 | 3.274 | 4 | 0.902 | 2.410 | 0.1513 | 26 | 400 |
| *12.5 | 0.5750 | 0.6005 | 0.8618 | 0.6949 | 0.9589 | 13.905 | 4 | 8.129 | 2.410 | 0.1513 | 170 | 400 |
| *25 | 0.2400 | 0.2507 | 0.5036 | 0.3537 | 0.6745 | 26.989 | 4 | 13.835 | 2.410 | 0.1513 | 304 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.981601 | 0.916 | -0.09971 | 0.299336 |
| Bartlett's Test indicates equal variances (p = 0.38) | 5.275941 | 15.08627 | | |
| The control means are not significantly different (p = 0.87) | 0.175539 | 2.446912 | | |

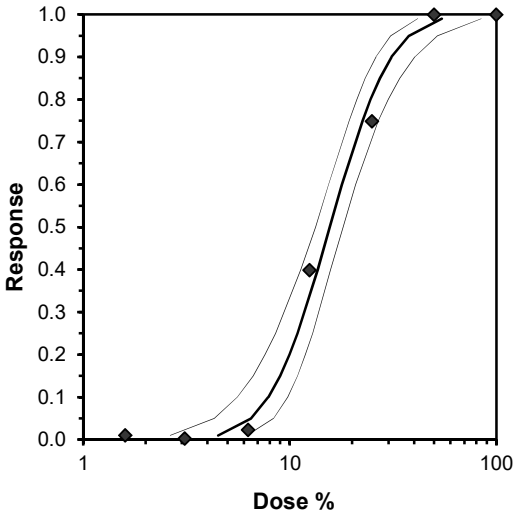
| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.078607 | 0.081794 | 0.526421 | 0.007882 | 5.5E-11 | 5, 18 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 4.301535 | 0.44916 | 3.146931 | 5.456138 | 0.0425 | 23.77123 | 11.0705 | 2.4E-04 | 1.194433 | 0.232475 | 5 |
| Intercept | -0.1379 | 0.565265 | -1.59096 | 1.315165 | | | | | | | |
| TSCR | 0.044103 | 0.012778 | 0.011255 | 0.07695 | | | | | | | |

| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 4.504174 | 2.641494 | 6.197175 |
| EC05 | 3.355 | 6.487026 | 4.311699 | 8.334077 |
| EC10 | 3.718 | 7.879603 | 5.584404 | 9.785016 |
| EC15 | 3.964 | 8.984383 | 6.637686 | 10.9229 |
| EC20 | 4.158 | 9.971884 | 7.603767 | 11.93814 |
| EC25 | 4.326 | 10.90514 | 8.53209 | 12.90182 |
| EC40 | 4.747 | 13.66269 | 11.30799 | 15.82467 |
| EC50 | 5.000 | 15.64708 | 13.2775 | 18.05275 |
| EC60 | 5.253 | 17.91968 | 15.44643 | 20.786 |
| EC75 | 5.674 | 22.45098 | 19.42831 | 26.86441 |
| EC80 | 5.842 | 24.55214 | 21.13958 | 29.94037 |
| EC85 | 6.036 | 27.25074 | 23.244 | 34.09206 |
| EC90 | 6.282 | 31.07149 | 26.0878 | 40.30351 |
| EC95 | 6.645 | 37.74165 | 30.78708 | 51.93311 |
| EC99 | 7.326 | 54.35649 | 41.60597 | 84.35676 |

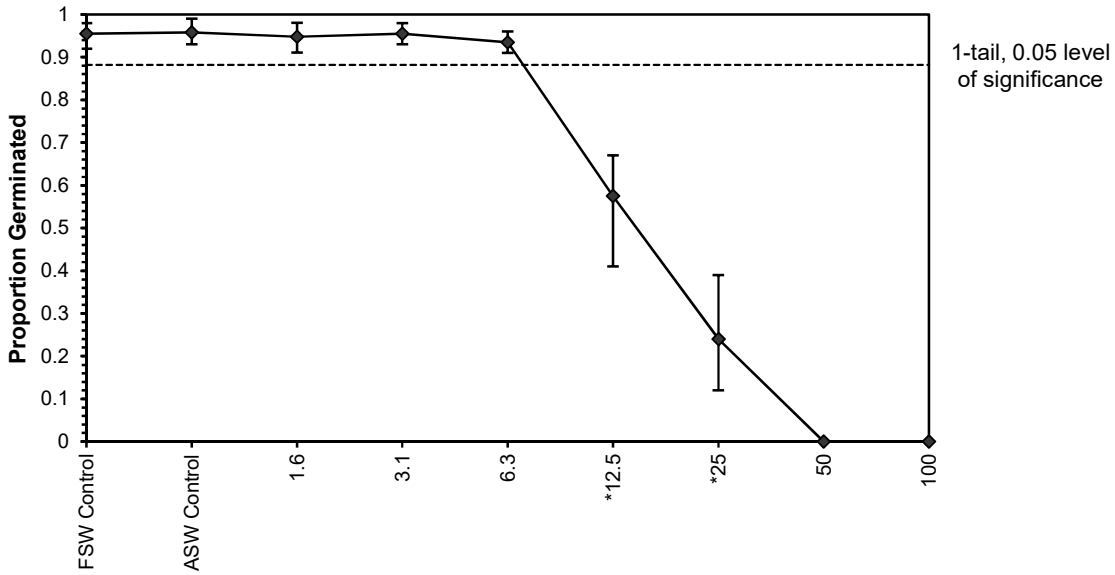
Significant heterogeneity detected (p = 2.40E-04)



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/03 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/03 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 95.50 | 92.00 | 98.00 | 2.65 | 1.70 | 4 |
| ASW Control | | 95.75 | 93.00 | 99.00 | 2.50 | 1.65 | 4 |
| 1.6 | | 94.75 | 91.00 | 98.00 | 2.99 | 1.82 | 4 |
| 3.1 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 6.3 | | 93.50 | 91.00 | 96.00 | 2.08 | 1.54 | 4 |
| 12.5 | | 57.50 | 41.00 | 67.00 | 11.82 | 5.98 | 4 |
| 25 | | 24.00 | 12.00 | 39.00 | 11.52 | 14.14 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:00 | Test ID: | PR1858/06 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | MN-Macquaria novemaculeata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| 1.6 | 0.8000 | 0.8000 | 1.0000 | 1.0000 |
| 3.1 | 0.6000 | 0.6000 | 0.8000 | 0.4000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

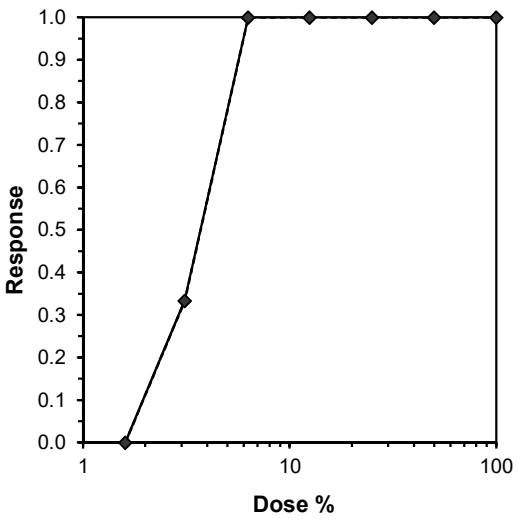
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | | | | | |
| ASW Control | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | * | | | 2 | 20 |
| 1.6 | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 0.000 | 2.180 | 0.2314 | 2 | 20 |
| *3.1 | 0.6000 | 0.6667 | 0.8910 | 0.6847 | 1.1071 | 19.366 | 4 | 3.159 | 2.180 | 0.2314 | 8 | 20 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.895444 | 0.859 | 0.057516 | -1.43497 |
| Bartlett's Test indicates equal variances (p = 0.91) | 0.187668 | 9.21034 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.182504 | 0.206012 | 0.149821 | 0.022526 | 0.016848 | 2, 9 |

### Trimmed Spearman-Karber

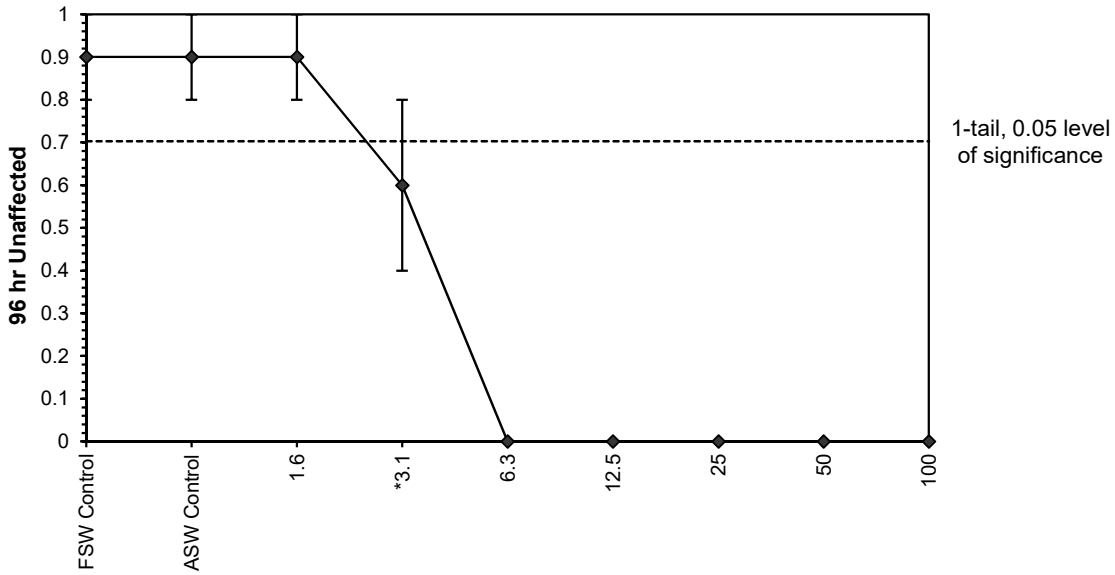
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.5168 | 3.0437 | 4.0634 |
| 5.0% | 3.5524 | 3.0218 | 4.1763 |
| 10.0% | 3.5872 | 2.9774 | 4.3219 |
| 20.0% | 3.6512 | 2.7833 | 4.7896 |
| Auto-0.0% | 3.5168 | 3.0437 | 4.0634 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:00 | Test ID: | PR1858/06 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | MN-Macquaria novemaculeata |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:00 | Test ID: | PR1858/06 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | MN-Macquaria novemaculeata |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| ASW Control | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 1.6 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 3.1 | | 60.00 | 40.00 | 80.00 | 16.33 | 6.74 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:00 | Test ID: | PR1858/06 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | MN-Macquaria novemaculeata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| 1.6 | 0.8000 | 0.8000 | 1.0000 | 1.0000 |
| 3.1 | 0.6000 | 0.6000 | 0.8000 | 0.4000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

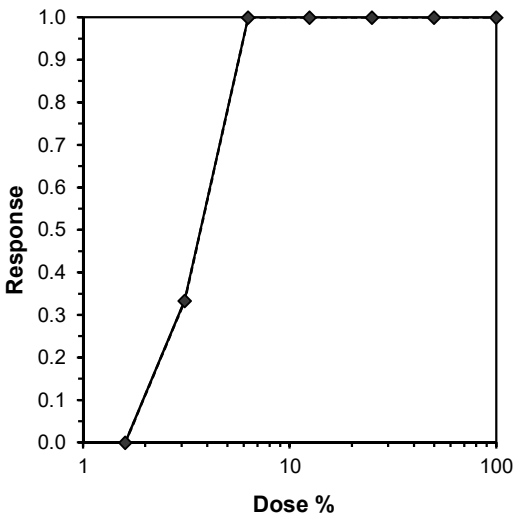
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | | | | | |
| ASW Control | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | * | | | 0.9000 | 1.0000 |
| 1.6 | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 0.000 | 2.180 | 0.2314 | 0.9000 | 1.0000 |
| *3.1 | 0.6000 | 0.6667 | 0.8910 | 0.6847 | 1.1071 | 19.366 | 4 | 3.159 | 2.180 | 0.2314 | 0.6000 | 0.6667 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.895444 | 0.859 | 0.057516 | -1.43497 |
| Bartlett's Test indicates equal variances (p = 0.91) | 0.187668 | 9.21034 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.182504 | 0.206012 | 0.149821 | 0.022526 | 0.016848 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.8951 | 0.4157 | 0.0000 | 2.2252 | -0.9916 |
| IC10 | 2.1439 | 0.3236 | 0.8814 | 2.8397 | -0.4616 |
| IC15 | 2.3670 | 0.3059 | 1.0202 | 3.1809 | -0.2162 |
| IC20 | 2.5750 | 0.2961 | 1.4886 | 3.4503 | -0.2842 |
| IC25 | 2.7745 | 0.2697 | 1.7863 | 3.4026 | -0.3367 |
| IC40 | 3.1607 | 0.1279 | 2.5292 | 3.3745 | -1.5697 |
| IC50 | 3.2518 | 0.0790 | 3.0065 | 3.4562 | -0.6610 |



# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 0.6000 | 0.6000 | 0.4000 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

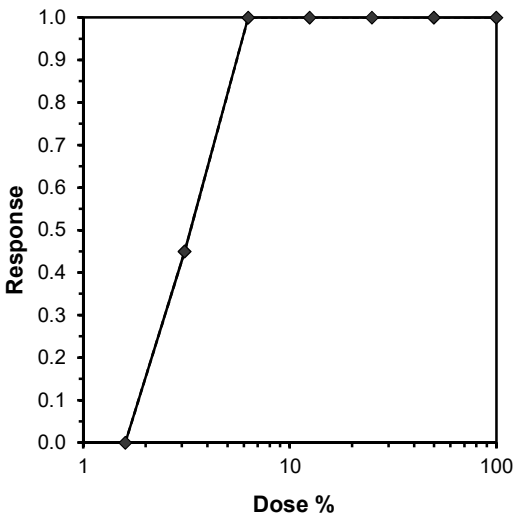
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 0 | 20 |
| *3.1 | 0.5500 | 0.5500 | 0.8357 | 0.6847 | 0.8861 | 12.047 | 4 | 10.00 | 11.00 | 9 | 20 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.633513 | 0.859 | -2.29783 | 7.088889 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 1.6 | 3.1 | 2.227106 | 62.5 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

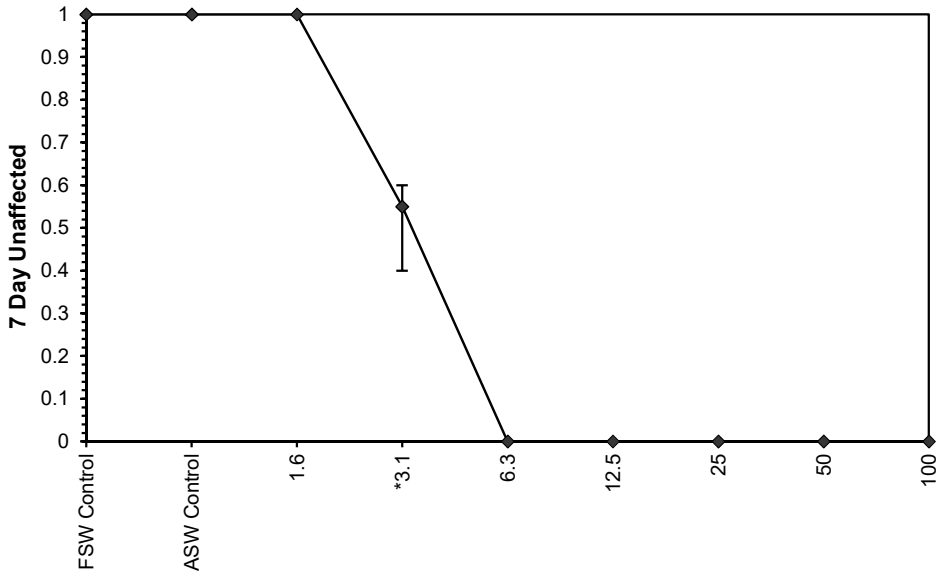
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.2466 | 2.7875 | 3.7813 |
| 5.0% | 3.2538 | 2.7460 | 3.8556 |
| 10.0% | 3.2611 | 2.6918 | 3.9508 |
| 20.0% | 3.2755 | 2.5232 | 4.2521 |
| Auto-0.0% | 3.2466 | 2.7875 | 3.7813 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 55.00 | 40.00 | 60.00 | 10.00 | 5.75 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 22.40 | 20.18 | 24.20 | 1.89 | 6.13 | 4 |
| ASW Control | | 22.09 | 19.94 | 24.38 | 2.46 | 7.10 | 4 |
| 1.6 | | 20.58 | 18.98 | 22.16 | 1.57 | 6.10 | 4 |
| 3.1 | | 10.83 | 8.06 | 11.80 | 1.84 | 12.54 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 0.6000 | 0.6000 | 0.4000 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

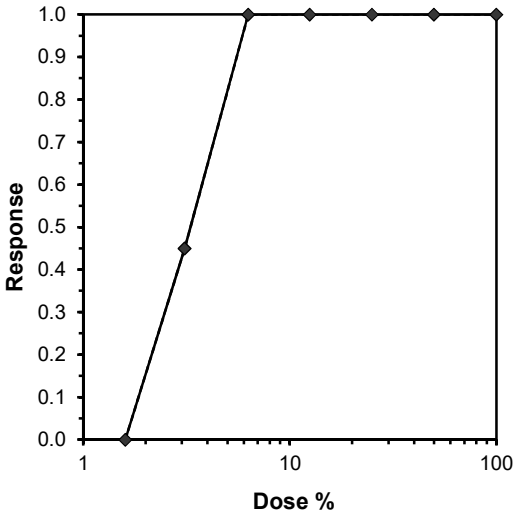
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| *3.1 | 0.5500 | 0.5500 | 0.8357 | 0.6847 | 0.8861 | 12.047 | 4 | 10.00 | 11.00 | 0.5500 | 0.5500 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.633513 | 0.859 | -2.29783 | 7.088889 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 1.6 | 3.1 | 2.227106 | 62.5 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.5690 | 0.0224 | 2.4923 | 2.6112 | -0.5832 |
| IC10 | 2.7064 | 0.0260 | 2.6174 | 2.7555 | -0.5813 |
| IC15 | 2.7941 | 0.0284 | 2.6970 | 2.8477 | -0.5801 |
| IC20 | 2.8615 | 0.0303 | 2.7581 | 2.9186 | -0.5792 |
| IC25 | 2.9180 | 0.0318 | 2.8094 | 2.9781 | -0.5785 |
| IC40 | 3.0578 | 0.0358 | 2.9357 | 3.1253 | -0.5768 |
| IC50 | 3.1507 | 0.0432 | 3.0061 | 3.2311 | -0.5273 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 23.700 | 24.200 | 20.180 | 21.500 |
| ASW Control | 19.980 | 19.940 | 24.060 | 24.380 |
| 1.6 | 21.680 | 22.160 | 19.500 | 18.980 |
| 3.1 | 11.800 | 11.740 | 8.060 | 11.700 |
| 6.3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 22.395 | 1.0138 | 22.395 | 20.180 | 24.200 | 8.420 | 4 | | | | | |
| ASW Control | 22.090 | 1.0000 | 22.090 | 19.940 | 24.380 | 11.150 | 4 | * | | | 22.090 | 1.0000 |
| 1.6 | 20.580 | 0.9316 | 20.580 | 18.980 | 22.160 | 7.648 | 4 | 1.070 | 2.180 | 3.076 | 20.580 | 0.9316 |
| *3.1 | 10.825 | 0.4900 | 10.825 | 8.060 | 11.800 | 17.033 | 4 | 7.984 | 2.180 | 3.076 | 10.825 | 0.4900 |
| 6.3 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

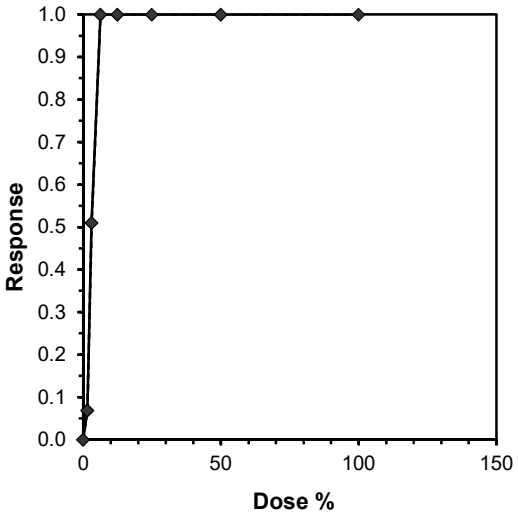
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.882251 | 0.859 | -0.34393 | -1.65716 |
| Bartlett's Test indicates equal variances (p = 0.76) | 0.551451 | 9.21034 | | |
| The control means are not significantly different (p = 0.85) | 0.196645 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 3.075745 | 0.139237 | 149.5602 | 3.981233 | 4.3E-05 | 2, 9 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05* | 1.1703 | 0.4380 | 0.0597 | 2.1276 | -0.1603 |
| IC10 | 1.7075 | 0.2517 | 0.4993 | 2.0752 | -1.4779 |
| IC15 | 1.8773 | 0.1593 | 1.1592 | 2.2431 | -1.0802 |
| IC20 | 2.0472 | 0.1365 | 1.5410 | 2.4110 | -0.5000 |
| IC25 | 2.2170 | 0.1298 | 1.7899 | 2.5792 | -0.3700 |
| IC40 | 2.7265 | 0.1259 | 2.3538 | 3.0930 | 0.0248 |
| IC50 | 3.0662 | 0.1740 | 2.6876 | 3.6711 | 0.5220 |

* indicates IC estimate less than the lowest concentration



# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report- Round 2

**October 2019**

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ABN 95 619 426 201

# Toxicity Test Report: TR1858/9 

Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 08 October 2019 at 1420h |

| Sample 9259*: Y0021019* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control | 95.3 ± 1.7 | | |
| ASW Control | 94.5 ± 1.3 | | |
| 1.6 | 94.8 ± 1.5 | | |
| 3.1 | 75.5 ± 13.3 * | | |
| 6.3 | 0.0 ± 0.0 | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **IC10 = 2.5 (2.09-3.30)%** | | | |
| **EC50 = 3.8 (3.74-3.96)%** | | | |
| **NOEC = 1.6%** | | | |
| **LOEC = 3.1%** | | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 95.3% | Yes |
| Reference Toxicant within cusum chart limits | 48.6-66.5µg Cu/L | 55.2µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR1858/10



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 08 October 2019 at 1400h |

| Sample 9259: *Y0021019* **Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 94.0 ± 3.4 | | |
| ASW Control | 96.3 ± 1.0 | | |
| 1.6 | 95.0 ± 1.8 | | |
| 3.1 | 85.5 ± 9.0 * | | |
| 6.3 | 0.0 ± 0.0 | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 = 3.0 (2.23-3.41)%**<br>**72-hr EC50 = 4.1 (4.01-4.20)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/10



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 94.0% | Yes |
| Reference Toxicant within cusum chart limits | 9.6-13.6µg Cu/L | 11.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR1858/11



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | The test was extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 04 October 2019 at 1600 h |

| Sample 9259: *Y0021019* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control: 78.8 ± 1.7 | | |
| ASW Control: 80.3 ± 3.3 | | |
| 1.6: 81.0 ± 3.6 | | |
| 3.1: 64.5 ± 10.2 * | | |
| 6.3: 0.0 ± 0.0 | | |
| 12.5: 0.0 ± 0.0 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr EC10 =2.3 (1.80-3.57)%**<br>**72-hr EC50 =3.9 (3.75-3.96)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/11 (Page 2 of 2)

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 78.8% | Yes |
| Reference Toxicant within cusum chart limits | 7.5-15.3µg Cu/L | 10.4µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.

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**Citations:**


APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.



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# Toxicity Test Report: TR1858/12



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 04 October 2019 at 1830h |

| Sample 9259: *Y0021019* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 95.0 ± 10.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 100 ± 0.0 | | |
| 12.5: 5.0 ± 10.0 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr EC10 = 7.9 (6.35-10.73)%** | | |
| **96-hr EC50 = 9.2 (8.59-9.83)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/12



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.5-8.6mg SDS/L | 3.3mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR1858/13 (Page 1 of 2)

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 04 october 2019 at 1630h |

| Sample 9259: *Y0021019* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | | |
| FSW Control: 16.6 ± 0.9 | | |
| ASW Control: 15.8 ± 0.8 | | |
| 1.6: 16.6 ± 1.0 | | |
| 3.1: 10.7 ± 1.9 * | | |
| 6.3: 1.1 ± 1.4 * | | |
| 12.5: 0.0 ± 0.0 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr IC10 = 2.0 (1.89-2.32%** | | |
| **72-hr IC50 = 4.0 (3.31-4.54)%** | | |
| **NOEC = 1.6%** | | |
| **LOEC = 3.1%** | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 17.7x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 5.3% | Yes |
| Reference Toxicant within cusum chart limits | 3.1-9.2µg Cu/L | 6.2µg Cu/L | Yes |

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# Toxicity Test Report: TR1858/13



Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR1858/14



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 04 October 2019 at 1630h |

| Sample 9259: *Y0021019* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control 94.0 ± 1.8 | | |
| ASW Control 93.0 ± 3.2 | | |
| 1.6 93.3 ± 2.5 | | |
| 3.1 92.8 ± 1.7 | | |
| 6.3 92.5 ± 2.1 | | |
| 12.5 87.3 ± 6.4 | | |
| 25 4.8 ± 2.8 * | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr EC10 = 13.3 (12.37-14.03)%** | | |
| **72-hr EC50 = 17.6 (16.76-18.24)%** | | |
| **NOEC = 12.5%** | | |
| **LOEC = 25%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/14



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 94.0% | Yes |
| Reference Toxicant within cusum chart limits | 110.1-266.95µg Cu/L | 168.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR1858/15



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using the Bass Macqauria novemaculeata. |
| **Test Protocol:** | ESA SOP 117 (ESA 2016), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample |
| **Source of Test Organisms:** | In-house cultures |
| **Test Initiated:** | 03 October 2019 at 1700h |

| Sample 9259: *Y0021019* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control — 90.0 ± 11.6 | | |
| ASW Control — 95.0 ± 10.0 | | |
| 1.6 — 95.0 ± 10.0 | | |
| 3.1 — 95.0 ± 10.0 | | |
| 6.3 — 45.0 ± 25.2 | | |
| 12.5 — 0.0 ± 0.0 | | |
| 25 — 0.0 ± 0.0 | | |
| 50 — 0.0 ± 0.0 | | |
| 100 — 0.0 ± 0.0 | | |
| **96-hr IC10 = 4.1%*** | | |
| **96-hr EC50 = 6.1 (5.26-7.18)%** | | |
| **NOEC =6.3%** | | |
| **LOEC = 12.5%** | | |

**\ The 95% Confidence Limits are not reliable.

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 90.0% | Yes |
| Reference Toxicant within cusum chart limits | 85.9-2437.6µg Cu/L | 606.2µg Cu/L | Yes |

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ABN 95 619 426 201

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 12. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR1858/8



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Size of Test Organisms:** | 12-15mm |
| **Test Initiated:** | 04 October 2019 at 1800h |

Sample 9259: *Y0021019*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.6 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (unaffected) = 4.1%***
**7 day IC50 (unaffected) = 4.5%***
**NOEC = 3.1%**
**LOEC = 6.3%**

Sample 9259: *Y0021019*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** |
|---|---|
| FSW Control | 16.8 ± 1.0 |
| ASW Control | 17.6 ± 1.8 |
| 1.6 | 17.8 ± 1.0 |
| 3.1 | 16.4 ± 0.9 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (biomass) = 3.2 (0.98-3.52)%**
**7 day IC50 (biomass) =4.6 (4.30-4.75) %**
**NOEC = 3.1%**
**LOEC = 6.3%**

*The 95% Confidence Limits are not available

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# Toxicity Test Report: TR1858/8



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | - | No |
| Reference Toxicant within cusum chart limits | 10.7-114.8mg $NH_4^+$/L | 46.3mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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ABN 95 619 426 201

# Chain-of-Custody Documentation

Datasheet ID: 601.2

Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Peter Young

**Client** : AECOM Australia Pty Ltd
Level 6, 3 Forrest Place
Perth WA 6849

**Email** : peter.young@aecom.com
**Telephone** : 08 6208 0000
**Facsimile** :

**Date** : 8/10/2019

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR1858 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 3/10/2019
**Time samples received** : 10:30
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 6-10°C

**Comments** : 4 x 2.5L sample received at 9oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

ecotox SERVICES AUSTRALIA

Customer: Beach Energy
Contact Name: Adrian Cukrowski
Phone:
Email: Adrian.cukrowski@beachenergy.com.au (please provide an email address for sample receipt notification)
X Sampled by: D. MCLACHLAN

Ship To: Ecotox Services Aust
Attention: Rich Krassoi

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | | | | | | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 96 h Acute toxicity to Blue Gill FIT | 72 h Algal toxicity 72 h Inhibition | 48 h Daphnia 1-h Immobilisation | 72 h Seed germination & root elongation | 7 d FIT of Growth | Sed - Sampling for Fingerprinting | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 18558 |
| 9.c | | | | | | | | | | | |
| X 2/10/19 | X 06:00 | X YO021019-1 | Grab | 4 x 2.5L | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 9259 " | 06:00 | YO021019-2 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| " | 06:00 | YO021019-3 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| " | 06:00 | YO021019-4 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| X D.MCLACH | 2/10/19 | | 3/10/19 | | | | |
| Of: YOLLA | Time: 12:00 | Of: ESA | Time: 1030 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:20 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 15:40 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9300 | 0.9700 |
| ASW Control | 0.9500 | 0.9400 | 0.9300 | 0.9600 |
| 1.6 | 0.9400 | 0.9600 | 0.9300 | 0.9600 |
| 3.1 | 0.8600 | 0.7900 | 0.8100 | 0.5600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

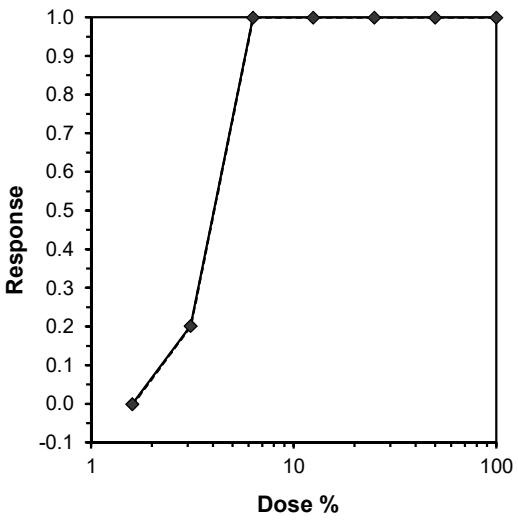
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9525 | 1.0079 | 1.3536 | 1.3030 | 1.3967 | 2.935 | 4 | | | | |
| ASW Control | 0.9450 | 1.0000 | 1.3353 | 1.3030 | 1.3694 | 2.140 | 4 | * | | 22 | 400 |
| 1.6 | 0.9475 | 1.0026 | 1.3413 | 1.3030 | 1.3694 | 2.499 | 4 | 19.00 | 11.00 | 21 | 400 |
| *3.1 | 0.7550 | 0.7989 | 1.0618 | 0.8455 | 1.1873 | 14.070 | 4 | 10.00 | 11.00 | 98 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.838216 | 0.859 | -1.60666 | 4.802703 |
| Bartlett's Test indicates equal variances (p = 0.01) | 8.495721 | 9.21034 | | |
| The control means are not significantly different (p = 0.48) | 0.749736 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 |

### Trimmed Spearman-Karber

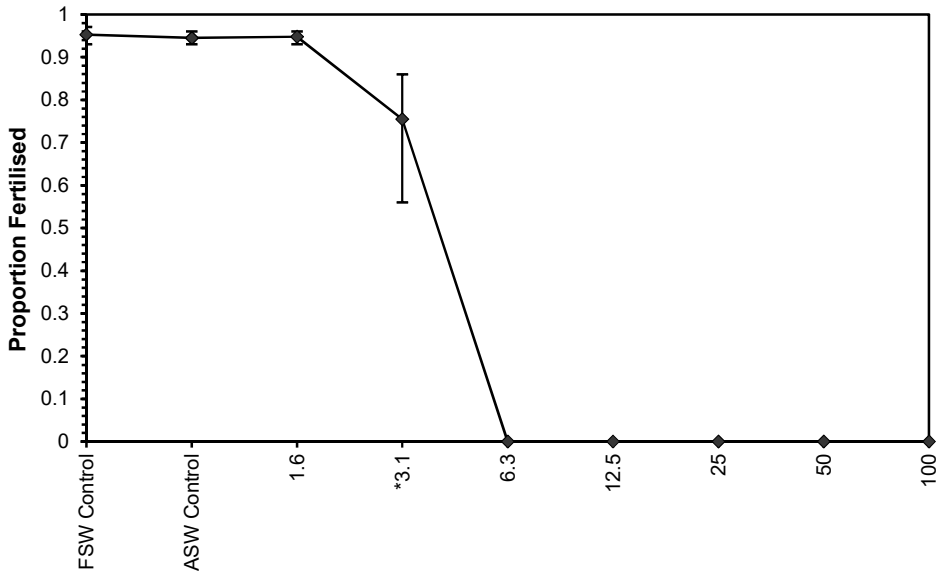
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.8477 | 3.7432 | 3.9550 |
| 5.0% | 3.9177 | 3.7966 | 4.0428 |
| 10.0% | 3.9774 | 3.8284 | 4.1322 |
| 20.0% | 4.0396 | 3.7814 | 4.3154 |
| Auto-0.0% | 3.8477 | 3.7432 | 3.9550 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:20 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 15:40 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:20 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 15:40 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 95.25 | 93.00 | 97.00 | 1.71 | 1.37 | 4 |
| ASW Control | | 94.50 | 93.00 | 96.00 | 1.29 | 1.20 | 4 |
| 1.6 | | 94.75 | 93.00 | 96.00 | 1.50 | 1.29 | 4 |
| 3.1 | | 75.50 | 56.00 | 86.00 | 13.33 | 4.84 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 25 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 50 | | 89.10 | 89.10 | 89.10 | 0.00 | 0.00 | 1 |
| 100 | | 69.30 | 69.30 | 69.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:20 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 15:40 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9300 | 0.9700 |
| ASW Control | 0.9500 | 0.9400 | 0.9300 | 0.9600 |
| 1.6 | 0.9400 | 0.9600 | 0.9300 | 0.9600 |
| 3.1 | 0.8600 | 0.7900 | 0.8100 | 0.5600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

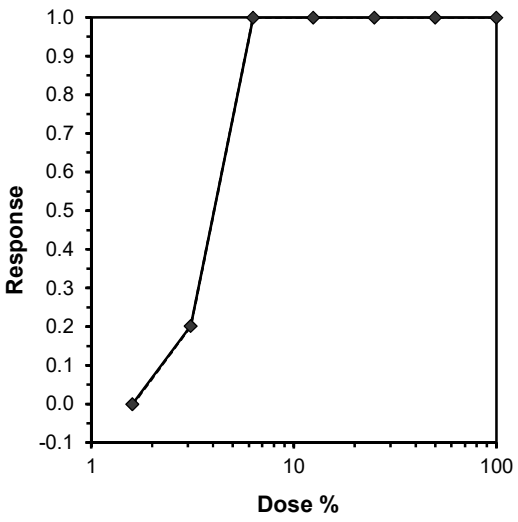
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9525 | 1.0079 | 1.3536 | 1.3030 | 1.3967 | 2.935 | 4 | | | | |
| ASW Control | 0.9450 | 1.0000 | 1.3353 | 1.3030 | 1.3694 | 2.140 | 4 | * | | 0.9463 | 1.0000 |
| 1.6 | 0.9475 | 1.0026 | 1.3413 | 1.3030 | 1.3694 | 2.499 | 4 | 19.00 | 11.00 | 0.9463 | 1.0000 |
| *3.1 | 0.7550 | 0.7989 | 1.0618 | 0.8455 | 1.1873 | 14.070 | 4 | 10.00 | 11.00 | 0.7550 | 0.7979 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.838216 | 0.859 | -1.60666 | 4.802703 |
| Bartlett's Test indicates equal variances (p = 0.01) | 8.495721 | 9.21034 | | |
| The control means are not significantly different (p = 0.48) | 0.749736 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.1079 | 0.1141 | 1.8191 | 2.5561 | 0.8421 |
| IC10 | 2.4849 | 0.2024 | 2.0934 | 3.2951 | 0.7723 |
| IC15 | 2.8027 | 0.2176 | 2.2448 | 3.3722 | 0.0347 |
| IC20 | 3.0884 | 0.1629 | 2.3634 | 3.3012 | -0.9995 |
| IC25 | 3.1533 | 0.1083 | 2.5887 | 3.3508 | -1.4413 |
| IC40 | 3.2999 | 0.0666 | 3.0669 | 3.4938 | -0.2953 |
| IC50 | 3.3921 | 0.0649 | 3.1638 | 3.5829 | -0.2576 |



# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:00 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 14:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9000 | 0.9300 | 0.9500 |
| ASW Control | 0.9700 | 0.9600 | 0.9500 | 0.9700 |
| 1.6 | 0.9600 | 0.9400 | 0.9300 | 0.9700 |
| 3.1 | 0.9500 | 0.7600 | 0.8000 | 0.9100 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

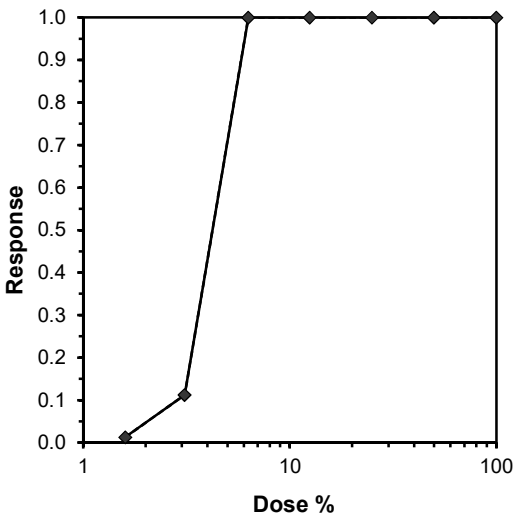
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9400 | 0.9766 | 1.3316 | 1.2490 | 1.4289 | 5.701 | 4 | | | | | |
| ASW Control | 0.9625 | 1.0000 | 1.3770 | 1.3453 | 1.3967 | 1.799 | 4 | * | | | 15 | 400 |
| 1.6 | 0.9500 | 0.9870 | 1.3481 | 1.3030 | 1.3967 | 3.165 | 4 | 0.496 | 2.180 | 0.1271 | 20 | 400 |
| *3.1 | 0.8550 | 0.8883 | 1.1943 | 1.0588 | 1.3453 | 11.223 | 4 | 3.133 | 2.180 | 0.1271 | 58 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.980881 | 0.859 | 0.172766 | 0.813745 |
| Bartlett's Test indicates equal variances (p = 0.03) | 7.189846 | 9.21034 | | |
| The control means are not significantly different (p = 0.30) | 1.13899 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.062402 | 0.064805 | 0.038577 | 0.0068 | 0.025469 | 2, 9 |

### Trimmed Spearman-Karber

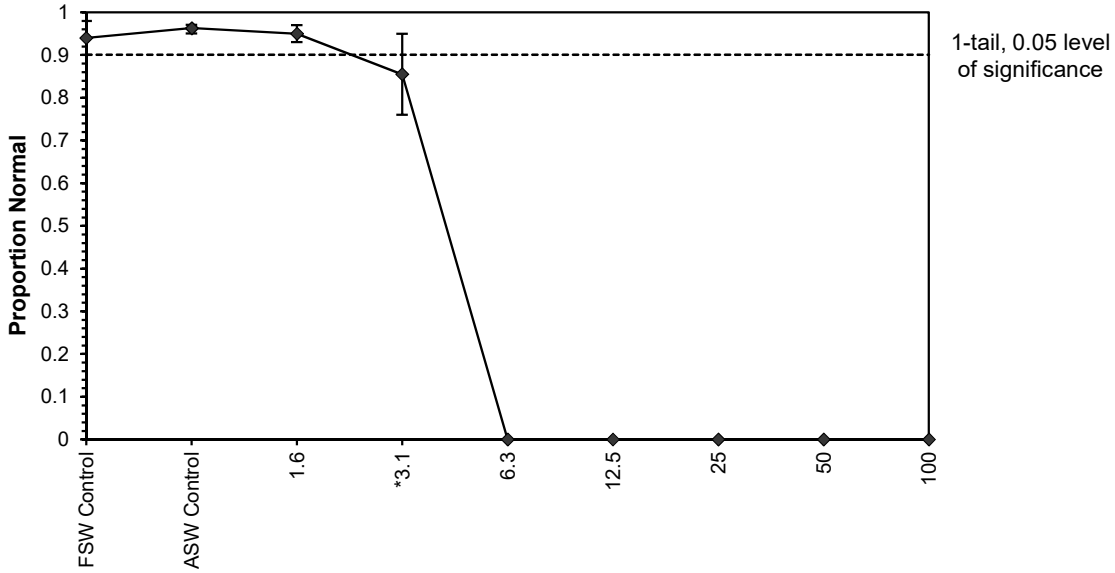
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 4.1742 | 4.0686 | 4.2825 |
| 10.0% | 4.2245 | 4.0713 | 4.3834 |
| 20.0% | 4.2266 | 4.1672 | 4.2868 |
| Auto-1.3% | 4.1036 | 4.0124 | 4.1970 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:00 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 14:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:00 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 14:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 94.00 | 90.00 | 98.00 | 3.37 | 1.95 | 4 |
| ASW Control | | 96.25 | 95.00 | 97.00 | 0.96 | 1.02 | 4 |
| 1.6 | | 95.00 | 93.00 | 97.00 | 1.83 | 1.42 | 4 |
| 3.1 | | 85.50 | 76.00 | 95.00 | 8.96 | 3.50 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 25 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 50 | | 89.10 | 89.10 | 89.10 | 0.00 | 0.00 | 1 |
| 100 | | 69.30 | 69.30 | 69.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:00 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 14:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9000 | 0.9300 | 0.9500 |
| ASW Control | 0.9700 | 0.9600 | 0.9500 | 0.9700 |
| 1.6 | 0.9600 | 0.9400 | 0.9300 | 0.9700 |
| 3.1 | 0.9500 | 0.7600 | 0.8000 | 0.9100 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

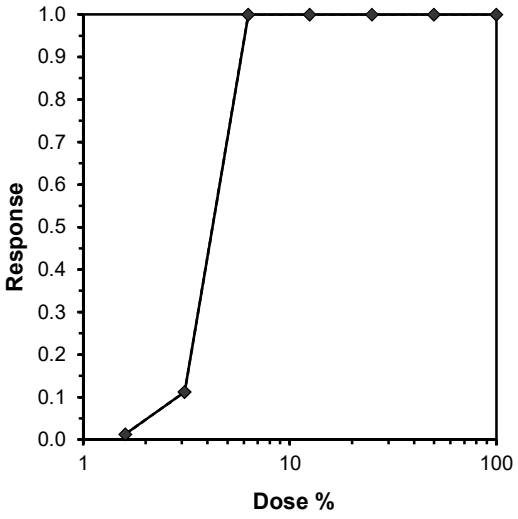
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9400 | 0.9766 | 1.3316 | 1.2490 | 1.4289 | 5.701 | 4 | | | | | |
| ASW Control | 0.9625 | 1.0000 | 1.3770 | 1.3453 | 1.3967 | 1.799 | 4 | * | | | 0.9625 | 1.0000 |
| 1.6 | 0.9500 | 0.9870 | 1.3481 | 1.3030 | 1.3967 | 3.165 | 4 | 0.496 | 2.180 | 0.1271 | 0.9500 | 0.9870 |
| *3.1 | 0.8550 | 0.8883 | 1.1943 | 1.0588 | 1.3453 | 11.223 | 4 | 3.133 | 2.180 | 0.1271 | 0.8550 | 0.8883 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.980881 | 0.859 | 0.172766 | 0.813745 |
| Bartlett's Test indicates equal variances (p = 0.03) | 7.189846 | 9.21034 | | |
| The control means are not significantly different (p = 0.30) | 1.13899 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.062402 | 0.064805 | 0.038577 | 0.0068 | 0.025469 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.2537 | 0.3023 | 1.7635 | 3.6583 | 1.0843 |
| IC10 | 2.9529 | 0.2325 | 2.2269 | 3.4099 | -0.5090 |
| IC15 | 3.1587 | 0.0989 | 2.7158 | 3.4119 | -1.5479 |
| IC20 | 3.2237 | 0.0656 | 3.0634 | 3.4755 | 0.2179 |
| IC25 | 3.2806 | 0.0640 | 3.1226 | 3.5305 | 0.3031 |
| IC40 | 3.4272 | 0.0620 | 3.2749 | 3.6710 | 0.3035 |
| IC50 | 3.5182 | 0.0607 | 3.3694 | 3.7574 | 0.3031 |



# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:00 | Test ID: | PR1858/104 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 16:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 103 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7900 | 0.8100 | 0.7800 | 0.7700 |
| ASW Control | 0.8000 | 0.8400 | 0.8100 | 0.7600 |
| 1.6 | 0.7600 | 0.8400 | 0.8100 | 0.8300 |
| 3.1 | 0.6400 | 0.7900 | 0.5900 | 0.5600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

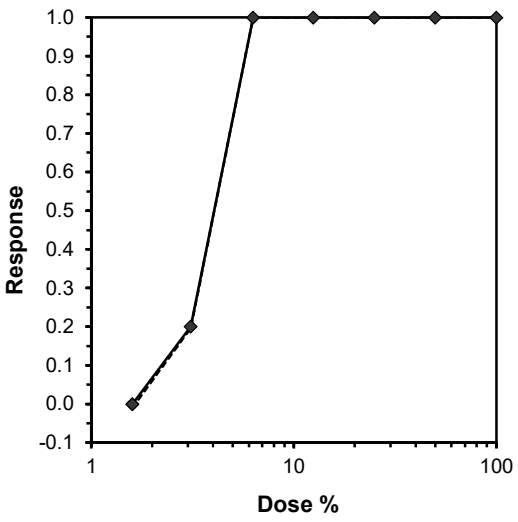
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7875 | 0.9813 | 1.0919 | 1.0706 | 1.1198 | 1.924 | 4 | | | | | |
| ASW Control | 0.8025 | 1.0000 | 1.1113 | 1.0588 | 1.1593 | 3.727 | 4 | * | | | 79 | 400 |
| 1.6 | 0.8100 | 1.0093 | 1.1209 | 1.0588 | 1.1593 | 3.972 | 4 | -0.187 | 2.180 | 0.1128 | 76 | 400 |
| *3.1 | 0.6450 | 0.8037 | 0.9359 | 0.8455 | 1.0948 | 11.879 | 4 | 3.390 | 2.180 | 0.1128 | 142 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.91614 | 0.859 | 1.075696 | 2.106456 |
| Bartlett's Test indicates equal variances (p = 0.18) | 3.381894 | 9.21034 | | |
| The control means are not significantly different (p = 0.44) | 0.832105 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.096583 | 0.120237 | 0.043396 | 0.005352 | 0.009694 | 2, 9 |

### Trimmed Spearman-Karber

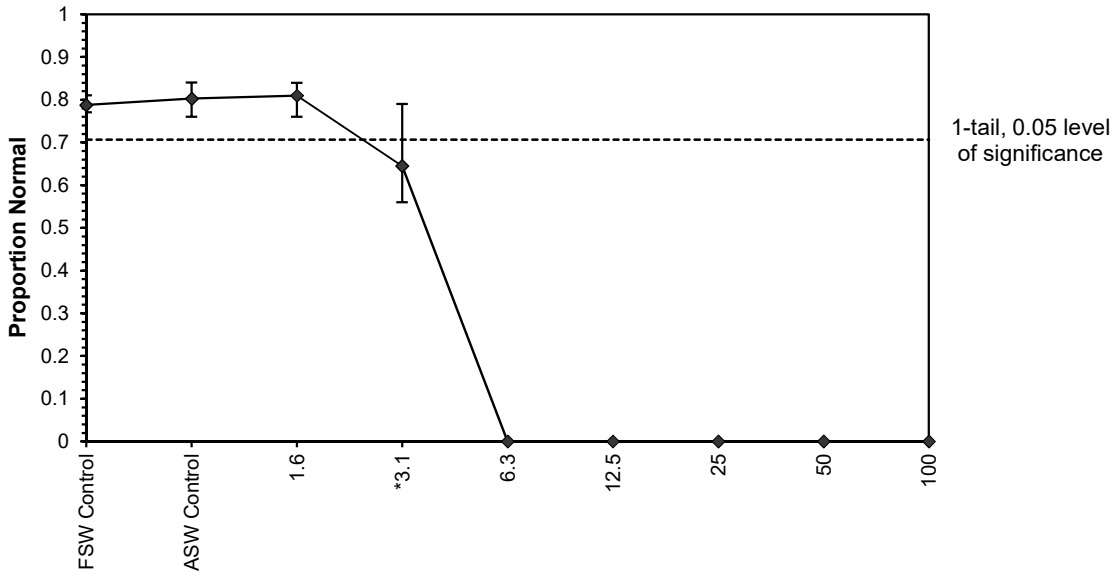
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.8533 | 3.7491 | 3.9603 |
| 5.0% | 3.9239 | 3.8029 | 4.0487 |
| 10.0% | 3.9837 | 3.8347 | 4.1385 |
| 20.0% | 4.0444 | 3.9558 | 4.1350 |
| Auto-0.0% | 3.8533 | 3.7491 | 3.9603 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:00 | Test ID: | PR1858/104 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 16:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 103 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:00 | Test ID: | PR1858/104 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 16:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 103 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 78.75 | 77.00 | 81.00 | 1.71 | 1.66 | 4 |
| ASW Control | | 80.25 | 76.00 | 84.00 | 3.30 | 2.27 | 4 |
| 1.6 | | 81.00 | 76.00 | 84.00 | 3.56 | 2.33 | 4 |
| 3.1 | | 64.50 | 56.00 | 79.00 | 10.21 | 4.96 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:00 | Test ID: | PR1858/104 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 16:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 103 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7900 | 0.8100 | 0.7800 | 0.7700 |
| ASW Control | 0.8000 | 0.8400 | 0.8100 | 0.7600 |
| 1.6 | 0.7600 | 0.8400 | 0.8100 | 0.8300 |
| 3.1 | 0.6400 | 0.7900 | 0.5900 | 0.5600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

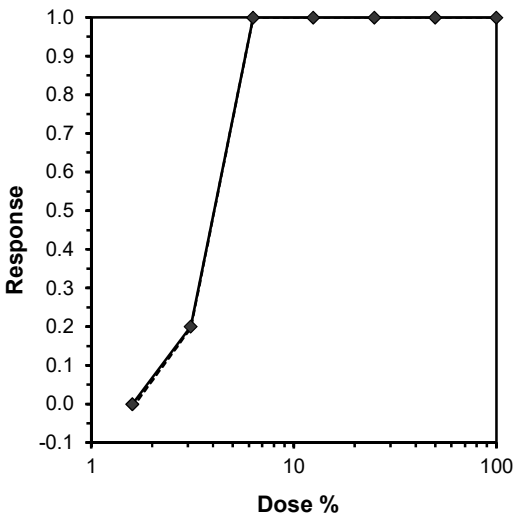
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7875 | 0.9813 | 1.0919 | 1.0706 | 1.1198 | 1.924 | 4 | | | | | |
| ASW Control | 0.8025 | 1.0000 | 1.1113 | 1.0588 | 1.1593 | 3.727 | 4 | * | | | 0.8063 | 1.0000 |
| 1.6 | 0.8100 | 1.0093 | 1.1209 | 1.0588 | 1.1593 | 3.972 | 4 | -0.187 | 2.180 | 0.1128 | 0.8063 | 1.0000 |
| *3.1 | 0.6450 | 0.8037 | 0.9359 | 0.8455 | 1.0948 | 11.879 | 4 | 3.390 | 2.180 | 0.1128 | 0.6450 | 0.8000 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.91614 | 0.859 | 1.075696 | 2.106456 |
| Bartlett's Test indicates equal variances (p = 0.18) | 3.381894 | 9.21034 | | |
| The control means are not significantly different (p = 0.44) | 0.832105 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.096583 | 0.120237 | 0.043396 | 0.005352 | 0.009694 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.9671 | 0.1809 | 1.5409 | 2.5694 | 0.4629 |
| IC10 | 2.3356 | 0.2611 | 1.7986 | 3.5670 | 1.1566 |
| IC15 | 2.7114 | 0.2681 | 2.0993 | 3.4161 | 0.3344 |
| IC20 | 3.1000 | 0.1873 | 2.3245 | 3.2529 | -0.6488 |
| IC25 | 3.1417 | 0.0865 | 2.7349 | 3.2947 | -1.2942 |
| IC40 | 3.2628 | 0.0444 | 3.1507 | 3.4147 | 0.3545 |
| IC50 | 3.3457 | 0.0435 | 3.2374 | 3.4952 | 0.3551 |



# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.2000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

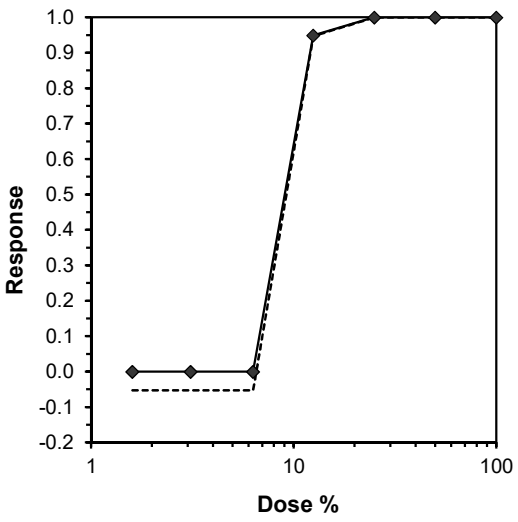
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | * | | 1 | 20 |
| 1.6 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0 | 20 |
| *12.5 | 0.0500 | 0.0526 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 19 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.811293 | 0.905 | -4.3E-14 | 4.066993 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 0.36) | 1 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

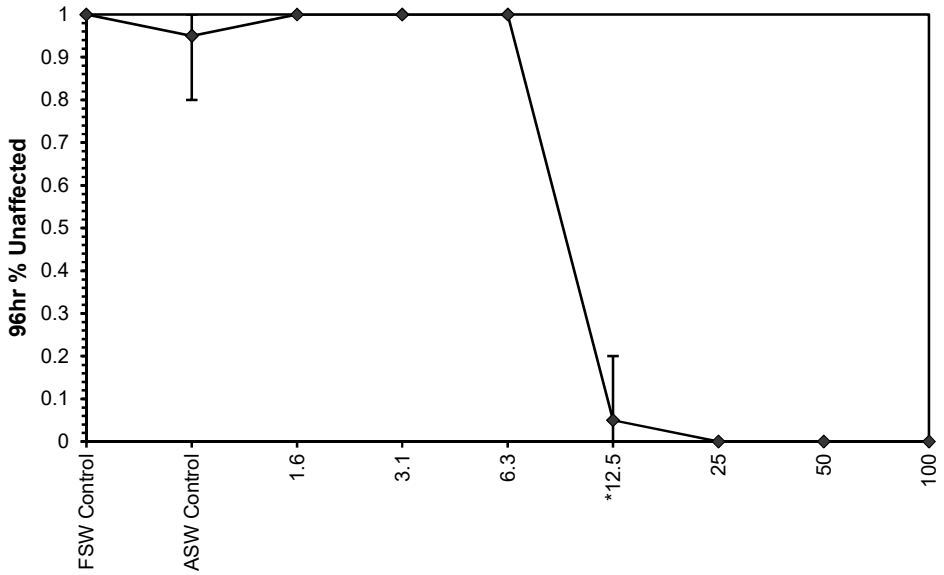
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 9.1892 | 8.5888 | 9.8316 |
| 5.0% | 9.0378 | 8.6976 | 9.3912 |
| 10.0% | 9.0378 | 8.7071 | 9.3809 |
| 20.0% | 9.0378 | 8.7071 | 9.3809 |
| Auto-0.0% | 9.1892 | 8.5888 | 9.8316 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.2000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

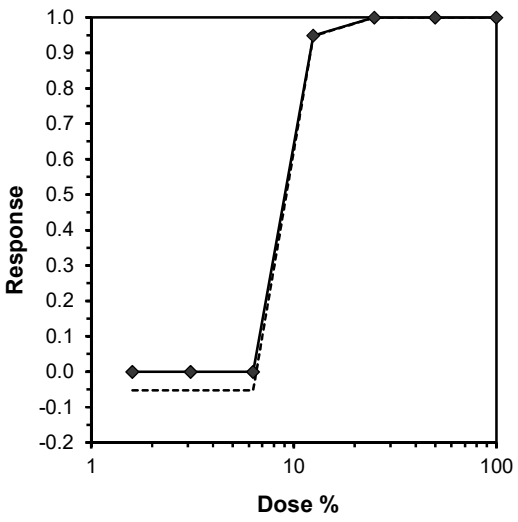
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | * | | 0.9875 | 1.0000 |
| 1.6 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0.9875 | 1.0000 |
| 3.1 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0.9875 | 1.0000 |
| 6.3 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0.9875 | 1.0000 |
| *12.5 | 0.0500 | 0.0526 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 0.0500 | 0.0506 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.811293 | 0.905 | -4.3E-14 | 4.066993 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 0.36) | 1 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

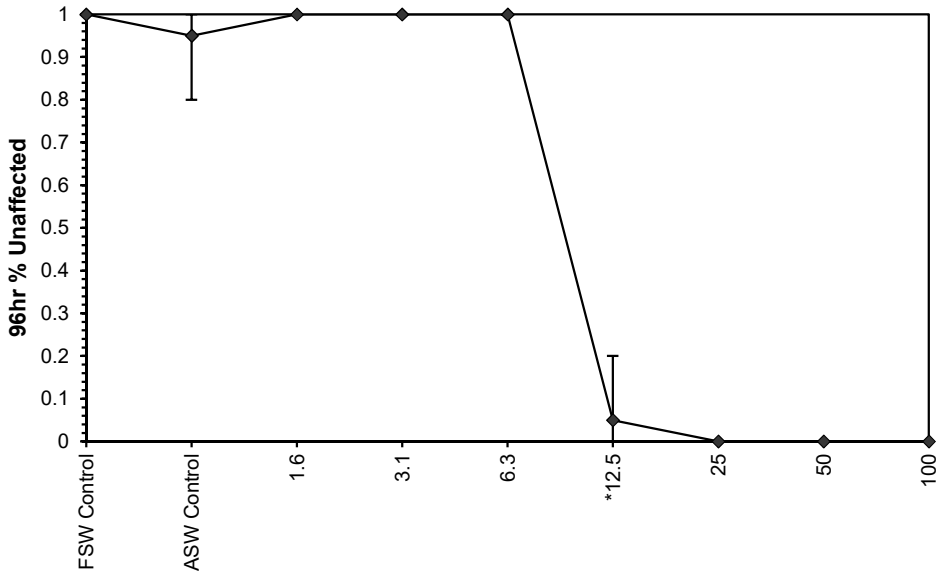
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.3866 | 0.8671 | 6.2975 | 10.3402 | 0.7131 |
| IC10 | 7.8507 | 0.8948 | 6.3541 | 10.7345 | 0.5631 |
| IC15 | 8.1722 | 0.9114 | 6.4007 | 10.9719 | 0.4202 |
| IC20 | 8.4291 | 0.9264 | 6.4397 | 11.1489 | 0.2870 |
| IC25 | 8.6502 | 0.9415 | 6.4736 | 11.2945 | 0.1633 |
| IC40 | 9.2135 | 0.9922 | 6.5588 | 11.6449 | -0.1592 |
| IC50 | 9.5622 | 1.0336 | 6.6092 | 11.8505 | -0.3403 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/102 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 16.994 | 16.560 | 15.260 | 17.210 | 15.585 | 16.452 | 17.969 | 17.102 |
| ASW Control | 15.369 | 14.935 | 16.777 | 15.910 | | | | |
| 1.6 | 16.344 | 17.860 | 15.585 | 16.452 | | | | |
| 3.1 | 8.219 | 11.360 | 10.494 | 12.769 | | | | |
| 6.3 | 0.000 | 1.394 | 0.000 | 3.019 | | | | |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

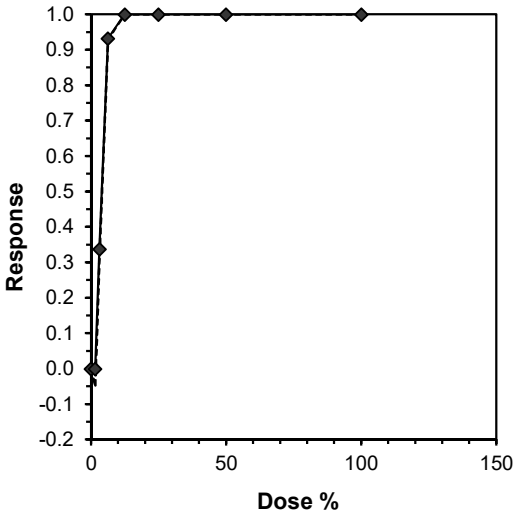
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 16.642 | 1.0568 | 16.642 | 15.260 | 17.969 | 5.320 | 8 | | | | | |
| ASW Control | 15.748 | 1.0000 | 15.748 | 14.935 | 16.777 | 5.040 | 4 | * | | | 16.154 | 1.0000 |
| 1.6 | 16.560 | 1.0516 | 16.560 | 15.585 | 17.860 | 5.728 | 4 | -0.855 | 2.290 | 2.177 | 16.154 | 1.0000 |
| *3.1 | 10.710 | 0.6801 | 10.710 | 8.219 | 12.769 | 17.809 | 4 | 5.299 | 2.290 | 2.177 | 10.710 | 0.6630 |
| *6.3 | 1.103 | 0.0700 | 1.103 | 0.000 | 3.019 | 130.194 | 4 | 15.405 | 2.290 | 2.177 | 1.103 | 0.0683 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.971959 | 0.887 | -0.01546 | 0.029112 |
| Bartlett's Test indicates equal variances (p = 0.49) | 2.424579 | 11.34487 | | |
| The control means are not significantly different (p = 0.12) | 1.699361 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 2.177035 | 0.138244 | 201.9835 | 1.807548 | 4.9E-09 | 3, 12 |

### Linear Interpolation (200 Resamples)

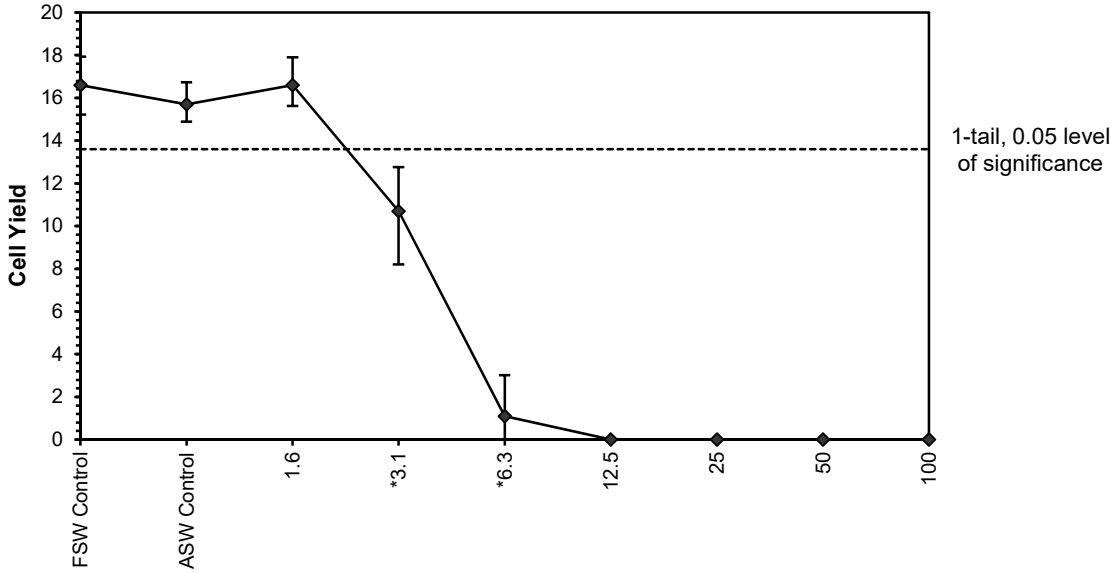
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.8226 | 0.0445 | 1.7147 | 1.9580 | -1.5970 |
| IC10 | 2.0451 | 0.0709 | 1.8906 | 2.3161 | 0.5371 |
| IC15 | 2.2677 | 0.1038 | 2.0359 | 2.6741 | 0.6902 |
| IC20 | 2.4902 | 0.1382 | 2.1812 | 3.0321 | 0.7386 |
| IC25 | 2.7128 | 0.1700 | 2.3266 | 3.3674 | 0.6835 |
| IC40 | 3.4390 | 0.2288 | 2.7656 | 4.0806 | -0.0785 |
| IC50 | 3.9771 | 0.2087 | 3.3138 | 4.5373 | -0.2787 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/102 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Dose-Response Plot



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/102 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 16.64 | 15.26 | 17.97 | 0.89 | 5.65 | 8 |
| ASW Control | | 15.75 | 14.94 | 16.78 | 0.79 | 5.66 | 4 |
| 1.6 | | 16.56 | 15.59 | 17.86 | 0.95 | 5.88 | 4 |
| 3.1 | | 10.71 | 8.22 | 12.77 | 1.91 | 12.89 | 4 |
| 6.3 | | 1.10 | 0.00 | 3.02 | 1.44 | 108.64 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 2 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 1.06 | 2.85 | 2 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/107 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 16:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9300 | 0.9600 | 0.9200 |
| ASW Control | 0.9700 | 0.9000 | 0.9100 | 0.9400 |
| 1.6 | 0.9400 | 0.9600 | 0.9300 | 0.9000 |
| 3.1 | 0.9200 | 0.9500 | 0.9100 | 0.9300 |
| 6.3 | 0.9200 | 0.9500 | 0.9300 | 0.9000 |
| 12.5 | 0.7900 | 0.8600 | 0.9400 | 0.9000 |
| 25 | 0.0300 | 0.0800 | 0.0600 | 0.0200 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9400 | 1.0108 | 1.3254 | 1.2840 | 1.3694 | 2.937 | 4 | | | | | |
| ASW Control | 0.9300 | 1.0000 | 1.3088 | 1.2490 | 1.3967 | 5.094 | 4 | * | | | 28 | 400 |
| 1.6 | 0.9325 | 1.0027 | 1.3112 | 1.2490 | 1.3694 | 3.805 | 4 | -0.055 | 2.410 | 0.1066 | 27 | 400 |
| 3.1 | 0.9275 | 0.9973 | 1.2996 | 1.2661 | 1.3453 | 2.614 | 4 | 0.208 | 2.410 | 0.1066 | 29 | 400 |
| 6.3 | 0.9250 | 0.9946 | 1.2954 | 1.2490 | 1.3453 | 3.096 | 4 | 0.304 | 2.410 | 0.1066 | 30 | 400 |
| 12.5 | 0.8725 | 0.9382 | 1.2136 | 1.0948 | 1.3233 | 7.976 | 4 | 2.153 | 2.410 | 0.1066 | 51 | 400 |
| *25 | 0.0475 | 0.0511 | 0.2126 | 0.1419 | 0.2868 | 31.205 | 4 | 24.790 | 2.410 | 0.1066 | 381 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

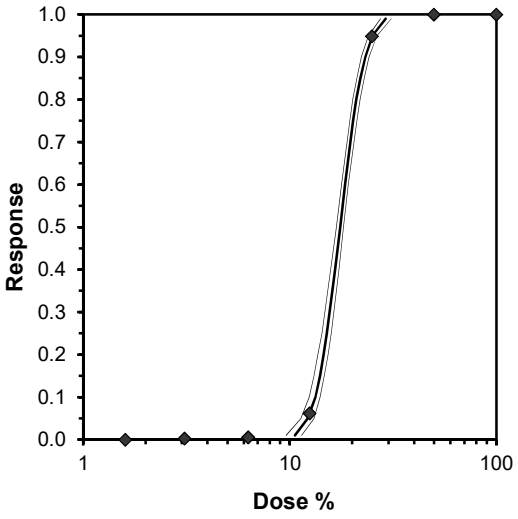
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.990604 | 0.916 | 0.038641 | -0.27548 |
| Bartlett's Test indicates equal variances (p = 0.57) | 3.828166 | 15.08627 | | |
| The control means are not significantly different (p = 0.68) | 0.431366 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 12.5 | 25 | 17.67767 | 8 | 0.062717 | 0.067227 | 0.773125 | 0.003911 | 4.5E-15 | 5, 18 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 10.57689 | 0.637561 | 9.327272 | 11.82651 | 0.07 | 0.179704 | 11.0705 | 1 | 1.243463 | 0.094546 | 5 |
| Intercept | -8.15197 | 0.829675 | -9.77813 | -6.5258 | | | | | | | |
| TSCR | 0.07125 | 0.006431 | 0.058645 | 0.083855 | | | | | | | |

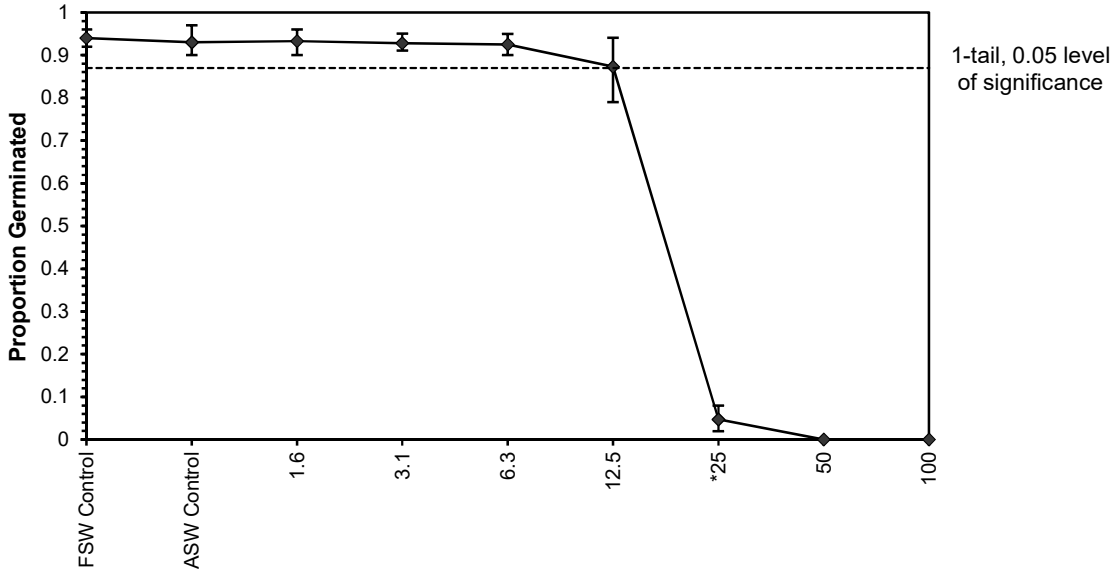
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 10.55641 | 9.597342 | 11.40222 |
| EC05 | 3.355 | 12.24471 | 11.32893 | 13.0509 |
| EC10 | 3.718 | 13.25248 | 12.37001 | 14.03231 |
| EC15 | 3.964 | 13.97887 | 13.12206 | 14.74019 |
| EC20 | 4.158 | 14.58448 | 13.7492 | 15.33156 |
| EC25 | 4.326 | 15.1249 | 14.30833 | 15.86081 |
| EC40 | 4.747 | 16.57714 | 15.80406 | 17.29447 |
| EC50 | 5.000 | 17.51711 | 16.76281 | 18.23531 |
| EC60 | 5.253 | 18.51038 | 17.76405 | 19.24429 |
| EC75 | 5.674 | 20.28769 | 19.51739 | 21.09522 |
| EC80 | 5.842 | 21.03944 | 20.24301 | 21.89683 |
| EC85 | 6.036 | 21.95093 | 21.11037 | 22.88333 |
| EC90 | 6.282 | 23.15409 | 22.23614 | 24.20815 |
| EC95 | 6.645 | 25.05973 | 23.98164 | 26.3519 |
| EC99 | 7.326 | 29.06758 | 27.54548 | 30.9977 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/107 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 16:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/107 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 16:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 94.00 | 92.00 | 96.00 | 1.83 | 1.44 | 4 |
| ASW Control | | 93.00 | 90.00 | 97.00 | 3.16 | 1.91 | 4 |
| 1.6 | | 93.25 | 90.00 | 96.00 | 2.50 | 1.70 | 4 |
| 3.1 | | 92.75 | 91.00 | 95.00 | 1.71 | 1.41 | 4 |
| 6.3 | | 92.50 | 90.00 | 95.00 | 2.08 | 1.56 | 4 |
| 12.5 | | 87.25 | 79.00 | 94.00 | 6.40 | 2.90 | 4 |
| 25 | | 4.75 | 2.00 | 8.00 | 2.75 | 34.94 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 3/10/2019 17:00 | Test ID: | PR1858/101 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | AB-Macquaria novemaculeata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 0.8000 | 1.0000 |
| 3.1 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 0.4000 | 0.4000 | 0.2000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

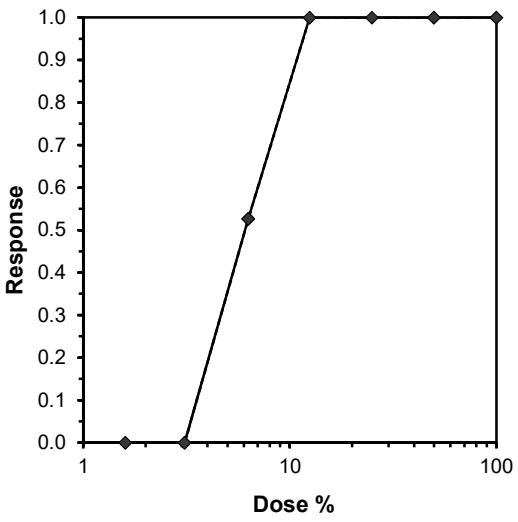
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9000 | 0.9474 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | * | | 1 | 20 |
| 1.6 | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 18.00 | 10.00 | 1 | 20 |
| 3.1 | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 18.00 | 10.00 | 1 | 20 |
| 6.3 | 0.4500 | 0.4737 | 0.7351 | 0.4636 | 1.1071 | 36.604 | 4 | 10.50 | 10.00 | 11 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.835925 | 0.887 | 0.351483 | 1.528959 |
| Bartlett's Test indicates equal variances (p = 0.37) | 3.147714 | 11.34487 | | |
| The control means are not significantly different (p = 0.54) | 0.654654 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

**Trimmed Spearman-Karber**

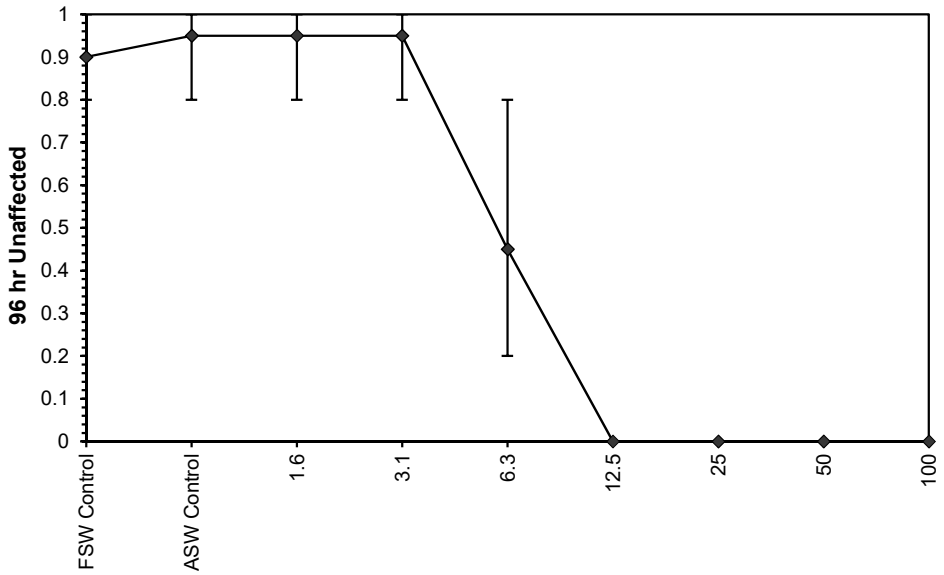
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 6.1485 | 5.2621 | 7.1842 |
| 5.0% | 6.1409 | 5.1663 | 7.2994 |
| 10.0% | 6.1334 | 5.0523 | 7.4458 |
| 20.0% | 6.1183 | 4.7374 | 7.9016 |
| Auto-0.0% | 6.1485 | 5.2621 | 7.1842 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 3/10/2019 17:00 | Test ID: | PR1858/101 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | AB-Macquaria novemaculeata |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 3/10/2019 17:00 | Test ID: | PR1858/101 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | AB-Macquaria novemaculeata |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| ASW Control | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 1.6 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 3.1 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 6.3 | | 45.00 | 20.00 | 80.00 | 25.17 | 11.15 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 3/10/2019 17:00 | Test ID: | PR1858/101 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | AB-Macquaria novemaculeata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 0.8000 | 1.0000 |
| 3.1 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 0.4000 | 0.4000 | 0.2000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

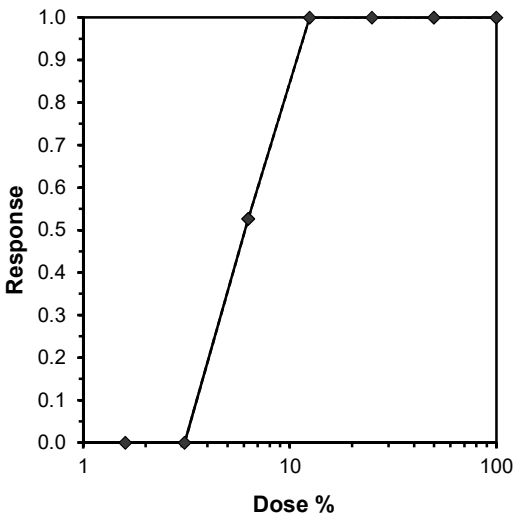
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9000 | 0.9474 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | * | | 0.9500 | 1.0000 |
| 1.6 | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 18.00 | 10.00 | 0.9500 | 1.0000 |
| 3.1 | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 18.00 | 10.00 | 0.9500 | 1.0000 |
| 6.3 | 0.4500 | 0.4737 | 0.7351 | 0.4636 | 1.1071 | 36.604 | 4 | 10.50 | 10.00 | 0.4500 | 0.4737 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.835925 | 0.887 | 0.351483 | 1.528959 |
| Bartlett's Test indicates equal variances (p = 0.37) | 3.147714 | 11.34487 | | |
| The control means are not significantly different (p = 0.54) | 0.654654 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.6781 | 0.9144 | 0.0000 | 5.9060 | -0.6436 |
| IC10 | 4.0815 | 0.6744 | 1.4566 | 6.1294 | -0.4518 |
| IC15 | 4.4090 | 0.5479 | 2.3146 | 6.2321 | 0.4305 |
| IC20 | 4.6953 | 0.5263 | 2.9463 | 6.3223 | 0.3390 |
| IC25 | 4.9572 | 0.5140 | 3.4978 | 6.7261 | 0.4404 |
| IC40 | 5.6817 | 0.4782 | 4.4137 | 6.9915 | 0.1725 |
| IC50 | 6.1665 | 0.4013 | 4.7351 | 7.0016 | -0.3281 |



# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:00 | Test ID: | PR1858/111 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 18:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

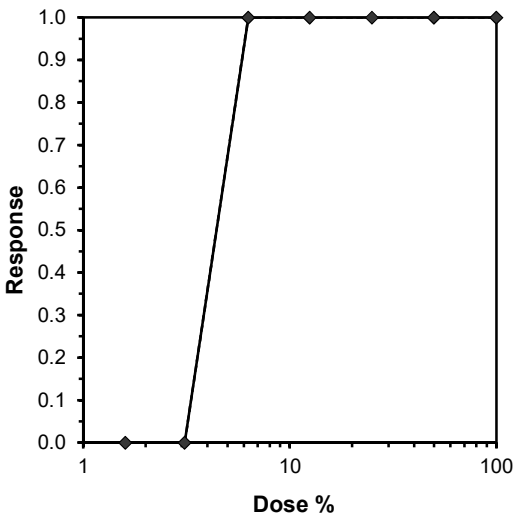
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 1 | 0.859 | | |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

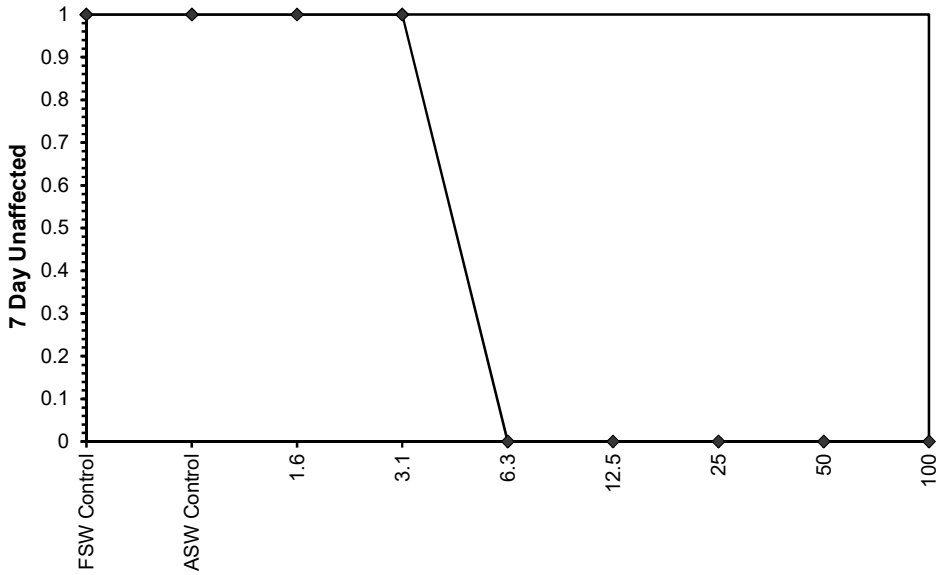
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.9889 | 0.0000 | 3.9889 | 3.9889 | 1.0076 |
| IC10 | 4.1070 | 0.0000 | 4.1070 | 4.1070 | -1.0076 |
| IC15 | 4.1816 | 0.0000 | 4.1816 | 4.1816 | -1.0076 |
| IC20 | 4.2384 | 0.0000 | 4.2384 | 4.2384 | 1.0076 |
| IC25 | 4.2858 | 0.0000 | 4.2858 | 4.2858 | #DIV/0! |
| IC40 | 4.4018 | 0.0000 | 4.4018 | 4.4018 | 1.0076 |
| IC50 | 4.4708 | 0.0000 | 4.4708 | 4.4708 | -1.0076 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:00 | Test ID: | PR1858/111 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 18:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:00 | Test ID: | PR1858/111 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 18:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 16.81 | 15.76 | 18.20 | 1.04 | 6.06 | 4 |
| ASW Control | | 17.64 | 15.98 | 19.98 | 1.76 | 7.52 | 4 |
| 1.6 | | 17.75 | 16.54 | 18.74 | 0.99 | 5.61 | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:00 | Test ID: | PR1858/111 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 18:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | EPAM 94 | Test Species: | MI |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 16.900 | 18.200 | 15.760 | 16.380 |
| ASW Control | 19.980 | 17.940 | 15.980 | 16.660 |
| 1.6 | 18.740 | 17.360 | 16.540 | 18.340 |
| 3.1 | 17.820 | 15.880 | 16.080 | 15.980 |
| 6.3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

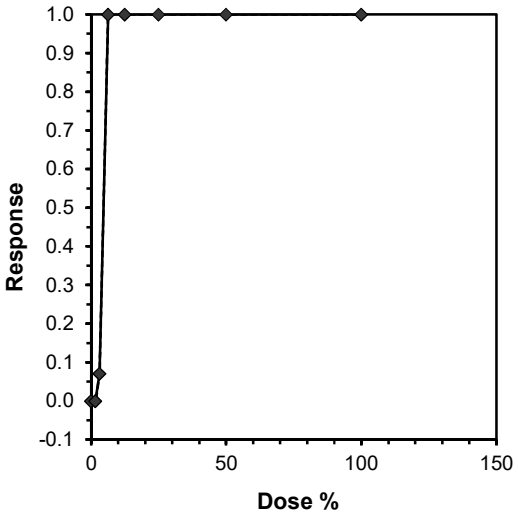
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 16.810 | 0.9529 | 16.810 | 15.760 | 18.200 | 6.170 | 4 | | | | | |
| ASW Control | 17.640 | 1.0000 | 17.640 | 15.980 | 19.980 | 9.971 | 4 | * | | | 17.693 | 1.0000 |
| 1.6 | 17.745 | 1.0060 | 17.745 | 16.540 | 18.740 | 5.583 | 4 | -0.116 | 2.180 | 1.976 | 17.693 | 1.0000 |
| 3.1 | 16.440 | 0.9320 | 16.440 | 15.880 | 17.820 | 5.618 | 4 | 1.324 | 2.180 | 1.976 | 16.440 | 0.9292 |
| 6.3 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.959799 | 0.859 | 0.631592 | -0.06225 |
| Bartlett's Test indicates equal variances (p = 0.50) | 1.404235 | 9.21034 | | |
| The control means are not significantly different (p = 0.45) | 0.812931 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 1.975752 | 0.112004 | 2.1027 | 1.642789 | 0.324187 | 2, 9 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.6594 | 0.6349 | 0.0000 | 3.5814 | -0.6979 |
| IC10 | 3.2006 | 0.3678 | 0.9839 | 3.5147 | -2.2527 |
| IC15 | 3.3728 | 0.1343 | 2.7574 | 3.6695 | -1.2580 |
| IC20 | 3.5450 | 0.1103 | 3.1021 | 3.8242 | -0.3437 |
| IC25 | 3.7172 | 0.1034 | 3.3019 | 3.9789 | -0.3437 |
| IC40 | 4.2337 | 0.0827 | 3.9016 | 4.4431 | -0.3437 |
| IC50 | 4.5781 | 0.0690 | 4.3013 | 4.7526 | -0.3437 |



# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report- Round 3

**October 2019**

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ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR1858/17 (Page 1 of 2)

Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 9 October 2019 |
| | | **Date Received:** | 10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9*, salinity 18.5 ‰*, total ammonia 31.4 mg/L*. Sample received at 14ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 10 October 2019 at 1010h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control: 94.5 ± 1.3 | | |
| ASW Control: 92.3 ± 2.6 | | |
| 1.6: 94.8 ± 1.7 | | |
| 3.1: 95.3 ± 1.7 | | |
| 6.3: 35.3 ± 8.5 * | | |
| 12.5: 0.0 ± 0.0 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **IC10 = 3.9 (3.77-4.07)%** | | |
| **EC50 = 5.7 (5.55-5.94)%** | | |
| **NOEC = 3.1%** | | |
| **LOEC = 6.3%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/17 (Page 2 of 2)

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 94.5% | Yes |
| Reference Toxicant within cusum chart limits | 48.7-66.5µg Cu/L | 56.2µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR1858/18



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9*, salinity 18.5 ‰*, total ammonia 31.4 mg/L *. Sample received at 14ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 10 October 2019 at 1030h |

| Sample 9262*: A1-5327*<br>**Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 95.3 ± 2.2 | | |
| ASW Control | 96.0 ± 1.8 | | |
| 1.6 | 95.8 ± 1.7 | | |
| 3.1 | 95.8 ± 2.2 | | |
| 6.3 | 95.5 ± 2.4 | | |
| 12.5 | 62.5 ± 9.0 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 = 8.8 (7.73-9.70)%**<br>**72-hr EC50 = 13.9 (13.41-14.34)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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ABN 95 619 426 201

# Toxicity Test Report: TR1858/18



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 95.3% | Yes |
| Reference Toxicant within cusum chart limits | 10.4-12.3µg Cu/L | 11.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.



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# Toxicity Test Report: TR1858/19 (Page 1 of 2)

Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 9 October 2019 |
| | | **Date Received:** | 10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9*, salinity 18.5 ‰*, total ammonia 31.4 mg/L *. Sample received at 14ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | The test was extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 10 October 2019 at 1230 h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control: 76.8 ± 3.3 | | |
| ASW Control: 74.3 ± 3.0 | | |
| 1.6: 79.3 ± 3.4 | | |
| 3.1: 78.0 ± 2.6 | | |
| 6.3: 77.5 ± 2.7 | | |
| 12.5: 37.0 ± 9.4 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr EC10 =7.4 (6.85-7.80)%**<br>**72-hr EC50 =12.3 (11.93-12.78)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/19 (Page 2 of 2)

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 76.8% | Yes |
| Reference Toxicant within cusum chart limits | 7.6-14.7µg Cu/L | 10.4µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.

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# Toxicity Test Report: TR1820/20



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 9 October 2019 |
| | | **Date Received:** | 10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 22 October 2019 at 1530h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 100 ± 0.0 | | |
| 12.5: 65.0 ± 10.0 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 11.1 (10.8-11.6)%** | | |
| **96-hr EC50 = 13.9 (12.0-16.1)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.6-9.0mg SDS/L | 3.1mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

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# Toxicity Test Report: TR1820/20



**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

# Toxicity Test Report: TR1858/21



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 9 October 2019 |
| | | **Date Received:** | 10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 22 October 2019 at 1430h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | | |
| FSW Control: 15.9 ± 0.9 | | |
| ASW Control: 15.0 ± 1.1 | | |
| 1.6: 16.2 ± 0.7 | | |
| 3.1: 15.5 ± 1.6 | | |
| 6.3: 16.1 ± 0.8 | | |
| 12.5: 14.1 ± 1.2 | | |
| 25: 2.2 ± 2.3 * | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr IC10 = 12.3 (8.33-13.88)%** | | |
| **72-hr IC50 = 19.0 (17.46-21.01)%** | | |
| **NOEC = 12.5%** | | |
| **LOEC = 25%** | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 16.9x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 5.5% | Yes |
| Reference Toxicant within cusum chart limits | 3.2-9.2µg Cu/L | 5.2µg Cu/L | Yes |

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Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR1858/22



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 10 October 2019 at 1330h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control — 97.3 ± 1.0 | | |
| ASW Control — 97.0 ± 2.5 | | |
| 1.6 — 97.3 ± 1.0 | | |
| 3.1 — 96.5 ± 1.3 | | |
| 6.3 — 98.3 ± 1.7 | | |
| 12.5 — 88.8 ± 5.4 * | | |
| 25 — 5.5 ± 3.4 * | | |
| 50 — 0.0 ± 0.0 | | |
| 100 — 0.0 ± 0.0 | | |
| **72-hr EC10 = 12.7 (10.17-13.86)%** | | |
| **72-hr EC50 = 17.3 (16.88-17.75)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/22



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 97.3% | Yes |
| Reference Toxicant within cusum chart limits | 118.5-257.9µg Cu/L | 184.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR1858/23



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using the Barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2016), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample |
| **Source of Test Organisms:** | In-house cultures |
| **Test Initiated:** | 22 October 2019 at 1430h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 65.0 ± 19.2 * | | |
| 12.5: 5.0 ± 10.0 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 4.8 (3.26-5.76)%** | | |
| **96-hr EC50 = 7.2 (6.09-8.58)%** | | |
| **NOEC =3.1%** | | |
| **LOEC = 6.3%** | | |

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 10.7-117.39µg Cu/L | 36.5µg Cu/L | Yes |

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Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 12. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR1858/24



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Age of Test Organisms:** | - |
| **Test Initiated:** | 22 October 2019 at 1430h |

Sample 9262: *A1-5327*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.6 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 95.0 ± 10.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (unaffected) = 6.6 (5.72-9.21)%**
**7 day IC50 (unaffected) = 8.6 (8.01-9.17)%**
**NOEC = 6.3%**
**LOEC = 12.5%**

Sample 9262: *A1-5327*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** | |
|---|---|---|
| FSW Control | 23.1 ± 0.8 | |
| ASW Control | 22.6 ± 0.7 | |
| 1.6 | 23.4 ± 2.0 | |
| 3.1 | 20.6 ± 0.6 | |
| 6.3 | 18.7 ± 1.9 | * |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day IC10 (biomass) = 3.1 (2.40-5.92)%**
**7 day IC50 (biomass) = 8.7 (8.08-9.12) %**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower fish biomass compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/24



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 17.1% | No* |
| Reference Toxicant within cusum chart limits | 10.7-117.4mg $NH_4^+$/L | 36.5mg $NH_4^+$/L | Yes |

*fish available for testing at 22 October were older and at a relatively lower growth phase than with younger fish

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Chain-of-Custody Documentation

Datasheet ID: 601.2

Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Peter Young

**Client** : AECOM Australia Pty Ltd
Level 6, 3 Forrest Place
Perth WA 6849

**Email** : peter.young@aecom.com
**Telephone** : 08 6208 0000
**Facsimile** :

**Date** : 10/10/2019

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR1858 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 10/10/2019
**Time samples received** : 8:30
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 11-15°C

**Comments** : 4 x 2.5L sample received at 14oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

ecotox SERVICES AUSTRALIA

Customer: Beach Energy
Contact Name: Adrian Cukrowski
Phone:
Email: Adrian.cukrowski@beachenergy (please provide an email address for sample receipt notification)
Sampled by: Rob McFadyen

Ship To: Ecotox Services Aust
Attention: Ruth Kirkham

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | | | | | | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 96 h Algal toxicity test 96 h Bass FIT | 72 h Nitzschia 72 h Ictalurus | 48 h Mysid 1 h Sperm motility test | 72 h Sperm cell density | 7 d FIT & Growth | Sediment - Sampling for Freezing | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 18558 |
| 9-10-19 | 0600 | Yolla-A, A1-5327 | Grab | 4 x 2 5L | / | / | / | / | / | / | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

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0262

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| | 9-10-19 | | 10/10/19 | | | | |
| Of: | Time: | Of: ESA | Time: 0830 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9700 | 0.9500 | 0.9400 | 0.9800 |
| 1.6 | 0.9400 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9300 | 0.9700 | 0.9500 | 0.9800 |
| 6.3 | 0.9700 | 0.9800 | 0.9400 | 0.9300 |
| 12.5 | 0.7600 | 0.5900 | 0.5700 | 0.5800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

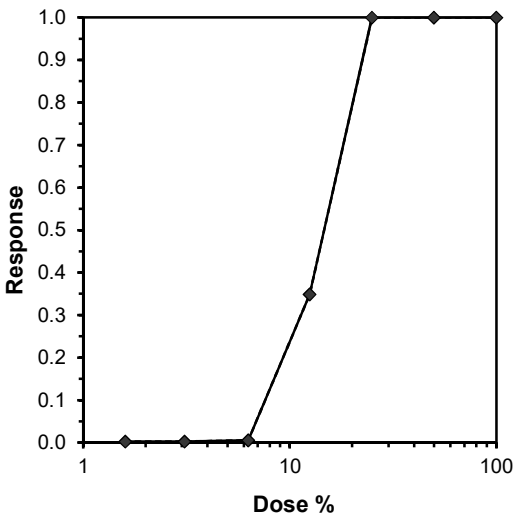
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3736 | 1.3233 | 1.4289 | 3.497 | 4 | * | | 16 | 400 |
| 1.6 | 0.9575 | 0.9974 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | 17.50 | 10.00 | 17 | 400 |
| 3.1 | 0.9575 | 0.9974 | 1.3685 | 1.3030 | 1.4289 | 4.062 | 4 | 17.50 | 10.00 | 17 | 400 |
| 6.3 | 0.9550 | 0.9948 | 1.3630 | 1.3030 | 1.4289 | 4.371 | 4 | 16.50 | 10.00 | 18 | 400 |
| *12.5 | 0.6250 | 0.6510 | 0.9140 | 0.8556 | 1.0588 | 10.600 | 4 | 10.00 | 10.00 | 150 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89649 | 0.905 | 0.91037 | 0.373947 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.205322 | 13.2767 | | |
| The control means are not significantly different (p = 0.65) | 0.471764 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Trimmed Spearman-Karber

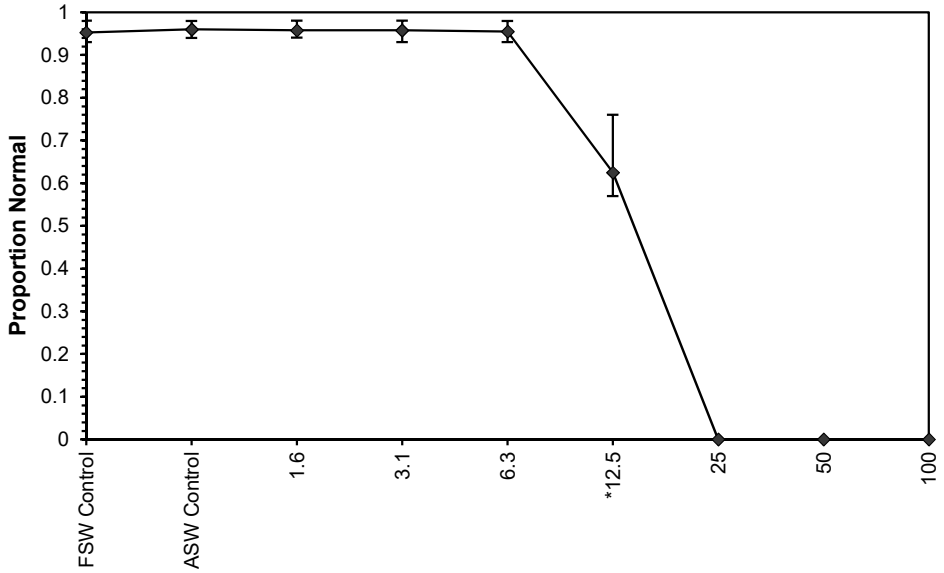
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 14.019 | 13.513 | 14.544 |
| 10.0% | 14.162 | 13.577 | 14.772 |
| 20.0% | 14.431 | 13.578 | 15.337 |
| Auto-0.3% | 13.869 | 13.412 | 14.340 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.25 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| ASW Control | | 96.00 | 94.00 | 98.00 | 1.83 | 1.41 | 4 |
| 1.6 | | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 3.1 | | 95.75 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| 6.3 | | 95.50 | 93.00 | 98.00 | 2.38 | 1.62 | 4 |
| 12.5 | | 62.50 | 57.00 | 76.00 | 9.04 | 4.81 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.60 | 97.60 | 97.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9700 | 0.9500 | 0.9400 | 0.9800 |
| 1.6 | 0.9400 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9300 | 0.9700 | 0.9500 | 0.9800 |
| 6.3 | 0.9700 | 0.9800 | 0.9400 | 0.9300 |
| 12.5 | 0.7600 | 0.5900 | 0.5700 | 0.5800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

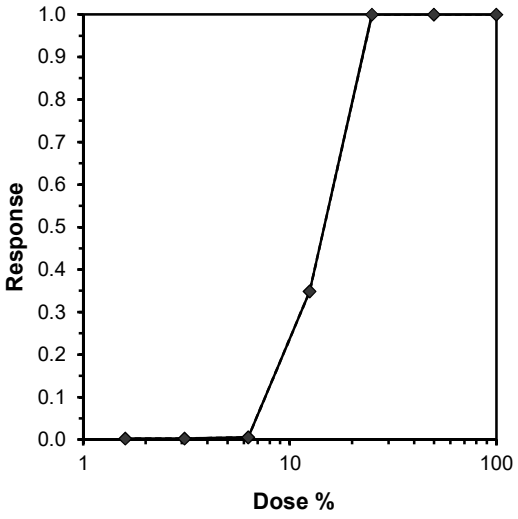
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3736 | 1.3233 | 1.4289 | 3.497 | 4 | * | | 0.9600 | 1.0000 |
| 1.6 | 0.9575 | 0.9974 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | 17.50 | 10.00 | 0.9575 | 0.9974 |
| 3.1 | 0.9575 | 0.9974 | 1.3685 | 1.3030 | 1.4289 | 4.062 | 4 | 17.50 | 10.00 | 0.9575 | 0.9974 |
| 6.3 | 0.9550 | 0.9948 | 1.3630 | 1.3030 | 1.4289 | 4.371 | 4 | 16.50 | 10.00 | 0.9550 | 0.9948 |
| *12.5 | 0.6250 | 0.6510 | 0.9140 | 0.8556 | 1.0588 | 10.600 | 4 | 10.00 | 10.00 | 0.6250 | 0.6510 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89649 | 0.905 | 0.91037 | 0.373947 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.205322 | 13.2767 | | |
| The control means are not significantly different (p = 0.65) | 0.471764 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.680 | 0.296 | 6.557 | 8.225 | -0.3105 |
| IC10 | 8.770 | 0.313 | 7.728 | 9.704 | 0.4079 |
| IC15 | 9.657 | 0.370 | 8.645 | 10.965 | 1.0192 |
| IC20 | 10.437 | 0.446 | 9.415 | 12.083 | 1.3913 |
| IC25 | 11.157 | 0.488 | 10.100 | 13.220 | 1.0515 |
| IC40 | 12.687 | 0.168 | 12.281 | 13.279 | 0.7576 |
| IC50 | 13.049 | 0.160 | 12.724 | 13.631 | 0.8966 |



# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9700 | 0.9500 | 0.9400 | 0.9800 |
| 1.6 | 0.9400 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9300 | 0.9700 | 0.9500 | 0.9800 |
| 6.3 | 0.9700 | 0.9800 | 0.9400 | 0.9300 |
| 12.5 | 0.7600 | 0.5900 | 0.5700 | 0.5800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

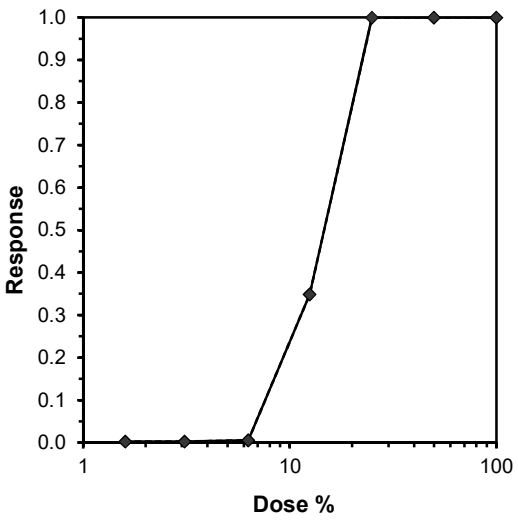
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3736 | 1.3233 | 1.4289 | 3.497 | 4 | * | | 16 | 400 |
| 1.6 | 0.9575 | 0.9974 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | 17.50 | 10.00 | 17 | 400 |
| 3.1 | 0.9575 | 0.9974 | 1.3685 | 1.3030 | 1.4289 | 4.062 | 4 | 17.50 | 10.00 | 17 | 400 |
| 6.3 | 0.9550 | 0.9948 | 1.3630 | 1.3030 | 1.4289 | 4.371 | 4 | 16.50 | 10.00 | 18 | 400 |
| *12.5 | 0.6250 | 0.6510 | 0.9140 | 0.8556 | 1.0588 | 10.600 | 4 | 10.00 | 10.00 | 150 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89649 | 0.905 | 0.91037 | 0.373947 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.205322 | 13.2767 | | |
| The control means are not significantly different (p = 0.65) | 0.471764 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Trimmed Spearman-Karber

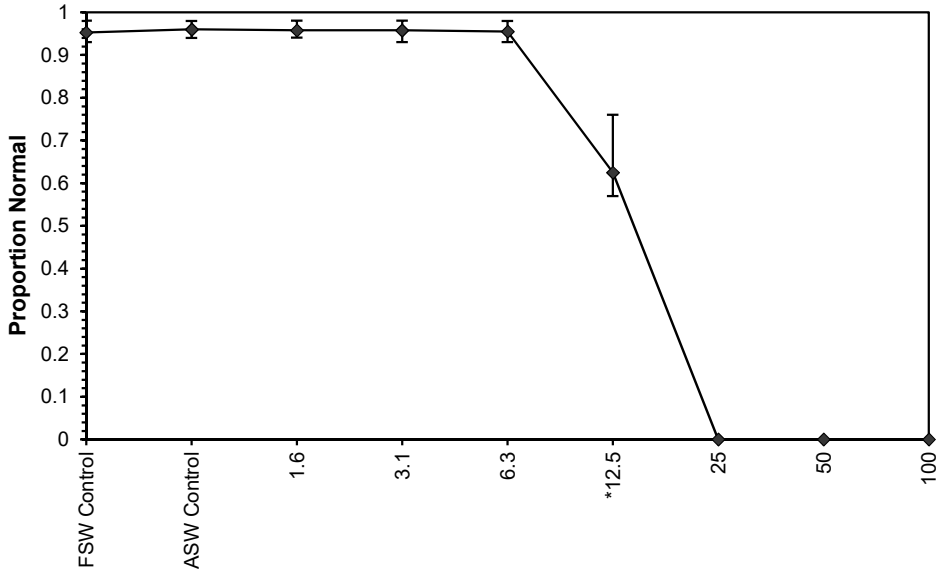
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 14.019 | 13.513 | 14.544 |
| 10.0% | 14.162 | 13.577 | 14.772 |
| 20.0% | 14.431 | 13.578 | 15.337 |
| Auto-0.3% | 13.869 | 13.412 | 14.340 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

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|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
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| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.25 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| ASW Control | | 96.00 | 94.00 | 98.00 | 1.83 | 1.41 | 4 |
| 1.6 | | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 3.1 | | 95.75 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| 6.3 | | 95.50 | 93.00 | 98.00 | 2.38 | 1.62 | 4 |
| 12.5 | | 62.50 | 57.00 | 76.00 | 9.04 | 4.81 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.60 | 97.60 | 97.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9700 | 0.9500 | 0.9400 | 0.9800 |
| 1.6 | 0.9400 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9300 | 0.9700 | 0.9500 | 0.9800 |
| 6.3 | 0.9700 | 0.9800 | 0.9400 | 0.9300 |
| 12.5 | 0.7600 | 0.5900 | 0.5700 | 0.5800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

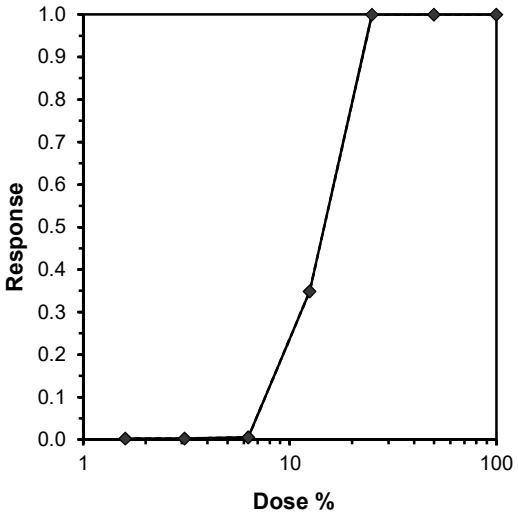
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3736 | 1.3233 | 1.4289 | 3.497 | 4 | * | | 0.9600 | 1.0000 |
| 1.6 | 0.9575 | 0.9974 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | 17.50 | 10.00 | 0.9575 | 0.9974 |
| 3.1 | 0.9575 | 0.9974 | 1.3685 | 1.3030 | 1.4289 | 4.062 | 4 | 17.50 | 10.00 | 0.9575 | 0.9974 |
| 6.3 | 0.9550 | 0.9948 | 1.3630 | 1.3030 | 1.4289 | 4.371 | 4 | 16.50 | 10.00 | 0.9550 | 0.9948 |
| *12.5 | 0.6250 | 0.6510 | 0.9140 | 0.8556 | 1.0588 | 10.600 | 4 | 10.00 | 10.00 | 0.6250 | 0.6510 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89649 | 0.905 | 0.91037 | 0.373947 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.205322 | 13.2767 | | |
| The control means are not significantly different (p = 0.65) | 0.471764 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.680 | 0.296 | 6.557 | 8.225 | -0.3105 |
| IC10 | 8.770 | 0.313 | 7.728 | 9.704 | 0.4079 |
| IC15 | 9.657 | 0.370 | 8.645 | 10.965 | 1.0192 |
| IC20 | 10.437 | 0.446 | 9.415 | 12.083 | 1.3913 |
| IC25 | 11.157 | 0.488 | 10.100 | 13.220 | 1.0515 |
| IC40 | 12.687 | 0.168 | 12.281 | 13.279 | 0.7576 |
| IC50 | 13.049 | 0.160 | 12.724 | 13.631 | 0.8966 |



# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 12:30 | Test ID: | PR1858/06 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 12:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7600 | 0.8100 | 0.7700 | 0.7300 |
| ASW Control | 0.7100 | 0.7300 | 0.7800 | 0.7500 |
| 1.6 | 0.7800 | 0.8400 | 0.7900 | 0.7600 |
| 3.1 | 0.7500 | 0.8100 | 0.7900 | 0.7700 |
| 6.3 | 0.7800 | 0.7600 | 0.7500 | 0.8100 |
| 12.5 | 0.2700 | 0.3100 | 0.4600 | 0.4400 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

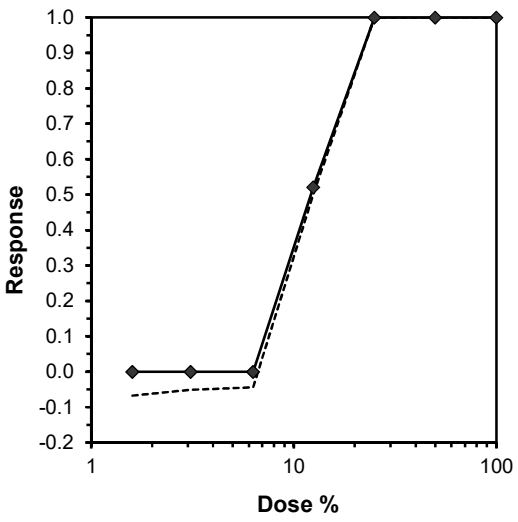
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7675 | 1.0337 | 1.0684 | 1.0244 | 1.1198 | 3.694 | 4 | | | | | |
| ASW Control | 0.7425 | 1.0000 | 1.0391 | 1.0021 | 1.0826 | 3.306 | 4 | * | | | 103 | 400 |
| 1.6 | 0.7925 | 1.0673 | 1.0989 | 1.0588 | 1.1593 | 3.909 | 4 | -1.559 | 2.360 | 0.0905 | 83 | 400 |
| 3.1 | 0.7800 | 1.0505 | 1.0831 | 1.0472 | 1.1198 | 2.883 | 4 | -1.148 | 2.360 | 0.0905 | 88 | 400 |
| 6.3 | 0.7750 | 1.0438 | 1.0771 | 1.0472 | 1.1198 | 2.974 | 4 | -0.992 | 2.360 | 0.0905 | 90 | 400 |
| *12.5 | 0.3700 | 0.4983 | 0.6519 | 0.5464 | 0.7454 | 15.086 | 4 | 10.100 | 2.360 | 0.0905 | 252 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.979874 | 0.905 | 0.018979 | 0.115837 |
| Bartlett's Test indicates equal variances (p = 0.18) | 6.202708 | 13.2767 | | |
| The control means are not significantly different (p = 0.31) | 1.120964 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.082617 | 0.111203 | 0.144838 | 0.00294 | 1.9E-08 | 4, 15 |

### Trimmed Spearman-Karber

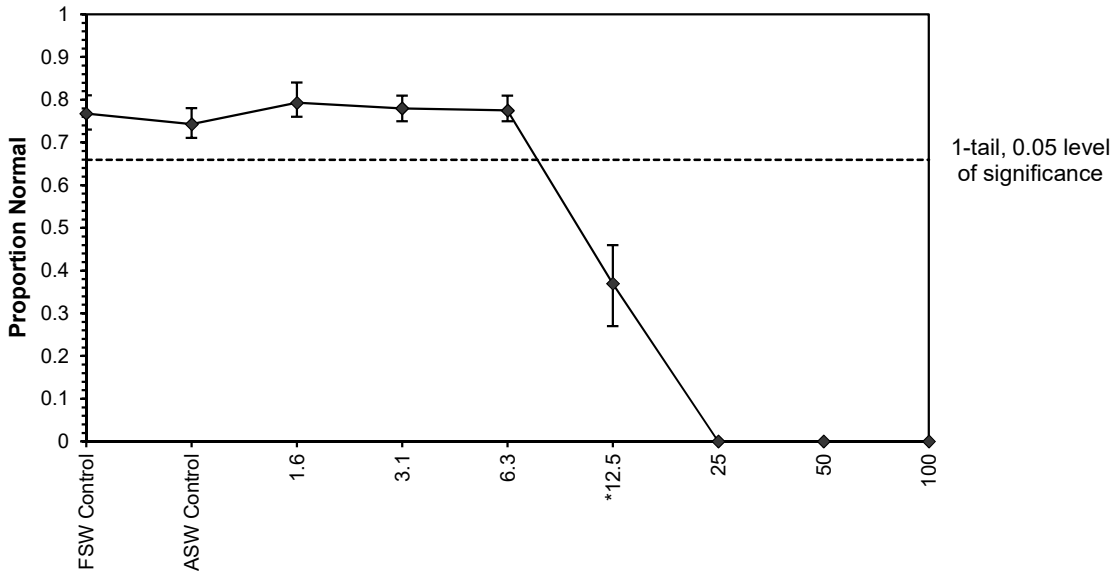
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 12.345 | 11.927 | 12.777 |
| 5.0% | 12.324 | 11.862 | 12.804 |
| 10.0% | 12.304 | 11.788 | 12.843 |
| 20.0% | 12.264 | 11.589 | 12.977 |
| Auto-0.0% | 12.345 | 11.927 | 12.777 |



**Bivalve Acute Toxicity Tests-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 12:30 | Test ID: | PR1858/06 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 12:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 12:30 | Test ID: | PR1858/06 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 12:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 76.75 | 73.00 | 81.00 | 3.30 | 2.37 | 4 |
| ASW Control | | 74.25 | 71.00 | 78.00 | 2.99 | 2.33 | 4 |
| 1.6 | | 79.25 | 76.00 | 84.00 | 3.40 | 2.33 | 4 |
| 3.1 | | 78.00 | 75.00 | 81.00 | 2.58 | 2.06 | 4 |
| 6.3 | | 77.50 | 75.00 | 81.00 | 2.65 | 2.10 | 4 |
| 12.5 | | 37.00 | 27.00 | 46.00 | 9.42 | 8.29 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.60 | 97.60 | 97.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 12:30 | Test ID: | PR1858/06 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 12:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7600 | 0.8100 | 0.7700 | 0.7300 |
| ASW Control | 0.7100 | 0.7300 | 0.7800 | 0.7500 |
| 1.6 | 0.7800 | 0.8400 | 0.7900 | 0.7600 |
| 3.1 | 0.7500 | 0.8100 | 0.7900 | 0.7700 |
| 6.3 | 0.7800 | 0.7600 | 0.7500 | 0.8100 |
| 12.5 | 0.2700 | 0.3100 | 0.4600 | 0.4400 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

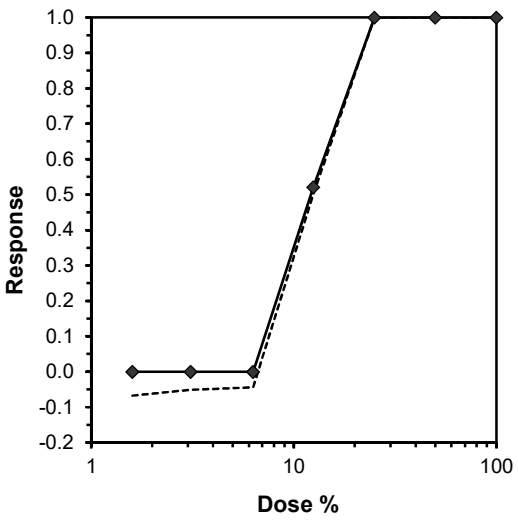
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7675 | 1.0337 | 1.0684 | 1.0244 | 1.1198 | 3.694 | 4 | | | | | |
| ASW Control | 0.7425 | 1.0000 | 1.0391 | 1.0021 | 1.0826 | 3.306 | 4 | * | | | 0.7725 | 1.0000 |
| 1.6 | 0.7925 | 1.0673 | 1.0989 | 1.0588 | 1.1593 | 3.909 | 4 | -1.559 | 2.360 | 0.0905 | 0.7725 | 1.0000 |
| 3.1 | 0.7800 | 1.0505 | 1.0831 | 1.0472 | 1.1198 | 2.883 | 4 | -1.148 | 2.360 | 0.0905 | 0.7725 | 1.0000 |
| 6.3 | 0.7750 | 1.0438 | 1.0771 | 1.0472 | 1.1198 | 2.974 | 4 | -0.992 | 2.360 | 0.0905 | 0.7725 | 1.0000 |
| *12.5 | 0.3700 | 0.4983 | 0.6519 | 0.5464 | 0.7454 | 15.086 | 4 | 10.100 | 2.360 | 0.0905 | 0.3700 | 0.4790 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.979874 | 0.905 | 0.018979 | 0.115837 |
| Bartlett's Test indicates equal variances (p = 0.18) | 6.202708 | 13.2767 | | |
| The control means are not significantly different (p = 0.31) | 1.120964 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.082617 | 0.111203 | 0.144838 | 0.00294 | 1.9E-08 | 4, 15 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.852 | 0.101 | 6.358 | 7.035 | -0.5888 |
| IC10 | 7.392 | 0.137 | 6.852 | 7.803 | 0.1359 |
| IC15 | 7.927 | 0.190 | 7.255 | 8.596 | 0.4035 |
| IC20 | 8.465 | 0.254 | 7.675 | 9.405 | 0.5073 |
| IC25 | 9.014 | 0.325 | 8.071 | 10.231 | 0.5609 |
| IC40 | 10.792 | 0.587 | 9.285 | 13.051 | 0.6458 |
| IC50 | 12.177 | 0.545 | 10.209 | 13.116 | -0.4472 |



# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 15:30 | Test ID: | PR1858/10 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 15:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.6000 | 0.8000 | 0.6000 | 0.6000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

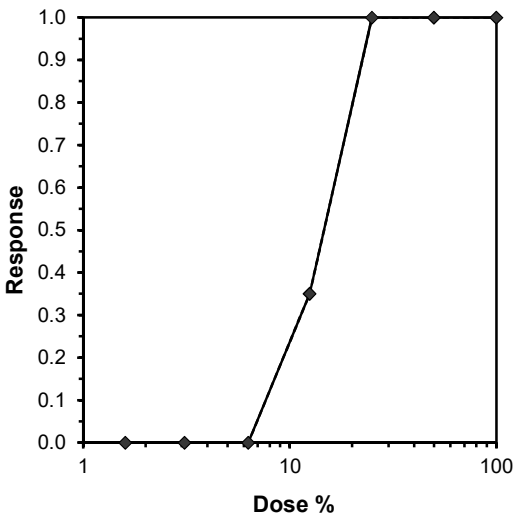
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *12.5 | 0.6500 | 0.6500 | 0.9413 | 0.8861 | 1.1071 | 11.742 | 4 | 10.00 | 10.00 | 7 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.508902 | 0.905 | 2.796235 | 11.6732 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

**Trimmed Spearman-Karber**

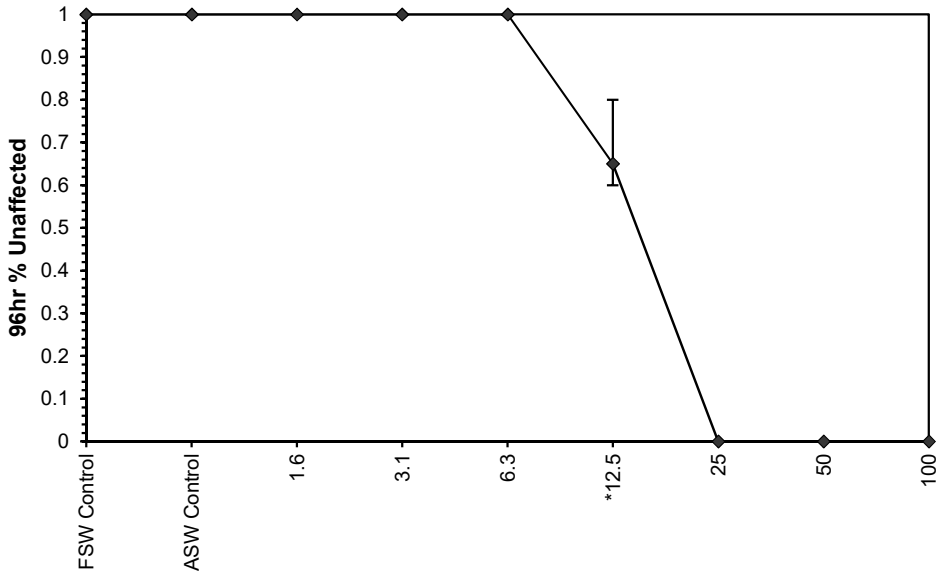
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 13.889 | 11.990 | 16.088 |
| 5.0% | 14.029 | 11.901 | 16.537 |
| 10.0% | 14.166 | 11.726 | 17.114 |
| 20.0% | 14.425 | 10.978 | 18.955 |
| Auto-0.0% | 13.889 | 11.990 | 16.088 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 15:30 | Test ID: | PR1858/10 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 15:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 15:30 | Test ID: | PR1858/10 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 15:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 65.00 | 60.00 | 80.00 | 10.00 | 4.87 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 94.20 | 94.20 | 94.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| 25 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 50 | | 84.10 | 84.10 | 84.10 | 0.00 | 0.00 | 1 |
| 100 | | 79.30 | 79.30 | 79.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 25 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 50 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 15:30 | Test ID: | PR1858/10 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 15:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.6000 | 0.8000 | 0.6000 | 0.6000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

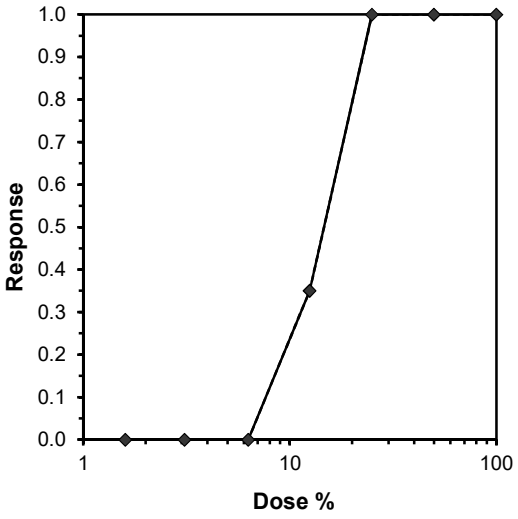
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *12.5 | 0.6500 | 0.6500 | 0.9413 | 0.8861 | 1.1071 | 11.742 | 4 | 10.00 | 10.00 | 0.6500 | 0.6500 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.508902 | 0.905 | 2.796235 | 11.6732 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 10.430 | 0.113 | 10.233 | 10.922 | 0.6357 |
| IC10 | 11.058 | 0.133 | 10.825 | 11.639 | 0.6380 |
| IC15 | 11.464 | 0.147 | 11.207 | 12.105 | 0.6395 |
| IC20 | 11.779 | 0.158 | 11.503 | 12.467 | 0.6406 |
| IC25 | 12.045 | 0.167 | 11.753 | 12.773 | 0.6416 |
| IC40 | 12.694 | 0.166 | 12.384 | 13.357 | 0.4839 |
| IC50 | 13.069 | 0.163 | 12.764 | 13.721 | 0.4830 |



# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/11 | Sample ID: | A1-5327 |
| End Date: | 25/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 16.763 | 15.563 | 16.863 | 14.463 | 15.963 | 14.863 | 16.363 | 16.263 |
| ASW Control | 14.763 | 13.563 | 15.763 | 15.763 | | | | |
| 1.6 | 16.563 | 15.363 | 16.863 | 15.963 | | | | |
| 3.1 | 16.263 | 14.763 | 13.663 | 17.163 | | | | |
| 6.3 | 16.563 | 16.863 | 14.963 | 15.863 | | | | |
| 12.5 | 13.463 | 13.963 | 13.063 | 15.763 | | | | |
| 25 | 5.463 | 0.163 | 0.903 | 2.063 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

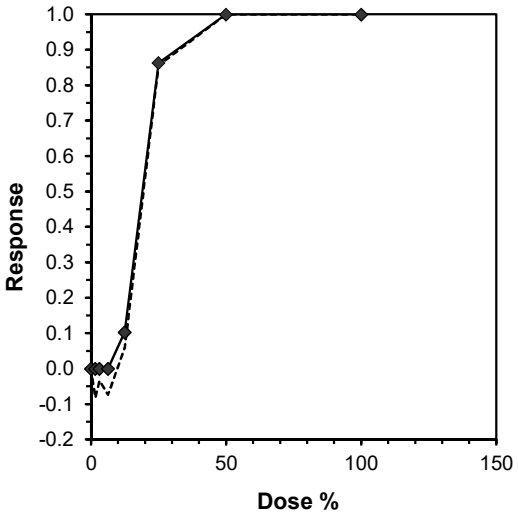
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 15.888 | 1.0618 | 15.888 | 14.463 | 16.863 | 5.464 | 8 | | | | | |
| ASW Control | 14.963 | 1.0000 | 14.963 | 13.563 | 15.763 | 6.988 | 4 | * | | | 15.669 | 1.0000 |
| 1.6 | 16.188 | 1.0819 | 16.188 | 15.363 | 16.863 | 4.109 | 4 | -1.247 | 2.410 | 2.368 | 15.669 | 1.0000 |
| 3.1 | 15.463 | 1.0334 | 15.463 | 13.663 | 17.163 | 10.061 | 4 | -0.509 | 2.410 | 2.368 | 15.669 | 1.0000 |
| 6.3 | 16.063 | 1.0735 | 16.063 | 14.963 | 16.863 | 5.258 | 4 | -1.120 | 2.410 | 2.368 | 15.669 | 1.0000 |
| 12.5 | 14.063 | 0.9399 | 14.063 | 13.063 | 15.763 | 8.474 | 4 | 0.916 | 2.410 | 2.368 | 14.063 | 0.8975 |
| *25 | 2.148 | 0.1435 | 2.148 | 0.163 | 5.463 | 109.152 | 4 | 13.043 | 2.410 | 2.368 | 2.148 | 0.1371 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.958622 | 0.916 | 0.688967 | 0.89182 |
| Bartlett's Test indicates equal variances (p = 0.36) | 5.505599 | 15.08627 | | |
| The control means are not significantly different (p = 0.13) | 1.633112 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 12.5 | 25 | 17.67767 | 8 | 2.367933 | 0.158256 | 118.5836 | 1.930789 | 1.1E-10 | 5, 18 |

### Linear Interpolation (200 Resamples)

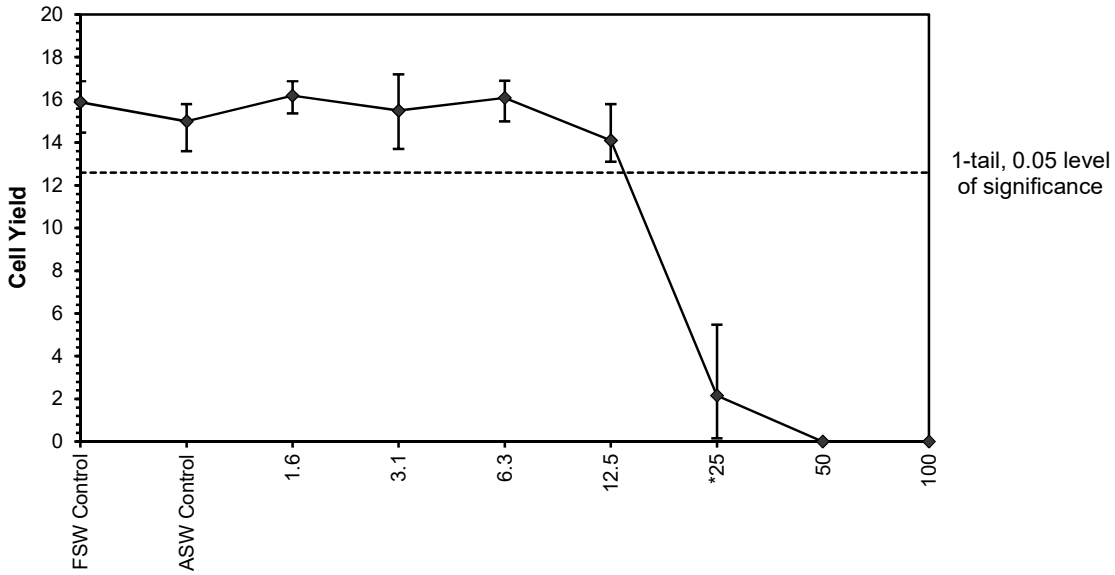
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 9.324 | 1.595 | 4.966 | 14.219 | -0.7465 |
| IC10 | 12.348 | 1.105 | 8.325 | 13.878 | -0.2383 |
| IC15 | 13.281 | 0.566 | 11.506 | 14.673 | -0.0083 |
| IC20 | 14.103 | 0.510 | 12.737 | 15.539 | 0.5533 |
| IC25 | 14.924 | 0.505 | 13.615 | 16.409 | 0.6795 |
| IC40 | 17.390 | 0.565 | 15.933 | 18.952 | 0.7747 |
| IC50 | 19.034 | 0.654 | 17.457 | 21.013 | 0.7583 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/11 | Sample ID: | A1-5327 |
| End Date: | 25/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Dose-Response Plot



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/11 | Sample ID: | A1-5327 |
| End Date: | 25/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 15.89 | 14.46 | 16.86 | 0.87 | 5.86 | 8 |
| ASW Control | | 14.96 | 13.56 | 15.76 | 1.05 | 6.83 | 4 |
| 1.6 | | 16.19 | 15.36 | 16.86 | 0.67 | 5.04 | 4 |
| 3.1 | | 15.46 | 13.66 | 17.16 | 1.56 | 8.07 | 4 |
| 6.3 | | 16.06 | 14.96 | 16.86 | 0.84 | 5.72 | 4 |
| 12.5 | | 14.06 | 13.06 | 15.76 | 1.19 | 7.76 | 4 |
| 25 | | 2.15 | 0.16 | 5.46 | 2.34 | 71.29 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 25 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 50 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 13:30 | Test ID: | PR1858/07 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 13:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9700 | 0.9800 |
| ASW Control | 0.9400 | 0.9900 | 0.9600 | 0.9900 |
| 1.6 | 0.9800 | 0.9600 | 0.9800 | 0.9700 |
| 3.1 | 0.9600 | 0.9800 | 0.9500 | 0.9700 |
| 6.3 | 0.9900 | 0.9600 | 1.0000 | 0.9800 |
| 12.5 | 0.8100 | 0.9300 | 0.8900 | 0.9200 |
| 25 | 0.0400 | 0.0600 | 0.1000 | 0.0200 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

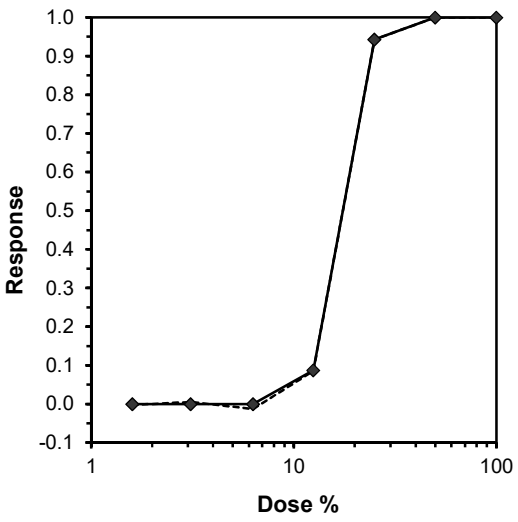
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9725 | 1.0026 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | | | | | |
| ASW Control | 0.9700 | 1.0000 | 1.4085 | 1.3233 | 1.4706 | 5.265 | 4 | * | | | 12 | 400 |
| 1.6 | 0.9725 | 1.0026 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | 0.056 | 2.410 | 0.1084 | 11 | 400 |
| 3.1 | 0.9650 | 0.9948 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | 0.521 | 2.410 | 0.1084 | 14 | 400 |
| 6.3 | 0.9825 | 1.0129 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | -0.866 | 2.410 | 0.1084 | 7 | 400 |
| *12.5 | 0.8875 | 0.9149 | 1.2349 | 1.1198 | 1.3030 | 6.664 | 4 | 3.861 | 2.410 | 0.1084 | 45 | 400 |
| *25 | 0.0550 | 0.0567 | 0.2281 | 0.1419 | 0.3218 | 33.281 | 4 | 26.248 | 2.410 | 0.1084 | 378 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.968111 | 0.916 | -0.31998 | -0.64273 |
| Bartlett's Test indicates equal variances (p = 0.54) | 4.080333 | 15.08627 | | |
| The control means are not significantly different (p = 0.95) | 0.063348 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.045383 | 0.0466 | 0.900647 | 0.004045 | 1.6E-15 | 5, 18 |

### Trimmed Spearman-Karber

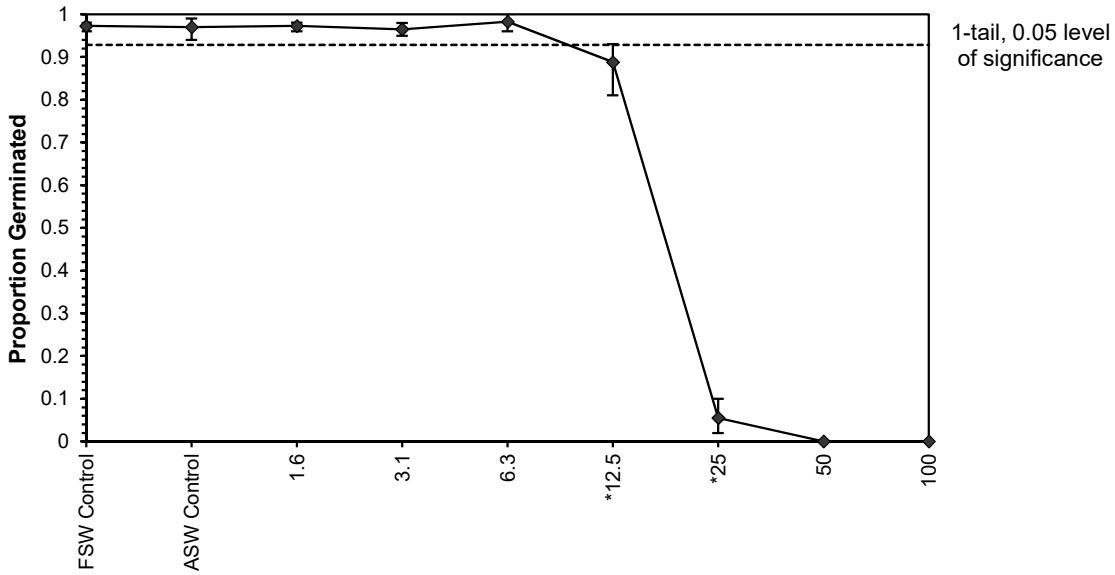
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 17.310 | 16.879 | 17.752 |
| 5.0% | 17.368 | 17.005 | 17.738 |
| 10.0% | 17.458 | 17.200 | 17.720 |
| 20.0% | 17.458 | 17.200 | 17.720 |
| Auto-0.0% | 17.310 | 16.879 | 17.752 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 13:30 | Test ID: | PR1858/07 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 13:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 13:30 | Test ID: | PR1858/07 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 13:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Germination, % | 97.25 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| ASW Control | | 97.00 | 94.00 | 99.00 | 2.45 | 1.61 | 4 |
| 1.6 | | 97.25 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| 3.1 | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 6.3 | | 98.25 | 96.00 | 100.00 | 1.71 | 1.33 | 4 |
| 12.5 | | 88.75 | 81.00 | 93.00 | 5.44 | 2.63 | 4 |
| 25 | | 5.50 | 2.00 | 10.00 | 3.42 | 33.60 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.60 | 97.60 | 97.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 13:30 | Test ID: | PR1858/07 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 13:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9700 | 0.9800 |
| ASW Control | 0.9400 | 0.9900 | 0.9600 | 0.9900 |
| 1.6 | 0.9800 | 0.9600 | 0.9800 | 0.9700 |
| 3.1 | 0.9600 | 0.9800 | 0.9500 | 0.9700 |
| 6.3 | 0.9900 | 0.9600 | 1.0000 | 0.9800 |
| 12.5 | 0.8100 | 0.9300 | 0.8900 | 0.9200 |
| 25 | 0.0400 | 0.0600 | 0.1000 | 0.0200 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

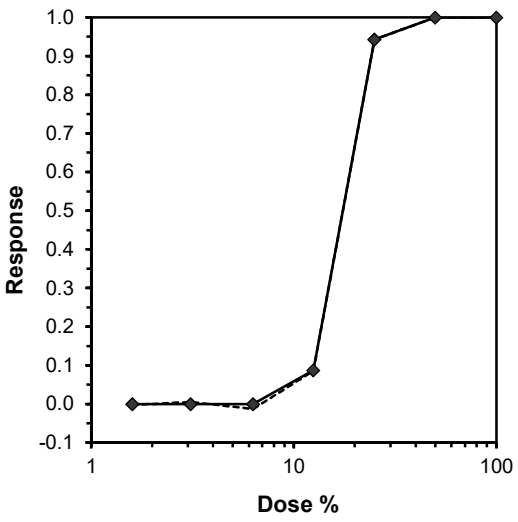
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9725 | 1.0026 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | | | | | |
| ASW Control | 0.9700 | 1.0000 | 1.4085 | 1.3233 | 1.4706 | 5.265 | 4 | * | | | 0.9725 | 1.0000 |
| 1.6 | 0.9725 | 1.0026 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | 0.056 | 2.410 | 0.1084 | 0.9725 | 1.0000 |
| 3.1 | 0.9650 | 0.9948 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | 0.521 | 2.410 | 0.1084 | 0.9725 | 1.0000 |
| 6.3 | 0.9825 | 1.0129 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | -0.866 | 2.410 | 0.1084 | 0.9725 | 1.0000 |
| *12.5 | 0.8875 | 0.9149 | 1.2349 | 1.1198 | 1.3030 | 6.664 | 4 | 3.861 | 2.410 | 0.1084 | 0.8875 | 0.9126 |
| *25 | 0.0550 | 0.0567 | 0.2281 | 0.1419 | 0.3218 | 33.281 | 4 | 26.248 | 2.410 | 0.1084 | 0.0550 | 0.0566 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.968111 | 0.916 | -0.31998 | -0.64273 |
| Bartlett's Test indicates equal variances (p = 0.54) | 4.080333 | 15.08627 | | |
| The control means are not significantly different (p = 0.95) | 0.063348 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.045383 | 0.0466 | 0.900647 | 0.004045 | 1.6E-15 | 5, 18 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 10.315 | 0.942 | 8.232 | 13.852 | 0.6791 |
| IC10 | 12.713 | 0.646 | 10.172 | 13.857 | -0.5679 |
| IC15 | 13.439 | 0.429 | 12.141 | 14.574 | -0.0023 |
| IC20 | 14.045 | 0.418 | 12.790 | 15.220 | 0.0216 |
| IC25 | 14.581 | 0.411 | 13.300 | 15.724 | 0.0335 |
| IC40 | 16.004 | 0.408 | 14.639 | 17.152 | 0.0041 |
| IC50 | 16.918 | 0.421 | 15.586 | 18.171 | -0.0635 |



# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 16:00 | Test ID: | PR1858/14 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 14:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.6000 | 0.4000 | 0.8000 | 0.8000 |
| 12.5 | 0.2000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *6.3 | 0.6500 | 0.6500 | 0.9463 | 0.6847 | 1.1071 | 21.467 | 4 | 10.00 | 10.00 | 7 | 20 |
| *12.5 | 0.0500 | 0.0500 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 19 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

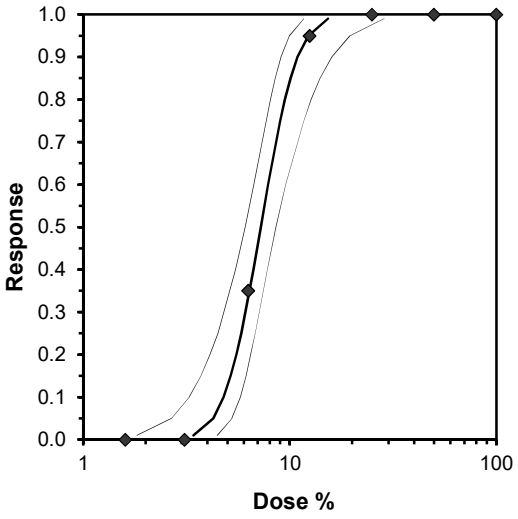
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.772021 | 0.905 | -0.337 | 3.142347 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 7.171209 | 1.622143 | 3.991809 | 10.35061 | 0 | 0.124313 | 11.0705 | 1 | 0.858989 | 0.139447 | 4 |
| Intercept | -1.15999 | 1.415627 | -3.93462 | 1.614642 | | | | | | | |
| TSCR | | | | | | | | | | | |

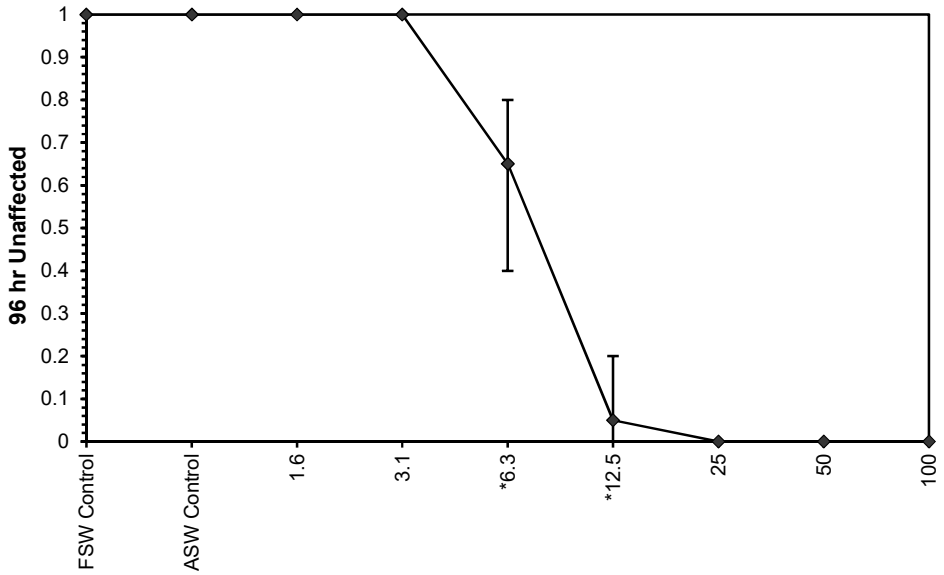
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 3.424425 | 1.823373 | 4.459235 |
| EC05 | 3.355 | 4.262061 | 2.668168 | 5.253962 |
| EC10 | 3.718 | 4.789397 | 3.255165 | 5.757561 |
| EC15 | 3.964 | 5.181574 | 3.711936 | 6.141831 |
| EC20 | 4.158 | 5.516042 | 4.110225 | 6.481224 |
| EC25 | 4.326 | 5.820141 | 4.475316 | 6.80322 |
| EC40 | 4.747 | 6.662855 | 5.467963 | 7.796544 |
| EC50 | 5.000 | 7.22751 | 6.086886 | 8.575823 |
| EC60 | 5.253 | 7.840019 | 6.697982 | 9.542679 |
| EC75 | 5.674 | 8.975196 | 7.679833 | 11.65338 |
| EC80 | 5.842 | 9.469998 | 8.062462 | 12.68679 |
| EC85 | 6.036 | 10.08128 | 8.508998 | 14.04641 |
| EC90 | 6.282 | 10.90678 | 9.077873 | 16.01571 |
| EC95 | 6.645 | 12.25626 | 9.949011 | 19.53719 |
| EC99 | 7.326 | 15.25421 | 11.72327 | 28.58626 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 16:00 | Test ID: | PR1858/14 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 14:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 16:00 | Test ID: | PR1858/14 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 14:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 65.00 | 40.00 | 80.00 | 19.15 | 6.73 | 4 |
| 12.5 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 25 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 50 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 94.20 | 94.20 | 94.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| 25 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 50 | | 84.10 | 84.10 | 84.10 | 0.00 | 0.00 | 1 |
| 100 | | 79.30 | 79.30 | 79.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

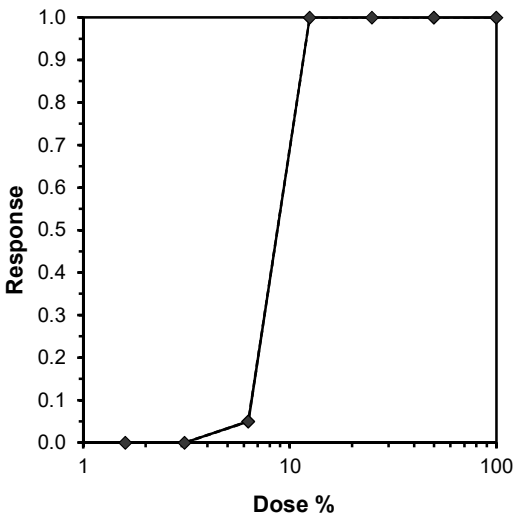
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 1 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.564851 | 0.887 | -2.55551 | 9.368132 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

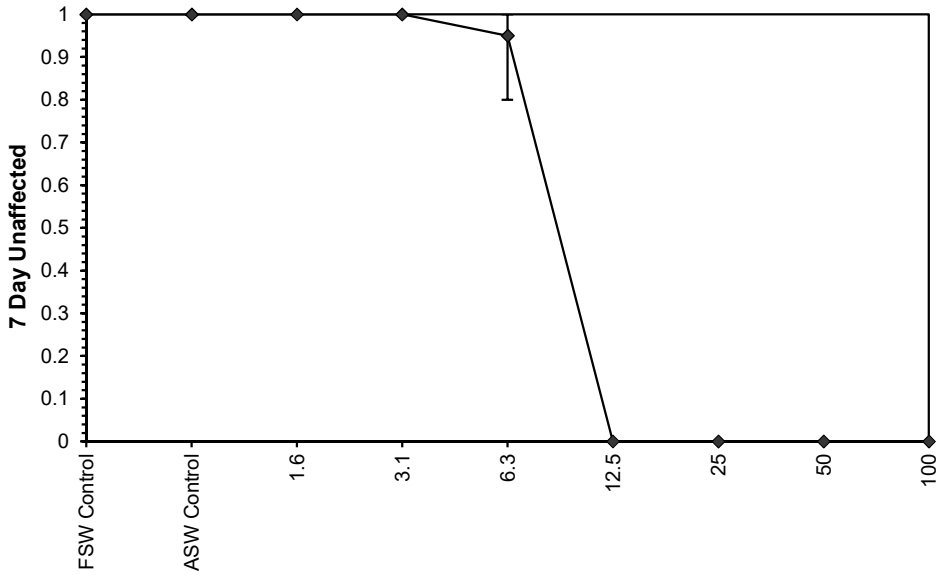
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 8.5701 | 8.0071 | 9.1727 |
| 5.0% | 8.7155 | 8.3990 | 9.0440 |
| 10.0% | 8.7155 | 8.3990 | 9.0440 |
| 20.0% | 8.7155 | 8.3990 | 9.0440 |
| Auto-0.0% | 8.5701 | 8.0071 | 9.1727 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Dose-Response Plot



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 23.06 | 22.16 | 24.14 | 0.82 | 3.92 | 4 |
| ASW Control | | 22.62 | 21.74 | 23.26 | 0.70 | 3.69 | 4 |
| 1.6 | | 23.38 | 21.24 | 26.14 | 2.04 | 6.10 | 4 |
| 3.1 | | 20.64 | 20.12 | 21.56 | 0.63 | 3.85 | 4 |
| 6.3 | | 18.72 | 16.02 | 19.94 | 1.86 | 7.28 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 25 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 50 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 94.20 | 94.20 | 94.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| 25 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 50 | | 84.10 | 84.10 | 84.10 | 0.00 | 0.00 | 1 |
| 100 | | 79.30 | 79.30 | 79.30 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

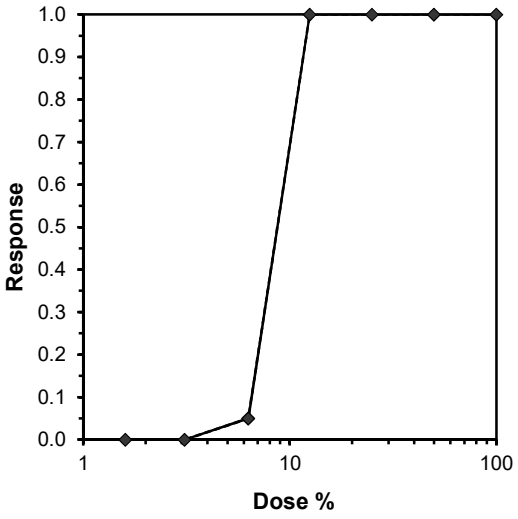
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 0.9500 | 0.9500 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.564851 | 0.887 | -2.55551 | 9.368132 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.3000 | 0.9048 | 5.2589 | 9.0169 | 0.6816 |
| IC10 | 6.5812 | 0.8405 | 5.7217 | 9.2117 | 0.7437 |
| IC15 | 6.7607 | 0.8178 | 6.0236 | 9.3337 | 0.7586 |
| IC20 | 6.8986 | 0.8037 | 6.1716 | 9.4262 | 0.7579 |
| IC25 | 7.0144 | 0.7916 | 6.2962 | 9.5031 | 0.7574 |
| IC40 | 7.3004 | 0.7606 | 6.6052 | 9.6898 | 0.7560 |
| IC50 | 7.4724 | 0.7414 | 6.7920 | 9.8001 | 0.7552 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 24.140 | 23.000 | 22.940 | 22.160 |
| ASW Control | 23.080 | 23.260 | 21.740 | 22.380 |
| 1.6 | 26.140 | 22.940 | 23.180 | 21.240 |
| 3.1 | 20.120 | 21.560 | 20.460 | 20.420 |
| 6.3 | 16.020 | 18.960 | 19.940 | 19.940 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

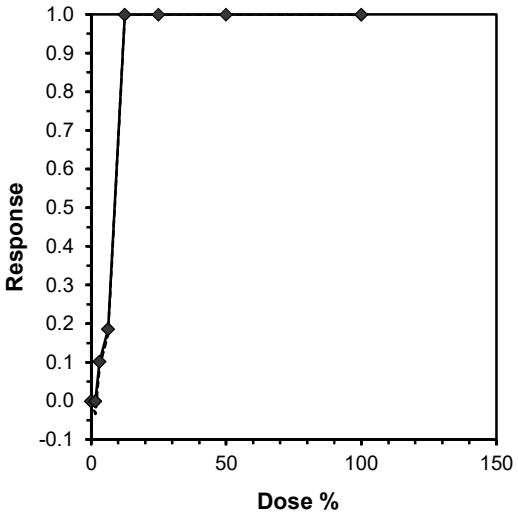
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 23.060 | 1.0197 | 23.060 | 22.160 | 24.140 | 3.536 | 4 | | | | | |
| ASW Control | 22.615 | 1.0000 | 22.615 | 21.740 | 23.260 | 3.077 | 4 | * | | | 22.995 | 1.0000 |
| 1.6 | 23.375 | 1.0336 | 23.375 | 21.240 | 26.140 | 8.708 | 4 | -0.739 | 2.290 | 2.356 | 22.995 | 1.0000 |
| 3.1 | 20.640 | 0.9127 | 20.640 | 20.120 | 21.560 | 3.061 | 4 | 1.920 | 2.290 | 2.356 | 20.640 | 0.8976 |
| *6.3 | 18.715 | 0.8275 | 18.715 | 16.020 | 19.940 | 9.912 | 4 | 3.791 | 2.290 | 2.356 | 18.715 | 0.8139 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.956336 | 0.887 | -0.14716 | 1.088529 |
| Bartlett's Test indicates equal variances (p = 0.16) | 5.23149 | 11.34487 | | |
| The control means are not significantly different (p = 0.44) | 0.83023 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 2.356109 | 0.104183 | 17.52989 | 2.117142 | 0.002973 | 3, 12 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.3323 | 0.1792 | 1.8219 | 2.8954 | 0.3291 |
| IC10 | 3.0646 | 0.5357 | 2.4006 | 5.9172 | 1.6593 |
| IC15 | 4.9190 | 0.9476 | 2.4558 | 7.4254 | 0.0603 |
| IC20 | 6.4057 | 0.5624 | 3.8844 | 7.0995 | -1.1757 |
| IC25 | 6.7866 | 0.3070 | 5.6365 | 7.4370 | -1.1526 |
| IC40 | 7.9293 | 0.2191 | 7.1906 | 8.4496 | -0.5149 |
| IC50 | 8.6910 | 0.1826 | 8.0755 | 9.1247 | -0.5149 |



# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report

**February-March 2021**

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ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR1978/1



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>16 February 2021<br>17 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9939 | Y0160221 | Aqueous sample, pH 6.1*, salinity 16.9‰*, total ammonia 24.4mg/L*. Sample received at 8ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 18 February 2021 at 1620hr |

| Sample 9939*: Y0160221* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control | 94.0 ± 2.2 | | |
| ASW Control | 91.5 ± 1.3 | | |
| 1.6 | 93.3 ± 1.7 | | |
| 3.1 | 93.3 ± 1.7 | | |
| 6.3 | 73.8 ± 9.2 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **IC10 = 4.8 (4.22-6.35)%** | | | |
| **EC50 = 7.7 (7.48-7.92)%** | | | |
| **NOEC =3.1 %** | | | |
| **LOEC = 6.3%** | | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/1



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 94.0% | Yes |
| Reference Toxicant within cusum chart limits | 54.0-59.9µg Cu/L | 56.4µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR1978/2



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>16 February 2021<br>17 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9939 | Y0160221 | Aqueous sample, pH 6.1*, salinity 16.9‰*, total ammonia 24.4mg/L*. Sample received at 8ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| 18 February 2021 at 1620hr | 18 February 2021 at 1530hr |

| Sample 9939*: Y0160221* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control 96.8 ± 1.5 | | |
| ASW Control 96.5 ± 1.3 | | |
| 1.6 96.8 ± 1.5 | | |
| 3.1 97.3 ± 2.2 | | |
| 6.3 96.8 ± 1.0 | | |
| 12.5 8.0 ± 2.5 * | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr EC10 = 7.5 (7.25-7.67)%**<br>**72-hr EC50 = 9.4 (9.21-9.57)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/2



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 96.8% | Yes |
| Reference Toxicant within cusum chart limits | 10.6-12.0µg Cu/L | 11.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR1978/3



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>16 February 2021<br>17 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9939 | Y0160221 | Aqueous sample, pH 6.1*, salinity 16.9‰*, total ammonia 24.4mg/L*. Sample received at 8ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 18 February 2021 at 1620hr |

| Sample 9939*: Y0160221* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control: 70.8 ± 2.4 | | |
| ASW Control: 72.0 ± 5.0 | | |
| 1.6: 70.3 ± 2.2 | | |
| 3.1: 71.0 ± 2.2 | | |
| 6.3: 70.3 ± 2.9 | | |
| 12.5: 0.0 ± 0.0 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **48-hr IC10 = 6.4 (6.26-6.46)%**<br>**48-hr EC50 = 8.8 (8.68-8.89)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/3



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 70.8% | Yes |
| Reference Toxicant within cusum chart limits | 7.6-14.2µg Cu/L | 11.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.



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# Toxicity Test Report: TR1978/4



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>16 February 2021<br>17 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9939 | Y0160221 | Aqueous sample, pH 6.1, salinity 16.9‰, total ammonia 24.4mg/L. Sample received at 8ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 18 February 2021 at 1620hr |

| Sample 9939*: Y0160221* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control — 96.8 ± 1.0 | | |
| ASW Control — 98.3 ± 1.7 | | |
| 1.6 — 95.5 ± 2.1 | | |
| 3.1 — 97.3 ± 1.7 | | |
| 6.3 — 96.5 ± 1.3 | | |
| 12.5 — 82.5 ± 3.1 * | | |
| 25 — 25.5 ± 7.2 * | | |
| 50 — 0.0 ± 0.0 | | |
| 100 — 0.0 ± 0.0 | | |
| **72-hr EC10 = 11.6 (10.76-12.40)%** | | |
| **72-hr EC50 = 19.1 (18.28-19.87)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/4



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 96.8% | Yes |
| Reference Toxicant within cusum chart limits | 100.3-811.8µg Cu/L | 182.0µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

NATA WORLD RECOGNISED ACCREDITATION

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# Toxicity Test Report: TR1978/5



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>16 February 2021<br>17 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9939 | Y0160221 | Aqueous sample, pH 6.1, salinity 16.9‰, total ammonia 24.4mg/L. Sample received at 8ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 18 February 2021 at 1400hr |

| Sample 9939*: Y0160221* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 90.0 ± 11.6 | | |
| 12.5: 40.0 ± 16.3 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr EC10 = 6.6 (4.50-8.10)%** | | |
| **96-hr EC50 = 10.8 (9.01-12.99)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/5



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.8-9.0mg SDS/L | 4.1mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR1978/6



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>16 February 2021<br>17 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9939 | Y0160221 | Aqueous sample, pH 6.1, salinity 16.9‰, total ammonia 24.4mg/L. Sample received at 8ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 18 February 2021 at 1830hr |

Sample 9939*: Y0160221*

| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** |
|---|---|
| FSW Control | 14.9 ± 1.0 |
| ASW Control | 14.4 ± 0.7 |
| 1.6 | 15.8 ± 1.0 |
| 3.1 | 14.8 ± 0.8 |
| 6.3 | 15.4 ± 0.8 |
| 12.5 | 6.8 ± 1.4 * |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**72-hr IC10 = 7.4 (6.79-7.72)%**
**72-hr IC50 = 11.9 (10.93-14.23)%**
**NOEC = 6.3%**
**LOEC = 12.5%**

*Vacant*

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/6



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean cell density | ≥16.0x10$^4$ cells/mL | 15.9x10$^4$ cells/mL* | Yes |
| Control coefficient of variation | <20% | 6.6% | Yes |
| Reference Toxicant within cusum chart limits | 3.8-8.7µg Cu/L | 6.0µg Cu/L | Yes |

* The SD of the density estimate overlaped the acceptability criterion

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR1978/7



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>16 February 2021<br>17 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9939 | Y0160221 | Aqueous sample, pH 6.1, salinity 16.9‰, total ammonia 24.4mg/L. Sample received at 8ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 18 February 2021 at 1930hr |

| Sample 9939*: Y0160221* | | Vacant | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** | | |
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 45.0 ± 10.0 * | | |
| 12.5 | 10.0 ± 20.0 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr EC10 = 3.9 (2.63-4.84)%** | | | |
| **96-hr EC50 = 6.6 (5.47-7.91)%** | | | |
| **NOEC = 3.1%** | | | |
| **LOEC = 6.3%** | | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/7



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 11.0-110.3mg $NH_4^+$/L | 17.5mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA



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# Toxicity Test Report: TR1978/8



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>16 February 2021<br>17 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9939 | Y0160221 | Aqueous sample, pH 6.1, salinity 16.9‰, total ammonia 24.4mg/L. Sample received at 8ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Age of Test Organisms:** | 12mm |
| **Test Initiated:** | 25 February 2021 at 1930hr |

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# Toxicity Test Report: TR1978/8



| Sample 9939*: Y0160221* | | | Sample 9939*: Y0160221* | | |
|---|---|---|---|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** | | **Concentration (%)** | **Biomass, mg (Mean ± SD)** | |
| FSW Control | 100 ± 0.0 | | FSW Control | 15.7 ± 0.8 | |
| ASW Control | 100 ± 0.0 | | ASW Control | 15.8 ± 0.4 | |
| 1.6 | 100 ± 0.0 | | 1.6 | 15.8 ± 1.3 | |
| 3.1 | 95.0 ± 10.0 | | 3.1 | 15.1 ± 0.8 | |
| 6.3 | 10.0 ± 11.6 | * | 6.3 | 1.3 ± 1.5 | ** |
| 12.5 | 0.0 ± 0.0 | | 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | | 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | | 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | | 100 | 0.0 ± 0.0 | |
| **7 day EC10 (unaffected) = 3.4 (2.52-3.97)%** | | | **7 day IC10 (biomass) = 3.3 (3.02-3.51)%** | | |
| **7 day EC50 (unaffected) = 4.6 (3.93-5.36)%** | | | **7 day IC50 (biomass) = 4.78 (1.46-5.11)%** | | |
| **NOEC = 3.1%** | | | **NOEC = 3.1%** | | |
| **LOEC = 6.3%** | | | **LOEC = 6.3%** | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

**Significantly lower fish biomass compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 26% | Yes |
| Reference Toxicant within cusum chart limits | 11.0-110.3mg $NH_4^+$/L | 17.5mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

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**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR1978/9



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| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>23 February 2021<br>24 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9966 | Y0230221 | Aqueous sample, pH 6.1*, salinity 16.1‰*, total ammonia 24.4mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 25 February 2021 at 1830hr |

| Sample 9966*: Y0230221* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control | 91.5 ± 1.3 | | |
| ASW Control | 91.5 ± 1.3 | | |
| 1.6 | 92.0 ± 1.8 | | |
| 3.1 | 90.8 ± 1.0 | | |
| 6.3 | 17.5 ± 6.5 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **EC10 = 3.9 (2.81-4.49)%**<br>**EC50 = 5.2 (4.52-5.52)%**<br>**NOEC =3.1 %**<br>**LOEC = 6.3%** | | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 91.5% | Yes |
| Reference Toxicant within cusum chart limits | 54.2-59.8µg Cu/L | 57.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR1978/10



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| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>23 February 2021<br>24 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9966 | Y0230221 | Aqueous sample, pH 6.1*, salinity 16.1‰*, total ammonia 24.4mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 25 February 2021 at 1800hr |

| Sample 9966*: Y0230221* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control 97.0 ± 2.2 | | |
| ASW Control 97.3 ± 1.0 | | |
| 1.6 96.0 ± 2.2 | | |
| 3.1 97.3 ± 0.5 | | |
| 6.3 96.0 ± 1.4 | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr IC10 = 6.8 (6.62-6.91)%**<br>**72-hr EC50 = 8.8 (8.74-8.89)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | |

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# Toxicity Test Report: TR1978/10



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 97.0% | Yes |
| Reference Toxicant within cusum chart limits | 10.6-12.0µg Cu/L | 11.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR1978/11



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| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>23 February 2021<br>24 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9966 | Y0230221 | Aqueous sample, pH 6.1*, salinity 16.1‰*, total ammonia 24.4mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 25 February 2021 at 1730hr |

| Sample 9966*: Y0230221* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control: 75.5 ± 2.7 | | |
| ASW Control: 73.5 ± 2.7 | | |
| 1.6: 74.0 ± 4.2 | | |
| 3.1: 75.8 ± 1.7 | | |
| 6.3: 69.8 ± 4.6 * | | |
| 12.5: 0.0 ± 0.0 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **48-hr IC10 = 6.4 (5.36-6.50)%**<br>**48-hr EC50 = 8.4 (8.27-8.60)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/11



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 75.5% | Yes |
| Reference Toxicant within cusum chart limits | 7.6-14.3µg Cu/L | 11.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.



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# Toxicity Test Report: TR1978/12



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>23 February 2021<br>24 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 9966 | Y0230221 | Aqueous sample, pH 6.1, salinity 16.1‰, total ammonia 24.4mg/L. Sample received at 9ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 25 February 2021 at 1430hr |

| Sample 9966*: Y0230221* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control 95.8 ± 1.7 | | |
| ASW Control 96.5 ± 1.3 | | |
| 1.6 93.5 ± 2.1 | | |
| 3.1 94.8 ± 1.7 | | |
| 6.3 95.3 ± 2.5 | | |
| 12.5 47.3 ± 7.4 * | | |
| 25 6.0 ± 1.8 * | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr EC10 = 7.8 (6.29-9.04)%** | | |
| **72-hr EC50 = 13.0 (11.68-14.21)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/12



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 95.8% | Yes |
| Reference Toxicant within cusum chart limits | 125.7-251.1µg Cu/L | 195.0µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR1978/13



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>23 February 2021<br>24 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9966 | Y0230221 | Aqueous sample, pH 6.1, salinity 16.1‰, total ammonia 24.4mg/L. Sample received at 9ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 25 February 2021 at 1500hr |

| Sample 9966*: Y0230221* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 95.0 ± 10.0 | | |
| 6.3: 100 ± 0.0 | | |
| 12.5: 25.0 ± 19.2 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 7.8 (6.08-11.82)%** | | |
| **96-hr EC50 = 10.2 (8.77-11.83)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/13



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.9-9.3mg SDS/L | 3.8mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR1978/14



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>23 February 2021<br>24 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9966 | Y0230221 | Aqueous sample, pH 6.1, salinity 16.1‰, total ammonia 24.4mg/L. Sample received at 9ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 25 February 2021 at 1500hr |

| Sample 9966*: Y0230221* | | *Vacant* | |
|---|---|---|---|
| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | | |
| FSW Control | 19.2 ± 0.9 | | |
| ASW Control | 18.9 ± 0.6 | | |
| 1.6 | 19.1 ± 0.5 | | |
| 3.1 | 19.0 ± 0.5 | | |
| 6.3 | 18.4 ± 0.9 | | |
| 12.5 | 8.5 ± 1.0 * | | |
| 25 | 3.7 ± 1.4 * | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr IC10 = 7.1 (6.36-7.62)%**<br>**72-hr IC50 = 11.9 (11.05-12.70)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/14



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean cell density | ≥16.0x10$^4$ cells/mL | 20.2x10$^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 4.4% | Yes |
| Reference Toxicant within cusum chart limits | 3.9-8.7µg Cu/L | 4.9µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR1978/15



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>23 February 2021<br>24 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9966 | Y0230221 | Aqueous sample, pH 6.1, salinity 16.1‰, total ammonia 24.4mg/L. Sample received at 9ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 25 February 2021 at 1930hr |

| Sample 9966*: Y0230221* | Vacant | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 90.0 ± 11.6 | | |
| 12.5: 0.0 ± 0.0 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 6.3 (5.62-9.38)%** | | |
| **96-hr EC50 = 8.3 (7.54-9.09)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

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# Toxicity Test Report: TR1978/15



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 9.8-114.1mg $NH_4^+$/L | 19.7mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

# Toxicity Test Report: TR1978/16



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>23 February 2021<br>24 February 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9966 | Y0230221 | Aqueous sample, pH 6.1, salinity 16.1‰, total ammonia 24.4mg/L. Sample received at 9ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Age of Test Organisms:** | 14mm |
| **Test Initiated:** | 18 February 2021 at 1930hr |

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# Toxicity Test Report: TR1978/16



| Sample 9966*: Y0230221* | | | Sample 9966*: Y0230221* | | |
|---|---|---|---|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** | | **Concentration (%)** | **Biomass, mg (Mean ± SD)** | |
| FSW Control | 100 ± 0.0 | | FSW Control | 18.1 ± 0.9 | |
| ASW Control | 100 ± 0.0 | | ASW Control | 18.7 ± 1.2 | |
| 1.6 | 95.0 ± 10.0 | | 1.6 | 16.9 ± 1.6 | |
| 3.1 | 95.0 ± 10.0 | | 3.1 | 17.4 ± 0.9 | |
| 6.3 | 20.0 ± 23.1 | * | 6.3 | 8.7 ± 9.0 | |
| 12.5 | 0.0 ± 0.0 | | 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | | 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | | 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | | 100 | 0.0 ± 0.0 | |
| **7 day EC10 (unaffected) = 2.7 (1.83-3.34)%** | | | **7 day IC10 (biomass) = 3.2%**** | | |
| **7 day EC50 (unaffected) = 4.6 (3.84-5.63)%** | | | **7 day IC50 (biomass) = 6.0 (3.96-11.05)%** | | |
| **NOEC = 3.1%** | | | **NOEC = 6.3%** | | |
| **LOEC = 6.3%** | | | **LOEC = 12.5%** | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)
**The 95% Confidence Limits are not reliable.

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 43% | Yes |
| Reference Toxicant within cusum chart limits | 9.8-114.1mg $NH_4^+$/L | 19.7mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR1978/17



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>02 March 2021<br>04 March 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9983 | Y020321 | Aqueous sample, pH 6.3*, salinity 16.2‰*, total ammonia 29.4mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 05 March 2021 at 1615hr |

| Sample 9983*: Y020321* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control 93.5 ± 2.1 | | |
| ASW Control 91.5 ± 2.7 | | |
| 1.6 93.8 ± 2.5 | | |
| 3.1 93.8 ± 2.8 | | |
| 6.3 59.8 ± 20.6 * | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **IC10 = 4.3 (3.73-5.70)%** | | |
| **EC50 = 6.9 (6.69-7.15)%** | | |
| **NOEC =3.1 %** | | |
| **LOEC = 6.3%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/17



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 93.5% | Yes |
| Reference Toxicant within cusum chart limits | 54.2-59.8µg Cu/L | 56.4µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR1978/18



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>02 March 2021<br>04 March 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9983 | Y020321 | Aqueous sample, pH 6.3*, salinity 16.2‰*, total ammonia 29.4mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 05 March 2021 at 1700hr |

| Sample 9983*: Y020321* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control 95.5 ± 2.1 | | |
| ASW Control 95.3 ± 1.7 | | |
| 1.6 94.5 ± 1.3 | | |
| 3.1 74.3 ± 10.7 * | | |
| 6.3 84.5 ± 6.1 * | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr IC10 = 2.6 (2.24-3.11)%** | | |
| **72-hr EC50 = 7.1 (6.82-7.35)%** | | |
| **NOEC = 1.6%** | | |
| **LOEC = 3.1%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 95.5% | Yes |
| Reference Toxicant within cusum chart limits | 10.6-10.3µg Cu/L | 11.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR1978/19



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>02 March 2021<br>04 March 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9983 | Y020321 | Aqueous sample, pH 6.3*, salinity 16.2‰*, total ammonia 29.4mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 05 March 2021 at 1530hr |

| Sample 9983*: Y020321* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **% Normal larvae (Mean ± SD)** | |
| FSW Control | 76.8 ± 4.4 | |
| ASW Control | 78.8 ± 2.2 | |
| 1.6 | 79.5 ± 2.7 | |
| 3.1 | 55.0 ± 3.4 * | |
| 6.3 | 0.0 ± 0.0 | |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |
| **48-hr IC10 = 2.1 (1.89-2.19)%**<br>**48-hr EC50 = 3.6 (3.47-3.70)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/19



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 76.8% | Yes |
| Reference Toxicant within cusum chart limits | 7.7-14.3µg Cu/L | 11.0µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.



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# Toxicity Test Report: TR1978/20



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>02 March 2021<br>04 March 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9983 | Y020321 | Aqueous sample, pH 6.3, salinity 16.2‰, total ammonia 29.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 05 March 2021 at 1230hr |

| Sample 9983*: Y020321* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control 95.5 ± 2.1 | | |
| ASW Control 95.8 ± 1.7 | | |
| 1.6 94.8 ± 2.4 | | |
| 3.1 95.5 ± 1.3 | | |
| 6.3 95.5 ± 1.9 | | |
| 12.5 77.0 ± 6.3 * | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr EC10 = 9.9 (8.67-11.81)%**<br>**72-hr EC50 = 15.5 (14.02-15.89)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/20



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 95.5% | Yes |
| Reference Toxicant within cusum chart limits | 126.1-253.8µg Cu/L | 211.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR1978/21



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:** | PR1978 |
| | | **Date Sampled:** | 02 March 2021 |
| | | **Date Received:** | 04 March 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9983 | Y020321 | Aqueous sample, pH 6.3, salinity 16.2‰, total ammonia 29.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 05 March 2021 at 1430hr |

| Sample 9983*: Y020321* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** | | |
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 95.0 ± 10.0 | | |
| 12.5 | 40.0 ± 32.7 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr EC10 = 7.4 (5.01-8.86)%** | | | |
| **96-hr EC50 = 11.2 (9.45-13.35)%** | | | |
| **NOEC = 6.3%** | | | |
| **LOEC = 12.5%** | | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/21



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.9-9.5mg SDS/L | 4.4mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

# Toxicity Test Report: TR1978/22



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1978<br>02 March 2021<br>04 March 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9983 | Y020321 | Aqueous sample, pH 6.3, salinity 16.2‰, total ammonia 29.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 05 March 2021 at 1400hr |

Sample 9983*: Y020321*

| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** |
|---|---|
| FSW Control | 17.5 ± 0.8 |
| ASW Control | 17.0 ± 0.6 |
| 1.6 | 17.6 ± 1.1 |
| 3.1 | 17.0 ± 0.7 |
| 6.3 | 10.3 ± 1.9 * |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

*Vacant*

**72-hr IC10 = 3.8 (3.30-4.20)%**
**72-hr IC50 = 7.3 (6.05-8.31)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/22



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean cell density | ≥16.0x10$^4$ cells/mL | 18.5x10$^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 4.6% | Yes |
| Reference Toxicant within cusum chart limits | 3.9-8.3µg Cu/L | 5.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR1978/23



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:** | PR1978 |
| | | **Date Sampled:** | 02 March 2021 |
| | | **Date Received:** | 04 March 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9983 | Y020321 | Aqueous sample, pH 6.3, salinity 16.2‰, total ammonia 29.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 05 March 2021 at 1730hr |

| Sample 9983*: Y020321* | | Vacant | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** | | |
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 5.0 ± 10.0 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr EC10 = 4.7 (3.74-5.06)%** | | | |
| **96-hr EC50 = 4.6 (4.28-4.90)%** | | | |
| **NOEC = 3.1%** | | | |
| **LOEC = 6.3%** | | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1978/23



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 9.2-110.7mg $NH_4^+$/L | 21.1mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA



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# Toxicity Test Report: TR1978/24



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:** | PR1978 |
| | | **Date Sampled:** | 02 March 2021 |
| | | **Date Received:** | 04 March 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL1978_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9983 | Y020321 | Aqueous sample, pH 6.3, salinity 16.2‰, total ammonia 29.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Age of Test Organisms:** | 14mm |
| **Test Initiated:** | 05 March 2021 at 1730hr |

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# Toxicity Test Report: TR1978/24



| Sample 9983*: Y020321* | |
|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.6 | 100 ± 0.0 |
| 3.1 | 90.0 ± 11.6 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (unaffected) = 3.1 (2.80-4.71)%**
**7 day EC50 (unaffected) = 4.1 (3.76-4.52)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

| Sample 9983*: Y020321* | |
|---|---|
| **Concentration (%)** | **Biomass, mg (Mean ± SD)** |
| FSW Control | 18.3 ± 0.4 |
| ASW Control | 18.2 ± 0.3 |
| 1.6 | 18.7 ± 0.4 |
| 3.1 | 16.5 ± 2.4 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (biomass) = 3.0 (1.85-3.67)**
**7 day IC50 (biomass) = 4.5 (4.11-4.81)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 3.9% | Yes |
| Reference Toxicant within cusum chart limits | 9.2-110.7mg $NH_4^+$/L | 21.1mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 April 2021

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Adrian Cukovski

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : Adrian.Cukovski@beachenergy.com.au
**Telephone** : 08 8433 2325
**Facsimile** :

**Date** : 18/02/2021

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR1978 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 17/02/2021
**Time samples received** : 18:00
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 6-10°C

**Comments** : 4 x 2.5L sample received at 8oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

Customer: Beach Energy
Contact Name: Adrian Cukowski
Phone: Email: Adrian.cukowski@beachenergy.com.au (please provide an email address for sample receipt notification)
Sampled by:

Ship To: Ecotox Services Aust
Attention: Rich Krassoy

8°C

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance): Acute Algal Growth Test | Acute Fish Test | Acute Inhibition to Microalgae | Acute Inhibition to Seagrass | Chronic Fish Test | Sub-Sampling Instructions | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16/2/2021 | 18:00 | Y0160221-1 | Grab | 4 x 250mL | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Beach Energy Work Order # 3600489 |
| " | " | Y0160221-2 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | " |
| " | " | Y0160221-3 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | " |
| " | " | Y0160221-4 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | " |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

**Note that testing will be delayed if an incomplete chain of custody is received**

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

*Note: An MSDS must be attached if Available* 5478

**ESA Project Number: PR** 18558

9939

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| D. McLachlan | 17/2/21 | | 17/2/21 | | | | |
| Of: | Time: 09:30 | Of: ESA | Time: 1800 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Adrian Cukovski

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : Adrian.Cukovski@beachenergy.com.au
**Telephone** : 08 8433 2325
**Facsimile** :

**Date** : 25/02/2021

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR1978 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 24/02/2021
**Time samples received** : 17:50
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 6-10°C

**Comments** : 4 x 2.5L sample received at 9oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

Customer: Beach Energy
Contact Name: Adrian Cukovski
Phone: 03 91102118 Email: adrian.cukovski@beachenergy.com.au
Sampled by: Colin

Ship To: ecotox services australia
Attention: Dr Rick Krassoi
(please provide an email address for sample receipt notification)

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | | | | | | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | As per PER178-401 | | | | | | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 1978 |
| 23/2/21 | 1700 | 40230221-1 | | 1x2·5l | / | | | | | | |
| 23/2/21 | 1700 | 40230221-2 | | 1x2·5l | | | | | | | |
| 23/2/21 | 1700 | 40230221-3 | | 1x2·5l | | | | | | | |
| 23/2/21 | 1700 | 40230221-4 | | 1x2·5l | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| COLIN | 24/2/21 | | 24/2/21 | | | | |
| Of: beachenergy | Time: 0900 | Of: ESP | Time: 1750 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Adrian Cukovski

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : Adrian.Cukovski@beachenergy.com.au
**Telephone** : 08 8433 2325
**Facsimile** :

**Date** : 5/03/2021

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR1978 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 4/03/2021
**Time samples received** : 19:05
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 11-15°C

**Comments** : 4 x 2.5L sample received at 12oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

Customer: BEACH ENERGY
Contact Name: ADRIAN CUKOVSKI
Phone: Email: ADRIAN.CUKOVSKI@BEACHENERGY.COM.AU (please provide an email address for sample receipt notification)
Sampled by: D. MCLACHLAN

Ship To: ECOTOX SERVICES AUSTRALIA
Attention: RICK KRASSOI

12°C

9483

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | Comments / Instructions |
|---|---|---|---|---|---|---|
| 2/3/21 | 18:00 | YO 020321 - 1 | GRAB | 1 x 2.5L | AS PER QUOTE PL1978 | Y3/Y4/Y5/Y6 wells online |
| 2/3/21 | 18:00 | YO 020321 - 2 | " | 1 x 2.5L | | " " |
| 2/3/21 | 18:00 | YO 020321 - 3 | " | 1 x 2.5L | | " " |
| 2/3/21 | 18:00 | YO 020321 - 4 | " | 1 x 2.5L | | " " |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**Note that testing will be delayed if an incomplete chain of custody is received**

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

*Note: An MSDS must be attached if Available*

**ESA Project Number: PR** ~~1858~~ 1978

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| D. MCLACHLAN | 3/3/21 | | 4/3/21 | | | | |
| Of: BEACH ENERGY | Time: 09:30 | Of: ESA | Time: 1405 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:10 | Test ID: | PR1978/01 | Sample ID: | Y0160221 |
| End Date: | 18/02/2021 16:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9500 | 0.9100 |
| ASW Control | 0.9300 | 0.9000 | 0.9200 | 0.9100 |
| 1.6 | 0.9400 | 0.9100 | 0.9300 | 0.9500 |
| 3.1 | 0.9100 | 0.9400 | 0.9300 | 0.9500 |
| 6.3 | 0.8500 | 0.7600 | 0.7100 | 0.6300 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

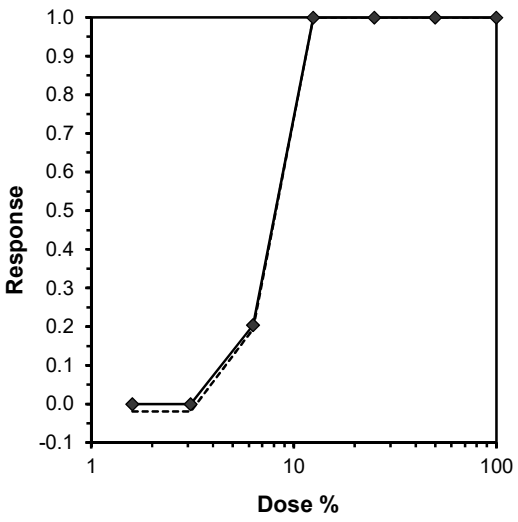
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9400 | 1.0273 | 1.3260 | 1.2661 | 1.3694 | 3.331 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | * | | | 34 | 400 |
| 1.6 | 0.9325 | 1.0191 | 1.3094 | 1.2661 | 1.3453 | 2.570 | 4 | -0.800 | 2.290 | 0.0970 | 27 | 400 |
| 3.1 | 0.9325 | 1.0191 | 1.3094 | 1.2661 | 1.3453 | 2.570 | 4 | -0.800 | 2.290 | 0.0970 | 27 | 400 |
| *6.3 | 0.7375 | 0.8060 | 1.0377 | 0.9169 | 1.1731 | 10.354 | 4 | 5.615 | 2.290 | 0.0970 | 105 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.915343 | 0.887 | 0.30544 | 3.091973 |
| Bartlett's Test indicates equal variances (p = 0.05) | 7.985884 | 11.34487 | | |
| The control means are not significantly different (p = 0.09) | 2.02303 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.061448 | 0.067132 | 0.068832 | 0.003587 | 7.1E-05 | 3, 12 |

### Trimmed Spearman-Karber

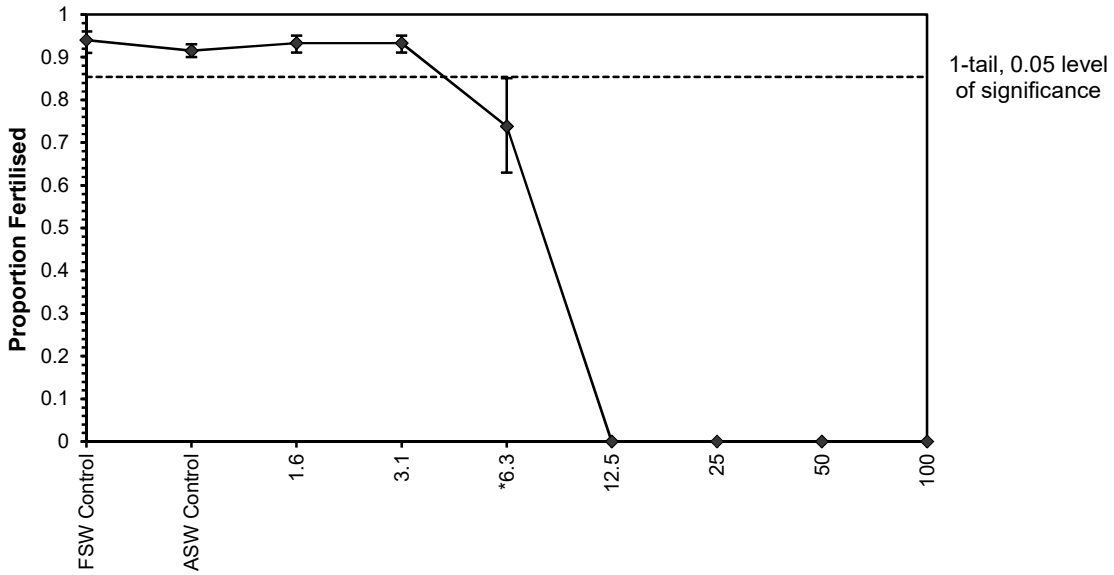
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 7.6969 | 7.4837 | 7.9163 |
| 5.0% | 7.8521 | 7.6039 | 8.1083 |
| 10.0% | 7.9849 | 7.6784 | 8.3037 |
| 20.0% | 8.1273 | 7.5912 | 8.7013 |
| Auto-0.0% | 7.6969 | 7.4837 | 7.9163 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:10 | Test ID: | PR1978/01 | Sample ID: | Y0160221 |
| End Date: | 18/02/2021 16:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:10 | Test ID: | PR1978/01 | Sample ID: | Y0160221 |
| End Date: | 18/02/2021 16:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 94.00 | 91.00 | 96.00 | 2.16 | 1.56 | 4 |
| ASW Control | | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| 1.6 | | 93.25 | 91.00 | 95.00 | 1.71 | 1.40 | 4 |
| 3.1 | | 93.25 | 91.00 | 95.00 | 1.71 | 1.40 | 4 |
| 6.3 | | 73.75 | 63.00 | 85.00 | 9.22 | 4.12 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:10 | Test ID: | PR1978/01 | Sample ID: | Y0160221 |
| End Date: | 18/02/2021 16:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9500 | 0.9100 |
| ASW Control | 0.9300 | 0.9000 | 0.9200 | 0.9100 |
| 1.6 | 0.9400 | 0.9100 | 0.9300 | 0.9500 |
| 3.1 | 0.9100 | 0.9400 | 0.9300 | 0.9500 |
| 6.3 | 0.8500 | 0.7600 | 0.7100 | 0.6300 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

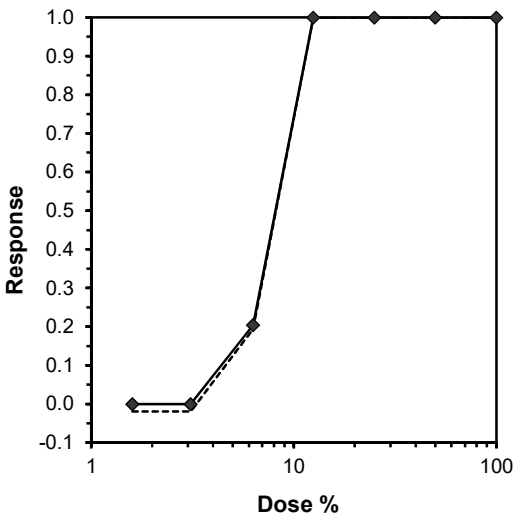
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9400 | 1.0273 | 1.3260 | 1.2661 | 1.3694 | 3.331 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | * | | | 0.9267 | 1.0000 |
| 1.6 | 0.9325 | 1.0191 | 1.3094 | 1.2661 | 1.3453 | 2.570 | 4 | -0.800 | 2.290 | 0.0970 | 0.9267 | 1.0000 |
| 3.1 | 0.9325 | 1.0191 | 1.3094 | 1.2661 | 1.3453 | 2.570 | 4 | -0.800 | 2.290 | 0.0970 | 0.9267 | 1.0000 |
| *6.3 | 0.7375 | 0.8060 | 1.0377 | 0.9169 | 1.1731 | 10.354 | 4 | 5.615 | 2.290 | 0.0970 | 0.7375 | 0.7959 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.915343 | 0.887 | 0.30544 | 3.091973 |
| Bartlett's Test indicates equal variances (p = 0.05) | 7.985884 | 11.34487 | | |
| The control means are not significantly different (p = 0.09) | 2.02303 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.061448 | 0.067132 | 0.068832 | 0.003587 | 7.1E-05 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

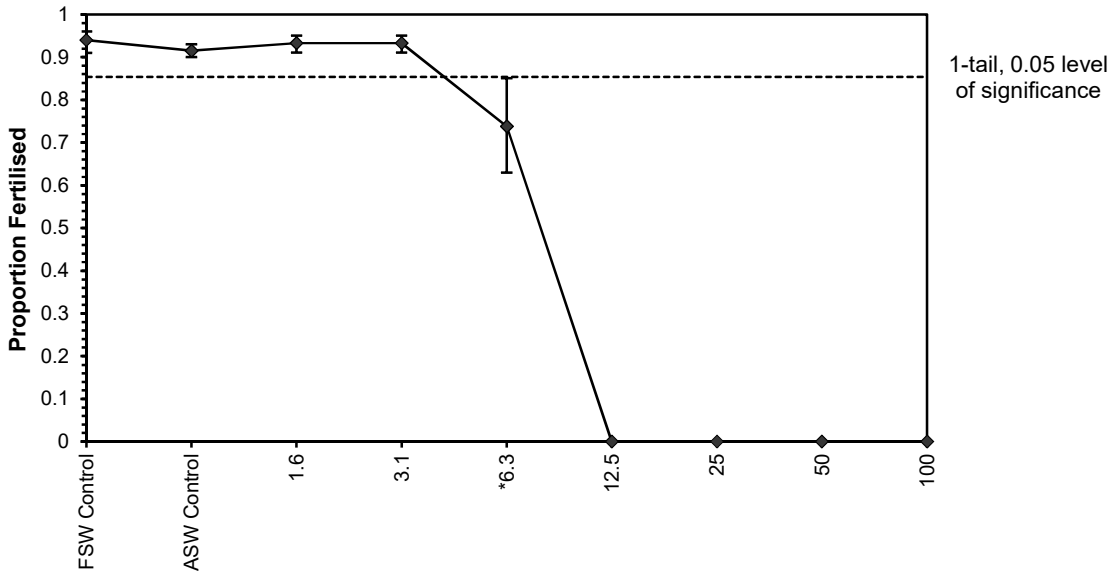
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 4.0458 | 0.1811 | 3.6809 | 4.7902 | 1.0804 |
| IC10 | 4.8408 | 0.3512 | 4.2192 | 6.3482 | 1.2349 |
| IC15 | 5.5617 | 0.4211 | 4.6527 | 6.8570 | 0.4524 |
| IC20 | 6.2445 | 0.3004 | 5.0348 | 6.6241 | -0.5946 |
| IC25 | 6.3923 | 0.1449 | 5.7034 | 6.6947 | -1.3406 |
| IC40 | 6.6628 | 0.0909 | 6.4104 | 6.9580 | 0.2661 |
| IC50 | 6.8357 | 0.0893 | 6.5881 | 7.1258 | 0.2610 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:10 | Test ID: | PR1978/01 | Sample ID: | Y0160221 |
| End Date: | 18/02/2021 16:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:10 | Test ID: | PR1978/01 | Sample ID: | Y0160221 |
| End Date: | 18/02/2021 16:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 94.00 | 91.00 | 96.00 | 2.16 | 1.56 | 4 |
| ASW Control | | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| 1.6 | | 93.25 | 91.00 | 95.00 | 1.71 | 1.40 | 4 |
| 3.1 | | 93.25 | 91.00 | 95.00 | 1.71 | 1.40 | 4 |
| 6.3 | | 73.75 | 63.00 | 85.00 | 9.22 | 4.12 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:30 | Test ID: | PR1978/01 | Sample ID: | REF-Ref Tox Test |
| End Date: | 25/02/2021 19:50 | Lab ID: | | Sample Type: | CU-Copper |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-ug/L | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9100 | 0.9000 | 0.9200 | 0.9300 |
| ASW Control | 0.9100 | 0.9000 | 0.9300 | 0.9200 |
| 15 | 0.9300 | 0.9000 | 0.9000 | |
| 30 | 0.9100 | 0.9200 | 0.9500 | |
| 60 | 0.4100 | 0.4000 | 0.3700 | |
| 120 | 0.0000 | 0.0000 | 0.0000 | |

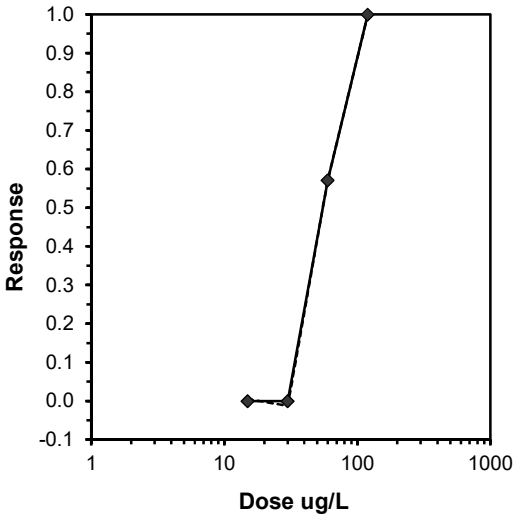
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-ug/L | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9150 | 1.0000 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | * | | | 34 | 400 |
| ASW Control | 0.9150 | 1.0000 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | | | | | |
| 15 | 0.9100 | 0.9945 | 1.2670 | 1.2490 | 1.3030 | 2.460 | 3 | 0.376 | 2.510 | 0.0569 | 27 | 300 |
| 30 | 0.9267 | 1.0128 | 1.2985 | 1.2661 | 1.3453 | 3.197 | 3 | -1.012 | 2.510 | 0.0569 | 22 | 300 |
| *60 | 0.3933 | 0.4299 | 0.6778 | 0.6539 | 0.6949 | 3.151 | 3 | 26.378 | 2.510 | 0.0569 | 182 | 300 |
| 120 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 3 | | | | 300 | 300 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.926326 | 0.866 | 0.545982 | -0.97764 |
| Bartlett's Test indicates equal variances (p = 0.79) | 1.041227 | 11.34487 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Bonferroni t Test | 30 | 60 | 42.42641 | | 0.034276 | 0.037446 | 0.279345 | 0.00088 | 1.9E-09 | 3, 9 |
| Treatments vs FSW Control | | | | | | | | | | |

**Trimmed Spearman-Karber**

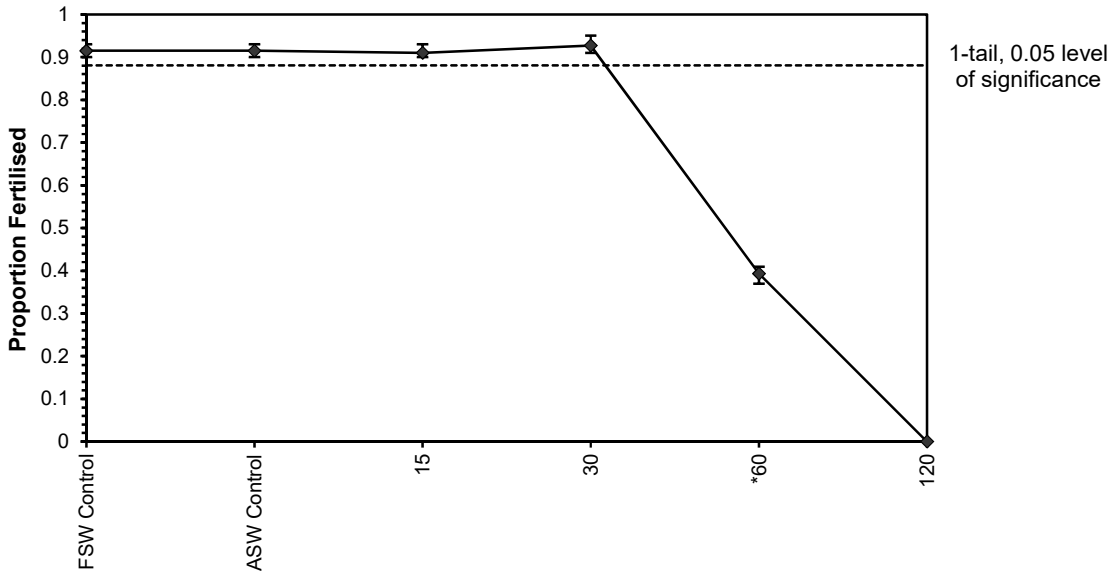
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 57.112 | 54.894 | 59.420 |
| 5.0% | 56.832 | 54.392 | 59.381 |
| 10.0% | 56.554 | 53.854 | 59.390 |
| 20.0% | 56.011 | 52.597 | 59.647 |
| Auto-0.0% | 57.112 | 54.894 | 59.420 |



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:30 | Test ID: | PR1978/01 | Sample ID: | REF-Ref Tox Test |
| End Date: | 25/02/2021 19:50 | Lab ID: | | Sample Type: | CU-Copper |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:30 | Test ID: | PR1978/01 | Sample ID: | REF-Ref Tox Test |
| End Date: | 25/02/2021 19:50 | Lab ID: | | Sample Type: | CU-Copper |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-ug/L | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| ASW Control | | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| 15 | | 91.00 | 90.00 | 93.00 | 1.73 | 1.45 | 3 |
| 30 | | 92.67 | 91.00 | 95.00 | 2.08 | 1.56 | 3 |
| 60 | | 39.33 | 37.00 | 41.00 | 2.08 | 3.67 | 3 |
| 120 | | 0.00 | 0.00 | 0.00 | 0.00 | | 3 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 15 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 30 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 60 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 120 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 15 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 30 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 60 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 120 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 15 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 30 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 60 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| 120 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:30 | Test ID: | PR1978/02 | Sample ID: | Y0230221 |
| End Date: | 25/02/2021 19:50 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9100 | 0.9000 | 0.9200 | 0.9300 |
| ASW Control | 0.9100 | 0.9000 | 0.9300 | 0.9200 |
| 1.6 | 0.9100 | 0.9400 | 0.9000 | 0.9300 |
| 3.1 | 0.9100 | 0.9000 | 0.9200 | 0.9000 |
| 6.3 | 0.1400 | 0.2700 | 0.1300 | 0.1600 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9150 | 1.0000 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | * | | | 34 | 400 |
| 1.6 | 0.9200 | 1.0055 | 1.2854 | 1.2490 | 1.3233 | 2.636 | 4 | -0.300 | 2.290 | 0.0749 | 32 | 400 |
| 3.1 | 0.9075 | 0.9918 | 1.2621 | 1.2490 | 1.2840 | 1.324 | 4 | 0.413 | 2.290 | 0.0749 | 37 | 400 |
| *6.3 | 0.1750 | 0.1913 | 0.4276 | 0.3689 | 0.5464 | 18.985 | 4 | 25.930 | 2.290 | 0.0749 | 330 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

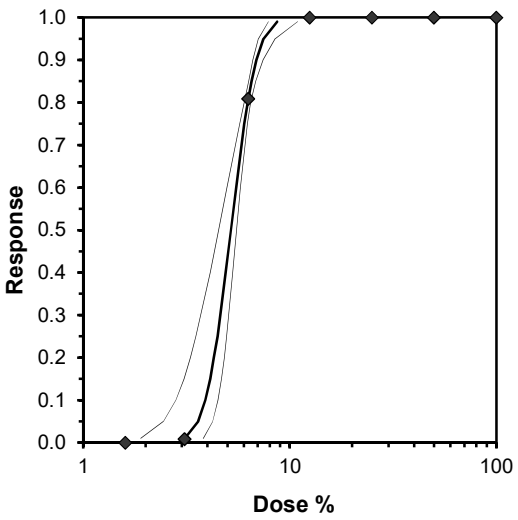
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.889811 | 0.887 | 1.50593 | 3.794957 |
| Bartlett's Test indicates equal variances (p = 0.05) | 7.665179 | 11.34487 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.046191 | 0.050463 | 0.71737 | 0.002139 | 7.8E-12 | 3, 12 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 10.37537 | 2.155756 | 6.150091 | 14.60066 | 0.085 | 0.054104 | 11.0705 | 1 | 0.71494 | 0.096382 | 3 |
| Intercept | -2.41777 | 1.714613 | -5.77842 | 0.942867 | | | | | | | |
| TSCR | 0.082701 | 0.0096 | 0.063886 | 0.101516 | | | | | | | |

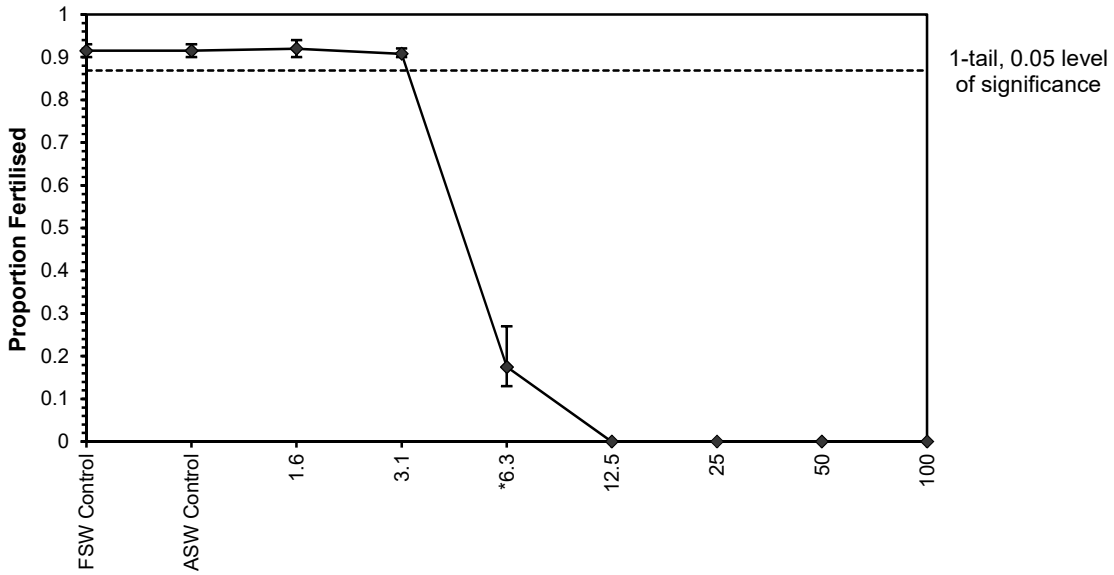
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 3.095439 | 1.900467 | 3.80577 |
| EC05 | 3.355 | 3.600858 | 2.451586 | 4.239765 |
| EC10 | 3.718 | 3.903209 | 2.807651 | 4.491598 |
| EC15 | 3.964 | 4.12142 | 3.076399 | 4.670309 |
| EC20 | 4.158 | 4.303514 | 3.307983 | 4.817748 |
| EC25 | 4.326 | 4.466134 | 3.520258 | 4.948289 |
| EC40 | 4.747 | 4.903682 | 4.11558 | 5.295659 |
| EC50 | 5.000 | 5.187289 | 4.518375 | 5.519689 |
| EC60 | 5.253 | 5.487298 | 4.95534 | 5.759294 |
| EC75 | 5.674 | 6.02489 | 5.732256 | 6.229291 |
| EC80 | 5.842 | 6.252556 | 6.023905 | 6.479006 |
| EC85 | 6.036 | 6.52881 | 6.315058 | 6.855327 |
| EC90 | 6.282 | 6.893805 | 6.62514 | 7.444827 |
| EC95 | 6.645 | 7.472653 | 7.052857 | 8.484765 |
| EC99 | 7.326 | 8.69278 | 7.87939 | 10.91436 |



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:30 | Test ID: | PR1978/02 | Sample ID: | Y0230221 |
| End Date: | 25/02/2021 19:50 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:30 | Test ID: | PR1978/02 | Sample ID: | Y0230221 |
| End Date: | 25/02/2021 19:50 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| ASW Control | | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| 1.6 | | 92.00 | 90.00 | 94.00 | 1.83 | 1.47 | 4 |
| 3.1 | | 90.75 | 90.00 | 92.00 | 0.96 | 1.08 | 4 |
| 6.3 | | 17.50 | 13.00 | 27.00 | 6.45 | 14.52 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 16:15 | Test ID: | PR1978/02 | Sample ID: | Y020321 |
| End Date: | 5/03/2021 17:35 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9100 | 0.9600 | 0.9300 |
| ASW Control | 0.9500 | 0.9000 | 0.8900 | 0.9200 |
| 1.6 | 0.9400 | 0.9100 | 0.9300 | 0.9700 |
| 3.1 | 0.9100 | 0.9700 | 0.9500 | 0.9200 |
| 6.3 | 0.7900 | 0.7600 | 0.4100 | 0.4300 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

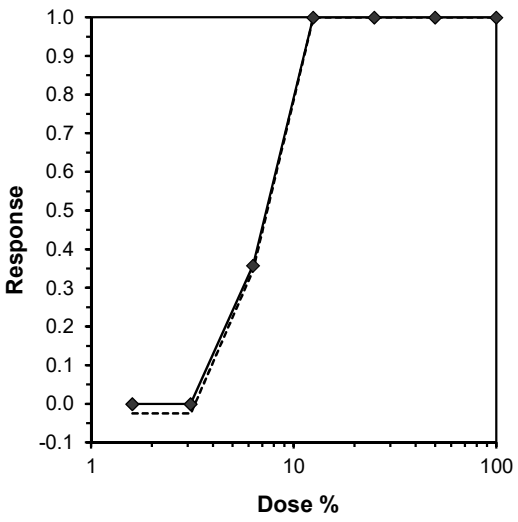
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9350 | 1.0219 | 1.3155 | 1.2661 | 1.3694 | 3.274 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2778 | 1.2327 | 1.3453 | 3.900 | 4 | * | | | 34 | 400 |
| 1.6 | 0.9375 | 1.0246 | 1.3223 | 1.2661 | 1.3967 | 4.158 | 4 | -0.535 | 2.290 | 0.1906 | 25 | 400 |
| 3.1 | 0.9375 | 1.0246 | 1.3230 | 1.2661 | 1.3967 | 4.511 | 4 | -0.544 | 2.290 | 0.1906 | 25 | 400 |
| *6.3 | 0.5975 | 0.6530 | 0.8909 | 0.6949 | 1.0948 | 24.165 | 4 | 4.648 | 2.290 | 0.1906 | 161 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.954867 | 0.887 | 0.0544 | 0.395355 |
| Bartlett's Test indicates equal variances (p = 0.03) | 8.93558 | 11.34487 | | |
| The control means are not significantly different (p = 0.30) | 1.144698 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.132781 | 0.144868 | 0.175503 | 0.013855 | 5.0E-04 | 3, 12 |

### Trimmed Spearman-Karber

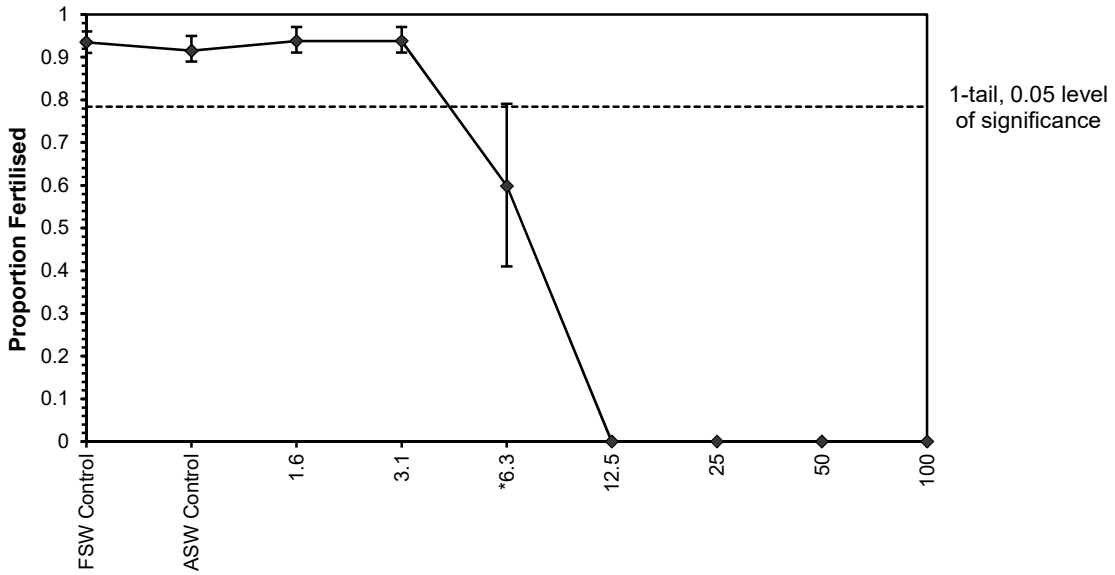
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 6.9163 | 6.6890 | 7.1513 |
| 5.0% | 6.9888 | 6.7324 | 7.2550 |
| 10.0% | 7.0603 | 6.7636 | 7.3700 |
| 20.0% | 7.1960 | 6.7641 | 7.6555 |
| Auto-0.0% | 6.9163 | 6.6890 | 7.1513 |



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 16:15 | Test ID: | PR1978/02 | Sample ID: | Y020321 |
| End Date: | 5/03/2021 17:35 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 16:15 | Test ID: | PR1978/02 | Sample ID: | Y020321 |
| End Date: | 5/03/2021 17:35 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 93.50 | 91.00 | 96.00 | 2.08 | 1.54 | 4 |
| ASW Control | | 91.50 | 89.00 | 95.00 | 2.65 | 1.78 | 4 |
| 1.6 | | 93.75 | 91.00 | 97.00 | 2.50 | 1.69 | 4 |
| 3.1 | | 93.75 | 91.00 | 97.00 | 2.75 | 1.77 | 4 |
| 6.3 | | 59.75 | 41.00 | 79.00 | 20.55 | 7.59 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 16:15 | Test ID: | PR1978/02 | Sample ID: | Y020321 |
| End Date: | 5/03/2021 17:35 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9100 | 0.9600 | 0.9300 |
| ASW Control | 0.9500 | 0.9000 | 0.8900 | 0.9200 |
| 1.6 | 0.9400 | 0.9100 | 0.9300 | 0.9700 |
| 3.1 | 0.9100 | 0.9700 | 0.9500 | 0.9200 |
| 6.3 | 0.7900 | 0.7600 | 0.4100 | 0.4300 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

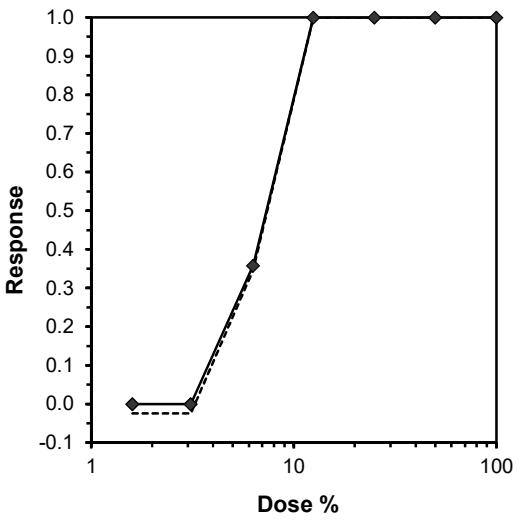
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9350 | 1.0219 | 1.3155 | 1.2661 | 1.3694 | 3.274 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2778 | 1.2327 | 1.3453 | 3.900 | 4 | * | | | 0.9300 | 1.0000 |
| 1.6 | 0.9375 | 1.0246 | 1.3223 | 1.2661 | 1.3967 | 4.158 | 4 | -0.535 | 2.290 | 0.1906 | 0.9300 | 1.0000 |
| 3.1 | 0.9375 | 1.0246 | 1.3230 | 1.2661 | 1.3967 | 4.511 | 4 | -0.544 | 2.290 | 0.1906 | 0.9300 | 1.0000 |
| *6.3 | 0.5975 | 0.6530 | 0.8909 | 0.6949 | 1.0948 | 24.165 | 4 | 4.648 | 2.290 | 0.1906 | 0.5975 | 0.6425 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.954867 | 0.887 | 0.0544 | 0.395355 |
| Bartlett's Test indicates equal variances (p = 0.03) | 8.93558 | 11.34487 | | |
| The control means are not significantly different (p = 0.30) | 1.144698 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.132781 | 0.144868 | 0.175503 | 0.013855 | 5.0E-04 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

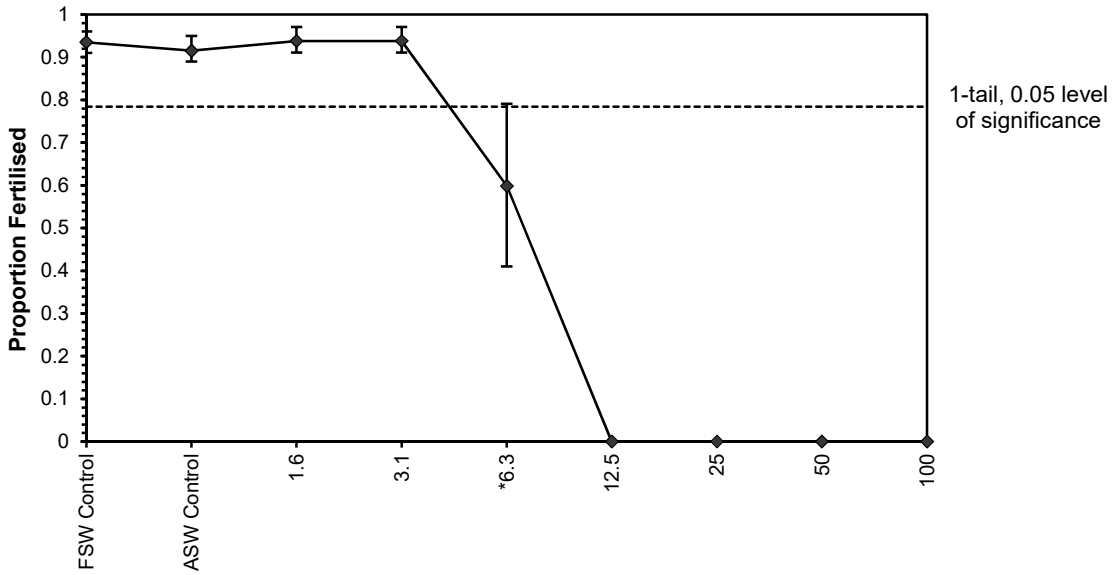
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.7520 | 0.1667 | 3.3240 | 4.4882 | 1.0177 |
| IC10 | 4.2657 | 0.2930 | 3.7315 | 5.7040 | 1.4363 |
| IC15 | 4.7106 | 0.4211 | 3.9832 | 6.8414 | 1.5300 |
| IC20 | 5.1168 | 0.4628 | 4.1873 | 7.1323 | 0.9305 |
| IC25 | 5.5010 | 0.4882 | 4.3683 | 7.0650 | 0.4184 |
| IC40 | 6.3761 | 0.2962 | 5.0338 | 6.9719 | -0.7369 |
| IC50 | 6.5545 | 0.1901 | 5.7452 | 7.1391 | -0.3882 |



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 16:15 | Test ID: | PR1978/02 | Sample ID: | Y020321 |
| End Date: | 5/03/2021 17:35 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 16:15 | Test ID: | PR1978/02 | Sample ID: | Y020321 |
| End Date: | 5/03/2021 17:35 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 93.50 | 91.00 | 96.00 | 2.08 | 1.54 | 4 |
| ASW Control | | 91.50 | 89.00 | 95.00 | 2.65 | 1.78 | 4 |
| 1.6 | | 93.75 | 91.00 | 97.00 | 2.50 | 1.69 | 4 |
| 3.1 | | 93.75 | 91.00 | 97.00 | 2.75 | 1.77 | 4 |
| 6.3 | | 59.75 | 41.00 | 79.00 | 20.55 | 7.59 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:30 | Test ID: | PR1978/03 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 15:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9500 | 0.9800 |
| ASW Control | 0.9500 | 0.9700 | 0.9600 | 0.9800 |
| 1.6 | 0.9800 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9500 | 0.9800 | 1.0000 | 0.9600 |
| 6.3 | 0.9800 | 0.9700 | 0.9600 | 0.9600 |
| 12.5 | 0.0800 | 0.0500 | 0.1100 | 0.0800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

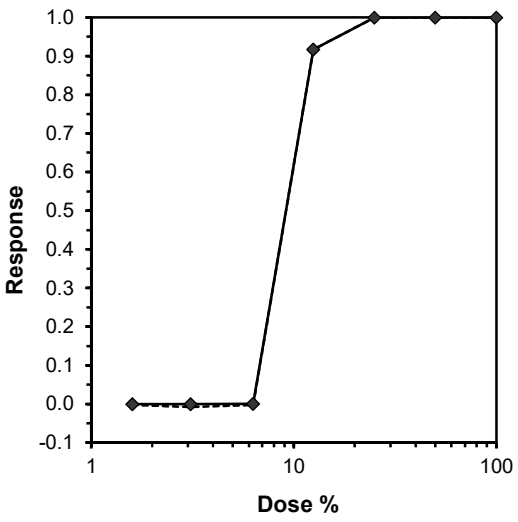
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9675 | 1.0026 | 1.3931 | 1.3453 | 1.4289 | 3.048 | 4 | | | | | |
| ASW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | * | | | 14 | 400 |
| 1.6 | 0.9675 | 1.0026 | 1.3931 | 1.3453 | 1.4289 | 3.048 | 4 | -0.231 | 2.360 | 0.0822 | 13 | 400 |
| 3.1 | 0.9725 | 1.0078 | 1.4161 | 1.3453 | 1.5208 | 5.517 | 4 | -0.891 | 2.360 | 0.0822 | 11 | 400 |
| 6.3 | 0.9675 | 1.0026 | 1.3911 | 1.3694 | 1.4289 | 2.033 | 4 | -0.173 | 2.360 | 0.0822 | 13 | 400 |
| *12.5 | 0.0800 | 0.0829 | 0.2843 | 0.2255 | 0.3381 | 16.195 | 4 | 31.618 | 2.360 | 0.0822 | 368 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.969538 | 0.905 | 0.465394 | 0.165521 |
| Bartlett's Test indicates equal variances (p = 0.51) | 3.291135 | 13.2767 | | |
| The control means are not significantly different (p = 0.78) | 0.28914 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.035964 | 0.037233 | 0.989942 | 0.002424 | 4.2E-15 | 4, 15 |

**Trimmed Spearman-Karber**

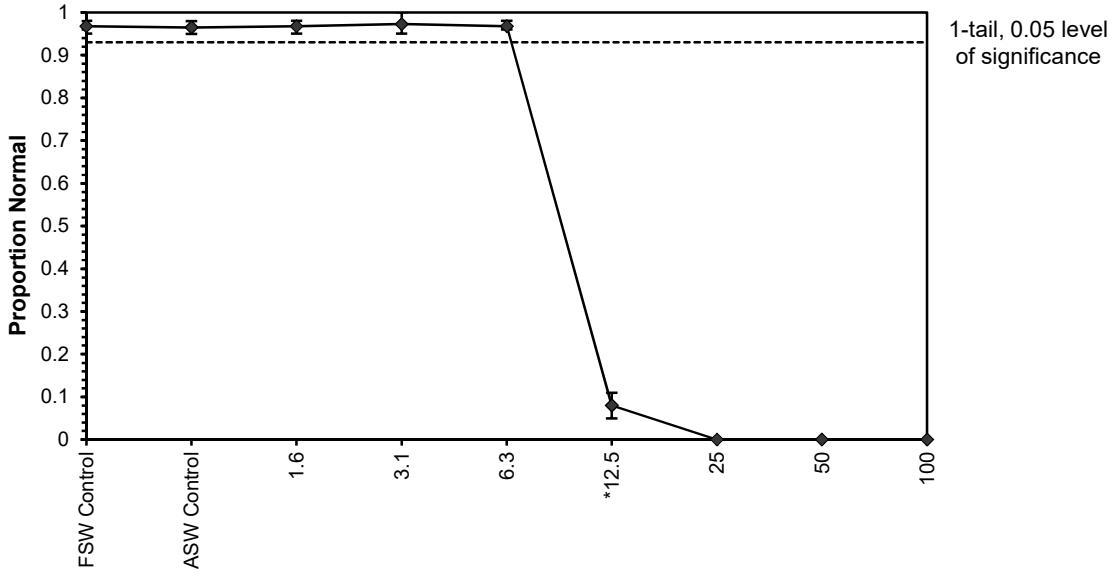
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 9.3884 | 9.2109 | 9.5693 |
| 5.0% | 9.1909 | 9.0337 | 9.3509 |
| 10.0% | 9.1495 | 9.0471 | 9.2530 |
| 20.0% | 9.1495 | 9.0471 | 9.2530 |
| Auto-0.0% | 9.3884 | 9.2109 | 9.5693 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:30 | Test ID: | PR1978/03 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 15:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:30 | Test ID: | PR1978/03 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 15:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 96.75 | 95.00 | 98.00 | 1.50 | 1.27 | 4 |
| ASW Control | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 1.6 | | 96.75 | 95.00 | 98.00 | 1.50 | 1.27 | 4 |
| 3.1 | | 97.25 | 95.00 | 100.00 | 2.22 | 1.53 | 4 |
| 6.3 | | 96.75 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| 12.5 | | 8.00 | 5.00 | 11.00 | 2.45 | 19.56 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:30 | Test ID: | PR1978/03 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 15:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9500 | 0.9800 |
| ASW Control | 0.9500 | 0.9700 | 0.9600 | 0.9800 |
| 1.6 | 0.9800 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9500 | 0.9800 | 1.0000 | 0.9600 |
| 6.3 | 0.9800 | 0.9700 | 0.9600 | 0.9600 |
| 12.5 | 0.0800 | 0.0500 | 0.1100 | 0.0800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

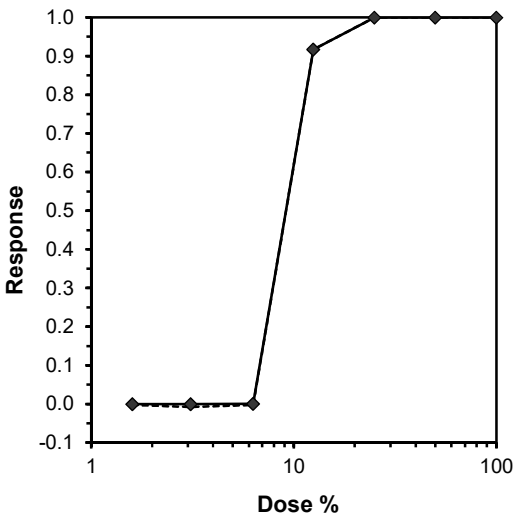
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9675 | 1.0026 | 1.3931 | 1.3453 | 1.4289 | 3.048 | 4 | | | | | |
| ASW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | * | | | 0.9683 | 1.0000 |
| 1.6 | 0.9675 | 1.0026 | 1.3931 | 1.3453 | 1.4289 | 3.048 | 4 | -0.231 | 2.360 | 0.0822 | 0.9683 | 1.0000 |
| 3.1 | 0.9725 | 1.0078 | 1.4161 | 1.3453 | 1.5208 | 5.517 | 4 | -0.891 | 2.360 | 0.0822 | 0.9683 | 1.0000 |
| 6.3 | 0.9675 | 1.0026 | 1.3911 | 1.3694 | 1.4289 | 2.033 | 4 | -0.173 | 2.360 | 0.0822 | 0.9675 | 0.9991 |
| *12.5 | 0.0800 | 0.0829 | 0.2843 | 0.2255 | 0.3381 | 16.195 | 4 | 31.618 | 2.360 | 0.0822 | 0.0800 | 0.0826 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.969538 | 0.905 | 0.465394 | 0.165521 |
| Bartlett's Test indicates equal variances (p = 0.51) | 3.291135 | 13.2767 | | |
| The control means are not significantly different (p = 0.78) | 0.28914 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.035964 | 0.037233 | 0.989942 | 0.002424 | 4.2E-15 | 4, 15 |

### Log-Logit Interpolation (200 Resamples)

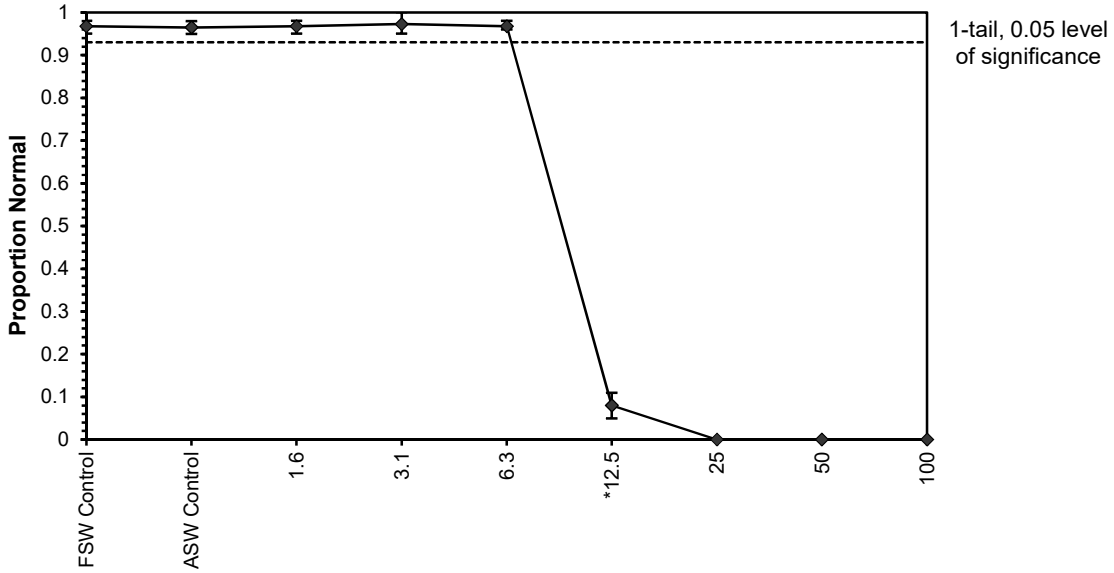
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.0703 | 0.0734 | 6.7578 | 7.1815 | -0.2633 |
| IC10 | 7.5310 | 0.0737 | 7.2544 | 7.6688 | 0.0902 |
| IC15 | 7.8766 | 0.0775 | 7.5889 | 8.0437 | 0.1675 |
| IC20 | 8.1641 | 0.0821 | 7.8635 | 8.3395 | 0.1658 |
| IC25 | 8.4177 | 0.0870 | 8.1004 | 8.6024 | 0.1417 |
| IC40 | 9.0840 | 0.1028 | 8.6997 | 9.2862 | 0.0579 |
| IC50 | 9.5072 | 0.1148 | 9.0795 | 9.7491 | 0.0154 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:30 | Test ID: | PR1978/03 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 15:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 15:30 | Test ID: | PR1978/03 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 15:30 | Lab ID: | 9939 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 96.75 | 95.00 | 98.00 | 1.50 | 1.27 | 4 |
| ASW Control | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 1.6 | | 96.75 | 95.00 | 98.00 | 1.50 | 1.27 | 4 |
| 3.1 | | 97.25 | 95.00 | 100.00 | 2.22 | 1.53 | 4 |
| 6.3 | | 96.75 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| 12.5 | | 8.00 | 5.00 | 11.00 | 2.45 | 19.56 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:00 | Test ID: | PR1978/03 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 18:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9700 | 1.0000 |
| ASW Control | 0.9800 | 0.9700 | 0.9600 | 0.9800 |
| 1.6 | 0.9800 | 0.9300 | 0.9700 | 0.9600 |
| 3.1 | 0.9700 | 0.9700 | 0.9800 | 0.9700 |
| 6.3 | 0.9800 | 0.9500 | 0.9600 | 0.9500 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

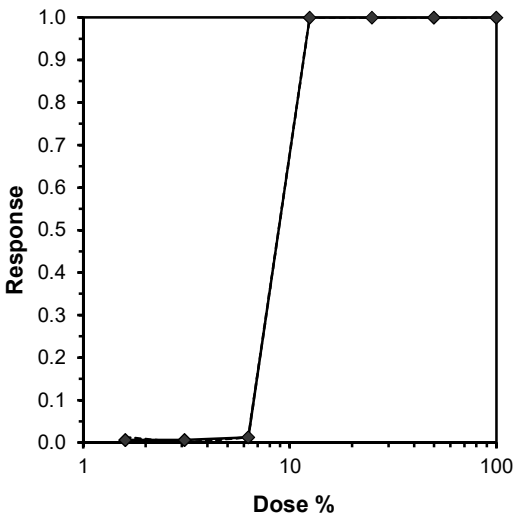
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9700 | 0.9974 | 1.4081 | 1.3453 | 1.5208 | 5.542 | 4 | | | | | |
| ASW Control | 0.9725 | 1.0000 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | * | | | 0.9725 | 1.0000 |
| 1.6 | 0.9600 | 0.9871 | 1.3745 | 1.3030 | 1.4289 | 3.892 | 4 | 1.200 | 2.290 | 0.0601 | 0.9663 | 0.9936 |
| 3.1 | 0.9725 | 1.0000 | 1.4048 | 1.3967 | 1.4289 | 1.146 | 4 | 0.047 | 2.290 | 0.0601 | 0.9663 | 0.9936 |
| 6.3 | 0.9600 | 0.9871 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | 1.287 | 2.290 | 0.0601 | 0.9600 | 0.9871 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.951544 | 0.887 | -0.13342 | 0.336982 |
| Bartlett's Test indicates equal variances (p = 0.32) | 3.491792 | 11.34487 | | |
| The control means are not significantly different (p = 0.96) | 0.049673 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.0228 | 0.023431 | 0.00137 | 0.001376 | 0.427914 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

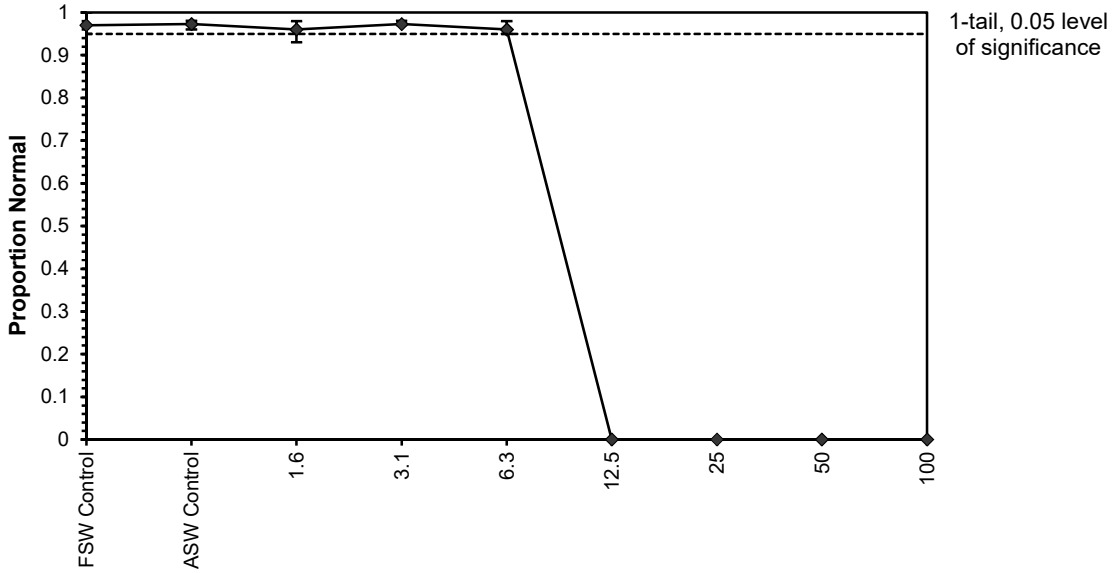
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.5513 | 0.0520 | 6.3964 | 6.7112 | 0.3206 |
| IC10 | 6.7594 | 0.0491 | 6.6195 | 6.9072 | 0.3429 |
| IC15 | 6.9096 | 0.0478 | 6.7803 | 7.0549 | 0.3441 |
| IC20 | 7.0314 | 0.0470 | 6.9038 | 7.1746 | 0.3419 |
| IC25 | 7.1368 | 0.0464 | 7.0107 | 7.2782 | 0.3394 |
| IC40 | 7.4053 | 0.0448 | 7.2834 | 7.5419 | 0.3332 |
| IC50 | 7.5705 | 0.0438 | 7.4513 | 7.7040 | 0.3304 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:00 | Test ID: | PR1978/03 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 18:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:00 | Test ID: | PR1978/03 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 18:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 97.00 | 95.00 | 100.00 | 2.16 | 1.52 | 4 |
| ASW Control | | 97.25 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| 1.6 | | 96.00 | 93.00 | 98.00 | 2.16 | 1.53 | 4 |
| 3.1 | | 97.25 | 97.00 | 98.00 | 0.50 | 0.73 | 4 |
| 6.3 | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:00 | Test ID: | PR1978/03 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 18:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9700 | 1.0000 |
| ASW Control | 0.9800 | 0.9700 | 0.9600 | 0.9800 |
| 1.6 | 0.9800 | 0.9300 | 0.9700 | 0.9600 |
| 3.1 | 0.9700 | 0.9700 | 0.9800 | 0.9700 |
| 6.3 | 0.9800 | 0.9500 | 0.9600 | 0.9500 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

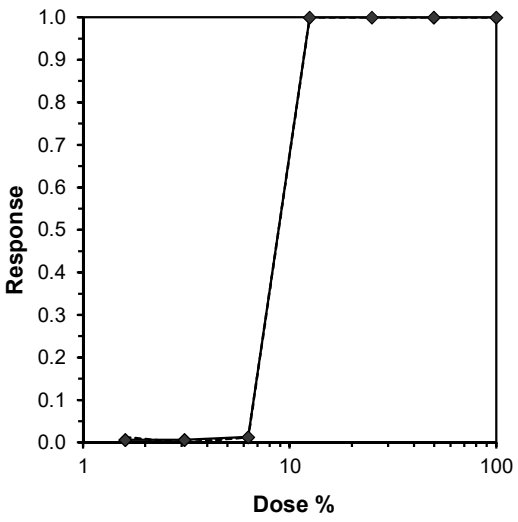
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9700 | 0.9974 | 1.4081 | 1.3453 | 1.5208 | 5.542 | 4 | | | | | |
| ASW Control | 0.9725 | 1.0000 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | * | | | 11 | 400 |
| 1.6 | 0.9600 | 0.9871 | 1.3745 | 1.3030 | 1.4289 | 3.892 | 4 | 1.200 | 2.290 | 0.0601 | 16 | 400 |
| 3.1 | 0.9725 | 1.0000 | 1.4048 | 1.3967 | 1.4289 | 1.146 | 4 | 0.047 | 2.290 | 0.0601 | 11 | 400 |
| 6.3 | 0.9600 | 0.9871 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | 1.287 | 2.290 | 0.0601 | 16 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.951544 | 0.887 | -0.13342 | 0.336982 |
| Bartlett's Test indicates equal variances (p = 0.32) | 3.491792 | 11.34487 | | |
| The control means are not significantly different (p = 0.96) | 0.049673 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.0228 | 0.023431 | 0.00137 | 0.001376 | 0.427914 | 3, 12 |

### Trimmed Spearman-Karber

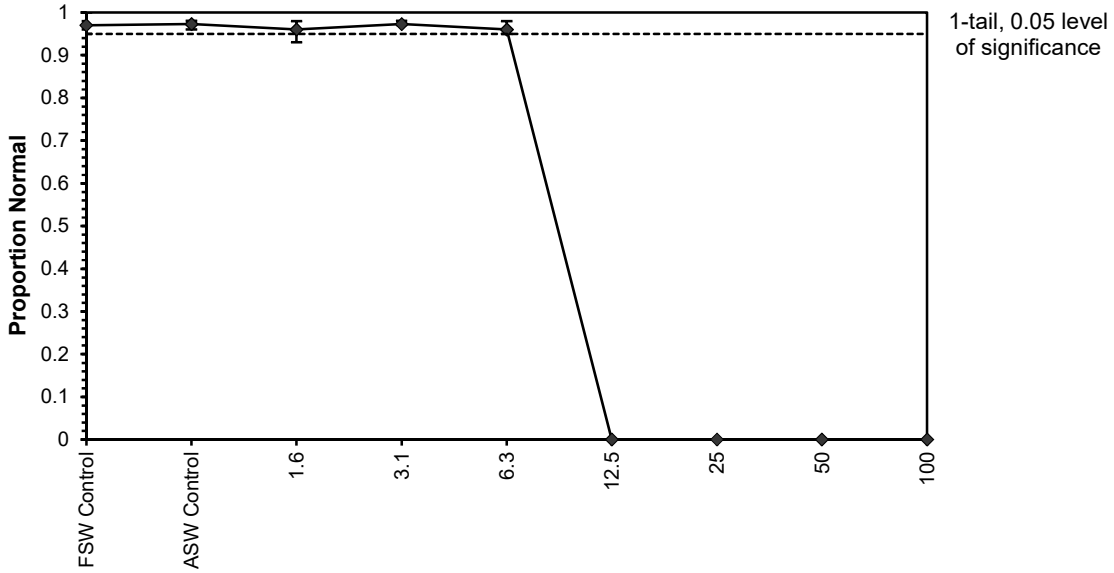
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 8.8346 | 8.7997 | 8.8697 |
| 10.0% | 8.8346 | 8.7997 | 8.8697 |
| 20.0% | 8.8346 | 8.7997 | 8.8697 |
| Auto-0.6% | 8.8144 | 8.7402 | 8.8892 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:00 | Test ID: | PR1978/03 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 18:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 18:00 | Test ID: | PR1978/03 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 18:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 97.00 | 95.00 | 100.00 | 2.16 | 1.52 | 4 |
| ASW Control | | 97.25 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| 1.6 | | 96.00 | 93.00 | 98.00 | 2.16 | 1.53 | 4 |
| 3.1 | | 97.25 | 97.00 | 98.00 | 0.50 | 0.73 | 4 |
| 6.3 | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:00 | Test ID: | PR1978/03 | Sample ID: | Y020321 |
| End Date: | 8/03/2021 17:00 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9500 | 0.9700 | 0.9300 | 0.9600 |
| 1.6 | 0.9400 | 0.9500 | 0.9600 | 0.9300 |
| 3.1 | 0.8400 | 0.7600 | 0.5900 | 0.7800 |
| 6.3 | 0.8400 | 0.8900 | 0.7600 | 0.8900 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

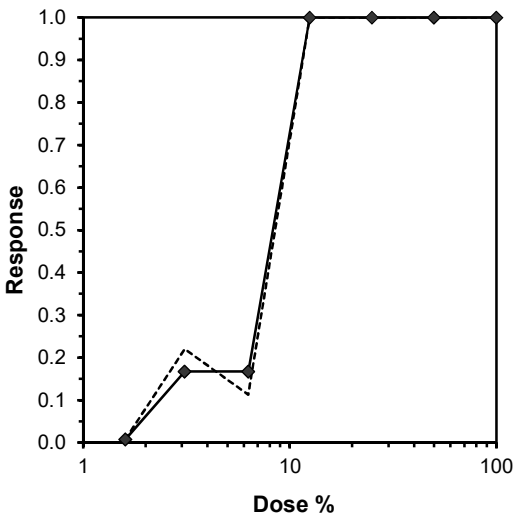
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9550 | 1.0026 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | | | | | |
| ASW Control | 0.9525 | 1.0000 | 1.3536 | 1.3030 | 1.3967 | 2.935 | 4 | * | | | 19 | 400 |
| 1.6 | 0.9450 | 0.9921 | 1.3353 | 1.3030 | 1.3694 | 2.140 | 4 | 0.338 | 2.290 | 0.1244 | 22 | 400 |
| *3.1 | 0.7425 | 0.7795 | 1.0441 | 0.8759 | 1.1593 | 11.500 | 4 | 5.698 | 2.290 | 0.1244 | 103 | 400 |
| *6.3 | 0.8450 | 0.8871 | 1.1709 | 1.0588 | 1.2327 | 7.033 | 4 | 3.365 | 2.290 | 0.1244 | 62 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.932068 | 0.887 | -0.97617 | 1.56561 |
| Bartlett's Test indicates equal variances (p = 0.11) | 5.95985 | 11.34487 | | |
| The control means are not significantly different (p = 0.82) | 0.244256 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.065758 | 0.06896 | 0.085779 | 0.005899 | 2.7E-04 | 3, 12 |

### Trimmed Spearman-Karber

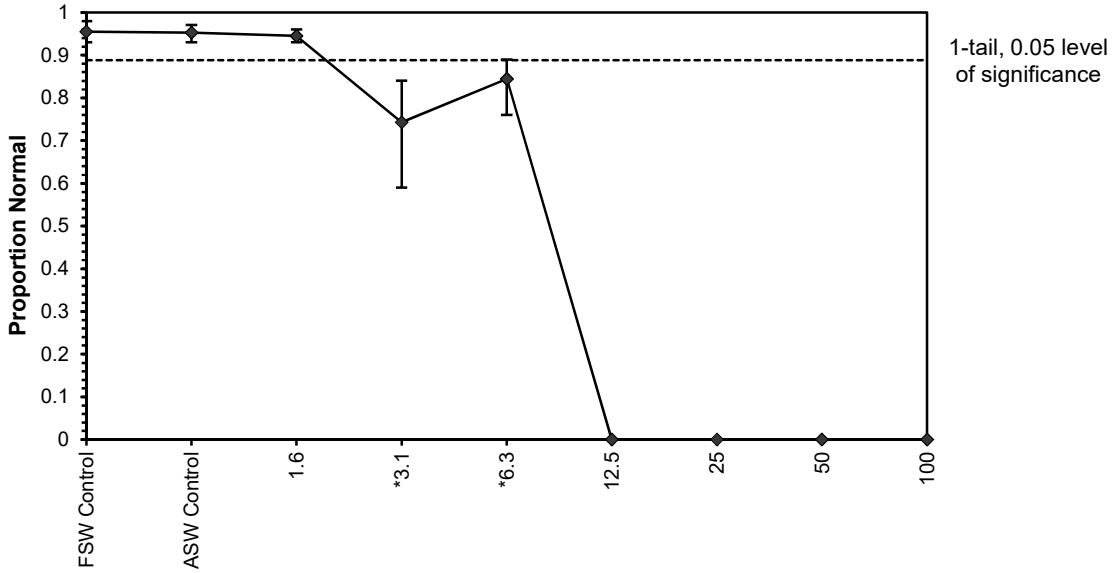
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 7.3700 | 7.0823 | 7.6693 |
| 10.0% | 7.7387 | 7.4212 | 8.0699 |
| 20.0% | 8.2864 | 8.1355 | 8.4402 |
| Auto-0.8% | 7.0808 | 6.8227 | 7.3487 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:00 | Test ID: | PR1978/03 | Sample ID: | Y020321 |
| End Date: | 8/03/2021 17:00 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:00 | Test ID: | PR1978/03 | Sample ID: | Y020321 |
| End Date: | 8/03/2021 17:00 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| ASW Control | | 95.25 | 93.00 | 97.00 | 1.71 | 1.37 | 4 |
| 1.6 | | 94.50 | 93.00 | 96.00 | 1.29 | 1.20 | 4 |
| 3.1 | | 74.25 | 59.00 | 84.00 | 10.72 | 4.41 | 4 |
| 6.3 | | 84.50 | 76.00 | 89.00 | 6.14 | 2.93 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:00 | Test ID: | PR1978/03 | Sample ID: | Y020321 |
| End Date: | 8/03/2021 17:00 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9500 | 0.9700 | 0.9300 | 0.9600 |
| 1.6 | 0.9400 | 0.9500 | 0.9600 | 0.9300 |
| 3.1 | 0.8400 | 0.7600 | 0.5900 | 0.7800 |
| 6.3 | 0.8400 | 0.8900 | 0.7600 | 0.8900 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

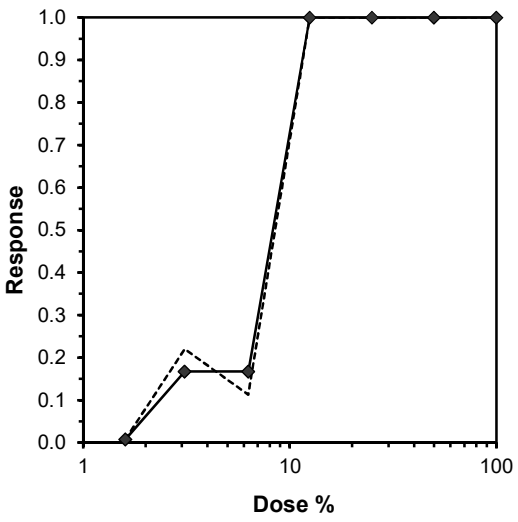
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9550 | 1.0026 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | | | | | |
| ASW Control | 0.9525 | 1.0000 | 1.3536 | 1.3030 | 1.3967 | 2.935 | 4 | * | | | 0.9525 | 1.0000 |
| 1.6 | 0.9450 | 0.9921 | 1.3353 | 1.3030 | 1.3694 | 2.140 | 4 | 0.338 | 2.290 | 0.1244 | 0.9450 | 0.9921 |
| *3.1 | 0.7425 | 0.7795 | 1.0441 | 0.8759 | 1.1593 | 11.500 | 4 | 5.698 | 2.290 | 0.1244 | 0.7938 | 0.8333 |
| *6.3 | 0.8450 | 0.8871 | 1.1709 | 1.0588 | 1.2327 | 7.033 | 4 | 3.365 | 2.290 | 0.1244 | 0.7938 | 0.8333 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.932068 | 0.887 | -0.97617 | 1.56561 |
| Bartlett's Test indicates equal variances (p = 0.11) | 5.95985 | 11.34487 | | |
| The control means are not significantly different (p = 0.82) | 0.244256 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.065758 | 0.06896 | 0.085779 | 0.005899 | 2.7E-04 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

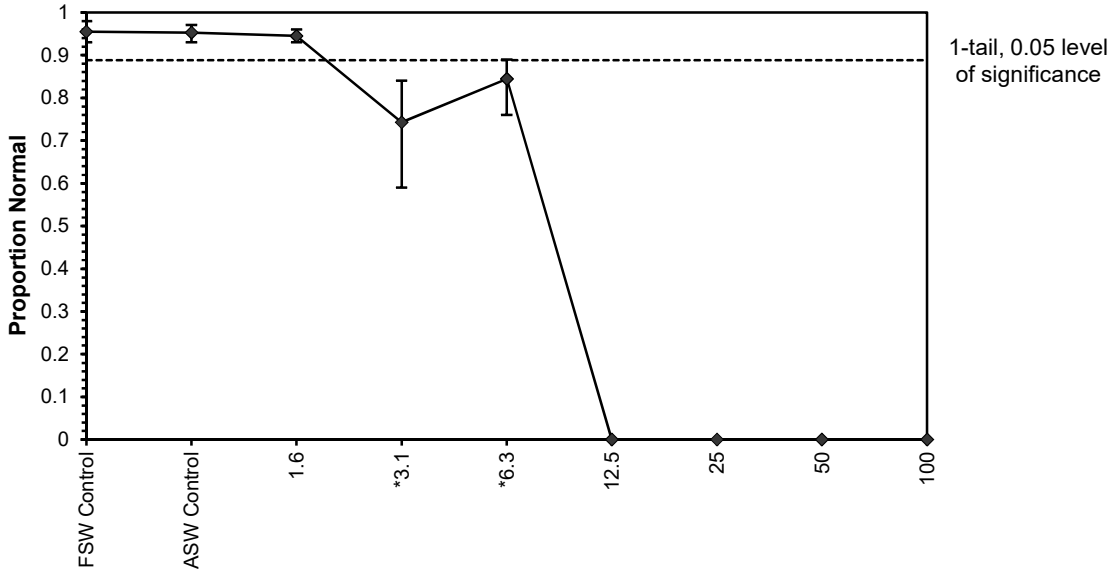
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.1127 | 0.1082 | 1.7900 | 2.4165 | 0.1195 |
| IC10 | 2.5806 | 0.3007 | 2.2352 | 3.1146 | 9.4537 |
| IC15 | 2.9772 | 1.5775 | 2.5158 | 8.4430 | 0.8945 |
| IC20 | 6.3786 | 1.0993 | 0.9704 | 6.5936 | -2.3462 |
| IC25 | 6.4855 | 0.0678 | 6.3000 | 6.7005 | 0.1202 |
| IC40 | 6.7647 | 0.0652 | 6.5860 | 6.9729 | 0.1268 |
| IC50 | 6.9398 | 0.0638 | 6.7645 | 7.1435 | 0.1285 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:00 | Test ID: | PR1978/03 | Sample ID: | Y020321 |
| End Date: | 8/03/2021 17:00 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:00 | Test ID: | PR1978/03 | Sample ID: | Y020321 |
| End Date: | 8/03/2021 17:00 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| ASW Control | | 95.25 | 93.00 | 97.00 | 1.71 | 1.37 | 4 |
| 1.6 | | 94.50 | 93.00 | 96.00 | 1.29 | 1.20 | 4 |
| 3.1 | | 74.25 | 59.00 | 84.00 | 10.72 | 4.41 | 4 |
| 6.3 | | 84.50 | 76.00 | 89.00 | 6.14 | 2.93 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Larval Development Test-Proportion Normal

| | | | |
|---|---|---|---|
| Start Date: | 18/02/2021 16:20 | Test ID: | PR1978/06 |
| End Date: | 21/02/2021 16:20 | Lab ID: | 9939 |
| Sample Date: | | Protocol: | ESA 106 |
| Comments: | | | |

| | | | | |
|---|---|---|---|---|
| Sample ID: | Y0160221 | | | |
| Sample Type: | PFW-Produced Formation Water | | | |
| Test Species: | MG-Mytilus galloprovincialis | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7100 | 0.6900 | 0.7400 | 0.6900 |
| ASW Control | 0.7900 | 0.6900 | 0.6800 | 0.7200 |
| 1.6 | 0.6900 | 0.7300 | 0.7100 | 0.6800 |
| 3.1 | 0.6900 | 0.7400 | 0.7100 | 0.7000 |
| 6.3 | 0.7100 | 0.6800 | 0.7400 | 0.6800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

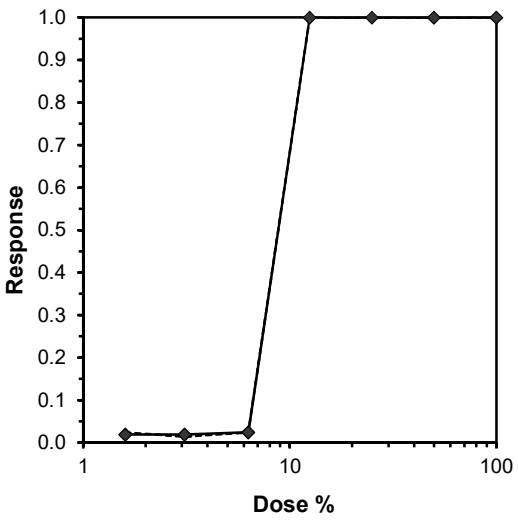
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7075 | 0.9826 | 0.9996 | 0.9803 | 1.0357 | 2.619 | 4 | | | | | |
| ASW Control | 0.7200 | 1.0000 | 1.0144 | 0.9695 | 1.0948 | 5.587 | 4 | * | | | 112 | 400 |
| 1.6 | 0.7025 | 0.9757 | 0.9941 | 0.9695 | 1.0244 | 2.448 | 4 | 0.785 | 2.290 | 0.0594 | 119 | 400 |
| 3.1 | 0.7100 | 0.9861 | 1.0023 | 0.9803 | 1.0357 | 2.393 | 4 | 0.467 | 2.290 | 0.0594 | 116 | 400 |
| 6.3 | 0.7025 | 0.9757 | 0.9942 | 0.9695 | 1.0357 | 3.183 | 4 | 0.780 | 2.290 | 0.0594 | 119 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.925698 | 0.887 | 1.004873 | 0.893876 |
| Bartlett's Test indicates equal variances (p = 0.41) | 2.88409 | 11.34487 | | |
| The control means are not significantly different (p = 0.65) | 0.47533 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.054699 | 0.075852 | 0.000368 | 0.001345 | 0.843352 | 3, 12 |

### Trimmed Spearman-Karber

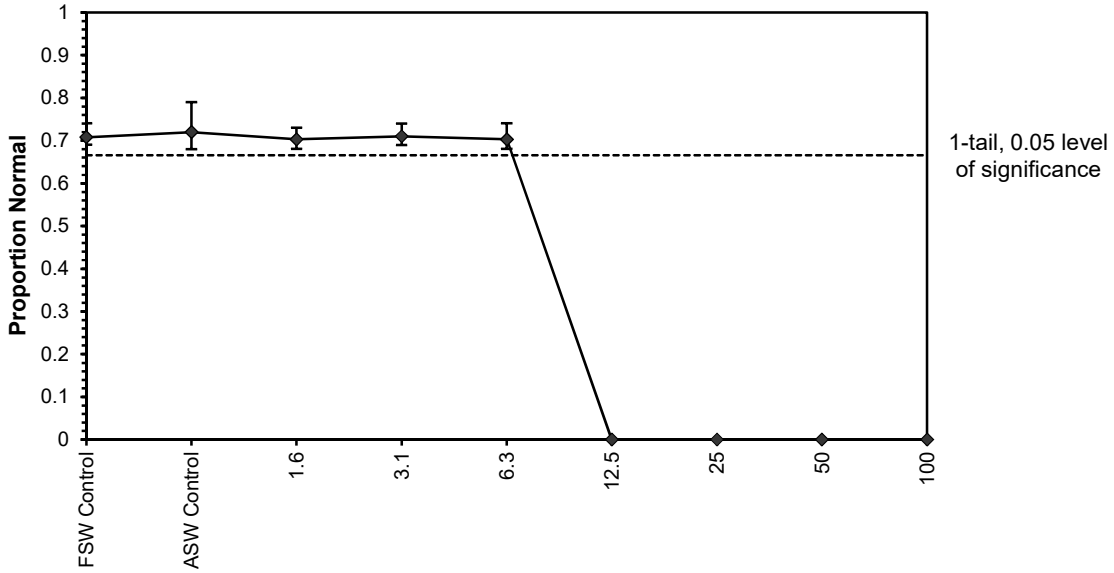
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 8.7987 | 8.7501 | 8.8476 |
| 10.0% | 8.7987 | 8.7501 | 8.8476 |
| 20.0% | 8.7987 | 8.7501 | 8.8476 |
| Auto-1.9% | 8.7819 | 8.6750 | 8.8901 |



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 16:20 | Test ID: | PR1978/06 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 16:20 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 16:20 | Test ID: | PR1978/06 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 16:20 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 70.75 | 69.00 | 74.00 | 2.36 | 2.17 | 4 |
| ASW Control | | 72.00 | 68.00 | 79.00 | 4.97 | 3.10 | 4 |
| 1.6 | | 70.25 | 68.00 | 73.00 | 2.22 | 2.12 | 4 |
| 3.1 | | 71.00 | 69.00 | 74.00 | 2.16 | 2.07 | 4 |
| 6.3 | | 70.25 | 68.00 | 74.00 | 2.87 | 2.41 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 16:20 | Test ID: | PR1978/06 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 16:20 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7100 | 0.6900 | 0.7400 | 0.6900 |
| ASW Control | 0.7900 | 0.6900 | 0.6800 | 0.7200 |
| 1.6 | 0.6900 | 0.7300 | 0.7100 | 0.6800 |
| 3.1 | 0.6900 | 0.7400 | 0.7100 | 0.7000 |
| 6.3 | 0.7100 | 0.6800 | 0.7400 | 0.6800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

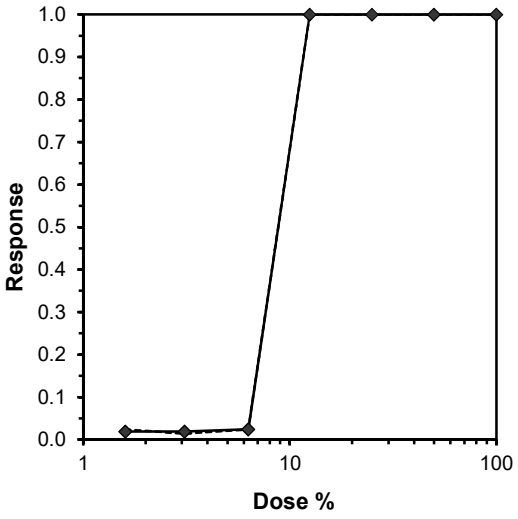
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7075 | 0.9826 | 0.9996 | 0.9803 | 1.0357 | 2.619 | 4 | | | | | |
| ASW Control | 0.7200 | 1.0000 | 1.0144 | 0.9695 | 1.0948 | 5.587 | 4 | * | | | 0.7200 | 1.0000 |
| 1.6 | 0.7025 | 0.9757 | 0.9941 | 0.9695 | 1.0244 | 2.448 | 4 | 0.785 | 2.290 | 0.0594 | 0.7063 | 0.9809 |
| 3.1 | 0.7100 | 0.9861 | 1.0023 | 0.9803 | 1.0357 | 2.393 | 4 | 0.467 | 2.290 | 0.0594 | 0.7063 | 0.9809 |
| 6.3 | 0.7025 | 0.9757 | 0.9942 | 0.9695 | 1.0357 | 3.183 | 4 | 0.780 | 2.290 | 0.0594 | 0.7025 | 0.9757 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.925698 | 0.887 | 1.004873 | 0.893876 |
| Bartlett's Test indicates equal variances (p = 0.41) | 2.88409 | 11.34487 | | |
| The control means are not significantly different (p = 0.65) | 0.47533 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.054699 | 0.075852 | 0.000368 | 0.001345 | 0.843352 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

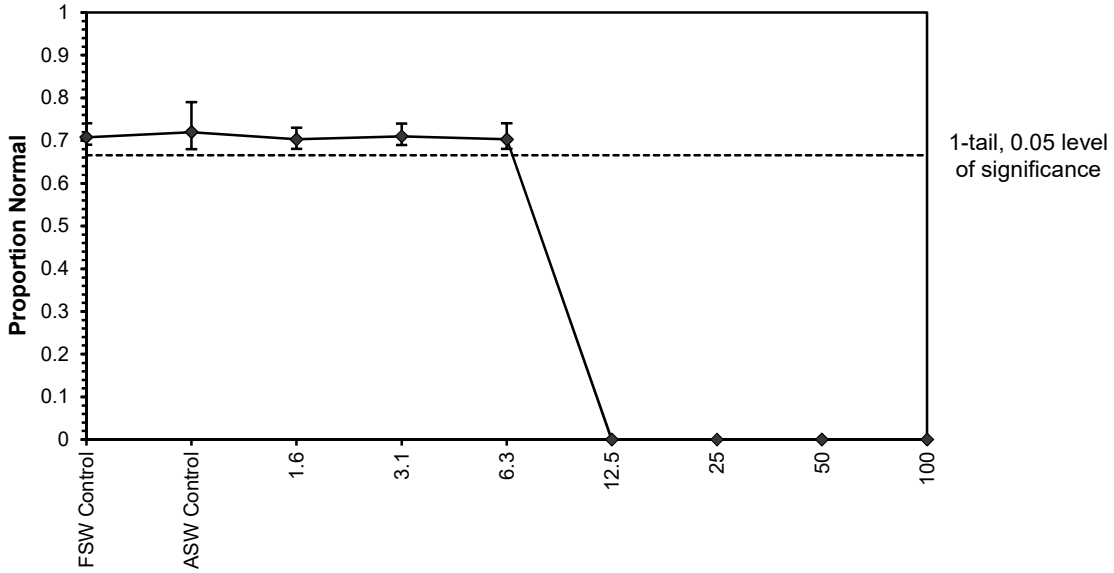
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.3389 | 1.9079 | 0.0000 | 6.3946 | -1.5964 |
| IC10 | 6.4118 | 0.1277 | 6.2621 | 6.4636 | -12.4284 |
| IC15 | 6.4821 | 0.0335 | 6.3421 | 6.5306 | -0.6303 |
| IC20 | 6.5506 | 0.0315 | 6.4219 | 6.5964 | -0.6105 |
| IC25 | 6.6182 | 0.0298 | 6.4974 | 6.6620 | -0.5930 |
| IC40 | 6.8228 | 0.0262 | 6.7177 | 6.8629 | -0.5505 |
| IC50 | 6.9683 | 0.0245 | 6.8675 | 7.0065 | -0.5289 |



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 16:20 | Test ID: | PR1978/06 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 16:20 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 16:20 | Test ID: | PR1978/06 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 16:20 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 70.75 | 69.00 | 74.00 | 2.36 | 2.17 | 4 |
| ASW Control | | 72.00 | 68.00 | 79.00 | 4.97 | 3.10 | 4 |
| 1.6 | | 70.25 | 68.00 | 73.00 | 2.22 | 2.12 | 4 |
| 3.1 | | 71.00 | 69.00 | 74.00 | 2.16 | 2.07 | 4 |
| 6.3 | | 70.25 | 68.00 | 74.00 | 2.87 | 2.41 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 17:30 | Test ID: | PR1978/06 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 17:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7400 | 0.7900 | 0.7600 | 0.7300 |
| ASW Control | 0.7500 | 0.7000 | 0.7600 | 0.7300 |
| 1.6 | 0.7300 | 0.7900 | 0.6900 | 0.7500 |
| 3.1 | 0.7600 | 0.7800 | 0.7400 | 0.7500 |
| 6.3 | 0.6900 | 0.6900 | 0.7600 | 0.6500 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

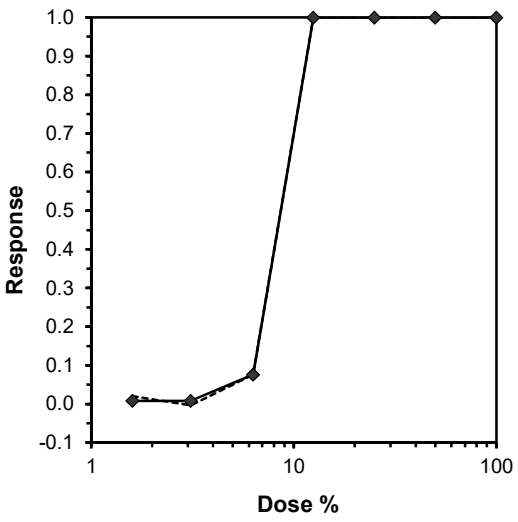
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7550 | 1.0272 | 1.0534 | 1.0244 | 1.0948 | 2.948 | 4 | * | | | 98 | 400 |
| ASW Control | 0.7350 | 1.0000 | 1.0304 | 0.9912 | 1.0588 | 2.893 | 4 | | | | | |
| 1.6 | 0.7400 | 1.0068 | 1.0367 | 0.9803 | 1.0948 | 4.597 | 4 | 0.603 | 2.290 | 0.0637 | 104 | 400 |
| 3.1 | 0.7575 | 1.0306 | 1.0561 | 1.0357 | 1.0826 | 1.897 | 4 | -0.096 | 2.290 | 0.0637 | 97 | 400 |
| *6.3 | 0.6975 | 0.9490 | 0.9893 | 0.9377 | 1.0588 | 5.106 | 4 | 2.306 | 2.290 | 0.0637 | 121 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.95443 | 0.887 | 0.462649 | -0.04225 |
| Bartlett's Test indicates equal variances (p = 0.48) | 2.470611 | 11.34487 | | |
| The control means are not significantly different (p = 0.33) | 1.070065 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs FSW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.056679 | 0.075034 | 0.003828 | 0.001547 | 0.111519 | 3, 12 |

### Trimmed Spearman-Karber

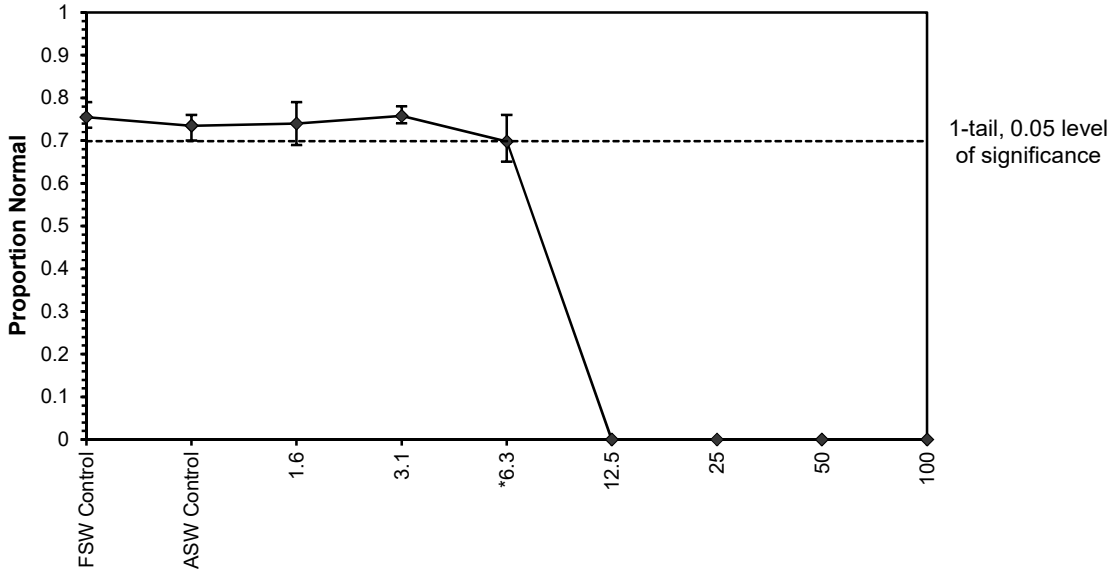
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 8.5952 | 8.3874 | 8.8082 |
| 10.0% | 8.6270 | 8.5356 | 8.7193 |
| 20.0% | 8.6270 | 8.5356 | 8.7193 |
| Auto-0.8% | 8.4331 | 8.2737 | 8.5956 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 17:30 | Test ID: | PR1978/06 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 17:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 17:30 | Test ID: | PR1978/06 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 17:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 75.50 | 73.00 | 79.00 | 2.65 | 2.15 | 4 |
| ASW Control | | 73.50 | 70.00 | 76.00 | 2.65 | 2.21 | 4 |
| 1.6 | | 74.00 | 69.00 | 79.00 | 4.16 | 2.76 | 4 |
| 3.1 | | 75.75 | 74.00 | 78.00 | 1.71 | 1.73 | 4 |
| 6.3 | | 69.75 | 65.00 | 76.00 | 4.57 | 3.07 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 17:30 | Test ID: | PR1978/06 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 17:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7400 | 0.7900 | 0.7600 | 0.7300 |
| ASW Control | 0.7500 | 0.7000 | 0.7600 | 0.7300 |
| 1.6 | 0.7300 | 0.7900 | 0.6900 | 0.7500 |
| 3.1 | 0.7600 | 0.7800 | 0.7400 | 0.7500 |
| 6.3 | 0.6900 | 0.6900 | 0.7600 | 0.6500 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

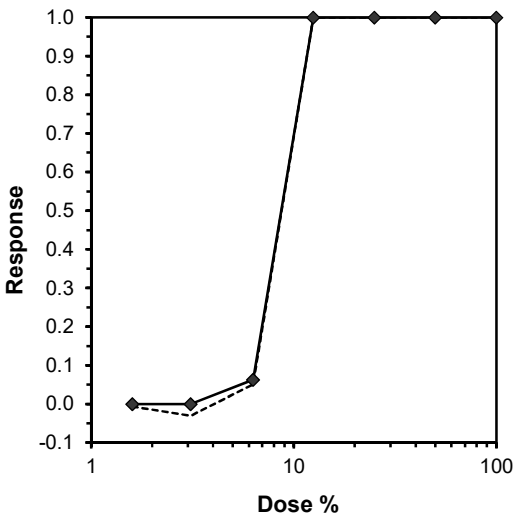
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7550 | 1.0272 | 1.0534 | 1.0244 | 1.0948 | 2.948 | 4 | | | | | |
| ASW Control | 0.7350 | 1.0000 | 1.0304 | 0.9912 | 1.0588 | 2.893 | 4 | * | | | 0.7442 | 1.0000 |
| 1.6 | 0.7400 | 1.0068 | 1.0367 | 0.9803 | 1.0948 | 4.597 | 4 | -0.227 | 2.290 | 0.0633 | 0.7442 | 1.0000 |
| 3.1 | 0.7575 | 1.0306 | 1.0561 | 1.0357 | 1.0826 | 1.897 | 4 | -0.929 | 2.290 | 0.0633 | 0.7442 | 1.0000 |
| 6.3 | 0.6975 | 0.9490 | 0.9893 | 0.9377 | 1.0588 | 5.106 | 4 | 1.487 | 2.290 | 0.0633 | 0.6975 | 0.9373 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.961676 | 0.887 | 0.339983 | 0.007771 |
| Bartlett's Test indicates equal variances (p = 0.47) | 2.556473 | 11.34487 | | |
| The control means are not significantly different (p = 0.33) | 1.070065 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.057586 | 0.078315 | 0.003157 | 0.001528 | 0.158328 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

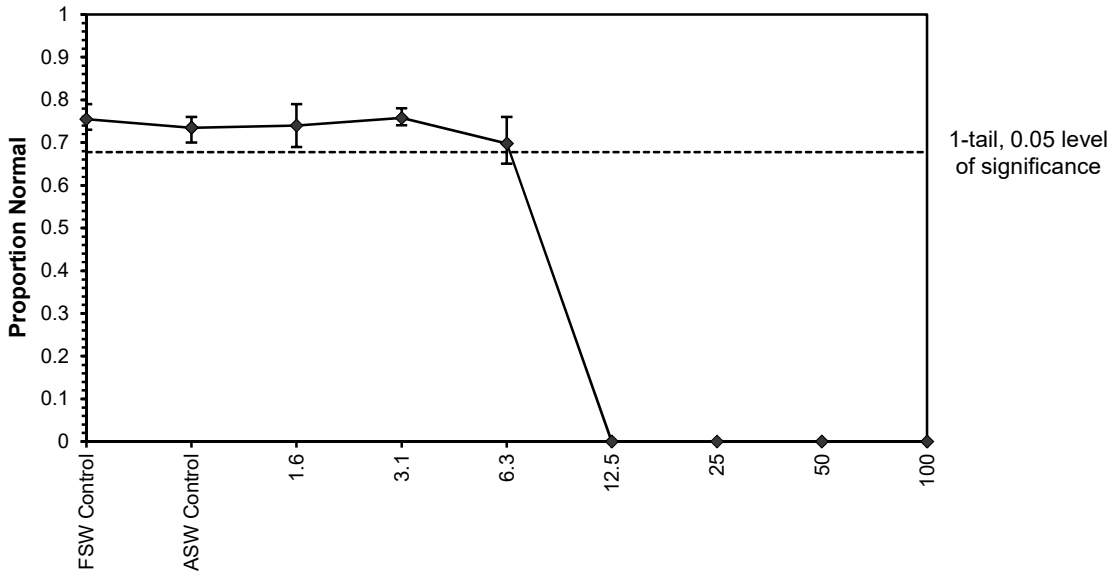
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 5.5244 | 0.7400 | 3.4417 | 6.8775 | -0.0480 |
| IC10 | 6.3576 | 0.1705 | 5.3561 | 6.5022 | -3.0444 |
| IC15 | 6.4318 | 0.0430 | 6.2996 | 6.5764 | 0.1431 |
| IC20 | 6.5036 | 0.0424 | 6.3730 | 6.6476 | 0.1509 |
| IC25 | 6.5739 | 0.0419 | 6.4448 | 6.7147 | 0.1570 |
| IC40 | 6.7846 | 0.0406 | 6.6594 | 6.9175 | 0.1694 |
| IC50 | 6.9330 | 0.0398 | 6.8102 | 7.0615 | 0.1745 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 17:30 | Test ID: | PR1978/06 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 17:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 17:30 | Test ID: | PR1978/06 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 17:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 75.50 | 73.00 | 79.00 | 2.65 | 2.15 | 4 |
| ASW Control | | 73.50 | 70.00 | 76.00 | 2.65 | 2.21 | 4 |
| 1.6 | | 74.00 | 69.00 | 79.00 | 4.16 | 2.76 | 4 |
| 3.1 | | 75.75 | 74.00 | 78.00 | 1.71 | 1.73 | 4 |
| 6.3 | | 69.75 | 65.00 | 76.00 | 4.57 | 3.07 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 15:30 | Test ID: | PR1978/06 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 15:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7100 | 0.7600 | 0.8100 | 0.7900 |
| ASW Control | 0.7800 | 0.8100 | 0.8000 | 0.7600 |
| 1.6 | 0.7900 | 0.8100 | 0.7600 | 0.8200 |
| 3.1 | 0.5100 | 0.5600 | 0.5900 | 0.5400 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

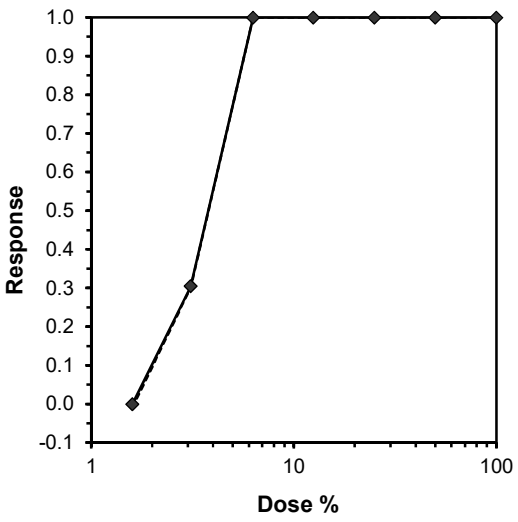
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7675 | 0.9746 | 1.0689 | 1.0021 | 1.1198 | 4.776 | 4 | | | | | |
| ASW Control | 0.7875 | 1.0000 | 1.0921 | 1.0588 | 1.1198 | 2.474 | 4 | * | | | 85 | 400 |
| 1.6 | 0.7950 | 1.0095 | 1.1015 | 1.0588 | 1.1326 | 2.951 | 4 | -0.426 | 2.180 | 0.0482 | 82 | 400 |
| *3.1 | 0.5500 | 0.6984 | 0.8356 | 0.7954 | 0.8759 | 4.054 | 4 | 11.600 | 2.180 | 0.0482 | 180 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.935305 | 0.859 | -0.2604 | -1.20059 |
| Bartlett's Test indicates equal variances (p = 0.93) | 0.144839 | 9.21034 | | |
| The control means are not significantly different (p = 0.45) | 0.803864 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.040695 | 0.051656 | 0.091072 | 0.000978 | 9.7E-07 | 2, 9 |

### Trimmed Spearman-Karber

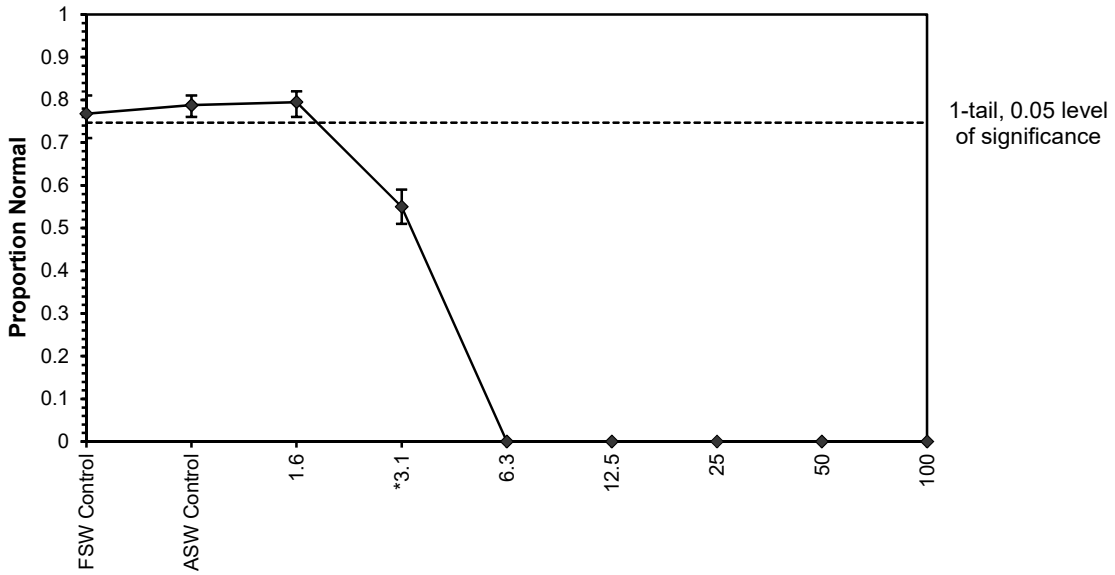
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.5860 | 3.4746 | 3.7009 |
| 5.0% | 3.6291 | 3.5028 | 3.7599 |
| 10.0% | 3.6704 | 3.5227 | 3.8242 |
| 20.0% | 3.7431 | 3.5207 | 3.9795 |
| Auto-0.0% | 3.5860 | 3.4746 | 3.7009 |



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 15:30 | Test ID: | PR1978/06 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 15:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 15:30 | Test ID: | PR1978/06 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 15:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 76.75 | 71.00 | 81.00 | 4.35 | 2.72 | 4 |
| ASW Control | | 78.75 | 76.00 | 81.00 | 2.22 | 1.89 | 4 |
| 1.6 | | 79.50 | 76.00 | 82.00 | 2.65 | 2.05 | 4 |
| 3.1 | | 55.00 | 51.00 | 59.00 | 3.37 | 3.34 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 15:30 | Test ID: | PR1978/06 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 15:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7100 | 0.7600 | 0.8100 | 0.7900 |
| ASW Control | 0.7800 | 0.8100 | 0.8000 | 0.7600 |
| 1.6 | 0.7900 | 0.8100 | 0.7600 | 0.8200 |
| 3.1 | 0.5100 | 0.5600 | 0.5900 | 0.5400 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

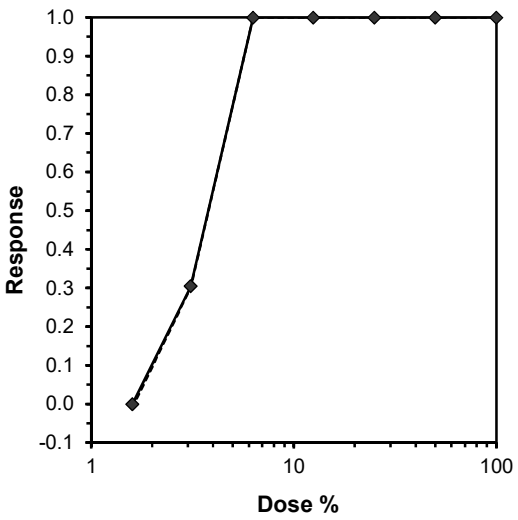
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7675 | 0.9746 | 1.0689 | 1.0021 | 1.1198 | 4.776 | 4 | | | | | |
| ASW Control | 0.7875 | 1.0000 | 1.0921 | 1.0588 | 1.1198 | 2.474 | 4 | * | | | 0.7913 | 1.0000 |
| 1.6 | 0.7950 | 1.0095 | 1.1015 | 1.0588 | 1.1326 | 2.951 | 4 | -0.426 | 2.180 | 0.0482 | 0.7913 | 1.0000 |
| *3.1 | 0.5500 | 0.6984 | 0.8356 | 0.7954 | 0.8759 | 4.054 | 4 | 11.600 | 2.180 | 0.0482 | 0.5500 | 0.6951 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.935305 | 0.859 | -0.2604 | -1.20059 |
| Bartlett's Test indicates equal variances (p = 0.93) | 0.144839 | 9.21034 | | |
| The control means are not significantly different (p = 0.45) | 0.803864 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.040695 | 0.051656 | 0.091072 | 0.000978 | 9.7E-07 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

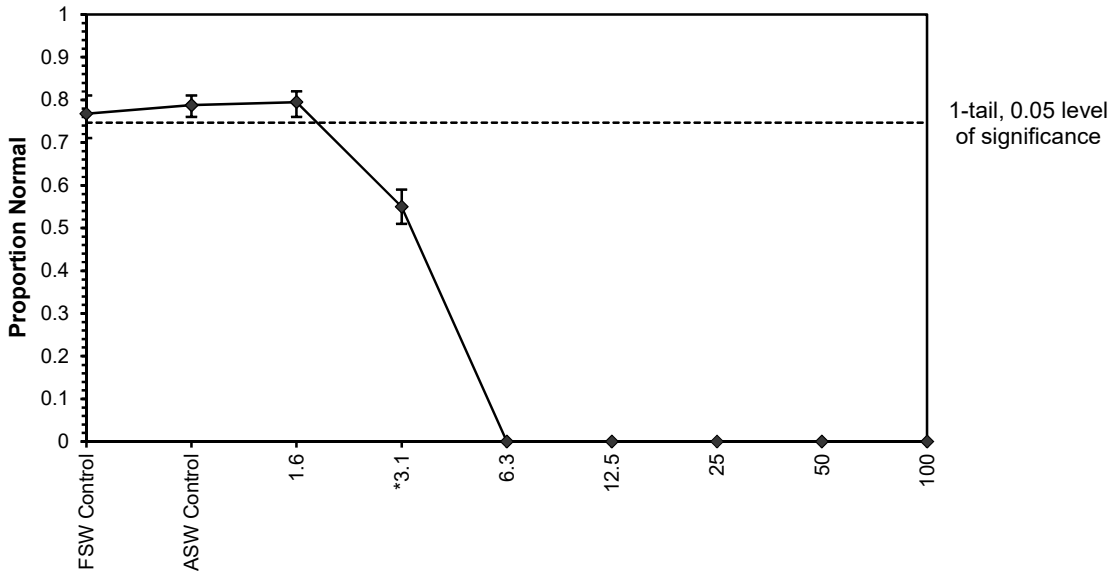
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.8462 | 0.0443 | 1.6141 | 1.8957 | -2.6331 |
| IC10 | 2.0872 | 0.0468 | 1.8892 | 2.1914 | -1.3638 |
| IC15 | 2.3270 | 0.0556 | 2.1421 | 2.4914 | -0.3001 |
| IC20 | 2.5693 | 0.0695 | 2.3547 | 2.8143 | 0.1567 |
| IC25 | 2.8173 | 0.0875 | 2.5487 | 3.1413 | 0.2987 |
| IC40 | 3.1765 | 0.0159 | 3.1251 | 3.2279 | -0.0982 |
| IC50 | 3.2600 | 0.0155 | 3.2105 | 3.3098 | -0.0963 |



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 15:30 | Test ID: | PR1978/06 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 15:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 15:30 | Test ID: | PR1978/06 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 15:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 76.75 | 71.00 | 81.00 | 4.35 | 2.72 | 4 |
| ASW Control | | 78.75 | 76.00 | 81.00 | 2.22 | 1.89 | 4 |
| 1.6 | | 79.50 | 76.00 | 82.00 | 2.65 | 2.05 | 4 |
| 3.1 | | 55.00 | 51.00 | 59.00 | 3.37 | 3.34 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 13:00 | Test ID: | PR1978/07 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 13:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9600 | 0.9800 | 0.9600 | 0.9700 |
| ASW Control | 0.9800 | 0.9900 | 1.0000 | 0.9600 |
| 1.6 | 0.9500 | 0.9800 | 0.9600 | 0.9300 |
| 3.1 | 0.9700 | 0.9500 | 0.9800 | 0.9900 |
| 6.3 | 0.9800 | 0.9700 | 0.9600 | 0.9500 |
| 12.5 | 0.8600 | 0.8100 | 0.7900 | 0.8400 |
| 25 | 0.3200 | 0.1600 | 0.2400 | 0.3000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9675 | 0.9847 | 1.3911 | 1.3694 | 1.4289 | 2.033 | 4 | | | | | |
| ASW Control | 0.9825 | 1.0000 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | * | | | 7 | 400 |
| 1.6 | 0.9550 | 0.9720 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | 2.104 | 2.410 | 0.0982 | 18 | 400 |
| 3.1 | 0.9725 | 0.9898 | 1.4104 | 1.3453 | 1.4706 | 3.751 | 4 | 0.909 | 2.410 | 0.0982 | 11 | 400 |
| 6.3 | 0.9650 | 0.9822 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | 1.530 | 2.410 | 0.0982 | 14 | 400 |
| *12.5 | 0.8250 | 0.8397 | 1.1403 | 1.0948 | 1.1873 | 3.603 | 4 | 7.535 | 2.410 | 0.0982 | 70 | 400 |
| *25 | 0.2550 | 0.2595 | 0.5261 | 0.4115 | 0.6013 | 16.220 | 4 | 22.602 | 2.410 | 0.0982 | 298 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

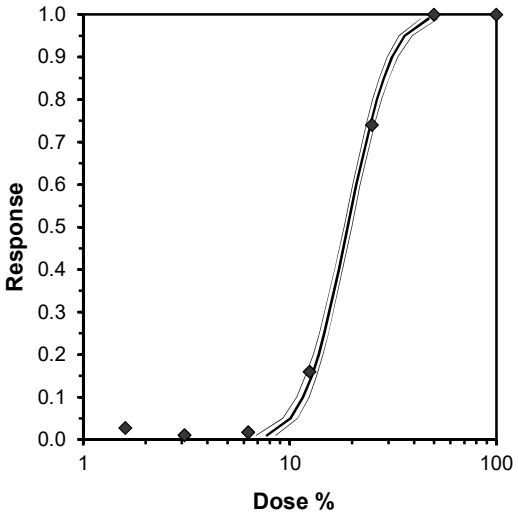
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.964728 | 0.916 | -0.33293 | -0.44461 |
| Bartlett's Test indicates equal variances (p = 0.76) | 2.599519 | 15.08627 | | |
| The control means are not significantly different (p = 0.16) | 1.606623 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.033168 | 0.033678 | 0.498198 | 0.003323 | 5.1E-14 | 5, 18 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 5.952886 | 0.31054 | 5.344227 | 6.561545 | 0.0175 | 6.558151 | 11.0705 | 0.26 | 1.28036 | 0.167986 | 7 |
| Intercept | -2.62184 | 0.407944 | -3.42141 | -1.82227 | | | | | | | |
| TSCR | 0.031063 | 0.004416 | 0.022407 | 0.03972 | | | | | | | |

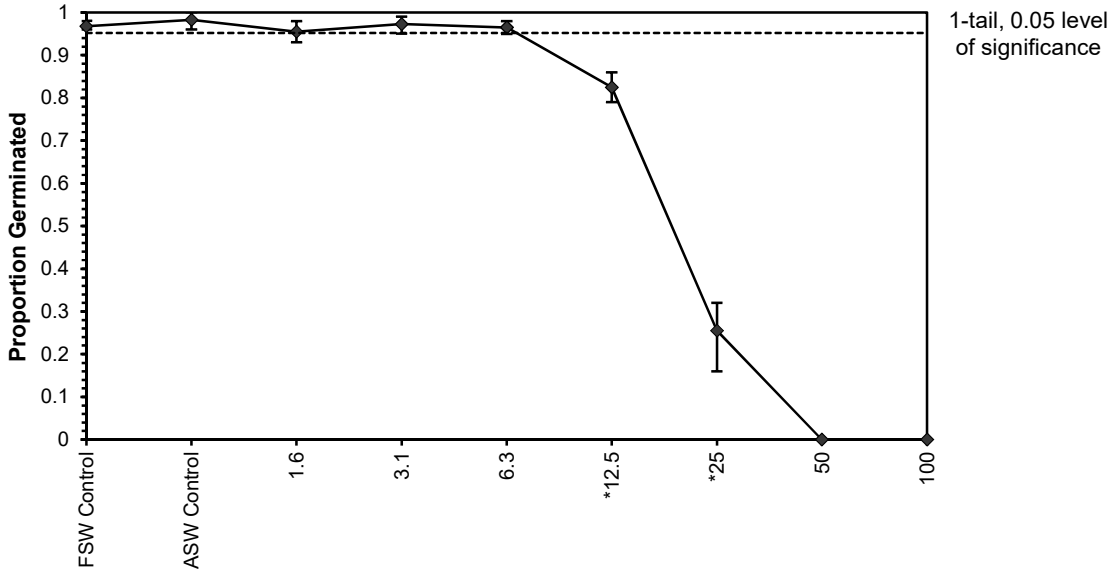
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 7.754731 | 6.893198 | 8.548282 |
| EC05 | 3.355 | 10.09365 | 9.220699 | 10.88723 |
| EC10 | 3.718 | 11.61656 | 10.75879 | 12.39557 |
| EC15 | 3.964 | 12.77185 | 11.9325 | 13.53696 |
| EC20 | 4.158 | 13.77145 | 12.95013 | 14.52517 |
| EC25 | 4.326 | 14.69113 | 13.88613 | 15.43685 |
| EC40 | 4.747 | 17.29025 | 16.51354 | 18.04208 |
| EC50 | 5.000 | 19.07041 | 18.28239 | 19.866 |
| EC60 | 5.253 | 21.03385 | 20.19265 | 21.92637 |
| EC75 | 5.674 | 24.7551 | 23.69533 | 25.97072 |
| EC80 | 5.842 | 26.4083 | 25.21053 | 27.81695 |
| EC85 | 6.036 | 28.47515 | 27.07802 | 30.15902 |
| EC90 | 6.282 | 31.30707 | 29.59854 | 33.41847 |
| EC95 | 6.645 | 36.03064 | 33.72919 | 38.95827 |
| EC99 | 7.326 | 46.89789 | 42.99547 | 52.06725 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 13:00 | Test ID: | PR1978/07 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 13:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 13:00 | Test ID: | PR1978/07 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 13:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 96.75 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| ASW Control | | 98.25 | 96.00 | 100.00 | 1.71 | 1.33 | 4 |
| 1.6 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 3.1 | | 97.25 | 95.00 | 99.00 | 1.71 | 1.34 | 4 |
| 6.3 | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 12.5 | | 82.50 | 79.00 | 86.00 | 3.11 | 2.14 | 4 |
| 25 | | 25.50 | 16.00 | 32.00 | 7.19 | 10.51 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 2:30:00 F | Test ID: | PR1978/0 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 14:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9600 | 0.9500 | 0.9800 | 0.9400 |
| ASW Control | 0.9700 | 0.9800 | 0.9600 | 0.9500 |
| 1.6 | 0.9400 | 0.9600 | 0.9100 | 0.9300 |
| 3.1 | 0.9400 | 0.9700 | 0.9500 | 0.9300 |
| 6.3 | 0.9800 | 0.9600 | 0.9500 | 0.9200 |
| 12.5 | 0.5700 | 0.4600 | 0.4700 | 0.3900 |
| 25 | 0.0500 | 0.0800 | 0.0700 | 0.0400 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9575 | 0.9922 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | | | | | |
| ASW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | * | | | 14 | 400 |
| 1.6 | 0.9350 | 0.9689 | 1.3155 | 1.2661 | 1.3694 | 3.274 | 4 | 1.940 | 2.410 | 0.0865 | 26 | 400 |
| 3.1 | 0.9475 | 0.9819 | 1.3421 | 1.3030 | 1.3967 | 3.002 | 4 | 1.199 | 2.410 | 0.0865 | 21 | 400 |
| 6.3 | 0.9525 | 0.9870 | 1.3569 | 1.2840 | 1.4289 | 4.419 | 4 | 0.785 | 2.410 | 0.0865 | 19 | 400 |
| *12.5 | 0.4725 | 0.4896 | 0.7577 | 0.6745 | 0.8556 | 9.838 | 4 | 17.489 | 2.410 | 0.0865 | 211 | 400 |
| *25 | 0.0600 | 0.0622 | 0.2453 | 0.2014 | 0.2868 | 15.866 | 4 | 31.773 | 2.410 | 0.0865 | 376 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.981844 | 0.916 | 0.255624 | -0.17532 |
| Bartlett's Test indicates equal variances (p = 0.79) | 2.391227 | 15.08627 | | |
| The control means are not significantly different (p = 0.55) | 0.632374 | 2.446912 | | |

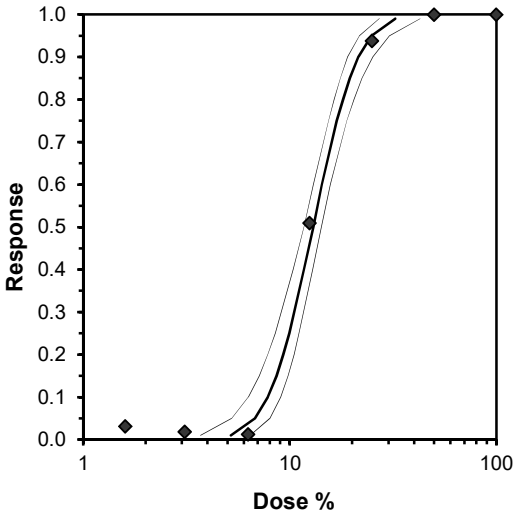
| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.038167 | 0.039514 | 0.87473 | 0.002574 | 3.7E-17 | 5, 18 |
| Treatments vs ASW Control | | | | | | | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 5.847336 | 0.54566 | 4.444673 | 7.25 | 0.035 | 13.4281 | 11.0705 | 2.0E-02 | 1.112765 | 0.171018 | 7 |
| Intercept | -1.50671 | 0.632979 | -3.13384 | 0.120411 | | | | | | | |
| TSCR | 0.045857 | 0.00957 | 0.021257 | 0.070456 | | | | | | | |

| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 5.18702 | 3.696781 | 6.425549 |
| EC05 | 3.355 | 6.783686 | 5.233532 | 8.021702 |
| EC10 | 3.718 | 7.827029 | 6.288953 | 9.043417 |
| EC15 | 3.964 | 8.620185 | 7.111119 | 9.815922 |
| EC20 | 4.158 | 9.307498 | 7.833418 | 10.48622 |
| EC25 | 4.326 | 9.940665 | 8.503852 | 11.10733 |
| EC40 | 4.747 | 11.73379 | 10.40192 | 12.91079 |
| EC50 | 5.000 | 12.96479 | 11.67543 | 14.21471 |
| EC60 | 5.253 | 14.32492 | 13.02628 | 15.74472 |
| EC75 | 5.674 | 16.9089 | 15.4006 | 18.93471 |
| EC80 | 5.842 | 18.05917 | 16.38724 | 20.46189 |
| EC85 | 6.036 | 19.49908 | 17.57688 | 22.44971 |
| EC90 | 6.282 | 21.47503 | 19.14717 | 25.29335 |
| EC95 | 6.645 | 24.77793 | 21.65936 | 30.29106 |
| EC99 | 7.326 | 32.40506 | 27.12698 | 42.74512 |

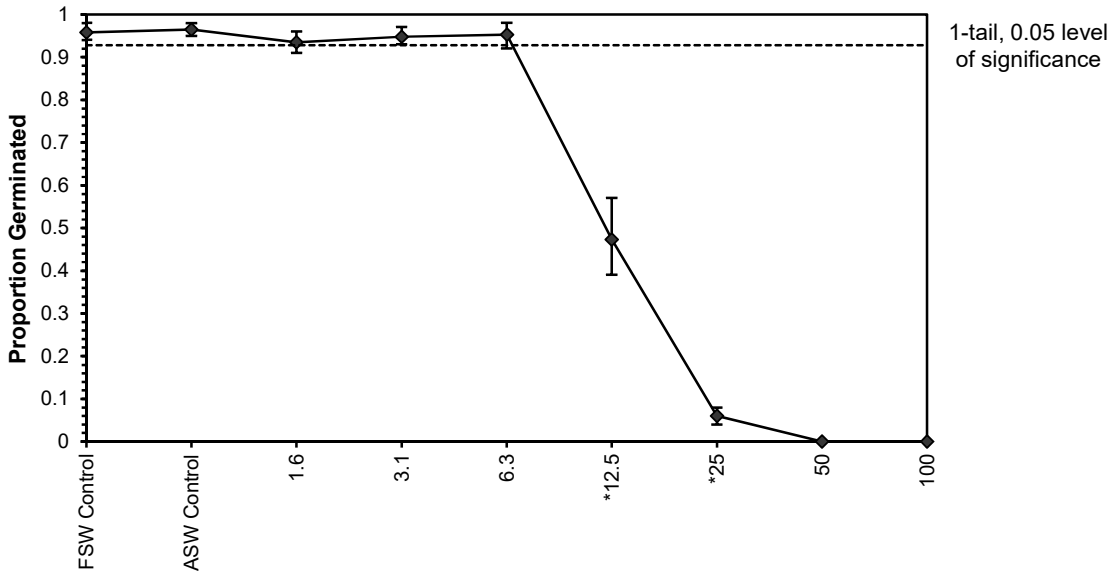
Significant heterogeneity detected (p = 2.00E-02)



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 2:30:00 F | Test ID: | PR1978/0 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 14:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 2:30:00 F | Test ID: | PR1978/0 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 14:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Germination, % | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| ASW Control | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 1.6 | | 93.50 | 91.00 | 96.00 | 2.08 | 1.54 | 4 |
| 3.1 | | 94.75 | 93.00 | 97.00 | 1.71 | 1.38 | 4 |
| 6.3 | | 95.25 | 92.00 | 98.00 | 2.50 | 1.66 | 4 |
| 12.5 | | 47.25 | 39.00 | 57.00 | 7.41 | 5.76 | 4 |
| 25 | | 6.00 | 4.00 | 8.00 | 1.83 | 22.52 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 12:30 | Test ID: | PR1978/07 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 12:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9600 | 0.9500 | 0.9800 | 0.9300 |
| ASW Control | 0.9400 | 0.9500 | 0.9600 | 0.9800 |
| 1.6 | 0.9800 | 0.9300 | 0.9500 | 0.9300 |
| 3.1 | 0.9500 | 0.9400 | 0.9600 | 0.9700 |
| 6.3 | 0.9400 | 0.9600 | 0.9800 | 0.9400 |
| 12.5 | 0.8500 | 0.7900 | 0.7300 | 0.7100 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

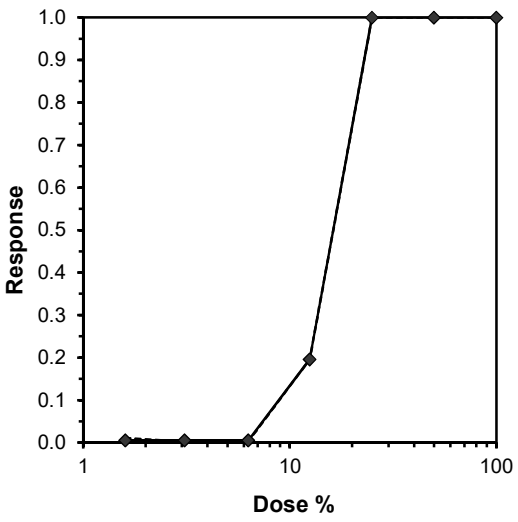
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9550 | 0.9974 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | | | | | |
| ASW Control | 0.9575 | 1.0000 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | * | | | 17 | 400 |
| 1.6 | 0.9475 | 0.9896 | 1.3451 | 1.3030 | 1.4289 | 4.411 | 4 | 0.559 | 2.360 | 0.0916 | 21 | 400 |
| 3.1 | 0.9550 | 0.9974 | 1.3587 | 1.3233 | 1.3967 | 2.324 | 4 | 0.207 | 2.360 | 0.0916 | 18 | 400 |
| 6.3 | 0.9550 | 0.9974 | 1.3612 | 1.3233 | 1.4289 | 3.678 | 4 | 0.141 | 2.360 | 0.0916 | 18 | 400 |
| *12.5 | 0.7700 | 0.8042 | 1.0736 | 1.0021 | 1.1731 | 7.190 | 4 | 7.555 | 2.360 | 0.0916 | 92 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.925771 | 0.905 | 0.66121 | -0.55677 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.17962 | 13.2767 | | |
| The control means are not significantly different (p = 0.89) | 0.145955 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.043815 | 0.045692 | 0.064935 | 0.003011 | 4.5E-06 | 4, 15 |

**Trimmed Spearman-Karber**

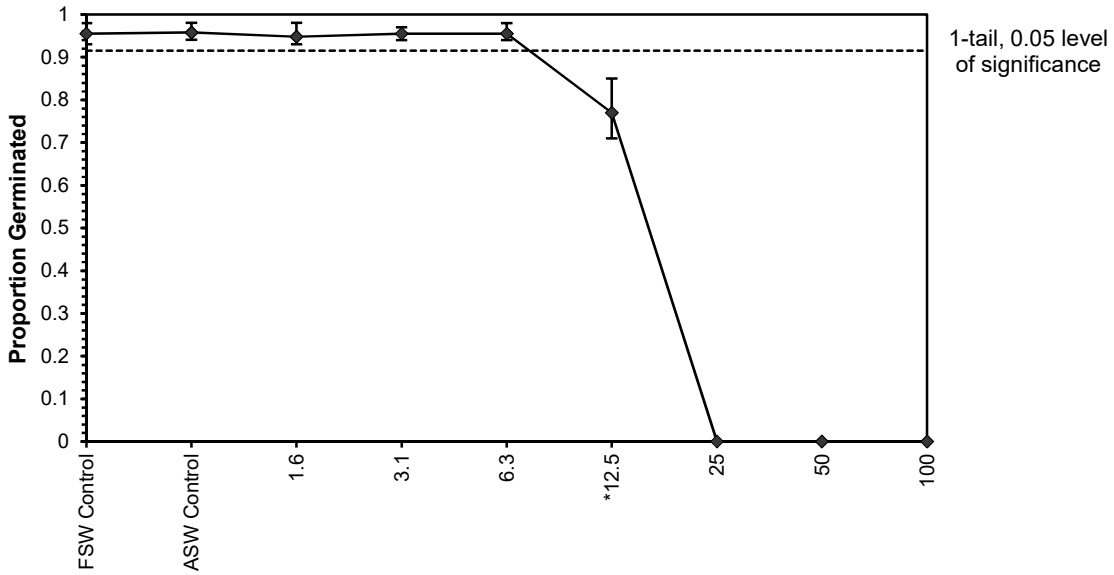
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 15.731 | 15.248 | 16.229 |
| 10.0% | 15.994 | 15.396 | 16.616 |
| 20.0% | 16.247 | 15.905 | 16.596 |
| Auto-0.5% | 15.452 | 15.029 | 15.887 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 12:30 | Test ID: | PR1978/07 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 12:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 12:30 | Test ID: | PR1978/07 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 12:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| ASW Control | | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 1.6 | | 94.75 | 93.00 | 98.00 | 2.36 | 1.62 | 4 |
| 3.1 | | 95.50 | 94.00 | 97.00 | 1.29 | 1.19 | 4 |
| 6.3 | | 95.50 | 94.00 | 98.00 | 1.91 | 1.45 | 4 |
| 12.5 | | 77.00 | 71.00 | 85.00 | 6.32 | 3.27 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 12:30 | Test ID: | PR1978/07 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 12:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9600 | 0.9500 | 0.9800 | 0.9300 |
| ASW Control | 0.9400 | 0.9500 | 0.9600 | 0.9800 |
| 1.6 | 0.9800 | 0.9300 | 0.9500 | 0.9300 |
| 3.1 | 0.9500 | 0.9400 | 0.9600 | 0.9700 |
| 6.3 | 0.9400 | 0.9600 | 0.9800 | 0.9400 |
| 12.5 | 0.8500 | 0.7900 | 0.7300 | 0.7100 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

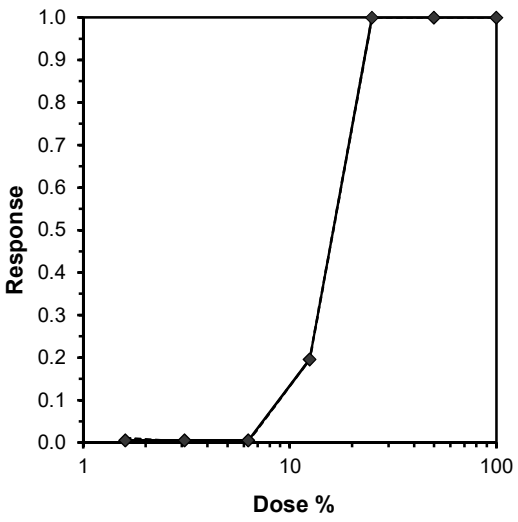
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9550 | 0.9974 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | | | | | |
| ASW Control | 0.9575 | 1.0000 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | * | | | 0.9575 | 1.0000 |
| 1.6 | 0.9475 | 0.9896 | 1.3451 | 1.3030 | 1.4289 | 4.411 | 4 | 0.559 | 2.360 | 0.0916 | 0.9525 | 0.9948 |
| 3.1 | 0.9550 | 0.9974 | 1.3587 | 1.3233 | 1.3967 | 2.324 | 4 | 0.207 | 2.360 | 0.0916 | 0.9525 | 0.9948 |
| 6.3 | 0.9550 | 0.9974 | 1.3612 | 1.3233 | 1.4289 | 3.678 | 4 | 0.141 | 2.360 | 0.0916 | 0.9525 | 0.9948 |
| *12.5 | 0.7700 | 0.8042 | 1.0736 | 1.0021 | 1.1731 | 7.190 | 4 | 7.555 | 2.360 | 0.0916 | 0.7700 | 0.8042 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.925771 | 0.905 | 0.66121 | -0.55677 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.17962 | 13.2767 | | |
| The control means are not significantly different (p = 0.89) | 0.145955 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.043815 | 0.045692 | 0.064935 | 0.003011 | 4.5E-06 | 4, 15 |

### Log-Logit Interpolation (200 Resamples)

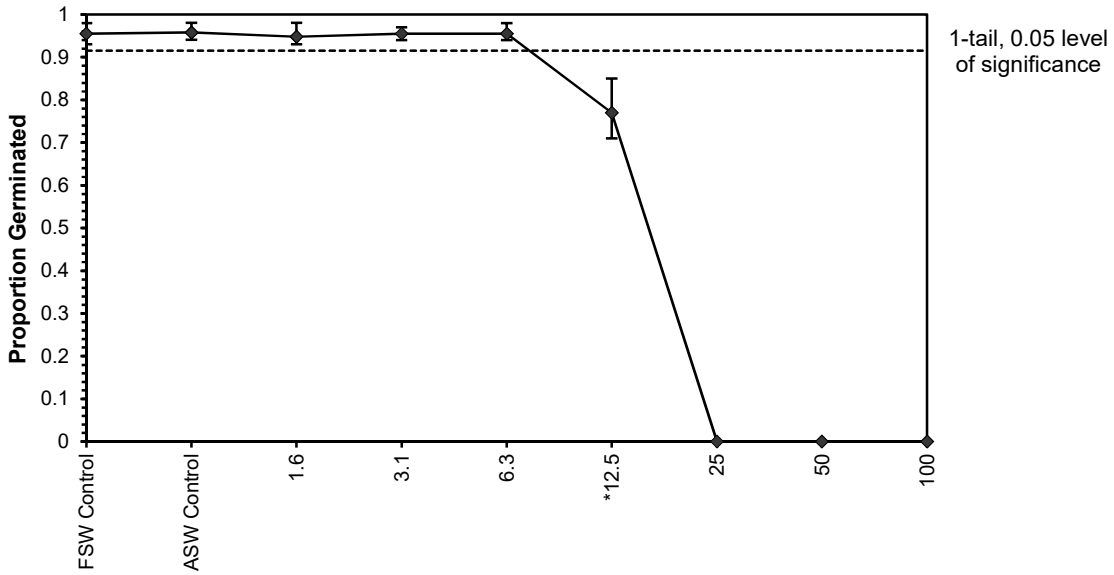
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 8.250 | 0.373 | 6.953 | 9.367 | -0.0198 |
| IC10 | 9.905 | 0.513 | 8.669 | 11.806 | 1.0912 |
| IC15 | 11.317 | 0.596 | 9.892 | 13.348 | 0.4246 |
| IC20 | 12.519 | 0.365 | 10.924 | 13.022 | -1.0313 |
| IC25 | 12.734 | 0.142 | 12.368 | 13.239 | 0.3233 |
| IC40 | 13.294 | 0.135 | 12.947 | 13.797 | 0.4328 |
| IC50 | 13.644 | 0.133 | 13.301 | 14.142 | 0.4323 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 12:30 | Test ID: | PR1978/07 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 12:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 12:30 | Test ID: | PR1978/07 | Sample ID: | Y0230321 |
| End Date: | 8/03/2021 12:30 | Lab ID: | 9983 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| ASW Control | | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 1.6 | | 94.75 | 93.00 | 98.00 | 2.36 | 1.62 | 4 |
| 3.1 | | 95.50 | 94.00 | 97.00 | 1.29 | 1.19 | 4 |
| 6.3 | | 95.50 | 94.00 | 98.00 | 1.91 | 1.45 | 4 |
| 12.5 | | 77.00 | 71.00 | 85.00 | 6.32 | 3.27 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y0160221 |
| End Date: | 22/02/2021 14:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 1.0000 | 0.8000 | 1.0000 |
| 12.5 | 0.6000 | 0.4000 | 0.2000 | 0.4000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 0.9000 | 0.9000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 14.00 | 10.00 | 2 | 20 |
| *12.5 | 0.4000 | 0.4000 | 0.6798 | 0.4636 | 0.8861 | 25.383 | 4 | 10.00 | 10.00 | 12 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

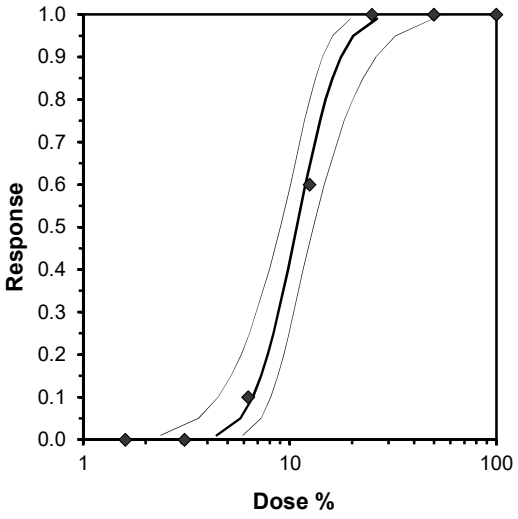
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.788756 | 0.905 | -0.11449 | 2.327683 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 6.007524 | 1.2196 | 3.617108 | 8.39794 | 0 | 0.616875 | 11.0705 | 0.99 | 1.033965 | 0.166458 | 5 |
| Intercept | -1.21157 | 1.279173 | -3.71875 | 1.295611 | | | | | | | |
| TSCR | | | | | | | | | | | |

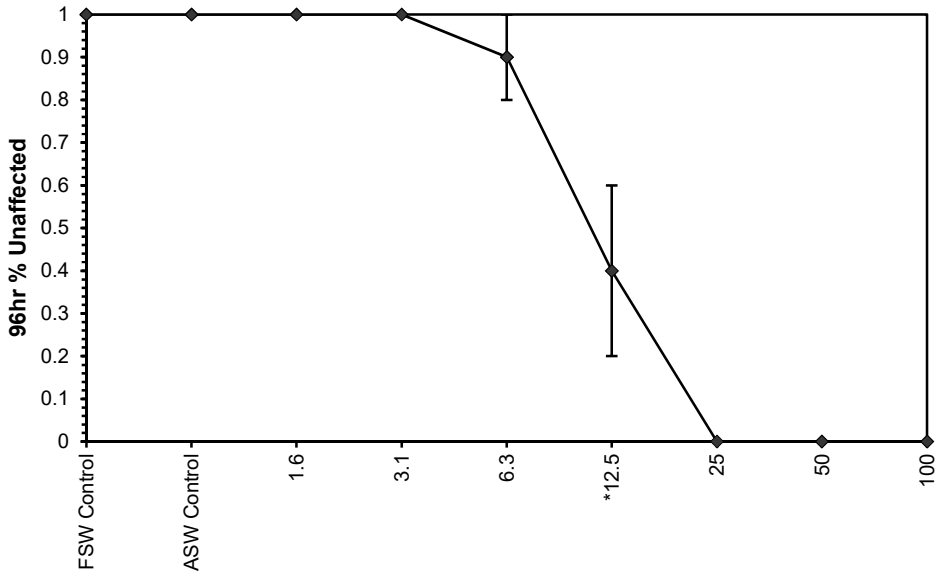
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 4.433288 | 2.371942 | 5.930733 |
| EC05 | 3.355 | 5.7566 | 3.610349 | 7.248063 |
| EC10 | 3.718 | 6.616686 | 4.4964 | 8.102277 |
| EC15 | 3.964 | 7.26846 | 5.198007 | 8.76172 |
| EC20 | 4.158 | 7.831959 | 5.817777 | 9.348142 |
| EC25 | 4.326 | 8.350083 | 6.392285 | 9.906804 |
| EC40 | 4.747 | 9.812809 | 7.987689 | 11.6345 |
| EC50 | 5.000 | 10.81347 | 9.012704 | 12.98742 |
| EC60 | 5.253 | 11.91617 | 10.05439 | 14.66328 |
| EC75 | 5.674 | 14.00358 | 11.79827 | 18.33783 |
| EC80 | 5.842 | 14.92999 | 12.50061 | 20.15313 |
| EC85 | 6.036 | 16.08746 | 13.33465 | 22.56047 |
| EC90 | 6.282 | 17.67215 | 14.41737 | 26.08542 |
| EC95 | 6.645 | 20.31252 | 16.11373 | 32.49291 |
| EC99 | 7.326 | 26.37571 | 19.68958 | 49.46604 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y0160221 |
| End Date: | 22/02/2021 14:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y0160221 |
| End Date: | 22/02/2021 14:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % unaffacted | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 12.5 | | 40.00 | 20.00 | 60.00 | 16.33 | 10.10 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO, % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 15:00 | Test ID: | PR1978/12 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 15:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 0.8000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.4000 | 0.2000 | 0.4000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

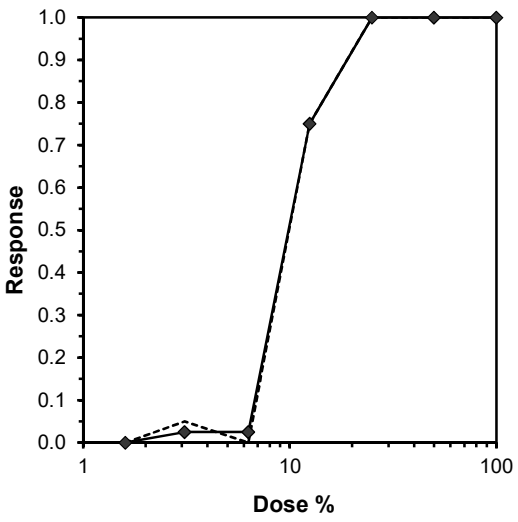
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 1 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *12.5 | 0.2500 | 0.2500 | 0.5146 | 0.2255 | 0.6847 | 42.578 | 4 | 10.00 | 10.00 | 15 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.774539 | 0.905 | -1.17369 | 3.745313 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

**Trimmed Spearman-Karber**

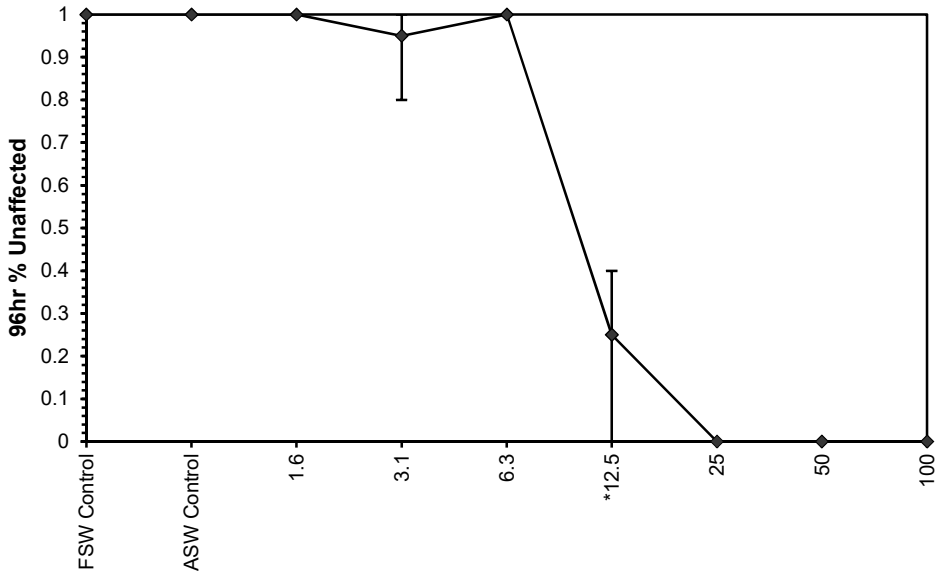
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 10.185 | 8.767 | 11.832 |
| 5.0% | 10.279 | 8.869 | 11.912 |
| 10.0% | 10.127 | 8.663 | 11.838 |
| 20.0% | 9.907 | 8.451 | 11.614 |
| Auto-0.0% | 10.185 | 8.767 | 11.832 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 15:00 | Test ID: | PR1978/12 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 15:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 15:00 | Test ID: | PR1978/12 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 15:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 25.00 | 0.00 | 40.00 | 19.15 | 17.50 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 15:00 | Test ID: | PR1978/12 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 15:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 0.8000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.4000 | 0.2000 | 0.4000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

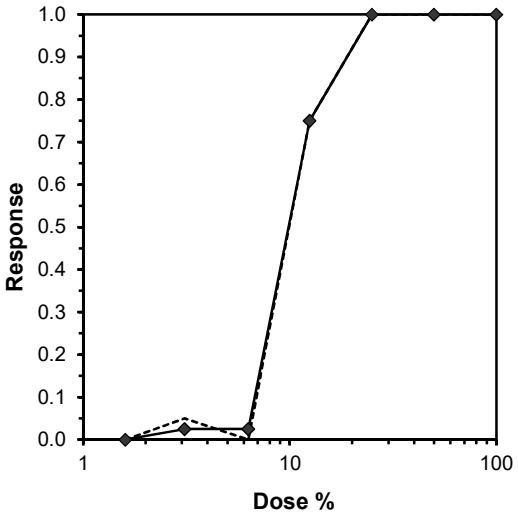
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 0.9750 | 0.9750 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0.9750 | 0.9750 |
| *12.5 | 0.2500 | 0.2500 | 0.5146 | 0.2255 | 0.6847 | 42.578 | 4 | 10.00 | 10.00 | 0.2500 | 0.2500 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.774539 | 0.905 | -1.17369 | 3.745313 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

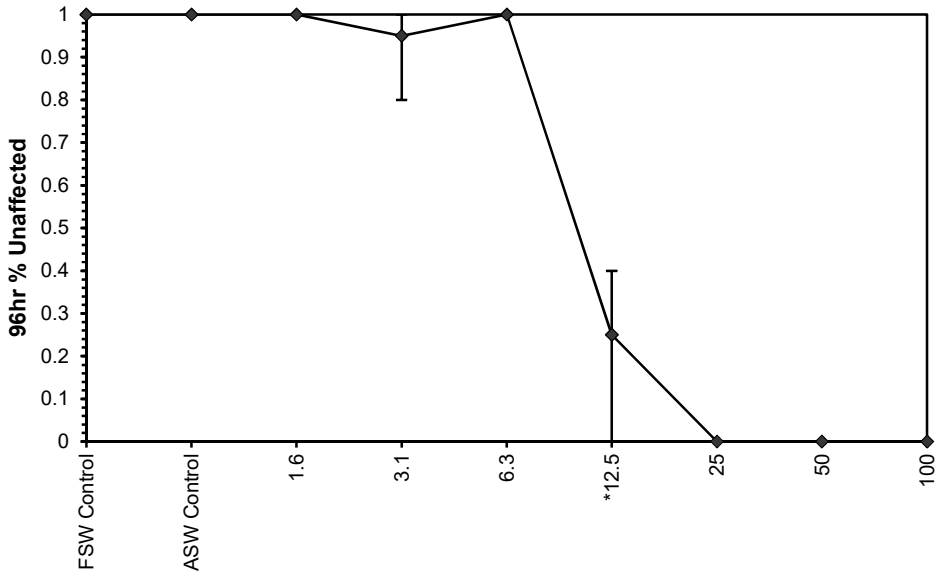
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.010 | 1.606 | 0.564 | 11.478 | -0.2676 |
| IC10 | 7.821 | 1.210 | 6.079 | 11.818 | 0.6554 |
| IC15 | 8.364 | 1.102 | 6.713 | 12.024 | 0.6104 |
| IC20 | 8.795 | 1.016 | 7.192 | 12.177 | 0.5477 |
| IC25 | 9.166 | 0.944 | 7.498 | 12.300 | 0.4643 |
| IC40 | 10.117 | 0.778 | 8.613 | 12.589 | 0.0622 |
| IC50 | 10.715 | 0.703 | 9.125 | 12.751 | -0.3157 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 15:00 | Test ID: | PR1978/12 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 15:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 15:00 | Test ID: | PR1978/12 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 15:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 25.00 | 0.00 | 40.00 | 19.15 | 17.50 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 14:00 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.8000 | 0.0000 | 0.4000 | 0.4000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 1 | 20 |
| *12.5 | 0.4000 | 0.4000 | 0.6755 | 0.2255 | 1.1071 | 53.304 | 4 | 10.00 | 10.00 | 12 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

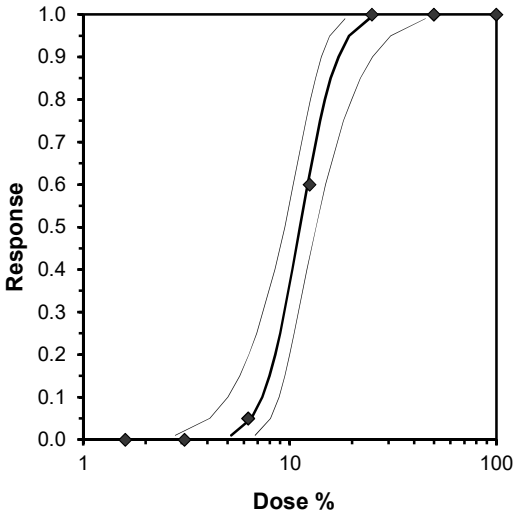
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.637021 | 0.905 | -0.26968 | 7.213282 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 6.966029 | 1.544247 | 3.939304 | 9.992754 | 0 | 0.269602 | 11.0705 | 1 | 1.050466 | 0.143554 | 4 |
| Intercept | -2.31758 | 1.639714 | -5.53142 | 0.896263 | | | | | | | |
| TSCR | | | | | | | | | | | |

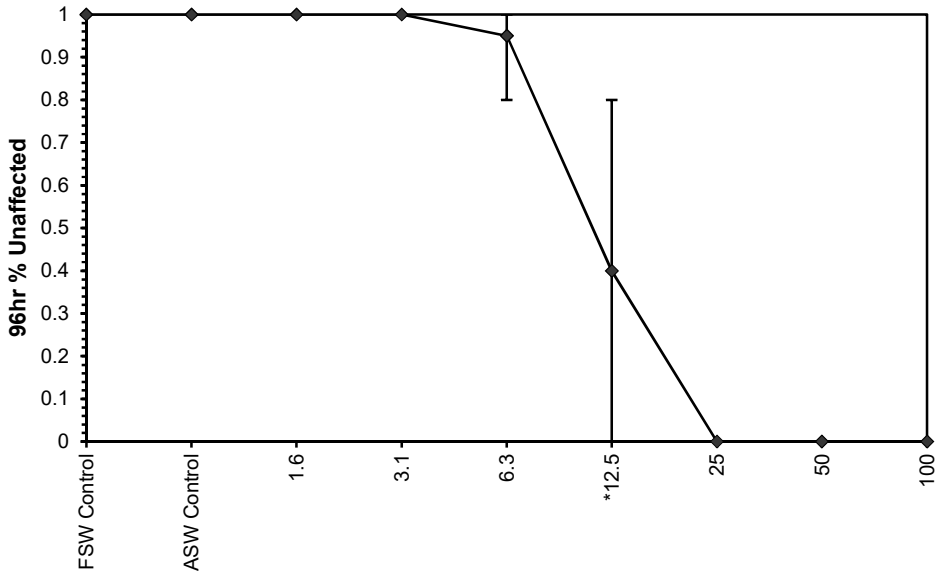
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 5.206068 | 2.785406 | 6.803598 |
| EC05 | 3.355 | 6.521401 | 4.096381 | 8.061657 |
| EC10 | 3.718 | 7.353503 | 5.010585 | 8.861713 |
| EC15 | 3.964 | 7.974105 | 5.723459 | 9.473291 |
| EC20 | 4.158 | 8.504484 | 6.34601 | 10.014 |
| EC25 | 4.326 | 8.98753 | 6.917417 | 10.52728 |
| EC40 | 4.747 | 10.32992 | 8.475073 | 12.1107 |
| EC50 | 5.000 | 11.23223 | 9.450396 | 13.35145 |
| EC60 | 5.253 | 12.21335 | 10.41795 | 14.88888 |
| EC75 | 5.674 | 14.03756 | 11.98398 | 18.24298 |
| EC80 | 5.842 | 14.83487 | 12.59798 | 19.88603 |
| EC85 | 6.036 | 15.82158 | 13.31679 | 22.04948 |
| EC90 | 6.282 | 17.15685 | 14.23558 | 25.18695 |
| EC95 | 6.645 | 19.34599 | 15.6481 | 30.80851 |
| EC99 | 7.326 | 24.23383 | 18.54133 | 45.3095 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 14:00 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 14:00 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 12.5 | | 40.00 | 0.00 | 80.00 | 32.66 | 14.29 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 18:30 | Test ID: | PR1978/11 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 18:30 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 16.045 | 13.845 | 14.545 | 15.645 | 16.045 | 13.445 | 14.445 | 15.145 |
| ASW Control | 13.845 | 14.445 | 13.845 | 15.345 | | | | |
| 1.6 | 17.045 | 14.845 | 15.345 | 15.945 | | | | |
| 3.1 | 13.845 | 14.545 | 15.645 | 14.845 | | | | |
| 6.3 | 15.545 | 14.445 | 16.345 | 15.145 | | | | |
| 12.5 | 8.545 | 5.345 | 7.345 | 5.945 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

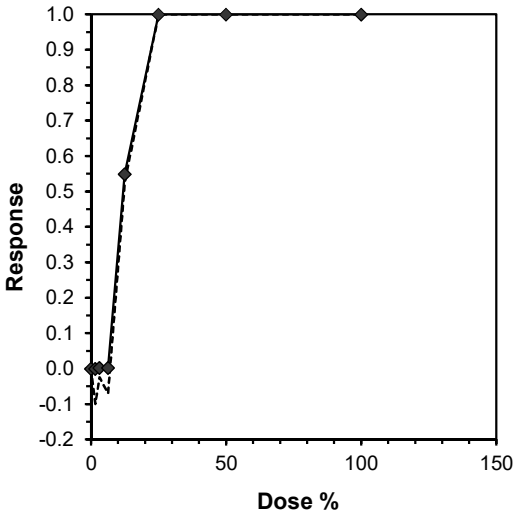
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 14.895 | 1.0365 | 14.895 | 13.445 | 16.045 | 6.617 | 8 | | | | | |
| ASW Control | 14.370 | 1.0000 | 14.370 | 13.845 | 15.345 | 4.933 | 4 | * | | | 15.083 | 1.0000 |
| 1.6 | 15.795 | 1.0992 | 15.795 | 14.845 | 17.045 | 5.995 | 4 | -2.090 | 2.360 | 1.609 | 15.083 | 1.0000 |
| 3.1 | 14.720 | 1.0244 | 14.720 | 13.845 | 15.645 | 5.065 | 4 | -0.513 | 2.360 | 1.609 | 15.045 | 0.9975 |
| 6.3 | 15.370 | 1.0696 | 15.370 | 14.445 | 16.345 | 5.161 | 4 | -1.467 | 2.360 | 1.609 | 15.045 | 0.9975 |
| *12.5 | 6.795 | 0.4729 | 6.795 | 5.345 | 8.545 | 21.139 | 4 | 11.112 | 2.360 | 1.609 | 6.795 | 0.4505 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.965445 | 0.905 | 0.349456 | -0.62478 |
| Bartlett's Test indicates equal variances (p = 0.73) | 2.006501 | 13.2767 | | |
| The control means are not significantly different (p = 0.37) | 0.940608 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 1.608873 | 0.11196 | 55.92575 | 0.9295 | 4.7E-09 | 4, 15 |

### Linear Interpolation (200 Resamples)

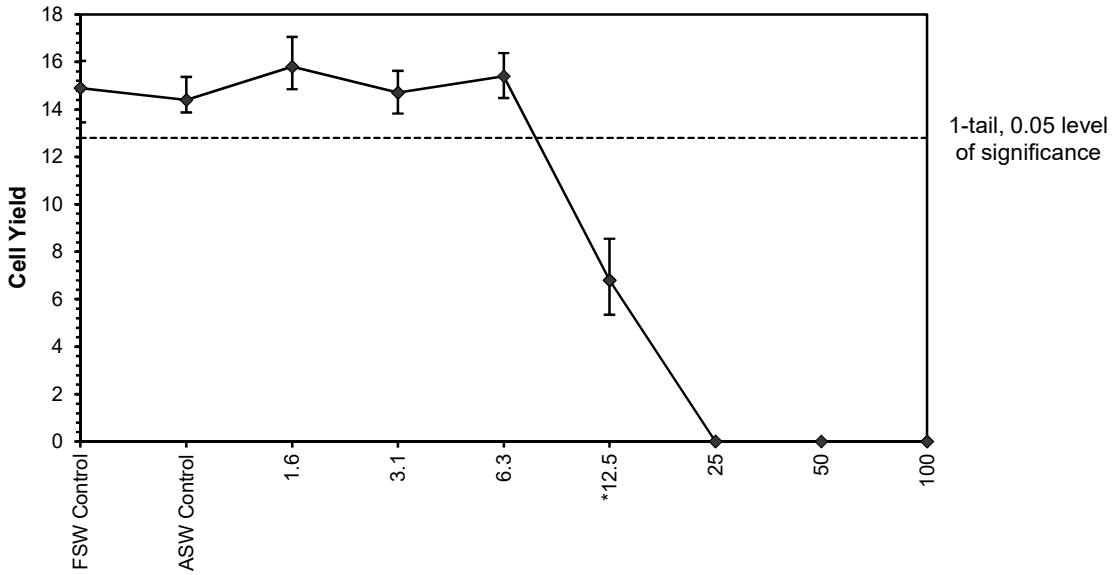
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.839 | 0.492 | 6.159 | 7.015 | -6.9344 |
| IC10 | 7.405 | 0.174 | 6.787 | 7.716 | -0.6019 |
| IC15 | 7.972 | 0.197 | 7.346 | 8.417 | -0.1704 |
| IC20 | 8.539 | 0.228 | 7.906 | 9.118 | 0.1012 |
| IC25 | 9.106 | 0.266 | 8.422 | 9.858 | 0.2475 |
| IC40 | 10.806 | 0.396 | 9.927 | 12.083 | 0.3840 |
| IC50 | 11.939 | 0.570 | 10.927 | 14.225 | 0.8150 |



**Microalgal Cell Yield-Cell Yield**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 18:30 | Test ID: | PR1978/11 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 18:30 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 18:30 | Test ID: | PR1978/11 | Sample ID: | Y0160221 |
| End Date: | 21/02/2021 18:30 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 14.90 | 13.45 | 16.05 | 0.99 | 6.67 | 8 |
| ASW Control | | 14.37 | 13.85 | 15.35 | 0.71 | 5.86 | 4 |
| 1.6 | | 15.80 | 14.85 | 17.05 | 0.95 | 6.16 | 4 |
| 3.1 | | 14.72 | 13.85 | 15.65 | 0.75 | 5.87 | 4 |
| 6.3 | | 15.37 | 14.45 | 16.35 | 0.79 | 5.79 | 4 |
| 12.5 | | 6.80 | 5.35 | 8.55 | 1.44 | 17.64 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| FSW Control | pH | 8.05 | 8.00 | 8.10 | 0.07 | 3.30 | 2 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 25 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 50 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |
| FSW Control | Salinity ppt | 35.35 | 35.20 | 35.50 | 0.21 | 1.30 | 2 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 50 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0 |

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:00 | Test ID: | PR1978/13 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 19.187 | 18.487 | 18.687 | 18.387 | 19.287 | 20.587 | 20.387 | 18.687 |
| ASW Control | 18.187 | 19.287 | 19.587 | 18.687 | | | | |
| 1.6 | 19.287 | 18.387 | 19.687 | 19.087 | | | | |
| 3.1 | 19.187 | 18.487 | 19.587 | 18.687 | | | | |
| 6.3 | 17.287 | 18.587 | 18.187 | 19.487 | | | | |
| 12.5 | 7.187 | 9.587 | 8.487 | 8.887 | | | | |
| 25 | 4.087 | 5.387 | 2.987 | 2.187 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

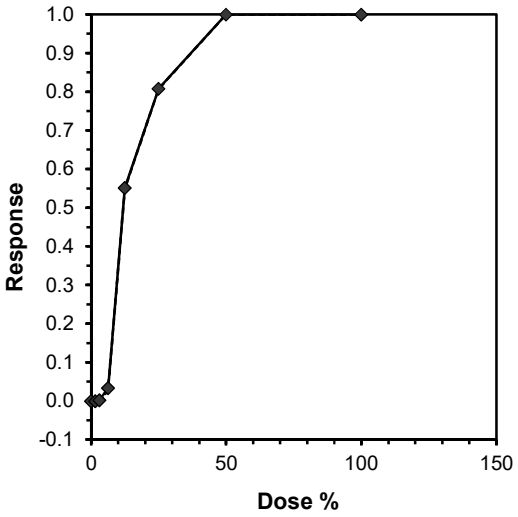
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 19.212 | 1.0145 | 19.212 | 18.387 | 20.587 | 4.415 | 8 | | | | | |
| ASW Control | 18.937 | 1.0000 | 18.937 | 18.187 | 19.587 | 3.298 | 4 | * | | | 19.024 | 1.0000 |
| 1.6 | 19.112 | 1.0092 | 19.112 | 18.387 | 19.687 | 2.846 | 4 | -0.279 | 2.410 | 1.510 | 19.024 | 1.0000 |
| 3.1 | 18.987 | 1.0026 | 18.987 | 18.487 | 19.587 | 2.616 | 4 | -0.080 | 2.410 | 1.510 | 18.987 | 0.9980 |
| 6.3 | 18.387 | 0.9710 | 18.387 | 17.287 | 19.487 | 4.965 | 4 | 0.878 | 2.410 | 1.510 | 18.387 | 0.9665 |
| *12.5 | 8.537 | 0.4508 | 8.537 | 7.187 | 9.587 | 11.811 | 4 | 16.597 | 2.410 | 1.510 | 8.537 | 0.4487 |
| *25 | 3.662 | 0.1934 | 3.662 | 2.187 | 5.387 | 37.933 | 4 | 24.377 | 2.410 | 1.510 | 3.662 | 0.1925 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.985417 | 0.916 | 0.01964 | -0.08421 |
| Bartlett's Test indicates equal variances (p = 0.51) | 4.29614 | 15.08627 | | |
| The control means are not significantly different (p = 0.58) | 0.570094 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 1.510128 | 0.079747 | 183.3237 | 0.785278 | 1.0E-15 | 5, 18 |

### Linear Interpolation (200 Resamples)

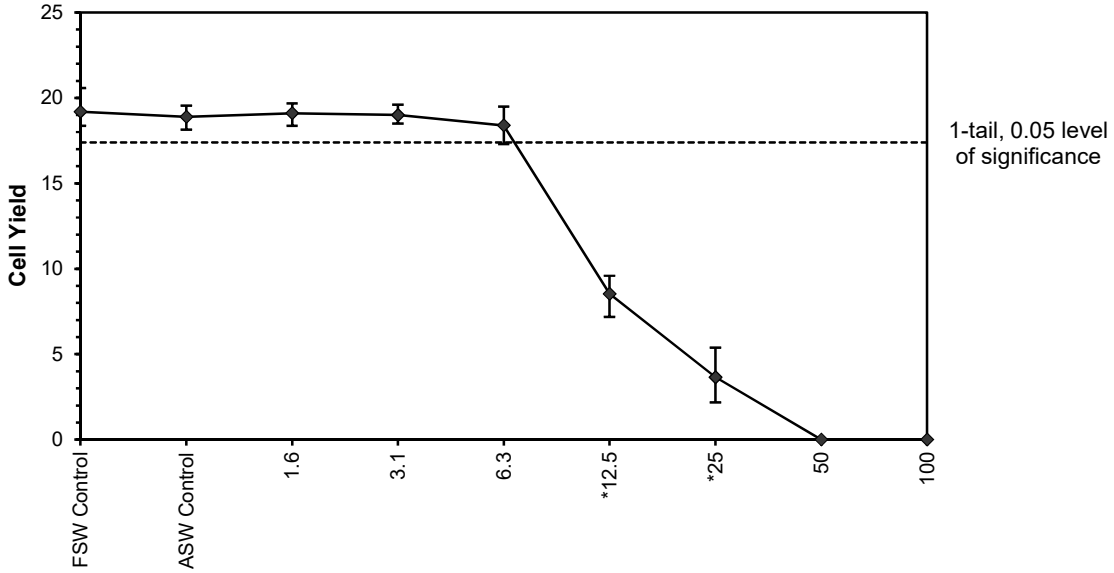
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.497 | 0.621 | 3.866 | 7.037 | -1.5256 |
| IC10 | 7.096 | 0.242 | 6.362 | 7.619 | -0.2038 |
| IC15 | 7.695 | 0.226 | 6.977 | 8.242 | -0.1287 |
| IC20 | 8.294 | 0.216 | 7.588 | 8.825 | -0.0412 |
| IC25 | 8.892 | 0.212 | 8.204 | 9.416 | 0.0400 |
| IC40 | 10.689 | 0.237 | 9.987 | 11.408 | 0.1130 |
| IC50 | 11.886 | 0.289 | 11.052 | 12.697 | 0.2998 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:00 | Test ID: | PR1978/13 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Dose-Response Plot



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:00 | Test ID: | PR1978/13 | Sample ID: | Y0230221 |
| End Date: | 28/02/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 19.21 | 18.39 | 20.59 | 0.85 | 4.79 | 8 |
| ASW Control | | 18.94 | 18.19 | 19.59 | 0.62 | 4.17 | 4 |
| 1.6 | | 19.11 | 18.39 | 19.69 | 0.54 | 3.86 | 4 |
| 3.1 | | 18.99 | 18.49 | 19.59 | 0.50 | 3.71 | 4 |
| 6.3 | | 18.39 | 17.29 | 19.49 | 0.91 | 5.20 | 4 |
| 12.5 | | 8.54 | 7.19 | 9.59 | 1.01 | 11.76 | 4 |
| 25 | | 3.66 | 2.19 | 5.39 | 1.39 | 32.19 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 14:00 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 17.200 | 17.000 | 18.200 | 18.800 | 17.100 | 17.200 | 18.000 | 16.300 |
| ASW Control | 17.100 | 16.100 | 17.500 | 17.200 | | | | |
| 1.6 | 18.800 | 16.300 | 17.900 | 17.200 | | | | |
| 3.1 | 16.100 | 17.300 | 16.800 | 17.600 | | | | |
| 6.3 | 12.900 | 9.600 | 10.200 | 8.500 | | | | |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

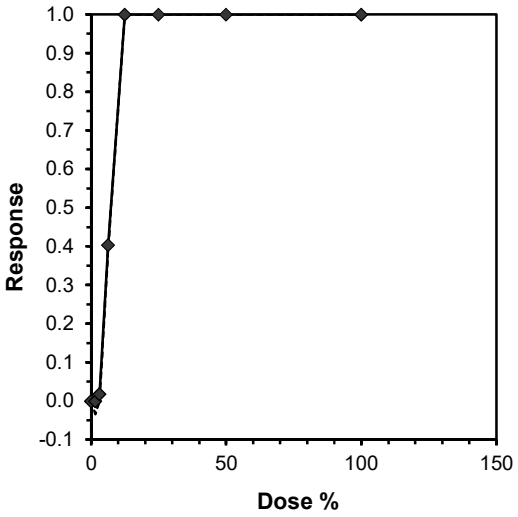
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 17.475 | 1.0295 | 17.475 | 16.300 | 18.800 | 4.565 | 8 | | | | | |
| ASW Control | 16.975 | 1.0000 | 16.975 | 16.100 | 17.500 | 3.579 | 4 | * | | | 17.262 | 1.0000 |
| 1.6 | 17.550 | 1.0339 | 17.550 | 16.300 | 18.800 | 6.039 | 4 | -0.698 | 2.290 | 1.885 | 17.262 | 1.0000 |
| 3.1 | 16.950 | 0.9985 | 16.950 | 16.100 | 17.600 | 3.869 | 4 | 0.030 | 2.290 | 1.885 | 16.950 | 0.9819 |
| *6.3 | 10.300 | 0.6068 | 10.300 | 8.500 | 12.900 | 18.164 | 4 | 8.108 | 2.290 | 1.885 | 10.300 | 0.5967 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.957731 | 0.887 | 0.714291 | 1.605152 |
| Bartlett's Test indicates equal variances (p = 0.22) | 4.447661 | 11.34487 | | |
| The control means are not significantly different (p = 0.30) | 1.094761 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 1.885343 | 0.111069 | 47.34396 | 1.355625 | 3.3E-06 | 3, 12 |

### Linear Interpolation (200 Resamples)

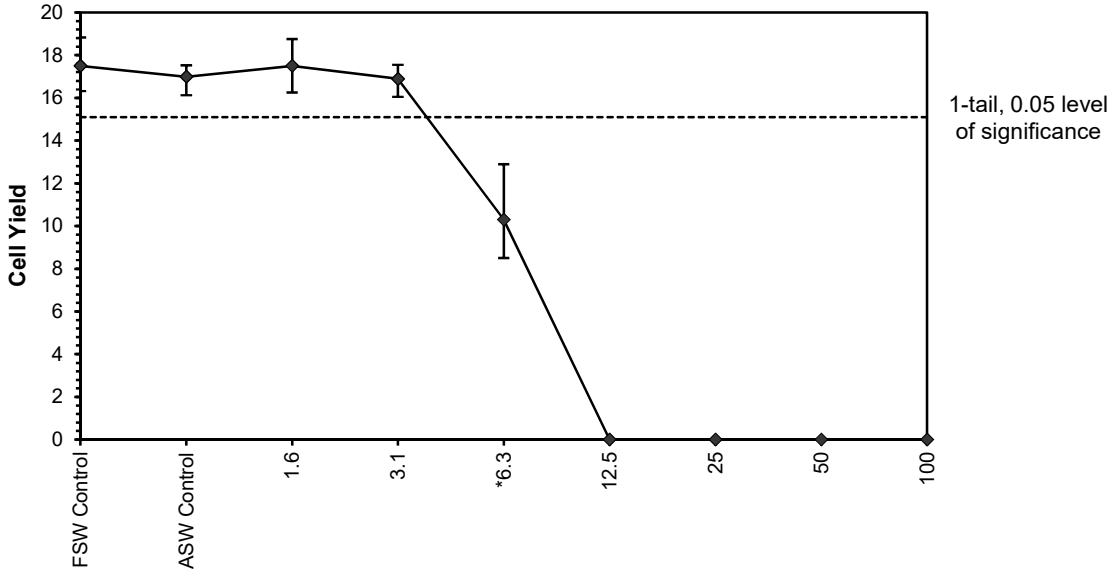
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.3650 | 0.1733 | 2.6357 | 3.6800 | -1.4384 |
| IC10 | 3.7803 | 0.1568 | 3.3047 | 4.1998 | -0.1935 |
| IC15 | 4.1956 | 0.1780 | 3.7133 | 4.7312 | 0.2264 |
| IC20 | 4.6109 | 0.2113 | 4.0998 | 5.2685 | 0.4339 |
| IC25 | 5.0263 | 0.2518 | 4.4452 | 5.8877 | 0.5232 |
| IC40 | 6.2722 | 0.3737 | 5.4426 | 7.4693 | 0.3492 |
| IC50 | 7.3044 | 0.3994 | 6.0539 | 8.3106 | -0.2019 |



**Microalgal Cell Yield-Cell Yield**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 14:00 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 14:00 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 14:00 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 17.47 | 16.30 | 18.80 | 0.80 | 5.11 | 8 |
| ASW Control | | 16.97 | 16.10 | 17.50 | 0.61 | 4.59 | 4 |
| 1.6 | | 17.55 | 16.30 | 18.80 | 1.06 | 5.87 | 4 |
| 3.1 | | 16.95 | 16.10 | 17.60 | 0.66 | 4.78 | 4 |
| 6.3 | | 10.30 | 8.50 | 12.90 | 1.87 | 13.28 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/12 | Sample ID: | Y0160221 |
| End Date: | 22/02/2021 19:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.4000 | 0.4000 | 0.6000 | 0.4000 |
| 12.5 | 0.4000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *6.3 | 0.4500 | 0.4500 | 0.7351 | 0.6847 | 0.8861 | 13.697 | 4 | 10.00 | 10.00 | 11 | 20 |
| *12.5 | 0.1000 | 0.1000 | 0.3403 | 0.2255 | 0.6847 | 67.468 | 4 | 10.00 | 10.00 | 18 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

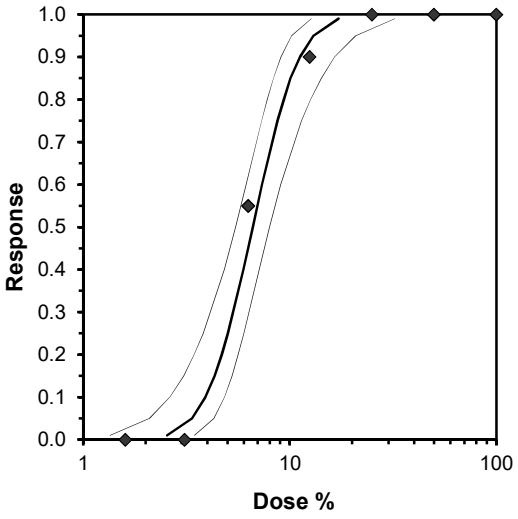
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.679268 | 0.905 | 2.328965 | 7.557935 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 5.61531 | 1.097113 | 3.464969 | 7.76565 | 0 | 2.004915 | 11.0705 | 0.85 | 0.820804 | 0.178085 | 6 |
| Intercept | 0.39093 | 0.929479 | -1.43085 | 2.212709 | | | | | | | |
| TSCR | | | | | | | | | | | |

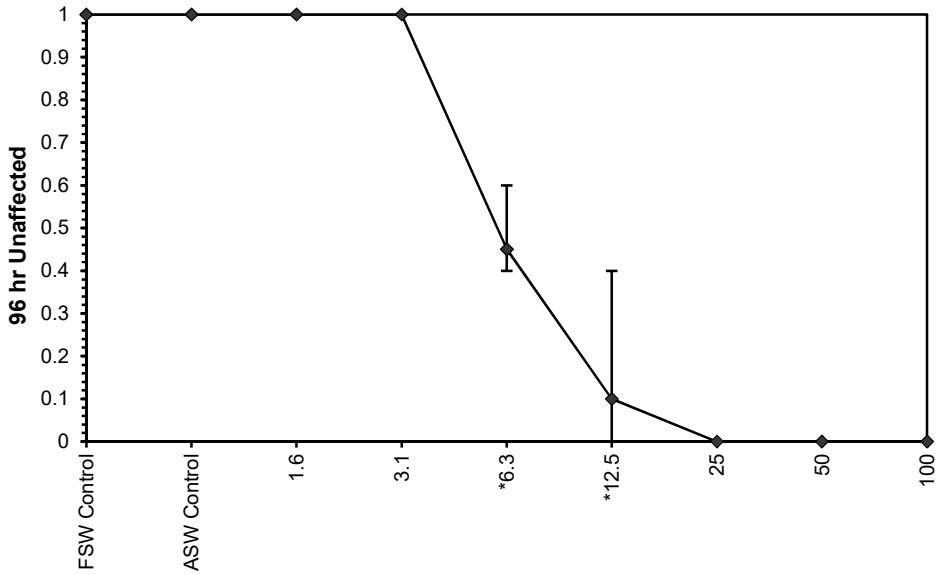
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.549867 | 1.350206 | 3.461013 |
| EC05 | 3.355 | 3.37195 | 2.094039 | 4.295932 |
| EC10 | 3.718 | 3.913629 | 2.634102 | 4.842201 |
| EC15 | 3.964 | 4.327444 | 3.065732 | 5.265595 |
| EC20 | 4.158 | 4.687319 | 3.449813 | 5.642816 |
| EC25 | 4.326 | 5.019818 | 3.808201 | 6.002442 |
| EC40 | 4.747 | 5.966052 | 4.816224 | 7.114029 |
| EC50 | 5.000 | 6.61918 | 5.474809 | 7.983515 |
| EC60 | 5.253 | 7.34381 | 6.153221 | 9.061528 |
| EC75 | 5.674 | 8.728115 | 7.306943 | 11.4378 |
| EC80 | 5.842 | 9.347253 | 7.776775 | 12.6193 |
| EC85 | 6.036 | 10.12458 | 8.337899 | 14.19345 |
| EC90 | 6.282 | 11.19512 | 9.070936 | 16.51196 |
| EC95 | 6.645 | 12.99353 | 10.22875 | 20.76164 |
| EC99 | 7.326 | 17.18268 | 12.70158 | 32.18585 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/12 | Sample ID: | Y0160221 |
| End Date: | 22/02/2021 19:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/12 | Sample ID: | Y0160221 |
| End Date: | 22/02/2021 19:00 | Lab ID: | 9939 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 45.00 | 40.00 | 60.00 | 10.00 | 7.03 | 4 |
| 12.5 | | 10.00 | 0.00 | 40.00 | 20.00 | 44.72 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 0.8000 | 0.8000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

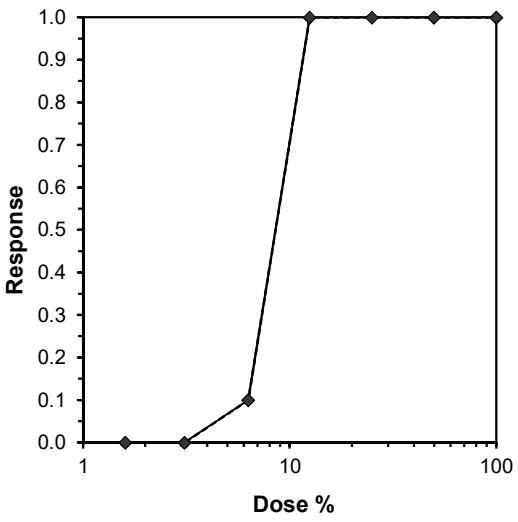
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 0.9000 | 0.9000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 14.00 | 10.00 | 2 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.696557 | 0.887 | 4.6E-15 | 1.895604 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

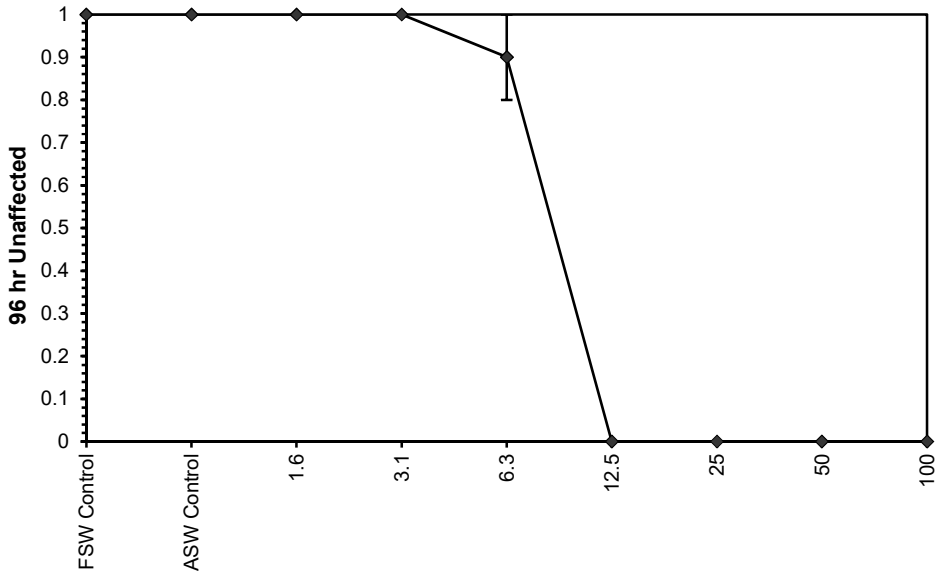
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 8.2765 | 7.5375 | 9.0880 |
| 5.0% | 8.4679 | 7.5330 | 9.5188 |
| 10.0% | 8.5427 | 8.0714 | 9.0414 |
| 20.0% | 8.5427 | 8.0714 | 9.0414 |
| Auto-0.0% | 8.2765 | 7.5375 | 9.0880 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 0.8000 | 0.8000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

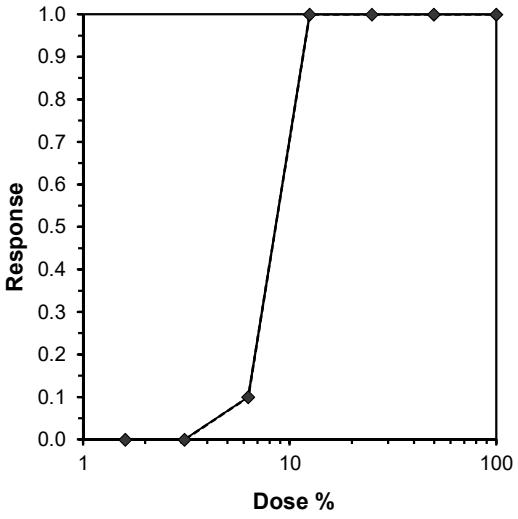
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 0.9000 | 0.9000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 14.00 | 10.00 | 0.9000 | 0.9000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.696557 | 0.887 | 4.6E-15 | 1.895604 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

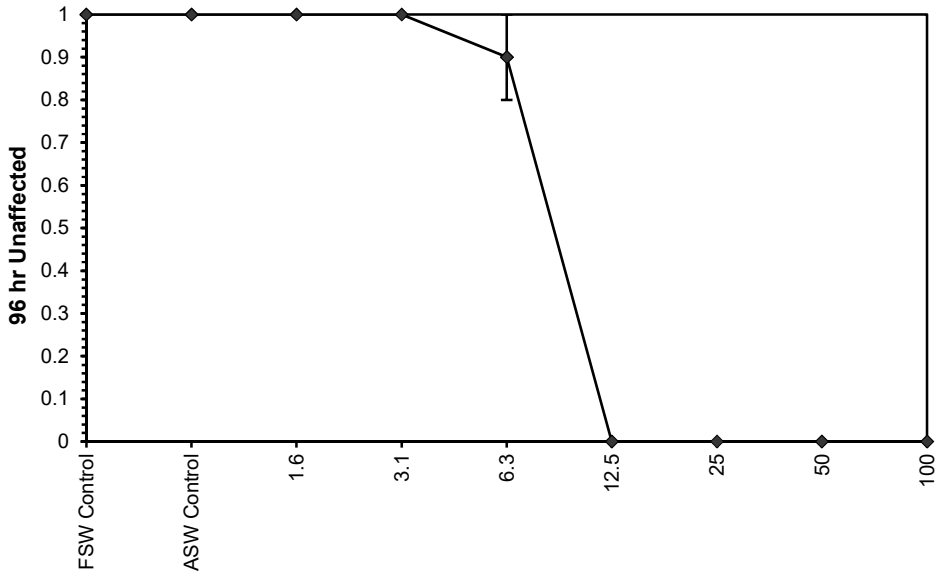
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 5.8648 | 0.6043 | 5.2934 | 9.2780 | 2.3198 |
| IC10 | 6.3000 | 0.5509 | 5.6221 | 9.3804 | 2.4259 |
| IC15 | 6.4843 | 0.5279 | 5.8933 | 9.4995 | 2.5474 |
| IC20 | 6.6261 | 0.5167 | 6.1043 | 9.5897 | 2.5782 |
| IC25 | 6.7453 | 0.5091 | 6.2294 | 9.6645 | 2.5748 |
| IC40 | 7.0401 | 0.4898 | 6.5399 | 9.8460 | 2.5664 |
| IC50 | 7.2177 | 0.4777 | 6.7276 | 9.9529 | 2.5615 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0230221 |
| End Date: | 1/03/2021 19:00 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.2000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

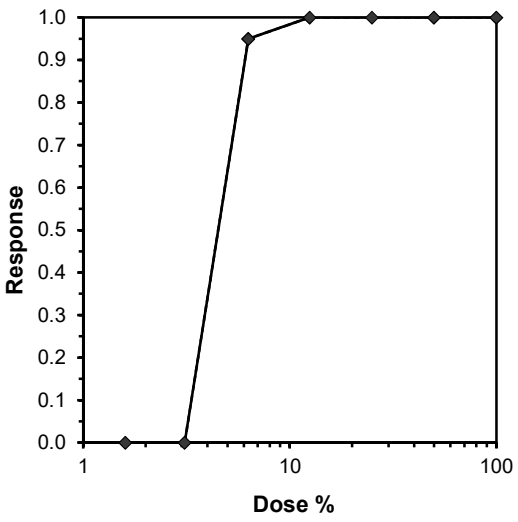
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *6.3 | 0.0500 | 0.0500 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 19 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.564851 | 0.887 | 2.555506 | 9.368132 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

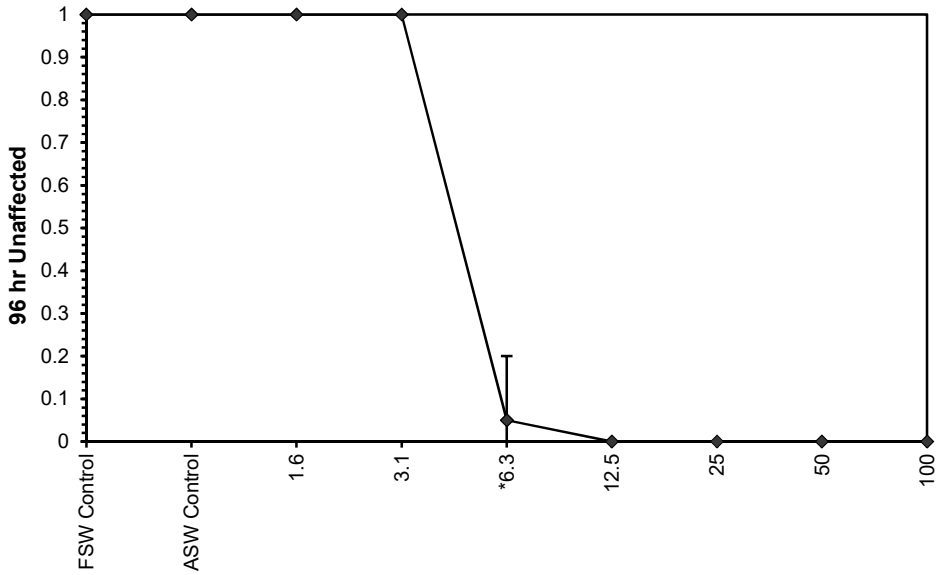
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 4.5760 | 4.2754 | 4.8978 |
| 5.0% | 4.5025 | 4.3334 | 4.6783 |
| 10.0% | 4.5025 | 4.3334 | 4.6783 |
| 20.0% | 4.5025 | 4.3334 | 4.6783 |
| Auto-0.0% | 4.5760 | 4.2754 | 4.8978 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.2000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

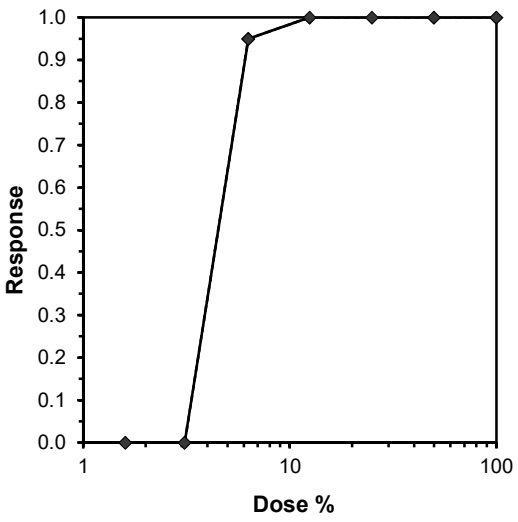
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *6.3 | 0.0500 | 0.0500 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 0.0500 | 0.0500 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.564851 | 0.887 | 2.555506 | 9.368132 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

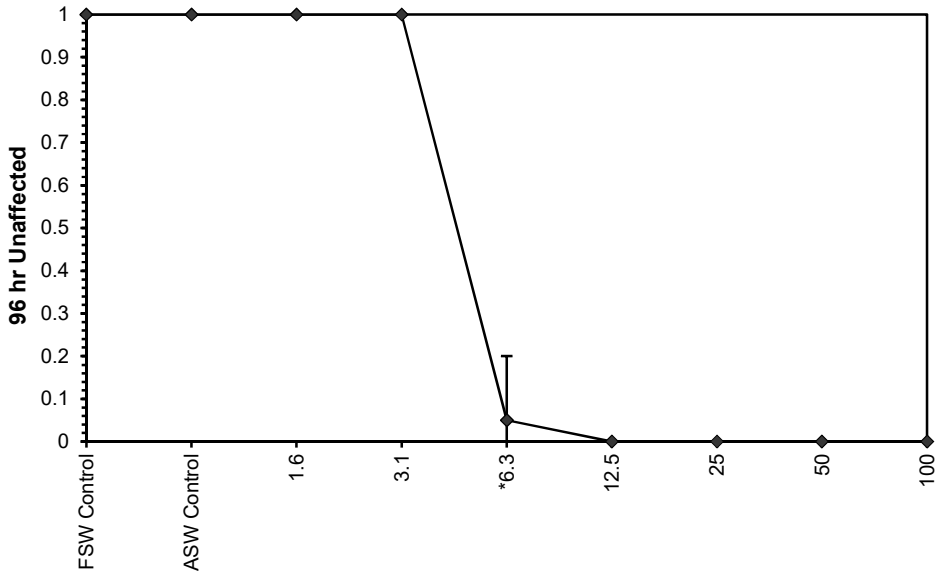
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 4.5200 | 0.2740 | 3.6703 | 4.8151 | -0.6877 |
| IC10 | 4.7193 | 0.3161 | 3.7397 | 5.0622 | -0.6862 |
| IC15 | 4.8462 | 0.3434 | 3.7828 | 5.2204 | -0.6852 |
| IC20 | 4.9437 | 0.3645 | 3.8152 | 5.3422 | -0.6845 |
| IC25 | 5.0254 | 0.3824 | 3.8421 | 5.4445 | -0.6839 |
| IC40 | 5.2269 | 0.4269 | 3.9067 | 5.6979 | -0.6824 |
| IC50 | 5.3479 | 0.4540 | 3.9446 | 5.8507 | -0.6815 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/10 | Sample ID: | Y020321 |
| End Date: | 9/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0160221 |
| End Date: | 25/02/2021 19:30 | Lab ID: | | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 0.8000 |
| 6.3 | 0.2000 | 0.0000 | 0.2000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 1 | 20 |
| *6.3 | 0.1000 | 0.1000 | 0.3446 | 0.2255 | 0.4636 | 39.900 | 4 | 10.00 | 10.00 | 18 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.871169 | 0.887 | -0.71699 | 0.523099 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

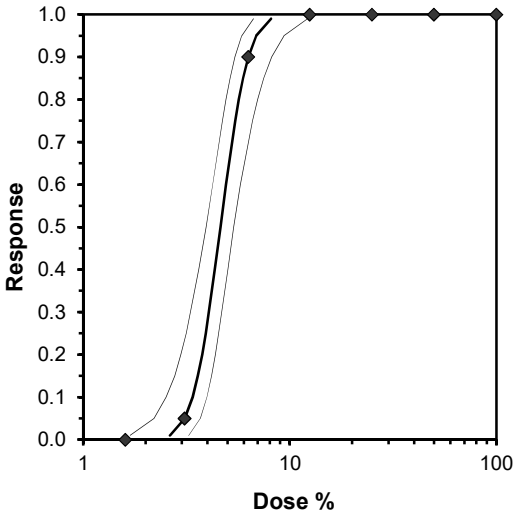
| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 9.505782 | 1.966966 | 5.650527 | 13.36104 | 0 | 0.000559 | 11.0705 | 1 | 0.664463 | 0.105199 | 3 |
| Intercept | -1.31624 | 1.365747 | -3.9931 | 1.360626 | | | | | | | |
| TSCR | | | | | | | | | | | |

| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.628652 | 1.686204 | 3.243257 |
| EC05 | 3.355 | 3.100456 | 2.198841 | 3.692418 |
| EC10 | 3.718 | 3.385671 | 2.524747 | 3.969842 |
| EC15 | 3.964 | 3.592782 | 2.765837 | 4.177245 |
| EC20 | 4.158 | 3.766387 | 2.969044 | 4.356697 |
| EC25 | 4.326 | 3.921995 | 3.150814 | 4.52312 |
| EC40 | 4.747 | 4.343211 | 3.632332 | 5.008724 |
| EC50 | 5.000 | 4.618094 | 3.93114 | 5.360334 |
| EC60 | 5.253 | 4.910376 | 4.230676 | 5.768968 |
| EC75 | 5.674 | 5.437741 | 4.722071 | 6.598226 |
| EC80 | 5.842 | 5.662401 | 4.914483 | 6.985039 |
| EC85 | 6.036 | 5.936011 | 5.137778 | 7.480468 |
| EC90 | 6.282 | 6.299135 | 5.418881 | 8.175605 |
| EC95 | 6.645 | 6.878599 | 5.840412 | 9.364237 |
| EC99 | 7.326 | 8.113208 | 6.666923 | 12.17878 |

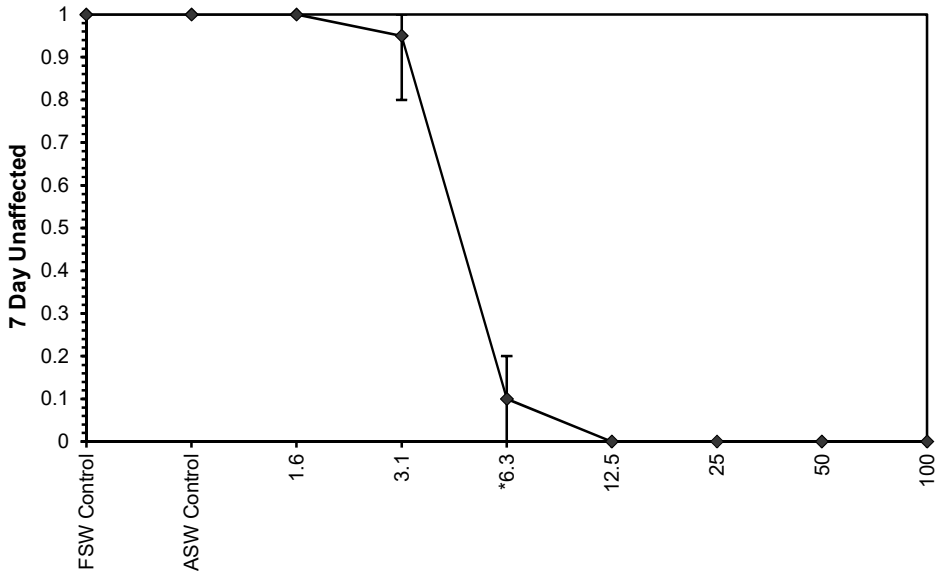
Significant heterogeneity detected (p < 0.01)



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0160221 |
| End Date: | 25/02/2021 19:30 | Lab ID: | | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0160221 |
| End Date: | 25/02/2021 19:30 | Lab ID: | | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 6.3 | | 10.00 | 0.00 | 20.00 | 11.55 | 33.98 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 15.65 | 14.98 | 16.82 | 0.83 | 5.83 | 4 |
| ASW Control | | 15.75 | 15.18 | 16.18 | 0.44 | 4.20 | 4 |
| 1.6 | | 15.76 | 14.38 | 16.88 | 1.27 | 7.15 | 4 |
| 3.1 | | 15.14 | 14.18 | 16.18 | 0.82 | 5.99 | 4 |
| 6.3 | | 1.31 | 0.00 | 2.78 | 1.52 | 94.06 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0160221 |
| End Date: | 25/02/2021 19:30 | Lab ID: | | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 14.980 | 16.820 | 15.660 | 15.140 |
| ASW Control | 15.180 | 16.180 | 15.980 | 15.640 |
| 1.6 | 14.980 | 14.380 | 16.800 | 16.880 |
| 3.1 | 16.180 | 15.220 | 14.980 | 14.180 |
| 6.3 | 2.460 | 2.780 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

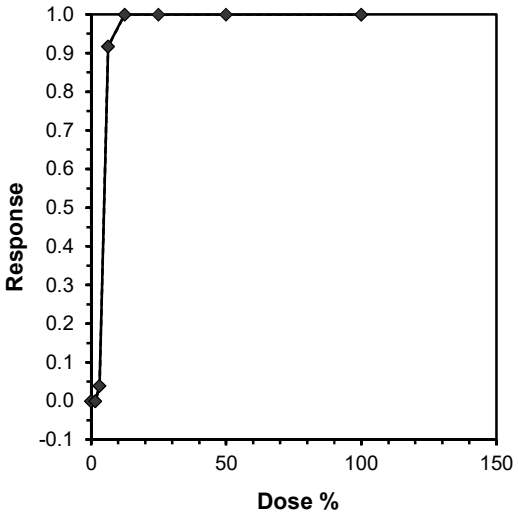
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 15.650 | 0.9940 | 15.650 | 14.980 | 16.820 | 5.318 | 4 | | | | | |
| ASW Control | 15.745 | 1.0000 | 15.745 | 15.180 | 16.180 | 2.780 | 4 | * | | | 15.753 | 1.0000 |
| 1.6 | 15.760 | 1.0010 | 15.760 | 14.380 | 16.880 | 8.067 | 4 | -0.019 | 2.290 | 1.772 | 15.753 | 1.0000 |
| 3.1 | 15.140 | 0.9616 | 15.140 | 14.180 | 16.180 | 5.440 | 4 | 0.782 | 2.290 | 1.772 | 15.140 | 0.9611 |
| *6.3 | 1.310 | 0.0832 | 1.310 | 0.000 | 2.780 | 115.900 | 4 | 18.652 | 2.290 | 1.772 | 1.310 | 0.0832 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.92257 | 0.887 | -0.01797 | -1.40763 |
| Bartlett's Test indicates equal variances (p = 0.28) | 3.812643 | 11.34487 | | |
| The control means are not significantly different (p = 0.85) | 0.202055 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 1.772243 | 0.112559 | 203.0638 | 1.197858 | 4.4E-10 | 3, 12 |

### Linear Interpolation (200 Resamples)

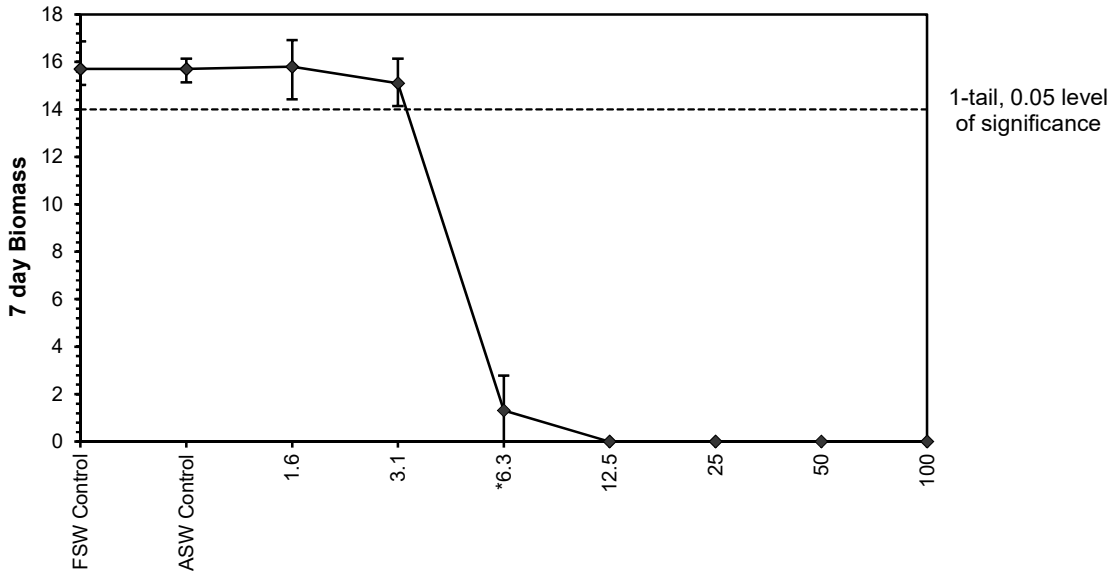
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.1405 | 0.4568 | 0.3510 | 3.3435 | -2.1042 |
| IC10 | 3.3228 | 0.0836 | 3.0216 | 3.5092 | -0.2901 |
| IC15 | 3.5050 | 0.0796 | 3.2081 | 3.7081 | 0.0277 |
| IC20 | 3.6872 | 0.0790 | 3.4056 | 3.9107 | 0.1245 |
| IC25 | 3.8695 | 0.0796 | 3.6015 | 4.1043 | 0.2071 |
| IC40 | 4.4162 | 0.0886 | 4.1231 | 4.7040 | 0.3311 |
| IC50 | 4.7807 | 0.0994 | 4.4584 | 5.1140 | 0.3399 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0160221 |
| End Date: | 25/02/2021 19:30 | Lab ID: | | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Dose-Response Plot



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 18/02/2021 19:30 | Test ID: | PR1978/14 | Sample ID: | Y0160221 |
| End Date: | 25/02/2021 19:30 | Lab ID: | | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 6.3 | | 10.00 | 0.00 | 20.00 | 11.55 | 33.98 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 15.65 | 14.98 | 16.82 | 0.83 | 5.83 | 4 |
| ASW Control | | 15.75 | 15.18 | 16.18 | 0.44 | 4.20 | 4 |
| 1.6 | | 15.76 | 14.38 | 16.88 | 1.27 | 7.15 | 4 |
| 3.1 | | 15.14 | 14.18 | 16.18 | 0.82 | 5.99 | 4 |
| 6.3 | | 1.31 | 0.00 | 2.78 | 1.52 | 94.06 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.30 | 98.30 | 98.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.90 | 101.90 | 101.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 101.50 | 101.50 | 101.50 | 0.00 | 0.00 | 1 |
| 25 | | 101.70 | 101.70 | 101.70 | 0.00 | 0.00 | 1 |
| 50 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 100 | | 75.20 | 75.20 | 75.20 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/15 | Sample ID: | Y0230221 |
| End Date: | 4/03/2021 19:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 0.8000 |
| 6.3 | 0.0000 | 0.4000 | 0.0000 | 0.4000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 1 | 20 |
| 3.1 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 1 | 20 |
| *6.3 | 0.2000 | 0.2000 | 0.4551 | 0.2255 | 0.6847 | 58.254 | 4 | 10.00 | 10.00 | 16 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

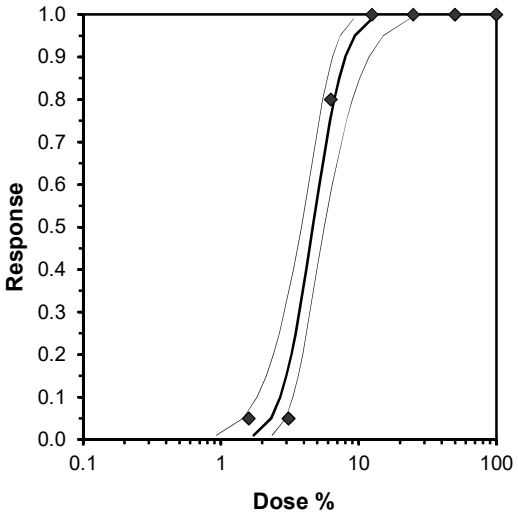
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.874636 | 0.887 | -0.27847 | -0.32298 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 5.417209 | 1.028097 | 3.402138 | 7.432279 | 0 | 8.83011 | 11.0705 | 0.12 | 0.66729 | 0.184597 | 4 |
| Intercept | 1.385152 | 0.716971 | -0.02011 | 2.790416 | | | | | | | |
| TSCR | | | | | | | | | | | |

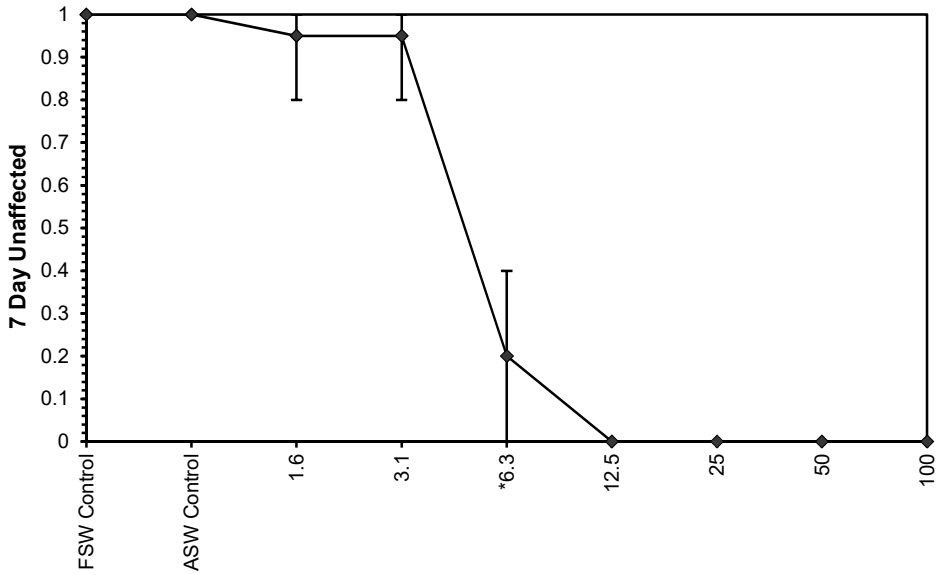
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 1.729231 | 0.925835 | 2.353387 |
| EC05 | 3.355 | 2.310228 | 1.447006 | 2.949606 |
| EC10 | 3.718 | 2.695996 | 1.827298 | 3.342664 |
| EC15 | 3.964 | 2.99204 | 2.132017 | 3.648715 |
| EC20 | 4.158 | 3.250342 | 2.403607 | 3.922298 |
| EC25 | 4.326 | 3.489643 | 2.657334 | 4.183797 |
| EC40 | 4.747 | 4.173714 | 3.372507 | 4.994769 |
| EC50 | 5.000 | 4.648253 | 3.841576 | 5.630064 |
| EC60 | 5.253 | 5.176746 | 4.327387 | 6.417287 |
| EC75 | 5.674 | 6.191537 | 5.16184 | 8.151251 |
| EC80 | 5.842 | 6.647379 | 5.504696 | 9.013805 |
| EC85 | 6.036 | 7.221247 | 5.916193 | 10.16418 |
| EC90 | 6.282 | 8.0142 | 6.456622 | 11.86145 |
| EC95 | 6.645 | 9.352434 | 7.315636 | 14.98163 |
| EC99 | 7.326 | 12.49472 | 9.167312 | 23.41945 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/15 | Sample ID: | Y0230221 |
| End Date: | 4/03/2021 19:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Dose-Response Plot



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/15 | Sample ID: | Y0230221 |
| End Date: | 4/03/2021 19:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 3.1 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 6.3 | | 20.00 | 0.00 | 40.00 | 23.09 | 24.03 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 18.01 | 16.98 | 19.14 | 0.92 | 5.33 | 4 |
| ASW Control | | 18.67 | 17.18 | 19.68 | 1.19 | 5.84 | 4 |
| 1.6 | | 16.92 | 14.66 | 18.32 | 1.58 | 7.43 | 4 |
| 3.1 | | 17.37 | 16.32 | 18.14 | 0.87 | 5.37 | 4 |
| 6.3 | | 8.67 | 0.00 | 21.36 | 9.03 | 34.68 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/15 | Sample ID: | Y0230221 |
| End Date: | 4/03/2021 19:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 17.640 | 18.280 | 16.980 | 19.140 |
| ASW Control | 18.240 | 17.180 | 19.580 | 19.680 |
| 1.6 | 14.660 | 18.320 | 17.180 | 17.520 |
| 3.1 | 18.020 | 16.980 | 18.140 | 16.320 |
| 6.3 | 21.360 | 6.280 | 0.000 | 7.020 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

| | | | Transform: Untransformed | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 18.010 | 0.9646 | 18.010 | 16.980 | 19.140 | 5.117 | 4 | | | | |
| ASW Control | 18.670 | 1.0000 | 18.670 | 17.180 | 19.680 | 6.378 | 4 | * | | 18.670 | 1.0000 |
| 1.6 | 16.920 | 0.9063 | 16.920 | 14.660 | 18.320 | 9.342 | 4 | 13.00 | 10.00 | 17.143 | 0.9182 |
| 3.1 | 17.365 | 0.9301 | 17.365 | 16.320 | 18.140 | 5.009 | 4 | 12.00 | 10.00 | 17.143 | 0.9182 |
| 6.3 | 8.665 | 0.4641 | 8.665 | 0.000 | 21.360 | 104.216 | 4 | 14.00 | 10.00 | 8.665 | 0.4641 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |

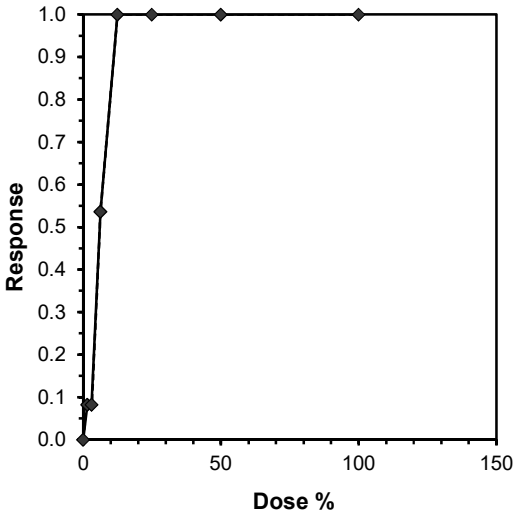
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.750951 | 0.887 | 1.454235 | 6.90931 |
| Bartlett's Test indicates unequal variances (p = 4.07E-04) | 18.16347 | 11.34487 | | |
| The control means are not significantly different (p = 0.41) | 0.876707 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05* | 0.9778 | 1.1113 | 0.3642 | 4.9634 | 2.0049 |
| IC10 | 3.2282 | 1.1541 | 0.0000 | 8.4829 | 0.6865 |
| IC15 | 3.5805 | 0.8754 | 2.9177 | 8.8037 | 2.1103 |
| IC20 | 3.9329 | 0.9084 | 3.1652 | 9.1245 | 2.0669 |
| IC25 | 4.2853 | 1.0056 | 3.3881 | 9.4454 | 1.5840 |
| IC40 | 5.3424 | 1.1644 | 3.7386 | 10.4078 | 0.9789 |
| IC50 | 6.0471 | 1.2839 | 3.9582 | 11.0494 | 0.6534 |

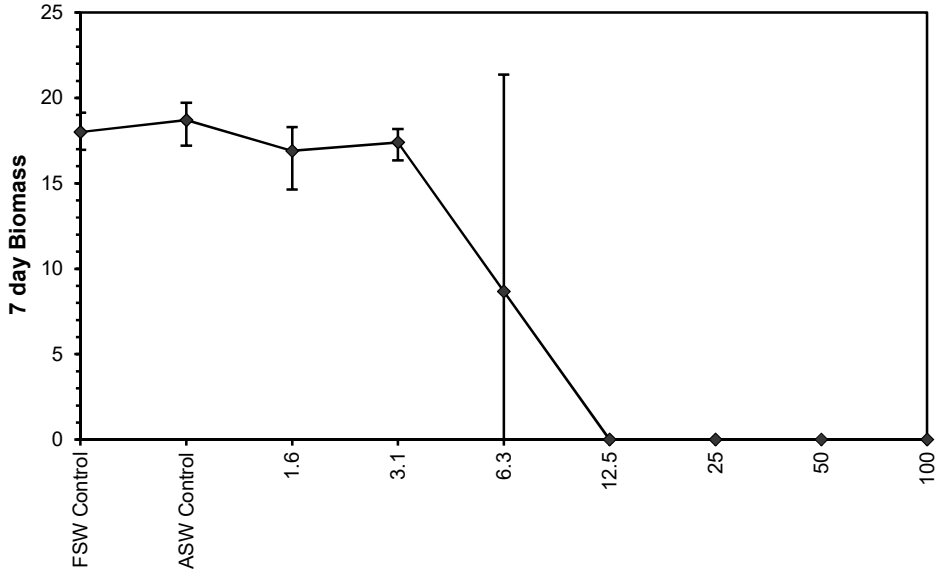
* indicates IC estimate less than the lowest concentration



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/15 | Sample ID: | Y0230221 |
| End Date: | 4/03/2021 19:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/02/2021 19:30 | Test ID: | PR1978/15 | Sample ID: | Y0230221 |
| End Date: | 4/03/2021 19:30 | Lab ID: | 9966 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 3.1 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 6.3 | | 20.00 | 0.00 | 40.00 | 23.09 | 24.03 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 18.01 | 16.98 | 19.14 | 0.92 | 5.33 | 4 |
| ASW Control | | 18.67 | 17.18 | 19.68 | 1.19 | 5.84 | 4 |
| 1.6 | | 16.92 | 14.66 | 18.32 | 1.58 | 7.43 | 4 |
| 3.1 | | 17.37 | 16.32 | 18.14 | 0.87 | 5.37 | 4 |
| 6.3 | | 8.67 | 0.00 | 21.36 | 9.03 | 34.68 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.40 | 6.40 | 6.40 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.65 | 35.65 | 35.65 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 25 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 103.60 | 103.60 | 103.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.10 | 101.10 | 101.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 100.30 | 100.30 | 100.30 | 0.00 | 0.00 | 1 |
| 50 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 100 | | 84.20 | 84.20 | 84.20 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 0.8000 | 0.8000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

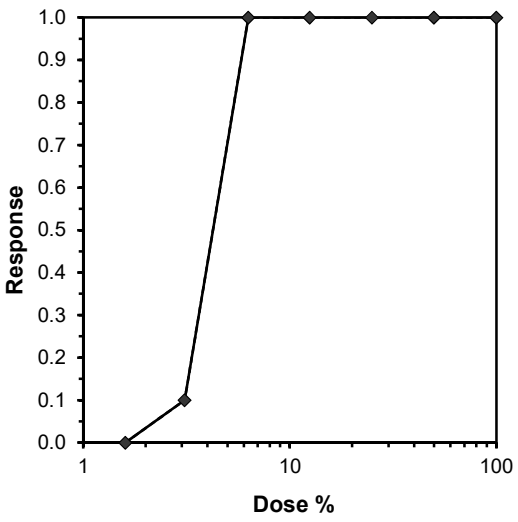
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 0 | 20 |
| 3.1 | 0.9000 | 0.9000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 14.00 | 11.00 | 2 | 20 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.7744 | 0.859 | 3.68E-15 | 0.733333 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

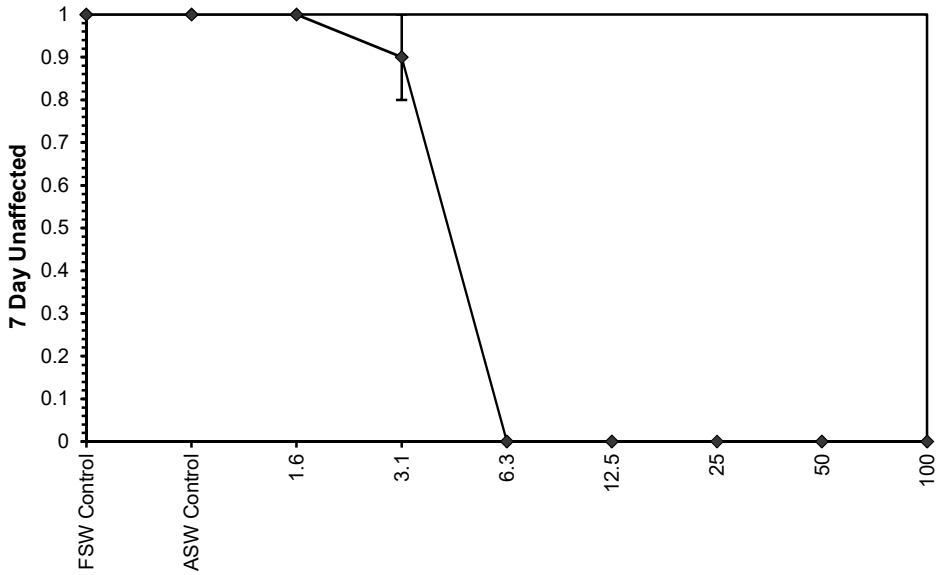
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 4.1266 | 3.7641 | 4.5240 |
| 5.0% | 4.2143 | 3.7591 | 4.7247 |
| 10.0% | 4.2486 | 4.0062 | 4.5055 |
| 20.0% | 4.2486 | 4.0062 | 4.5055 |
| Auto-0.0% | 4.1266 | 3.7641 | 4.5240 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 18.33 | 18.08 | 18.90 | 0.39 | 3.41 | 4 |
| ASW Control | | 18.19 | 17.94 | 18.44 | 0.25 | 2.73 | 4 |
| 1.6 | | 18.65 | 18.34 | 18.96 | 0.36 | 3.21 | 4 |
| 3.1 | | 16.50 | 14.30 | 18.62 | 2.36 | 9.31 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 0.8000 | 0.8000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

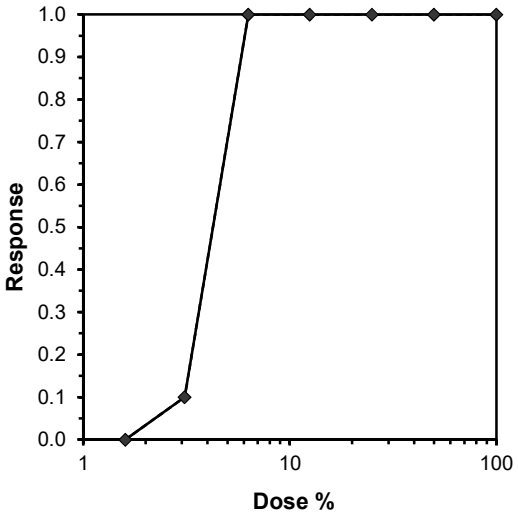
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 3.1 | 0.9000 | 0.9000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 14.00 | 11.00 | 0.9000 | 0.9000 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.7744 | 0.859 | 3.68E-15 | 0.733333 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

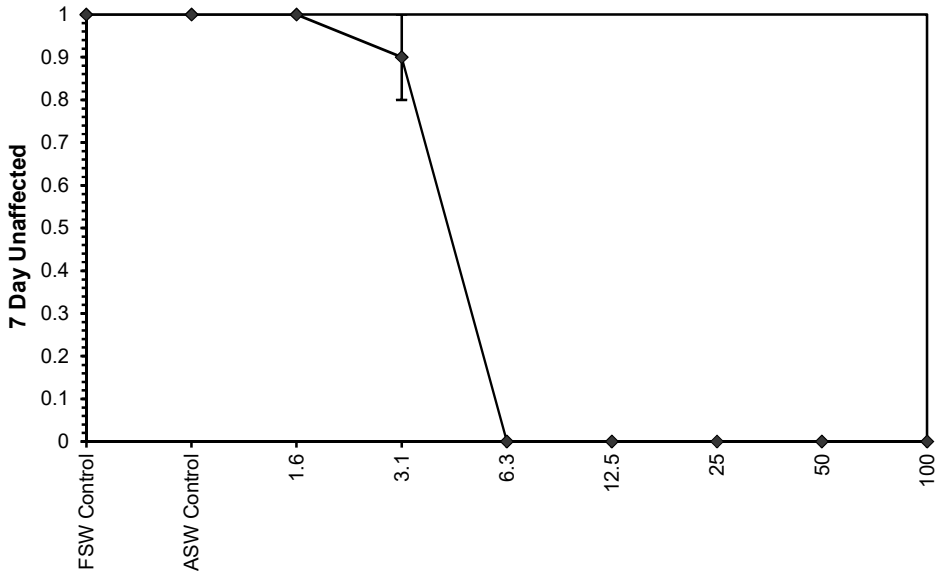
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.9058 | 0.3362 | 2.6477 | 4.6388 | 2.2724 |
| IC10 | 3.1000 | 0.3172 | 2.7975 | 4.7113 | 2.2816 |
| IC15 | 3.1971 | 0.3074 | 2.9101 | 4.7723 | 2.3154 |
| IC20 | 3.2716 | 0.3016 | 2.9970 | 4.8185 | 2.3184 |
| IC25 | 3.3342 | 0.2970 | 3.0630 | 4.8567 | 2.3162 |
| IC40 | 3.4889 | 0.2852 | 3.2265 | 4.9496 | 2.3107 |
| IC50 | 3.5819 | 0.2778 | 3.3251 | 5.0042 | 2.3074 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 18.33 | 18.08 | 18.90 | 0.39 | 3.41 | 4 |
| ASW Control | | 18.19 | 17.94 | 18.44 | 0.25 | 2.73 | 4 |
| 1.6 | | 18.65 | 18.34 | 18.96 | 0.36 | 3.21 | 4 |
| 3.1 | | 16.50 | 14.30 | 18.62 | 2.36 | 9.31 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 18.240 | 18.080 | 18.900 | 18.080 |
| ASW Control | 18.020 | 17.940 | 18.360 | 18.440 |
| 1.6 | 18.340 | 18.340 | 18.960 | 18.960 |
| 3.1 | 18.460 | 18.620 | 14.620 | 14.300 |
| 6.3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

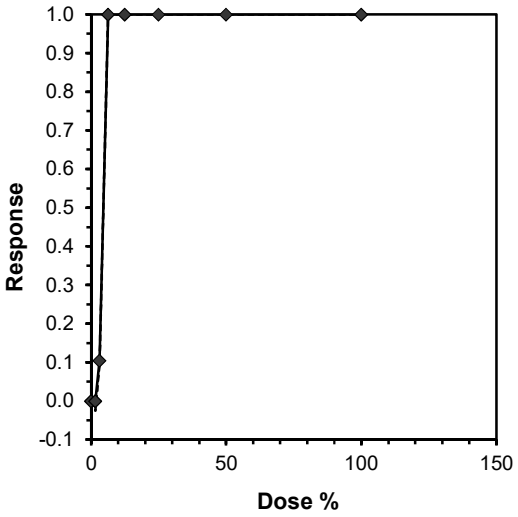
| | | | Transform: Untransformed | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 18.325 | 1.0074 | 18.325 | 18.080 | 18.900 | 2.132 | 4 | | | | |
| ASW Control | 18.190 | 1.0000 | 18.190 | 17.940 | 18.440 | 1.357 | 4 | * | | 18.420 | 1.0000 |
| 1.6 | 18.650 | 1.0253 | 18.650 | 18.340 | 18.960 | 1.919 | 4 | 22.00 | 11.00 | 18.420 | 1.0000 |
| 3.1 | 16.500 | 0.9071 | 16.500 | 14.300 | 18.620 | 14.304 | 4 | 18.00 | 11.00 | 16.500 | 0.8958 |
| 6.3 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.899507 | 0.859 | -0.01302 | 0.49654 |
| Bartlett's Test indicates unequal variances (p = 1.29E-03) | 13.30438 | 9.21034 | | |
| The control means are not significantly different (p = 0.58) | 0.584248 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 |

### Linear Interpolation (200 Resamples)

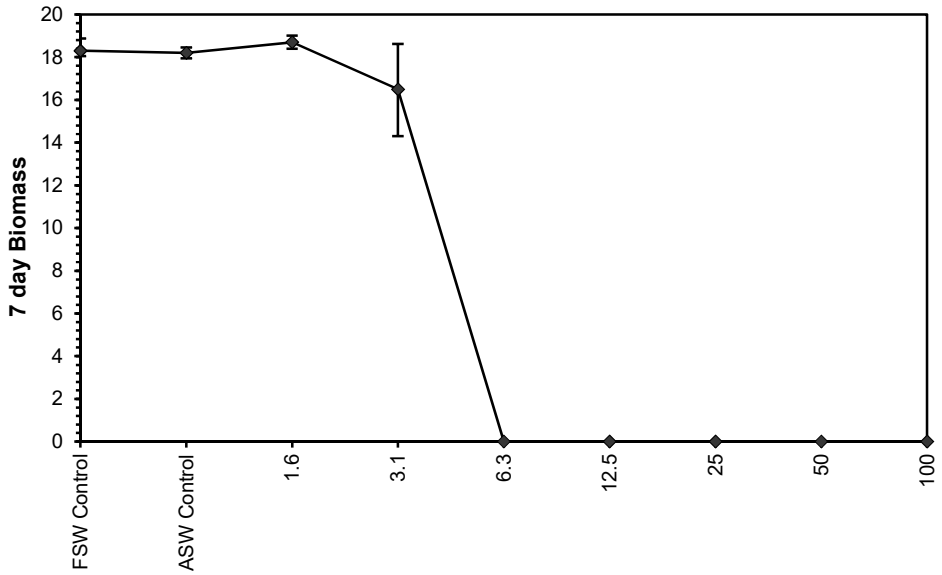
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.3195 | 0.4121 | 1.7253 | 3.8243 | 0.9570 |
| IC10 | 3.0391 | 0.3229 | 1.8506 | 3.6486 | -0.3338 |
| IC15 | 3.2635 | 0.2130 | 2.2729 | 3.7699 | -0.5991 |
| IC20 | 3.4421 | 0.1706 | 2.7227 | 3.9187 | -0.2542 |
| IC25 | 3.6207 | 0.1557 | 3.0131 | 4.0676 | -0.1057 |
| IC40 | 4.1566 | 0.1246 | 3.6705 | 4.5141 | -0.1057 |
| IC50 | 4.5138 | 0.1038 | 4.1087 | 4.8117 | -0.1057 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Dose-Response Plot



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/03/2021 17:30 | Test ID: | PR1978/16 | Sample ID: | Y020321 |
| End Date: | 12/03/2021 17:30 | Lab ID: | 9983 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 18.33 | 18.08 | 18.90 | 0.39 | 3.41 | 4 |
| ASW Control | | 18.19 | 17.94 | 18.44 | 0.25 | 2.73 | 4 |
| 1.6 | | 18.65 | 18.34 | 18.96 | 0.36 | 3.21 | 4 |
| 3.1 | | 16.50 | 14.30 | 18.62 | 2.36 | 9.31 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.50 | 6.50 | 6.50 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 100 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.40 | 101.40 | 101.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 103.00 | 103.00 | 103.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 25 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 50 | | 92.00 | 92.00 | 92.00 | 0.00 | 0.00 | 1 |
| 100 | | 88.90 | 88.90 | 88.90 | 0.00 | 0.00 | 1 |

# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report

**July-August 2021**

T +61 2 9420 9481
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia
www.ecotox.com.au
ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR2029/1



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>28 July 2021<br>29 July 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 10165 | MI-5327 | Aqueous sample, pH 6.0*, salinity 16.1‰*, total ammonia 24.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 30 July 2021 at 1615h |

| Sample 10165*: MI-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control 92.3 ± 2.2 | | |
| ASW Control 91.5 ± 2.4 | | |
| 1.6 92.8 ± 1.5 | | |
| 3.1 60.0 ± 11.1 * | | |
| 6.3 0.0 ± 0.0 | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **IC10 = 2.2 (2.00-2.33)%** | | |
| **EC50 = 3.5 (3.37-3.60)%** | | |
| **NOEC = 1.6%** | | |
| **LOEC = 3.1%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 92.3% | Yes |
| Reference Toxicant within cusum chart limits | 54.8-59.3µg Cu/L | 56.7µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR2029/2



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|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>28 July 2021<br>29 July 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10165 | MI-5327 | Aqueous sample, pH 6.0*, salinity 16.1‰*, total ammonia 24.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 30 July 2021 at 1630h |

| Sample 10165*: MI-5327* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Normal larvae (Mean ± SD)** | | |
| FSW Control | 95.5 ± 2.1 | | |
| ASW Control | 96.0 ± 1.4 | | |
| 1.6 | 96.0 ± 1.4 | | |
| 3.1 | 92.0 ± 1.4 * | | |
| 6.3 | 46.3 ± 5.9 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 = 3.7 (3.45-3.95)%** | | | |
| **72-hr EC50 = 6.0 (5.79-6.24)%** | | | |
| **NOEC = 1.6%** | | | |
| **LOEC = 3.1%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/2



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 95.5% | Yes |
| Reference Toxicant within cusum chart limits | 10.6-10.8µg Cu/L | 11.0µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.



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# Toxicity Test Report: TR2029/3



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| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>28 July 2021<br>29 July 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 10165 | MI-5327 | Aqueous sample, pH 6.0*, salinity 16.1‰*, total ammonia 24.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Test duration extended to 72hr. |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 30 July 2021 at 1730h |

| Sample 10165: *MI-5327*<br>**Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 70.8 ± 2.5 | | |
| ASW Control | 71.5 ± 3.4 | | |
| 1.3 | 73.0 ± 4.8 | | |
| 3.1 | 72.5 ± 1.3 | | |
| 6.3 | 32.0 ± 5.5 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 = 3.6 (3.34-3.68)%**<br>**72-hr EC50 = 6.0 (5.81-6.23)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/3



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 70.8% | Yes |
| Reference Toxicant within cusum chart limits | 8.3-13.0µg Cu/L | 11.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.



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# Toxicity Test Report: TR2029/4



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>28 July 2021<br>29 July 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10165 | MI-5327 | Aqueous sample, pH 6.0, salinity 16.1‰, total ammonia 24.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 30 July 2021 at 1430 h |

| Sample 10165: *MI-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **% Germination (Mean ± SD)** | |
| FSW Control | 98.0 ± 1.6 | |
| ASW Control | 97.3 ± 1.0 | |
| 1.3 | 97.5 ± 1.7 | |
| 3.1 | 98.3 ± 1.7 | |
| 6.3 | 96.8 ± 1.5 | |
| 12.5 | 84.0 ± 2.9 * | |
| 25 | 9.5 ± 4.7 * | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |
| **72-hr EC10 = 11.8 (11.16-12.42)%** | | |
| **72-hr EC50 = 17.1 (16.55-17.76)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/4



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 98.0% | Yes |
| Reference Toxicant within cusum chart limits | 125.3-258.6µg Cu/L | 174.0µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR2029/5



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited | **ESA Job #:** | PR2029 |
| | Level 15 150 Lonsdale Street | **Date Sampled:** | 28 July 2021 |
| | Melbourne Vic 3000 | **Date Received:** | 29 July 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10165 | MI-5327 | Aqueous sample, pH 6.0, salinity 16.1‰, total ammonia 24.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing. The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 30 July 2021 at 1900h |

| Sample 10165: *MI-5327* **Concentration (%)** | **% Unaffected (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 100 ± 0.0 | | |
| 12.5 | 50.0 ± 20.0 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr IC10 = 10.7 (9.94-11.07)%** | | | |
| **96-hr EC50 = 12.5 (10.74-14.61)%** | | | |
| **NOEC = 6.3%** | | | |
| **LOEC = 12.5%** | | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/5



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 1.5-6.8mg SDS/L | 4.1mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR2029/6



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>28 July 2021<br>29 July 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10165 | MI-5327 | Aqueous sample, pH 6.0, salinity 16.1‰, total ammonia 24.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 30 July 2021 at 1815h |

Sample 10165: *MI-5327*

| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** |
|---|---|
| FSW Control | 16.2 ± 0.4 |
| ASW Control | 16.2 ± 0.6 |
| 1.6 | 16.2 ± 0.8 |
| 3.1 | 16.8 ± 0.2 |
| 6.3 | 14.2 ± 0.8 * |
| 12.5 | 7.0 ± 1.2 * |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**72-hr IC10 = 5.6 (4.66-6.92)%**
**72-hr IC50 = 11.5 (10.60-12.69)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 17.2x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 2.7% | Yes |
| Reference Toxicant within cusum chart limits | 3.5-8.5µg Cu/L | 5.5µg Cu/L | Yes |

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Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR2029/7



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>28 July 2021<br>29 July 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10165 | MI-5327 | Aqueous sample, pH 6.0, salinity 16.1‰, total ammonia 24.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 30 July 2021 at 1900h |

Sample 10165: *MI-5327*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.3 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 15.0 ± 19.2 * |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**96-hr EC10 = 4.9 (3.61-5.25)%**
**96-hr EC50 = 4.9 (4.39-5.48)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 6.1-117.8mg $NH_4^+$/L | 19.2mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR2029/8



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited | **ESA Job #:** | PR2029 |
| | Level 15 150 Lonsdale Street | **Date Sampled:** | 28 July 2021 |
| | Melbourne Vic 3000 | **Date Received:** | 29 July 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10165 | MI-5327 | Aqueous sample, pH 6.0, salinity 16.1‰, total ammonia 24.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing. The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Size of Test Organisms:** | 12mm |
| **Test Initiated:** | 30 July 2021 at 1900h |

Sample 10165: *MI-5327*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.3 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (unaffected) = 4.1 (3.1-6.3)%**
**7 day EC50 (unaffected) = 4.5 (3.1-6.3)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

Sample 10165: *MI-5327*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** |
|---|---|
| FSW Control | 15.6 ± 0.8 |
| ASW Control | 17.0 ± 4.6 |
| 1.3 | 16.1 ± 1.0 |
| 3.1 | 14.2 ± 0.6 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (biomass) = 2.2 %***
**7 day IC50 (biomass) = 4.4 (3.52-4.74)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*The 95% Confidence Limits are not reliable.

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 14.0 | No* |
| Reference Toxicant within cusum chart limits | 6.0-101.8mg $NH_4^+$/L | 19.2mg $NH_4^+$/L | Yes |

* Fish available at the time of testing were 10mm in length, smaller than 12-16mm to which this criterion typically applies.

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

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# Toxicity Test Report: TR2029/8



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**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR2029/9



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>03 August 2021<br>05 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10167 | Y003082021 | Aqueous sample, pH 6.1*, salinity 15.7‰*, total ammonia 29.0mg/L*. Sample received at 10ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 06 August 2021 at 1530h |

| Sample 10167*: Y003082021* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control 95.8 ± 1.7 | | |
| ASW Control 94.5 ± 1.7 | | |
| 1.6 94.5 ± 1.7 | | |
| 3.1 92.8 ± 1.7 | | |
| 6.3 75.5 ± 7.9 * | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **IC10 = 4.7 (3.97-5.80)%** | | |
| **EC50 = 7.6 (7.40-7.84)%** | | |
| **NOEC = 3.1%** | | |
| **LOEC = 6.3%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/9



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 95.8% | Yes |
| Reference Toxicant within cusum chart limits | 54.4-59.6µg Cu/L | 55.6µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.



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# Toxicity Test Report: TR2029/10



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>03 August 2021<br>05 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10167 | Y003082021 | Aqueous sample, pH 6.1*, salinity 15.7‰*, total ammonia 29.0mg/L*. Sample received at 10ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 06 August 2021 at 1500h |

| Sample 10167*: Y003082021* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control 95.0 ± 1.6 | | |
| ASW Control 94.5 ± 2.7 | | |
| 1.6 95.5 ± 2.1 | | |
| 3.1 94.0 ± 1.8 | | |
| 6.3 42.5 ± 3.4 * | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr EC10 = 3.9 (3.59-4.14)%**<br>**72-hr EC50 = 6.0 (5.79-6.21)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/10



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 95.0% | Yes |
| Reference Toxicant within cusum chart limits | 10.6-11.7µg Cu/L | 11.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.



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# Toxicity Test Report: TR2029/11



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>03 August 2021<br>05 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10167 | Y003082021 | Aqueous sample, pH 6.1*, salinity 15.7‰*, total ammonia 29.0mg/L*. Sample received at 10ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Test duration extended to 72hr. |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 06 August 2021 at 1600h |

| Sample 10167*: Y003082021* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control: 83.3 ± 2.2 | | |
| ASW Control: 79.8 ± 3.0 | | |
| 1.3: 82.3 ± 3.5 | | |
| 3.1: 82.3 ± 3.0 | | |
| 6.3: 57.8 ± 10.5 * | | |
| 12.5: 0.0 ± 0.0 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr IC10 = 4.2 (3.73-5.10)%** | | |
| **72-hr EC50 = 7.2 (7.02-7.48)%** | | |
| **NOEC = 3.1%** | | |
| **LOEC = 6.3%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/11



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 83.3% | Yes |
| Reference Toxicant within cusum chart limits | 8.3-13.2µg Cu/L | 10.5µg Cu/L | Yes |

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.



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# Toxicity Test Report: TR2029/12



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>03 August 2021<br>05 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10167 | Y003082021 | Aqueous sample, pH 6.1, salinity 15.7‰, total ammonia 29.0mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 06 August 2021 at 1700h |

| Sample 10167*: Y003082021* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **% Germination (Mean ± SD)** | |
| FSW Control | 96.5 ± 1.3 | |
| ASW Control | 96.5 ± 1.3 | |
| 1.3 | 96.0 ± 1.4 | |
| 3.1 | 96.8 ± 1.7 | |
| 6.3 | 94.3 ± 2.6 | |
| 12.5 | 77.5 ± 3.1 * | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |
| **72-hr EC10 = 9.4 (8.04-10.59)%** | | |
| **72-hr EC50 = 15.2 (14.76-15.66)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/12



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 96.5% | Yes |
| Reference Toxicant within cusum chart limits | 125.5-258.6µg Cu/L | 178.7µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR2029/13



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited | **ESA Job #:** | PR2029 |
| | Level 15 150 Lonsdale Street | **Date Sampled:** | 03 August 2021 |
| | Melbourne Vic 3000 | **Date Received:** | 05 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10167 | Y003082021 | Aqueous sample, pH 6.1, salinity 15.7‰, total ammonia 29.0mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing. The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 06 August 2021 at 1730h |

| Sample 10167*: Y003082021* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** | | |
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 100 ± 0.0 | | |
| 12.5 | 65.0 ± 19.2 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr IC10 = 11.1 (10.42-12.03)%** | | | |
| **96-hr EC50 = 13.9 (12.00-16.09)%** | | | |
| **NOEC = 6.3%** | | | |
| **LOEC = 12.5%** | | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/13



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 1.5-6.8mg SDS/L | 4.1mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR2029/6



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>03 August 2021<br>05 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10167 | Y003082021 | Aqueous sample, pH 6.1, salinity 15.7‰, total ammonia 29.0mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 06 August 2021 at 1800h |

Sample 10167*: Y003082021*

| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** |
|---|---|
| FSW Control | 18.7 ± 0.8 |
| ASW Control | 17.7 ± 0.6 |
| 1.6 | 18.3 ± 0.5 |
| 3.1 | 19.0 ± 0.3 |
| 6.3 | 12.9 ± 1.9 * |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**72-hr IC10 = 4.2 (3.83-4.86)%**
**72-hr IC50 = 8.1 (7.24-8.82)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower cell yield compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 19.7x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 4.1% | Yes |
| Reference Toxicant within cusum chart limits | 3.4-8.5µg Cu/L | 5.4µg Cu/L | Yes |

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# Toxicity Test Report: TR2029/6



Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR2029/15



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>03 August 2021<br>05 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10167 | Y003082021 | Aqueous sample, pH 6.1, salinity 15.7‰, total ammonia 29.0mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 06 August 2021 at 1800h |

Sample 10167*: Y003082021*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.3 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 20.0 ± 16.3 * |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**96-hr EC10 = 5.0 (4.74-5.30)%**
**96-hr EC50 = 5.1 (4.48-5.76)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/15



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 6.1-117.8mg $NH_4^+$/L | 21.0mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA



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# Toxicity Test Report: TR2029/16



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited | **ESA Job #:** | PR2029 |
| | Level 15 150 Lonsdale Street | **Date Sampled:** | 03 August 2021 |
| | Melbourne Vic 3000 | **Date Received:** | 05 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10167 | Y003082021 | Aqueous sample, pH 6.1, salinity 15.7‰, total ammonia 29.0mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing. The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Size of Test Organisms:** | 12mm |
| **Test Initiated:** | 06 August 2021 at 1800h |

Sample 10167*: Y003082021*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.3 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (unaffected) = 4.1 (3.1-6.3)%**
**7 day IC50 (unaffected) = 4.4 (3.1-6.3)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

Sample 10167*: Y003082021*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** | |
|---|---|---|
| FSW Control | 17.2 ± 0.2 | |
| ASW Control | 17.5 ± 0.3 | |
| 1.3 | 17.0 ± 1.0 | |
| 3.1 | 15.1 ± 1.0 | * |
| 6.3 | 0.0 ± 0.0 | |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day IC10 (biomass) = 2.5 (1.60-3.48)%**
**7 day IC50 (biomass) = 4.4 (4.28-4.60)%**
**NOEC = 1.3%**
**LOEC = 6.3%**

*Significantly lower fish biomass compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 26.3% | Yes |
| Reference Toxicant within cusum chart limits | 6.1-117.8mg $NH_4^+$/L | 21.0mg $NH_4^+$/L | Yes |

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# Toxicity Test Report: TR2029/16



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**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

# Toxicity Test Report: TR2029/17



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>18 August 2021<br>19 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 10178 | A1-5327 | Aqueous sample, pH 6.5*, salinity 15.9‰*, total ammonia 15.6mg/L*. Sample received at 10ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 20 August 2021 at 1630h |

| Sample 10178*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control 91.5 ± 1.3 | | |
| ASW Control 90.3 ± 1.3 | | |
| 1.6 92.3 ± 1.3 | | |
| 3.1 91.5 ± 1.3 | | |
| 6.3 91.5 ± 1.7 | | |
| 12.5 6.0 ± 4.2 * | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **IC10 = 7.1 (6.84-7.19)%** | | |
| **EC50 = 9.3 (9.13-9.44)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 91.5% | Yes |
| Reference Toxicant within cusum chart limits | 54.8-59.3µg Cu/L | 57.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR2029/18 (Page 1 of 2)

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| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>18 August 2021<br>19 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10178 | A1-5327 | Aqueous sample, pH 6.5*, salinity 15.9‰*, total ammonia 15.6mg/L*. Sample received at 10ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 20 August 2021 at 1700h |

| Sample 10178*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control 91.5 ± 1.3 | | |
| ASW Control 90.3 ± 1.3 | | |
| 1.6 93.8 ± 2.2 | | |
| 3.1 96.0 ± 2.9 | | |
| 6.3 93.8 ± 2.8 | | |
| 12.5 22.0 ± 44.0 * | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr IC10 = 7.5 (6.04-9.18)%**<br>**72-hr EC50 = 10.4 (10.14-10.75)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Steel"s many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/18 (Page 2 of 2)

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 91.5% | Yes |
| Reference Toxicant within cusum chart limits | 10.6-11.7µg Cu/L | 11.4µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR2029/19



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| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>18 August 2021<br>19 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10178 | A1-5327 | Aqueous sample, pH 6.5*, salinity 15.9‰*, total ammonia 15.6mg/L*. Sample received at 10ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Test duration extended to 72hr. |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 20 August 2021 at 1730h |

| Sample 10178*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control 75.5 ± 2.9 | | |
| ASW Control 72.8 ± 4.3 | | |
| 1.3 78.5 ± 3.5 | | |
| 3.1 74.0 ± 2.9 | | |
| 6.3 64.5 ± 10.1 | | |
| 12.5 0.8 ± 1.5 * | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr IC10 = 3.7 (5.62-6.42)%**<br>**72-hr EC50 = 7.8 (7.43-8.23)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/19



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 75.5% | Yes |
| Reference Toxicant within cusum chart limits | 8.6-13.0µg Cu/L | 10.7µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.



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# Toxicity Test Report: TR2029/20



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>18 August 2021<br>19 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10178 | A1-5327 | Aqueous sample, pH 6.5, salinity 15.9‰, total ammonia 15.6mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 20 August 2021 at 1530h |

| Sample 10178*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **% Germination (Mean ± SD)** | |
| FSW Control | 95.5 ± 2.1 | |
| ASW Control | 95.5 ± 2.1 | |
| 1.3 | 95.5 ± 2.1 | |
| 3.1 | 97.0 ± 1.7 | |
| 6.3 | 96.5 ± 1.3 | |
| 12.5 | 96.5 ± 1.3 | |
| 25 | 3.0 ± 1.6 * | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |
| **72-hr IC10 = 14.4 (13.92-14.64)%** | | |
| **72-hr EC50 = 18.1 (17.85-18.28)%** | | |
| **NOEC = 12.5%** | | |
| **LOEC = 25%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Bonferroni tTest, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2029/20



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 95.5% | Yes |
| Reference Toxicant within cusum chart limits | 125.4-256.8µg Cu/L | 180.8µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR2029/21



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>18 August 2021<br>19 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10178 | A1-5327 | Aqueous sample, pH 6.5, salinity 15.9‰, total ammonia 15.6mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 20 August 2021 at 1800h |

| Sample 10178*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 100 ± 0.0 | | |
| 12.5: 80.0 ± 16.3 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 11.7 (10.95-13.02)%** | | |
| **96-hr EC50 = 13.7 (12.69-15.49)%** | | |
| **NOEC = 12.5%** | | |
| **LOEC = 25%** | | |

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ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR2029/21



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 1.5-7.0mg SDS/L | 3.8mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR2029/22



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>18 August 2021<br>19 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10178 | A1-5327 | Aqueous sample, pH 6.5, salinity 15.9‰, total ammonia 15.6mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 20 August 2021 at 1800h |

Sample 10178*: A1-5327*

| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** |
|---|---|
| FSW Control | 17.7 ± 0.6 |
| ASW Control | 17.5 ± 0.8 |
| 1.6 | 17.5 ± 0.5 |
| 3.1 | 17.9 ± 0.8 |
| 6.3 | 12.5 ± 1.1 * |
| 12.5 | 3.0 ± 2.0 * |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**72-hr IC10 = 4.2 (3.64-4.50)%**
**72-hr IC50 = 8.7 (7.87-9.91)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 18.7x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 3.4% | Yes |
| Reference Toxicant within cusum chart limits | 3.5-8.2µg Cu/L | 4.6µg Cu/L | Yes |

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# Toxicity Test Report: TR2029/22



Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR2029/23 (Page 1 of 2)

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15 150 Lonsdale Street<br>Melbourne Vic 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2029<br>18 August 2021<br>19 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10178 | A1-5327 | Aqueous sample, pH 6.5, salinity 15.9‰, total ammonia 15.6mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 20 August 2021 at 1930h |

Sample 10178*: A1-5327*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.3 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 80.0 ± 16.3 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**96-hr IC10 = 5.9 (5.38-7.00)%**
**96-hr EC50 = 7.7 (6.81-8.74)%**
**NOEC = 6.3%**
**LOEC = 12.5%**

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# Toxicity Test Report: TR2029/23 (Page 2 of 2)

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 6.0-110.3mg $NH_4^+$/L | 17.2mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR2029/24 (Page 1 of 2)

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited | **ESA Job #:** | PR2029 |
| | Level 15 150 Lonsdale Street | **Date Sampled:** | 18 August 2021 |
| | Melbourne Vic 3000 | **Date Received:** | 19 August 2021 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | Not Supplied | **ESA Quote #:** | PL2029_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10178 | A1-5327 | Aqueous sample, pH 6.5, salinity 15.9‰, total ammonia 15.6mg/L. Sample received at 10ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing. The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Size of Test Organisms:** | 12mm |
| **Test Initiated:** | 20 August 2021 at 1930h |

Sample 10178*: A1-5327*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** | |
|---|---|---|
| FSW Control | 100 ± 0.0 | |
| ASW Control | 100 ± 0.0 | |
| 1.3 | 100 ± 0.0 | |
| 3.1 | 100 ± 0.0 | |
| 6.3 | 70.0 ± 11.6 | * |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day IC10 (unaffected) = 5.7 (5.40-6.01)%**
**7 day IC50 (unaffected) = 7.2 (6.24-8.31)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

Sample 10178*: A1-5327*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** | |
|---|---|---|
| FSW Control | 17.2 ± 0.8 | |
| ASW Control | 16.7 ± 0.7 | |
| 1.3 | 17.8 ± 0.6 | |
| 3.1 | 17.5 ± 0.6 | |
| 6.3 | 10.2 ± 1.5 | ** |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day IC10 (biomass) = 3.9 (3.61-4.10)%**
**7 day IC50 (biomass) = 7.2 (6.14-8.09)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower fish biomass compared with the ASW Control (Steel's Many-One rank Test, 1-tailed, P=0.05)
*Significantly lower fish biomass compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 28.8% | Yes |
| Reference Toxicant within cusum chart limits | 6.0-110.3mg $NH_4^+$/L | 17.2mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

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# Toxicity Test Report: TR2029/24 

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Adrian Cukovski

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : Adrian.Cukovski@beachenergy.com.au
**Telephone** : 08 8433 2325
**Facsimile** :

**Date** : 29/07/2021

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR2029 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 29/07/2021
**Time samples received** : 8:45
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 11-15°C

**Comments** : 4 x 2.5L sample received at 12oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 01 June 2021

Customer: Beach Energy
Contact Name: Adrian Cukovski
Phone: _____ Email: Adrian.Cukovski@BeachEnergy.com.au (please provide an email address for sample receipt notification)
Helen.Northcote@BeachEnergy.com.au
Sampled by: R. McAdyen

Ship To: Ecotox Services Aust.
Attention: Rick Krassoi

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | | | | | | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 96-H Algal Toxicity Acute | 96-H Fish Toxicity | 72-H Algal Growth | 72-H Marine Inhibition | 7-D Fish Growth | Sub Sample to Eurofins | |
| 28-7-21 | 0630 | Wet Test - MW-5827 | Grab | 4x250ml | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Test Requested As Per Submitted COC/Service Request |
| | | | | | | | | | | | |
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| | | | | | | | | | | | |

12°C
10165

**Note that testing will be delayed if an incomplete chain of custody is received**

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

*Note: An MSDS must be attached if Available*

**ESA Project Number: PR~~1858~~ 2029**

| 1) Released By: | Date: | 2) Received By: | Date: 29/7/21 | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| Of: | Time: | Of: ESA | Time: 0845 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Adrian Cukovski

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : Adrian.Cukovski@beachenergy.com.au
**Telephone** : 08 8433 2325
**Facsimile** :

**Date** : 6/08/2021

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR2029 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 5/08/2021
**Time samples received** : 9:05
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 6-10°C

**Comments** : 4 x 2.5L sample received at 10oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 01 June 2021

Customer: BEACH ENERGY
Contact Name: ADRIAN CUKOUSKI
Phone: Email: @BEACHENERGY.COM.AU (please provide an email address for sample receipt notification)
Sampled by: C. VALLANCE.

Ship To: ECOTOX SERVICES AUSTRALIA.
Attention: RICK KRASSOI

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | | | | | | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 96-H Allorchestes Acute | 96-H Beak Gt. | 72-H Nitzschia. | 72-H Hormosira. | 48-H Mussel Larval Dev. - Cent. 1-H Sea Urch ???? | 72-4 Sea Urch ???? | 7-d Gt + Growth | Sed - Sampling for Eurofins | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 1858 |
| 10°C | | | | | | | | | | | | | |
| 10167 03/08/21 | 18:00 | YO03082021 | GRAB | 4x 2.5L | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | | | | | | | | | | | | | |
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| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| C. VALLANCE | 04-08-2021 | | 5/8/21 | | | | |
| Of: | Time: | Of: ESA | Time: 0905 | Of: | Time: | Of: | Time: |
| | 09:00 | | | | | | |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Email: info@ecotox.com.au

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Adrian Cukovski

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : Adrian.Cukovski@beachenergy.com.au
**Telephone** : 08 8433 2325
**Facsimile** :

**Date** : 19/08/2021

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR2029 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 19/08/2021
**Time samples received** : 10:30
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 6-10°C

**Comments** : 4 x 2.5L sample received at 11oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 01 June 2021

Customer: BEACH ENERGY
Contact Name: ADRIAN COKROVSKI
Phone: Email: ADRIAN.COKROVSKI@BEACHENERGY.COM.AU (please provide an email address for sample receipt notification)
Sampled by: R. MCFADYEN

Ship To: ECOTOX SERVICES AUST
Attention: RICK KRASSOI

UR 32061504

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | | | | | | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | None - Additional tests | | | | | Hold Sample for Further Instructions | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 1858 |
| | | AI-5327-Wet Test | SCRAB | 4×25mL | | | | | | | |
| | | | | | | | | | | | |
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| | | | | | | | | | | | |

11°C

10178

| 1) Released By: | Date: | 2) Received By: | Date: 19/8/21 | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| Of: | Time: | Of: ESA | Time: 1030 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
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# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:15 | Test ID: | PR2029/01 | Sample ID: | MI-5327 |
| End Date: | 30/07/2021 17:35 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9000 | 0.9300 | 0.9100 |
| ASW Control | 0.9000 | 0.9000 | 0.9500 | 0.9100 |
| 1.6 | 0.9100 | 0.9400 | 0.9200 | 0.9400 |
| 3.1 | 0.4600 | 0.6100 | 0.7300 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

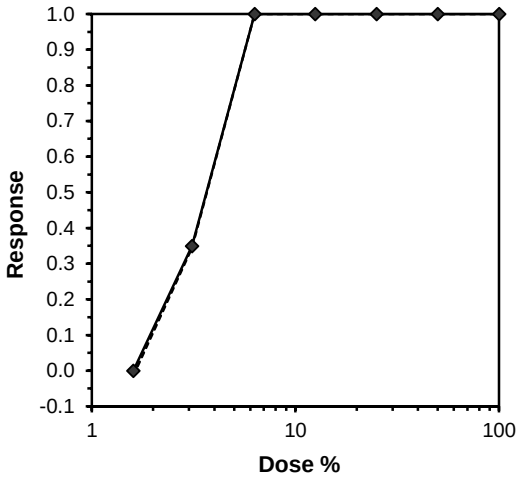
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9225 | 1.0082 | 1.2909 | 1.2490 | 1.3453 | 3.308 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2774 | 1.2490 | 1.3453 | 3.600 | 4 | * | | | 0.9213 | 1.0000 |
| 1.6 | 0.9275 | 1.0137 | 1.2992 | 1.2661 | 1.3233 | 2.217 | 4 | -0.423 | 2.180 | 0.1124 | 0.9213 | 1.0000 |
| *3.1 | 0.6000 | 0.6557 | 0.8880 | 0.7454 | 1.0244 | 12.843 | 4 | 7.551 | 2.180 | 0.1124 | 0.6000 | 0.6513 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.916519 | 0.859 | -0.04319 | 2.499077 |
| Bartlett's Test indicates equal variances (p = 0.09) | 4.925493 | 9.21034 | | |
| The control means are not significantly different (p = 0.68) | 0.430136 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 1.6 | 3.1 | 2.227106 | 62.5 | 0.072199 | 0.07879 | 0.214078 | 0.005317 | 3.2E-05 | 2, 9 |
| Treatments vs ASW Control | | | | | | | | | | |

### Log-Logit Interpolation (200 Resamples)

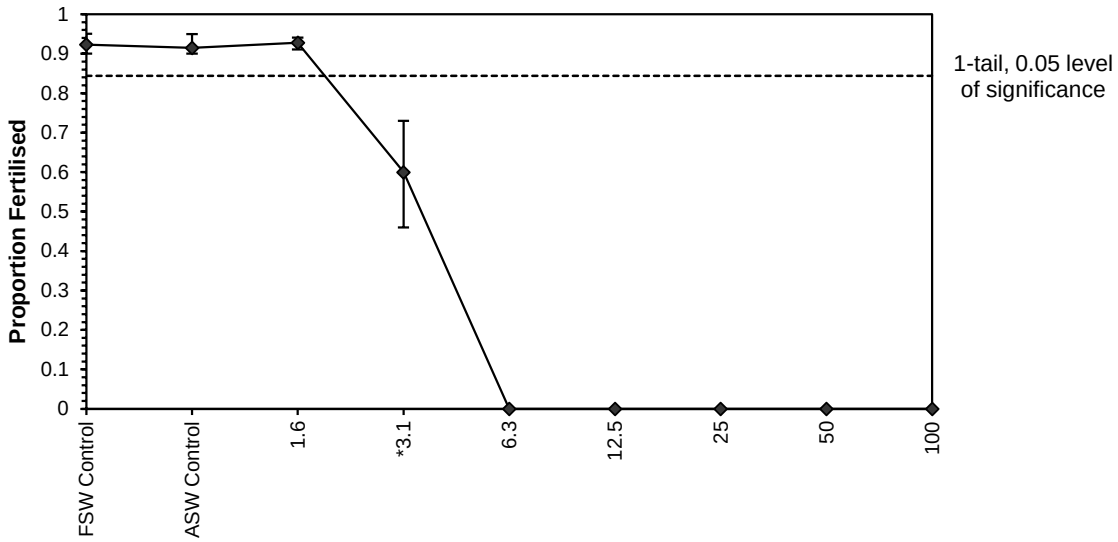
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.9125 | 0.0368 | 1.7905 | 2.0102 | -0.1290 |
| IC10 | 2.1603 | 0.0627 | 1.9969 | 2.3322 | 0.1280 |
| IC15 | 2.3745 | 0.0885 | 2.1427 | 2.6266 | 0.1503 |
| IC20 | 2.5694 | 0.1137 | 2.2729 | 2.9009 | 0.1712 |
| IC25 | 2.7528 | 0.1372 | 2.3924 | 3.1700 | 0.1194 |
| IC40 | 3.1479 | 0.0718 | 2.8064 | 3.2676 | -1.5926 |
| IC50 | 3.2409 | 0.0485 | 3.0754 | 3.3574 | -0.4523 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:15 | Test ID: | PR2029/01 | Sample ID: | MI-5327 |
| End Date: | 30/07/2021 17:35 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:15 | Test ID: | PR2029/01 | Sample ID: | MI-5327 |
| End Date: | 30/07/2021 17:35 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 92.25 | 90.00 | 95.00 | 2.22 | 1.61 | 4 |
| ASW Control | | 91.50 | 90.00 | 95.00 | 2.38 | 1.69 | 4 |
| 1.6 | | 92.75 | 91.00 | 94.00 | 1.50 | 1.32 | 4 |
| 3.1 | | 60.00 | 46.00 | 73.00 | 11.05 | 5.54 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:15 | Test ID: | PR2029/01 | Sample ID: | MI-5327 |
| End Date: | 30/07/2021 17:35 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9000 | 0.9300 | 0.9100 |
| ASW Control | 0.9000 | 0.9000 | 0.9500 | 0.9100 |
| 1.6 | 0.9100 | 0.9400 | 0.9200 | 0.9400 |
| 3.1 | 0.4600 | 0.6100 | 0.7300 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

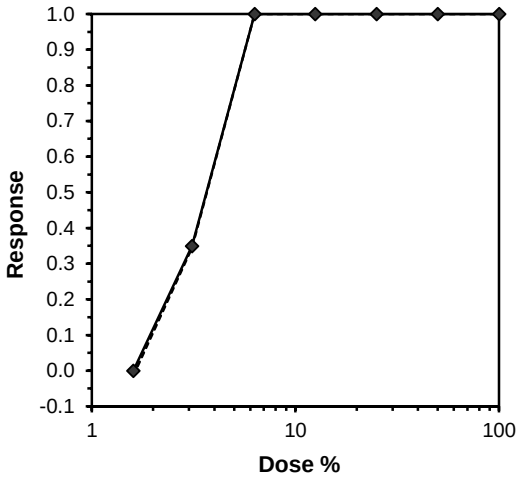
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9225 | 1.0082 | 1.2909 | 1.2490 | 1.3453 | 3.308 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2774 | 1.2490 | 1.3453 | 3.600 | 4 | * | | | 34 | 400 |
| 1.6 | 0.9275 | 1.0137 | 1.2992 | 1.2661 | 1.3233 | 2.217 | 4 | -0.423 | 2.180 | 0.1124 | 29 | 400 |
| *3.1 | 0.6000 | 0.6557 | 0.8880 | 0.7454 | 1.0244 | 12.843 | 4 | 7.551 | 2.180 | 0.1124 | 160 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.916519 | 0.859 | -0.04319 | 2.499077 |
| Bartlett's Test indicates equal variances (p = 0.09) | 4.925493 | 9.21034 | | |
| The control means are not significantly different (p = 0.68) | 0.430136 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.072199 | 0.07879 | 0.214078 | 0.005317 | 3.2E-05 | 2, 9 |

### Trimmed Spearman-Karber

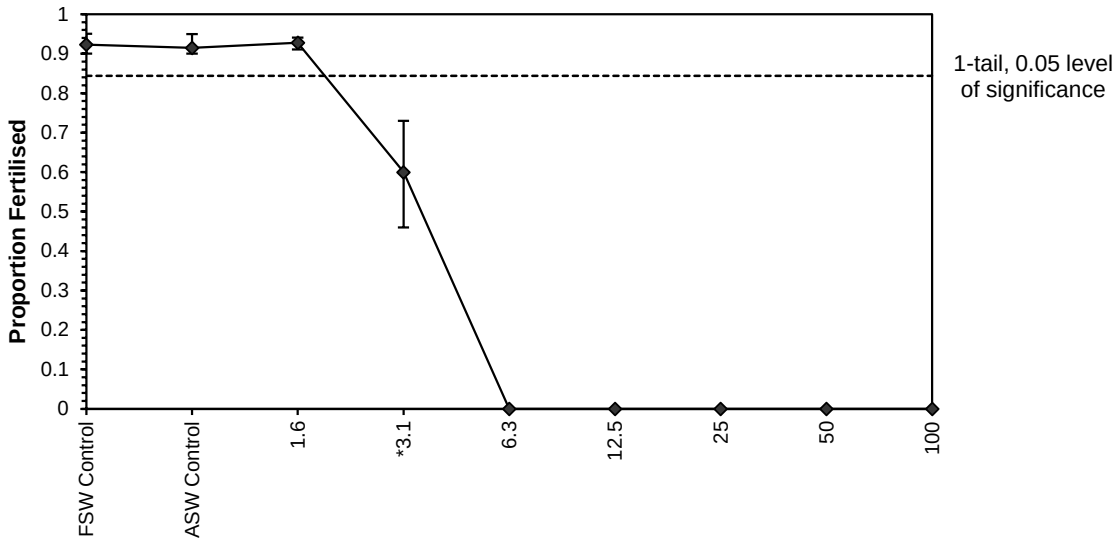
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.4799 | 3.3681 | 3.5955 |
| 5.0% | 3.5116 | 3.3857 | 3.6423 |
| 10.0% | 3.5427 | 3.3972 | 3.6945 |
| 20.0% | 3.6011 | 3.3900 | 3.8254 |
| Auto-0.0% | 3.4799 | 3.3681 | 3.5955 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:15 | Test ID: | PR2029/01 | Sample ID: | MI-5327 |
| End Date: | 30/07/2021 17:35 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:15 | Test ID: | PR2029/01 | Sample ID: | MI-5327 |
| End Date: | 30/07/2021 17:35 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 92.25 | 90.00 | 95.00 | 2.22 | 1.61 | 4 |
| ASW Control | | 91.50 | 90.00 | 95.00 | 2.38 | 1.69 | 4 |
| 1.6 | | 92.75 | 91.00 | 94.00 | 1.50 | 1.32 | 4 |
| 3.1 | | 60.00 | 46.00 | 73.00 | 11.05 | 5.54 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:30 | Test ID: | PR2029/16 | Sample ID: | Y003082021 |
| End Date: | 6/08/2021 16:50 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9800 | 0.9400 |
| ASW Control | 0.9500 | 0.9600 | 0.9200 | 0.9500 |
| 1.6 | 0.9500 | 0.9600 | 0.9200 | 0.9500 |
| 3.1 | 0.9300 | 0.9100 | 0.9200 | 0.9500 |
| 6.3 | 0.8600 | 0.7100 | 0.7700 | 0.6800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

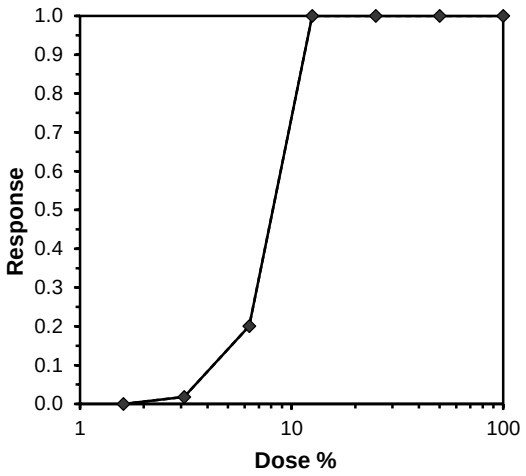
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9575 | 1.0132 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | | | | | |
| ASW Control | 0.9450 | 1.0000 | 1.3360 | 1.2840 | 1.3694 | 2.730 | 4 | * | | | 0.9450 | 1.0000 |
| 1.6 | 0.9450 | 1.0000 | 1.3360 | 1.2840 | 1.3694 | 2.730 | 4 | 0.000 | 2.290 | 0.0926 | 0.9450 | 1.0000 |
| 3.1 | 0.9275 | 0.9815 | 1.2996 | 1.2661 | 1.3453 | 2.614 | 4 | 0.900 | 2.290 | 0.0926 | 0.9275 | 0.9815 |
| *6.3 | 0.7550 | 0.7989 | 1.0574 | 0.9695 | 1.1873 | 9.108 | 4 | 6.888 | 2.290 | 0.0926 | 0.7550 | 0.7989 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.929079 | 0.887 | 0.681746 | 1.76518 |
| Bartlett's Test indicates equal variances (p = 0.19) | 4.743424 | 11.34487 | | |
| The control means are not significantly different (p = 0.33) | 1.053584 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.049306 | 0.052127 | 0.072193 | 0.003272 | 3.6E-05 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Log-Logit Interpolation (200 Resamples)

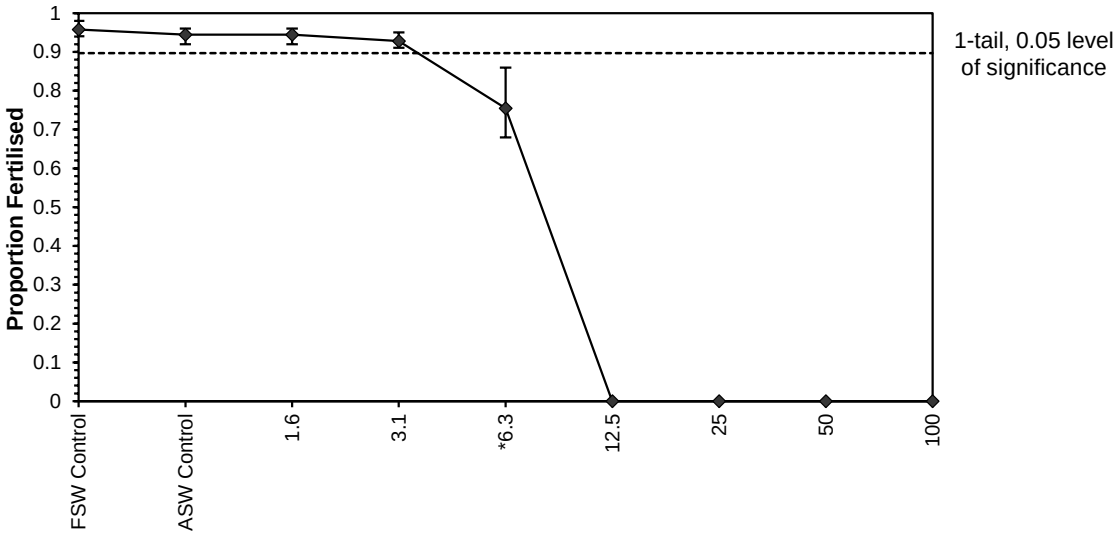
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.7757 | 0.2179 | 3.1005 | 4.4061 | 0.2227 |
| IC10 | 4.6940 | 0.3012 | 3.9731 | 5.8046 | 0.8262 |
| IC15 | 5.5135 | 0.3934 | 4.6297 | 6.8294 | 0.5078 |
| IC20 | 6.2840 | 0.2715 | 5.1289 | 6.5593 | -0.7717 |
| IC25 | 6.4033 | 0.1000 | 5.9850 | 6.6561 | -1.1808 |
| IC40 | 6.6813 | 0.0756 | 6.4812 | 6.9241 | 0.2746 |
| IC50 | 6.8567 | 0.0742 | 6.6612 | 7.0939 | 0.2762 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:30 | Test ID: | PR2029/16 | Sample ID: | Y003082021 |
| End Date: | 6/08/2021 16:50 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:30 | Test ID: | PR2029/16 | Sample ID: | Y003082021 |
| End Date: | 6/08/2021 16:50 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| ASW Control | | 94.50 | 92.00 | 96.00 | 1.73 | 1.39 | 4 |
| 1.6 | | 94.50 | 92.00 | 96.00 | 1.73 | 1.39 | 4 |
| 3.1 | | 92.75 | 91.00 | 95.00 | 1.71 | 1.41 | 4 |
| 6.3 | | 75.50 | 68.00 | 86.00 | 7.94 | 3.73 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:30 | Test ID: | PR2029/16 | Sample ID: | Y003082021 |
| End Date: | 6/08/2021 16:50 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9800 | 0.9400 |
| ASW Control | 0.9500 | 0.9600 | 0.9200 | 0.9500 |
| 1.6 | 0.9500 | 0.9600 | 0.9200 | 0.9500 |
| 3.1 | 0.9300 | 0.9100 | 0.9200 | 0.9500 |
| 6.3 | 0.8600 | 0.7100 | 0.7700 | 0.6800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

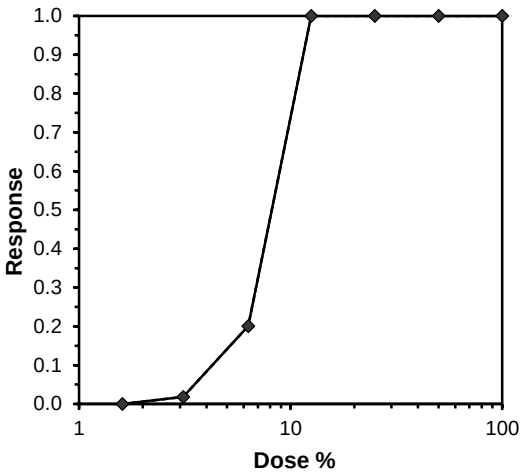
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9575 | 1.0132 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | | | | | |
| ASW Control | 0.9450 | 1.0000 | 1.3360 | 1.2840 | 1.3694 | 2.730 | 4 | * | | | 22 | 400 |
| 1.6 | 0.9450 | 1.0000 | 1.3360 | 1.2840 | 1.3694 | 2.730 | 4 | 0.000 | 2.290 | 0.0926 | 22 | 400 |
| 3.1 | 0.9275 | 0.9815 | 1.2996 | 1.2661 | 1.3453 | 2.614 | 4 | 0.900 | 2.290 | 0.0926 | 29 | 400 |
| *6.3 | 0.7550 | 0.7989 | 1.0574 | 0.9695 | 1.1873 | 9.108 | 4 | 6.888 | 2.290 | 0.0926 | 98 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.929079 | 0.887 | 0.681746 | 1.76518 |
| Bartlett's Test indicates equal variances (p = 0.19) | 4.743424 | 11.34487 | | |
| The control means are not significantly different (p = 0.33) | 1.053584 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.049306 | 0.052127 | 0.072193 | 0.003272 | 3.6E-05 | 3, 12 |

### Trimmed Spearman-Karber

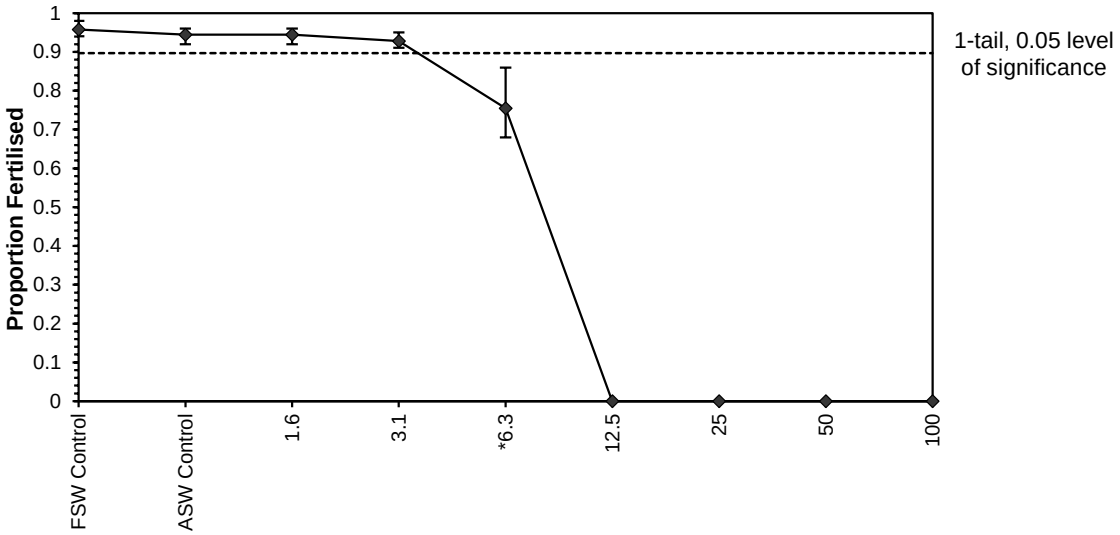
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 7.6162 | 7.3953 | 7.8437 |
| 5.0% | 7.8346 | 7.5904 | 8.0866 |
| 10.0% | 7.9853 | 7.6857 | 8.2966 |
| 20.0% | 8.1411 | 7.6017 | 8.7187 |
| Auto-0.0% | 7.6162 | 7.3953 | 7.8437 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:30 | Test ID: | PR2029/16 | Sample ID: | Y003082021 |
| End Date: | 6/08/2021 16:50 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:30 | Test ID: | PR2029/16 | Sample ID: | Y003082021 |
| End Date: | 6/08/2021 16:50 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| ASW Control | | 94.50 | 92.00 | 96.00 | 1.73 | 1.39 | 4 |
| 1.6 | | 94.50 | 92.00 | 96.00 | 1.73 | 1.39 | 4 |
| 3.1 | | 92.75 | 91.00 | 95.00 | 1.71 | 1.41 | 4 |
| 6.3 | | 75.50 | 68.00 | 86.00 | 7.94 | 3.73 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 16:30 | Test ID: | PR2029/1 | Sample ID: | A1-5327 |
| End Date: | 20/08/2021 17:40 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9300 | 0.9000 | 0.9100 | 0.9200 |
| ASW Control | 0.9000 | 0.8900 | 0.9200 | 0.9000 |
| 1.6 | 0.9100 | 0.9400 | 0.9200 | 0.9200 |
| 3.1 | 0.9100 | 0.9300 | 0.9000 | 0.9200 |
| 6.3 | 0.9100 | 0.9000 | 0.9400 | 0.9100 |
| 12.5 | 0.1200 | 0.0300 | 0.0600 | 0.0300 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

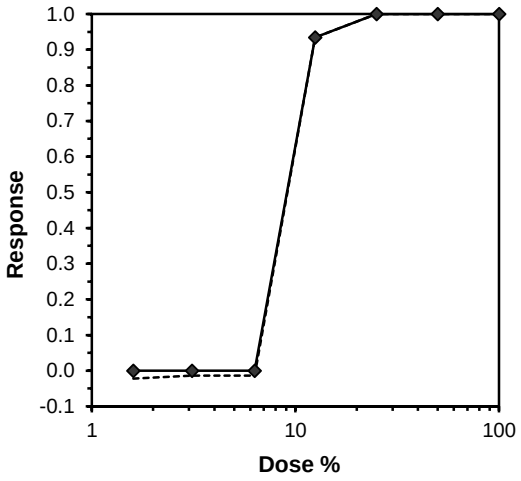
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9150 | 1.0139 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | | | | |
| ASW Control | 0.9025 | 1.0000 | 1.2537 | 1.2327 | 1.2840 | 1.725 | 4 | * | | 0.9138 | 1.0000 |
| 1.6 | 0.9225 | 1.0222 | 1.2894 | 1.2661 | 1.3233 | 1.874 | 4 | 24.00 | 10.00 | 0.9138 | 1.0000 |
| 3.1 | 0.9150 | 1.0139 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | 22.50 | 10.00 | 0.9138 | 1.0000 |
| 6.3 | 0.9150 | 1.0139 | 1.2761 | 1.2490 | 1.3233 | 2.544 | 4 | 22.00 | 10.00 | 0.9138 | 1.0000 |
| *12.5 | 0.0600 | 0.0665 | 0.2373 | 0.1741 | 0.3537 | 35.796 | 4 | 10.00 | 10.00 | 0.0600 | 0.0657 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89997 | 0.905 | 1.143075 | 3.157613 |
| Bartlett's Test indicates equal variances (p = 0.07) | 8.68866 | 13.2767 | | |
| The control means are not significantly different (p = 0.22) | 1.376102 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

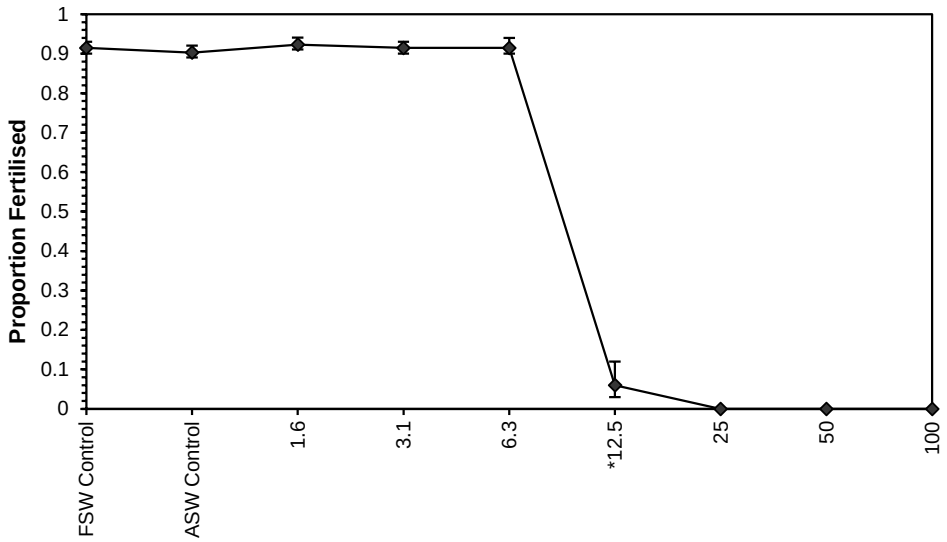
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.7305 | 0.0427 | 6.5396 | 6.8003 | -0.4497 |
| IC10 | 7.0642 | 0.0588 | 6.8408 | 7.1898 | -0.0595 |
| IC15 | 7.3465 | 0.0762 | 7.0796 | 7.5247 | 0.0090 |
| IC20 | 7.5979 | 0.0934 | 7.2873 | 7.8172 | 0.0302 |
| IC25 | 7.8299 | 0.1101 | 7.4767 | 8.0959 | 0.0424 |
| IC40 | 8.4732 | 0.1599 | 7.9707 | 8.9168 | 0.0693 |
| IC50 | 8.9002 | 0.1951 | 8.2938 | 9.4496 | 0.0848 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 16:30 | Test ID: | PR2029/1 | Sample ID: | A1-5327 |
| End Date: | 20/08/2021 17:40 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 16:30 | Test ID: | PR2029/1 | Sample ID: | A1-5327 |
| End Date: | 20/08/2021 17:40 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| ASW Control | | 90.25 | 89.00 | 92.00 | 1.26 | 1.24 | 4 |
| 1.6 | | 92.25 | 91.00 | 94.00 | 1.26 | 1.22 | 4 |
| 3.1 | | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| 6.3 | | 91.50 | 90.00 | 94.00 | 1.73 | 1.44 | 4 |
| 12.5 | | 6.00 | 3.00 | 12.00 | 4.24 | 34.33 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 16:30 | Test ID: | PR2029/1 | Sample ID: | A1-5327 |
| End Date: | 20/08/2021 17:40 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9300 | 0.9000 | 0.9100 | 0.9200 |
| ASW Control | 0.9000 | 0.8900 | 0.9200 | 0.9000 |
| 1.6 | 0.9100 | 0.9400 | 0.9200 | 0.9200 |
| 3.1 | 0.9100 | 0.9300 | 0.9000 | 0.9200 |
| 6.3 | 0.9100 | 0.9000 | 0.9400 | 0.9100 |
| 12.5 | 0.1200 | 0.0300 | 0.0600 | 0.0300 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

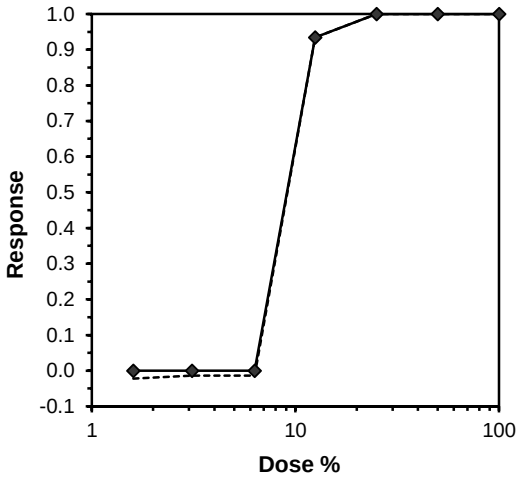
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9150 | 1.0139 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | | | | |
| ASW Control | 0.9025 | 1.0000 | 1.2537 | 1.2327 | 1.2840 | 1.725 | 4 | * | | 39 | 400 |
| 1.6 | 0.9225 | 1.0222 | 1.2894 | 1.2661 | 1.3233 | 1.874 | 4 | 24.00 | 10.00 | 31 | 400 |
| 3.1 | 0.9150 | 1.0139 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | 22.50 | 10.00 | 34 | 400 |
| 6.3 | 0.9150 | 1.0139 | 1.2761 | 1.2490 | 1.3233 | 2.544 | 4 | 22.00 | 10.00 | 34 | 400 |
| *12.5 | 0.0600 | 0.0665 | 0.2373 | 0.1741 | 0.3537 | 35.796 | 4 | 10.00 | 10.00 | 376 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89997 | 0.905 | 1.143075 | 3.157613 |
| Bartlett's Test indicates equal variances (p = 0.07) | 8.68866 | 13.2767 | | |
| The control means are not significantly different (p = 0.22) | 1.376102 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

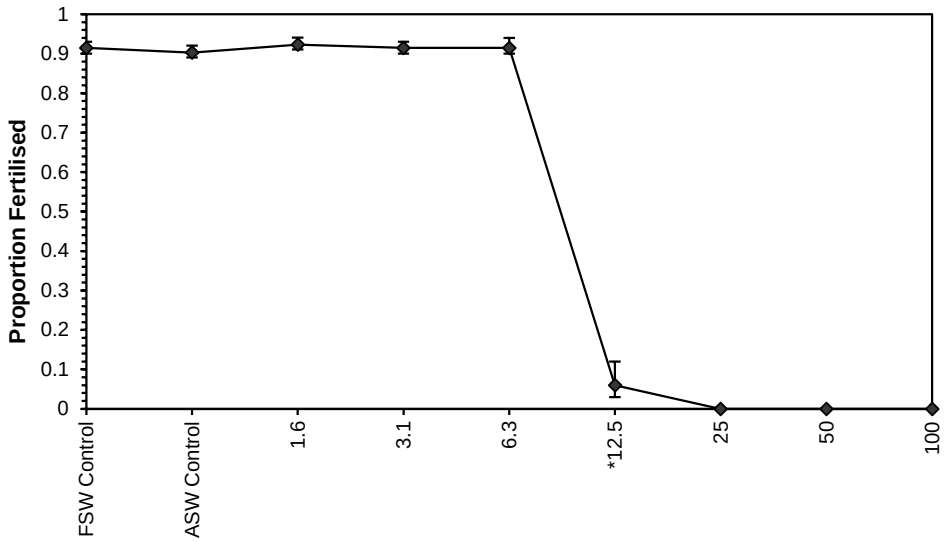
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 9.2849 | 9.1278 | 9.4448 |
| 5.0% | 9.1025 | 8.9808 | 9.2259 |
| 10.0% | 9.0904 | 9.0024 | 9.1792 |
| 20.0% | 9.0904 | 9.0024 | 9.1792 |
| Auto-0.0% | 9.2849 | 9.1278 | 9.4448 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 16:30 | Test ID: | PR2029/1 | Sample ID: | A1-5327 |
| End Date: | 20/08/2021 17:40 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 16:30 | Test ID: | PR2029/1 | Sample ID: | A1-5327 |
| End Date: | 20/08/2021 17:40 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| ASW Control | | 90.25 | 89.00 | 92.00 | 1.26 | 1.24 | 4 |
| 1.6 | | 92.25 | 91.00 | 94.00 | 1.26 | 1.22 | 4 |
| 3.1 | | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| 6.3 | | 91.50 | 90.00 | 94.00 | 1.73 | 1.44 | 4 |
| 12.5 | | 6.00 | 3.00 | 12.00 | 4.24 | 34.33 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:30 | Test ID: | PR2029/04 | Sample ID: | MI-5327 |
| End Date: | 02/08/2021 16:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9500 | 0.9300 |
| ASW Control | 0.9800 | 0.9500 | 0.9500 | 0.9600 |
| 1.6 | 0.9500 | 0.9800 | 0.9600 | 0.9500 |
| 3.1 | 0.9400 | 0.9100 | 0.9200 | 0.9100 |
| 6.3 | 0.4600 | 0.5100 | 0.3800 | 0.5000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

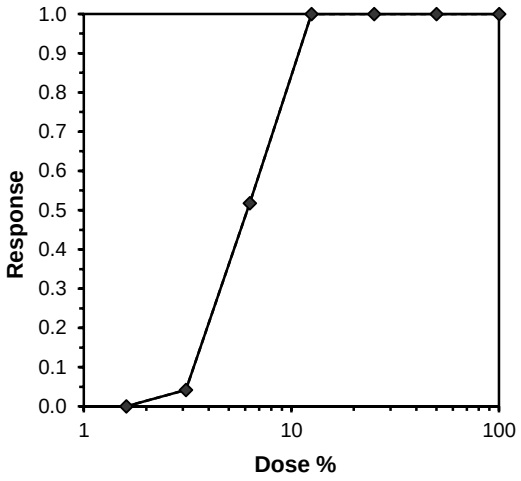
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9550 | 0.9948 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | * | | | 0.9600 | 1.0000 |
| 1.6 | 0.9600 | 1.0000 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | 0.000 | 2.290 | 0.0696 | 0.9600 | 1.0000 |
| *3.1 | 0.9200 | 0.9583 | 1.2849 | 1.2661 | 1.3233 | 2.100 | 4 | 2.872 | 2.290 | 0.0696 | 0.9200 | 0.9583 |
| *6.3 | 0.4625 | 0.4818 | 0.7476 | 0.6642 | 0.7954 | 7.978 | 4 | 20.538 | 2.290 | 0.0696 | 0.4625 | 0.4818 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.908265 | 0.887 | -0.11647 | -0.03466 |
| Bartlett's Test indicates equal variances (p = 0.65) | 1.641557 | 11.34487 | | |
| The control means are not significantly different (p = 0.76) | 0.321425 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.031316 | 0.032584 | 0.361428 | 0.00185 | 1.9E-10 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

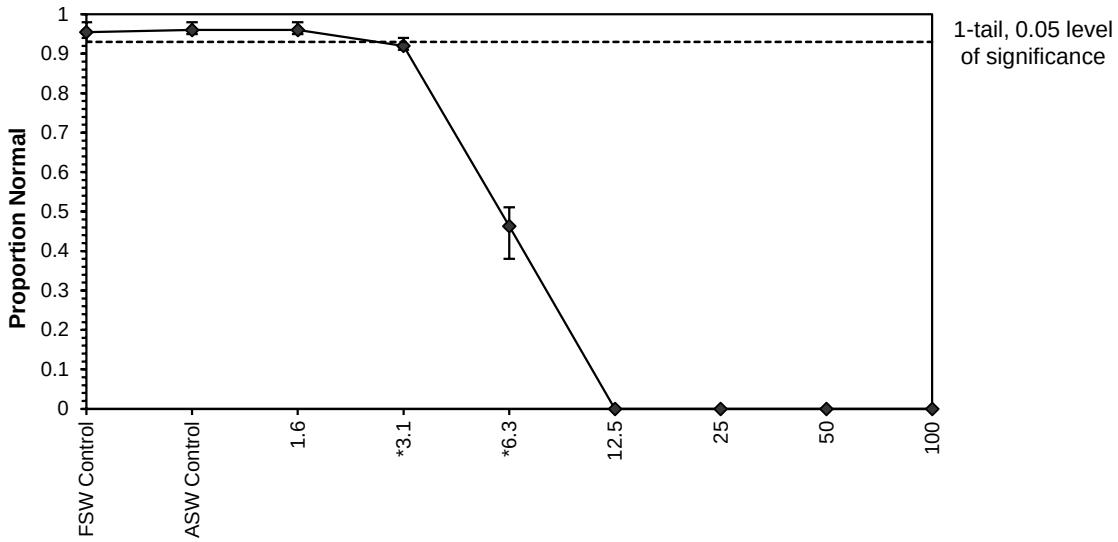
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.1960 | 0.1185 | 2.7264 | 3.4715 | -0.7401 |
| IC10 | 3.6788 | 0.0773 | 3.4479 | 3.9469 | 0.3239 |
| IC15 | 4.0683 | 0.0745 | 3.8353 | 4.3218 | 0.2496 |
| IC20 | 4.4091 | 0.0784 | 4.1692 | 4.6603 | 0.1249 |
| IC25 | 4.7218 | 0.0866 | 4.4524 | 5.0043 | 0.0044 |
| IC40 | 5.5947 | 0.1260 | 5.2239 | 5.9866 | -0.1777 |
| IC50 | 6.1868 | 0.1366 | 5.7140 | 6.4538 | -0.7441 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:30 | Test ID: | PR2029/04 | Sample ID: | MI-5327 |
| End Date: | 02/08/2021 16:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:30 | Test ID: | PR2029/04 | Sample ID: | MI-5327 |
| End Date: | 02/08/2021 16:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| ASW Control | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 1.6 | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 3.1 | | 92.00 | 91.00 | 94.00 | 1.41 | 1.29 | 4 |
| 6.3 | | 46.25 | 38.00 | 51.00 | 5.91 | 5.26 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:30 | Test ID: | PR2029/04 | Sample ID: | MI-5327 |
| End Date: | 02/08/2021 16:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9500 | 0.9300 |
| ASW Control | 0.9800 | 0.9500 | 0.9500 | 0.9600 |
| 1.6 | 0.9500 | 0.9800 | 0.9600 | 0.9500 |
| 3.1 | 0.9400 | 0.9100 | 0.9200 | 0.9100 |
| 6.3 | 0.4600 | 0.5100 | 0.3800 | 0.5000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

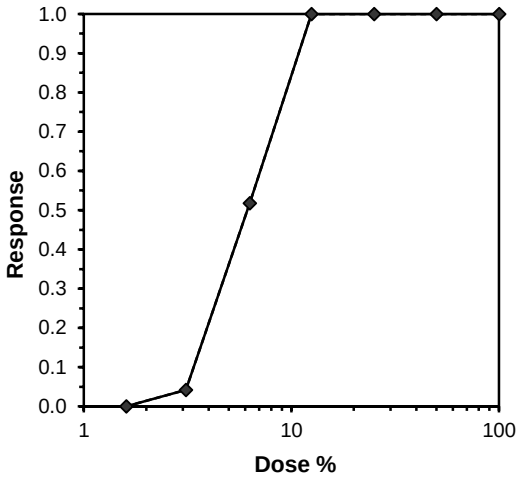
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9550 | 0.9948 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | * | | | 16 | 400 |
| 1.6 | 0.9600 | 1.0000 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | 0.000 | 2.290 | 0.0696 | 16 | 400 |
| *3.1 | 0.9200 | 0.9583 | 1.2849 | 1.2661 | 1.3233 | 2.100 | 4 | 2.872 | 2.290 | 0.0696 | 32 | 400 |
| *6.3 | 0.4625 | 0.4818 | 0.7476 | 0.6642 | 0.7954 | 7.978 | 4 | 20.538 | 2.290 | 0.0696 | 215 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.908265 | 0.887 | -0.11647 | -0.03466 |
| Bartlett's Test indicates equal variances (p = 0.65) | 1.641557 | 11.34487 | | |
| The control means are not significantly different (p = 0.76) | 0.321425 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.031316 | 0.032584 | 0.361428 | 0.00185 | 1.9E-10 | 3, 12 |

### Trimmed Spearman-Karber

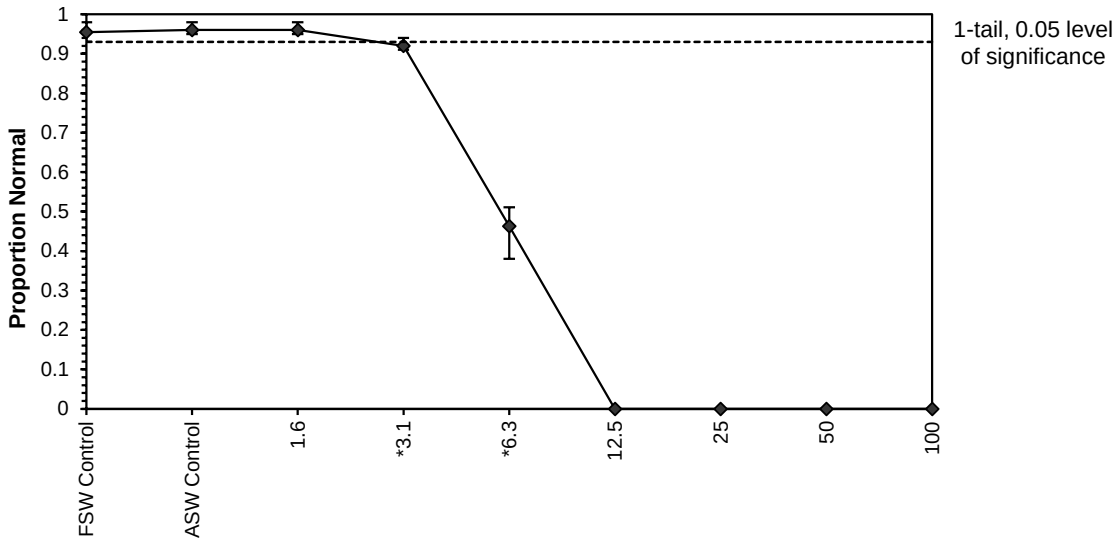
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 6.0092 | 5.7885 | 6.2384 |
| 5.0% | 6.0897 | 5.8553 | 6.3335 |
| 10.0% | 6.0947 | 5.8354 | 6.3657 |
| 20.0% | 6.1048 | 5.7686 | 6.4605 |
| Auto-0.0% | 6.0092 | 5.7885 | 6.2384 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:30 | Test ID: | PR2029/04 | Sample ID: | MI-5327 |
| End Date: | 02/08/2021 16:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 16:30 | Test ID: | PR2029/04 | Sample ID: | MI-5327 |
| End Date: | 02/08/2021 16:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| ASW Control | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 1.6 | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 3.1 | | 92.00 | 91.00 | 94.00 | 1.41 | 1.29 | 4 |
| 6.3 | | 46.25 | 38.00 | 51.00 | 5.91 | 5.26 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:00 | Test ID: | PR2029/19 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 15:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9300 | 0.9700 | 0.9500 |
| ASW Control | 0.9100 | 0.9400 | 0.9700 | 0.9600 |
| 1.6 | 0.9600 | 0.9800 | 0.9300 | 0.9500 |
| 3.1 | 0.9200 | 0.9500 | 0.9600 | 0.9300 |
| 6.3 | 0.4400 | 0.3800 | 0.4600 | 0.4200 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

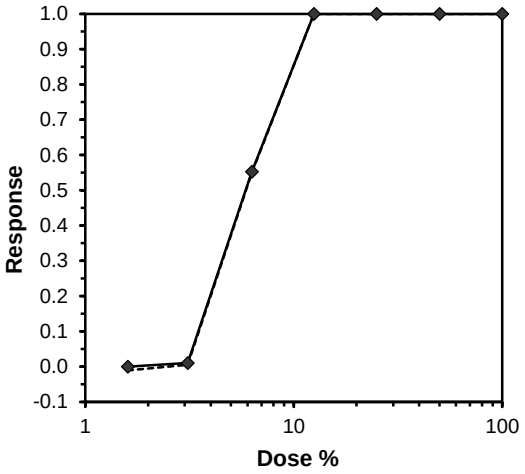
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9500 | 1.0053 | 1.3476 | 1.3030 | 1.3967 | 2.845 | 4 | | | | | |
| ASW Control | 0.9450 | 1.0000 | 1.3389 | 1.2661 | 1.3967 | 4.272 | 4 | * | | | 0.9500 | 1.0000 |
| 1.6 | 0.9550 | 1.0106 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | -0.688 | 2.290 | 0.0757 | 0.9500 | 1.0000 |
| 3.1 | 0.9400 | 0.9947 | 1.3254 | 1.2840 | 1.3694 | 2.937 | 4 | 0.407 | 2.290 | 0.0757 | 0.9400 | 0.9895 |
| *6.3 | 0.4250 | 0.4497 | 0.7100 | 0.6642 | 0.7454 | 4.882 | 4 | 19.016 | 2.290 | 0.0757 | 0.4250 | 0.4474 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.975202 | 0.887 | -0.11092 | -0.9243 |
| Bartlett's Test indicates equal variances (p = 0.83) | 0.87213 | 11.34487 | | |
| The control means are not significantly different (p = 0.81) | 0.252154 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.038873 | 0.041041 | 0.40036 | 0.002188 | 2.8E-10 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Log-Logit Interpolation (200 Resamples)

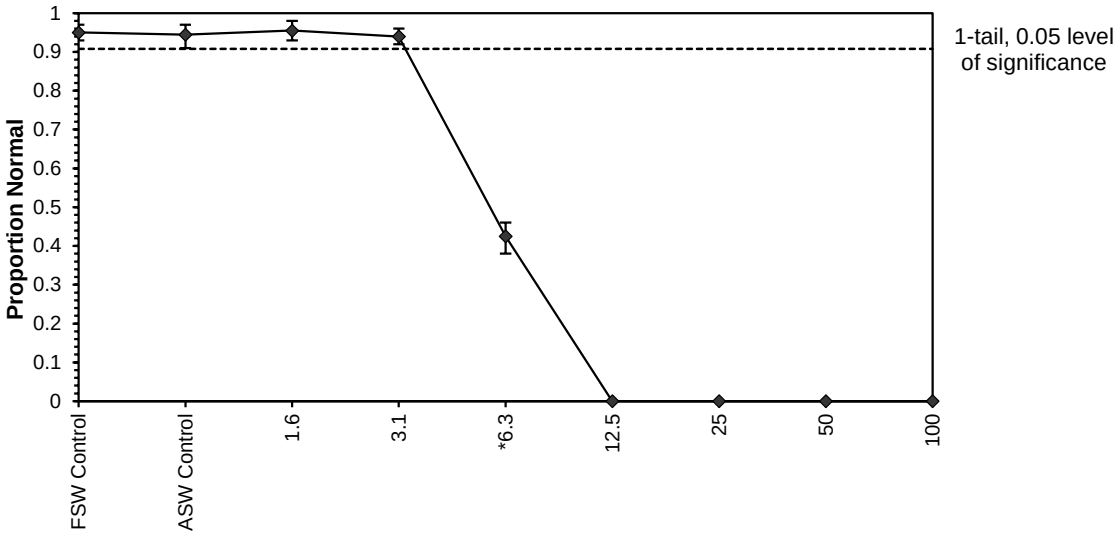
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.5285 | 0.1032 | 3.1492 | 3.7510 | -0.4982 |
| IC10 | 3.9312 | 0.0890 | 3.5916 | 4.1366 | -0.4665 |
| IC15 | 4.2588 | 0.0805 | 3.9714 | 4.4476 | -0.4496 |
| IC20 | 4.5457 | 0.0747 | 4.3051 | 4.7290 | -0.4444 |
| IC25 | 4.8085 | 0.0709 | 4.5901 | 4.9924 | -0.4434 |
| IC40 | 5.5373 | 0.0697 | 5.3183 | 5.7276 | -0.3783 |
| IC50 | 6.0264 | 0.0779 | 5.7777 | 6.2594 | -0.2516 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:00 | Test ID: | PR2029/19 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 15:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:00 | Test ID: | PR2029/19 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 15:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 95.00 | 93.00 | 97.00 | 1.63 | 1.35 | 4 |
| ASW Control | | 94.50 | 91.00 | 97.00 | 2.65 | 1.72 | 4 |
| 1.6 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 3.1 | | 94.00 | 92.00 | 96.00 | 1.83 | 1.44 | 4 |
| 6.3 | | 42.50 | 38.00 | 46.00 | 3.42 | 4.35 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:00 | Test ID: | PR2029/19 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 15:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9300 | 0.9700 | 0.9500 |
| ASW Control | 0.9100 | 0.9400 | 0.9700 | 0.9600 |
| 1.6 | 0.9600 | 0.9800 | 0.9300 | 0.9500 |
| 3.1 | 0.9200 | 0.9500 | 0.9600 | 0.9300 |
| 6.3 | 0.4400 | 0.3800 | 0.4600 | 0.4200 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

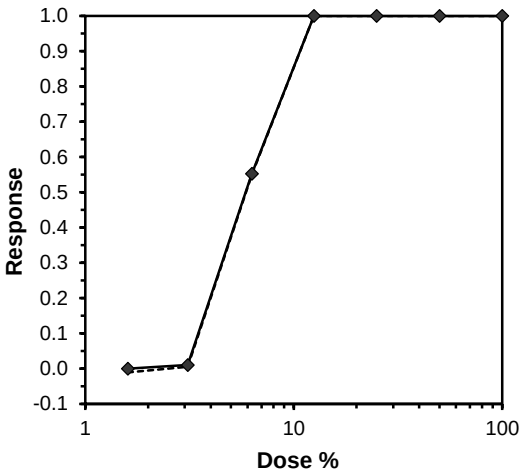
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9500 | 1.0053 | 1.3476 | 1.3030 | 1.3967 | 2.845 | 4 | | | | | |
| ASW Control | 0.9450 | 1.0000 | 1.3389 | 1.2661 | 1.3967 | 4.272 | 4 | * | | | 22 | 400 |
| 1.6 | 0.9550 | 1.0106 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | -0.688 | 2.290 | 0.0757 | 18 | 400 |
| 3.1 | 0.9400 | 0.9947 | 1.3254 | 1.2840 | 1.3694 | 2.937 | 4 | 0.407 | 2.290 | 0.0757 | 24 | 400 |
| *6.3 | 0.4250 | 0.4497 | 0.7100 | 0.6642 | 0.7454 | 4.882 | 4 | 19.016 | 2.290 | 0.0757 | 230 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.975202 | 0.887 | -0.11092 | -0.9243 |
| Bartlett's Test indicates equal variances (p = 0.83) | 0.87213 | 11.34487 | | |
| The control means are not significantly different (p = 0.81) | 0.252154 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.038873 | 0.041041 | 0.40036 | 0.002188 | 2.8E-10 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Trimmed Spearman-Karber

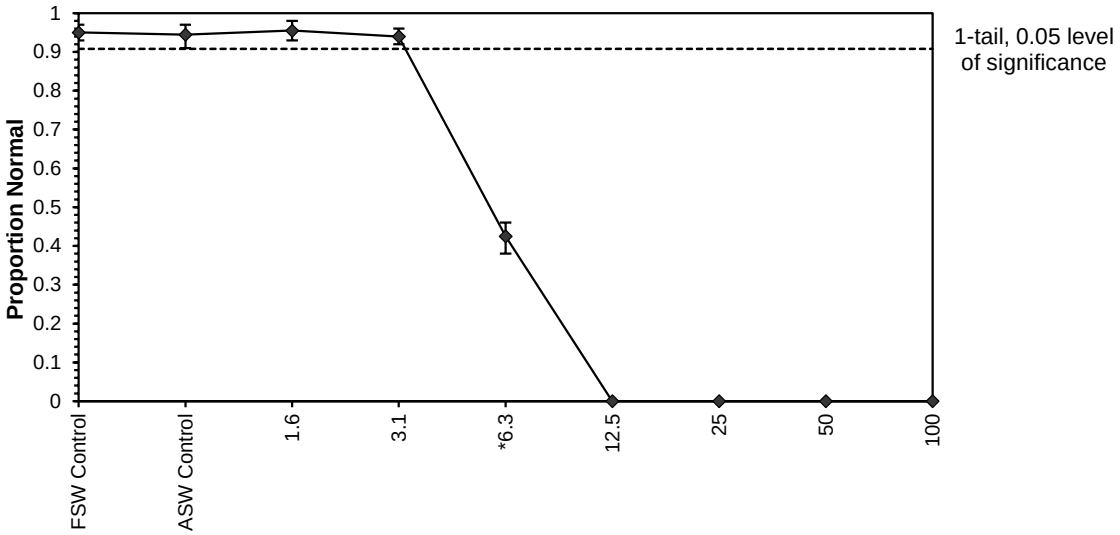
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 5.9934 | 5.7851 | 6.2091 |
| 5.0% | 5.9973 | 5.7705 | 6.2329 |
| 10.0% | 5.9808 | 5.7292 | 6.2435 |
| 20.0% | 5.9482 | 5.6257 | 6.2893 |
| Auto-0.0% | 5.9934 | 5.7851 | 6.2091 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:00 | Test ID: | PR2029/19 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 15:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 15:00 | Test ID: | PR2029/19 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 15:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 95.00 | 93.00 | 97.00 | 1.63 | 1.35 | 4 |
| ASW Control | | 94.50 | 91.00 | 97.00 | 2.65 | 1.72 | 4 |
| 1.6 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 3.1 | | 94.00 | 92.00 | 96.00 | 1.83 | 1.44 | 4 |
| 6.3 | | 42.50 | 38.00 | 46.00 | 3.42 | 4.35 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9300 | 0.9000 | 0.9100 | 0.9200 |
| ASW Control | 0.9000 | 0.8900 | 0.9200 | 0.9000 |
| 1.6 | 0.9100 | 0.9500 | 0.9300 | 0.9600 |
| 3.1 | 0.9900 | 0.9800 | 0.9400 | 0.9300 |
| 6.3 | 0.9700 | 0.9500 | 0.9100 | 0.9200 |
| 12.5 | 0.8800 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

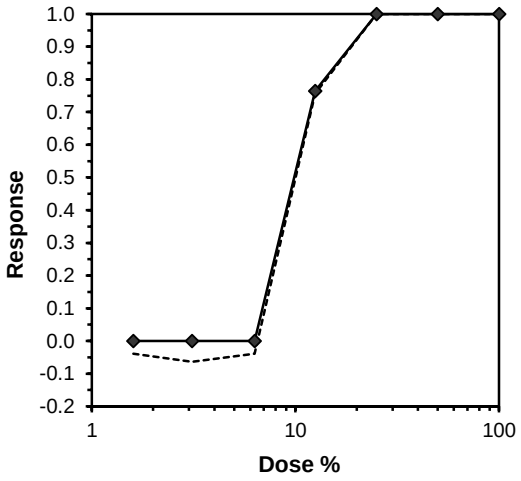
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9150 | 1.0139 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | | | | |
| ASW Control | 0.9025 | 1.0000 | 1.2537 | 1.2327 | 1.2840 | 1.725 | 4 | * | | 0.9344 | 1.0000 |
| 1.6 | 0.9375 | 1.0388 | 1.3210 | 1.2661 | 1.3694 | 3.461 | 4 | 25.00 | 10.00 | 0.9344 | 1.0000 |
| 3.1 | 0.9600 | 1.0637 | 1.3815 | 1.3030 | 1.4706 | 5.871 | 4 | 26.00 | 10.00 | 0.9344 | 1.0000 |
| 6.3 | 0.9375 | 1.0388 | 1.3230 | 1.2661 | 1.3967 | 4.511 | 4 | 24.50 | 10.00 | 0.9344 | 1.0000 |
| *12.5 | 0.2200 | 0.2438 | 0.3418 | 0.0500 | 1.2171 | 170.729 | 4 | 10.00 | 10.00 | 0.2200 | 0.2355 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.662242 | 0.905 | 2.648046 | 10.60315 |
| Bartlett's Test indicates unequal variances (p = 1.42E-06) | 32.62678 | 13.2767 | | |
| The control means are not significantly different (p = 0.22) | 1.376102 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

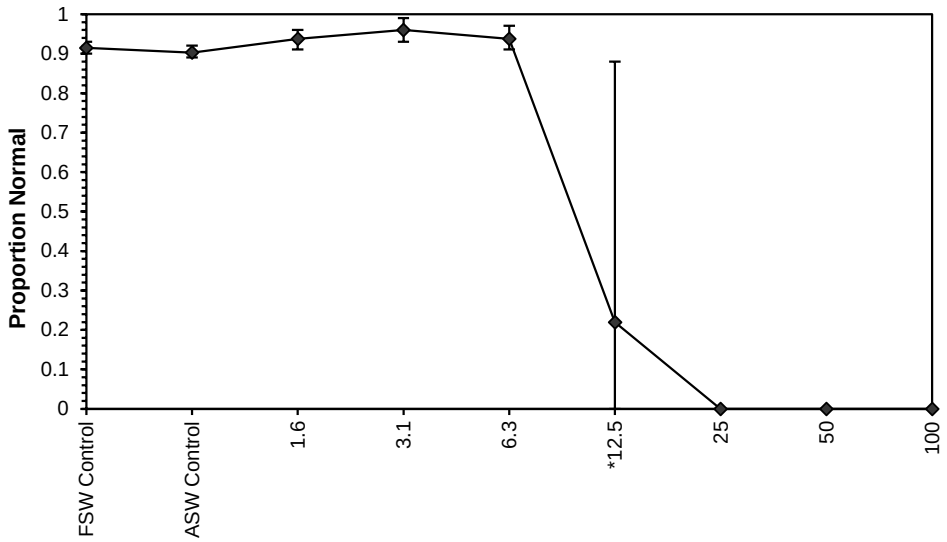
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.006 | 0.324 | 6.086 | 7.561 | 0.2516 |
| IC10 | 7.527 | 0.576 | 6.036 | 9.181 | 0.2267 |
| IC15 | 7.958 | 0.798 | 5.987 | 10.705 | 0.2566 |
| IC20 | 8.338 | 1.003 | 5.942 | 12.157 | 0.2962 |
| IC25 | 8.688 | 1.197 | 5.894 | 13.564 | 0.3375 |
| IC40 | 9.655 | 1.641 | 5.737 | 14.815 | 0.0221 |
| IC50 | 10.301 | 1.935 | 5.615 | 14.988 | -0.1073 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| ASW Control | | 90.25 | 89.00 | 92.00 | 1.26 | 1.24 | 4 |
| 1.6 | | 93.75 | 91.00 | 96.00 | 2.22 | 1.59 | 4 |
| 3.1 | | 96.00 | 93.00 | 99.00 | 2.94 | 1.79 | 4 |
| 6.3 | | 93.75 | 91.00 | 97.00 | 2.75 | 1.77 | 4 |
| 12.5 | | 22.00 | 0.00 | 88.00 | 44.00 | 30.15 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9300 | 0.9000 | 0.9100 | 0.9200 |
| ASW Control | 0.9000 | 0.8900 | 0.9200 | 0.9000 |
| 1.6 | 0.9100 | 0.9500 | 0.9300 | 0.9600 |
| 3.1 | 0.9900 | 0.9800 | 0.9400 | 0.9300 |
| 6.3 | 0.9700 | 0.9500 | 0.9100 | 0.9200 |
| 12.5 | 0.8800 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

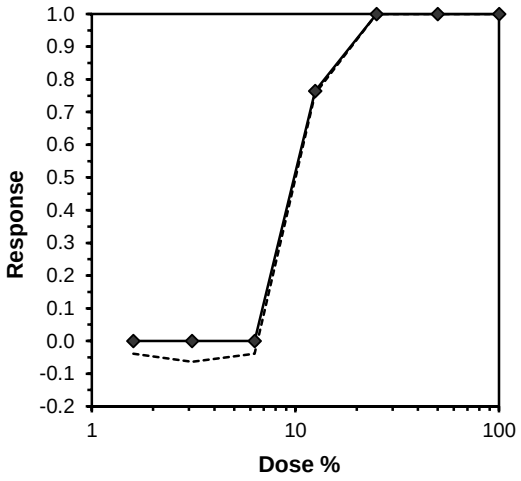
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9150 | 1.0139 | 1.2756 | 1.2490 | 1.3030 | 1.821 | 4 | | | | |
| ASW Control | 0.9025 | 1.0000 | 1.2537 | 1.2327 | 1.2840 | 1.725 | 4 | * | | 39 | 400 |
| 1.6 | 0.9375 | 1.0388 | 1.3210 | 1.2661 | 1.3694 | 3.461 | 4 | 25.00 | 10.00 | 25 | 400 |
| 3.1 | 0.9600 | 1.0637 | 1.3815 | 1.3030 | 1.4706 | 5.871 | 4 | 26.00 | 10.00 | 16 | 400 |
| 6.3 | 0.9375 | 1.0388 | 1.3230 | 1.2661 | 1.3967 | 4.511 | 4 | 24.50 | 10.00 | 25 | 400 |
| *12.5 | 0.2200 | 0.2438 | 0.3418 | 0.0500 | 1.2171 | 170.729 | 4 | 10.00 | 10.00 | 312 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.662242 | 0.905 | 2.648046 | 10.60315 |
| Bartlett's Test indicates unequal variances (p = 1.42E-06) | 32.62678 | 13.2767 | | |
| The control means are not significantly different (p = 0.22) | 1.376102 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

**Trimmed Spearman-Karber**

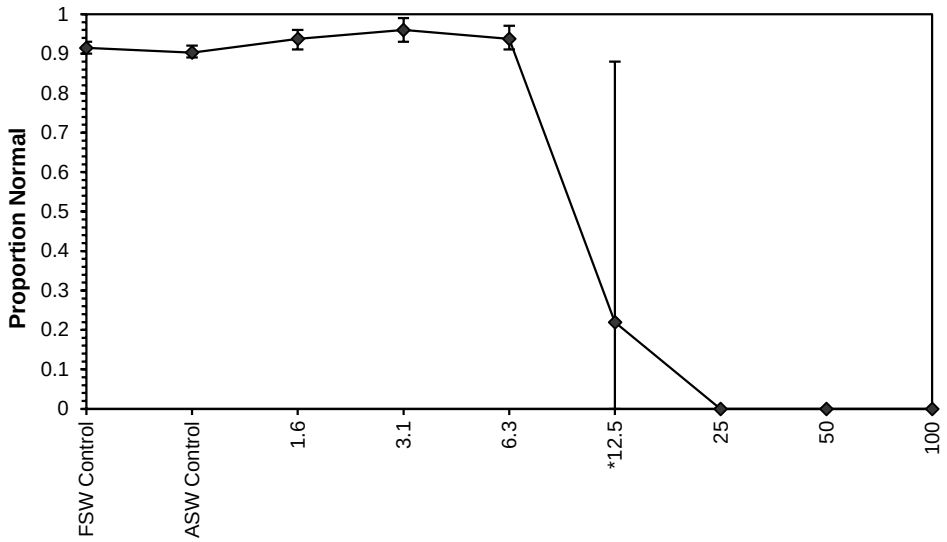
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 10.437 | 10.137 | 10.747 |
| 5.0% | 10.255 | 9.934 | 10.587 |
| 10.0% | 10.096 | 9.763 | 10.440 |
| 20.0% | 9.883 | 9.565 | 10.211 |
| Auto-0.0% | 10.437 | 10.137 | 10.747 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 91.50 | 90.00 | 93.00 | 1.29 | 1.24 | 4 |
| ASW Control | | 90.25 | 89.00 | 92.00 | 1.26 | 1.24 | 4 |
| 1.6 | | 93.75 | 91.00 | 96.00 | 2.22 | 1.59 | 4 |
| 3.1 | | 96.00 | 93.00 | 99.00 | 2.94 | 1.79 | 4 |
| 6.3 | | 93.75 | 91.00 | 97.00 | 2.75 | 1.77 | 4 |
| 12.5 | | 22.00 | 0.00 | 88.00 | 44.00 | 30.15 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 17:30 | Test ID: | PR2029/05 | Sample ID: | MI-5327 |
| End Date: | 2/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.6800 | 0.7400 | 0.7000 | 0.7100 |
| ASW Control | 0.6700 | 0.7500 | 0.7100 | 0.7300 |
| 1.6 | 0.7800 | 0.7600 | 0.6800 | 0.7000 |
| 3.1 | 0.7100 | 0.7400 | 0.7300 | 0.7200 |
| 6.3 | 0.3500 | 0.2600 | 0.2900 | 0.3800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

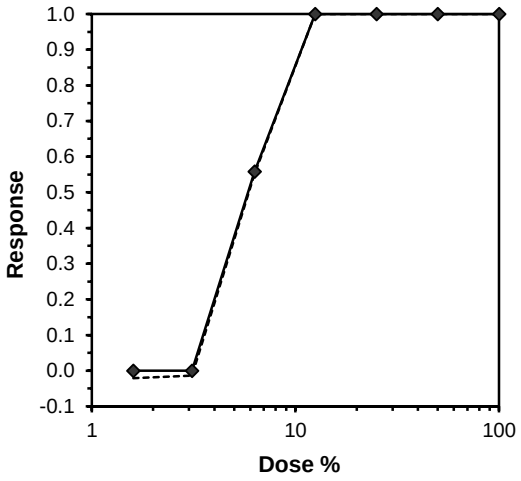
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7075 | 0.9895 | 0.9996 | 0.9695 | 1.0357 | 2.762 | 4 | | | | | |
| ASW Control | 0.7150 | 1.0000 | 1.0081 | 0.9589 | 1.0472 | 3.736 | 4 | * | | | 0.7233 | 1.0000 |
| 1.6 | 0.7300 | 1.0210 | 1.0255 | 0.9695 | 1.0826 | 5.246 | 4 | -0.550 | 2.290 | 0.0724 | 0.7233 | 1.0000 |
| 3.1 | 0.7250 | 1.0140 | 1.0189 | 1.0021 | 1.0357 | 1.419 | 4 | -0.339 | 2.290 | 0.0724 | 0.7233 | 1.0000 |
| *6.3 | 0.3200 | 0.4476 | 0.6003 | 0.5351 | 0.6642 | 9.815 | 4 | 12.905 | 2.290 | 0.0724 | 0.3200 | 0.4424 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.965075 | 0.887 | -0.07256 | -1.0392 |
| Bartlett's Test indicates equal variances (p = 0.22) | 4.417692 | 11.34487 | | |
| The control means are not significantly different (p = 0.73) | 0.364438 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.067342 | 0.094126 | 0.174308 | 0.001998 | 2.0E-08 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Log-Logit Interpolation (200 Resamples)

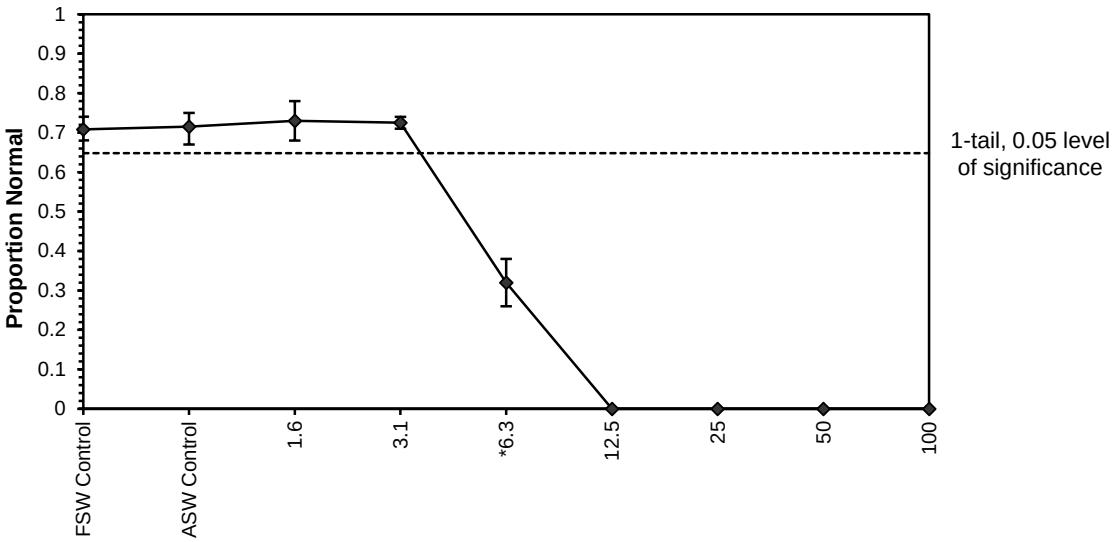
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.3474 | 0.1342 | 3.0737 | 3.3916 | -10.9754 |
| IC10 | 3.5931 | 0.0589 | 3.3355 | 3.6842 | -0.9176 |
| IC15 | 3.8402 | 0.0678 | 3.5734 | 3.9812 | -0.4484 |
| IC20 | 4.0914 | 0.0812 | 3.7956 | 4.2857 | -0.1636 |
| IC25 | 4.3493 | 0.0979 | 4.0381 | 4.6011 | -0.0161 |
| IC40 | 5.1943 | 0.1655 | 4.7030 | 5.6617 | 0.1343 |
| IC50 | 5.8581 | 0.2230 | 5.2229 | 6.5177 | 0.0650 |



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 17:30 | Test ID: | PR2029/05 | Sample ID: | MI-5327 |
| End Date: | 2/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 17:30 | Test ID: | PR2029/05 | Sample ID: | MI-5327 |
| End Date: | 2/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 70.75 | 68.00 | 74.00 | 2.50 | 2.23 | 4 |
| ASW Control | | 71.50 | 67.00 | 75.00 | 3.42 | 2.58 | 4 |
| 1.6 | | 73.00 | 68.00 | 78.00 | 4.76 | 2.99 | 4 |
| 3.1 | | 72.50 | 71.00 | 74.00 | 1.29 | 1.57 | 4 |
| 6.3 | | 32.00 | 26.00 | 38.00 | 5.48 | 7.31 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 17:30 | Test ID: | PR2029/05 | Sample ID: | MI-5327 |
| End Date: | 2/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.6800 | 0.7400 | 0.7000 | 0.7100 |
| ASW Control | 0.6700 | 0.7500 | 0.7100 | 0.7300 |
| 1.6 | 0.7800 | 0.7600 | 0.6800 | 0.7000 |
| 3.1 | 0.7100 | 0.7400 | 0.7300 | 0.7200 |
| 6.3 | 0.3500 | 0.2600 | 0.2900 | 0.3800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

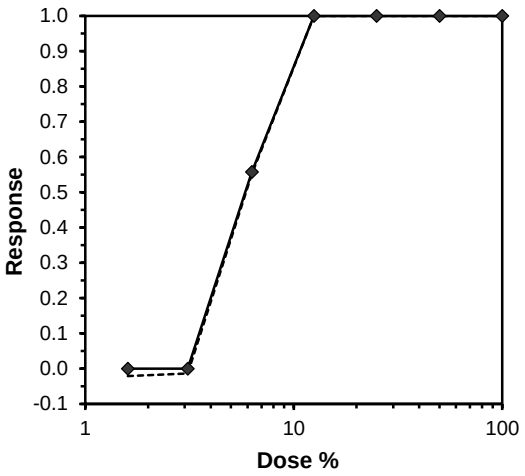
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7075 | 0.9895 | 0.9996 | 0.9695 | 1.0357 | 2.762 | 4 | | | | | |
| ASW Control | 0.7150 | 1.0000 | 1.0081 | 0.9589 | 1.0472 | 3.736 | 4 | * | | | 114 | 400 |
| 1.6 | 0.7300 | 1.0210 | 1.0255 | 0.9695 | 1.0826 | 5.246 | 4 | -0.550 | 2.290 | 0.0724 | 108 | 400 |
| 3.1 | 0.7250 | 1.0140 | 1.0189 | 1.0021 | 1.0357 | 1.419 | 4 | -0.339 | 2.290 | 0.0724 | 110 | 400 |
| *6.3 | 0.3200 | 0.4476 | 0.6003 | 0.5351 | 0.6642 | 9.815 | 4 | 12.905 | 2.290 | 0.0724 | 272 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.965075 | 0.887 | -0.07256 | -1.0392 |
| Bartlett's Test indicates equal variances (p = 0.22) | 4.417692 | 11.34487 | | |
| The control means are not significantly different (p = 0.73) | 0.364438 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.067342 | 0.094126 | 0.174308 | 0.001998 | 2.0E-08 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Trimmed Spearman-Karber

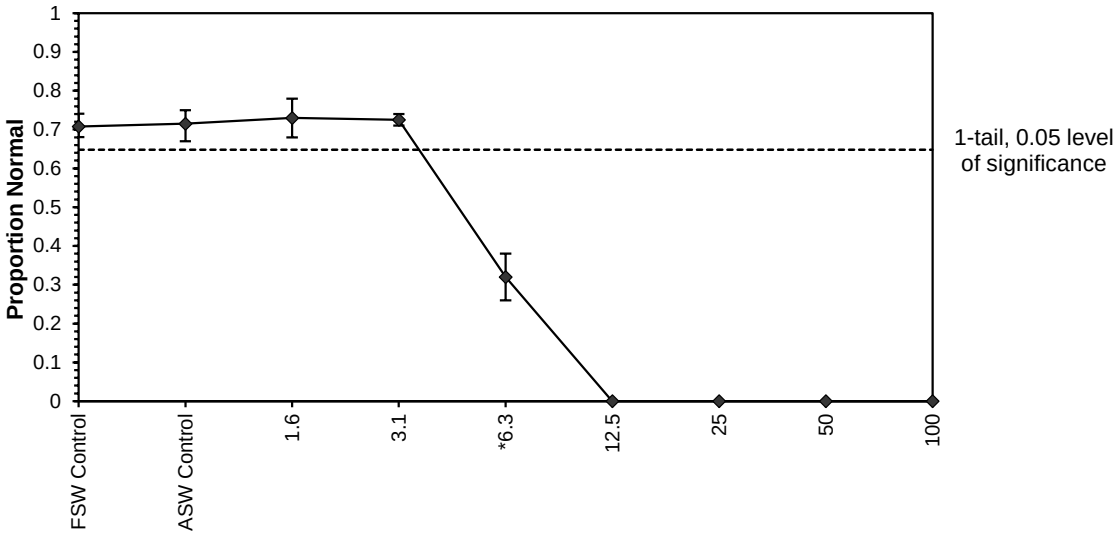
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 6.0159 | 5.8111 | 6.2278 |
| 5.0% | 5.9954 | 5.7696 | 6.2300 |
| 10.0% | 5.9750 | 5.7241 | 6.2370 |
| 20.0% | 5.9349 | 5.6134 | 6.2748 |
| Auto-0.0% | 6.0159 | 5.8111 | 6.2278 |



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 17:30 | Test ID: | PR2029/05 | Sample ID: | MI-5327 |
| End Date: | 2/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 17:30 | Test ID: | PR2029/05 | Sample ID: | MI-5327 |
| End Date: | 2/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 70.75 | 68.00 | 74.00 | 2.50 | 2.23 | 4 |
| ASW Control | | 71.50 | 67.00 | 75.00 | 3.42 | 2.58 | 4 |
| 1.6 | | 73.00 | 68.00 | 78.00 | 4.76 | 2.99 | 4 |
| 3.1 | | 72.50 | 71.00 | 74.00 | 1.29 | 1.57 | 4 |
| 6.3 | | 32.00 | 26.00 | 38.00 | 5.48 | 7.31 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 16:00 | Test ID: | PR2029/20 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 16:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.8400 | 0.8100 | 0.8600 | 0.8200 |
| ASW Control | 0.7900 | 0.8100 | 0.8300 | 0.7600 |
| 1.6 | 0.8400 | 0.8100 | 0.8600 | 0.7800 |
| 3.1 | 0.7900 | 0.8300 | 0.8100 | 0.8600 |
| 6.3 | 0.4900 | 0.7000 | 0.6300 | 0.4900 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

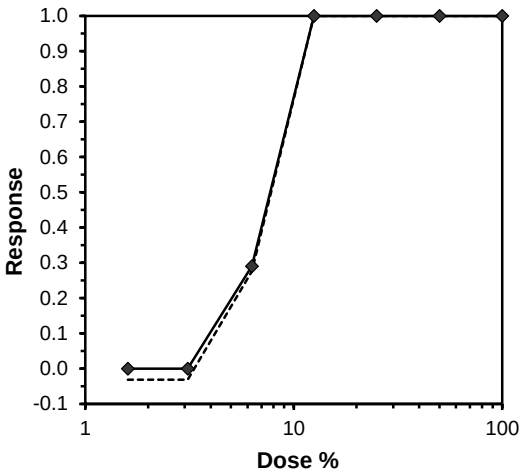
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.8325 | 1.0439 | 1.1497 | 1.1198 | 1.1873 | 2.605 | 4 | | | | | |
| ASW Control | 0.7975 | 1.0000 | 1.1048 | 1.0588 | 1.1458 | 3.354 | 4 | * | | | 0.8142 | 1.0000 |
| 1.6 | 0.8225 | 1.0313 | 1.1372 | 1.0826 | 1.1873 | 4.024 | 4 | -0.713 | 2.290 | 0.1043 | 0.8142 | 1.0000 |
| 3.1 | 0.8225 | 1.0313 | 1.1369 | 1.0948 | 1.1873 | 3.477 | 4 | -0.705 | 2.290 | 0.1043 | 0.8142 | 1.0000 |
| *6.3 | 0.5775 | 0.7241 | 0.8647 | 0.7754 | 0.9912 | 12.432 | 4 | 5.273 | 2.290 | 0.1043 | 0.5775 | 0.7093 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.964082 | 0.887 | 0.290807 | 0.120023 |
| Bartlett's Test indicates equal variances (p = 0.21) | 4.580443 | 11.34487 | | |
| The control means are not significantly different (p = 0.11) | 1.886902 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.089565 | 0.112221 | 0.069359 | 0.004147 | 1.4E-04 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Log-Logit Interpolation (200 Resamples)

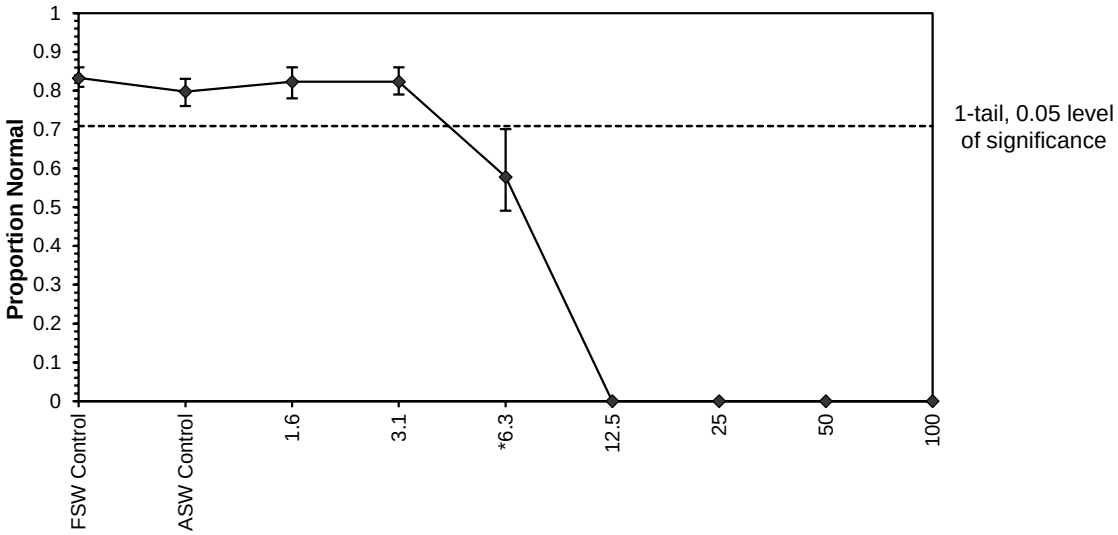
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.6390 | 0.1247 | 3.2747 | 4.0202 | 0.7050 |
| IC10 | 4.1713 | 0.2401 | 3.7259 | 5.1005 | 1.4705 |
| IC15 | 4.7067 | 0.3739 | 4.0262 | 6.2890 | 1.4895 |
| IC20 | 5.2536 | 0.4547 | 4.3117 | 6.9797 | 0.7872 |
| IC25 | 5.8197 | 0.4240 | 4.5938 | 6.7676 | -0.0208 |
| IC40 | 6.4709 | 0.0893 | 6.2005 | 6.7464 | 0.1392 |
| IC50 | 6.6318 | 0.0868 | 6.3656 | 6.9024 | 0.2038 |



**Bivalve Acute Toxicity Tests-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 16:00 | Test ID: | PR2029/20 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 16:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 16:00 | Test ID: | PR2029/20 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 16:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 83.25 | 81.00 | 86.00 | 2.22 | 1.79 | 4 |
| ASW Control | | 79.75 | 76.00 | 83.00 | 2.99 | 2.17 | 4 |
| 1.6 | | 82.25 | 78.00 | 86.00 | 3.50 | 2.27 | 4 |
| 3.1 | | 82.25 | 79.00 | 86.00 | 2.99 | 2.10 | 4 |
| 6.3 | | 57.75 | 49.00 | 70.00 | 10.50 | 5.61 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 16:00 | Test ID: | PR2029/20 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 16:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.8400 | 0.8100 | 0.8600 | 0.8200 |
| ASW Control | 0.7900 | 0.8100 | 0.8300 | 0.7600 |
| 1.6 | 0.8400 | 0.8100 | 0.8600 | 0.7800 |
| 3.1 | 0.7900 | 0.8300 | 0.8100 | 0.8600 |
| 6.3 | 0.4900 | 0.7000 | 0.6300 | 0.4900 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

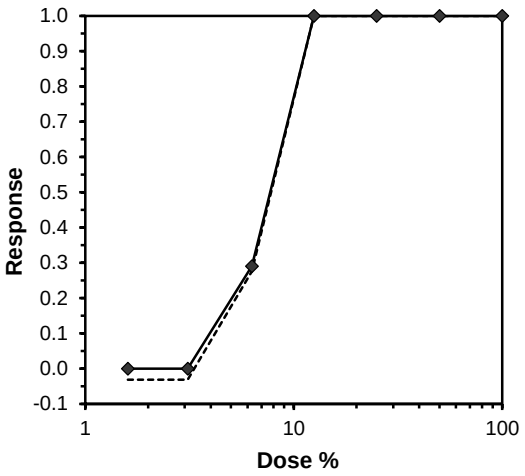
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.8325 | 1.0439 | 1.1497 | 1.1198 | 1.1873 | 2.605 | 4 | | | | | |
| ASW Control | 0.7975 | 1.0000 | 1.1048 | 1.0588 | 1.1458 | 3.354 | 4 | * | | | 81 | 400 |
| 1.6 | 0.8225 | 1.0313 | 1.1372 | 1.0826 | 1.1873 | 4.024 | 4 | -0.713 | 2.290 | 0.1043 | 71 | 400 |
| 3.1 | 0.8225 | 1.0313 | 1.1369 | 1.0948 | 1.1873 | 3.477 | 4 | -0.705 | 2.290 | 0.1043 | 71 | 400 |
| *6.3 | 0.5775 | 0.7241 | 0.8647 | 0.7754 | 0.9912 | 12.432 | 4 | 5.273 | 2.290 | 0.1043 | 169 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.964082 | 0.887 | 0.290807 | 0.120023 |
| Bartlett's Test indicates equal variances (p = 0.21) | 4.580443 | 11.34487 | | |
| The control means are not significantly different (p = 0.11) | 1.886902 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.089565 | 0.112221 | 0.069359 | 0.004147 | 1.4E-04 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Trimmed Spearman-Karber

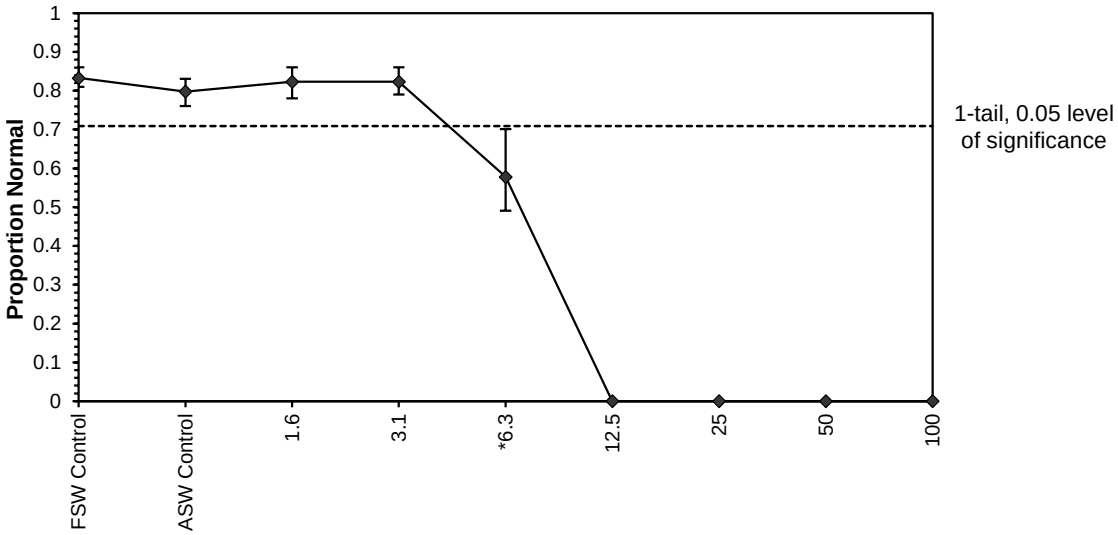
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 7.2462 | 7.0204 | 7.4793 |
| 5.0% | 7.3545 | 7.0972 | 7.6212 |
| 10.0% | 7.4577 | 7.1541 | 7.7743 |
| 20.0% | 7.6342 | 7.1652 | 8.1339 |
| Auto-0.0% | 7.2462 | 7.0204 | 7.4793 |



**Bivalve Acute Toxicity Tests-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 16:00 | Test ID: | PR2029/20 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 16:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 16:00 | Test ID: | PR2029/20 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 16:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 83.25 | 81.00 | 86.00 | 2.22 | 1.79 | 4 |
| ASW Control | | 79.75 | 76.00 | 83.00 | 2.99 | 2.17 | 4 |
| 1.6 | | 82.25 | 78.00 | 86.00 | 3.50 | 2.27 | 4 |
| 3.1 | | 82.25 | 79.00 | 86.00 | 2.99 | 2.10 | 4 |
| 6.3 | | 57.75 | 49.00 | 70.00 | 10.50 | 5.61 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7500 | 0.7900 | 0.7600 | 0.7200 |
| ASW Control | 0.6800 | 0.7400 | 0.7100 | 0.7800 |
| 1.6 | 0.7600 | 0.8100 | 0.8200 | 0.7500 |
| 3.1 | 0.7100 | 0.7200 | 0.7700 | 0.7600 |
| 6.3 | 0.5100 | 0.7400 | 0.6300 | 0.7000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0300 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7550 | 1.0378 | 1.0535 | 1.0132 | 1.0948 | 3.193 | 4 | | | | | |
| ASW Control | 0.7275 | 1.0000 | 1.0225 | 0.9695 | 1.0826 | 4.726 | 4 | * | | | 109 | 400 |
| 1.6 | 0.7850 | 1.0790 | 1.0896 | 1.0472 | 1.1326 | 3.933 | 4 | -1.494 | 2.360 | 0.1060 | 86 | 400 |
| 3.1 | 0.7400 | 1.0172 | 1.0362 | 1.0021 | 1.0706 | 3.243 | 4 | -0.305 | 2.360 | 0.1060 | 104 | 400 |
| 6.3 | 0.6450 | 0.8866 | 0.9348 | 0.7954 | 1.0357 | 11.239 | 4 | 1.952 | 2.360 | 0.1060 | 142 | 400 |
| *12.5 | 0.0075 | 0.0103 | 0.0810 | 0.0500 | 0.1741 | 76.547 | 4 | 20.954 | 2.360 | 0.1060 | 397 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

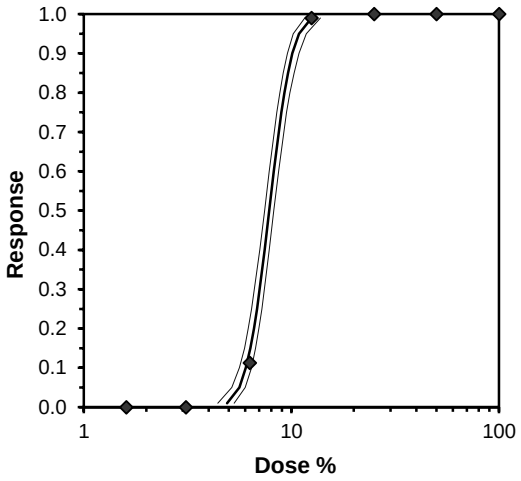
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.939862 | 0.905 | -0.23612 | 0.741992 |
| Bartlett's Test indicates equal variances (p = 0.36) | 4.372557 | 13.2767 | | |
| The control means are not significantly different (p = 0.33) | 1.05303 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.098744 | 0.13558 | 0.718854 | 0.004037 | 1.9E-12 | 4, 15 |
| Treatments vs ASW Control | | | | | | | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 11.43527 | 0.890313 | 9.690253 | 13.18028 | 0.2725 | 2.747321 | 11.0705 | 0.74 | 0.893438 | 0.087449 | 3 |
| Intercept | -5.2167 | 0.802332 | -6.78927 | -3.64413 | | | | | | | |
| TSCR | 0.249166 | 0.012486 | 0.224693 | 0.273639 | | | | | | | |

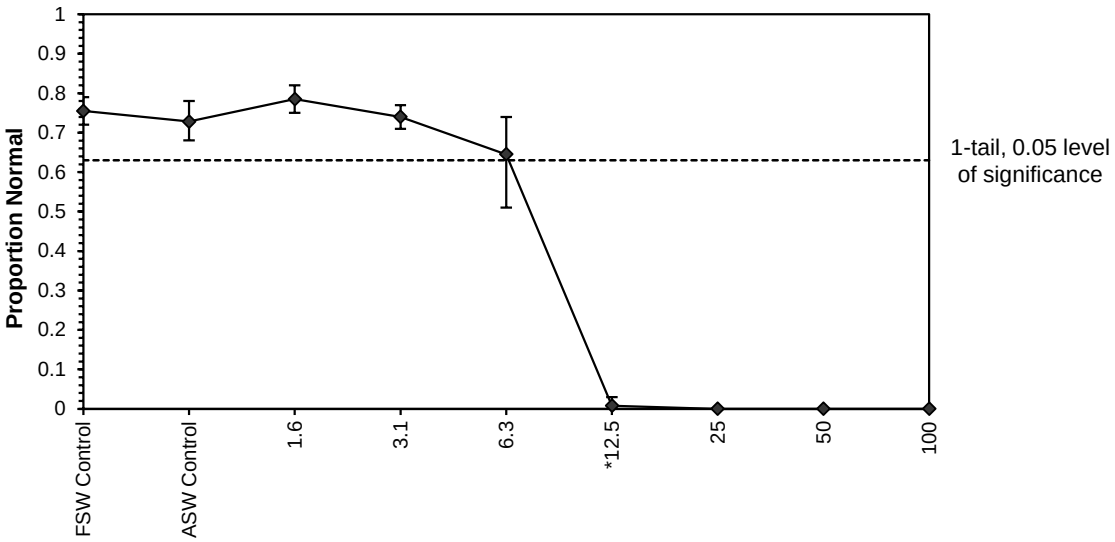
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 4.897809 | 4.41871 | 5.304506 |
| EC05 | 3.355 | 5.618206 | 5.171699 | 6.002617 |
| EC10 | 3.718 | 6.044605 | 5.618138 | 6.418552 |
| EC15 | 3.964 | 6.350432 | 5.937205 | 6.719548 |
| EC20 | 4.158 | 6.604491 | 6.200836 | 6.971984 |
| EC25 | 4.326 | 6.830536 | 6.433864 | 7.198841 |
| EC40 | 4.747 | 7.435038 | 7.047309 | 7.818511 |
| EC50 | 5.000 | 7.824166 | 7.432911 | 8.229143 |
| EC60 | 5.253 | 8.233661 | 7.829918 | 8.672065 |
| EC75 | 5.674 | 8.962339 | 8.514628 | 9.486958 |
| EC80 | 5.842 | 9.269084 | 8.795372 | 9.839347 |
| EC85 | 6.036 | 9.639908 | 9.129686 | 10.27186 |
| EC90 | 6.282 | 10.12764 | 9.562085 | 10.85038 |
| EC95 | 6.645 | 10.89629 | 10.22981 | 11.78109 |
| EC99 | 7.326 | 12.49897 | 11.58298 | 13.78055 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 17:00 | Test ID: | PR2029/4 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 17:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 75.50 | 72.00 | 79.00 | 2.89 | 2.25 | 4 |
| ASW Control | | 72.75 | 68.00 | 78.00 | 4.27 | 2.84 | 4 |
| 1.6 | | 78.50 | 75.00 | 82.00 | 3.51 | 2.39 | 4 |
| 3.1 | | 74.00 | 71.00 | 77.00 | 2.94 | 2.32 | 4 |
| 6.3 | | 64.50 | 51.00 | 74.00 | 10.08 | 4.92 | 4 |
| 12.5 | | 0.75 | 0.00 | 3.00 | 1.50 | 163.30 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 14:30 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9800 | 1.0000 |
| ASW Control | 0.9700 | 0.9800 | 0.9600 | 0.9800 |
| 1.6 | 0.9800 | 0.9500 | 0.9900 | 0.9800 |
| 3.1 | 1.0000 | 0.9800 | 0.9600 | 0.9900 |
| 6.3 | 0.9800 | 0.9600 | 0.9500 | 0.9800 |
| 12.5 | 0.8100 | 0.8700 | 0.8600 | 0.8200 |
| 25 | 0.0900 | 0.1600 | 0.0800 | 0.0500 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9800 | 1.0077 | 1.4370 | 1.3694 | 1.5208 | 4.348 | 4 | | | | | |
| ASW Control | 0.9725 | 1.0000 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | * | | | 11 | 400 |
| 1.6 | 0.9750 | 1.0026 | 1.4184 | 1.3453 | 1.4706 | 3.707 | 4 | -0.329 | 2.410 | 0.0910 | 10 | 400 |
| 3.1 | 0.9825 | 1.0103 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | -1.097 | 2.410 | 0.0910 | 7 | 400 |
| 6.3 | 0.9675 | 0.9949 | 1.3931 | 1.3453 | 1.4289 | 3.048 | 4 | 0.340 | 2.410 | 0.0910 | 13 | 400 |
| *12.5 | 0.8400 | 0.8638 | 1.1604 | 1.1198 | 1.2019 | 3.472 | 4 | 6.501 | 2.410 | 0.0910 | 64 | 400 |
| *25 | 0.0950 | 0.0977 | 0.3071 | 0.2255 | 0.4115 | 25.207 | 4 | 29.090 | 2.410 | 0.0910 | 362 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

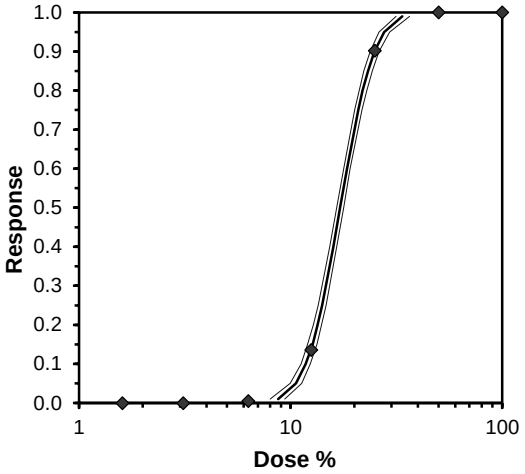
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.978289 | 0.916 | 0.094715 | -0.22336 |
| Bartlett's Test indicates equal variances (p = 0.68) | 3.158997 | 15.08627 | | |
| The control means are not significantly different (p = 0.40) | 0.902073 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.037124 | 0.038151 | 0.789366 | 0.002854 | 2.3E-16 | 5, 18 |
| Treatments vs ASW Control | | | | | | | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 7.929295 | 0.404031 | 7.137394 | 8.721195 | 0.0275 | 1.800027 | 11.0705 | 0.88 | 1.234262 | 0.126115 | 4 |
| Intercept | -4.78683 | 0.506762 | -5.78008 | -3.79358 | | | | | | | |
| TSCR | 0.025535 | 0.003956 | 0.01778 | 0.033289 | | | | | | | |

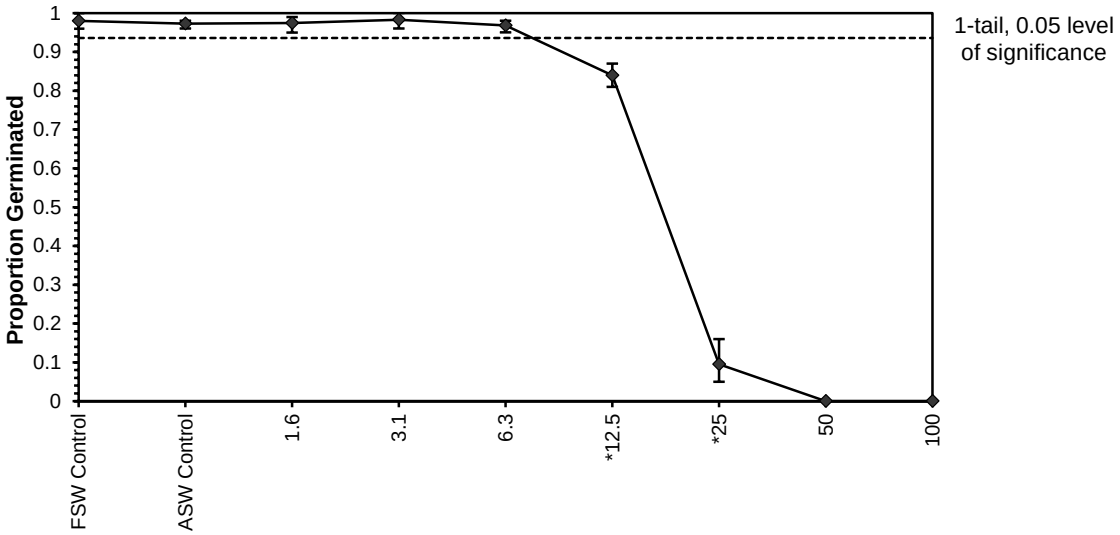
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 8.727219 | 8.002732 | 9.382743 |
| EC05 | 3.355 | 10.63708 | 9.943638 | 11.26282 |
| EC10 | 3.718 | 11.82061 | 11.15542 | 12.42411 |
| EC15 | 3.964 | 12.69267 | 12.04943 | 13.28108 |
| EC20 | 4.158 | 13.43141 | 12.80577 | 14.00963 |
| EC25 | 4.326 | 14.09936 | 13.4876 | 14.67161 |
| EC40 | 4.747 | 15.93352 | 15.341 | 16.51405 |
| EC50 | 5.000 | 17.14993 | 16.54768 | 17.76296 |
| EC60 | 5.253 | 18.45921 | 17.82206 | 19.13551 |
| EC75 | 5.674 | 20.86053 | 20.0957 | 21.72648 |
| EC80 | 5.842 | 21.89793 | 21.0564 | 22.87118 |
| EC85 | 6.036 | 23.17244 | 22.22257 | 24.29466 |
| EC90 | 6.282 | 24.88197 | 23.76683 | 26.22905 |
| EC95 | 6.645 | 27.65047 | 26.23029 | 29.41097 |
| EC99 | 7.326 | 33.70148 | 31.50234 | 36.52534 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 14:30 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 14:30 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 17:30 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 98.00 | 96.00 | 100.00 | 1.63 | 1.30 | 4 |
| ASW Control | | 97.25 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| 1.6 | | 97.50 | 95.00 | 99.00 | 1.73 | 1.35 | 4 |
| 3.1 | | 98.25 | 96.00 | 100.00 | 1.71 | 1.33 | 4 |
| 6.3 | | 96.75 | 95.00 | 98.00 | 1.50 | 1.27 | 4 |
| 12.5 | | 84.00 | 81.00 | 87.00 | 2.94 | 2.04 | 4 |
| 25 | | 9.50 | 5.00 | 16.00 | 4.65 | 22.71 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:00 | Test ID: | PR2029/23 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 17:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9600 | 0.9800 | 0.9500 | 0.9700 |
| ASW Control | 0.9800 | 0.9500 | 0.9600 | 0.9700 |
| 1.6 | 0.9500 | 0.9800 | 0.9600 | 0.9500 |
| 3.1 | 0.9700 | 0.9900 | 0.9500 | 0.9600 |
| 6.3 | 0.9400 | 0.9300 | 0.9800 | 0.9200 |
| 12.5 | 0.8100 | 0.7600 | 0.7400 | 0.7900 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

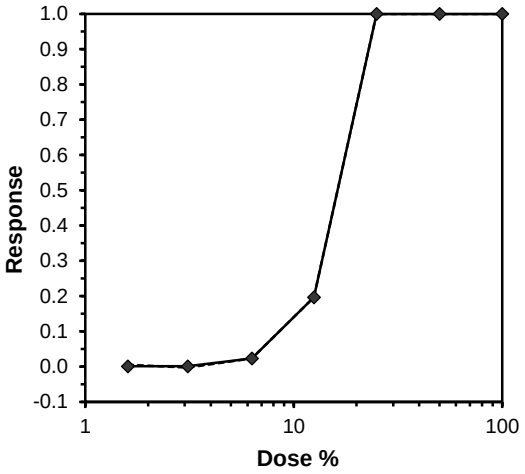
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | | | | | |
| ASW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | * | | | 0.9650 | 1.0000 |
| 1.6 | 0.9600 | 0.9948 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | 0.381 | 2.360 | 0.0796 | 0.9638 | 0.9987 |
| 3.1 | 0.9675 | 1.0026 | 1.3955 | 1.3453 | 1.4706 | 3.891 | 4 | -0.309 | 2.360 | 0.0796 | 0.9638 | 0.9987 |
| 6.3 | 0.9425 | 0.9767 | 1.3348 | 1.2840 | 1.4289 | 4.850 | 4 | 1.490 | 2.360 | 0.0796 | 0.9425 | 0.9767 |
| *12.5 | 0.7750 | 0.8031 | 1.0773 | 1.0357 | 1.1198 | 3.464 | 4 | 9.123 | 2.360 | 0.0796 | 0.7750 | 0.8031 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.911847 | 0.905 | 0.854102 | -0.21306 |
| Bartlett's Test indicates equal variances (p = 0.83) | 1.501473 | 13.2767 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.034674 | 0.035898 | 0.071557 | 0.002277 | 3.9E-07 | 4, 15 |
| Treatments vs ASW Control | | | | | | | | | | |

### Log-Logit Interpolation (200 Resamples)

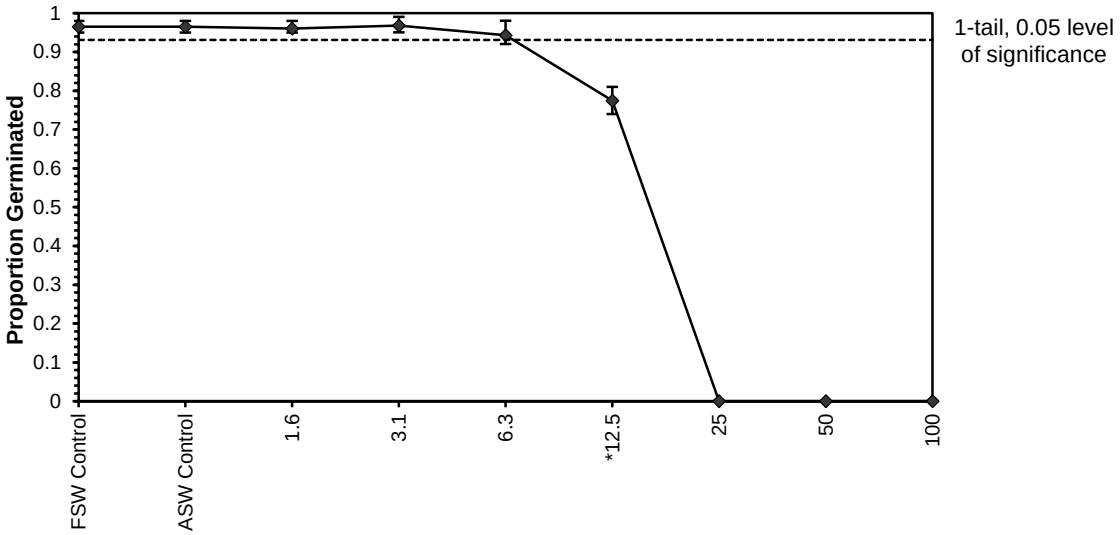
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.539 | 0.572 | 5.762 | 9.094 | 0.1594 |
| IC10 | 9.445 | 0.438 | 8.035 | 10.586 | 0.0800 |
| IC15 | 11.083 | 0.375 | 9.913 | 12.113 | 0.0380 |
| IC20 | 12.515 | 0.227 | 11.369 | 12.700 | -1.3564 |
| IC25 | 12.734 | 0.064 | 12.520 | 12.914 | -0.0208 |
| IC40 | 13.300 | 0.062 | 13.091 | 13.475 | -0.0390 |
| IC50 | 13.653 | 0.061 | 13.446 | 13.825 | -0.0467 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:00 | Test ID: | PR2029/23 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 17:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:00 | Test ID: | PR2029/23 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 17:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| ASW Control | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 1.6 | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 3.1 | | 96.75 | 95.00 | 99.00 | 1.71 | 1.35 | 4 |
| 6.3 | | 94.25 | 92.00 | 98.00 | 2.63 | 1.72 | 4 |
| 12.5 | | 77.50 | 74.00 | 81.00 | 3.11 | 2.28 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:00 | Test ID: | PR2029/23 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 17:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9600 | 0.9800 | 0.9500 | 0.9700 |
| ASW Control | 0.9800 | 0.9500 | 0.9600 | 0.9700 |
| 1.6 | 0.9500 | 0.9800 | 0.9600 | 0.9500 |
| 3.1 | 0.9700 | 0.9900 | 0.9500 | 0.9600 |
| 6.3 | 0.9400 | 0.9300 | 0.9800 | 0.9200 |
| 12.5 | 0.8100 | 0.7600 | 0.7400 | 0.7900 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

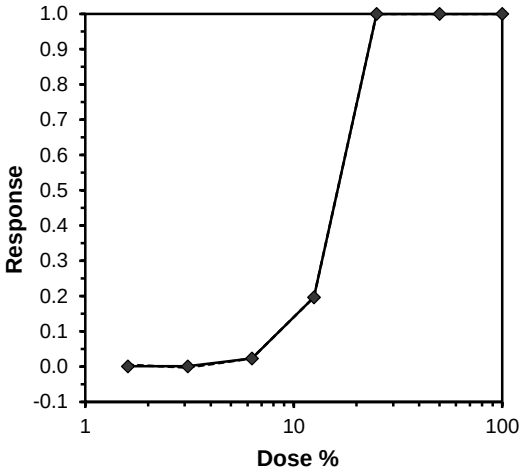
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | | | | | |
| ASW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | * | | | 14 | 400 |
| 1.6 | 0.9600 | 0.9948 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | 0.381 | 2.360 | 0.0796 | 16 | 400 |
| 3.1 | 0.9675 | 1.0026 | 1.3955 | 1.3453 | 1.4706 | 3.891 | 4 | -0.309 | 2.360 | 0.0796 | 13 | 400 |
| 6.3 | 0.9425 | 0.9767 | 1.3348 | 1.2840 | 1.4289 | 4.850 | 4 | 1.490 | 2.360 | 0.0796 | 23 | 400 |
| *12.5 | 0.7750 | 0.8031 | 1.0773 | 1.0357 | 1.1198 | 3.464 | 4 | 9.123 | 2.360 | 0.0796 | 90 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.911847 | 0.905 | 0.854102 | -0.21306 |
| Bartlett's Test indicates equal variances (p = 0.83) | 1.501473 | 13.2767 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.034674 | 0.035898 | 0.071557 | 0.002277 | 3.9E-07 | 4, 15 |
| Treatments vs ASW Control | | | | | | | | | | |

### Trimmed Spearman-Karber

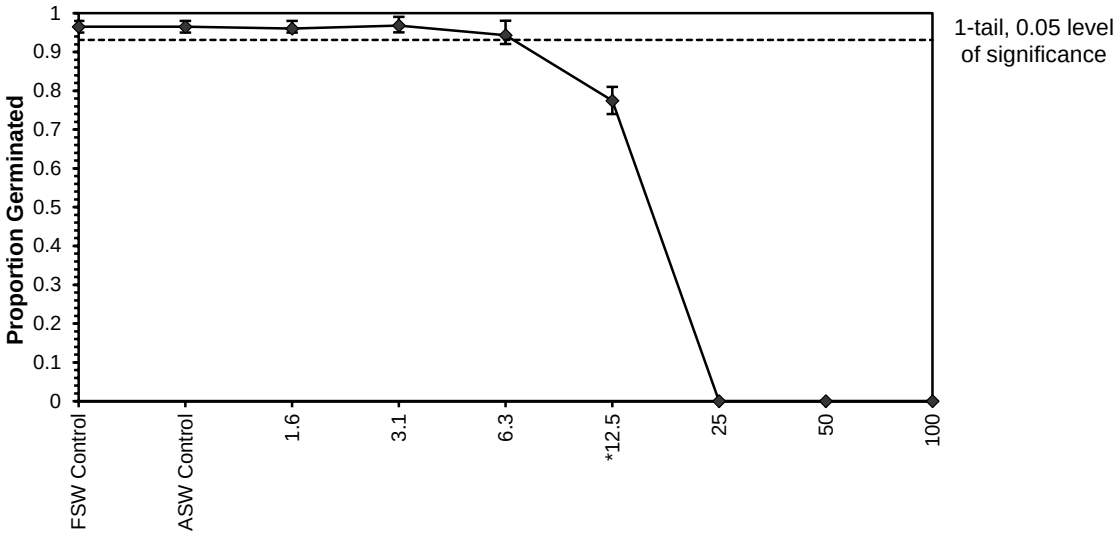
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 15.648 | 15.170 | 16.141 |
| 10.0% | 15.946 | 15.362 | 16.554 |
| 20.0% | 16.238 | 15.894 | 16.588 |
| Auto-0.1% | 15.200 | 14.759 | 15.655 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:00 | Test ID: | PR2029/23 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 17:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:00 | Test ID: | PR2029/23 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 17:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| ASW Control | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 1.6 | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 3.1 | | 96.75 | 95.00 | 99.00 | 1.71 | 1.35 | 4 |
| 6.3 | | 94.25 | 92.00 | 98.00 | 2.63 | 1.72 | 4 |
| 12.5 | | 77.50 | 74.00 | 81.00 | 3.11 | 2.28 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 15:30 | Test ID: | PR2029/7 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 15:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9600 | 0.9300 | 0.9800 | 0.9500 |
| ASW Control | 0.9500 | 0.9300 | 0.9600 | 0.9800 |
| 1.6 | 0.9600 | 0.9800 | 0.9300 | 0.9500 |
| 3.1 | 0.9500 | 0.9800 | 0.9800 | |
| 6.3 | 0.9500 | 0.9700 | 0.9600 | 0.9800 |
| 12.5 | 0.9500 | 0.9700 | 0.9800 | 0.9600 |
| 25 | 0.0500 | 0.0300 | 0.0100 | 0.0300 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

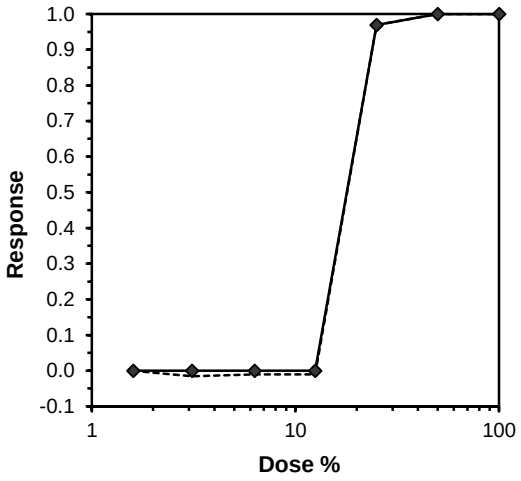
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9550 | 1.0000 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | | | | | |
| ASW Control | 0.9550 | 1.0000 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | * | | | 0.9620 | 1.0000 |
| 1.6 | 0.9550 | 1.0000 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | 0.000 | 2.567 | 0.0847 | 0.9620 | 1.0000 |
| 3.1 | 0.9700 | 1.0157 | 1.4010 | 1.3453 | 1.4289 | 3.446 | 3 | -1.105 | 2.567 | 0.0914 | 0.9620 | 1.0000 |
| 6.3 | 0.9650 | 1.0105 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | -0.710 | 2.567 | 0.0847 | 0.9620 | 1.0000 |
| 12.5 | 0.9650 | 1.0105 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | -0.710 | 2.567 | 0.0847 | 0.9620 | 1.0000 |
| *25 | 0.0300 | 0.0314 | 0.1685 | 0.1002 | 0.2255 | 30.620 | 4 | 36.178 | 2.567 | 0.0847 | 0.0300 | 0.0312 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.953388 | 0.914 | -0.02008 | -0.9118 |
| Bartlett's Test indicates equal variances (p = 0.98) | 0.824421 | 15.08627 | | |
| The control means are not significantly different (p = 1.00) | 5.97E-15 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Bonferroni t Test | 12.5 | 25 | 17.67767 | 8 | 0.040758 | 0.042594 | 0.96725 | 0.002176 | 2.2E-17 | 5, 17 |
| Treatments vs ASW Control | | | | | | | | | | |

### Log-Logit Interpolation (200 Resamples)

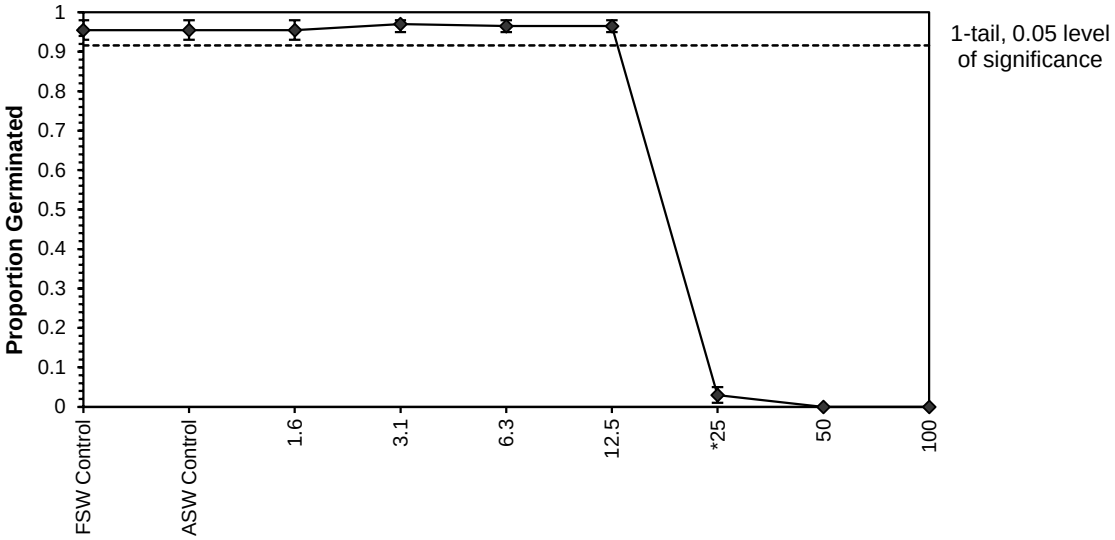
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 13.697 | 0.104 | 13.138 | 13.844 | -0.8944 |
| IC10 | 14.429 | 0.110 | 13.917 | 14.642 | -0.4924 |
| IC15 | 14.987 | 0.124 | 14.454 | 15.248 | -0.4080 |
| IC20 | 15.454 | 0.138 | 14.889 | 15.754 | -0.3730 |
| IC25 | 15.868 | 0.152 | 15.253 | 16.189 | -0.3462 |
| IC40 | 16.958 | 0.194 | 16.179 | 17.381 | -0.2772 |
| IC50 | 17.650 | 0.224 | 16.745 | 18.190 | -0.2377 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 15:30 | Test ID: | PR2029/7 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 15:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 15:30 | Test ID: | PR2029/7 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 15:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| ASW Control | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 1.6 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 3.1 | | 97.00 | 95.00 | 98.00 | 1.73 | 1.36 | 3 |
| 6.3 | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 12.5 | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 25 | | 3.00 | 1.00 | 5.00 | 1.63 | 42.60 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 15:30 | Test ID: | PR2029/7 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 15:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9600 | 0.9300 | 0.9800 | 0.9500 |
| ASW Control | 0.9500 | 0.9300 | 0.9600 | 0.9800 |
| 1.6 | 0.9600 | 0.9800 | 0.9300 | 0.9500 |
| 3.1 | 0.9500 | 0.9800 | 0.9800 | |
| 6.3 | 0.9500 | 0.9700 | 0.9600 | 0.9800 |
| 12.5 | 0.9500 | 0.9700 | 0.9800 | 0.9600 |
| 25 | 0.0500 | 0.0300 | 0.0100 | 0.0300 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

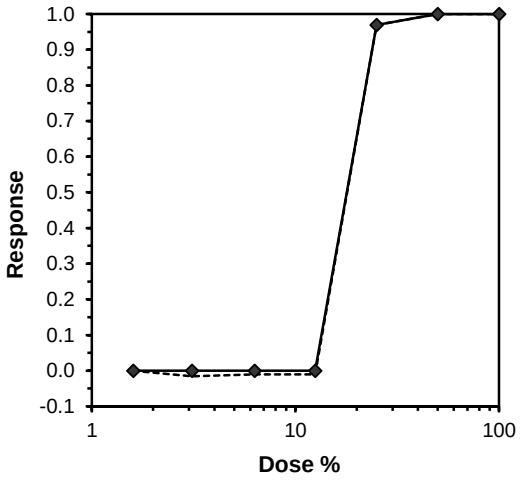
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9550 | 1.0000 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | | | | | |
| ASW Control | 0.9550 | 1.0000 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | * | | | 18 | 400 |
| 1.6 | 0.9550 | 1.0000 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | 0.000 | 2.567 | 0.0847 | 18 | 400 |
| 3.1 | 0.9700 | 1.0157 | 1.4010 | 1.3453 | 1.4289 | 3.446 | 3 | -1.105 | 2.567 | 0.0914 | 9 | 300 |
| 6.3 | 0.9650 | 1.0105 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | -0.710 | 2.567 | 0.0847 | 14 | 400 |
| 12.5 | 0.9650 | 1.0105 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | -0.710 | 2.567 | 0.0847 | 14 | 400 |
| *25 | 0.0300 | 0.0314 | 0.1685 | 0.1002 | 0.2255 | 30.620 | 4 | 36.178 | 2.567 | 0.0847 | 388 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.953388 | 0.914 | -0.02008 | -0.9118 |
| Bartlett's Test indicates equal variances (p = 0.98) | 0.824421 | 15.08627 | | |
| The control means are not significantly different (p = 1.00) | 5.97E-15 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Bonferroni t Test | 12.5 | 25 | 17.67767 | 8 | 0.040758 | 0.042594 | 0.96725 | 0.002176 | 2.2E-17 | 5, 17 |
| Treatments vs ASW Control | | | | | | | | | | |

### Trimmed Spearman-Karber

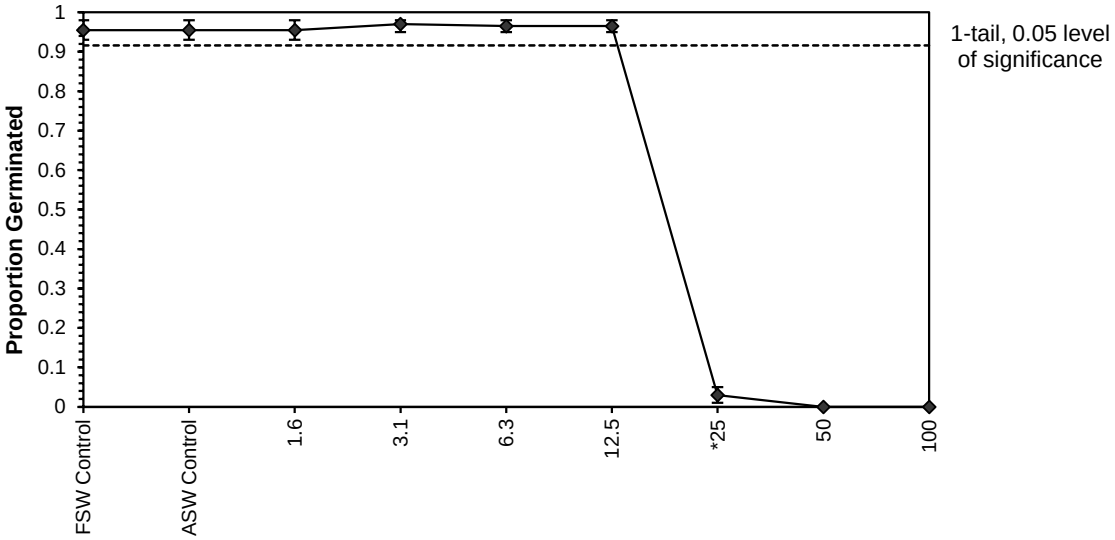
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 18.064 | 17.848 | 18.283 |
| 5.0% | 17.876 | 17.762 | 17.991 |
| 10.0% | 17.876 | 17.762 | 17.991 |
| 20.0% | 17.876 | 17.762 | 17.991 |
| Auto-0.0% | 18.064 | 17.848 | 18.283 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 15:30 | Test ID: | PR2029/7 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 15:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 15:30 | Test ID: | PR2029/7 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 15:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| ASW Control | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 1.6 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 3.1 | | 97.00 | 95.00 | 98.00 | 1.73 | 1.36 | 3 |
| 6.3 | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 12.5 | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 25 | | 3.00 | 1.00 | 5.00 | 1.63 | 42.60 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.6000 | 0.6000 | 0.2000 | 0.6000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

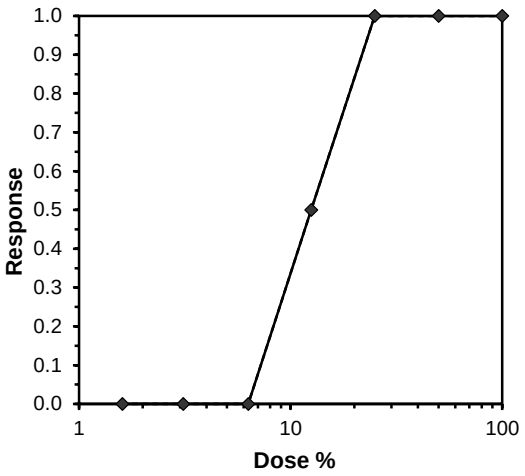
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *12.5 | 0.5000 | 0.5000 | 0.7805 | 0.4636 | 0.8861 | 27.063 | 4 | 10.00 | 10.00 | 0.5000 | 0.5000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.508902 | 0.905 | -2.79623 | 11.6732 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

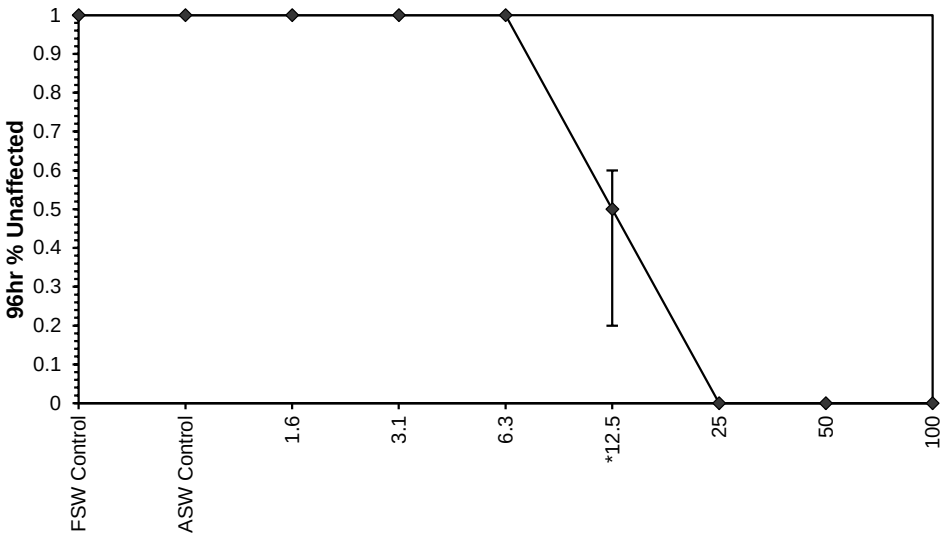
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 10.091 | 0.181 | 9.477 | 10.436 | -0.3522 |
| IC10 | 10.658 | 0.213 | 9.937 | 11.065 | -0.3491 |
| IC15 | 11.024 | 0.234 | 10.232 | 11.471 | -0.3472 |
| IC20 | 11.307 | 0.251 | 10.459 | 11.786 | -0.3458 |
| IC25 | 11.545 | 0.265 | 10.650 | 12.052 | -0.3446 |
| IC40 | 12.140 | 0.302 | 11.124 | 12.716 | -0.3418 |
| IC50 | 12.500 | 0.320 | 11.410 | 13.105 | -0.3623 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 50.00 | 20.00 | 60.00 | 20.00 | 8.94 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.6000 | 0.6000 | 0.2000 | 0.6000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

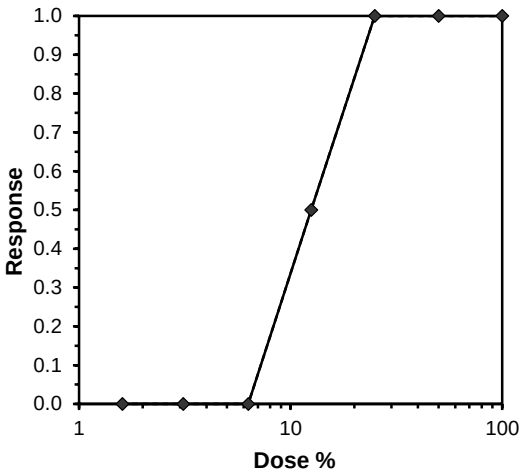
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *12.5 | 0.5000 | 0.5000 | 0.7805 | 0.4636 | 0.8861 | 27.063 | 4 | 10.00 | 10.00 | 10 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.508902 | 0.905 | -2.79623 | 11.6732 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

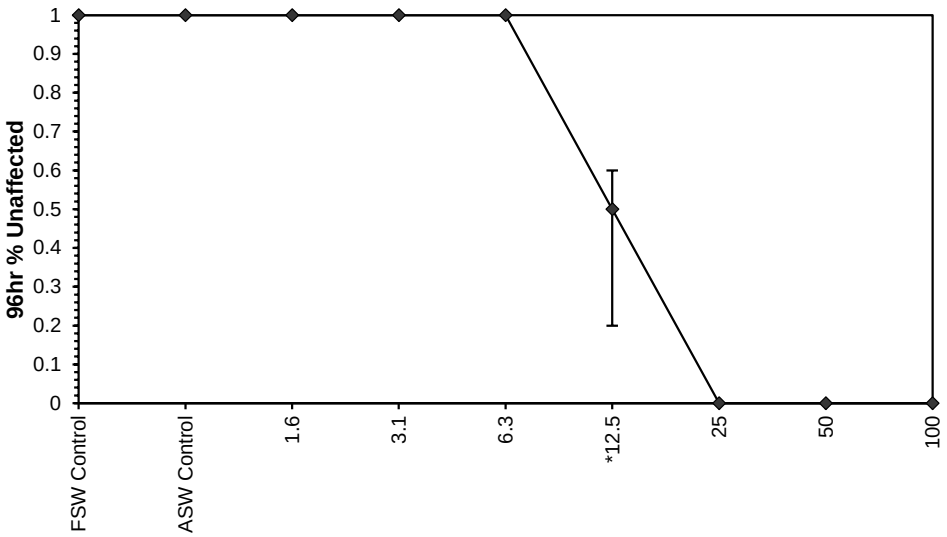
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 12.525 | 10.736 | 14.612 |
| 5.0% | 12.522 | 10.552 | 14.861 |
| 10.0% | 12.520 | 10.327 | 15.179 |
| 20.0% | 12.515 | 9.683 | 16.176 |
| Auto-0.0% | 12.525 | 10.736 | 14.612 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/08 | Sample ID: | MI-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 50.00 | 20.00 | 60.00 | 20.00 | 8.94 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:30 | Test ID: | PR2029/24 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 17:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.8000 | 0.8000 | 0.6000 | 0.4000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

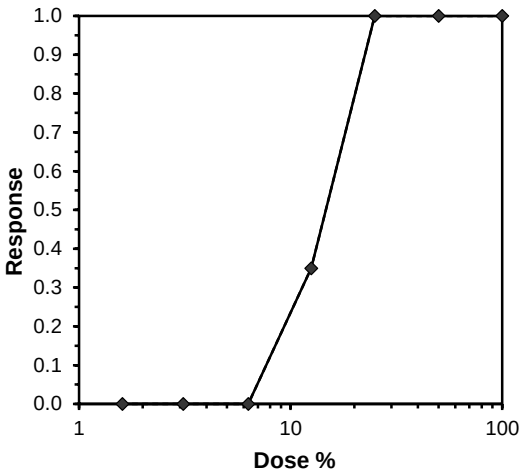
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *12.5 | 0.6500 | 0.6500 | 0.9463 | 0.6847 | 1.1071 | 21.467 | 4 | 10.00 | 10.00 | 0.6500 | 0.6500 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.593086 | 0.905 | -1.08791 | 6.726431 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

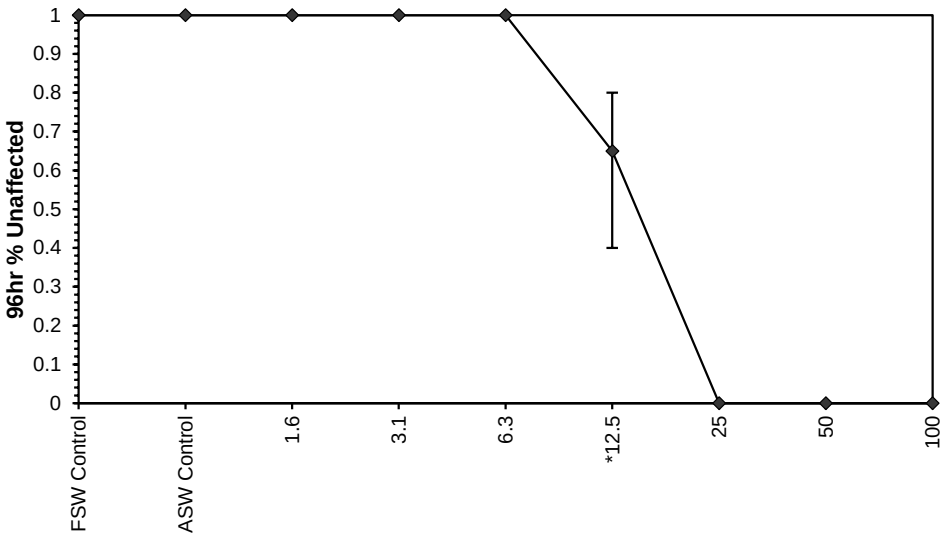
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 10.430 | 0.233 | 9.887 | 11.253 | 0.1908 |
| IC10 | 11.058 | 0.275 | 10.418 | 12.032 | 0.1962 |
| IC15 | 11.464 | 0.303 | 10.760 | 12.538 | 0.1996 |
| IC20 | 11.779 | 0.325 | 11.024 | 12.933 | 0.2022 |
| IC25 | 12.045 | 0.335 | 11.246 | 13.161 | 0.0968 |
| IC40 | 12.694 | 0.337 | 11.807 | 13.735 | -0.1021 |
| IC50 | 13.069 | 0.336 | 12.159 | 14.092 | -0.1593 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:30 | Test ID: | PR2029/24 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 17:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:30 | Test ID: | PR2029/24 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 17:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 65.00 | 40.00 | 80.00 | 19.15 | 6.73 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:30 | Test ID: | PR2029/24 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 17:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.8000 | 0.8000 | 0.6000 | 0.4000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

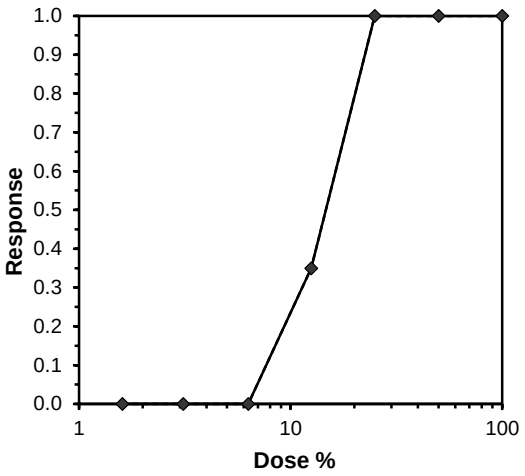
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *12.5 | 0.6500 | 0.6500 | 0.9463 | 0.6847 | 1.1071 | 21.467 | 4 | 10.00 | 10.00 | 7 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.593086 | 0.905 | -1.08791 | 6.726431 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

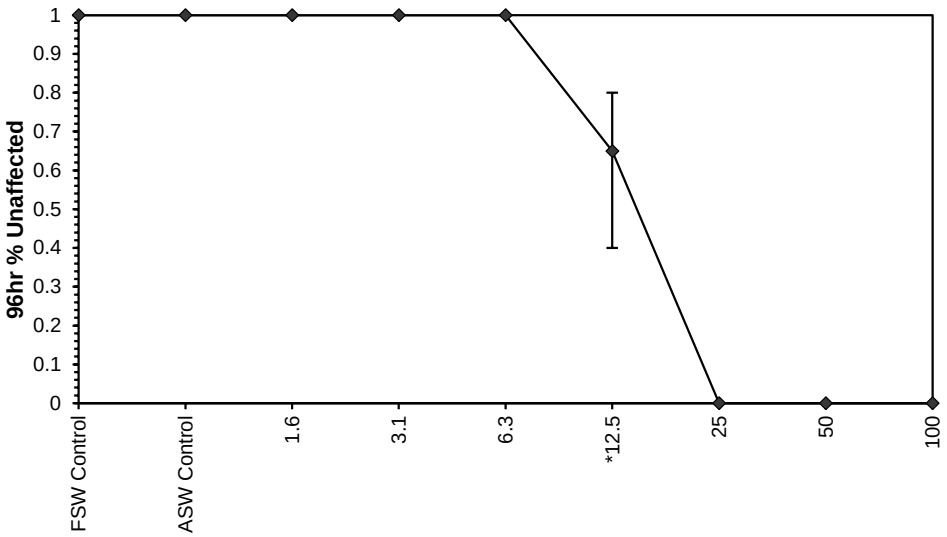
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 13.889 | 11.990 | 16.088 |
| 5.0% | 14.029 | 11.901 | 16.537 |
| 10.0% | 14.166 | 11.726 | 17.114 |
| 20.0% | 14.425 | 10.978 | 18.955 |
| Auto-0.0% | 13.889 | 11.990 | 16.088 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:30 | Test ID: | PR2029/24 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 17:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 17:30 | Test ID: | PR2029/24 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 17:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 65.00 | 40.00 | 80.00 | 19.15 | 6.73 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 18:00 | Test ID: | PR2029/8 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 18:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.8000 | 0.8000 | 1.0000 | 0.6000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

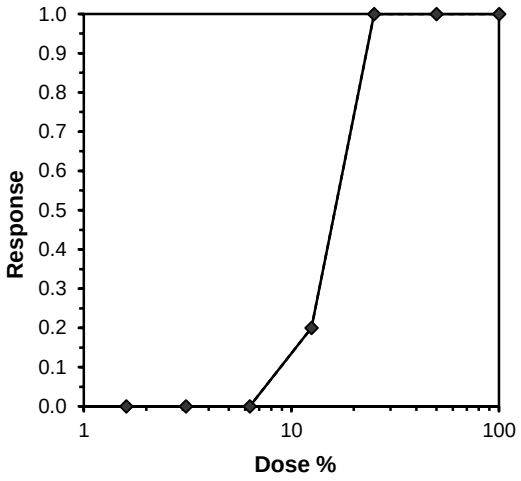
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 12.5 | 0.8000 | 0.8000 | 1.1114 | 0.8861 | 1.3453 | 16.874 | 4 | 12.00 | 10.00 | 0.8000 | 0.8000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.458116 | 0.905 | 0.190677 | 9.508986 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 12.5 | 25 | 17.67767 | 8 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

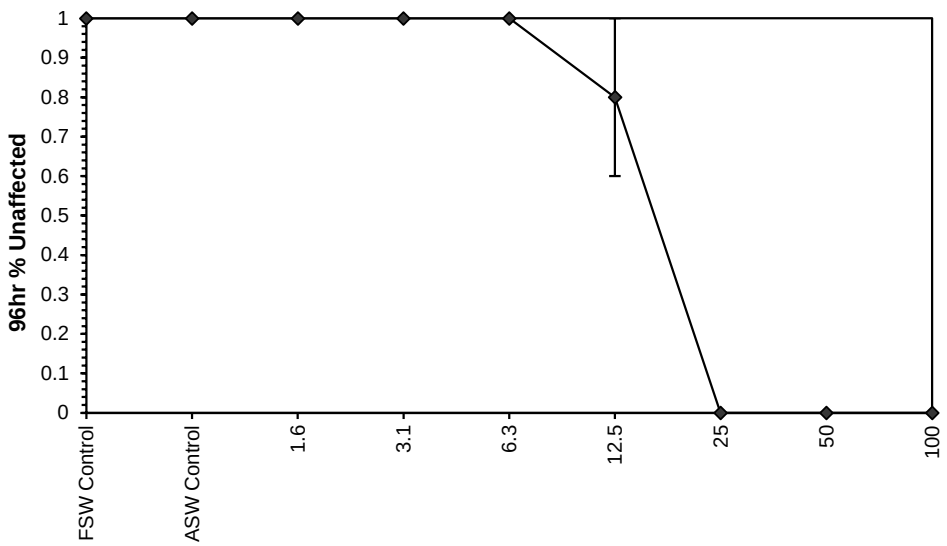
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 10.944 | 0.519 | 10.342 | 12.098 | 4.6389 |
| IC10 | 11.667 | 0.539 | 10.953 | 13.022 | 3.5202 |
| IC15 | 12.136 | 0.525 | 11.347 | 13.322 | 3.2990 |
| IC20 | 12.500 | 0.503 | 11.653 | 13.552 | 3.4095 |
| IC25 | 12.742 | 0.486 | 11.951 | 13.783 | 3.5948 |
| IC40 | 13.344 | 0.466 | 12.616 | 14.356 | 3.6525 |
| IC50 | 13.709 | 0.457 | 12.993 | 14.701 | 3.6209 |



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 18:00 | Test ID: | PR2029/8 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 18:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 18:00 | Test ID: | PR2029/8 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 18:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 80.00 | 60.00 | 100.00 | 16.33 | 5.05 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 18:10 | Test ID: | PR2029/11 | Sample ID: | IM-5327 |
| End Date: | 2/08/2021 18:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 15.808 | 16.008 | 16.508 | 15.908 | 16.008 | 15.608 | 16.908 | 16.508 |
| ASW Control | 15.808 | 16.408 | 15.608 | 16.808 | | | | |
| 1.6 | 16.008 | 16.508 | 15.108 | 17.008 | | | | |
| 3.1 | 16.808 | 17.008 | 16.508 | 16.808 | | | | |
| 6.3 | 13.408 | 15.108 | 14.608 | 13.808 | | | | |
| 12.5 | 5.508 | 7.908 | 6.708 | 8.008 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

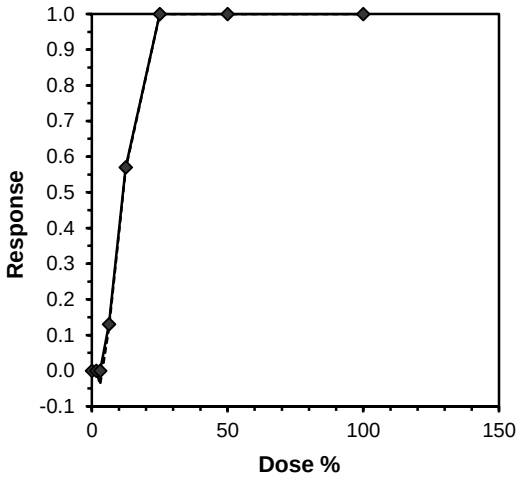
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 16.158 | 1.0000 | 16.158 | 15.608 | 16.908 | 2.708 | 8 | | | | | |
| ASW Control | 16.158 | 1.0000 | 16.158 | 15.608 | 16.808 | 3.409 | 4 | * | | | 16.366 | 1.0000 |
| 1.6 | 16.158 | 1.0000 | 16.158 | 15.108 | 17.008 | 5.015 | 4 | 0.000 | 2.360 | 1.287 | 16.366 | 1.0000 |
| 3.1 | 16.783 | 1.0387 | 16.783 | 16.508 | 17.008 | 1.228 | 4 | -1.146 | 2.360 | 1.287 | 16.366 | 1.0000 |
| *6.3 | 14.233 | 0.8809 | 14.233 | 13.408 | 15.108 | 5.393 | 4 | 3.530 | 2.360 | 1.287 | 14.233 | 0.8696 |
| *12.5 | 7.033 | 0.4353 | 7.033 | 5.508 | 8.008 | 16.719 | 4 | 16.732 | 2.360 | 1.287 | 7.033 | 0.4297 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.961544 | 0.905 | -0.4238 | -0.2433 |
| Bartlett's Test indicates equal variances (p = 0.18) | 6.29877 | 13.2767 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 1.287048 | 0.079656 | 65.62575 | 0.594833 | 6.2E-11 | 4, 15 |
| Treatments vs ASW Control | | | | | | | | | | |

### Linear Interpolation (200 Resamples)

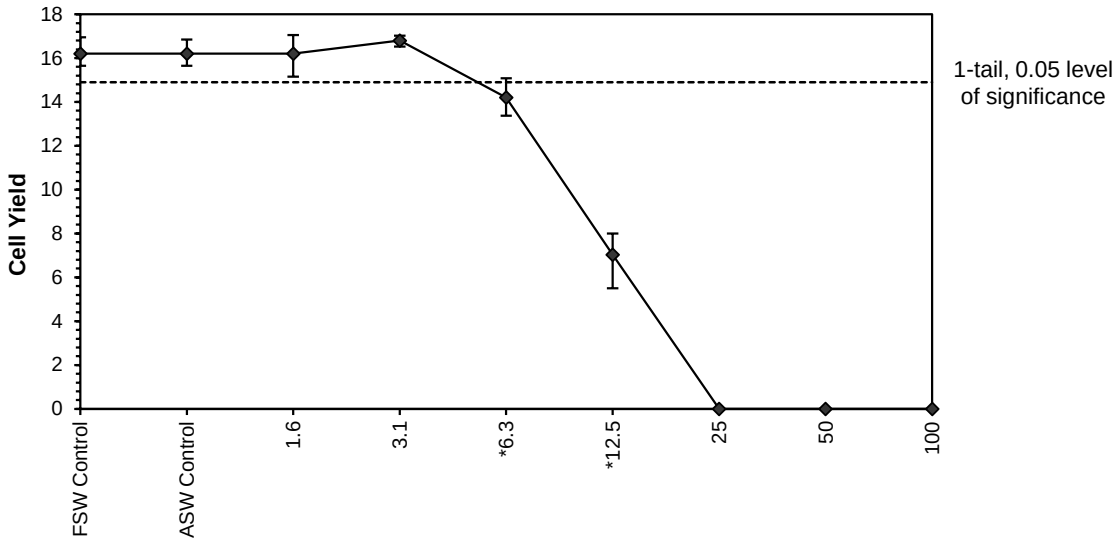
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 4.327 | 0.261 | 3.809 | 5.246 | 1.0171 |
| IC10 | 5.555 | 0.422 | 4.657 | 6.924 | 0.5458 |
| IC15 | 6.577 | 0.317 | 5.565 | 7.445 | -0.0710 |
| IC20 | 7.282 | 0.281 | 6.464 | 8.157 | 0.1657 |
| IC25 | 7.986 | 0.270 | 7.227 | 8.902 | 0.1962 |
| IC40 | 10.100 | 0.308 | 9.325 | 11.086 | 0.0566 |
| IC50 | 11.509 | 0.379 | 10.599 | 12.690 | 0.0422 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 18:10 | Test ID: | PR2029/11 | Sample ID: | IM-5327 |
| End Date: | 2/08/2021 18:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Dose-Response Plot



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 18:10 | Test ID: | PR2029/11 | Sample ID: | IM-5327 |
| End Date: | 2/08/2021 18:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 16.16 | 15.61 | 16.91 | 0.44 | 4.09 | 8 |
| ASW Control | | 16.16 | 15.61 | 16.81 | 0.55 | 4.59 | 4 |
| 1.6 | | 16.16 | 15.11 | 17.01 | 0.81 | 5.57 | 4 |
| 3.1 | | 16.78 | 16.51 | 17.01 | 0.21 | 2.71 | 4 |
| 6.3 | | 14.23 | 13.41 | 15.11 | 0.77 | 6.16 | 4 |
| 12.5 | | 7.03 | 5.51 | 8.01 | 1.18 | 15.42 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 18:00 | Test ID: | PR2029/13 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 18:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 18.970 | 18.270 | 19.170 | 17.770 | 17.670 | 18.970 | 19.970 | 18.470 |
| ASW Control | 17.970 | 17.270 | 18.370 | 17.070 | | | | |
| 1.6 | 18.070 | 17.770 | 18.970 | 18.370 | | | | |
| 3.1 | 18.770 | 18.970 | 19.370 | 18.870 | | | | |
| 6.3 | 14.970 | 12.770 | 10.470 | 13.370 | | | | |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

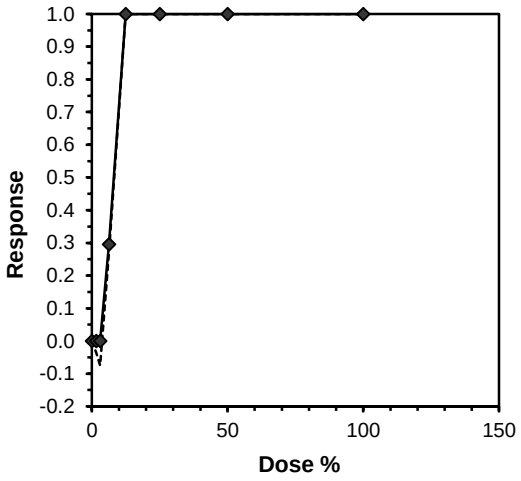
| | | | Transform: Untransformed | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 18.658 | 1.0559 | 18.658 | 17.670 | 19.970 | 4.116 | 8 | | | | |
| ASW Control | 17.670 | 1.0000 | 17.670 | 17.070 | 18.370 | 3.427 | 4 | * | | 18.320 | 1.0000 |
| 1.6 | 18.295 | 1.0354 | 18.295 | 17.770 | 18.970 | 2.800 | 4 | 22.50 | 10.00 | 18.320 | 1.0000 |
| 3.1 | 18.995 | 1.0750 | 18.995 | 18.770 | 19.370 | 1.385 | 4 | 26.00 | 10.00 | 18.320 | 1.0000 |
| *6.3 | 12.895 | 0.7298 | 12.895 | 10.470 | 14.970 | 14.458 | 4 | 10.00 | 10.00 | 12.895 | 0.7039 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.884713 | 0.887 | -0.49342 | 3.994247 |
| Bartlett's Test indicates equal variances (p = 0.02) | 10.36982 | 11.34487 | | |
| The control means are significantly different (p = 0.05) | 2.230091 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Linear Interpolation (200 Resamples)

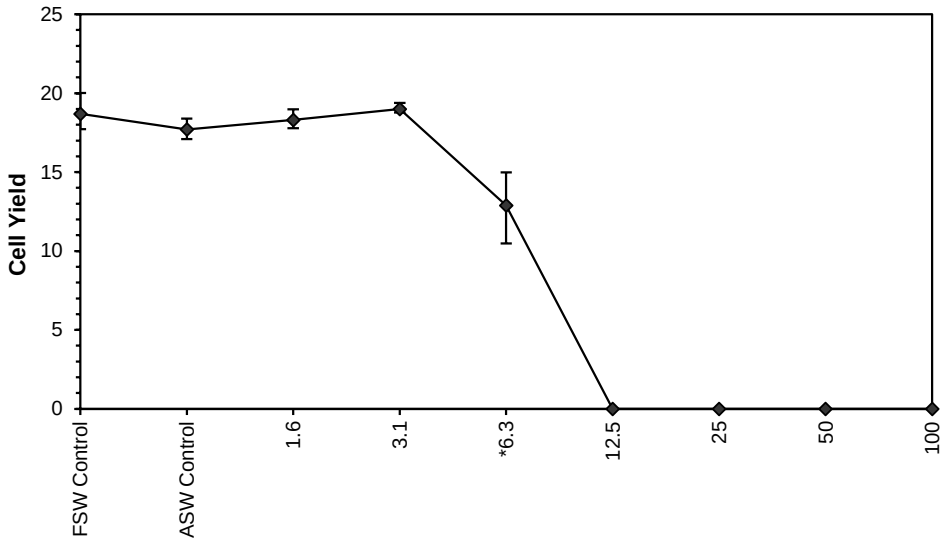
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.6403 | 0.0874 | 3.4663 | 3.9789 | 0.9880 |
| IC10 | 4.1807 | 0.1749 | 3.8326 | 4.8579 | 0.9880 |
| IC15 | 4.7210 | 0.2623 | 4.1989 | 5.7368 | 0.9880 |
| IC20 | 5.2613 | 0.3427 | 4.5652 | 6.6158 | 0.8214 |
| IC25 | 5.8016 | 0.3799 | 4.9315 | 7.0328 | 0.3581 |
| IC40 | 7.2150 | 0.3290 | 6.1846 | 8.0894 | -0.2693 |
| IC50 | 8.0959 | 0.2743 | 7.2372 | 8.8245 | -0.2738 |



**Microalgal Cell Yield-Cell Yield**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 18:00 | Test ID: | PR2029/13 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 18:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 18:00 | Test ID: | PR2029/13 | Sample ID: | Y003082021 |
| End Date: | 9/08/2021 18:00 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 18.66 | 17.67 | 19.97 | 0.77 | 4.70 | 8 |
| ASW Control | | 17.67 | 17.07 | 18.37 | 0.61 | 4.40 | 4 |
| 1.6 | | 18.30 | 17.77 | 18.97 | 0.51 | 3.91 | 4 |
| 3.1 | | 19.00 | 18.77 | 19.37 | 0.26 | 2.70 | 4 |
| 6.3 | | 12.90 | 10.47 | 14.97 | 1.86 | 10.59 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 1.68 | 0.00 | 6.70 | 3.35 | 109.27 | 4 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 18:00 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 18:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| FSW Control | 18.361 | 17.361 | 16.861 | 18.161 | 18.261 | 17.061 | 17.661 |
| ASW Control | 16.861 | 18.161 | 18.261 | 16.761 | | | |
| 1.6 | 17.361 | 18.261 | 17.161 | 17.261 | | | |
| 3.1 | 18.761 | 18.361 | 17.261 | 17.061 | | | |
| 6.3 | 12.761 | 13.761 | 12.261 | 11.161 | | | |
| 12.5 | 5.861 | 2.761 | 1.161 | 2.361 | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | |

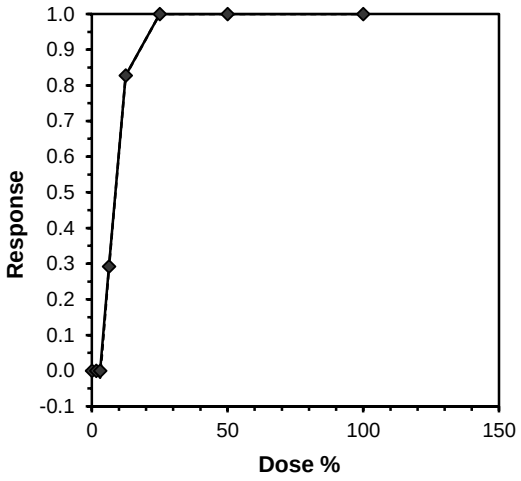
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 17.675 | 1.0094 | 17.675 | 16.861 | 18.361 | 3.417 | 7 | | | | | |
| ASW Control | 17.511 | 1.0000 | 17.511 | 16.761 | 18.261 | 4.628 | 4 | * | | | 17.627 | 1.0000 |
| 1.6 | 17.511 | 1.0000 | 17.511 | 17.161 | 18.261 | 2.893 | 4 | 0.000 | 2.360 | 1.943 | 17.627 | 1.0000 |
| 3.1 | 17.861 | 1.0200 | 17.861 | 17.061 | 18.761 | 4.640 | 4 | -0.425 | 2.360 | 1.943 | 17.627 | 1.0000 |
| *6.3 | 12.486 | 0.7130 | 12.486 | 11.161 | 13.761 | 8.660 | 4 | 6.103 | 2.360 | 1.943 | 12.486 | 0.7083 |
| *12.5 | 3.036 | 0.1734 | 3.036 | 1.161 | 5.861 | 65.962 | 4 | 17.582 | 2.360 | 1.943 | 3.036 | 0.1722 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.945059 | 0.905 | 0.838036 | 1.794875 |
| Bartlett's Test indicates equal variances (p = 0.23) | 5.64632 | 13.2767 | | |
| The control means are not significantly different (p = 0.71) | 0.385595 | 2.262157 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 1.943003 | 0.110962 | 161.5543 | 1.355667 | 3.6E-11 | 4, 15 |
| Treatments vs ASW Control | | | | | | | | | | |

### Linear Interpolation (200 Resamples)

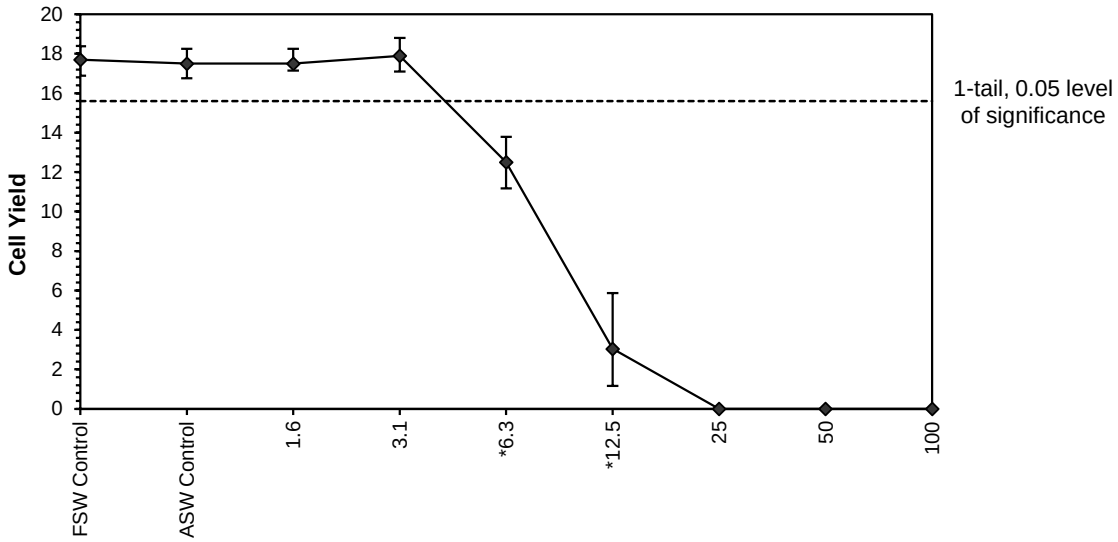
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.6485 | 0.1281 | 3.0738 | 3.7977 | -2.4820 |
| IC10 | 4.1971 | 0.1382 | 3.6429 | 4.4954 | -0.4183 |
| IC15 | 4.7456 | 0.1743 | 4.1095 | 5.1931 | 0.0585 |
| IC20 | 5.2941 | 0.2182 | 4.6220 | 5.9036 | 0.2228 |
| IC25 | 5.8426 | 0.2642 | 5.0753 | 6.6135 | 0.2408 |
| IC40 | 7.5526 | 0.3140 | 6.6263 | 8.4938 | 0.2480 |
| IC50 | 8.7091 | 0.3609 | 7.8681 | 9.9058 | 0.9031 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 18:00 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 18:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 18:00 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 23/08/2021 18:00 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 17.67 | 16.86 | 18.36 | 0.60 | 4.40 | 7 |
| ASW Control | | 17.51 | 16.76 | 18.26 | 0.81 | 5.14 | 4 |
| 1.6 | | 17.51 | 17.16 | 18.26 | 0.51 | 4.06 | 4 |
| 3.1 | | 17.86 | 17.06 | 18.76 | 0.83 | 5.10 | 4 |
| 6.3 | | 12.49 | 11.16 | 13.76 | 1.08 | 8.33 | 4 |
| 12.5 | | 3.04 | 1.16 | 5.86 | 2.00 | 46.62 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/12 | Sample ID: | IM-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.4000 | 0.0000 | 0.0000 | 0.2000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

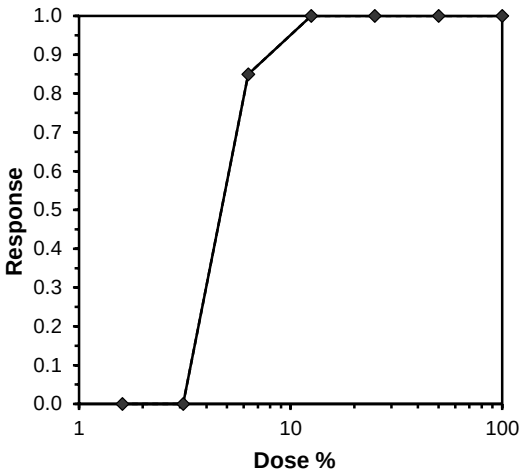
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *6.3 | 0.1500 | 0.1500 | 0.3998 | 0.2255 | 0.6847 | 55.174 | 4 | 10.00 | 10.00 | 0.1500 | 0.1500 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.6604 | 0.887 | 1.013954 | 5.176551 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

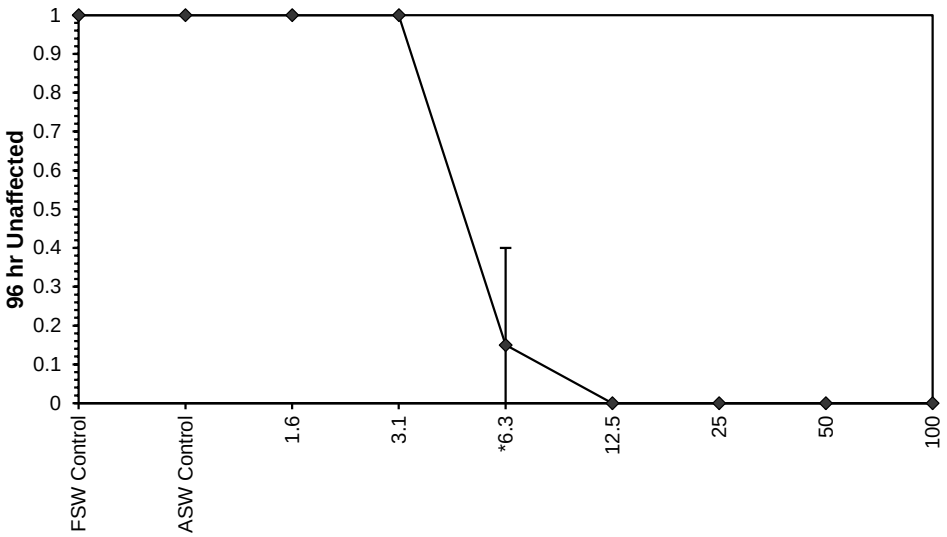
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 4.7045 | 0.2277 | 3.5596 | 4.9743 | -1.9274 |
| IC10 | 4.9336 | 0.2634 | 3.6111 | 5.2483 | -1.9162 |
| IC15 | 5.0801 | 0.2866 | 3.6425 | 5.4242 | -1.9093 |
| IC20 | 5.1927 | 0.3047 | 3.6658 | 5.5599 | -1.9041 |
| IC25 | 5.2873 | 0.3200 | 3.6849 | 5.6740 | -1.8998 |
| IC40 | 5.5213 | 0.3582 | 3.7301 | 5.9574 | -1.8893 |
| IC50 | 5.6622 | 0.3815 | 3.7560 | 6.1286 | -1.8832 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/12 | Sample ID: | IM-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/12 | Sample ID: | IM-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 15.00 | 0.00 | 40.00 | 19.15 | 29.17 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/12 | Sample ID: | IM-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.4000 | 0.0000 | 0.0000 | 0.2000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

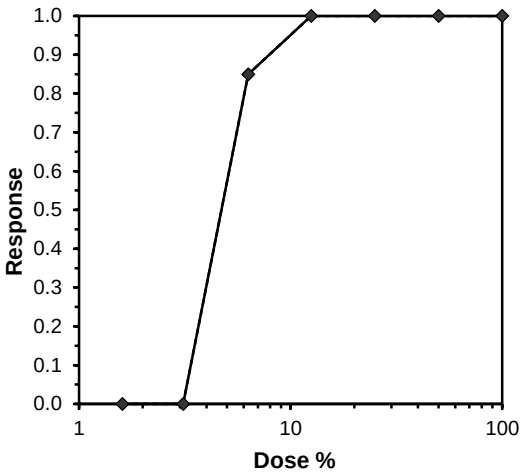
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *6.3 | 0.1500 | 0.1500 | 0.3998 | 0.2255 | 0.6847 | 55.174 | 4 | 10.00 | 10.00 | 17 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.6604 | 0.887 | 1.013954 | 5.176551 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

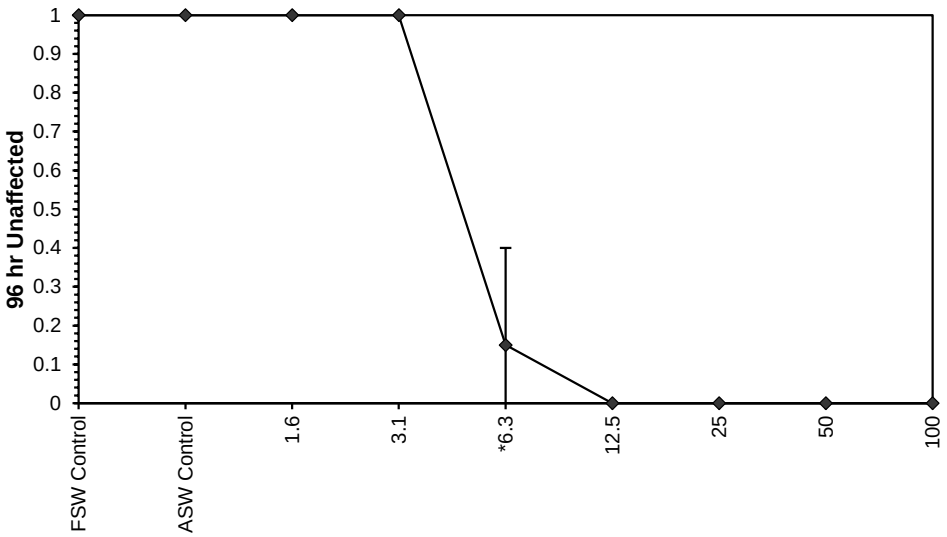
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 4.9064 | 4.3895 | 5.4842 |
| 5.0% | 4.8032 | 4.2722 | 5.4003 |
| 10.0% | 4.7322 | 4.2403 | 5.2811 |
| 20.0% | 4.7046 | 4.3500 | 5.0882 |
| Auto-0.0% | 4.9064 | 4.3895 | 5.4842 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/12 | Sample ID: | IM-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/12 | Sample ID: | IM-5327 |
| End Date: | 3/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 15.00 | 0.00 | 40.00 | 19.15 | 29.17 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/27 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.4000 | 0.2000 | 0.2000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

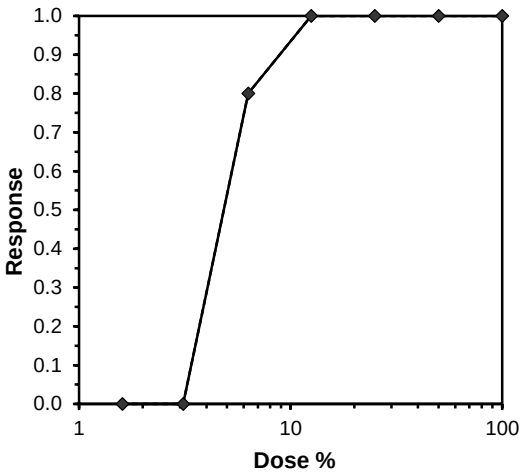
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *6.3 | 0.2000 | 0.2000 | 0.4594 | 0.2255 | 0.6847 | 40.823 | 4 | 10.00 | 10.00 | 0.2000 | 0.2000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.521878 | 0.887 | -0.17426 | 7.507724 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

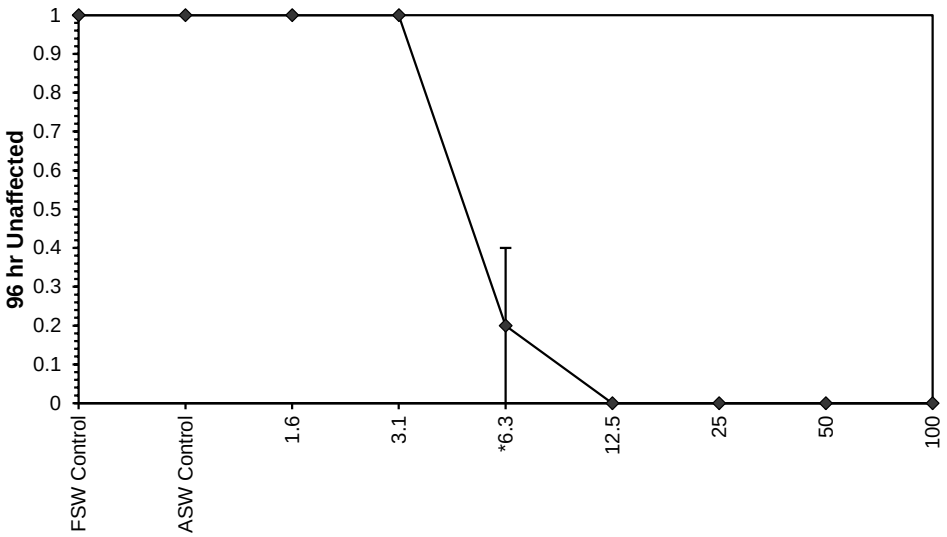
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 4.7667 | 0.1037 | 4.5413 | 5.0157 | -2.1697 |
| IC10 | 5.0061 | 0.1206 | 4.7438 | 5.2969 | -2.1313 |
| IC15 | 5.1593 | 0.1316 | 4.8728 | 5.4774 | -2.1077 |
| IC20 | 5.2772 | 0.1402 | 4.9718 | 5.6168 | -2.0902 |
| IC25 | 5.3763 | 0.1475 | 5.0549 | 5.7341 | -2.0757 |
| IC40 | 5.6215 | 0.1659 | 5.2597 | 6.0255 | -2.0413 |
| IC50 | 5.7693 | 0.1772 | 5.3827 | 6.2017 | -2.0213 |



**Fish Imbalance Test-96 hr Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/27 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/27 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 20.00 | 0.00 | 40.00 | 16.33 | 20.21 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | Conductivity uS/cm | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/27 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.4000 | 0.2000 | 0.2000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

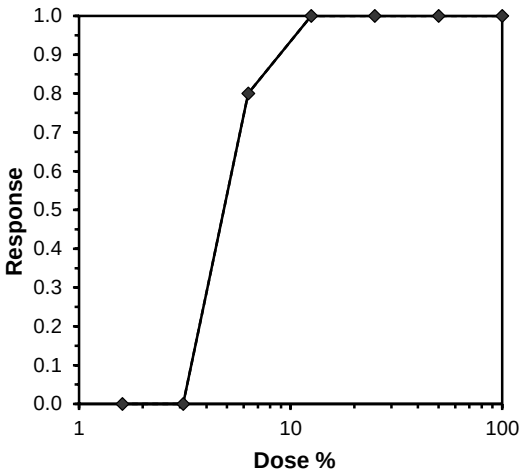
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *6.3 | 0.2000 | 0.2000 | 0.4594 | 0.2255 | 0.6847 | 40.823 | 4 | 10.00 | 10.00 | 16 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.521878 | 0.887 | -0.17426 | 7.507724 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

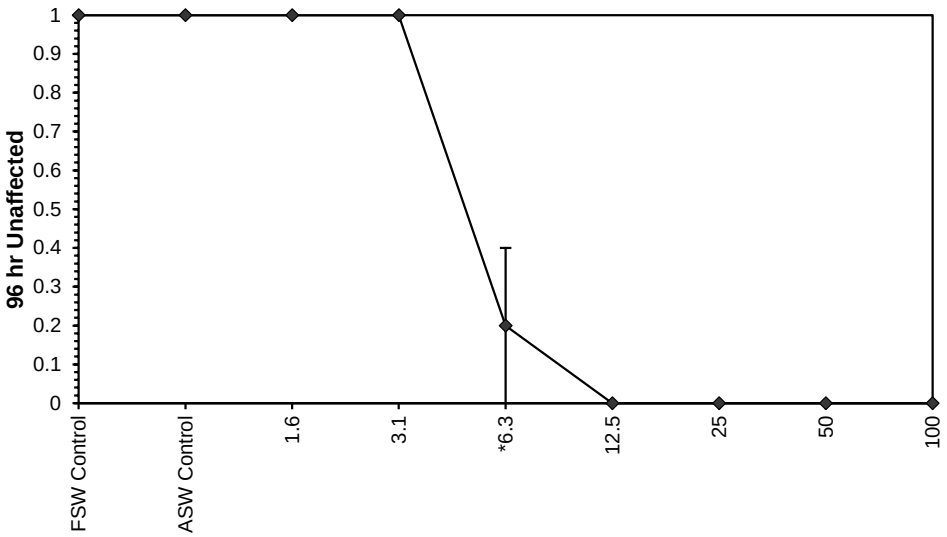
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 5.0805 | 4.4848 | 5.7553 |
| 5.0% | 4.9846 | 4.3570 | 5.7028 |
| 10.0% | 4.9062 | 4.2738 | 5.6320 |
| 20.0% | 4.8289 | 4.3733 | 5.3320 |
| Auto-0.0% | 5.0805 | 4.4848 | 5.7553 |



**Fish Imbalance Test-96 hr Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/27 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/27 | Sample ID: | Y003082021 |
| End Date: | 10/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 20.00 | 0.00 | 40.00 | 16.33 | 20.21 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | Conductivity uS/cm | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 0.8000 | 1.0000 | 0.6000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

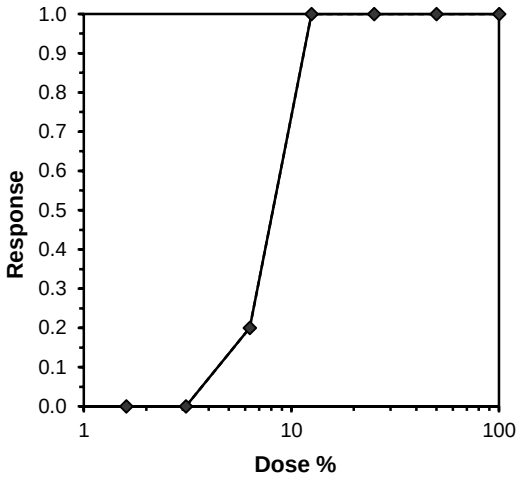
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 0.8000 | 1.1114 | 0.8861 | 1.3453 | 16.874 | 4 | 12.00 | 10.00 | 0.8000 | 0.8000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.521878 | 0.887 | 0.174262 | 7.507724 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

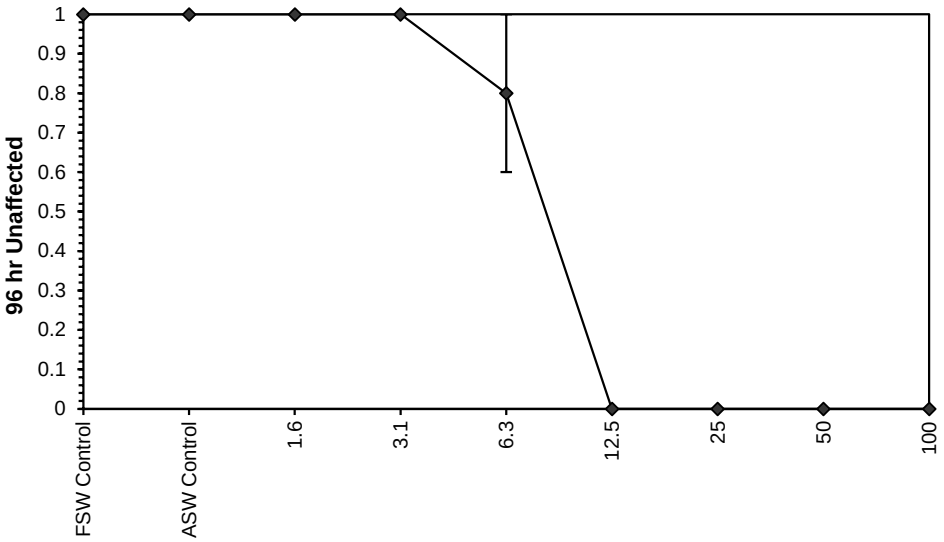
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 5.5077 | 0.3208 | 5.0868 | 6.7754 | 4.6773 |
| IC10 | 5.8763 | 0.3228 | 5.3798 | 7.0041 | 3.8035 |
| IC15 | 6.1149 | 0.3139 | 5.5681 | 7.1482 | 3.6024 |
| IC20 | 6.3000 | 0.3025 | 5.7135 | 7.2578 | 3.6848 |
| IC25 | 6.4229 | 0.2940 | 5.8561 | 7.3693 | 3.8154 |
| IC40 | 6.7275 | 0.2816 | 6.2006 | 7.6441 | 3.8715 |
| IC50 | 6.9114 | 0.2754 | 6.3943 | 7.8090 | 3.8452 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 80.00 | 60.00 | 100.00 | 16.33 | 5.05 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 0.8000 | 1.0000 | 0.6000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

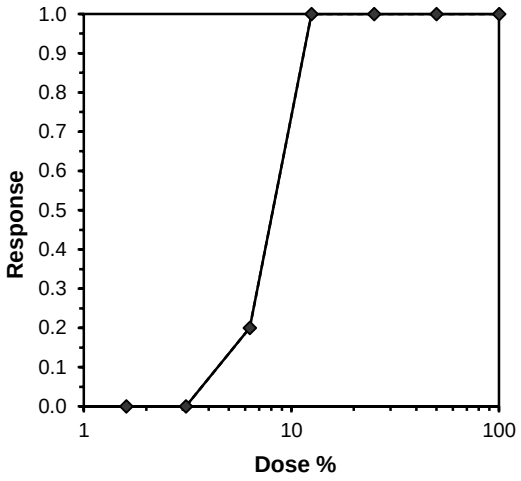
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 0.8000 | 0.8000 | 1.1114 | 0.8861 | 1.3453 | 16.874 | 4 | 12.00 | 10.00 | 4 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.521878 | 0.887 | 0.174262 | 7.507724 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

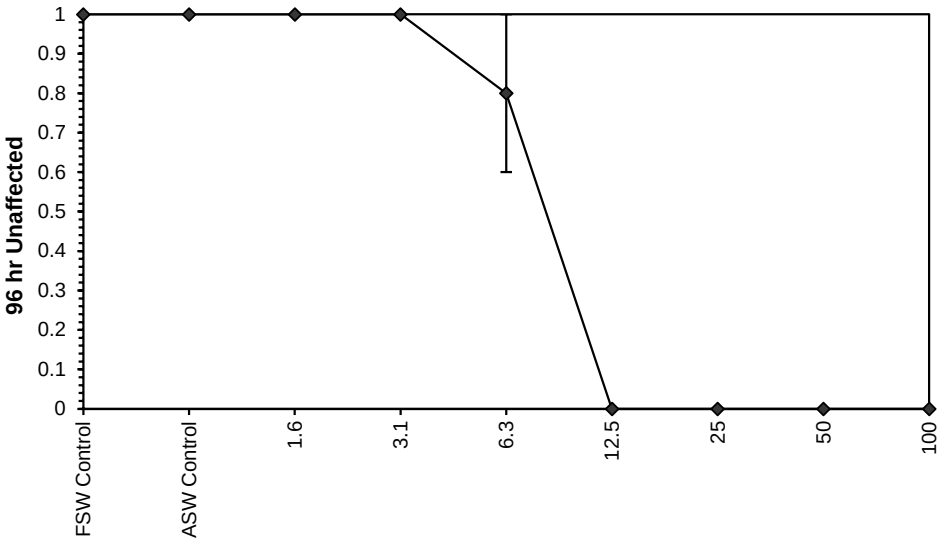
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 7.7192 | 6.8141 | 8.7444 |
| 5.0% | 7.8764 | 6.8289 | 9.0846 |
| 10.0% | 8.0099 | 6.7273 | 9.5372 |
| 20.0% | 8.1457 | 7.4019 | 8.9643 |
| Auto-0.0% | 7.7192 | 6.8141 | 8.7444 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/11 | Sample ID: | A1-5327 |
| End Date: | 24/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 80.00 | 60.00 | 100.00 | 16.33 | 5.05 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/15 | Sample ID: | MI-5327 |
| End Date: | 6/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 15.600 | 16.280 | 14.380 | 15.920 |
| ASW Control | 16.080 | 14.180 | 23.680 | 13.980 |
| 1.6 | 17.020 | 15.640 | 14.900 | 16.940 |
| 3.1 | 14.980 | 13.780 | 13.900 | 14.020 |
| 6.3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

| | | | Transform: Untransformed | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 15.545 | 0.9155 | 15.545 | 14.380 | 16.280 | 5.306 | 4 | | | | |
| ASW Control | 16.980 | 1.0000 | 16.980 | 13.980 | 23.680 | 26.889 | 4 | * | | 16.980 | 1.0000 |
| 1.6 | 16.125 | 0.9496 | 16.125 | 14.900 | 17.020 | 6.406 | 4 | 20.00 | 11.00 | 16.125 | 0.9496 |
| 3.1 | 14.170 | 0.8345 | 14.170 | 13.780 | 14.980 | 3.873 | 4 | 13.00 | 11.00 | 14.170 | 0.8345 |
| 6.3 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |

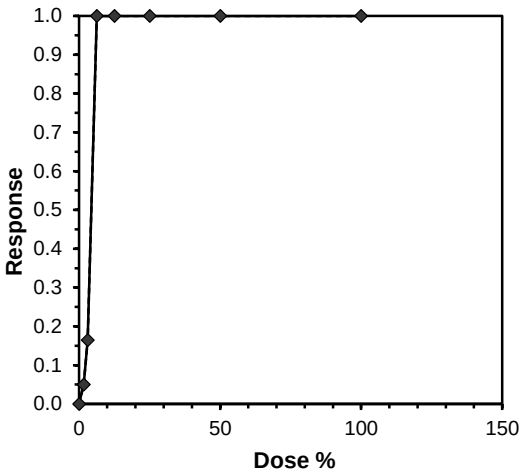
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.804848 | 0.859 | 1.834935 | 5.248119 |
| Bartlett's Test indicates unequal variances (p = 4.69E-03) | 10.72429 | 9.21034 | | |
| The control means are not significantly different (p = 0.56) | 0.618571 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05* | 1.5888 | 0.8560 | 0.0000 | 3.7669 | 0.0216 |
| IC10 | 2.2468 | 0.8748 | 0.0000 | 3.8529 | -0.3698 |
| IC15 | 2.8982 | 0.7999 | 0.0000 | 3.7331 | -0.9421 |
| IC20 | 3.2323 | 0.6909 | 0.0000 | 3.8037 | -1.4048 |
| IC25 | 3.4241 | 0.5421 | 0.3390 | 3.9597 | -2.0843 |
| IC40 | 3.9993 | 0.2453 | 2.9625 | 4.4278 | -1.0480 |
| IC50 | 4.3827 | 0.2031 | 3.5187 | 4.7398 | -0.9935 |

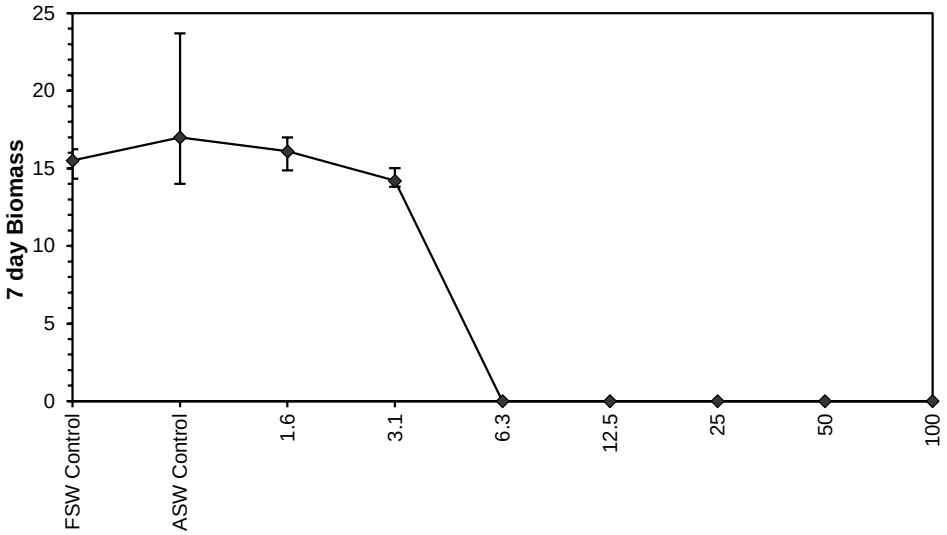
* indicates IC estimate less than the lowest concentration



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/15 | Sample ID: | MI-5327 |
| End Date: | 6/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/15 | Sample ID: | MI-5327 |
| End Date: | 6/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 15.55 | 14.38 | 16.28 | 0.82 | 5.84 | 4 |
| ASW Control | | 16.98 | 13.98 | 23.68 | 4.57 | 12.58 | 4 |
| 1.6 | | 16.13 | 14.90 | 17.02 | 1.03 | 6.30 | 4 |
| 3.1 | | 14.17 | 13.78 | 14.98 | 0.55 | 5.23 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/15 | Sample ID: | MI-5327 |
| End Date: | 6/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

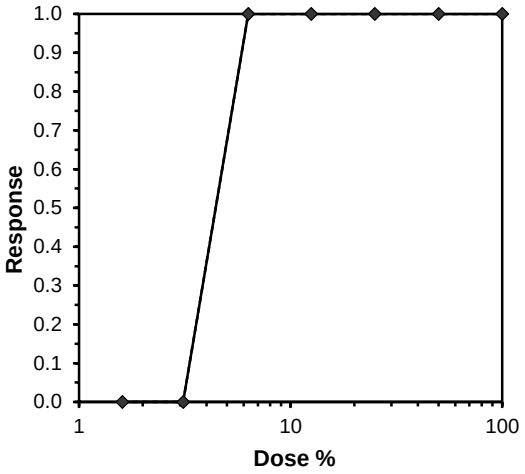
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 1 | 0.859 | | |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

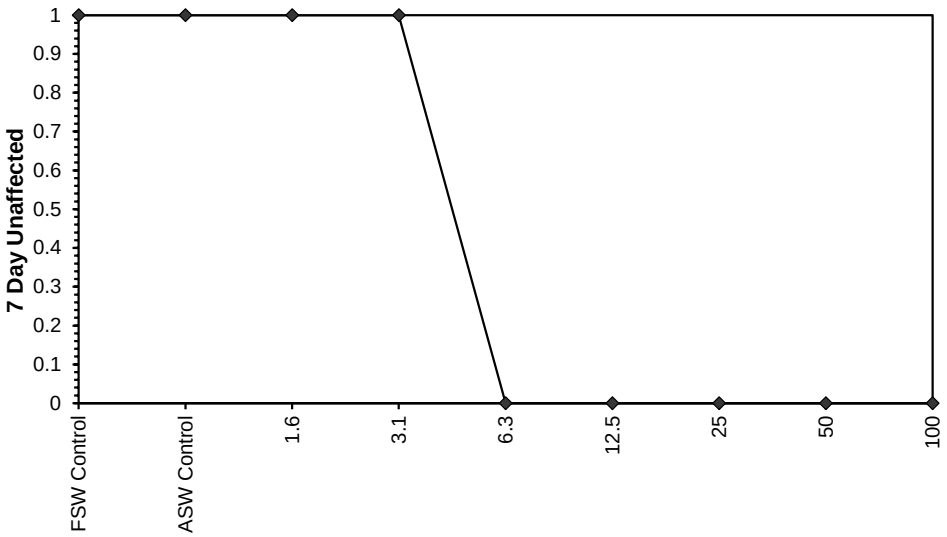
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.9889 | 0.0000 | 3.9889 | 3.9889 | 1.0076 |
| IC10 | 4.1070 | 0.0000 | 4.1070 | 4.1070 | -1.0076 |
| IC15 | 4.1816 | 0.0000 | 4.1816 | 4.1816 | -1.0076 |
| IC20 | 4.2384 | 0.0000 | 4.2384 | 4.2384 | 1.0076 |
| IC25 | 4.2858 | 0.0000 | 4.2858 | 4.2858 | #DIV/0! |
| IC40 | 4.4018 | 0.0000 | 4.4018 | 4.4018 | 1.0076 |
| IC50 | 4.4708 | 0.0000 | 4.4708 | 4.4708 | -1.0076 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/15 | Sample ID: | MI-5327 |
| End Date: | 6/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 30/07/2021 19:00 | Test ID: | PR2029/15 | Sample ID: | MI-5327 |
| End Date: | 6/08/2021 19:00 | Lab ID: | 10165 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 15.55 | 14.38 | 16.28 | 0.82 | 5.84 | 4 |
| ASW Control | | 16.98 | 13.98 | 23.68 | 4.57 | 12.58 | 4 |
| 1.6 | | 16.13 | 14.90 | 17.02 | 1.03 | 6.30 | 4 |
| 3.1 | | 14.17 | 13.78 | 14.98 | 0.55 | 5.23 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| 100 | | 6.30 | 6.30 | 6.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 25 | | 96.90 | 96.90 | 96.90 | 0.00 | 0.00 | 1 |
| 50 | | 95.00 | 95.00 | 95.00 | 0.00 | 0.00 | 1 |
| 100 | | 78.30 | 78.30 | 78.30 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 16.940 | 17.340 | 17.380 | 17.220 |
| ASW Control | 17.580 | 17.860 | 17.580 | 17.140 |
| 1.6 | 16.380 | 15.980 | 18.080 | 17.460 |
| 3.1 | 15.960 | 14.180 | 15.800 | 14.240 |
| 6.3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

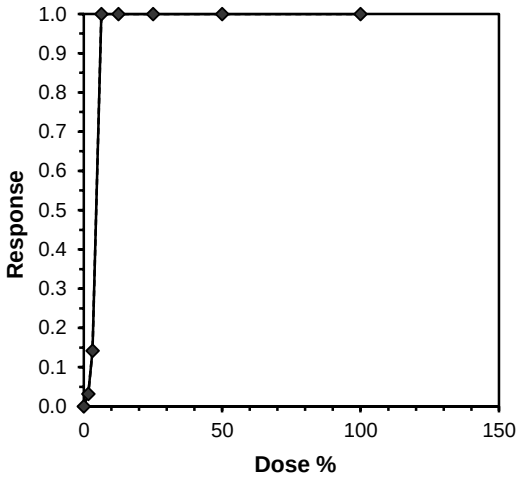
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 17.220 | 0.9818 | 17.220 | 16.940 | 17.380 | 1.154 | 4 | | | | | |
| ASW Control | 17.540 | 1.0000 | 17.540 | 17.140 | 17.860 | 1.696 | 4 | * | | | 17.540 | 1.0000 |
| 1.6 | 16.975 | 0.9678 | 16.975 | 15.980 | 18.080 | 5.692 | 4 | 0.989 | 2.180 | 1.245 | 16.975 | 0.9678 |
| *3.1 | 15.045 | 0.8578 | 15.045 | 14.180 | 15.960 | 6.425 | 4 | 4.369 | 2.180 | 1.245 | 15.045 | 0.8578 |
| 6.3 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.93722 | 0.859 | 0.073904 | -1.43569 |
| Bartlett's Test indicates equal variances (p = 0.19) | 3.340829 | 9.21034 | | |
| The control means are not significantly different (p = 0.12) | 1.788854 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 1.24485 | 0.070972 | 6.8461 | 0.652156 | 0.00444 | 2, 9 |

### Linear Interpolation (200 Resamples)

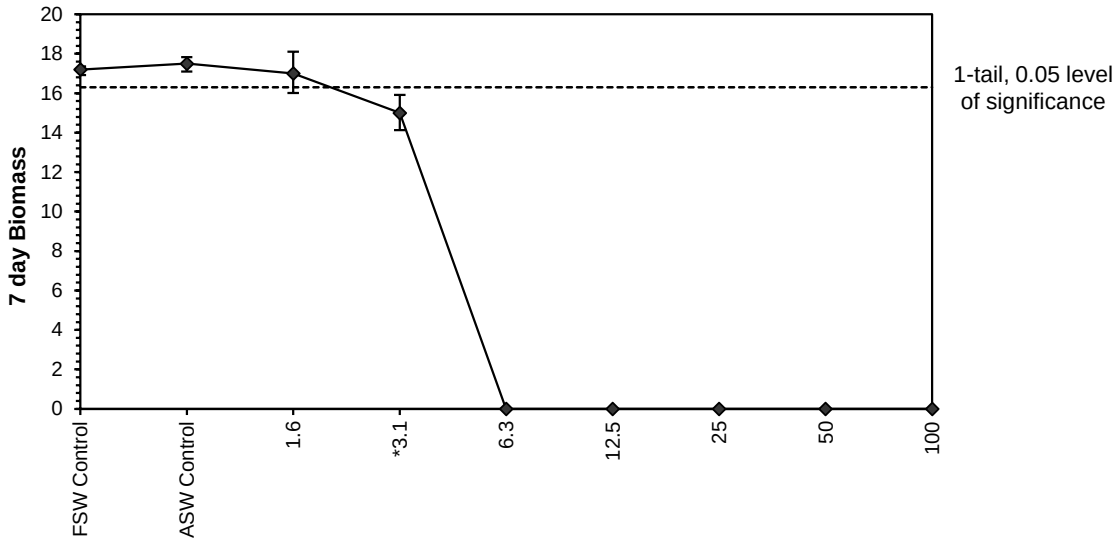
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.8425 | 0.3359 | 0.4305 | 2.5257 | -0.7866 |
| IC10 | 2.5241 | 0.2850 | 1.5938 | 3.4840 | 0.1884 |
| IC15 | 3.1289 | 0.1569 | 2.5033 | 3.4034 | -0.7034 |
| IC20 | 3.3155 | 0.0834 | 3.0664 | 3.5738 | 0.2038 |
| IC25 | 3.5020 | 0.0782 | 3.2685 | 3.7442 | 0.2038 |
| IC40 | 4.0616 | 0.0625 | 3.8748 | 4.2553 | 0.2038 |
| IC50 | 4.4347 | 0.0521 | 4.2790 | 4.5961 | 0.2038 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.22 | 16.94 | 17.38 | 0.20 | 2.59 | 4 |
| ASW Control | | 17.54 | 17.14 | 17.86 | 0.30 | 3.11 | 4 |
| 1.6 | | 16.98 | 15.98 | 18.08 | 0.97 | 5.79 | 4 |
| 3.1 | | 15.05 | 14.18 | 15.96 | 0.97 | 6.54 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

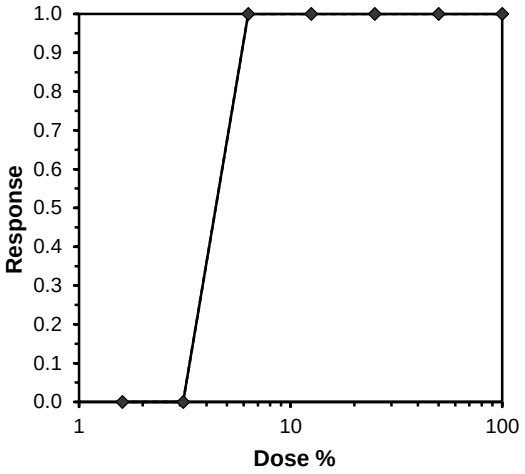
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 1 | 0.859 | | |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

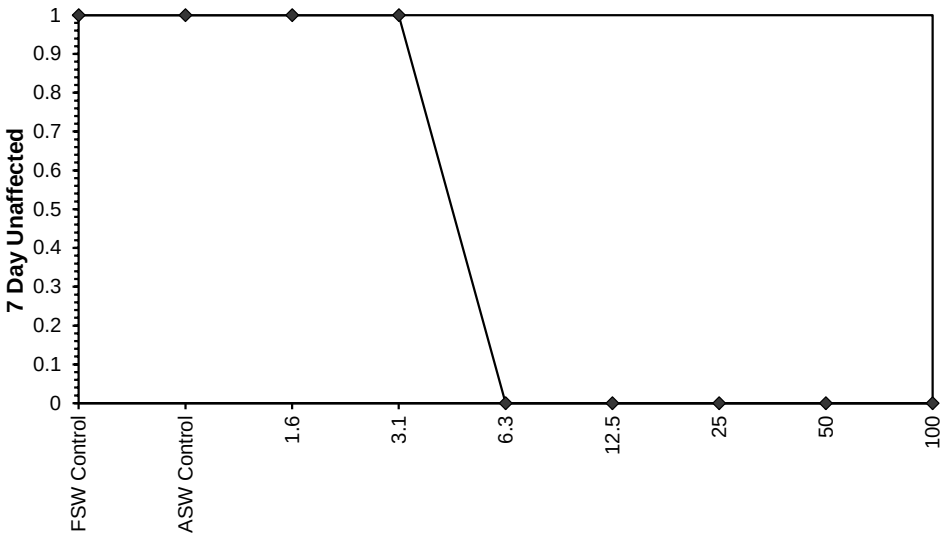
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.9889 | 0.0000 | 3.9889 | 3.9889 | 1.0076 |
| IC10 | 4.1070 | 0.0000 | 4.1070 | 4.1070 | -1.0076 |
| IC15 | 4.1816 | 0.0000 | 4.1816 | 4.1816 | -1.0076 |
| IC20 | 4.2384 | 0.0000 | 4.2384 | 4.2384 | 1.0076 |
| IC25 | 4.2858 | 0.0000 | 4.2858 | 4.2858 | #DIV/0! |
| IC40 | 4.4018 | 0.0000 | 4.4018 | 4.4018 | 1.0076 |
| IC50 | 4.4708 | 0.0000 | 4.4708 | 4.4708 | -1.0076 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.22 | 16.94 | 17.38 | 0.20 | 2.59 | 4 |
| ASW Control | | 17.54 | 17.14 | 17.86 | 0.30 | 3.11 | 4 |
| 1.6 | | 16.98 | 15.98 | 18.08 | 0.97 | 5.79 | 4 |
| 3.1 | | 15.05 | 14.18 | 15.96 | 0.97 | 6.54 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

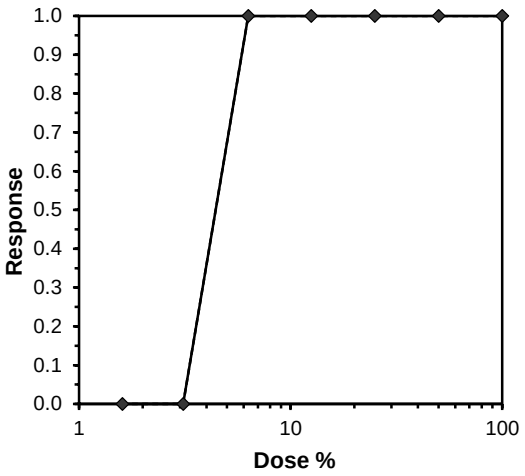
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 0 | 20 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 1 | 0.859 | | |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

**Graphical Method**

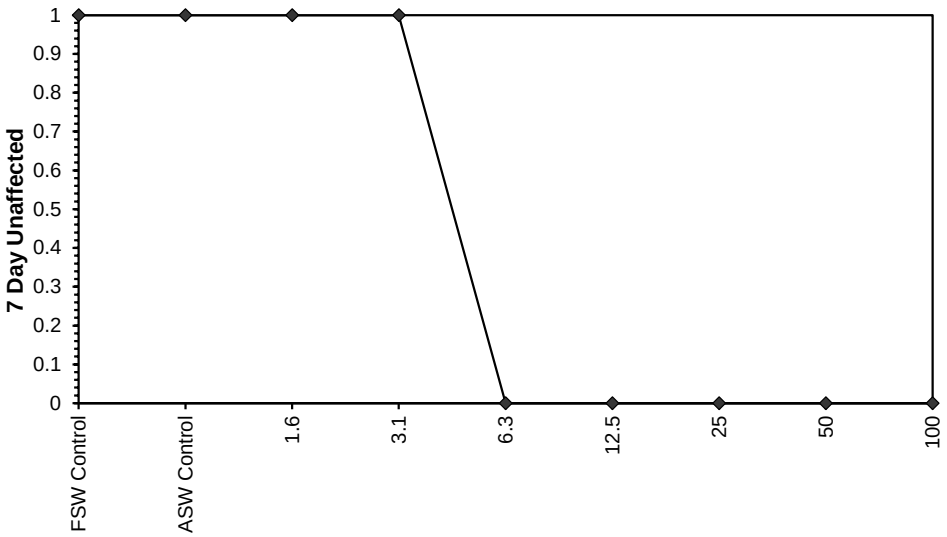
| Trim Level | EC50 |
|---|---|
| 0.0% | 4.4193 |
| | 4.4193 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 6/08/2021 19:30 | Test ID: | PR2029/8 | Sample ID: | Y003082021 |
| End Date: | 13/08/2021 19:30 | Lab ID: | 10167 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.22 | 16.94 | 17.38 | 0.20 | 2.59 | 4 |
| ASW Control | | 17.54 | 17.14 | 17.86 | 0.30 | 3.11 | 4 |
| 1.6 | | 16.98 | 15.98 | 18.08 | 0.97 | 5.79 | 4 |
| 3.1 | | 15.05 | 14.18 | 15.96 | 0.97 | 6.54 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 25 | | 7.20 | 7.20 | 7.20 | 0.00 | 0.00 | 1 |
| 50 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 100 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.80 | 99.80 | 99.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 25 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 50 | | 96.30 | 96.30 | 96.30 | 0.00 | 0.00 | 1 |
| 100 | | 85.00 | 85.00 | 85.00 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 17.580 | 17.920 | 16.120 | 16.980 |
| ASW Control | 16.940 | 17.440 | 15.980 | 16.280 |
| 1.6 | 17.580 | 16.980 | 18.240 | 18.280 |
| 3.1 | 16.980 | 17.920 | 18.080 | 16.940 |
| 6.3 | 8.660 | 9.260 | 11.360 | 11.500 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

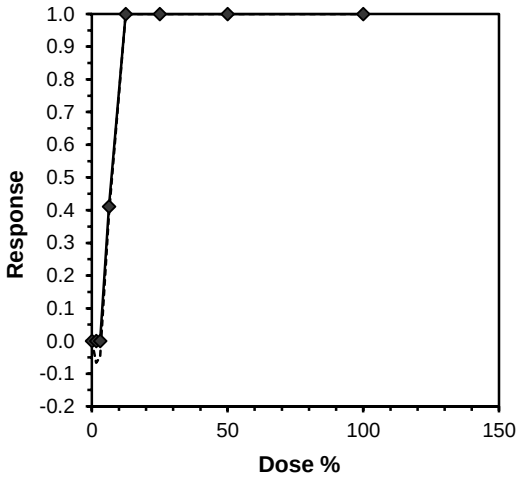
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 17.150 | 1.0294 | 17.150 | 16.120 | 17.920 | 4.601 | 4 | | | | | |
| ASW Control | 16.660 | 1.0000 | 16.660 | 15.980 | 17.440 | 3.942 | 4 | * | | | 17.303 | 1.0000 |
| 1.6 | 17.770 | 1.0666 | 17.770 | 16.980 | 18.280 | 3.471 | 4 | -1.735 | 2.290 | 1.465 | 17.303 | 1.0000 |
| 3.1 | 17.480 | 1.0492 | 17.480 | 16.940 | 18.080 | 3.457 | 4 | -1.282 | 2.290 | 1.465 | 17.303 | 1.0000 |
| *6.3 | 10.195 | 0.6119 | 10.195 | 8.660 | 11.500 | 14.204 | 4 | 10.107 | 2.290 | 1.465 | 10.195 | 0.5892 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.964738 | 0.887 | -0.10759 | -0.80537 |
| Bartlett's Test indicates equal variances (p = 0.34) | 3.353989 | 11.34487 | | |
| The control means are not significantly different (p = 0.38) | 0.954686 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 1.464877 | 0.087928 | 51.41223 | 0.818392 | 1.3E-07 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Linear Interpolation (200 Resamples)

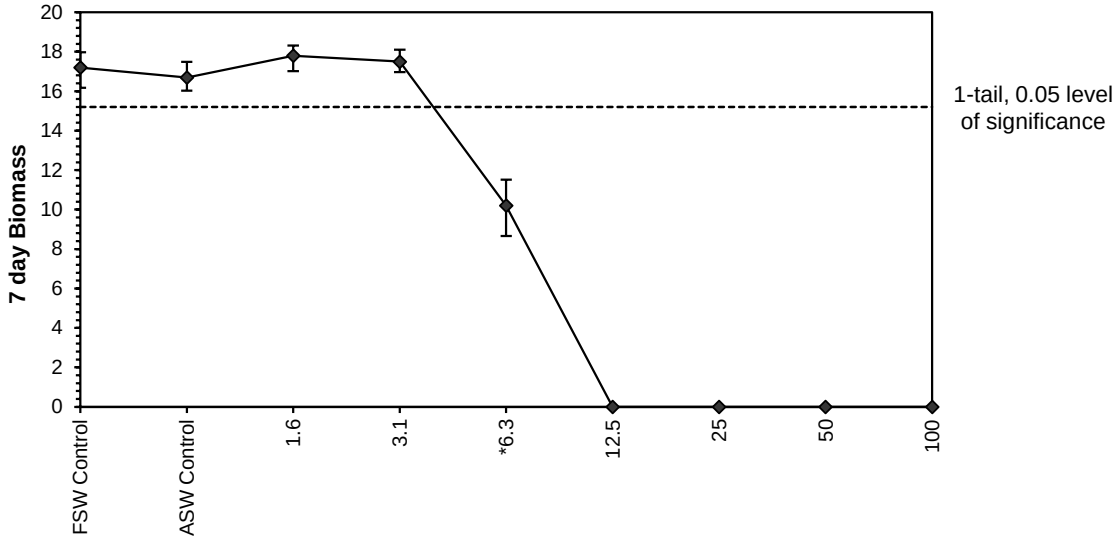
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.4895 | 0.0553 | 3.2187 | 3.5923 | -1.2067 |
| IC10 | 3.8790 | 0.0763 | 3.6126 | 4.0991 | -0.0520 |
| IC15 | 4.2684 | 0.1047 | 3.9617 | 4.6058 | 0.2572 |
| IC20 | 4.6579 | 0.1360 | 4.2696 | 5.1126 | 0.3312 |
| IC25 | 5.0474 | 0.1686 | 4.6053 | 5.6440 | 0.3491 |
| IC40 | 6.2158 | 0.2779 | 5.5084 | 7.1875 | 0.3269 |
| IC50 | 7.2386 | 0.3156 | 6.1413 | 8.0877 | -0.3038 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 70.00 | 60.00 | 80.00 | 11.55 | 4.85 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.15 | 16.12 | 17.92 | 0.79 | 5.18 | 4 |
| ASW Control | | 16.66 | 15.98 | 17.44 | 0.66 | 4.86 | 4 |
| 1.6 | | 17.77 | 16.98 | 18.28 | 0.62 | 4.42 | 4 |
| 3.1 | | 17.48 | 16.94 | 18.08 | 0.60 | 4.45 | 4 |
| 6.3 | | 10.20 | 8.66 | 11.50 | 1.45 | 11.80 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.6000 | 0.6000 | 0.8000 | 0.8000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

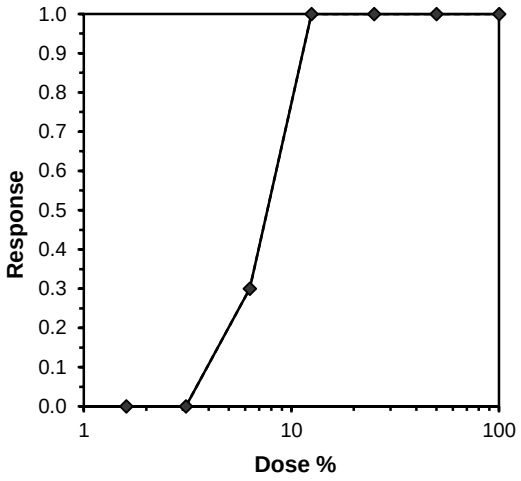
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *6.3 | 0.7000 | 0.7000 | 0.9966 | 0.8861 | 1.1071 | 12.807 | 4 | 10.00 | 10.00 | 0.7000 | 0.7000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.696557 | 0.887 | 0 | 1.895604 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

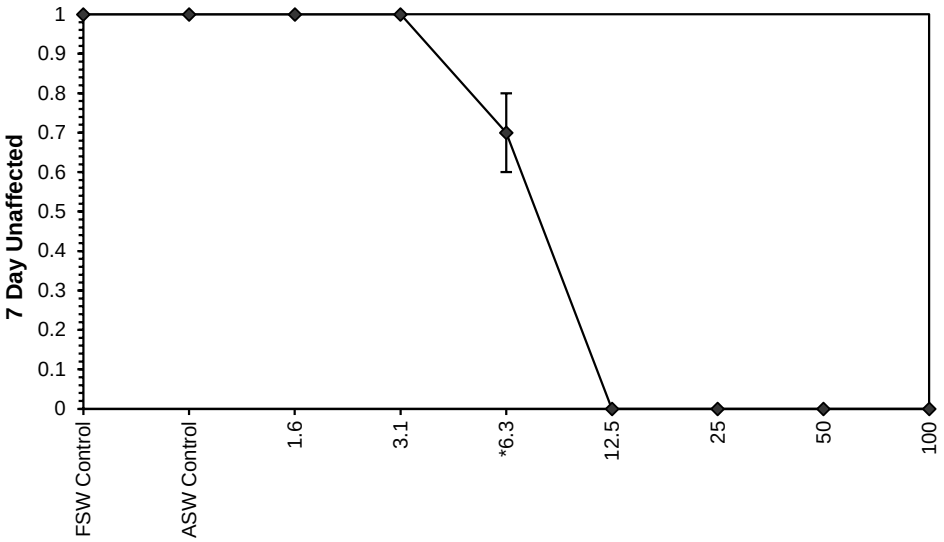
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 5.3168 | 0.0793 | 5.0999 | 5.6223 | 0.5130 |
| IC10 | 5.6509 | 0.0935 | 5.3957 | 6.0115 | 0.5173 |
| IC15 | 5.8666 | 0.1030 | 5.5859 | 6.2639 | 0.5200 |
| IC20 | 6.0336 | 0.1104 | 5.7329 | 6.4599 | 0.5220 |
| IC25 | 6.1745 | 0.1117 | 5.8567 | 6.5719 | 0.3311 |
| IC40 | 6.4999 | 0.1045 | 6.1801 | 6.8641 | 0.2160 |
| IC50 | 6.6881 | 0.1026 | 6.3739 | 7.0454 | 0.2144 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 70.00 | 60.00 | 80.00 | 11.55 | 4.85 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.15 | 16.12 | 17.92 | 0.79 | 5.18 | 4 |
| ASW Control | | 16.66 | 15.98 | 17.44 | 0.66 | 4.86 | 4 |
| 1.6 | | 17.77 | 16.98 | 18.28 | 0.62 | 4.42 | 4 |
| 3.1 | | 17.48 | 16.94 | 18.08 | 0.60 | 4.45 | 4 |
| 6.3 | | 10.20 | 8.66 | 11.50 | 1.45 | 11.80 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.6000 | 0.6000 | 0.8000 | 0.8000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

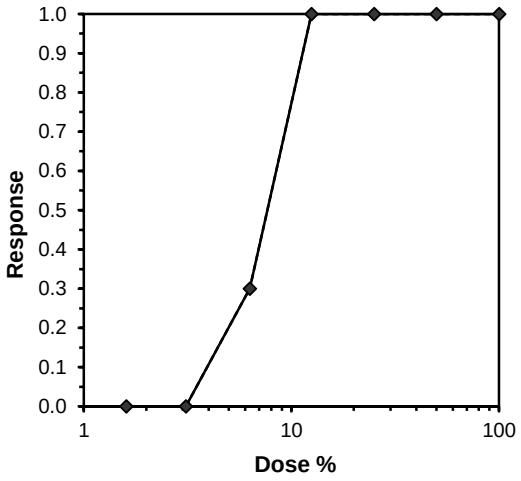
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *6.3 | 0.7000 | 0.7000 | 0.9966 | 0.8861 | 1.1071 | 12.807 | 4 | 10.00 | 10.00 | 6 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.696557 | 0.887 | 0 | 1.895604 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

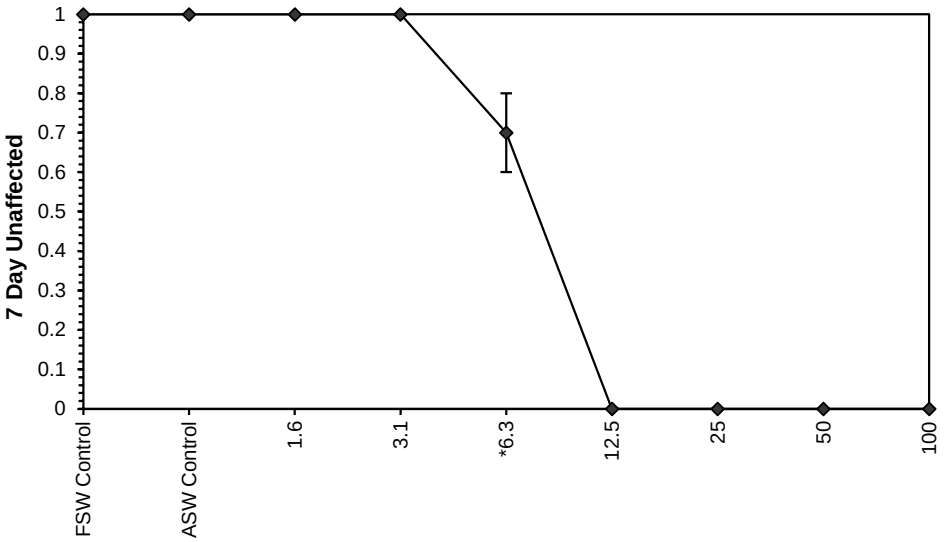
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 7.1993 | 6.2408 | 8.3051 |
| 5.0% | 7.3026 | 6.2191 | 8.5747 |
| 10.0% | 7.4016 | 6.1398 | 8.9226 |
| 20.0% | 7.5744 | 5.7109 | 10.0460 |
| Auto-0.0% | 7.1993 | 6.2408 | 8.3051 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/08/2021 19:30 | Test ID: | PR2029/12 | Sample ID: | A1-5327 |
| End Date: | 27/08/2021 19:30 | Lab ID: | 10178 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 70.00 | 60.00 | 80.00 | 11.55 | 4.85 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.15 | 16.12 | 17.92 | 0.79 | 5.18 | 4 |
| ASW Control | | 16.66 | 15.98 | 17.44 | 0.66 | 4.86 | 4 |
| 1.6 | | 17.77 | 16.98 | 18.28 | 0.62 | 4.42 | 4 |
| 3.1 | | 17.48 | 16.94 | 18.08 | 0.60 | 4.45 | 4 |
| 6.3 | | 10.20 | 8.66 | 11.50 | 1.45 | 11.80 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 50 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 100 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 100 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 50 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 100 | | 88.50 | 88.50 | 88.50 | 0.00 | 0.00 | 1 |

# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report

**September 2022**

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www.ecotox.com.au
ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR2113/1



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2113<br>31 August 2022<br>01 September 2022 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | BE00060922 | **ESA Quote #:** | PL2113_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10677 | Y03/0822-1 | Aqueous sample, pH 8.3*, salinity 12.9‰*, total ammonia 12.9mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 21.2±0.2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 02 October 2022 at 1720h |

| Sample 10677*: Y03/0822-1* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control 92.8 ± 1.7<br>ASW Control 93.5 ± 2.7<br>1.6 92.8 ± 1.7<br>3.1 53.8 ± 14.8 *<br>6.3 5.5 ± 1.5 *<br>12.5 0.0 ± 0.0<br>25 0.0 ± 0.0<br>50 0.0 ± 0.0<br>100 0.0 ± 0.0 | | |
| **IC10 = 2.0 (1.86-2.22)%**<br>**EC50 = 3.4 (3.21-3.52)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2113/1



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 92.8% | Yes |
| Reference Toxicant within cusum chart limits | 55.0-58.1µg Cu/L | 25.6µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 13 October 2022

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

This document shall not be reproduced except in full.

**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

# Toxicity Test Report: TR2113/2



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2113<br>31 August 2022<br>01 September 2022 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | BE00060922 | **ESA Quote #:** | PL2113_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10677 | Y03/0822-1 | Aqueous sample, pH 8.3*, salinity 12.9‰*, total ammonia 12.9mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 18.8-21.6°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 02 October 2022 at 1730h |

| Sample 10677: *Y03/0822-1*<br>**Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 95.0 ± 2.9 | | |
| ASW Control | 93.3 ± 3.2 | | |
| 1.6 | 93.0 ± 1.8 | | |
| 3.1 | 58.8 ± 8.7 * | | |
| 6.3 | 0.0 ± 0.0 | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 = 2.1 (1.88-2.70)%**<br>**72-hr EC50 = 3.4 (3.32-3.54)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2113/2



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 95.0% | Yes |
| Reference Toxicant within cusum chart limits | 10.6-11.6µg Cu/L | 11.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 13 October 2022

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.



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# Toxicity Test Report: TR2113/3



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2113<br>31 August 2022<br>01 September 2022 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | BE00060922 | **ESA Quote #:** | PL2113_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10677 | Y03/0822-1 | Aqueous sample, pH 8.3*, salinity 12.9‰*, total ammonia 12.9mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 18.8-21.6°C. |
| **Deviations from Protocol:** | Test duration extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 02 October 2022 at 1830h |

| Sample 10677: *Y03/0822-1*<br>**Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 72.5 ± 5.9 | | |
| ASW Control | 70.5 ± 2.7 | | |
| 1.6 | 74.3 ± 1.7 | | |
| 3.1 | 46.3 ± 7.7 * | | |
| 6.3 | 0.0 ± 0.0 | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **48-hr EC10 = 2.0 (1.87-2.16)%**<br>**48-hr EC50 = 3.5 (3.34-3.57)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2113/3



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 72.5% | Yes |
| Reference Toxicant within cusum chart limits | 8.9-12.4µg Cu/L | 10.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 13 October 2022

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.

# Toxicity Test Report: TR2113/4



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2113<br>31 August 2022<br>01 September 2022 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | BE00060922 | **ESA Quote #:** | PL2113_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10677 | Y03/0822-1 | Aqueous sample, pH 8.3, salinity 12.9‰, total ammonia 12.9mg/L. Sample received at 9º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 02 October 2022 at 2000h |

| Sample 10677: *Y03/0822-1*<br>**Concentration (%)** | **% Germination (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 97.8 ± 1.3 | | |
| ASW Control | 95.0 ± 1.8 | | |
| 1.6 | 95.5 ± 2.1 | | |
| 3.1 | 95.3 ± 2.5 | | |
| 6.3 | 72.3 ± 9.4 * | | |
| 12.5 | 22.0 ± 5.0 * | | |
| 25 | 38.5 ± 16.3 * | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 = 3.8%**** | | | |
| **72-hr EC50 = 11.3 (3.4-21.5)%** | | | |
| **NOEC = 3.1%** | | | |
| **LOEC = 6.3%** | | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)
** The 95% Confidence limits are not reliable.

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# Toxicity Test Report: TR2113/4



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 97.8% | Yes |
| Reference Toxicant within cusum chart limits | 157.1-219.2µg Cu/L | 183.0µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 13 October 2022

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR2113/5



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2113<br>31 August 2022<br>01 September 2022 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | BE00060922 | **ESA Quote #:** | PL2113_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10677 | Y03/0822-1 | Aqueous sample, pH 8.3, salinity 12.9‰, total ammonia 12.9mg/L. Sample received at 9º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 02 October 2022 at 1900h |

| Sample 10677: *Y03/0822-1*<br>**Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 15.4 ± 0.6 | | |
| ASW Control | 14.5 ± 0.7 | | |
| 1.6 | 14.5 ± 1.1 | | |
| 3.1 | 15.4 ± 1.0 | | |
| 6.3 | 12.3 ± 0.4 * | | |
| 12.5 | 3.9 ± 1.2 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr IC10 = 5.0 (3.92-7.19)%**<br>**72-hr IC50 = 9.9 (9.10-10.68)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 16.4x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 4.1% | Yes |
| Reference Toxicant within cusum chart limits | 3.6-8.4µg Cu/L | 5.7µg Cu/L | Yes |

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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR2113/6



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2113<br>31 August 2022<br>01 September 2022 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | BE00060922 | **ESA Quote #:** | PL2113_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10677 | Y03/0822-1 | Aqueous sample, pH 8.3, salinity 12.9‰, total ammonia 12.9mg/L. Sample received at 9º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 02 October 2022 at 1930h |

| Sample 10677: *Y03/0822-1*<br>**Concentration (%)** | **% Unaffected (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 100 ± 0.0 | | |
| 12.5 | 60.0 ± 16.3 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr EC10 = 10.9 (10.51-11.41)%**<br>**96-hr EC50 = 13.4 (11.54-15.61)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 5.8-98.7mg $NH_4^+$/L | 47.0mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 13 October 2022

Results are based on the samples in the condition as received by ESA.
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**Animal Ethics Approval:**

Animal Research Authority CSB V20/10359(4) issued by the Animal Care and Ethics Committee of The Secretary, Department of Regional NSW, NSW Department of Primary Industries, valid from 11 May 2022 to 11 May 2023.

**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR2113/7



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:** | PR2113 |
| | | **Date Sampled:** | 31 August 2022 |
| | | **Date Received:** | 01 September 2022 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | BE00060922 | **ESA Quote #:** | PL2113_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10677 | Y03/0822-1 | Aqueous sample, pH 8.3, salinity 12.9‰, total ammonia 12.9mg/L. Sample received at 9º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Sizw of Test Organisms:** | 12mm |
| **Test Initiated:** | 02 October 2022 at 1930h |

Sample 10677: *Y03/0822-1*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.6 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 90.0 ± 20.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day EC10 (unaffected) = 6.3 (5.3-9.4)%**
**7 day EC50 (unaffected) = 8.3 (7.54-9.09)%**
**NOEC = 6.3%**
**LOEC = 12.5%**

Sample 10677: *Y03/0822-1*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** |
|---|---|
| FSW Control | 17.8 ± 1.1 |
| ASW Control | 17.0 ± 1.3 |
| 1.6 | 17.8 ± 0.6 |
| 3.1 | 17.9 ± 1.2 |
| 6.3 | 14.4 ± 3.3 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (biomass) = 4.9 (3.40-7.51)%**
**7 day IC50 (biomass) = 8.7 (7.00-9.45)%**
**NOEC = 6.3%**
**LOEC = 12.5%**

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# Toxicity Test Report: TR2113/7



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 24% | Yes |
| Reference Toxicant within cusum chart limits | 5.8-98.7mg $NH_4^+$/L | 47.0mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 13 October 2022

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Animal Ethics Approval:**

Animal Research Authority CSB V20/10359(4) issued by the Animal Care and Ethics Committee of The Secretary, Department of Regional NSW, NSW Department of Primary Industries, valid from 11 May 2022 to 11 May 2023.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

# Toxicity Test Report: TR2113/8



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2113<br>31 August 2022<br>01 September 2022 |
| **Attention:** | Adrian Cukovski | **Sampled By:** | Client |
| **Client Ref:** | BE00060922 | **ESA Quote #:** | PL2113_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 10677 | Y03/0822-1 | Aqueous sample, pH 8.3, salinity 12.9‰, total ammonia 12.9mg/L. Sample received at 9º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 02 September 2022 at 1830h |

| Sample 10677*: Y03/0822-1* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** | | |
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 100 ± 0.0 | | |
| 12.5 | 25.0 ± 19.2 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr IC10 = 10.1 (9.39-10.63)%** | | | |
| **96-hr EC50 = 10.5 (9.23-12.05)%** | | | |
| **NOEC = 6.3%** | | | |
| **LOEC = 12.5%** | | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2113/8



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 1.5-6.7mg SDS/L | 3.8mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 21 October 2022

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Adrian Cukovski

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : Adrian.Cukovski@beachenergy.com.au
**Telephone** : 08 8433 2325
**Facsimile** :

**Date** : 2/09/2022

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR2113 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 1/09/2022
**Time samples received** : 18:15
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 6-10°C

**Comments** : 8 x 1L of sample received at 9oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

ecotox SERVICES AUSTRALIA

Datasheet ID: 601.1
Last Revised: 20 September 2018

Customer: Beach Energy Ltd — Ship To: Ecotox Services Aust
Contact Name: Adrian Culverson — Attention: Rich Whitman
Phone: — Email: Adrian.culverson@beachenergy.com.au (please provide an email address for sample receipt notification) helen.Nottage@beachenergy.com.au
Sampled by: D. McCACHLAN

| Sample Date (day/month/year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg. 2 x 1L) | Tests Requested (See reverse for guidance) | Comments / Instructions |
|---|---|---|---|---|---|---|
| 31/8/22 | 06:00 | YO3/0822-1 | GRAB | ~~8x1.25 GAL~~ 8x1L | | |

9°C

10677

3.75 FLU

**Note that testing will be delayed if an incomplete chain of custody is received**

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

*Note: An MSDS must be attached if Available*

ESA Project Number: PR ~~1898~~ 2113

| 1) Released By | Date | 2) Received By | Date | 3) Released By | Date | 4) Received By | Date |
|---|---|---|---|---|---|---|---|
| Of | Time | Of ESA | Time 1815 | Of | Time | Of | Time |
| | 31/8/22 | | 1/9/22 | | | | |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

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Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

Page 1 of 1

# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:20 | Test ID: | PR2113/02 | Sample ID: | Y03/0822-1 |
| End Date: | 2/09/2022 18:40 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9300 | 0.9100 | 0.9500 | 0.9200 |
| ASW Control | 0.9300 | 0.9500 | 0.9600 | 0.9000 |
| 1.6 | 0.9500 | 0.9100 | 0.9300 | 0.9200 |
| 3.1 | 0.4600 | 0.6900 | 0.6300 | 0.3700 |
| 6.3 | 0.0200 | 0.0500 | 0.0300 | 0.1200 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9275 | 0.9920 | 1.2996 | 1.2661 | 1.3453 | 2.614 | 4 | | | | | |
| ASW Control | 0.9350 | 1.0000 | 1.3167 | 1.2490 | 1.3694 | 4.010 | 4 | * | | | 26 | 400 |
| 1.6 | 0.9275 | 0.9920 | 1.2996 | 1.2661 | 1.3453 | 2.614 | 4 | 0.257 | 2.290 | 0.1522 | 29 | 400 |
| *3.1 | 0.5375 | 0.5749 | 0.8241 | 0.6539 | 0.9803 | 18.293 | 4 | 7.409 | 2.290 | 0.1522 | 185 | 400 |
| *6.3 | 0.0550 | 0.0588 | 0.2238 | 0.1419 | 0.3537 | 41.650 | 4 | 16.439 | 2.290 | 0.1522 | 378 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

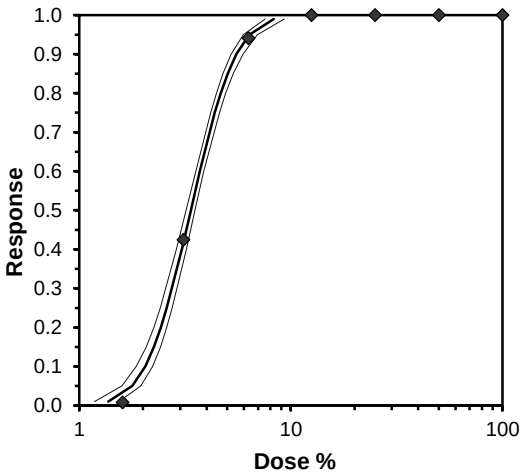
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.982269 | 0.887 | 0.079525 | 0.113428 |
| Bartlett's Test indicates equal variances (p = 0.11) | 5.960432 | 11.34487 | | |
| The control means are not significantly different (p = 0.61) | 0.544263 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 1.6 | 3.1 | 2.227106 | 62.5 | 0.093035 | 0.099311 | 1.060391 | 0.00884 | 3.3E-09 | 3, 12 |
| Treatments vs ASW Control | | | | | | | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 5.937539 | 0.362736 | 5.226576 | 6.648502 | 0.065 | 1.306729 | 11.0705 | 0.93 | 0.527138 | 0.16842 | 5 |
| Intercept | 1.870095 | 0.212009 | 1.454558 | 2.285633 | | | | | | | |
| TSCR | 0.058244 | 0.010175 | 0.038302 | 0.078187 | | | | | | | |

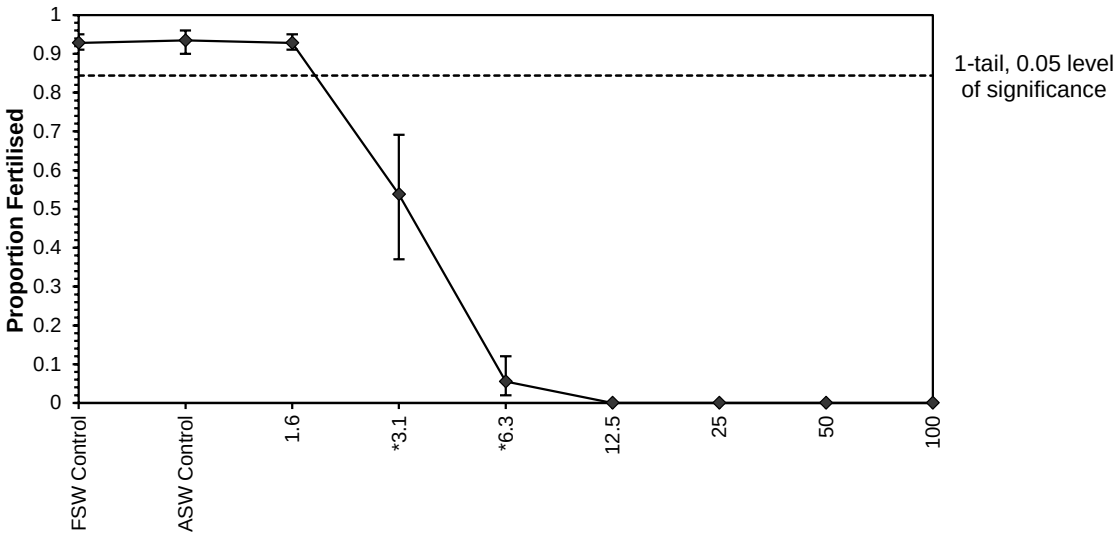
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 1.365636 | 1.177408 | 1.537088 |
| EC05 | 3.355 | 1.778739 | 1.585791 | 1.951073 |
| EC10 | 3.718 | 2.047857 | 1.857286 | 2.217151 |
| EC15 | 3.964 | 2.252072 | 2.065294 | 2.418014 |
| EC20 | 4.158 | 2.428805 | 2.24623 | 2.591562 |
| EC25 | 4.326 | 2.591438 | 2.413142 | 2.751366 |
| EC40 | 4.747 | 3.051193 | 2.884166 | 3.206507 |
| EC50 | 5.000 | 3.366188 | 3.202956 | 3.524359 |
| EC60 | 5.253 | 3.713702 | 3.547625 | 3.883937 |
| EC75 | 5.674 | 4.372561 | 4.176207 | 4.595672 |
| EC80 | 5.842 | 4.665349 | 4.445944 | 4.923597 |
| EC85 | 6.036 | 5.031465 | 4.776756 | 5.341811 |
| EC90 | 6.282 | 5.533211 | 5.22103 | 5.926959 |
| EC95 | 6.645 | 6.370368 | 5.945475 | 6.927176 |
| EC99 | 7.326 | 8.297396 | 7.561781 | 9.311347 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:20 | Test ID: | PR2113/02 | Sample ID: | Y03/0822-1 |
| End Date: | 2/09/2022 18:40 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:20 | Test ID: | PR2113/02 | Sample ID: | Y03/0822-1 |
| End Date: | 2/09/2022 18:40 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 92.75 | 91.00 | 95.00 | 1.71 | 1.41 | 4 |
| ASW Control | | 93.50 | 90.00 | 96.00 | 2.65 | 1.74 | 4 |
| 1.6 | | 92.75 | 91.00 | 95.00 | 1.71 | 1.41 | 4 |
| 3.1 | | 53.75 | 37.00 | 69.00 | 14.82 | 7.16 | 4 |
| 6.3 | | 5.50 | 2.00 | 12.00 | 4.51 | 38.61 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:30 | Test ID: | PR2113/03 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 17:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9500 | 0.9100 | 0.9600 |
| ASW Control | 0.9200 | 0.9100 | 0.9800 | 0.9200 |
| 1.6 | 0.9500 | 0.9100 | 0.9400 | 0.9200 |
| 3.1 | 0.4600 | 0.6300 | 0.6100 | 0.6500 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

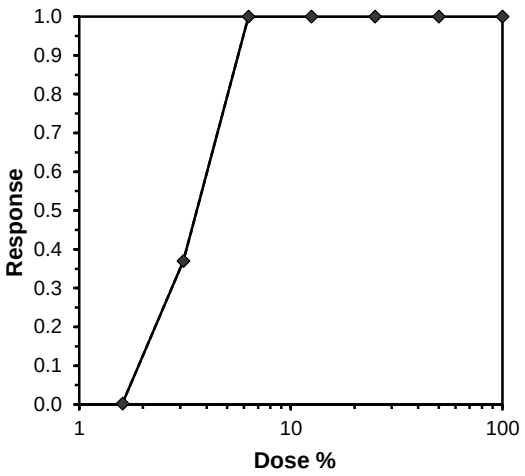
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9500 | 1.0188 | 1.3524 | 1.2661 | 1.4289 | 4.986 | 4 | | | | | |
| ASW Control | 0.9325 | 1.0000 | 1.3158 | 1.2661 | 1.4289 | 5.768 | 4 | * | | | 27 | 400 |
| 1.6 | 0.9300 | 0.9973 | 1.3047 | 1.2661 | 1.3453 | 2.767 | 4 | 0.224 | 2.180 | 0.1080 | 28 | 400 |
| *3.1 | 0.5875 | 0.6300 | 0.8741 | 0.7454 | 0.9377 | 10.007 | 4 | 8.919 | 2.180 | 0.1080 | 165 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.969252 | 0.859 | -0.22177 | 0.582948 |
| Bartlett's Test indicates equal variances (p = 0.39) | 1.88071 | 9.21034 | | |
| The control means are not significantly different (p = 0.50) | 0.722233 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.062428 | 0.066671 | 0.25376 | 0.004905 | 1.2E-05 | 2, 9 |

### Trimmed Spearman-Karber

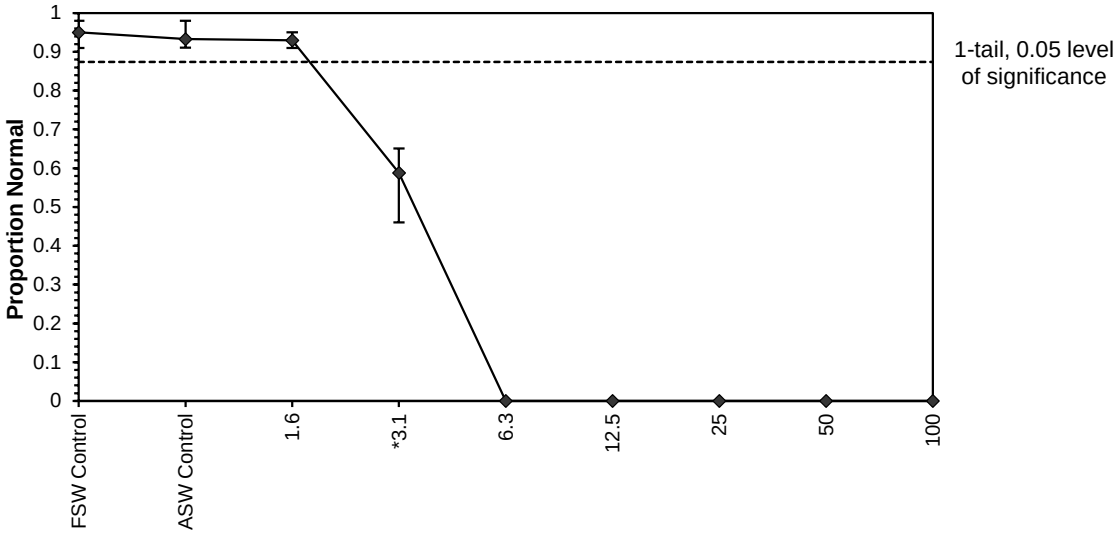
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 3.4534 | 3.3281 | 3.5834 |
| 10.0% | 3.4799 | 3.3360 | 3.6300 |
| 20.0% | 3.5307 | 3.3253 | 3.7489 |
| Auto-0.3% | 3.4280 | 3.3157 | 3.5441 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:30 | Test ID: | PR2113/03 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 17:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:30 | Test ID: | PR2113/03 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 17:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.00 | 91.00 | 98.00 | 2.94 | 1.81 | 4 |
| ASW Control | | 93.25 | 91.00 | 98.00 | 3.20 | 1.92 | 4 |
| 1.6 | | 93.00 | 91.00 | 95.00 | 1.83 | 1.45 | 4 |
| 3.1 | | 58.75 | 46.00 | 65.00 | 8.66 | 5.01 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:30 | Test ID: | PR2113/03 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 17:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9500 | 0.9100 | 0.9600 |
| ASW Control | 0.9200 | 0.9100 | 0.9800 | 0.9200 |
| 1.6 | 0.9500 | 0.9100 | 0.9400 | 0.9200 |
| 3.1 | 0.4600 | 0.6300 | 0.6100 | 0.6500 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

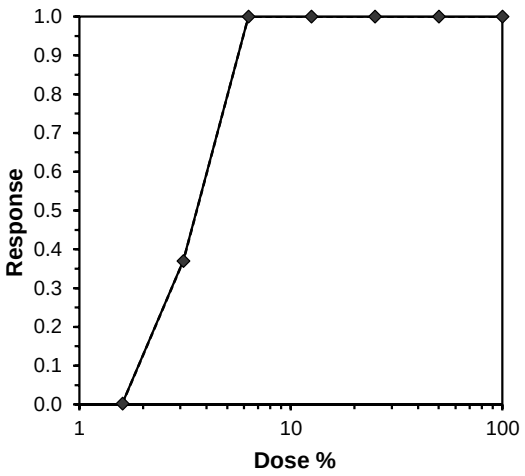
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9500 | 1.0188 | 1.3524 | 1.2661 | 1.4289 | 4.986 | 4 | | | | | |
| ASW Control | 0.9325 | 1.0000 | 1.3158 | 1.2661 | 1.4289 | 5.768 | 4 | * | | | 0.9325 | 1.0000 |
| 1.6 | 0.9300 | 0.9973 | 1.3047 | 1.2661 | 1.3453 | 2.767 | 4 | 0.224 | 2.180 | 0.1080 | 0.9300 | 0.9973 |
| *3.1 | 0.5875 | 0.6300 | 0.8741 | 0.7454 | 0.9377 | 10.007 | 4 | 8.919 | 2.180 | 0.1080 | 0.5875 | 0.6300 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.969252 | 0.859 | -0.22177 | 0.582948 |
| Bartlett's Test indicates equal variances (p = 0.39) | 1.88071 | 9.21034 | | |
| The control means are not significantly different (p = 0.50) | 0.722233 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 1.6 | 3.1 | 2.227106 | 62.5 | 0.062428 | 0.066671 | 0.25376 | 0.004905 | 1.2E-05 | 2, 9 |
| Treatments vs ASW Control | | | | | | | | | | |

### Log-Logit Interpolation (200 Resamples)

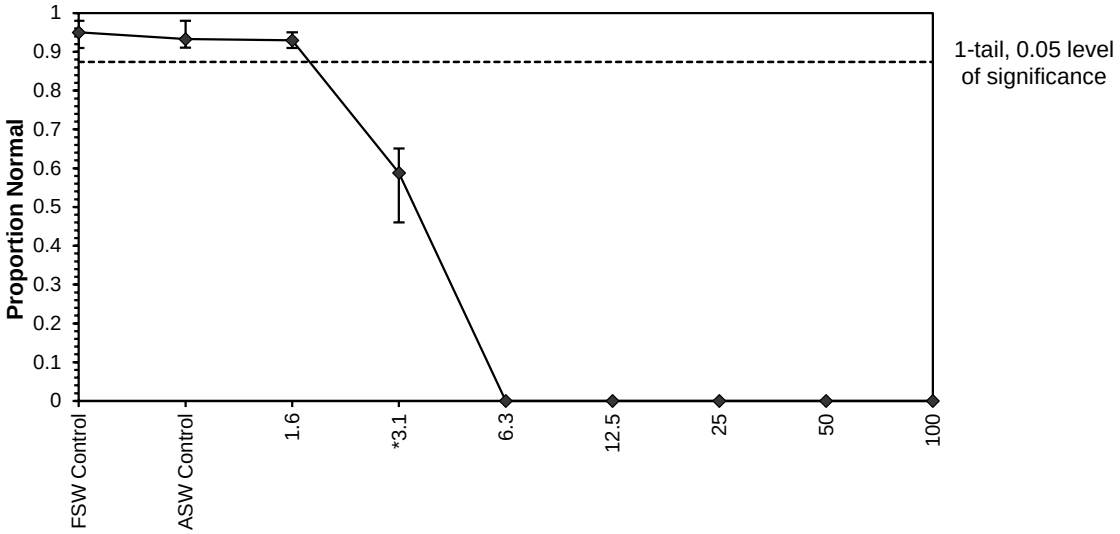
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.9012 | 0.0703 | 1.5740 | 1.9785 | -1.6194 |
| IC10 | 2.1457 | 0.0630 | 1.8779 | 2.2690 | -0.8028 |
| IC15 | 2.3522 | 0.0687 | 2.1180 | 2.5208 | -0.4151 |
| IC20 | 2.5373 | 0.0797 | 2.2493 | 2.7449 | -0.3200 |
| IC25 | 2.7095 | 0.0931 | 2.4118 | 2.9593 | -0.3116 |
| IC40 | 3.1284 | 0.0636 | 2.8133 | 3.2168 | -2.0289 |
| IC50 | 3.2227 | 0.0383 | 3.0833 | 3.3091 | -0.8865 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:30 | Test ID: | PR2113/03 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 17:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 17:30 | Test ID: | PR2113/03 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 17:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.00 | 91.00 | 98.00 | 2.94 | 1.81 | 4 |
| ASW Control | | 93.25 | 91.00 | 98.00 | 3.20 | 1.92 | 4 |
| 1.6 | | 93.00 | 91.00 | 95.00 | 1.83 | 1.45 | 4 |
| 3.1 | | 58.75 | 46.00 | 65.00 | 8.66 | 5.01 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7900 | 0.6800 | 0.6700 | 0.7600 |
| ASW Control | 0.7100 | 0.6800 | 0.7400 | 0.6900 |
| 1.6 | 0.7500 | 0.7400 | 0.7600 | 0.7200 |
| 3.1 | 0.5700 | 0.4300 | 0.3900 | 0.4600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

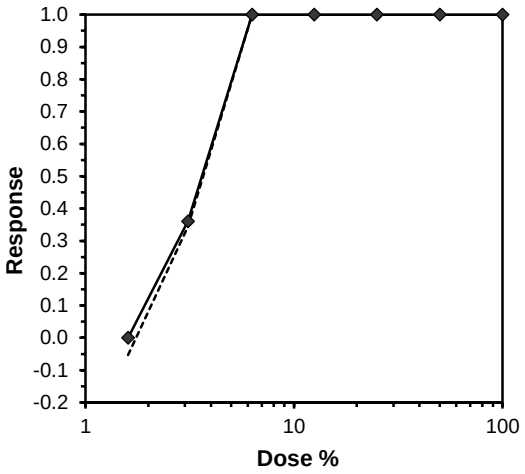
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7250 | 1.0284 | 1.0205 | 0.9589 | 1.0948 | 6.545 | 4 | | | | | |
| ASW Control | 0.7050 | 1.0000 | 0.9969 | 0.9695 | 1.0357 | 2.930 | 4 | * | | | 118 | 400 |
| 1.6 | 0.7425 | 1.0532 | 1.0387 | 1.0132 | 1.0588 | 1.874 | 4 | -1.203 | 2.180 | 0.0758 | 103 | 400 |
| *3.1 | 0.4625 | 0.6560 | 0.7477 | 0.6745 | 0.8556 | 10.381 | 4 | 7.168 | 2.180 | 0.0758 | 215 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.91914 | 0.859 | 1.063294 | 2.773777 |
| Bartlett's Test indicates equal variances (p = 0.07) | 5.182642 | 9.21034 | | |
| The control means are not significantly different (p = 0.54) | 0.64683 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 1.6 | 3.1 | 2.227106 | 62.5 | 0.071217 | 0.100979 | 0.099069 | 0.002419 | 3.0E-05 | 2, 9 |
| Treatments vs ASW Control | | | | | | | | | | |

### Trimmed Spearman-Karber

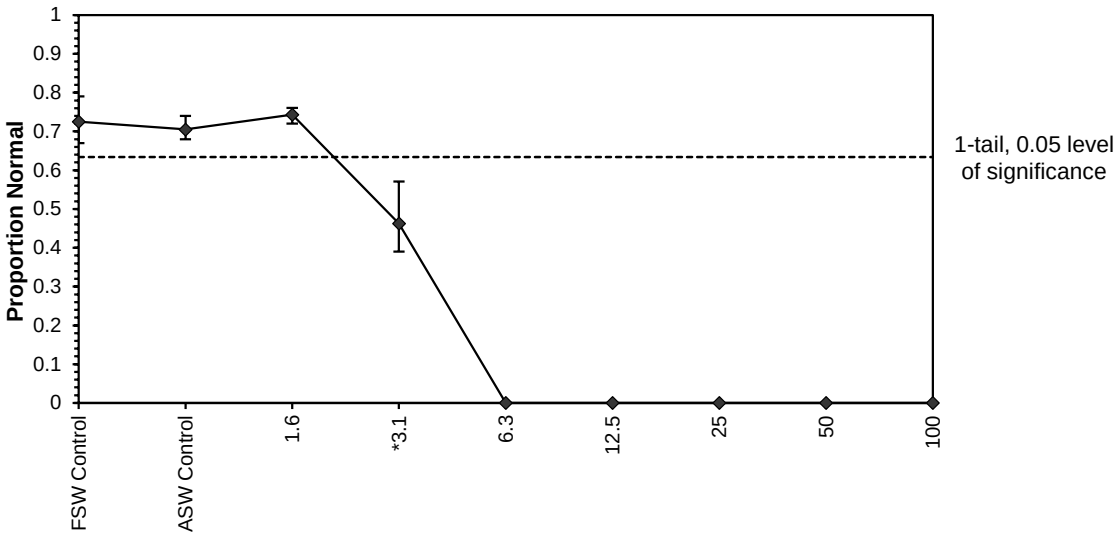
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.4508 | 3.3391 | 3.5663 |
| 5.0% | 3.4794 | 3.3537 | 3.6098 |
| 10.0% | 3.5076 | 3.3629 | 3.6586 |
| 20.0% | 3.5612 | 3.3531 | 3.7821 |
| Auto-0.0% | 3.4508 | 3.3391 | 3.5663 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 72.50 | 67.00 | 79.00 | 5.92 | 3.35 | 4 |
| ASW Control | | 70.50 | 68.00 | 74.00 | 2.65 | 2.31 | 4 |
| 1.6 | | 74.25 | 72.00 | 76.00 | 1.71 | 1.76 | 4 |
| 3.1 | | 46.25 | 39.00 | 57.00 | 7.72 | 6.01 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7900 | 0.6800 | 0.6700 | 0.7600 |
| ASW Control | 0.7100 | 0.6800 | 0.7400 | 0.6900 |
| 1.6 | 0.7500 | 0.7400 | 0.7600 | 0.7200 |
| 3.1 | 0.5700 | 0.4300 | 0.3900 | 0.4600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

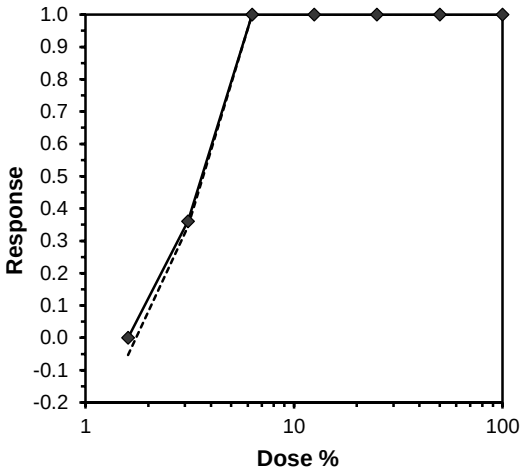
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7250 | 1.0284 | 1.0205 | 0.9589 | 1.0948 | 6.545 | 4 | | | | | |
| ASW Control | 0.7050 | 1.0000 | 0.9969 | 0.9695 | 1.0357 | 2.930 | 4 | * | | | 0.7238 | 1.0000 |
| 1.6 | 0.7425 | 1.0532 | 1.0387 | 1.0132 | 1.0588 | 1.874 | 4 | -1.203 | 2.180 | 0.0758 | 0.7238 | 1.0000 |
| *3.1 | 0.4625 | 0.6560 | 0.7477 | 0.6745 | 0.8556 | 10.381 | 4 | 7.168 | 2.180 | 0.0758 | 0.4625 | 0.6390 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.91914 | 0.859 | 1.063294 | 2.773777 |
| Bartlett's Test indicates equal variances (p = 0.07) | 5.182642 | 9.21034 | | |
| The control means are not significantly different (p = 0.54) | 0.64683 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.071217 | 0.100979 | 0.099069 | 0.002419 | 3.0E-05 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

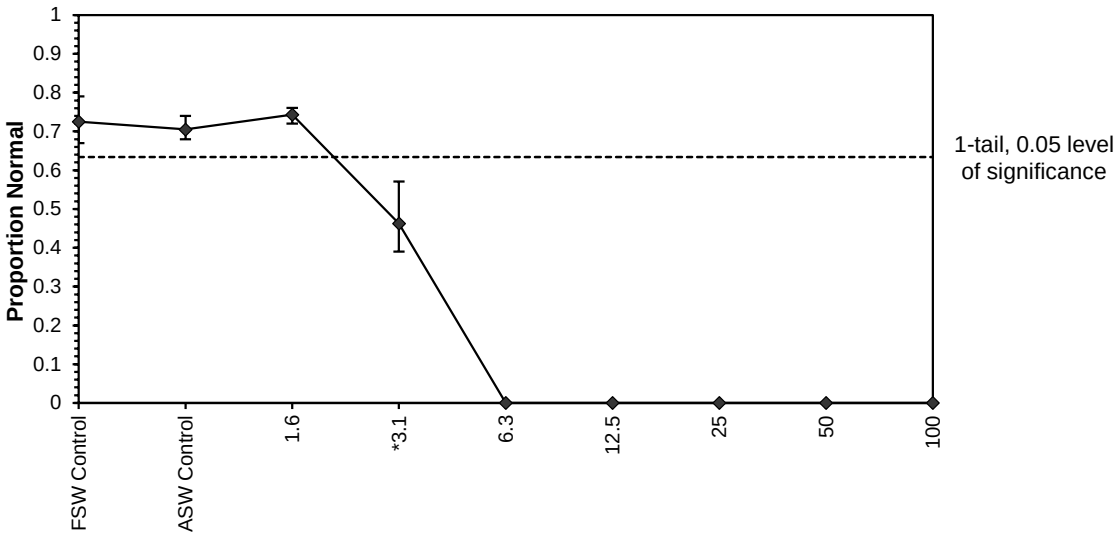
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.7923 | 0.0264 | 1.7383 | 1.8754 | 0.3169 |
| IC10 | 1.9856 | 0.0531 | 1.8732 | 2.1613 | 0.7059 |
| IC15 | 2.1822 | 0.0824 | 2.0066 | 2.4606 | 0.7813 |
| IC20 | 2.3843 | 0.1144 | 2.1400 | 2.7769 | 0.8172 |
| IC25 | 2.5941 | 0.1494 | 2.2750 | 3.1139 | 0.8319 |
| IC40 | 3.1299 | 0.0682 | 2.8045 | 3.2248 | -1.3708 |
| IC50 | 3.2103 | 0.0343 | 3.1088 | 3.3030 | 0.1746 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 72.50 | 67.00 | 79.00 | 5.92 | 3.35 | 4 |
| ASW Control | | 70.50 | 68.00 | 74.00 | 2.65 | 2.31 | 4 |
| 1.6 | | 74.25 | 72.00 | 76.00 | 1.71 | 1.76 | 4 |
| 3.1 | | 46.25 | 39.00 | 57.00 | 7.72 | 6.01 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 20:00 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 20:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9900 | 0.9800 |
| ASW Control | 0.9600 | 0.9400 | 0.9300 | 0.9700 |
| 1.6 | 0.9300 | 0.9500 | 0.9800 | 0.9600 |
| 3.1 | 0.9500 | 0.9600 | 0.9800 | 0.9200 |
| 6.3 | 0.7600 | 0.8100 | 0.5900 | 0.7300 |
| 12.5 | 0.2700 | 0.1600 | 0.2500 | 0.2000 |
| 25 | 0.1600 | 0.5100 | 0.3700 | 0.5000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9775 | 1.0289 | 1.4245 | 1.3694 | 1.4706 | 2.922 | 4 | | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.3481 | 1.3030 | 1.3967 | 3.165 | 4 | * | | | 20 | 400 |
| 1.6 | 0.9550 | 1.0053 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | -0.201 | 2.410 | 0.1625 | 18 | 400 |
| 3.1 | 0.9525 | 1.0026 | 1.3569 | 1.2840 | 1.4289 | 4.419 | 4 | -0.130 | 2.410 | 0.1625 | 19 | 400 |
| *6.3 | 0.7225 | 0.7605 | 1.0197 | 0.8759 | 1.1198 | 10.167 | 4 | 4.870 | 2.410 | 0.1625 | 111 | 400 |
| *12.5 | 0.2200 | 0.2316 | 0.4863 | 0.4115 | 0.5464 | 12.514 | 4 | 12.780 | 2.410 | 0.1625 | 312 | 400 |
| *25 | 0.3850 | 0.4053 | 0.6616 | 0.4115 | 0.7954 | 27.016 | 4 | 10.181 | 2.410 | 0.1625 | 246 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.936798 | 0.916 | -1.05089 | 2.292015 |
| Bartlett's Test indicates equal variances (p = 0.13) | 8.508464 | 15.08627 | | |
| The control means are significantly different (p = 0.04) | 2.561066 | 2.446912 | | |

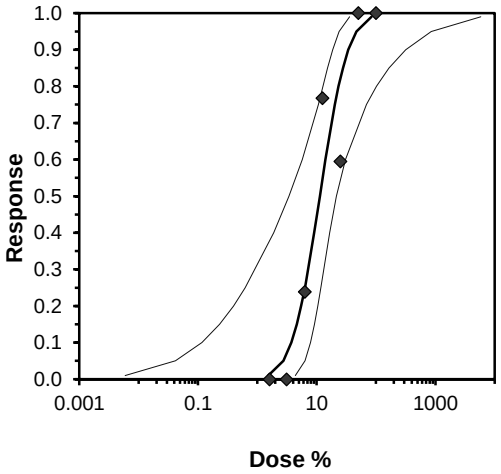
| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.092411 | 0.097149 | 0.599256 | 0.009096 | 6.2E-11 | 5, 18 |
| Treatments vs ASW Control | | | | | | | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 2.673244 | 0.7324 | 0.790551 | 4.555937 | 0.05 | 235.225 | 11.0705 | 8.1E-49 | 1.054159 | 0.374077 | 5 |
| Intercept | 2.181976 | 0.859218 | -0.02671 | 4.390665 | | | | | | | |
| TSCR | 0.03613 | 0.050944 | -0.09483 | 0.167086 | | | | | | | |

| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 1.527302 | 0.005933 | 4.369182 |
| EC05 | 3.355 | 2.746985 | 0.041703 | 6.384861 |
| EC10 | 3.718 | 3.756292 | 0.116654 | 7.90157 |
| EC15 | 3.964 | 4.639301 | 0.231727 | 9.193838 |
| EC20 | 4.158 | 5.486904 | 0.39713 | 10.44061 |
| EC25 | 4.326 | 6.336471 | 0.626114 | 11.72469 |
| EC40 | 4.747 | 9.107252 | 1.877909 | 16.49067 |
| EC50 | 5.000 | 11.32814 | 3.419151 | 21.53137 |
| EC60 | 5.253 | 14.09062 | 5.734066 | 30.5214 |
| EC75 | 5.674 | 20.2521 | 10.71983 | 68.87119 |
| EC80 | 5.842 | 23.38784 | 12.82951 | 101.8851 |
| EC85 | 6.036 | 27.66081 | 15.32921 | 165.9538 |
| EC90 | 6.282 | 34.16316 | 18.58472 | 316.3824 |
| EC95 | 6.645 | 46.71551 | 23.82128 | 854.4783 |
| EC99 | 7.326 | 84.02195 | 35.87876 | 5827.236 |

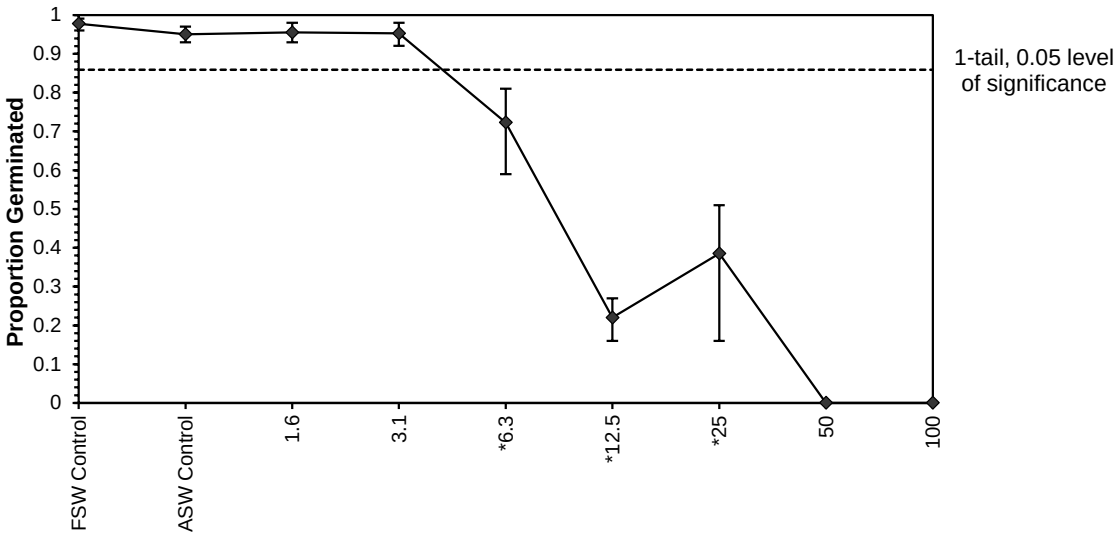
Significant heterogeneity detected (p = 8.11E-49)



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 20:00 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 20:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 20:00 | Test ID: | PR2113/06 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 20:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 97.75 | 96.00 | 99.00 | 1.26 | 1.15 | 4 |
| ASW Control | | 95.00 | 93.00 | 97.00 | 1.83 | 1.42 | 4 |
| 1.6 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 3.1 | | 95.25 | 92.00 | 98.00 | 2.50 | 1.66 | 4 |
| 6.3 | | 72.25 | 59.00 | 81.00 | 9.43 | 4.25 | 4 |
| 12.5 | | 22.00 | 16.00 | 27.00 | 4.97 | 10.13 | 4 |
| 25 | | 38.50 | 16.00 | 51.00 | 16.30 | 10.49 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 15.107 | 14.407 | 15.507 | 15.107 | 15.607 | 14.907 | 16.507 | 15.807 |
| ASW Control | 14.407 | 15.507 | 14.107 | 13.907 | | | | |
| 1.6 | 13.407 | 14.107 | 15.907 | 14.607 | | | | |
| 3.1 | 16.107 | 16.507 | 14.707 | 14.407 | | | | |
| 6.3 | 11.607 | 14.207 | 12.407 | 11.007 | | | | |
| 12.5 | 5.107 | 3.607 | 2.407 | 4.607 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

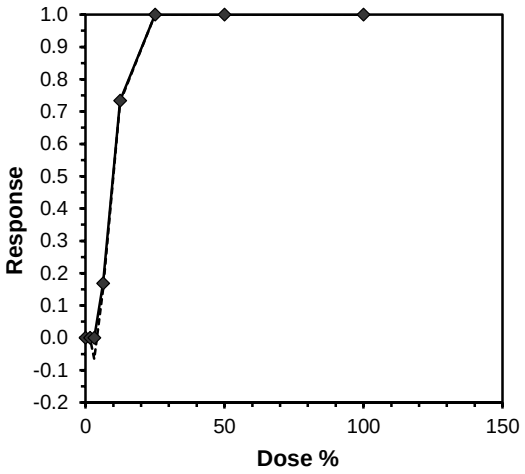
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 15.369 | 1.0613 | 15.369 | 14.407 | 16.507 | 4.143 | 8 | | | | | |
| ASW Control | 14.482 | 1.0000 | 14.482 | 13.907 | 15.507 | 4.927 | 4 | * | | | 14.807 | 1.0000 |
| 1.6 | 14.507 | 1.0017 | 14.507 | 13.407 | 15.907 | 7.274 | 4 | -0.032 | 2.360 | 1.834 | 14.807 | 1.0000 |
| 3.1 | 15.432 | 1.0656 | 15.432 | 14.407 | 16.507 | 6.680 | 4 | -1.222 | 2.360 | 1.834 | 14.807 | 1.0000 |
| *6.3 | 12.307 | 0.8498 | 12.307 | 11.007 | 14.207 | 11.298 | 4 | 2.798 | 2.360 | 1.834 | 12.307 | 0.8312 |
| *12.5 | 3.932 | 0.2715 | 3.932 | 2.407 | 5.107 | 30.335 | 4 | 13.574 | 2.360 | 1.834 | 3.932 | 0.2655 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.961337 | 0.905 | 0.310398 | -0.90701 |
| Bartlett's Test indicates equal variances (p = 0.88) | 1.16697 | 13.2767 | | |
| The control means are significantly different (p = 0.05) | 2.193302 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 3.1 | 6.3 | 4.419276 | 32.25806 | 1.834258 | 0.12666 | 89.32375 | 1.208167 | 1.1E-09 | 4, 15 |
| Treatments vs ASW Control | | | | | | | | | | |

### Linear Interpolation (200 Resamples)

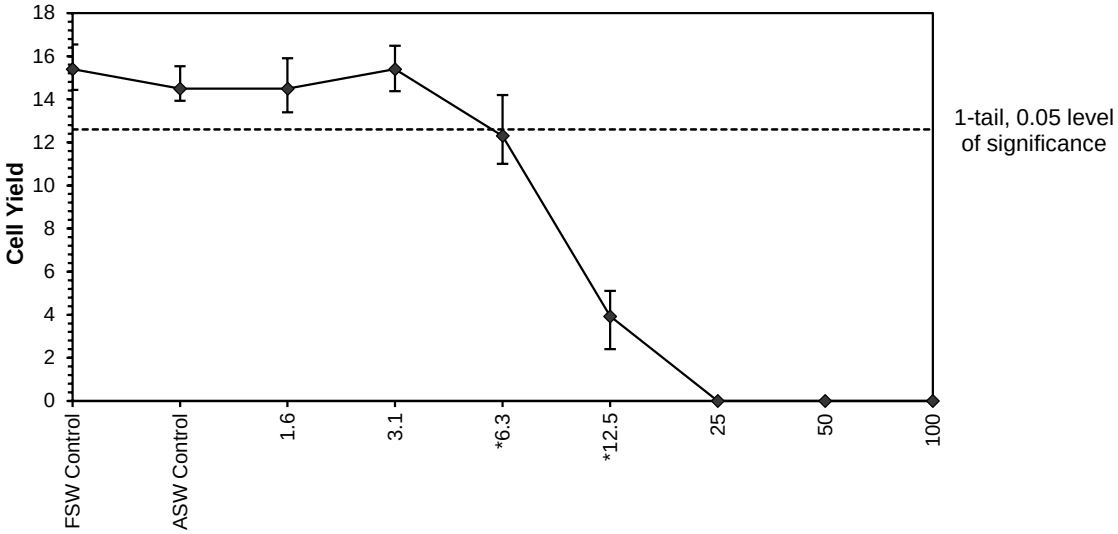
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 4.0476 | 0.4835 | 3.1788 | 5.5405 | 0.2727 |
| IC10 | 4.9953 | 0.5797 | 3.9210 | 7.1943 | 1.0014 |
| IC15 | 5.9429 | 0.5698 | 4.5593 | 7.4001 | 0.2270 |
| IC20 | 6.6415 | 0.4724 | 5.2884 | 7.7580 | -0.0050 |
| IC25 | 7.1896 | 0.4153 | 5.9912 | 8.1827 | 0.0492 |
| IC40 | 8.8338 | 0.3173 | 7.9679 | 9.6644 | -0.0160 |
| IC50 | 9.9299 | 0.2904 | 9.1049 | 10.6804 | -0.0987 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 15.37 | 14.41 | 16.51 | 0.64 | 5.19 | 8 |
| ASW Control | | 14.48 | 13.91 | 15.51 | 0.71 | 5.83 | 4 |
| 1.6 | | 14.51 | 13.41 | 15.91 | 1.06 | 7.08 | 4 |
| 3.1 | | 15.43 | 14.41 | 16.51 | 1.03 | 6.58 | 4 |
| 6.3 | | 12.31 | 11.01 | 14.21 | 1.39 | 9.58 | 4 |
| 12.5 | | 3.93 | 2.41 | 5.11 | 1.19 | 27.78 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Growth Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.6000 | 0.4000 | 0.6000 | 0.8000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

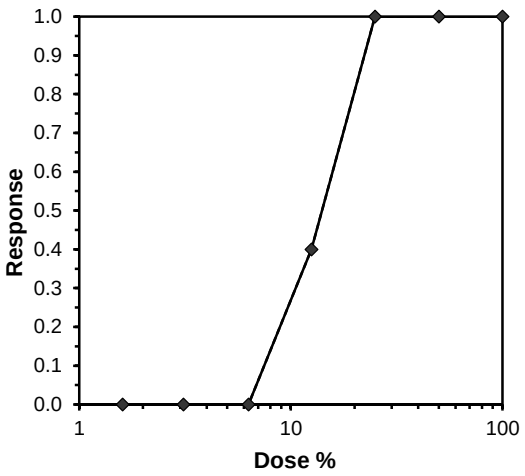
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *12.5 | 0.6000 | 0.6000 | 0.8910 | 0.6847 | 1.1071 | 19.366 | 4 | 10.00 | 10.00 | 8 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.460565 | 0.905 | 0.23934 | 9.51416 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

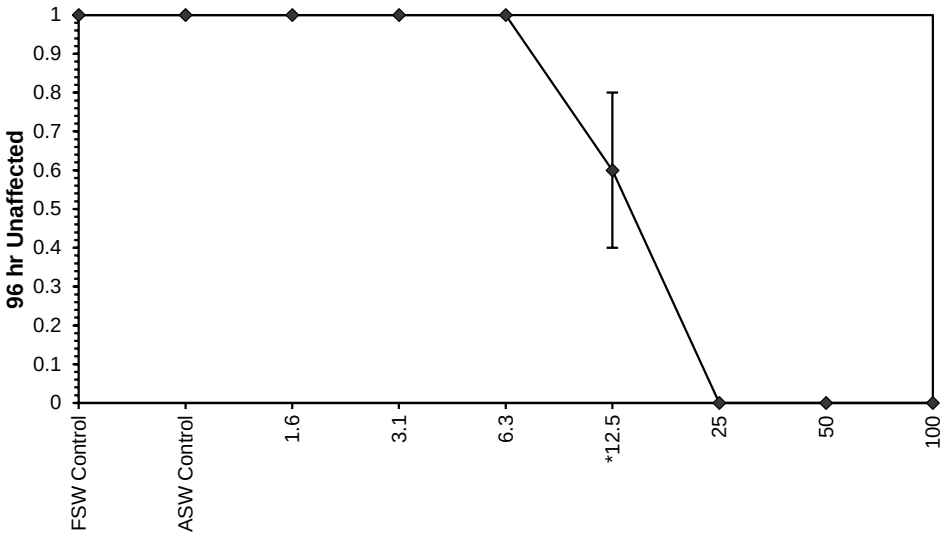
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 13.419 | 11.538 | 15.606 |
| 5.0% | 13.508 | 11.414 | 15.987 |
| 10.0% | 13.597 | 11.222 | 16.475 |
| 20.0% | 13.772 | 10.526 | 18.021 |
| Auto-0.0% | 13.419 | 11.538 | 15.606 |



## Fish Growth Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 60.00 | 40.00 | 80.00 | 16.33 | 6.74 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

## Fish Growth Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.6000 | 0.4000 | 0.6000 | 0.8000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

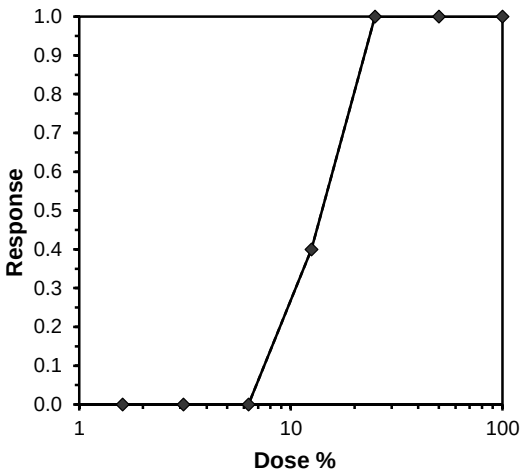
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *12.5 | 0.6000 | 0.6000 | 0.8910 | 0.6847 | 1.1071 | 19.366 | 4 | 10.00 | 10.00 | 0.6000 | 0.6000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.460565 | 0.905 | 0.23934 | 9.51416 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

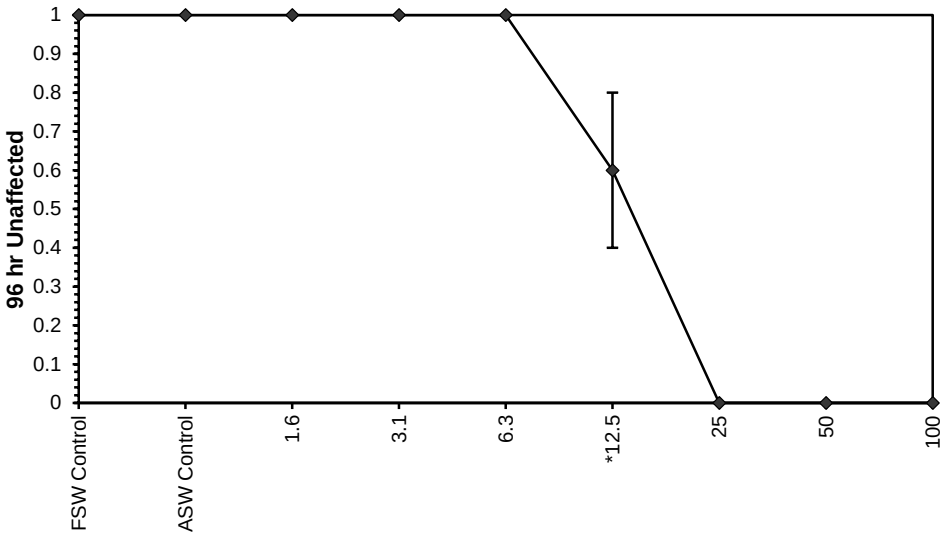
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 10.307 | 0.161 | 9.962 | 10.730 | 0.4767 |
| IC10 | 10.912 | 0.189 | 10.506 | 11.412 | 0.4825 |
| IC15 | 11.303 | 0.209 | 10.856 | 11.854 | 0.4861 |
| IC20 | 11.606 | 0.224 | 11.127 | 12.197 | 0.4888 |
| IC25 | 11.862 | 0.235 | 11.355 | 12.487 | 0.4400 |
| IC40 | 12.500 | 0.251 | 11.923 | 13.131 | 0.2172 |
| IC50 | 12.878 | 0.254 | 12.273 | 13.499 | 0.1310 |



## Fish Growth Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:00 | Test ID: | PR2113/09 | Sample ID: | Y03/0822-1 |
| End Date: | 5/09/2022 19:00 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 60.00 | 40.00 | 80.00 | 16.33 | 6.74 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 0.6000 | 1.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

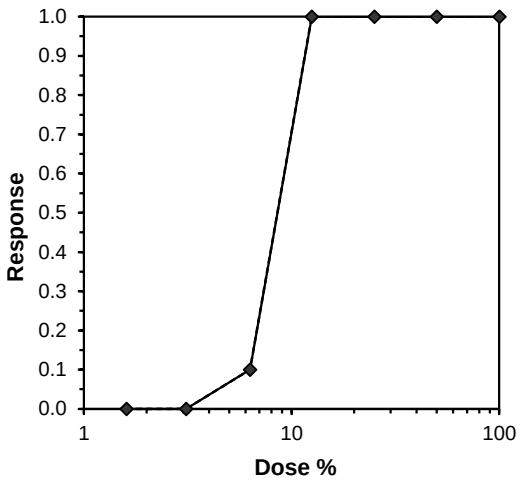
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 0.9000 | 0.9000 | 1.2305 | 0.8861 | 1.3453 | 18.660 | 4 | 16.00 | 10.00 | 2 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.564851 | 0.887 | -2.55551 | 9.368132 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

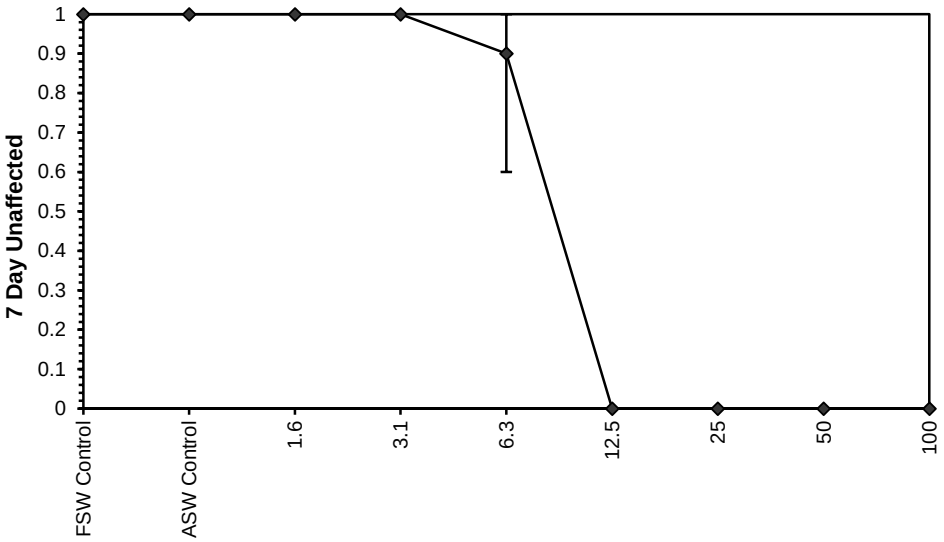
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 8.2765 | 7.5375 | 9.0880 |
| 5.0% | 8.4679 | 7.5330 | 9.5188 |
| 10.0% | 8.5427 | 8.0714 | 9.0414 |
| 20.0% | 8.5427 | 8.0714 | 9.0414 |
| Auto-0.0% | 8.2765 | 7.5375 | 9.0880 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Dose-Response Plot



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 90.00 | 60.00 | 100.00 | 20.00 | 4.97 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.80 | 16.28 | 18.96 | 1.12 | 5.94 | 4 |
| ASW Control | | 17.00 | 15.96 | 18.62 | 1.29 | 6.68 | 4 |
| 1.6 | | 17.80 | 16.94 | 18.28 | 0.64 | 4.48 | 4 |
| 3.1 | | 17.88 | 16.34 | 18.94 | 1.18 | 6.07 | 4 |
| 6.3 | | 14.42 | 9.54 | 16.24 | 3.26 | 12.52 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 0.6000 | 1.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

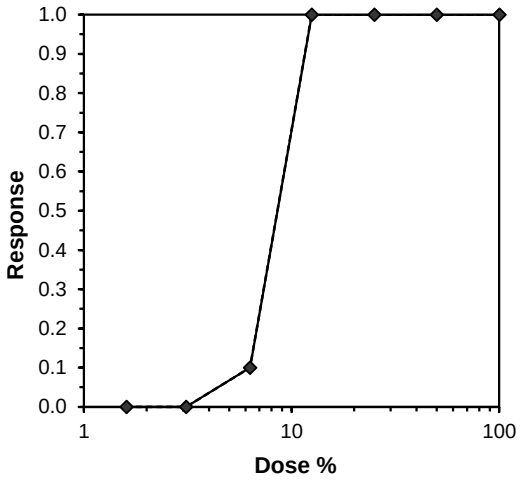
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 0.9000 | 0.9000 | 1.2305 | 0.8861 | 1.3453 | 18.660 | 4 | 16.00 | 10.00 | 0.9000 | 0.9000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.564851 | 0.887 | -2.55551 | 9.368132 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

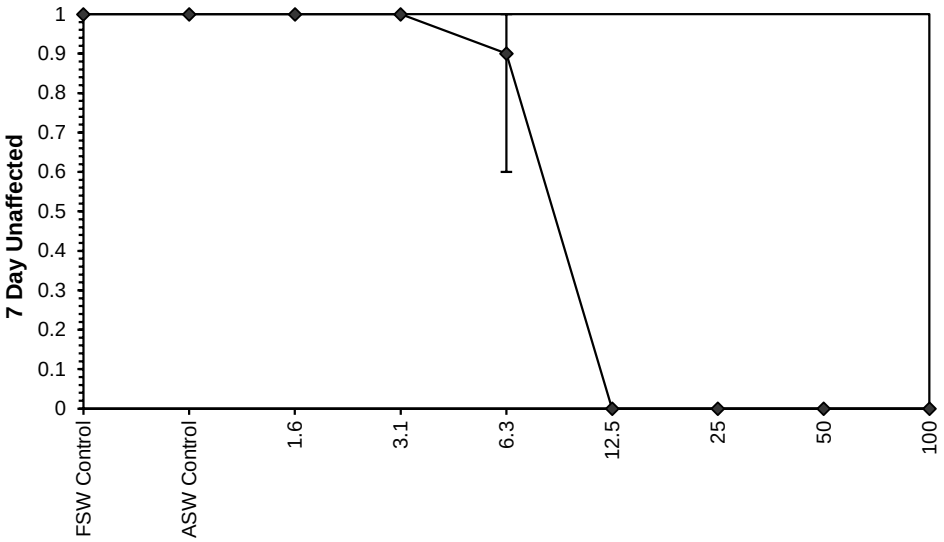
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 5.8648 | 1.1115 | 4.9880 | 9.2780 | 0.4981 |
| IC10 | 6.3000 | 1.0302 | 5.2615 | 9.3804 | 0.4547 |
| IC15 | 6.4843 | 0.9995 | 5.4960 | 9.4995 | 0.4672 |
| IC20 | 6.6261 | 0.9752 | 5.6780 | 9.5897 | 0.4767 |
| IC25 | 6.7453 | 0.9600 | 5.8321 | 9.6645 | 0.4788 |
| IC40 | 7.0401 | 0.9226 | 6.1757 | 9.8460 | 0.4798 |
| IC50 | 7.2177 | 0.8998 | 6.3703 | 9.9529 | 0.4789 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Dose-Response Plot



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 90.00 | 60.00 | 100.00 | 20.00 | 4.97 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.80 | 16.28 | 18.96 | 1.12 | 5.94 | 4 |
| ASW Control | | 17.00 | 15.96 | 18.62 | 1.29 | 6.68 | 4 |
| 1.6 | | 17.80 | 16.94 | 18.28 | 0.64 | 4.48 | 4 |
| 3.1 | | 17.88 | 16.34 | 18.94 | 1.18 | 6.07 | 4 |
| 6.3 | | 14.42 | 9.54 | 16.24 | 3.26 | 12.52 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 16.280 | 18.080 | 17.880 | 18.960 |
| ASW Control | 15.960 | 18.620 | 15.960 | 17.460 |
| 1.6 | 17.680 | 18.280 | 16.940 | 18.280 |
| 3.1 | 16.340 | 18.940 | 18.640 | 17.580 |
| 6.3 | 16.100 | 15.780 | 16.240 | 9.540 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

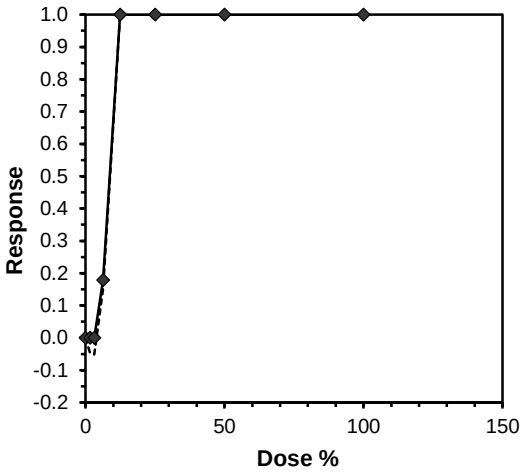
| | | | Transform: Untransformed | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 17.800 | 1.0471 | 17.800 | 16.280 | 18.960 | 6.273 | 4 | | | | |
| ASW Control | 17.000 | 1.0000 | 17.000 | 15.960 | 18.620 | 7.593 | 4 | * | | 17.557 | 1.0000 |
| 1.6 | 17.795 | 1.0468 | 17.795 | 16.940 | 18.280 | 3.576 | 4 | 21.00 | 10.00 | 17.557 | 1.0000 |
| 3.1 | 17.875 | 1.0515 | 17.875 | 16.340 | 18.940 | 6.590 | 4 | 23.00 | 10.00 | 17.557 | 1.0000 |
| 6.3 | 14.415 | 0.8479 | 14.415 | 9.540 | 16.240 | 22.585 | 4 | 14.00 | 10.00 | 14.415 | 0.8211 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.854787 | 0.887 | -1.66028 | 3.910153 |
| Bartlett's Test indicates equal variances (p = 0.07) | 7.198588 | 11.34487 | | |
| The control means are not significantly different (p = 0.38) | 0.9374 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Linear Interpolation (200 Resamples)

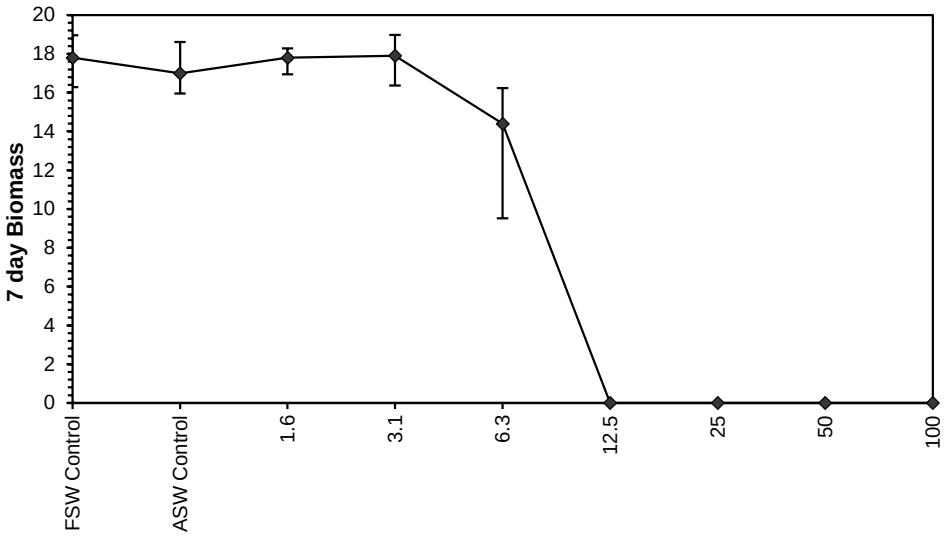
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.9941 | 0.6219 | 2.9801 | 6.3204 | 0.6828 |
| IC10 | 4.8883 | 0.9092 | 3.3983 | 7.5073 | 0.3904 |
| IC15 | 5.7824 | 0.8006 | 3.5685 | 7.5019 | -0.1526 |
| IC20 | 6.4590 | 0.7136 | 3.8769 | 7.6270 | -0.6088 |
| IC25 | 6.8366 | 0.6316 | 4.3626 | 7.9316 | -0.7040 |
| IC40 | 7.9692 | 0.5016 | 5.8571 | 8.8453 | -0.8271 |
| IC50 | 8.7244 | 0.4180 | 6.9643 | 9.4544 | -0.8271 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 19:30 | Test ID: | PR2113/11 | Sample ID: | Y03/0822-1 |
| End Date: | 9/09/2022 19:30 | Lab ID: | 10677 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 90.00 | 60.00 | 100.00 | 20.00 | 4.97 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 17.80 | 16.28 | 18.96 | 1.12 | 5.94 | 4 |
| ASW Control | | 17.00 | 15.96 | 18.62 | 1.29 | 6.68 | 4 |
| 1.6 | | 17.80 | 16.94 | 18.28 | 0.64 | 4.48 | 4 |
| 3.1 | | 17.88 | 16.34 | 18.94 | 1.18 | 6.07 | 4 |
| 6.3 | | 14.42 | 9.54 | 16.24 | 3.26 | 12.52 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113_31 | Sample ID: | Y03 |
| End Date: | 6/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.2000 | 0.4000 | 0.0000 | 0.4000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

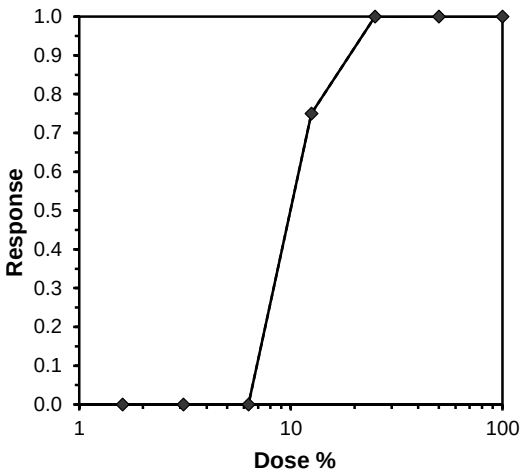
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *12.5 | 0.2500 | 0.2500 | 0.5146 | 0.2255 | 0.6847 | 42.578 | 4 | 10.00 | 10.00 | 15 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.577304 | 0.905 | -1.28154 | 7.355779 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 10.543 | 9.226 | 12.048 |
| 5.0% | 10.367 | 8.962 | 11.992 |
| 10.0% | 10.211 | 8.746 | 11.922 |
| 20.0% | 9.986 | 8.521 | 11.704 |
| Auto-0.0% | 10.543 | 9.226 | 12.048 |



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113_31 | Sample ID: | Y03 |
| End Date: | 6/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 25.00 | 0.00 | 40.00 | 19.15 | 17.50 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113_31 | Sample ID: | Y03 |
| End Date: | 6/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

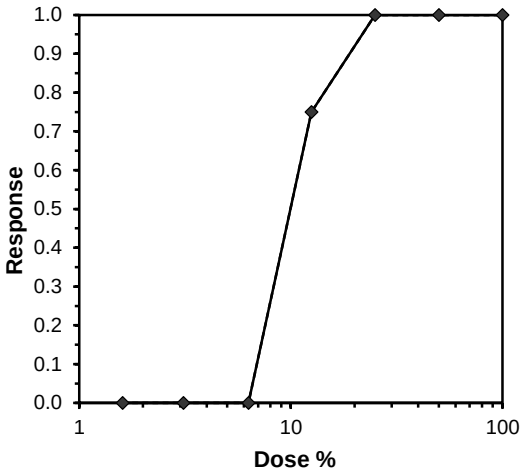
| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.2000 | 0.4000 | 0.0000 | 0.4000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 1.0000 | 1.0000 |
| 12.5 | 0.2500 | 0.2500 | 0.5146 | 0.2255 | 0.6847 | 42.578 | 4 | 0.2500 | 0.2500 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.577304 | 0.905 | -1.28154 | 7.355779 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 9.608 | 0.216 | 9.008 | 10.071 | -2.3474 |
| IC10 | 10.091 | 0.252 | 9.390 | 10.634 | -2.3074 |
| IC15 | 10.401 | 0.276 | 9.635 | 10.997 | -2.2829 |
| IC20 | 10.641 | 0.295 | 9.822 | 11.278 | -2.2646 |
| IC25 | 10.842 | 0.310 | 9.979 | 11.514 | -2.2496 |
| IC40 | 11.342 | 0.350 | 10.368 | 12.104 | -2.2138 |
| IC50 | 11.644 | 0.375 | 10.601 | 12.461 | -2.1932 |



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 2/09/2022 18:30 | Test ID: | PR2113_31 | Sample ID: | Y03 |
| End Date: | 6/09/2022 18:30 | Lab ID: | 10677 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 25.00 | 0.00 | 40.00 | 19.15 | 17.50 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.80 | 98.80 | 98.80 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 98.70 | 98.70 | 98.70 | 0.00 | 0.00 | 1 |
| 100 | | 84.70 | 84.70 | 84.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 50 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 100 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |

# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report

**September 2023**

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ABN 95 619 426 201

# Toxicity Test Report: TR2187/1



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2187<br>23 August 2023<br>24 August 2023 |
| **Attention:** | Adrian Cukovski / Phil Wemyss | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00076590 | **ESA Quote #:** | PL2187_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11237 | Y0230823 | Aqueous sample, pH 6.0*, salinity 17.1‰*, total ammonia 25.5mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20.0±1.0°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 25 August 2023 at 1850h |

| Sample 11237: Y0230823<br>**Concentration (%)** | **% Fertilised Eggs (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 91.0 ± 1.6 | | |
| ASW Control | 92.5 ± 2.1 | | |
| 1.6 | 93.3 ± 2.2 | | |
| 3.1 | 92.0 ± 0.8 | | |
| 6.3 | 59.3 ± 10.6 * | | |
| 12.5 | 0.8 ± 1.5 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **IC10 = 4.1 (3.76-4.64)%**<br>**EC50 = 6.9 (6.65-7.13)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2187/1



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 91.0% | Yes |
| Reference Toxicant within cusum chart limits | 54.6-58.1µg Cu/L | 56.8µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 20 September 2023

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.



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# Toxicity Test Report: TR2187/2



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2187<br>23 August 2023<br>24 August 2023 |
| **Attention:** | Adrian Cukovski / Phil Wemyss | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00076590 | **ESA Quote #:** | PL2187_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 11237 | Y0230823 | Aqueous sample, pH 6.0*, salinity 17.1‰*, total ammonia 25.5mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20.0±1.0°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 25 August 2023 at 1900h |

| Sample 11237*:* Y0230823<br>**Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 94.3 ± 1.7 | | |
| ASW Control | 95.3 ± 2.1 | | |
| 1.6 | 95.3 ± 2.5 | | |
| 3.1 | 94.5 ± 1.7 | | |
| 6.3 | 96.0 ± 1.4 | | |
| 12.5 | 56.3 ± 7.3 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 = 8.6 (7.83-8.94)%**<br>**72-hr EC50 = 13.3 (12.89-13.79)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2187/2



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 94.3% | Yes |
| Reference Toxicant within cusum chart limits | 10.7-11.6µg Cu/L | 11.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 20 September 2023

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.



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# Toxicity Test Report: TR2187/3



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2187<br>23 August 2023<br>24 August 2023 |
| **Attention:** | Adrian Cukovski / Phil Wemyss | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00076590 | **ESA Quote #:** | PL2187_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11237 | Y0230823 | Aqueous sample, pH 6.0*, salinity 17.1‰*, total ammonia 25.5mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Test duration extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 25 August 2023 at 1930h |

| Sample 11237*:* Y0230823<br>**Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 78.0 ± 8.5 | | |
| ASW Control | 70.5 ± 2.4 | | |
| 1.6 | 79.5 ± 12.5 | | |
| 3.1 | 77.0 ± 4.2 | | |
| 6.3 | 71.8 ± 7.6 | | |
| 12.5 | 23.3 ± 7.0 * | | |
| 25 | 17.3 ± 5.4 * | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **48-hr EC10 = 5.1%**** | | | |
| **48-hr EC50 = 11.9 (5.83-17.02)%** | | | |
| **NOEC = 6.3%** | | | |
| **LOEC = 12.5%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)
**The 95% confidence limits are not reliable

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# Toxicity Test Report: TR2187/3



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 72.5% | Yes |
| Reference Toxicant within cusum chart limits | 8.9-12.4µg Cu/L | 10.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 20 September 2023

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.

# Toxicity Test Report: TR2187/4



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2187<br>23 August 2023<br>24 August 2023 |
| **Attention:** | Adrian Cukovski / Phil Wemyss | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00076590 | **ESA Quote #:** | PL2187_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11237 | Y0230823 | Aqueous sample, pH 6.0, salinity 17.1‰, total ammonia 25.5mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 25 August 2023 at 1730h |

| Sample 11237*:* Y0230823 | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 100 ± 0.0 | | |
| 12.5: 100 ± 0.0 | | |
| 25: 30.0 ± 11.6 * | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr EC10 = 20.3 (19.5421.05)%** | | |
| **96-hr EC50 = 21.8 (18.88-25.09)%** | | |
| **NOEC = 12.5%** | | |
| **LOEC = 25%** | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2187/4



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 6.1-117.0mg $NH_4^+$/L | 38.0mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 20 September 2023

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA



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# Toxicity Test Report: TR2187/6



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2187<br>23 August 2023<br>24 August 2023 |
| **Attention:** | Adrian Cukovski / Phil Wemyss | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00076590 | **ESA Quote #:** | PL2187_q01 |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 25 August 2023 at 1900h |

| Sample 11237*: Y0230823* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 100 ± 0.0 | | |
| 12.5: 100 ± 0.0 | | |
| 25: 90.0 ± 11.6 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 25.0 (22.27-37.16)%** | | |
| **96-hr EC50 = 33.0 (30.06-36.20)%** | | |
| **NOEC = 25%** | | |
| **LOEC = 50%** | | |

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 1.5-7.9mg SDS/L | 4.4mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 20 September 2023

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# Toxicity Test Report: TR2187/6



**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

NATA WORLD RECOGNISED ACCREDITATION

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# Toxicity Test Report: TR2187/7



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2187<br>23 August 2023<br>24 August 2023 |
| **Attention:** | Adrian Cukovski / Phil Wemyss | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00076590 | **ESA Quote #:** | PL2187_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11237 | Y0230823 | Aqueous sample, pH 6.0, salinity 17.1‰, total ammonia 25.5mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 25 August 2023 at 1900h |

| Sample 11237*: Y0230823* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **% Germination (Mean ± SD)** | |
| FSW Control | 94.3 ± 2.6 | |
| ASW Control | 95.5 ± 2.9 | |
| 1.6 | 97.0 ± 1.8 | |
| 3.1 | 96.0 ± 3.2 | |
| 6.3 | 96.8 ± 1.0 | |
| 12.5 | 95.5 ± 2.1 | |
| 25 | 56.8 ± 11.3 * | |
| 50 | 10.5 ± 5.5 | |
| 100 | 0.0 ± 0.0 | |
| **72-hr EC10 = 16.4 (15.01-17.62)%** | | |
| **72-hr EC50 = 28.4 (27.11-29.66)%** | | |
| **NOEC = 12.5%** | | |
| **LOEC = 25%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2187/7



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 94.3% | Yes |
| Reference Toxicant within cusum chart limits | 159.0-217.9µg Cu/L | 191.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 20 September 2023

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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www.ecotox.com.au
ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR2187/8 (Page 1 of 2)

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2187<br>23 August 2023<br>24 August 2023 |
| **Attention:** | Adrian Cukovski / Phil Wemyss | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00076590 | **ESA Quote #:** | PL2187_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11237 | Y0230823 | Aqueous sample, pH 6.0, salinity 17.1‰, total ammonia 25.5mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 25 August 2023 at 1630h |

| Sample 11237*: Y0230823* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | |
| FSW Control | 16.7 ± 0.7 | |
| ASW Control | 16.7 ± 0.5 | |
| 1.6 | 17.1 ± 0.6 | |
| 3.1 | 17.0 ± 0.7 | |
| 6.3 | 16.9 ± 0.8 | |
| 12.5 | 11.6 ± 1.8 * | |
| 25 | 2.2 ± 1.8 * | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |
| **72-hr IC10 = 8.3 (7.01-9.31)%** | | |
| **72-hr IC50 = 16.7 (13.95-18.71)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 17.7x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 4.3% | Yes |
| Reference Toxicant within cusum chart limits | 3.9-8.4µg Cu/L | 6.2µg Cu/L | Yes |

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ABN 95 619 426 201

# Toxicity Test Report: TR2187/8 

Test Report Authorised by: Dr Rick Krassoi, Director on 20 September 2023

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Chain-of-Custody Documentation

# Chain-of-Custody / Service Request Form

ecotox SERVICES AUSTRALIA

Datasheet ID: 601.1
Last Revised: 20 September 2018

Customer: Beach Energy — Ship To: Ecotox Services Aust
Contact Name: Adrian Cukovski — Attention: Rach Kitson
Phone: — Email: Adrian.cukovski@beachenergy.com.au (please provide an email address for sample receipt notification)
Sampled by: A. EVANS — Helen.Nottage@beachenergy.com.au

12°C.

| Sample Date (day/month/year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | Comments / Instructions |
|---|---|---|---|---|---|---|
| | | | Grab | 4 x 25L | | |
| 11237 23.8.23 | | Y0230823-1 | Grab | 1x 5ltr | ✓ ✓ ✓ ✓ ✓ ✓ | |
| 23.8.23 | | Y0230823-2 | Grab | 1x 5ltr | ✓ ✓ ✓ ✓ ✓ ✓ | |
| 23.8.23 | | Y0230823-3 | Grab | 1x 5ltr | ✓ ✓ ✓ ✓ ✓ ✓ | |

Note that testing will be delayed if an incomplete chain of custody is received

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

*Note: An MSDS must be attached if Available* 2188

ESA Project Number: PR [illegible]

| 1) Released By | Date | 2) Received By | Date | 3) Released By | Date | 4) Received By | Date |
|---|---|---|---|---|---|---|---|
| A EVANS | 23/8/23 | | 24/8/23 | | | | |
| Of: Beach Energy | Time: | Of: ESA | Time: 0820 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

Page 1 of 1

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Adrian Cukovski

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : Adrian.Cukovski@beachenergy.com.au
**Telephone** : 08 8433 2325
**Facsimile** :

**Date** : 25/08/2023

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR2187 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 24/08/2023
**Time samples received** : 8:20
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 11-15°C

**Comments** : 3 x 5L of sample received at 12 degrees C in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 18:50 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 25/08/2023 19:10 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9100 | 0.8900 | 0.9300 | 0.9100 |
| ASW Control | 0.9200 | 0.9500 | 0.9000 | 0.9300 |
| 1.6 | 0.9200 | 0.9100 | 0.9600 | 0.9400 |
| 3.1 | 0.9300 | 0.9200 | 0.9100 | 0.9200 |
| 6.3 | 0.7300 | 0.5200 | 0.6200 | 0.5000 |
| 12.5 | 0.0000 | 0.0000 | 0.0300 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

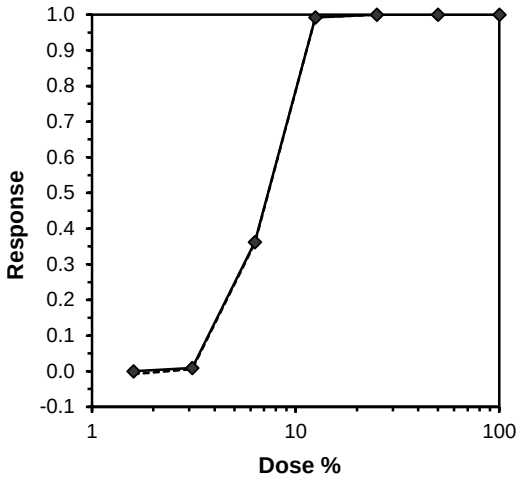
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9100 | 0.9838 | 1.2670 | 1.2327 | 1.3030 | 2.267 | 4 | | | | | |
| ASW Control | 0.9250 | 1.0000 | 1.2954 | 1.2490 | 1.3453 | 3.096 | 4 | * | | | 0.9288 | 1.0000 |
| 1.6 | 0.9325 | 1.0081 | 1.3107 | 1.2661 | 1.3694 | 3.499 | 4 | -0.345 | 2.360 | 0.1050 | 0.9288 | 1.0000 |
| 3.1 | 0.9200 | 0.9946 | 1.2843 | 1.2661 | 1.3030 | 1.174 | 4 | 0.248 | 2.360 | 0.1050 | 0.9200 | 0.9906 |
| *6.3 | 0.5925 | 0.6405 | 0.8804 | 0.7854 | 1.0244 | 12.454 | 4 | 9.322 | 2.360 | 0.1050 | 0.5925 | 0.6380 |
| *12.5 | 0.0075 | 0.0081 | 0.0810 | 0.0500 | 0.1741 | 76.547 | 4 | 27.283 | 2.360 | 0.1050 | 0.0075 | 0.0081 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.951621 | 0.905 | 0.85477 | 1.248147 |
| Bartlett's Test indicates equal variances (p = 0.07) | 8.766927 | 13.2767 | | |
| The control means are not significantly different (p = 0.29) | 1.149839 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.063945 | 0.069053 | 1.119011 | 0.003962 | 6.4E-14 | 4, 15 |

### Log-Logit Interpolation (200 Resamples)

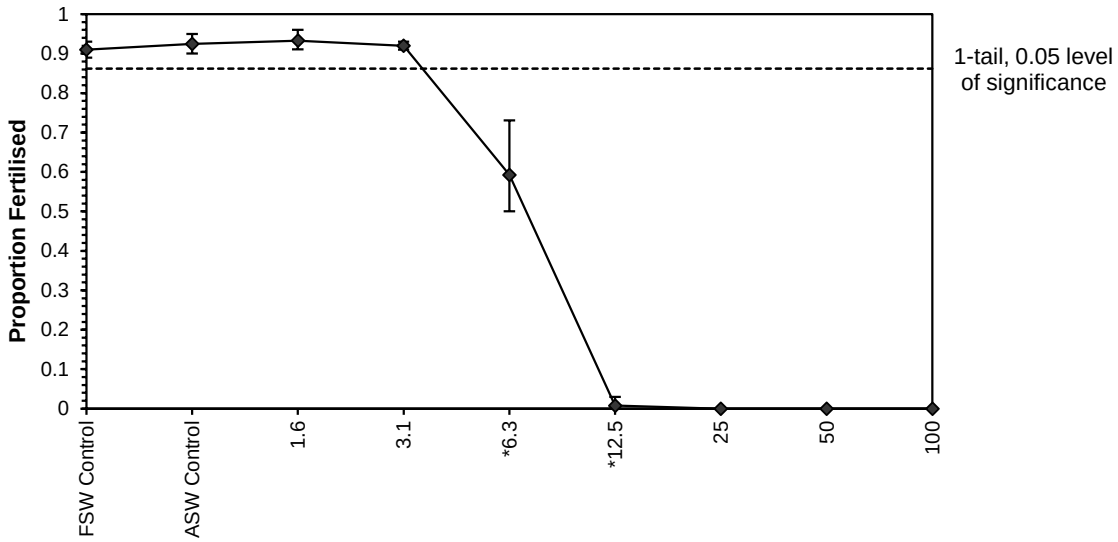
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.6197 | 0.1097 | 3.2440 | 3.9152 | -0.0486 |
| IC10 | 4.1459 | 0.1375 | 3.7598 | 4.6412 | 0.4508 |
| IC15 | 4.6049 | 0.1837 | 4.1571 | 5.2882 | 0.6149 |
| IC20 | 5.0264 | 0.2356 | 4.4986 | 5.8924 | 0.6658 |
| IC25 | 5.4268 | 0.2892 | 4.8018 | 6.4753 | 0.6624 |
| IC40 | 6.4242 | 0.1924 | 5.7022 | 6.9240 | -0.3352 |
| IC50 | 6.7548 | 0.1911 | 6.2043 | 7.3324 | 0.4833 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 18:50 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 25/08/2023 19:10 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 18:50 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 25/08/2023 19:10 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 91.00 | 89.00 | 93.00 | 1.63 | 1.40 | 4 |
| ASW Control | | 92.50 | 90.00 | 95.00 | 2.08 | 1.56 | 4 |
| 1.6 | | 93.25 | 91.00 | 96.00 | 2.22 | 1.60 | 4 |
| 3.1 | | 92.00 | 91.00 | 93.00 | 0.82 | 0.98 | 4 |
| 6.3 | | 59.25 | 50.00 | 73.00 | 10.56 | 5.49 | 4 |
| 12.5 | | 0.75 | 0.00 | 3.00 | 1.50 | 163.30 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 18:50 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 25/08/2023 19:10 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9100 | 0.8900 | 0.9300 | 0.9100 |
| ASW Control | 0.9200 | 0.9500 | 0.9000 | 0.9300 |
| 1.6 | 0.9200 | 0.9100 | 0.9600 | 0.9400 |
| 3.1 | 0.9300 | 0.9200 | 0.9100 | 0.9200 |
| 6.3 | 0.7300 | 0.5200 | 0.6200 | 0.5000 |
| 12.5 | 0.0000 | 0.0000 | 0.0300 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

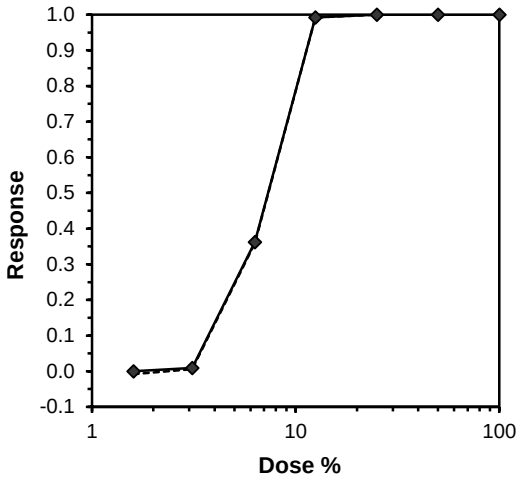
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9100 | 0.9838 | 1.2670 | 1.2327 | 1.3030 | 2.267 | 4 | | | | | |
| ASW Control | 0.9250 | 1.0000 | 1.2954 | 1.2490 | 1.3453 | 3.096 | 4 | * | | | 30 | 400 |
| 1.6 | 0.9325 | 1.0081 | 1.3107 | 1.2661 | 1.3694 | 3.499 | 4 | -0.345 | 2.360 | 0.1050 | 27 | 400 |
| 3.1 | 0.9200 | 0.9946 | 1.2843 | 1.2661 | 1.3030 | 1.174 | 4 | 0.248 | 2.360 | 0.1050 | 32 | 400 |
| *6.3 | 0.5925 | 0.6405 | 0.8804 | 0.7854 | 1.0244 | 12.454 | 4 | 9.322 | 2.360 | 0.1050 | 163 | 400 |
| *12.5 | 0.0075 | 0.0081 | 0.0810 | 0.0500 | 0.1741 | 76.547 | 4 | 27.283 | 2.360 | 0.1050 | 397 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.951621 | 0.905 | 0.85477 | 1.248147 |
| Bartlett's Test indicates equal variances (p = 0.07) | 8.766927 | 13.2767 | | |
| The control means are not significantly different (p = 0.29) | 1.149839 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.063945 | 0.069053 | 1.119011 | 0.003962 | 6.4E-14 | 4, 15 |

### Trimmed Spearman-Karber

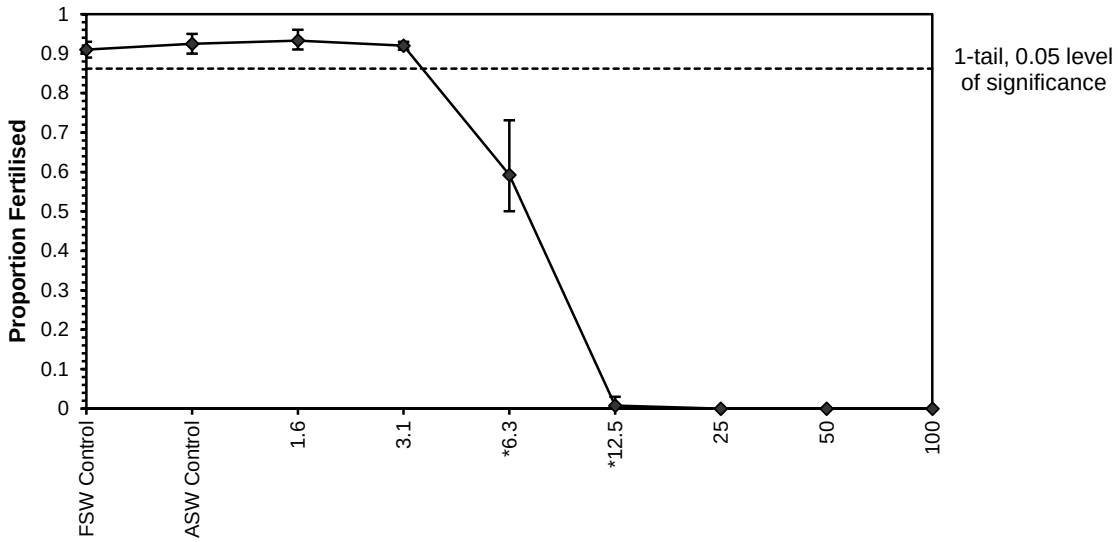
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 6.8884 | 6.6535 | 7.1317 |
| 5.0% | 6.9634 | 6.7062 | 7.2305 |
| 10.0% | 7.0357 | 6.7395 | 7.3448 |
| 20.0% | 7.1736 | 6.7447 | 7.6298 |
| Auto-0.0% | 6.8884 | 6.6535 | 7.1317 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 18:50 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 25/08/2023 19:10 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 18:50 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 25/08/2023 19:10 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 91.00 | 89.00 | 93.00 | 1.63 | 1.40 | 4 |
| ASW Control | | 92.50 | 90.00 | 95.00 | 2.08 | 1.56 | 4 |
| 1.6 | | 93.25 | 91.00 | 96.00 | 2.22 | 1.60 | 4 |
| 3.1 | | 92.00 | 91.00 | 93.00 | 0.82 | 0.98 | 4 |
| 6.3 | | 59.25 | 50.00 | 73.00 | 10.56 | 5.49 | 4 |
| 12.5 | | 0.75 | 0.00 | 3.00 | 1.50 | 163.30 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9500 | 0.9200 |
| ASW Control | 0.9500 | 0.9300 | 0.9800 | 0.9500 |
| 1.6 | 0.9800 | 0.9200 | 0.9600 | 0.9500 |
| 3.1 | 0.9300 | 0.9400 | 0.9700 | 0.9400 |
| 6.3 | 0.9800 | 0.9600 | 0.9500 | 0.9500 |
| 12.5 | 0.6300 | 0.5100 | 0.4900 | 0.6200 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

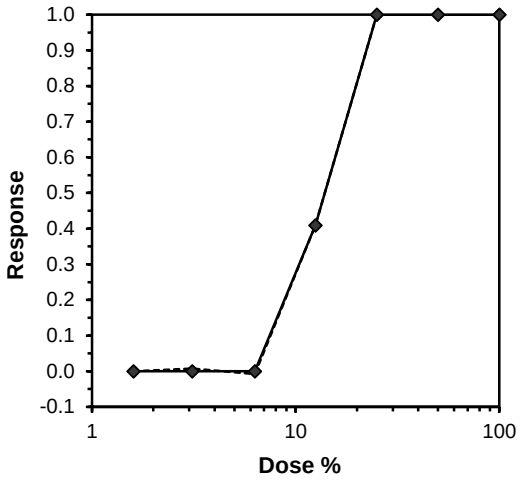
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9425 | 0.9895 | 1.3305 | 1.2840 | 1.3694 | 2.725 | 4 | | | | |
| ASW Control | 0.9525 | 1.0000 | 1.3556 | 1.3030 | 1.4289 | 3.891 | 4 | * | | 0.9525 | 1.0000 |
| 1.6 | 0.9525 | 1.0000 | 1.3569 | 1.2840 | 1.4289 | 4.419 | 4 | 18.50 | 10.00 | 0.9525 | 1.0000 |
| 3.1 | 0.9450 | 0.9921 | 1.3366 | 1.3030 | 1.3967 | 3.083 | 4 | 15.50 | 10.00 | 0.9525 | 1.0000 |
| 6.3 | 0.9600 | 1.0079 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | 20.50 | 10.00 | 0.9525 | 1.0000 |
| *12.5 | 0.5625 | 0.5906 | 0.8486 | 0.7754 | 0.9169 | 8.664 | 4 | 10.00 | 10.00 | 0.5625 | 0.5906 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.904353 | 0.905 | 0.263791 | -1.14122 |
| Bartlett's Test indicates equal variances (p = 0.84) | 1.438048 | 13.2767 | | |
| The control means are not significantly different (p = 0.46) | 0.784255 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

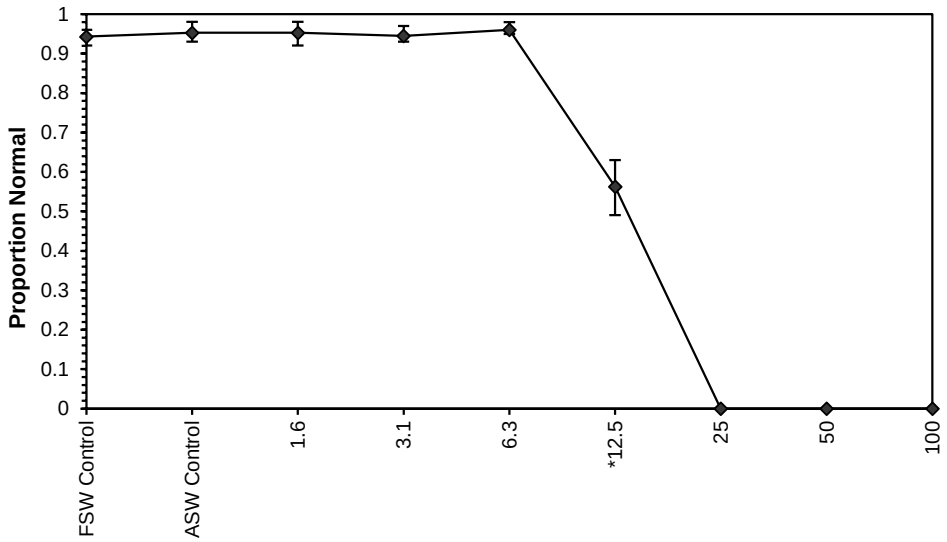
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.626 | 0.174 | 6.702 | 7.825 | -0.5805 |
| IC10 | 8.561 | 0.177 | 7.827 | 8.939 | 0.0088 |
| IC15 | 9.329 | 0.204 | 8.612 | 9.850 | 0.2367 |
| IC20 | 10.007 | 0.240 | 9.218 | 10.711 | 0.2986 |
| IC25 | 10.632 | 0.279 | 9.767 | 11.516 | 0.3096 |
| IC40 | 12.390 | 0.297 | 11.225 | 12.895 | -0.6544 |
| IC50 | 12.828 | 0.127 | 12.411 | 13.206 | -0.0623 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 94.25 | 92.00 | 96.00 | 1.71 | 1.39 | 4 |
| ASW Control | | 95.25 | 93.00 | 98.00 | 2.06 | 1.51 | 4 |
| 1.6 | | 95.25 | 92.00 | 98.00 | 2.50 | 1.66 | 4 |
| 3.1 | | 94.50 | 93.00 | 97.00 | 1.73 | 1.39 | 4 |
| 6.3 | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 12.5 | | 56.25 | 49.00 | 63.00 | 7.27 | 4.79 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 3.10 | 80.07 | 4 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9500 | 0.9200 |
| ASW Control | 0.9500 | 0.9300 | 0.9800 | 0.9500 |
| 1.6 | 0.9800 | 0.9200 | 0.9600 | 0.9500 |
| 3.1 | 0.9300 | 0.9400 | 0.9700 | 0.9400 |
| 6.3 | 0.9800 | 0.9600 | 0.9500 | 0.9500 |
| 12.5 | 0.6300 | 0.5100 | 0.4900 | 0.6200 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

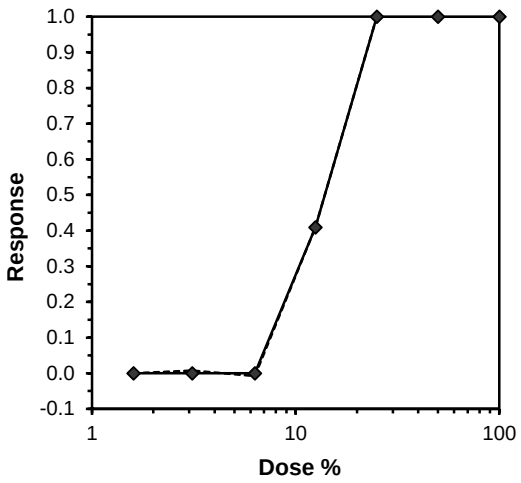
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9425 | 0.9895 | 1.3305 | 1.2840 | 1.3694 | 2.725 | 4 | | | | |
| ASW Control | 0.9525 | 1.0000 | 1.3556 | 1.3030 | 1.4289 | 3.891 | 4 | * | | 19 | 400 |
| 1.6 | 0.9525 | 1.0000 | 1.3569 | 1.2840 | 1.4289 | 4.419 | 4 | 18.50 | 10.00 | 19 | 400 |
| 3.1 | 0.9450 | 0.9921 | 1.3366 | 1.3030 | 1.3967 | 3.083 | 4 | 15.50 | 10.00 | 22 | 400 |
| 6.3 | 0.9600 | 1.0079 | 1.3722 | 1.3453 | 1.4289 | 2.876 | 4 | 20.50 | 10.00 | 16 | 400 |
| *12.5 | 0.5625 | 0.5906 | 0.8486 | 0.7754 | 0.9169 | 8.664 | 4 | 10.00 | 10.00 | 175 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.904353 | 0.905 | 0.263791 | -1.14122 |
| Bartlett's Test indicates equal variances (p = 0.84) | 1.438048 | 13.2767 | | |
| The control means are not significantly different (p = 0.46) | 0.784255 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

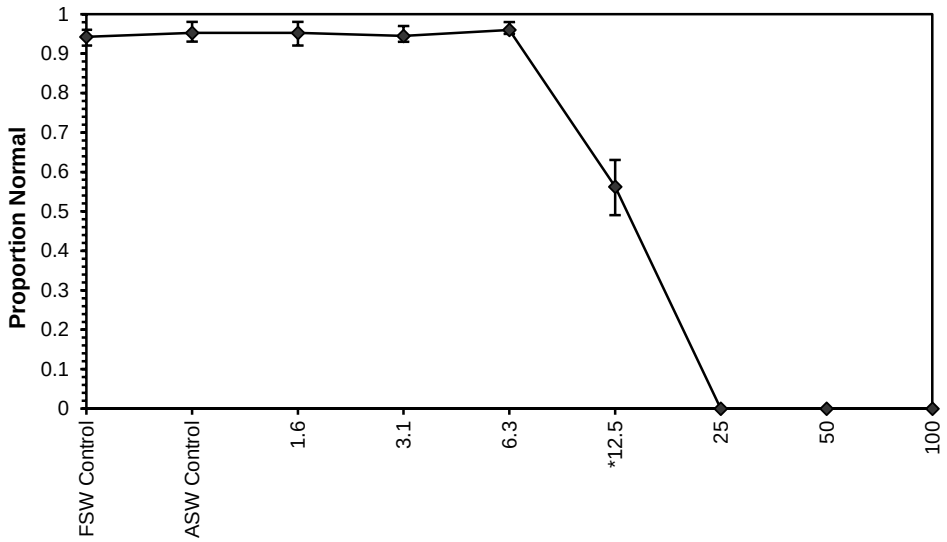
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 13.331 | 12.887 | 13.791 |
| 5.0% | 13.412 | 12.914 | 13.929 |
| 10.0% | 13.492 | 12.924 | 14.085 |
| 20.0% | 13.650 | 12.856 | 14.493 |
| Auto-0.0% | 13.331 | 12.887 | 13.791 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 94.25 | 92.00 | 96.00 | 1.71 | 1.39 | 4 |
| ASW Control | | 95.25 | 93.00 | 98.00 | 2.06 | 1.51 | 4 |
| 1.6 | | 95.25 | 92.00 | 98.00 | 2.50 | 1.66 | 4 |
| 3.1 | | 94.50 | 93.00 | 97.00 | 1.73 | 1.39 | 4 |
| 6.3 | | 96.00 | 95.00 | 98.00 | 1.41 | 1.24 | 4 |
| 12.5 | | 56.25 | 49.00 | 63.00 | 7.27 | 4.79 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:30 | Test ID: | PR2187/04 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.8900 | 0.8000 | 0.7300 | 0.7000 |
| ASW Control | 0.7300 | 0.6800 | 0.6900 | 0.7200 |
| 1.6 | 0.9800 | 0.7300 | 0.7100 | 0.7600 |
| 3.1 | 0.7400 | 0.8200 | 0.7300 | 0.7900 |
| 6.3 | 0.7300 | 0.6100 | 0.7900 | 0.7400 |
| 12.5 | 0.2700 | 0.1400 | 0.3000 | 0.2200 |
| 25 | 0.1400 | 0.1200 | 0.2400 | 0.1900 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.7800 | 1.1064 | 1.0889 | 0.9912 | 1.2327 | 9.882 | 4 | | | | |
| ASW Control | 0.7050 | 1.0000 | 0.9969 | 0.9695 | 1.0244 | 2.620 | 4 | * | | 118 | 400 |
| 1.6 | 0.7950 | 1.1277 | 1.1286 | 1.0021 | 1.4289 | 17.862 | 4 | 23.50 | 10.00 | 82 | 400 |
| 3.1 | 0.7700 | 1.0922 | 1.0719 | 1.0244 | 1.1326 | 4.750 | 4 | 25.50 | 10.00 | 92 | 400 |
| 6.3 | 0.7175 | 1.0177 | 1.0128 | 0.8963 | 1.0948 | 8.251 | 4 | 21.50 | 10.00 | 113 | 400 |
| *12.5 | 0.2325 | 0.3298 | 0.4994 | 0.3835 | 0.5796 | 17.227 | 4 | 10.00 | 10.00 | 307 | 400 |
| *25 | 0.1725 | 0.2447 | 0.4251 | 0.3537 | 0.5120 | 16.659 | 4 | 10.00 | 10.00 | 331 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.889254 | 0.916 | 1.388444 | 4.099237 |
| Bartlett's Test indicates equal variances (p = 0.04) | 11.43386 | 15.08627 | | |
| The control means are not significantly different (p = 0.15) | 1.661795 | 2.446912 | | |

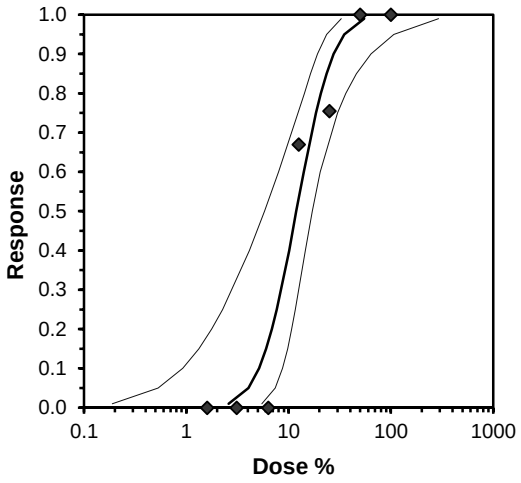
| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 3.510846 | 0.786596 | 1.488836 | 5.532856 | 0.295 | 70.18016 | 11.0705 | 9.4E-14 | 1.075874 | 0.284832 | 8 |
| Intercept | 1.222772 | 0.957879 | -1.23953 | 3.685079 | | | | | | | |
| TSCR | 0.231982 | 0.049014 | 0.105987 | 0.357977 | | | | | | | |

| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.589742 | 0.18875 | 5.465036 |
| EC05 | 3.355 | 4.049186 | 0.53241 | 7.381441 |
| EC10 | 3.718 | 5.138633 | 0.921097 | 8.704866 |
| EC15 | 3.964 | 6.03483 | 1.32917 | 9.759485 |
| EC20 | 4.158 | 6.857309 | 1.774351 | 10.71585 |
| EC25 | 4.326 | 7.651702 | 2.267665 | 11.63994 |
| EC40 | 4.747 | 10.08586 | 4.138734 | 14.57625 |
| EC50 | 5.000 | 11.90897 | 5.829392 | 17.01548 |
| EC60 | 5.253 | 14.06162 | 8.002264 | 20.38021 |
| EC75 | 5.674 | 18.53489 | 12.40681 | 30.04312 |
| EC80 | 5.842 | 20.68209 | 14.26382 | 36.27713 |
| EC85 | 6.036 | 23.50082 | 16.43709 | 46.14266 |
| EC90 | 6.282 | 27.59945 | 19.19491 | 63.92652 |
| EC95 | 6.645 | 35.02518 | 23.45509 | 106.7358 |
| EC99 | 7.326 | 54.76355 | 32.6659 | 291.9857 |

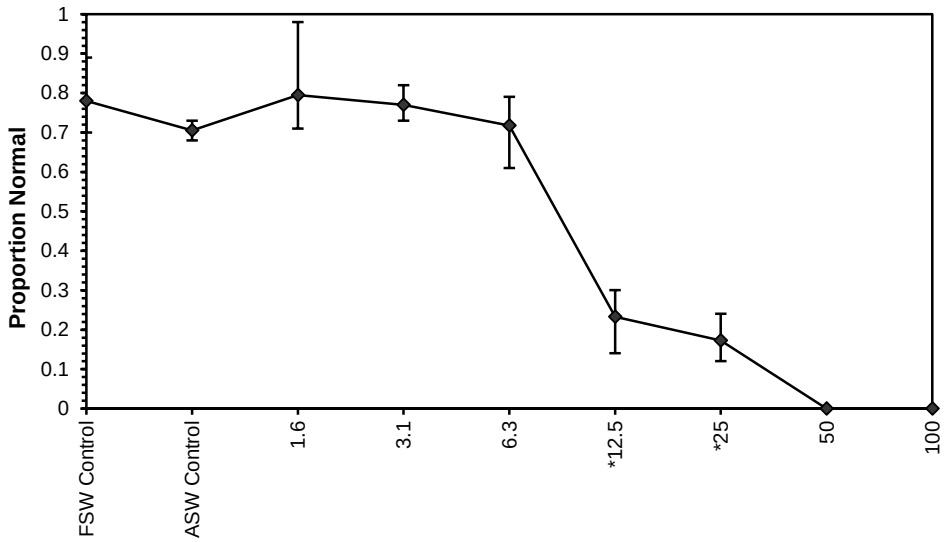
Significant heterogeneity detected (p = 9.40E-14)



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:30 | Test ID: | PR2187/04 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:30 | Test ID: | PR2187/04 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 78.00 | 70.00 | 89.00 | 8.45 | 3.73 | 4 |
| ASW Control | | 70.50 | 68.00 | 73.00 | 2.38 | 2.19 | 4 |
| 1.6 | | 79.50 | 71.00 | 98.00 | 12.50 | 4.45 | 4 |
| 3.1 | | 77.00 | 73.00 | 82.00 | 4.24 | 2.68 | 4 |
| 6.3 | | 71.75 | 61.00 | 79.00 | 7.63 | 3.85 | 4 |
| 12.5 | | 23.25 | 14.00 | 30.00 | 6.99 | 11.37 | 4 |
| 25 | | 17.25 | 12.00 | 24.00 | 5.38 | 13.44 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 25 | 0.4000 | 0.2000 | 0.2000 | 0.4000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

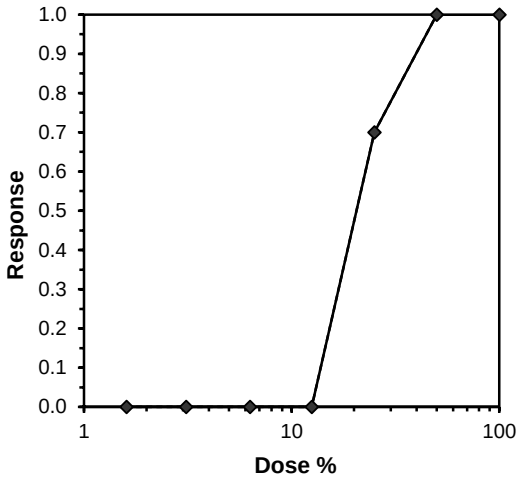
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *25 | 0.3000 | 0.3000 | 0.5742 | 0.4636 | 0.6847 | 22.229 | 4 | 10.00 | 10.00 | 0.3000 | 0.3000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.576233 | 0.916 | 2.19E-15 | 4.032468 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 12.5 | 25 | 17.67767 | 8 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

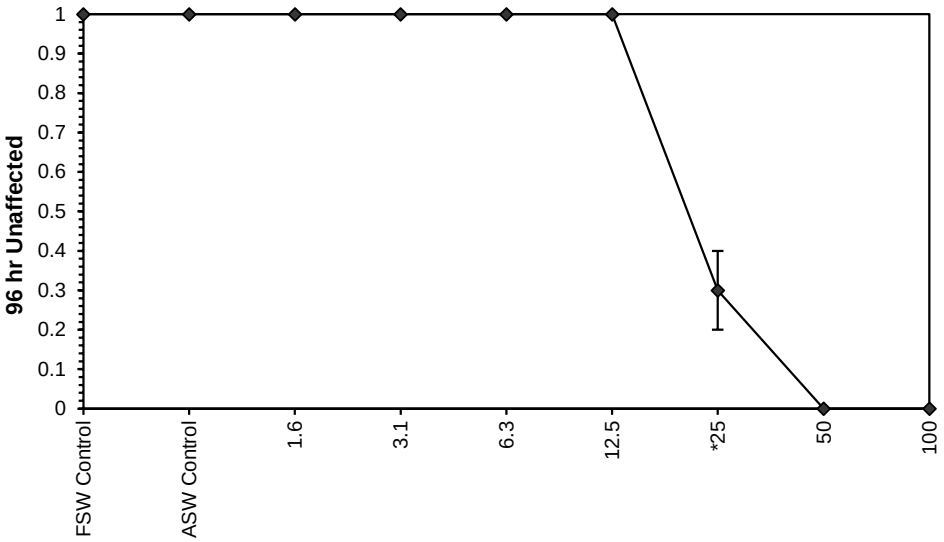
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 19.308 | 0.199 | 18.640 | 19.923 | -0.1785 |
| IC10 | 20.321 | 0.234 | 19.537 | 21.045 | -0.1761 |
| IC15 | 20.974 | 0.257 | 20.113 | 21.770 | -0.1746 |
| IC20 | 21.478 | 0.275 | 20.557 | 22.331 | -0.1735 |
| IC25 | 21.904 | 0.291 | 20.931 | 22.804 | -0.1725 |
| IC40 | 22.962 | 0.330 | 21.859 | 23.986 | -0.1703 |
| IC50 | 23.603 | 0.355 | 22.420 | 24.704 | -0.1690 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 25 | | 30.00 | 20.00 | 40.00 | 11.55 | 11.33 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.40 | 8.40 | 8.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 25 | 0.4000 | 0.2000 | 0.2000 | 0.4000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

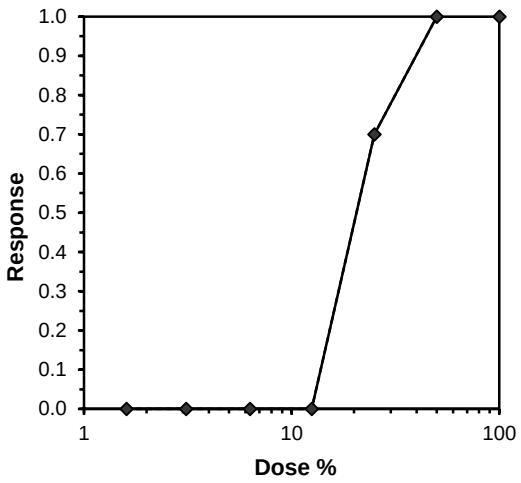
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 12.5 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *25 | 0.3000 | 0.3000 | 0.5742 | 0.4636 | 0.6847 | 22.229 | 4 | 10.00 | 10.00 | 14 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.576233 | 0.916 | 2.19E-15 | 4.032468 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 12.5 | 25 | 17.67767 | 8 |
| Treatments vs ASW Control | | | | |

**Trimmed Spearman-Karber**

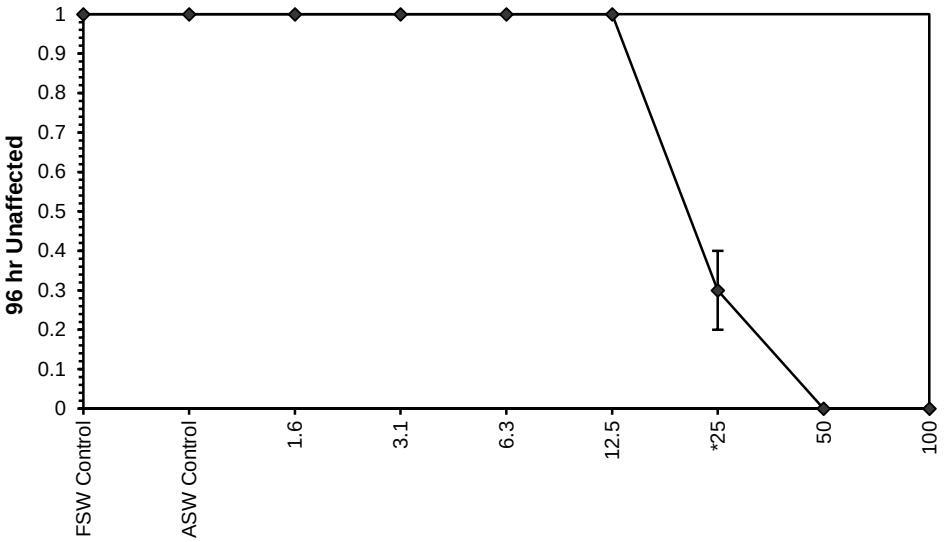
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 21.764 | 18.882 | 25.086 |
| 5.0% | 21.470 | 18.368 | 25.096 |
| 10.0% | 21.197 | 17.892 | 25.112 |
| 20.0% | 20.735 | 17.082 | 25.170 |
| Auto-0.0% | 21.764 | 18.882 | 25.086 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 25 | | 30.00 | 20.00 | 40.00 | 11.55 | 11.33 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/08 | Sample ID: | Y0230823 |
| End Date: | 31/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 19.740 | 19.140 | 18.940 | 19.140 |
| ASW Control | 17.500 | 19.020 | 19.740 | 17.940 |
| 1.6 | 17.580 | 19.140 | 18.160 | 19.020 |
| 3.1 | 19.180 | 19.640 | 17.980 | 17.580 |
| 6.3 | 16.380 | 19.500 | 19.080 | 18.760 |
| 12.5 | 14.920 | 14.980 | 16.980 | 16.440 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

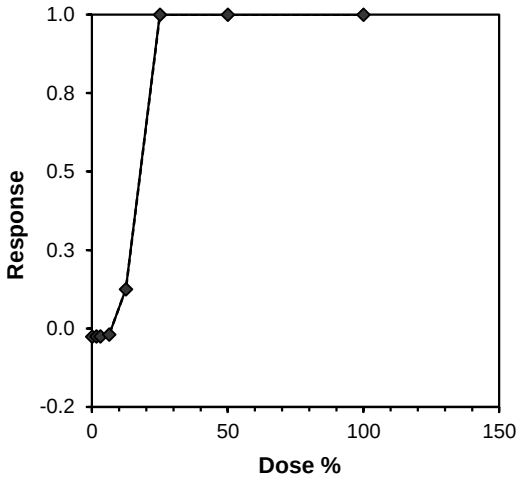
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 19.240 | 1.0372 | 19.240 | 18.940 | 19.740 | 1.800 | 4 | | | | | |
| ASW Control | 18.550 | 1.0000 | 18.550 | 17.500 | 19.740 | 5.490 | 4 | * | | | 18.550 | 1.0000 |
| 1.6 | 18.475 | 0.9960 | 18.475 | 17.580 | 19.140 | 4.001 | 4 | 0.100 | 2.360 | 1.762 | 18.535 | 0.9992 |
| 3.1 | 18.595 | 1.0024 | 18.595 | 17.580 | 19.640 | 5.235 | 4 | -0.060 | 2.360 | 1.762 | 18.535 | 0.9992 |
| 6.3 | 18.430 | 0.9935 | 18.430 | 16.380 | 19.500 | 7.596 | 4 | 0.161 | 2.360 | 1.762 | 18.430 | 0.9935 |
| *12.5 | 15.830 | 0.8534 | 15.830 | 14.920 | 16.980 | 6.570 | 4 | 3.644 | 2.360 | 1.762 | 15.830 | 0.8534 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.906583 | 0.905 | -0.46226 | -0.82254 |
| Bartlett's Test indicates equal variances (p = 0.90) | 1.091563 | 13.2767 | | |
| The control means are not significantly different (p = 0.25) | 1.282847 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 6.3 | 12.5 | 8.87412 | 15.87302 | 1.761736 | 0.094972 | 5.77307 | 1.11452 | 0.007985 | 4, 15 |
| Treatments vs ASW Control | | | | | | | | | | |

### Linear Interpolation (200 Resamples)

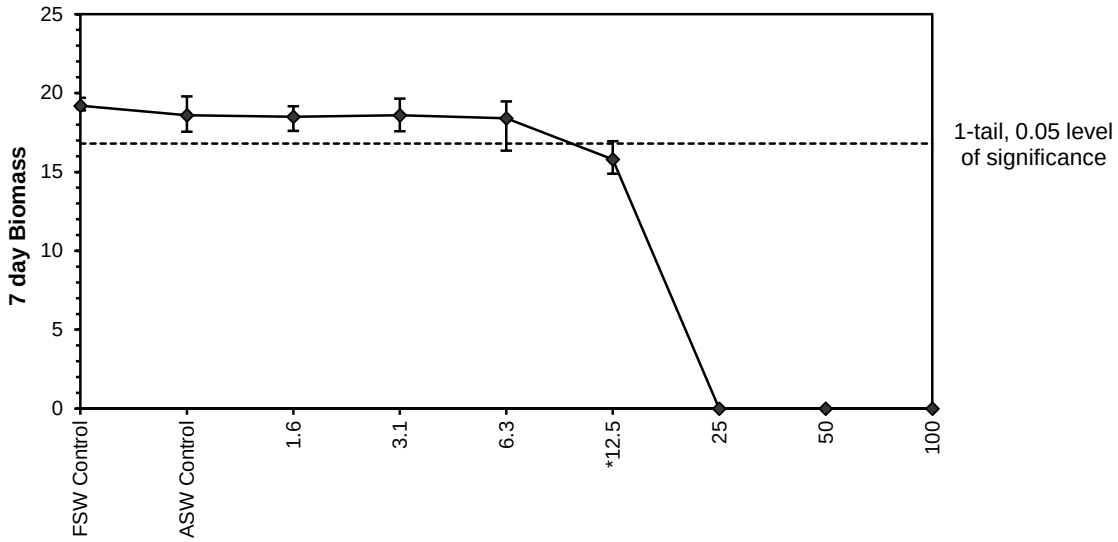
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 8.226 | 1.540 | 0.000 | 9.467 | -1.5712 |
| IC10 | 10.437 | 1.225 | 5.363 | 13.297 | -0.7848 |
| IC15 | 12.549 | 0.923 | 8.520 | 13.488 | -2.0940 |
| IC20 | 13.282 | 0.444 | 11.808 | 14.165 | -2.2745 |
| IC25 | 14.014 | 0.343 | 12.767 | 14.842 | -0.1566 |
| IC40 | 16.211 | 0.275 | 15.214 | 16.874 | -0.1566 |
| IC50 | 17.676 | 0.229 | 16.845 | 18.228 | -0.1566 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/08 | Sample ID: | Y0230823 |
| End Date: | 31/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/08 | Sample ID: | Y0230823 |
| End Date: | 31/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 19.24 | 18.94 | 19.74 | 0.35 | 3.06 | 4 |
| ASW Control | | 18.55 | 17.50 | 19.74 | 1.02 | 5.44 | 4 |
| 1.6 | | 18.48 | 17.58 | 19.14 | 0.74 | 4.65 | 4 |
| 3.1 | | 18.60 | 17.58 | 19.64 | 0.97 | 5.31 | 4 |
| 6.3 | | 18.43 | 16.38 | 19.50 | 1.40 | 6.42 | 4 |
| 12.5 | | 15.83 | 14.92 | 16.98 | 1.04 | 6.44 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 25 | 0.4000 | 0.2000 | 0.2000 | 0.4000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

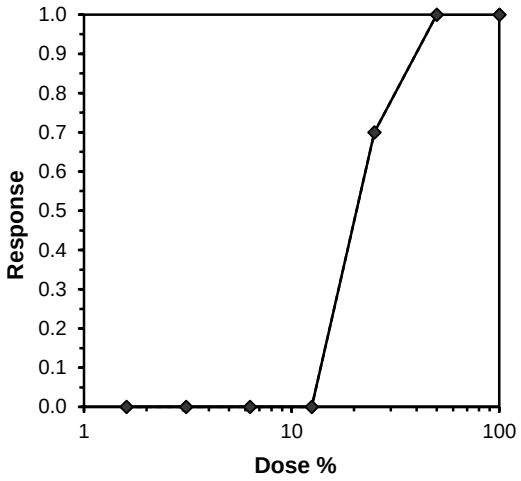
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *25 | 0.3000 | 0.3000 | 0.5742 | 0.4636 | 0.6847 | 22.229 | 4 | 10.00 | 10.00 | 0.3000 | 0.3000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.576233 | 0.916 | 2.19E-15 | 4.032468 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 12.5 | 25 | 17.67767 | 8 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

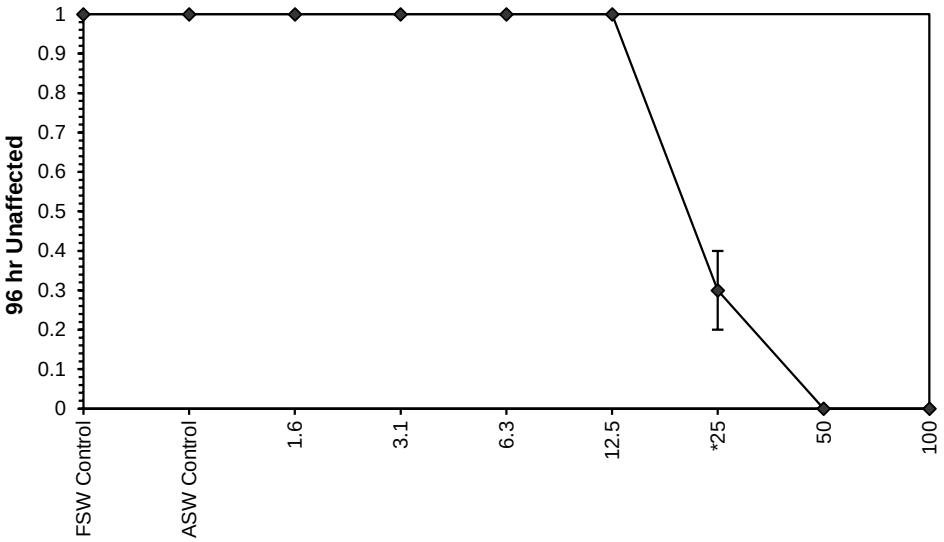
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 19.308 | 0.199 | 18.640 | 19.923 | -0.1785 |
| IC10 | 20.321 | 0.234 | 19.537 | 21.045 | -0.1761 |
| IC15 | 20.974 | 0.257 | 20.113 | 21.770 | -0.1746 |
| IC20 | 21.478 | 0.275 | 20.557 | 22.331 | -0.1735 |
| IC25 | 21.904 | 0.291 | 20.931 | 22.804 | -0.1725 |
| IC40 | 22.962 | 0.330 | 21.859 | 23.986 | -0.1703 |
| IC50 | 23.603 | 0.355 | 22.420 | 24.704 | -0.1690 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 17:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 17:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 25 | | 30.00 | 20.00 | 40.00 | 11.55 | 11.33 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.40 | 8.40 | 8.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/02 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 25 | 0.8000 | 1.0000 | 0.8000 | 1.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

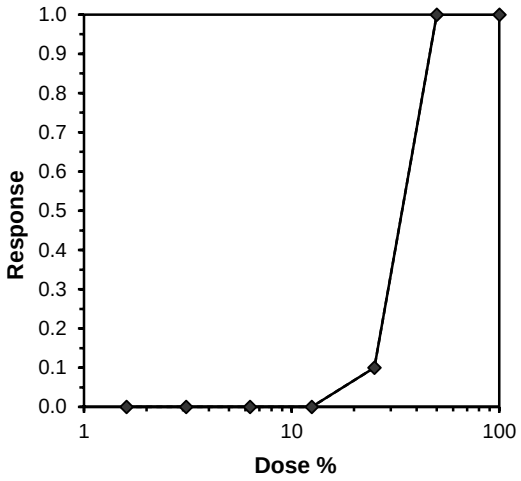
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 25 | 0.9000 | 0.9000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 14.00 | 10.00 | 0.9000 | 0.9000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.576233 | 0.916 | 6.57E-15 | 4.032468 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 25 | 50 | 35.35534 | 4 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

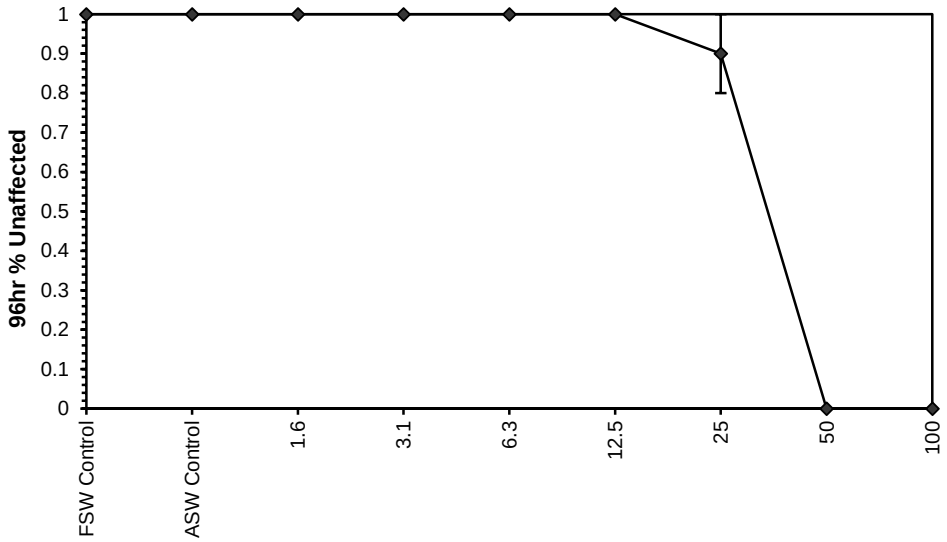
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 23.246 | 2.443 | 20.962 | 36.767 | 2.2460 |
| IC10 | 25.000 | 2.229 | 22.268 | 37.164 | 2.3567 |
| IC15 | 25.720 | 2.122 | 23.372 | 37.649 | 2.5052 |
| IC20 | 26.276 | 2.078 | 24.235 | 38.017 | 2.5413 |
| IC25 | 26.743 | 2.050 | 24.722 | 38.322 | 2.5374 |
| IC40 | 27.902 | 1.979 | 25.935 | 39.064 | 2.5280 |
| IC50 | 28.603 | 1.933 | 26.671 | 39.501 | 2.5224 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/02 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/02 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 25 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.40 | 8.40 | 8.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/02 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 25 | 0.8000 | 1.0000 | 0.8000 | 1.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

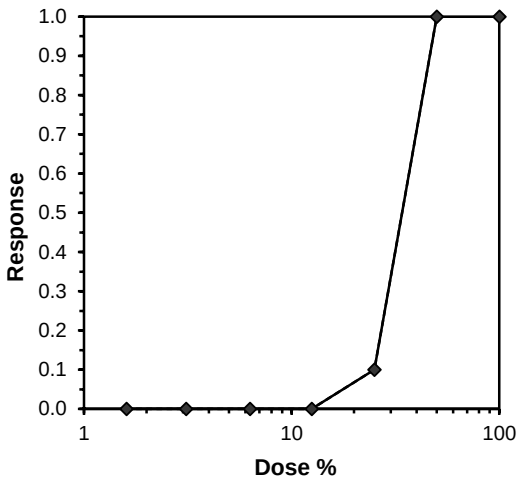
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 12.5 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 25 | 0.9000 | 0.9000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 14.00 | 10.00 | 2 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.576233 | 0.916 | 6.57E-15 | 4.032468 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 25 | 50 | 35.35534 | 4 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

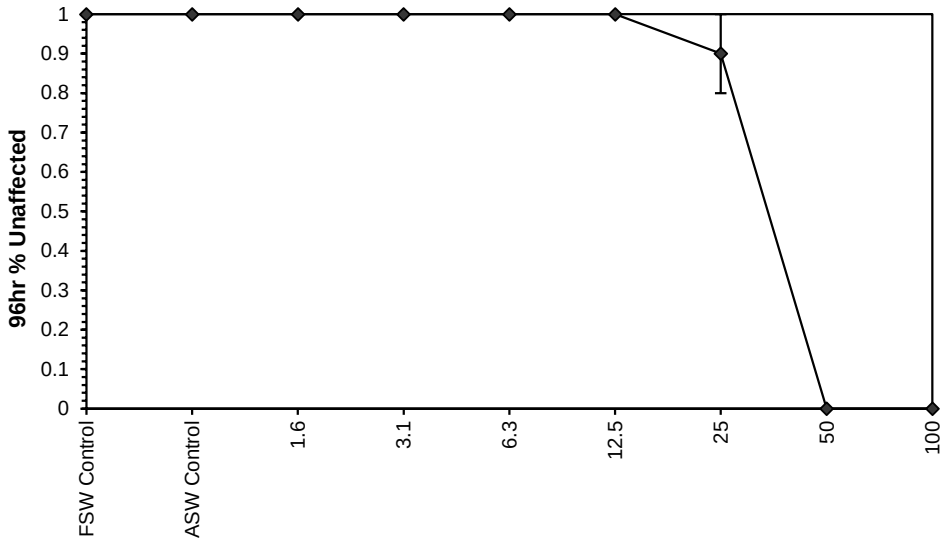
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 32.988 | 30.058 | 36.203 |
| 5.0% | 33.730 | 30.033 | 37.882 |
| 10.0% | 34.020 | 32.122 | 36.030 |
| 20.0% | 34.020 | 32.122 | 36.030 |
| Auto-0.0% | 32.988 | 30.058 | 36.203 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/02 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 19:00 | Test ID: | PR2187/02 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 19:00 | Lab ID: | 11237 | Sample Type: | Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 25 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.40 | 8.40 | 8.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 20:30 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 20:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9200 | 0.9300 | 0.9800 |
| ASW Control | 0.9600 | 0.9500 | 0.9200 | 0.9900 |
| 1.6 | 0.9500 | 0.9800 | 0.9600 | 0.9900 |
| 3.1 | 0.9800 | 0.9500 | 0.9200 | 0.9900 |
| 6.3 | 0.9700 | 0.9800 | 0.9600 | 0.9600 |
| 12.5 | 0.9800 | 0.9600 | 0.9500 | 0.9300 |
| 25 | 0.4300 | 0.6200 | 0.6900 | 0.5300 |
| 50 | 0.1100 | 0.0300 | 0.1200 | 0.1600 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9425 | 0.9869 | 1.3348 | 1.2840 | 1.4289 | 4.850 | 4 | | | | | |
| ASW Control | 0.9550 | 1.0000 | 1.3673 | 1.2840 | 1.4706 | 5.680 | 4 | * | | | 18 | 400 |
| 1.6 | 0.9700 | 1.0157 | 1.4036 | 1.3453 | 1.4706 | 4.051 | 4 | -0.651 | 2.451 | 0.1364 | 12 | 400 |
| 3.1 | 0.9600 | 1.0052 | 1.3822 | 1.2840 | 1.4706 | 6.053 | 4 | -0.267 | 2.451 | 0.1364 | 16 | 400 |
| 6.3 | 0.9675 | 1.0131 | 1.3911 | 1.3694 | 1.4289 | 2.033 | 4 | -0.427 | 2.451 | 0.1364 | 13 | 400 |
| 12.5 | 0.9550 | 1.0000 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | 0.102 | 2.451 | 0.1364 | 18 | 400 |
| *25 | 0.5675 | 0.5942 | 0.8544 | 0.7152 | 0.9803 | 13.427 | 4 | 9.217 | 2.451 | 0.1364 | 173 | 400 |
| *50 | 0.1050 | 0.1099 | 0.3194 | 0.1741 | 0.4115 | 31.898 | 4 | 18.830 | 2.451 | 0.1364 | 358 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

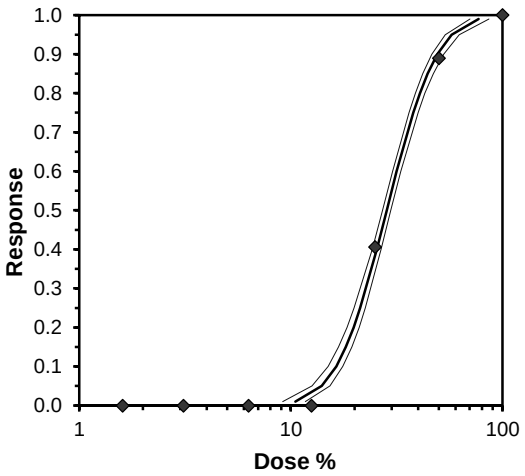
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.978578 | 0.924 | -0.27794 | -0.28183 |
| Bartlett's Test indicates equal variances (p = 0.46) | 5.697355 | 16.81189 | | |
| The control means are not significantly different (p = 0.54) | 0.643295 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 12.5 | 25 | 17.67767 | 8 | 0.070316 | 0.073309 | 0.697099 | 0.006195 | 7.4E-15 | 6, 21 |
| Treatments vs ASW Control | | | | | | | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 5.362889 | 0.281181 | 4.811775 | 5.914003 | 0.045 | 5.584663 | 11.0705 | 0.35 | 1.453081 | 0.186467 | 4 |
| Intercept | -2.79271 | 0.421241 | -3.61835 | -1.96708 | | | | | | | |
| TSCR | 0.034896 | 0.004471 | 0.026133 | 0.043659 | | | | | | | |

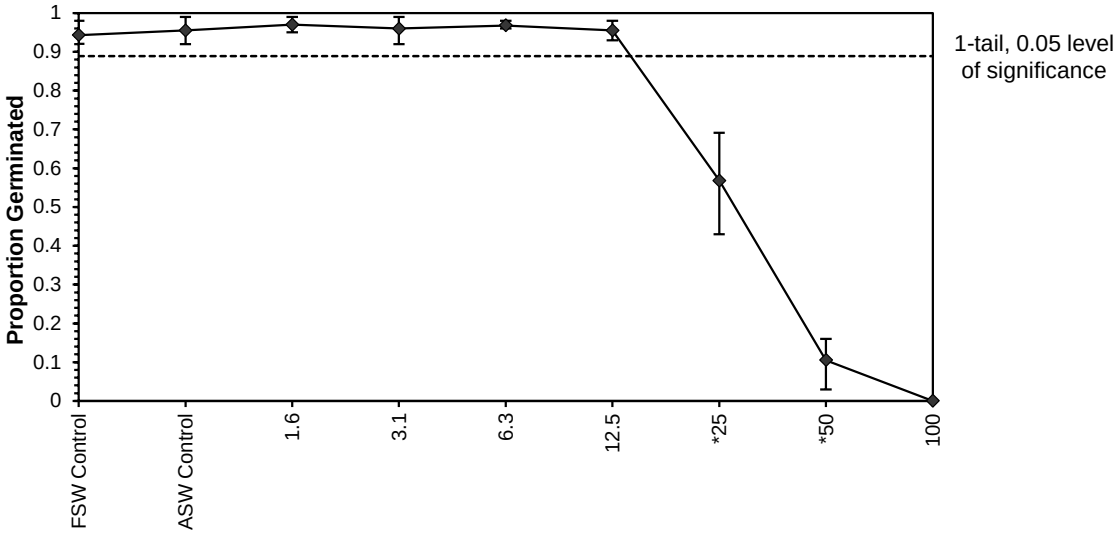
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 10.4543 | 9.147259 | 11.67215 |
| EC05 | 3.355 | 14.00784 | 12.64032 | 15.25978 |
| EC10 | 3.718 | 16.37249 | 15.00703 | 17.61754 |
| EC15 | 3.964 | 18.18952 | 16.84039 | 19.42121 |
| EC20 | 4.158 | 19.7764 | 18.4477 | 20.99489 |
| EC25 | 4.326 | 21.24768 | 19.93987 | 22.45575 |
| EC40 | 4.747 | 25.45896 | 24.19411 | 26.67317 |
| EC50 | 5.000 | 28.38451 | 27.10737 | 29.66109 |
| EC60 | 5.253 | 31.64625 | 30.29057 | 33.07173 |
| EC75 | 5.674 | 37.91851 | 36.20563 | 39.87702 |
| EC80 | 5.842 | 40.73951 | 38.79103 | 43.02903 |
| EC85 | 6.036 | 44.29368 | 41.99823 | 47.06406 |
| EC90 | 6.282 | 49.2094 | 46.36194 | 52.74084 |
| EC95 | 6.645 | 57.51641 | 53.59596 | 62.53312 |
| EC99 | 7.326 | 77.06689 | 70.15873 | 86.30285 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 20:30 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 20:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 20:30 | Test ID: | PR2187/03 | Sample ID: | Y0230823 |
| End Date: | 29/08/2023 20:00 | Lab ID: | 11237 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Germination, % | 94.25 | 92.00 | 98.00 | 2.63 | 1.72 | 4 |
| ASW Control | | 95.50 | 92.00 | 99.00 | 2.89 | 1.78 | 4 |
| 1.6 | | 97.00 | 95.00 | 99.00 | 1.83 | 1.39 | 4 |
| 3.1 | | 96.00 | 92.00 | 99.00 | 3.16 | 1.85 | 4 |
| 6.3 | | 96.75 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| 12.5 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 25 | | 56.75 | 43.00 | 69.00 | 11.27 | 5.91 | 4 |
| 50 | | 10.50 | 3.00 | 16.00 | 5.45 | 22.23 | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.40 | 8.40 | 8.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 89.40 | 89.40 | 89.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 3.1 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.00 | 99.00 | 99.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.40 | 98.40 | 98.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.70 | 97.70 | 97.70 | 0.00 | 0.00 | 1 |
| 100 | | 93.30 | 93.30 | 93.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 16:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 16:30 | Lab ID: | 11232 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 15.771 | 17.971 | 17.171 | 16.271 | 17.071 | 16.071 | 16.471 | 16.371 |
| ASW Control | 16.071 | 17.171 | 17.071 | 16.571 | | | | |
| 1.6 | 16.871 | 17.171 | 16.371 | 17.771 | | | | |
| 3.1 | 17.971 | 16.271 | 16.571 | 16.971 | | | | |
| 6.3 | 17.471 | 15.771 | 16.871 | 17.371 | | | | |
| 12.5 | 13.471 | 9.471 | 12.771 | 10.771 | | | | |
| 25 | 2.271 | 0.000 | 4.271 | 2.371 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

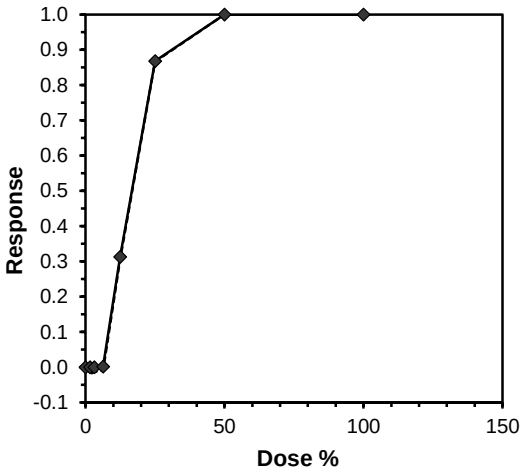
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 16.646 | 0.9955 | 16.646 | 15.771 | 17.971 | 4.281 | 8 | | | | | |
| ASW Control | 16.721 | 1.0000 | 16.721 | 16.071 | 17.171 | 3.030 | 4 | * | | | 16.904 | 1.0000 |
| 1.6 | 17.046 | 1.0194 | 17.046 | 16.371 | 17.771 | 3.433 | 4 | -0.394 | 2.410 | 1.989 | 16.904 | 1.0000 |
| 3.1 | 16.946 | 1.0135 | 16.946 | 16.271 | 17.971 | 4.373 | 4 | -0.273 | 2.410 | 1.989 | 16.904 | 1.0000 |
| 6.3 | 16.871 | 1.0090 | 16.871 | 15.771 | 17.471 | 4.617 | 4 | -0.182 | 2.410 | 1.989 | 16.871 | 0.9980 |
| *12.5 | 11.621 | 0.6950 | 11.621 | 9.471 | 13.471 | 15.782 | 4 | 6.181 | 2.410 | 1.989 | 11.621 | 0.6874 |
| *25 | 2.228 | 0.1332 | 2.228 | 0.000 | 4.271 | 78.424 | 4 | 17.563 | 2.410 | 1.989 | 2.228 | 0.1318 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.965956 | 0.916 | -0.24053 | 0.596638 |
| Bartlett's Test indicates equal variances (p = 0.15) | 8.112268 | 15.08627 | | |
| The control means are not significantly different (p = 0.86) | 0.186231 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 6.3 | 12.5 | 8.87412 | 15.87302 | 1.988672 | 0.118936 | 141.3891 | 1.361828 | 1.3E-12 | 5, 18 |
| Treatments vs ASW Control | | | | | | | | | | |

### Linear Interpolation (200 Resamples)

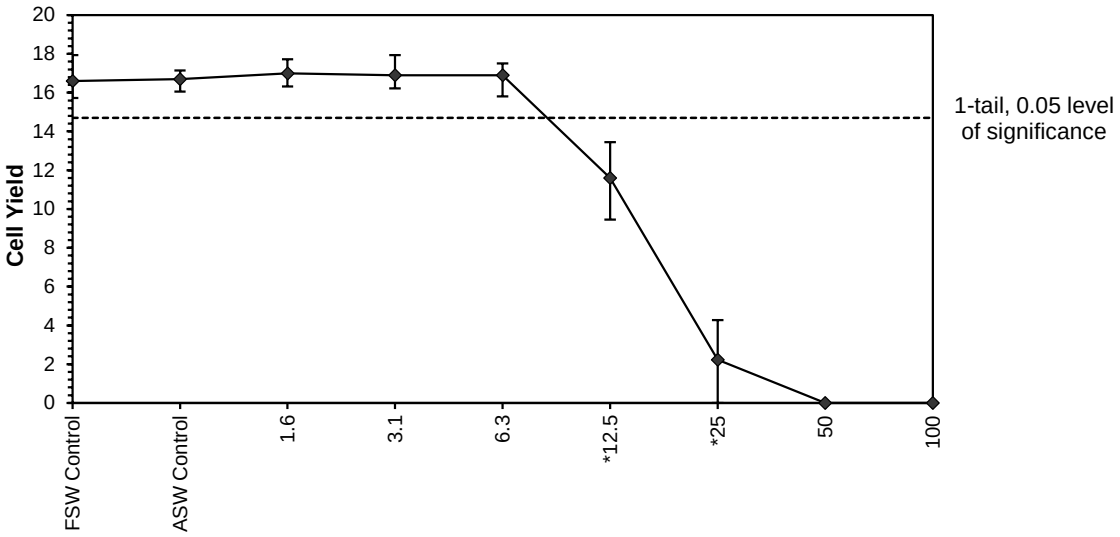
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.259 | 0.357 | 5.997 | 7.814 | -2.5940 |
| IC10 | 8.257 | 0.397 | 7.012 | 9.314 | 0.2087 |
| IC15 | 9.255 | 0.534 | 7.900 | 10.980 | 0.5204 |
| IC20 | 10.253 | 0.694 | 8.603 | 12.673 | 0.6221 |
| IC25 | 11.251 | 0.820 | 9.328 | 13.899 | 0.4482 |
| IC40 | 14.467 | 0.955 | 11.351 | 16.643 | -0.3035 |
| IC50 | 16.717 | 0.826 | 13.953 | 18.705 | -0.3849 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 16:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 16:30 | Lab ID: | 11232 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 25/08/2023 16:30 | Test ID: | PR2187/06 | Sample ID: | Y0230823 |
| End Date: | 28/08/2023 16:30 | Lab ID: | 11232 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 16.65 | 15.77 | 17.97 | 0.71 | 5.07 | 8 |
| ASW Control | | 16.72 | 16.07 | 17.17 | 0.51 | 4.26 | 4 |
| 1.6 | | 17.05 | 16.37 | 17.77 | 0.59 | 4.49 | 4 |
| 3.1 | | 16.95 | 16.27 | 17.97 | 0.74 | 5.08 | 4 |
| 6.3 | | 16.87 | 15.77 | 17.47 | 0.78 | 5.23 | 4 |
| 12.5 | | 11.62 | 9.47 | 13.47 | 1.83 | 11.65 | 4 |
| 25 | | 2.23 | 0.00 | 4.27 | 1.75 | 59.33 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.40 | 8.40 | 8.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 7.90 | 7.90 | 7.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| 25 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 50 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 100 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| ASW Control | | 34.70 | 34.70 | 34.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 25 | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| 100 | | 35.00 | 35.00 | 35.00 | 0.00 | 0.00 | 1 |

# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report

**September 2024**

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ABN 95 619 426 201

# Toxicity Test Report: TR2234/1_R01



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2234<br>11 September 2024<br>12 September 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00089994 | **ESA Quote #:** | PL2234_q02 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11710 | Y0110924 | Aqueous sample, pH 5.9*, salinity 10.0‰*, total ammonia 21.4mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20.0±1.0°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 13 September 2024 at 1840h |

| Sample 11710*: Y0110924* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control | 93.0 ± 1.8 | | |
| ASW Control | 91.5 ± 2.4 | | |
| 1.6 | 92.0 ± 1.8 | | |
| 3.1 | 92.0 ± 2.2 | | |
| 6.3 | 57.8 ± 9.2 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **IC10 = 4.2 (3.77-4.46)%** | | | |
| **EC50 = 6.9 (6.62-7.09)%** | | | |
| **NOEC = 3.1%** | | | |
| **LOEC = 6.3%** | | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2234/1_R01



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 93.0% | Yes |
| Reference Toxicant within cusum chart limits | 55.0-58.1µg Cu/L | 55.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 27 September 2024

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Document Change Control:**

Test Report TR2234/1 replaced with TR2234/1_R01 to correct a typographic error for the test commencement time.

**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.



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# Toxicity Test Report: TR2234/2



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2234<br>11 September 2024<br>12 September 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00089994 | **ESA Quote #:** | PL2234_q02 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11710 | Y0110924 | Aqueous sample, pH 5.9*, salinity 10.0‰*, total ammonia 21.4mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20.0±1.0°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 13 September 2024 at 1800h |

| Sample 11710*: Y0110924* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control 96.5 ± 1.3 | | |
| ASW Control 96.5 ± 2.7 | | |
| 1.6 96.8 ± 1.5 | | |
| 3.1 98.3 ± 1.7 | | |
| 6.3 75.3 ± 5.5 * | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr EC10 = 5.0 (4.61-5.42)%**<br>**72-hr EC50 = 7.6 (7.37-7.81)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2234/2



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 96.5% | Yes |
| Reference Toxicant within cusum chart limits | 10.8-11.4µg Cu/L | 11.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 26 September 2024

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.



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# Toxicity Test Report: TR2234/3_R01



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2234<br>11 September 2024<br>12 September 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00089994 | **ESA Quote #:** | PL2234_q02 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11710 | Y0110924 | Aqueous sample, pH 5.9*, salinity 10.0‰*, total ammonia 21.4mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Test duration extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Spencer Gulf, SA |
| **Test Initiated:** | 13 September 2024 at 1600h |

| Sample 11710*: Y0110924* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control: 75.3 ± 6.5 | | |
| ASW Control: 71.3 ± 3.3 | | |
| 1.6: 73.5 ± 2.1 | | |
| 3.1: 71.5 ± 7.8 | | |
| 6.3: 20.3 ± 10.7 * | | |
| 12.5: 0.0 ± 0.0 | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr EC10 = 3.4 (2.92-3.59)%**<br>**72-hr EC50 = 5.3 (5.16-5.50)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 75.3% | Yes |
| Reference Toxicant within cusum chart limits | 8.9-11.8µg Cu/L | 10.0µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 27 September 2024

Results are based on the samples in the condition as received by ESA.

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**Document Change Control:**

Test Report TR2234/3 replaced with TR2234/3_R01 to correct a typographic error for the test duration of the EC10 and EC50 endpoints.

**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.

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# Toxicity Test Report: TR2234/4



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2234<br>11 September 2024<br>12 September 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00089994 | **ESA Quote #:** | PL2234_q02 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11710 | Y0110924 | Aqueous sample, pH 5.9, salinity 10.0‰, total ammonia 21.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 17 September 2024 at 1900h |

| Sample 11710*: Y0110924* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Unaffected (Mean ± SD)** | | |
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 20.0 ± 23.1 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr EC10 = 5.0 (3.57-5.39)%** | | | |
| **96-hr EC50 = 5.0 (4.49-5.76)%** | | | |
| **NOEC = 3.1%** | | | |
| **LOEC = 6.3%** | | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2234/4



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 9.7-107.3mg $NH_4^+$/L | 37.7mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 27 September 2024

Results are based on the samples in the condition as received by ESA.
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**Animal Ethics Approval:**

Animal Research Authority CSB V20/10359 issued by the Animal Care and Ethics Committee of The Secretary, Department of Regional NSW, NSW Department of Primary Industries, valid from 11 May 2023 to 11 May 2028.

**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR2234/5



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2234<br>11 September 2024<br>12 September 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00089994 | **ESA Quote #:** | PL2234_q02 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11710 | Y0110924 | Aqueous sample, pH 5.9, salinity 10.0‰, total ammonia 21.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Sizw of Test Organisms:** | 12mm |
| **Test Initiated:** | 17 September 2024 at 1900h |

Sample 11710*: Y0110924*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.6 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (unaffected) = 4.1 (4.11-4.11)%**
**7 day IC50 (unaffected) = 4.5 (4.47-4.47)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

Sample 11710*: Y0110924*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** |
|---|---|
| FSW Control | 19.3 ± 0.6 |
| ASW Control | 18.9 ± 0.7 |
| 1.6 | 19.3 ± 0.2 |
| 3.1 | 17.0 ± 2.2 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 15.8 ± 1.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (biomass) = 10.4 (5.36-13.30)%**
**7 day IC50 (biomass) = 17.7 (16.85-18.23)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 23.1% | Yes |
| Reference Toxicant within cusum chart limits | 9.7-107.3mg $NH_4^+$/L | 37.7mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 26 September 2024

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

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ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR2234/5



**Animal Ethics Approval:**

Animal Research Authority CSB V20/10359 issued by the Animal Care and Ethics Committee of The Secretary, Department of Regional NSW, NSW Department of Primary Industries, valid from 11 May 2023 to 11 May 2028.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

# Toxicity Test Report: TR2187/6



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2234<br>11 September 2024<br>12 September 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00089994 | **ESA Quote #:** | PL2234_q02 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11710 | Y0110924 | Aqueous sample, pH 5.9, salinity 10.0‰, total ammonia 21.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 13 September 2024 at 1930h |

| Sample 11710*: Y0110924* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 100 ± 0.0 | | |
| 12.5: 25.0 ± 19.2 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 10.1 (8.95-10.63)%** | | |
| **96-hr IC50 = 11.6 (9.96-12.46)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of unaffected amphipods compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 1.5-7.9.4mg SDS/L | 4.4mg SDS/L | Yes |

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# Toxicity Test Report: TR2187/6



Test Report Authorised by: Dr Rick Krassoi, Director on 26 September 2024

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR2234/7



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2234<br>11 September 2024<br>12 September 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00089994 | **ESA Quote #:** | PL2234_q02 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11710 | Y0110924 | Aqueous sample, pH 5.9, salinity 10.0‰, total ammonia 21.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 13 September 2024 at 1530h |

| Sample 11710*: Y0110924* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control — 97.0 ± 1.8 | | |
| ASW Control — 98.3 ± 1.7 | | |
| 1.6 — 97.3 ± 2.2 | | |
| 3.1 — 95.0 ± 1.8 | | |
| 6.3 — 74.0 ± 17.8 * | | |
| 12.5 — 5.3 ± 3.3 * | | |
| 25 — 0.0 ± 0.0 | | |
| 50 — 0.0 ± 0.0 | | |
| 100 — 0.0 ± 0.0 | | |
| **72-hr IC10 = 4.4 (3.51-7.37)%** | | |
| **72-hr EC50 = 7.6 (7.31-7.87)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 97.0% | Yes |
| Reference Toxicant within cusum chart limits | 156.0-212.9µg Cu/L | 169.8µg Cu/L | Yes |

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# Toxicity Test Report: TR2234/7



Test Report Authorised by: Dr Rick Krassoi, Director on 26 September 2024

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR2234/8 (Page 1 of 2)

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2234<br>11 September 2024<br>12 September 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00089994 | **ESA Quote #:** | PL2234_q02 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11710 | Y0110924 | Aqueous sample, pH 5.9, salinity 10.0‰, total ammonia 21.4mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 13 September 2024 at 2100h |

| Sample 11710*: Y0110924* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x10$^4$ ± SD)** | |
| FSW Control | 17.3 ± 0.7 | |
| ASW Control | 17.3 ± 0.9 | |
| 1.6 | 17.3 ± 0.9 | |
| 3.1 | 17.4 ± 0.4 | |
| 6.3 | 17.4 ± 0.7 | |
| 12.5 | 17.4 ± 0.6 | |
| 25 | 5.0 ± 1.3 * | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |
| **72-hr IC10 = 14.3 (13.04-14.44)%** | | |
| **72-hr IC50 = 21.3 (20.08-22.24)%** | | |
| **NOEC = 12.5%** | | |
| **LOEC = 25%** | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x10$^4$ cells/mL | 17.3x10$^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 4.6% | Yes |
| Reference Toxicant within cusum chart limits | 3.7-8.7µg Cu/L | 5.6µg Cu/L | Yes |

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# Toxicity Test Report: TR2234/8 (Page 2 of 2)

Test Report Authorised by: Dr Rick Krassoi, Director on 26 September 2024

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Ronie Magcamit

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : ronie.magcamit@beachenergy.com.au
**Telephone** :
**Facsimile** :

**Date** : 18/09/2024

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR2234 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 12/09/2024
**Time samples received** : 11:50
**No. of samples received** : 2
**Sample matrix** : Aqueous
**Sample temperature** : 11-15°C

**Comments** : 5 x 2.5L of sample YO110924 and 1 x 2.5L of sample Y0110925-6 (Descaler) received at 12 degrees C in apparent good condition

## *Contact Details*


Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au


Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 14 December 2022

ecotox SERVICES AUSTRALIA

Customer: Beach Energy
Contact Name: Ronie Magcamit
Phone: 0427760486 Email: ronie.magcamit@beachenergy.com.au (please provide an email address for sample receipt notification)
Purchase Order: BG Yolla WET Testing

Ship To: Ecotox Services Australia
Attention: Rick Krassoy

12°C

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance): 96-h Acute Allonadella 60-h Bass FIT; 72-h Nitzschia; 72-h Hormosira; 48-h mysid; 1-h Seacrest Fert; 72-h Sentinel Lamna; 7 d FIT & Growth; Sub-Sampling for Envirolab | Comments / Instructions |
|---|---|---|---|---|---|---|
| 11-9-24 | 1100 | Yolla0924 - 1 | Grab | 1x1 1ltr | ✓ ✓ ✓ ✓ ✓ ✓ | Prod Water |
| 11-9-24 | 1100 | Yolla0924 - 2 | Grab | 1x1 1ltr | ✓ ✓ ✓ ✓ ✓ ✓ | Prod Water |
| 11-9-24 (1710) | 1100 | Yolla0924 - 3 | Grab | 1x1 1ltr | ✓ ✓ ✓ ✓ ✓ ✓ | Prod Water (1 Sample P.) |
| 11-9-24 | 1100 | Yolla0924 - 4 | Grab | 1x1 1ltr | ✓ ✓ ✓ ✓ ✓ ✓ | Prod Water |
| 11-9-24 | 1100 | Yolla0924 - 5 | Grab | 1x1 1ltr | ✓ ✓ ✓ ✓ ✓ ✓ | Prod Water |
| 11-9-24 (1711) | 1100 | Yolla0925 - 6 | Grab | 1x1 1ltr | ✓ ✓ ✓ ✓ ✓ ✓ | (Chemical De Scaler See Attached MSDS) |
| | | | | 2-St P. | | |

**ESA Project Number: PR 2234**

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

*Note: An MSDS must be attached if Available*

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| C. Parry | 11-9-24 | | 12/9/24 | | | | |
| Of: Beach Energy Yolla Platform | Time: 1100 | Of: ESA | Time: 1150 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Email: info@ecotox.com.au

# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:40 | Test ID: | P2234/03 | Sample ID: | PFW |
| End Date: | 13/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9100 | 0.9500 | 0.9200 |
| ASW Control | 0.9000 | 0.9100 | 0.9500 | 0.9000 |
| 1.6 | 0.9100 | 0.9400 | 0.9000 | 0.9300 |
| 3.1 | 0.9000 | 0.9100 | 0.9200 | 0.9500 |
| 6.3 | 0.6300 | 0.5100 | 0.4900 | 0.6800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

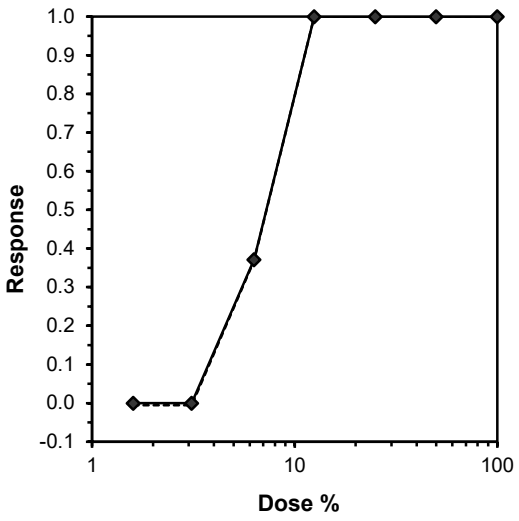
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9300 | 1.0164 | 1.3047 | 1.2661 | 1.3453 | 2.767 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2774 | 1.2490 | 1.3453 | 3.600 | 4 | * | | | 0.9183 | 1.0000 |
| 1.6 | 0.9200 | 1.0055 | 1.2854 | 1.2490 | 1.3233 | 2.636 | 4 | -0.192 | 2.290 | 0.0953 | 0.9183 | 1.0000 |
| 3.1 | 0.9200 | 1.0055 | 1.2861 | 1.2490 | 1.3453 | 3.262 | 4 | -0.210 | 2.290 | 0.0953 | 0.9183 | 1.0000 |
| *6.3 | 0.5775 | 0.6311 | 0.8643 | 0.7754 | 0.9695 | 10.873 | 4 | 9.926 | 2.290 | 0.0953 | 0.5775 | 0.6289 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.9635 | 0.887 | 0.365682 | -0.38332 |
| Bartlett's Test indicates equal variances (p = 0.32) | 3.526163 | 11.34487 | | |
| The control means are not significantly different (p = 0.39) | 0.934569 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.059988 | 0.065465 | 0.175327 | 0.003463 | 4.4E-07 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

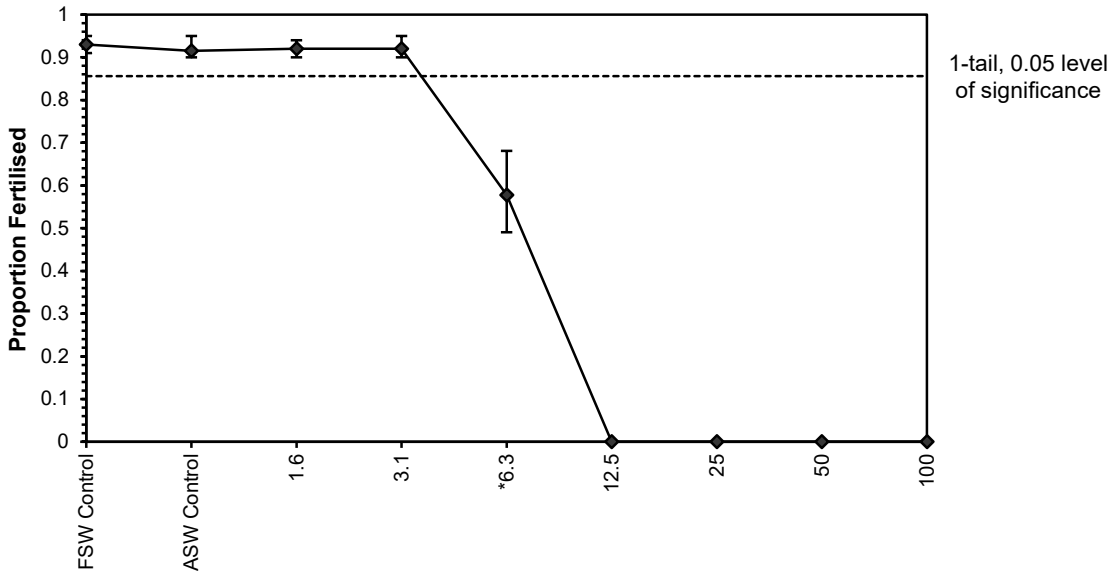
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.6981 | 0.0870 | 3.2838 | 3.8384 | -1.2578 |
| IC10 | 4.1867 | 0.1064 | 3.7743 | 4.4564 | -0.0662 |
| IC15 | 4.6183 | 0.1395 | 4.1602 | 5.0362 | 0.3176 |
| IC20 | 5.0173 | 0.1778 | 4.4755 | 5.6007 | 0.4509 |
| IC25 | 5.3981 | 0.2187 | 4.7489 | 6.1771 | 0.5186 |
| IC40 | 6.3510 | 0.1365 | 5.6571 | 6.5799 | -1.3010 |
| IC50 | 6.5279 | 0.0729 | 6.2786 | 6.7547 | 0.0484 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:40 | Test ID: | P2234/03 | Sample ID: | PFW |
| End Date: | 13/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:40 | Test ID: | P2234/03 | Sample ID: | PFW |
| End Date: | 13/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Fertilised | 93.00 | 91.00 | 95.00 | 1.83 | 1.45 | 4 |
| ASW Control | | 91.50 | 90.00 | 95.00 | 2.38 | 1.69 | 4 |
| 1.6 | | 92.00 | 90.00 | 94.00 | 1.83 | 1.47 | 4 |
| 3.1 | | 92.00 | 90.00 | 95.00 | 2.16 | 1.60 | 4 |
| 6.3 | | 57.75 | 49.00 | 68.00 | 9.22 | 5.26 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:40 | Test ID: | P2234/03 | Sample ID: | PFW |
| End Date: | 13/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9100 | 0.9500 | 0.9200 |
| ASW Control | 0.9000 | 0.9100 | 0.9500 | 0.9000 |
| 1.6 | 0.9100 | 0.9400 | 0.9000 | 0.9300 |
| 3.1 | 0.9000 | 0.9100 | 0.9200 | 0.9500 |
| 6.3 | 0.6300 | 0.5100 | 0.4900 | 0.6800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

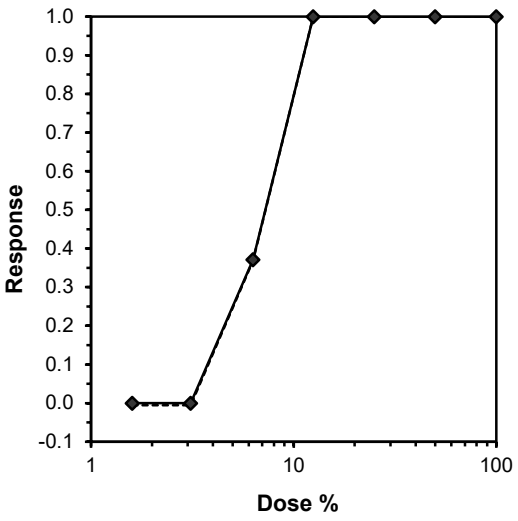
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9300 | 1.0164 | 1.3047 | 1.2661 | 1.3453 | 2.767 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2774 | 1.2490 | 1.3453 | 3.600 | 4 | * | | | 34 | 400 |
| 1.6 | 0.9200 | 1.0055 | 1.2854 | 1.2490 | 1.3233 | 2.636 | 4 | -0.192 | 2.290 | 0.0953 | 32 | 400 |
| 3.1 | 0.9200 | 1.0055 | 1.2861 | 1.2490 | 1.3453 | 3.262 | 4 | -0.210 | 2.290 | 0.0953 | 32 | 400 |
| *6.3 | 0.5775 | 0.6311 | 0.8643 | 0.7754 | 0.9695 | 10.873 | 4 | 9.926 | 2.290 | 0.0953 | 169 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.9635 | 0.887 | 0.365682 | -0.38332 |
| Bartlett's Test indicates equal variances (p = 0.32) | 3.526163 | 11.34487 | | |
| The control means are not significantly different (p = 0.39) | 0.934569 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.059988 | 0.065465 | 0.175327 | 0.003463 | 4.4E-07 | 3, 12 |

### Trimmed Spearman-Karber

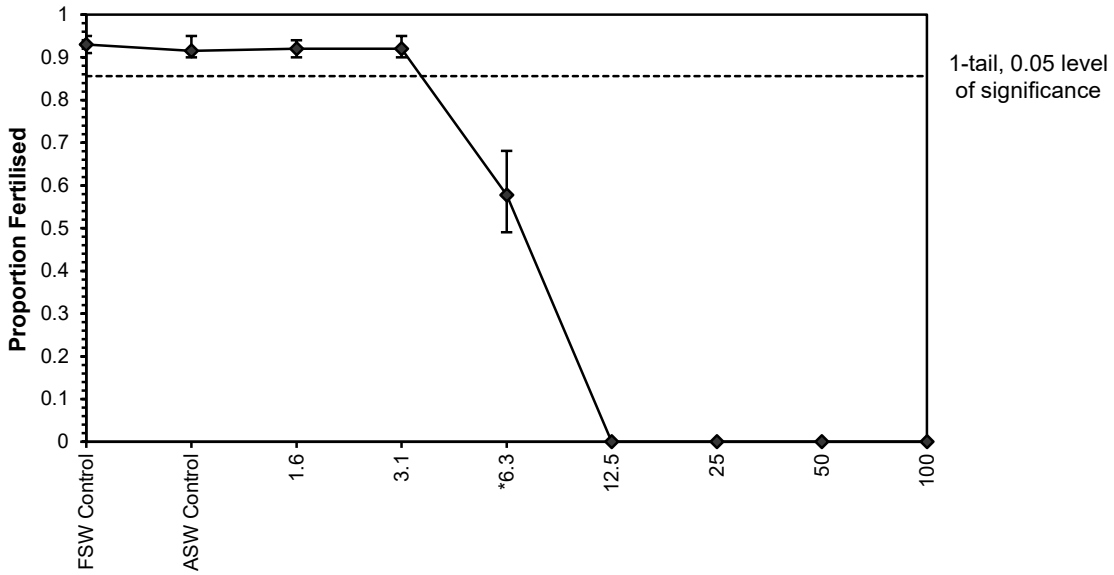
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 6.8510 | 6.6241 | 7.0857 |
| 5.0% | 6.9164 | 6.6608 | 7.1818 |
| 10.0% | 6.9812 | 6.6865 | 7.2889 |
| 20.0% | 7.1057 | 6.6810 | 7.5575 |
| Auto-0.0% | 6.8510 | 6.6241 | 7.0857 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:40 | Test ID: | P2234/03 | Sample ID: | PFW |
| End Date: | 13/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:40 | Test ID: | P2234/03 | Sample ID: | PFW |
| End Date: | 13/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Fertilised | 93.00 | 91.00 | 95.00 | 1.83 | 1.45 | 4 |
| ASW Control | | 91.50 | 90.00 | 95.00 | 2.38 | 1.69 | 4 |
| 1.6 | | 92.00 | 90.00 | 94.00 | 1.83 | 1.47 | 4 |
| 3.1 | | 92.00 | 90.00 | 95.00 | 2.16 | 1.60 | 4 |
| 6.3 | | 57.75 | 49.00 | 68.00 | 9.22 | 5.26 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:00 | Test ID: | P2234/07 | Sample ID: | PFW |
| End Date: | 16/09/2024 18:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9500 | 0.9700 |
| ASW Control | 0.9800 | 0.9900 | 0.9300 | 0.9600 |
| 1.6 | 0.9800 | 0.9600 | 0.9500 | 0.9800 |
| 3.1 | 0.9600 | 0.9900 | 0.9800 | 1.0000 |
| 6.3 | 0.7400 | 0.6800 | 0.7900 | 0.8000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

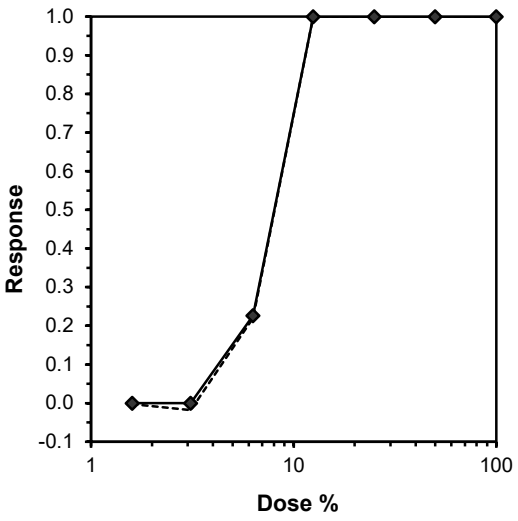
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | | | | | |
| ASW Control | 0.9650 | 1.0000 | 1.3930 | 1.3030 | 1.4706 | 5.237 | 4 | * | | | 0.9717 | 1.0000 |
| 1.6 | 0.9675 | 1.0026 | 1.3931 | 1.3453 | 1.4289 | 3.048 | 4 | -0.003 | 2.290 | 0.0999 | 0.9717 | 1.0000 |
| 3.1 | 0.9825 | 1.0181 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | -1.248 | 2.290 | 0.0999 | 0.9717 | 1.0000 |
| *6.3 | 0.7525 | 0.7798 | 1.0518 | 0.9695 | 1.1071 | 5.997 | 4 | 7.823 | 2.290 | 0.0999 | 0.7525 | 0.7744 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.927114 | 0.887 | -0.29233 | -1.15286 |
| Bartlett's Test indicates equal variances (p = 0.86) | 0.758431 | 11.34487 | | |
| The control means are not significantly different (p = 0.85) | 0.194652 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.043861 | 0.045278 | 0.131793 | 0.003804 | 3.4E-06 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

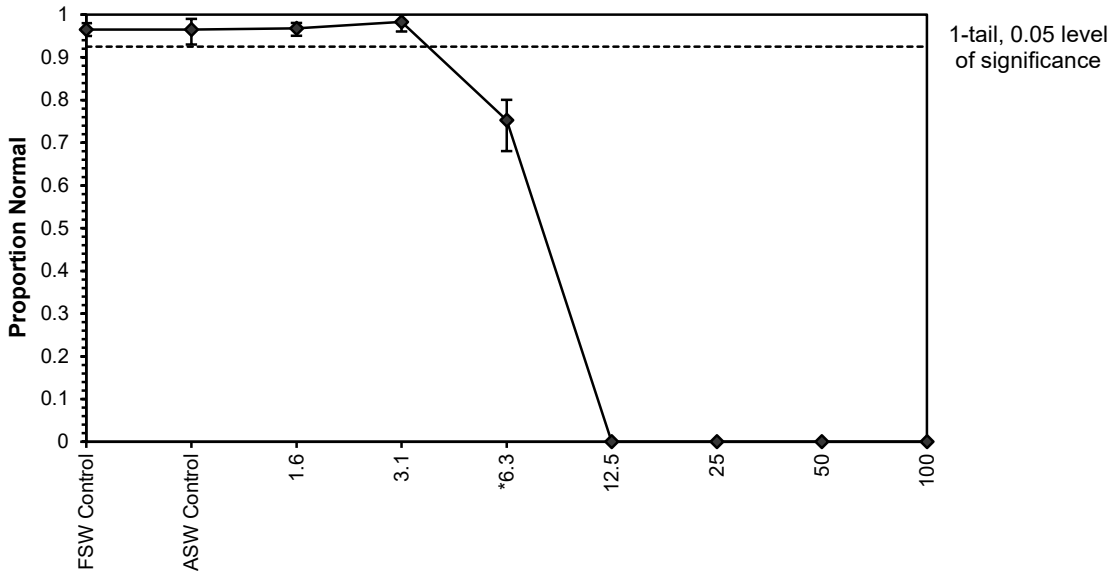
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 4.2644 | 0.0950 | 3.9733 | 4.5521 | -0.1673 |
| IC10 | 4.9919 | 0.1313 | 4.6117 | 5.4146 | -0.0130 |
| IC15 | 5.5662 | 0.1689 | 5.1296 | 6.0984 | 0.0259 |
| IC20 | 6.0637 | 0.1859 | 5.5443 | 6.5064 | -0.3298 |
| IC25 | 6.3540 | 0.0870 | 6.0087 | 6.5111 | -1.7330 |
| IC40 | 6.6457 | 0.0546 | 6.4915 | 6.8011 | -0.3078 |
| IC50 | 6.8262 | 0.0536 | 6.6750 | 6.9796 | -0.3090 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:00 | Test ID: | P2234/07 | Sample ID: | PFW |
| End Date: | 16/09/2024 18:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:00 | Test ID: | P2234/07 | Sample ID: | PFW |
| End Date: | 16/09/2024 18:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| ASW Control | | 96.50 | 93.00 | 99.00 | 2.65 | 1.69 | 4 |
| 1.6 | | 96.75 | 95.00 | 98.00 | 1.50 | 1.27 | 4 |
| 3.1 | | 98.25 | 96.00 | 100.00 | 1.71 | 1.33 | 4 |
| 6.3 | | 75.25 | 68.00 | 80.00 | 5.50 | 3.12 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:00 | Test ID: | P2234/07 | Sample ID: | PFW |
| End Date: | 16/09/2024 18:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9500 | 0.9700 |
| ASW Control | 0.9800 | 0.9900 | 0.9300 | 0.9600 |
| 1.6 | 0.9800 | 0.9600 | 0.9500 | 0.9800 |
| 3.1 | 0.9600 | 0.9900 | 0.9800 | 1.0000 |
| 6.3 | 0.7400 | 0.6800 | 0.7900 | 0.8000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

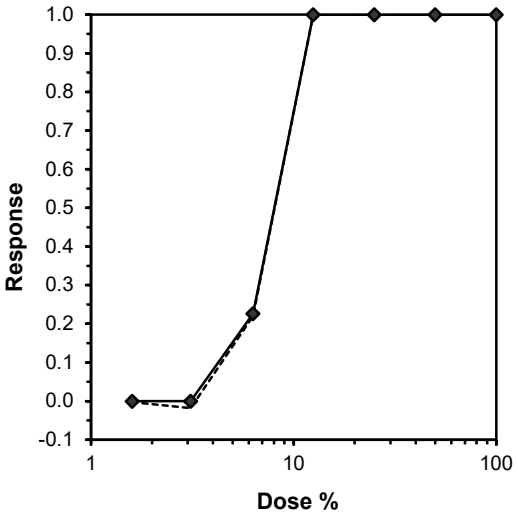
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9650 | 1.0000 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | | | | | |
| ASW Control | 0.9650 | 1.0000 | 1.3930 | 1.3030 | 1.4706 | 5.237 | 4 | * | | | 14 | 400 |
| 1.6 | 0.9675 | 1.0026 | 1.3931 | 1.3453 | 1.4289 | 3.048 | 4 | -0.003 | 2.290 | 0.0999 | 13 | 400 |
| 3.1 | 0.9825 | 1.0181 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | -1.248 | 2.290 | 0.0999 | 7 | 400 |
| *6.3 | 0.7525 | 0.7798 | 1.0518 | 0.9695 | 1.1071 | 5.997 | 4 | 7.823 | 2.290 | 0.0999 | 99 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.927114 | 0.887 | -0.29233 | -1.15286 |
| Bartlett's Test indicates equal variances (p = 0.86) | 0.758431 | 11.34487 | | |
| The control means are not significantly different (p = 0.85) | 0.194652 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.043861 | 0.045278 | 0.131793 | 0.003804 | 3.4E-06 | 3, 12 |

### Trimmed Spearman-Karber

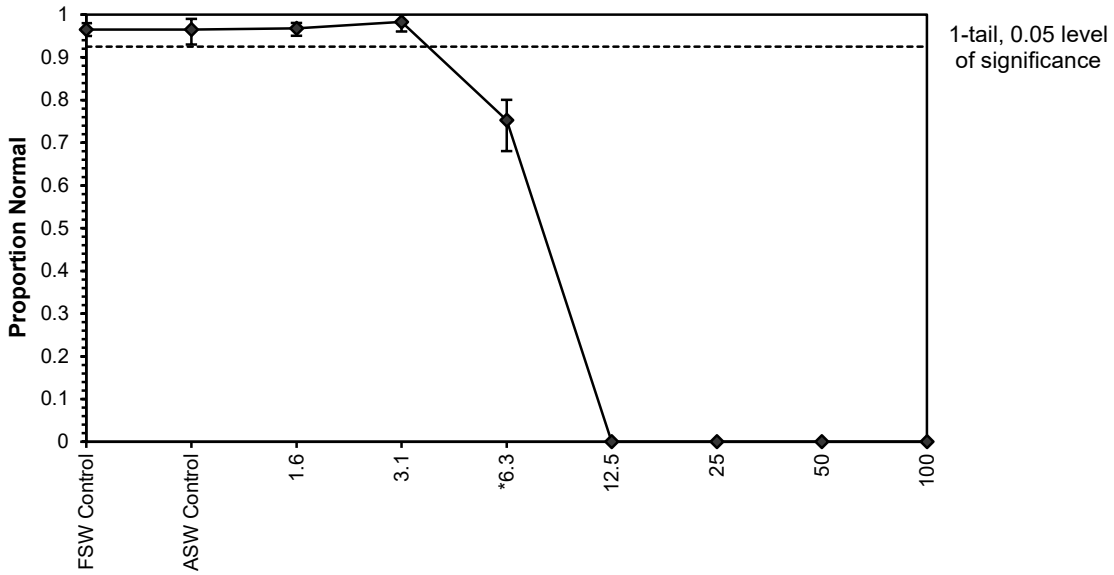
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 7.5828 | 7.3651 | 7.8070 |
| 5.0% | 7.7267 | 7.4750 | 7.9868 |
| 10.0% | 7.8546 | 7.5484 | 8.1732 |
| 20.0% | 8.0215 | 7.5063 | 8.5722 |
| Auto-0.0% | 7.5828 | 7.3651 | 7.8070 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:00 | Test ID: | P2234/07 | Sample ID: | PFW |
| End Date: | 16/09/2024 18:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 18:00 | Test ID: | P2234/07 | Sample ID: | PFW |
| End Date: | 16/09/2024 18:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| ASW Control | | 96.50 | 93.00 | 99.00 | 2.65 | 1.69 | 4 |
| 1.6 | | 96.75 | 95.00 | 98.00 | 1.50 | 1.27 | 4 |
| 3.1 | | 98.25 | 96.00 | 100.00 | 1.71 | 1.33 | 4 |
| 6.3 | | 75.25 | 68.00 | 80.00 | 5.50 | 3.12 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 16:00 | Test ID: | P2234/12 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7200 | 0.6900 | 0.7600 | 0.8400 |
| ASW Control | 0.6800 | 0.7300 | 0.6900 | 0.7500 |
| 1.6 | 0.7400 | 0.7100 | 0.7300 | 0.7600 |
| 3.1 | 0.6800 | 0.7400 | 0.8100 | 0.6300 |
| 6.3 | 0.2400 | 0.1600 | 0.3300 | 0.0800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

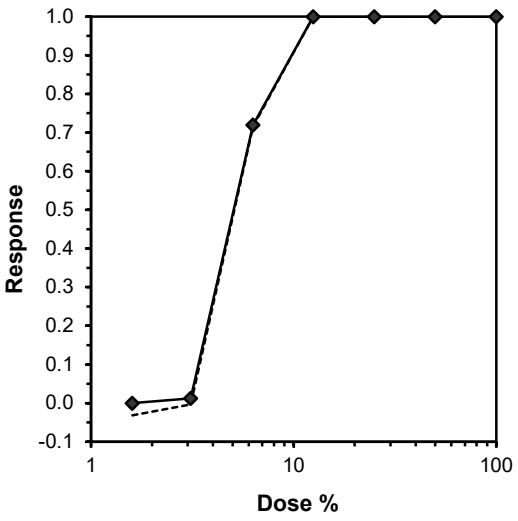
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7525 | 1.0561 | 1.0529 | 0.9803 | 1.1593 | 7.397 | 4 | | | | | |
| ASW Control | 0.7125 | 1.0000 | 1.0054 | 0.9695 | 1.0472 | 3.643 | 4 | * | | | 0.7238 | 1.0000 |
| 1.6 | 0.7350 | 1.0316 | 1.0303 | 1.0021 | 1.0588 | 2.291 | 4 | -0.414 | 2.290 | 0.1377 | 0.7238 | 1.0000 |
| 3.1 | 0.7150 | 1.0035 | 1.0105 | 0.9169 | 1.1198 | 8.668 | 4 | -0.085 | 2.290 | 0.1377 | 0.7150 | 0.9879 |
| *6.3 | 0.2025 | 0.2842 | 0.4555 | 0.2868 | 0.6119 | 30.541 | 4 | 9.143 | 2.290 | 0.1377 | 0.2025 | 0.2798 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.969438 | 0.887 | -0.0756 | 1.211304 |
| Bartlett's Test indicates equal variances (p = 0.04) | 8.440406 | 11.34487 | | |
| The control means are not significantly different (p = 0.31) | 1.104778 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.131047 | 0.183815 | 0.313862 | 0.007232 | 1.0E-06 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

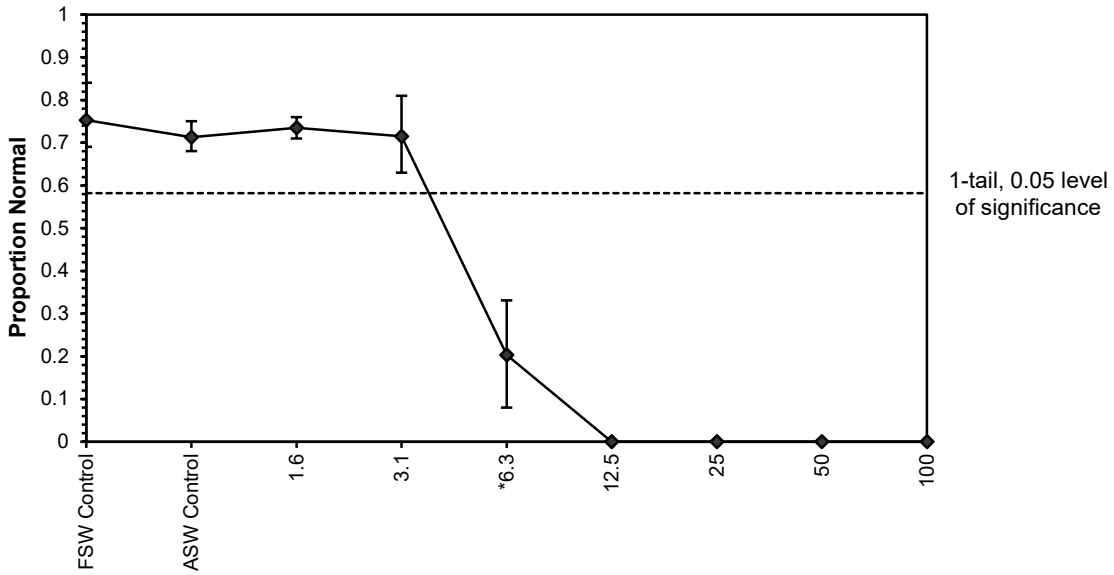
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.2376 | 0.2912 | 1.7344 | 3.3612 | -1.9653 |
| IC10 | 3.4159 | 0.1283 | 2.9196 | 3.5918 | -1.7953 |
| IC15 | 3.5928 | 0.1216 | 3.0805 | 3.8258 | -0.6630 |
| IC20 | 3.7702 | 0.1330 | 3.2188 | 4.0605 | -0.3568 |
| IC25 | 3.9501 | 0.1493 | 3.3873 | 4.3004 | -0.1162 |
| IC40 | 4.5249 | 0.2242 | 3.8899 | 5.2255 | 0.2625 |
| IC50 | 4.9626 | 0.2965 | 4.1180 | 5.9850 | 0.3826 |



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 16:00 | Test ID: | P2234/12 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 16:00 | Test ID: | P2234/12 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 75.25 | 69.00 | 84.00 | 6.50 | 3.39 | 4 |
| ASW Control | | 71.25 | 68.00 | 75.00 | 3.30 | 2.55 | 4 |
| 1.6 | | 73.50 | 71.00 | 76.00 | 2.08 | 1.96 | 4 |
| 3.1 | | 71.50 | 63.00 | 81.00 | 7.77 | 3.90 | 4 |
| 6.3 | | 20.25 | 8.00 | 33.00 | 10.72 | 16.17 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 16:00 | Test ID: | P2234/12 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7200 | 0.6900 | 0.7600 | 0.8400 |
| ASW Control | 0.6800 | 0.7300 | 0.6900 | 0.7500 |
| 1.6 | 0.7400 | 0.7100 | 0.7300 | 0.7600 |
| 3.1 | 0.6800 | 0.7400 | 0.8100 | 0.6300 |
| 6.3 | 0.2400 | 0.1600 | 0.3300 | 0.0800 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

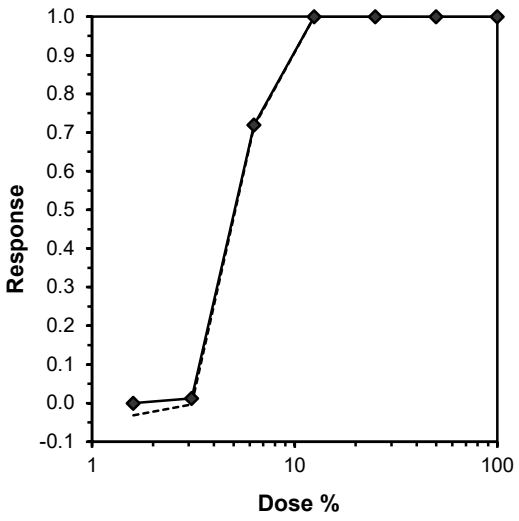
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7525 | 1.0561 | 1.0529 | 0.9803 | 1.1593 | 7.397 | 4 | | | | | |
| ASW Control | 0.7125 | 1.0000 | 1.0054 | 0.9695 | 1.0472 | 3.643 | 4 | * | | | 115 | 400 |
| 1.6 | 0.7350 | 1.0316 | 1.0303 | 1.0021 | 1.0588 | 2.291 | 4 | -0.414 | 2.290 | 0.1377 | 106 | 400 |
| 3.1 | 0.7150 | 1.0035 | 1.0105 | 0.9169 | 1.1198 | 8.668 | 4 | -0.085 | 2.290 | 0.1377 | 114 | 400 |
| *6.3 | 0.2025 | 0.2842 | 0.4555 | 0.2868 | 0.6119 | 30.541 | 4 | 9.143 | 2.290 | 0.1377 | 319 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.969438 | 0.887 | -0.0756 | 1.211304 |
| Bartlett's Test indicates equal variances (p = 0.04) | 8.440406 | 11.34487 | | |
| The control means are not significantly different (p = 0.31) | 1.104778 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 0.131047 | 0.183815 | 0.313862 | 0.007232 | 1.0E-06 | 3, 12 |

### Trimmed Spearman-Karber

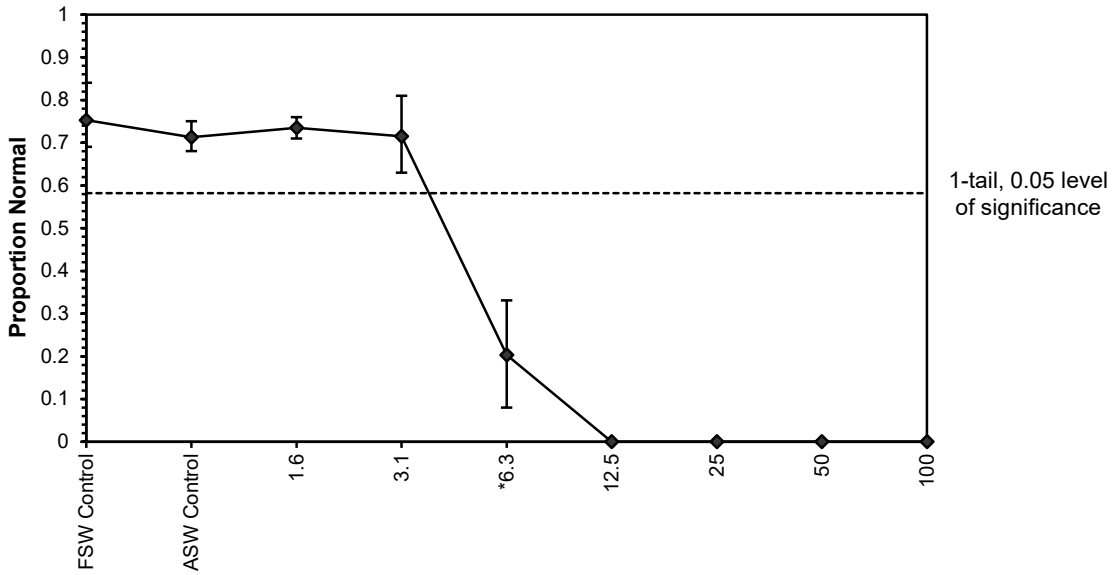
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 5.3268 | 5.1581 | 5.5010 |
| 5.0% | 5.2724 | 5.0936 | 5.4574 |
| 10.0% | 5.2032 | 5.0134 | 5.4001 |
| 20.0% | 5.0922 | 4.8872 | 5.3057 |
| Auto-0.0% | 5.3268 | 5.1581 | 5.5010 |



**Bivalve Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 16:00 | Test ID: | P2234/12 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 16:00 | Test ID: | P2234/12 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 75.25 | 69.00 | 84.00 | 6.50 | 3.39 | 4 |
| ASW Control | | 71.25 | 68.00 | 75.00 | 3.30 | 2.55 | 4 |
| 1.6 | | 73.50 | 71.00 | 76.00 | 2.08 | 1.96 | 4 |
| 3.1 | | 71.50 | 63.00 | 81.00 | 7.77 | 3.90 | 4 |
| 6.3 | | 20.25 | 8.00 | 33.00 | 10.72 | 16.17 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | P2234/32 | Sample ID: | PFW |
| End Date: | 21/09/2024 19:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT- Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.4000 | 0.4000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

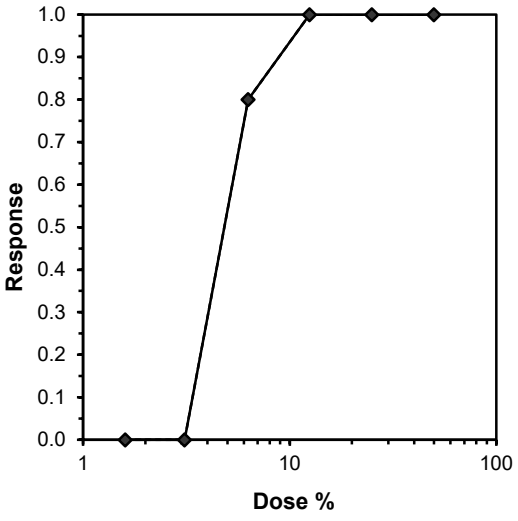
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *6.3 | 0.2000 | 0.2000 | 0.4551 | 0.2255 | 0.6847 | 58.254 | 4 | 10.00 | 10.00 | 0.2000 | 0.2000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.696557 | 0.887 | 8.12E-16 | 1.895604 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

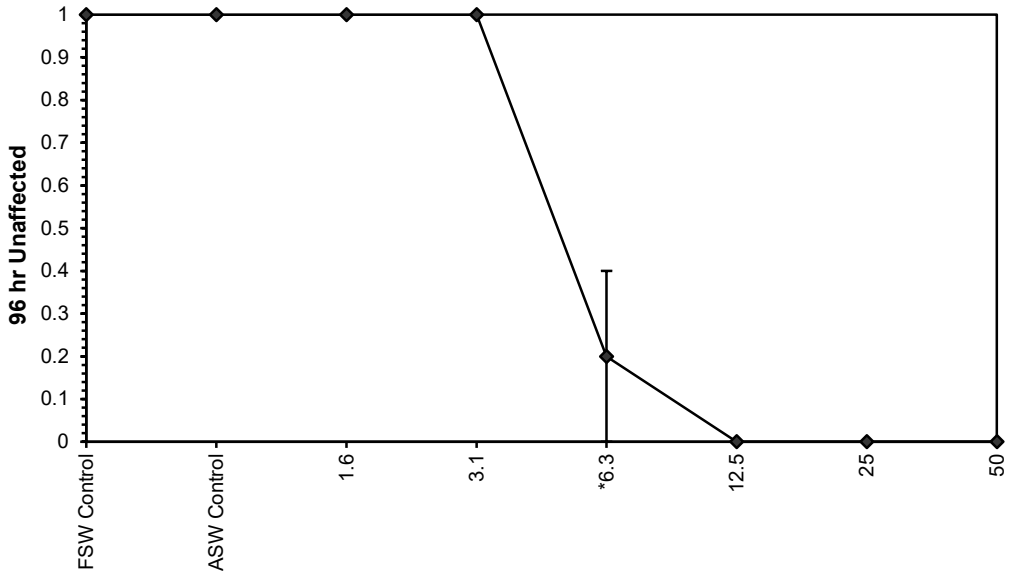
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 4.7667 | 0.2386 | 3.5222 | 5.0934 | -2.1082 |
| IC10 | 5.0061 | 0.2762 | 3.5676 | 5.3878 | -2.0962 |
| IC15 | 5.1593 | 0.3007 | 3.5949 | 5.5771 | -2.0887 |
| IC20 | 5.2772 | 0.3197 | 3.6151 | 5.7232 | -2.0831 |
| IC25 | 5.3763 | 0.3358 | 3.6315 | 5.8464 | -2.0784 |
| IC40 | 5.6215 | 0.3761 | 3.6700 | 6.1524 | -2.0671 |
| IC50 | 5.7693 | 0.4008 | 3.6917 | 6.3377 | -2.0605 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | P2234/32 | Sample ID: | PFW |
| End Date: | 21/09/2024 19:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT- Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | P2234/32 | Sample ID: | PFW |
| End Date: | 21/09/2024 19:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT- Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 20.00 | 0.00 | 40.00 | 23.09 | 24.03 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.30 | 101.30 | 101.30 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.90 | 100.90 | 100.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 25 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 50 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | P2234/32 | Sample ID: | PFW |
| End Date: | 21/09/2024 19:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT- Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.4000 | 0.4000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

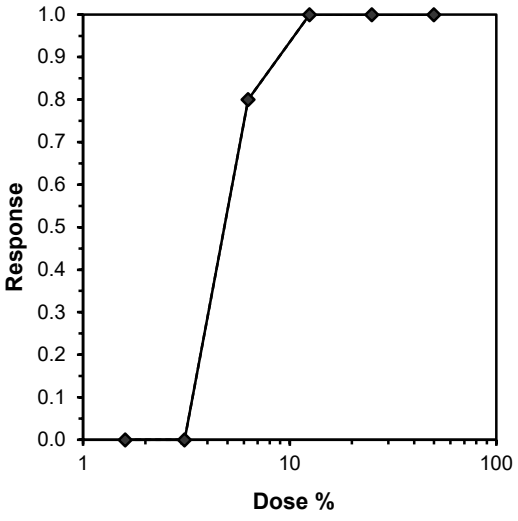
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *6.3 | 0.2000 | 0.2000 | 0.4551 | 0.2255 | 0.6847 | 58.254 | 4 | 10.00 | 10.00 | 16 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.696557 | 0.887 | 8.12E-16 | 1.895604 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

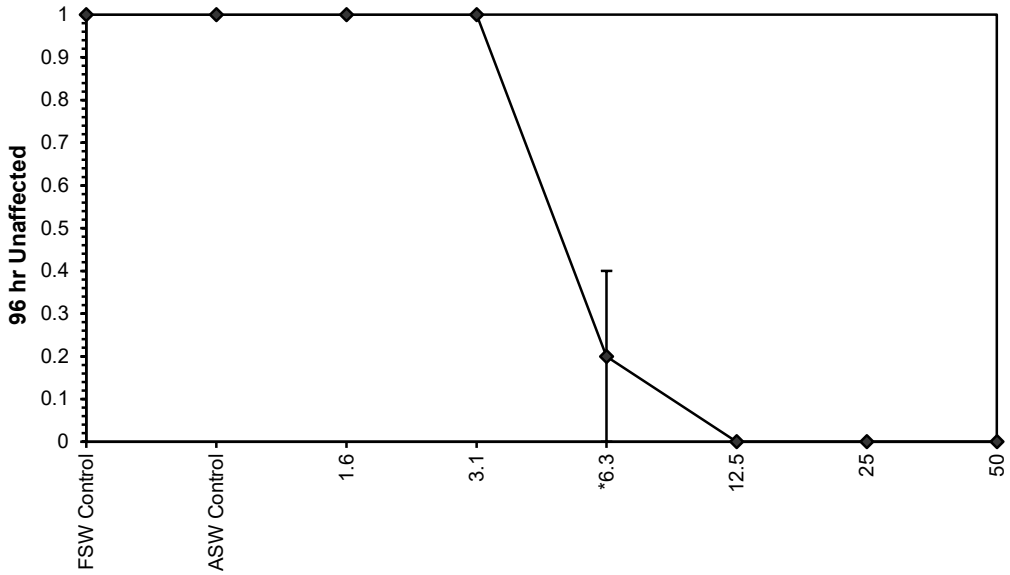
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 5.0805 | 4.4848 | 5.7553 |
| 5.0% | 4.9846 | 4.3570 | 5.7028 |
| 10.0% | 4.9062 | 4.2738 | 5.6320 |
| 20.0% | 4.8289 | 4.3733 | 5.3320 |
| Auto-0.0% | 5.0805 | 4.4848 | 5.7553 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | P2234/32 | Sample ID: | PFW |
| End Date: | 21/09/2024 19:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT- Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | P2234/32 | Sample ID: | PFW |
| End Date: | 21/09/2024 19:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT- Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 20.00 | 0.00 | 40.00 | 23.09 | 24.03 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.00 | 102.00 | 102.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.30 | 101.30 | 101.30 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.90 | 100.90 | 100.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 25 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 50 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | PR2234/41 | Sample ID: | YO110924 |
| End Date: | 14/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | 11/09/2024 | Protocol: | ESA SOP122 | Test Species: | Lates calcarifer |
| Comments: | PFW | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

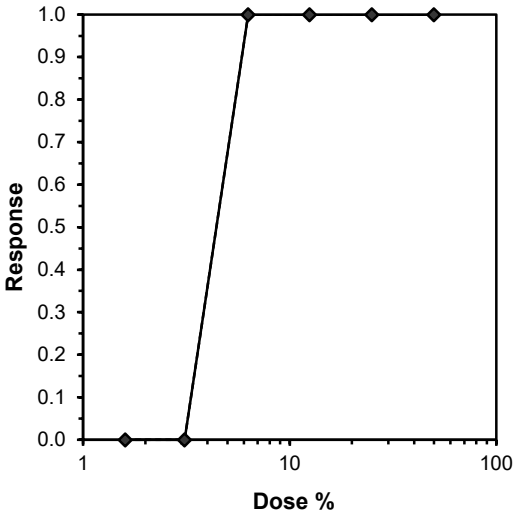
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 1 | 0.859 | | |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.9889 | 0.0000 | 3.9889 | 3.9889 | 1.0076 |
| IC10 | 4.1070 | 0.0000 | 4.1070 | 4.1070 | -1.0076 |
| IC15 | 4.1816 | 0.0000 | 4.1816 | 4.1816 | -1.0076 |
| IC20 | 4.2384 | 0.0000 | 4.2384 | 4.2384 | 1.0076 |
| IC25 | 4.2858 | 0.0000 | 4.2858 | 4.2858 | #DIV/0! |
| IC40 | 4.4018 | 0.0000 | 4.4018 | 4.4018 | 1.0076 |
| IC50 | 4.4708 | 0.0000 | 4.4708 | 4.4708 | -1.0076 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | PR2234/41 | Sample ID: | YO110924 |
| End Date: | 14/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | 11/09/2024 | Protocol: | ESA SOP122 | Test Species: | Lates calcarifer |
| Comments: | PFW | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 19.26 | 18.54 | 19.74 | 0.55 | 3.83 | 4 |
| ASW Control | | 18.91 | 17.94 | 19.46 | 0.67 | 4.32 | 4 |
| 1.6 | | 19.32 | 19.02 | 19.50 | 0.23 | 2.48 | 4 |
| 3.1 | | 17.04 | 15.18 | 19.66 | 2.17 | 8.65 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.30 | 101.30 | 101.30 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.90 | 100.90 | 100.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 25 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 50 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | PR2234/41 | Sample ID: | YO110924 |
| End Date: | 14/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | 11/09/2024 | Protocol: | ESA 122 | Test Species: | Lates calcarifer |
| Comments: | PFW | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 19.140 | 19.740 | 18.540 | 19.620 |
| ASW Control | 19.460 | 17.940 | 19.140 | 19.100 |
| 1.6 | 19.500 | 19.500 | 19.020 | 19.260 |
| 3.1 | 17.980 | 19.660 | 15.180 | 15.320 |
| 6.3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |

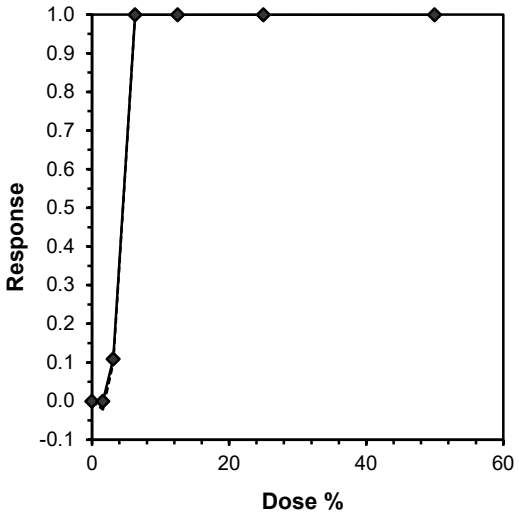
| | | | Transform: Untransformed | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 19.260 | 1.0185 | 19.260 | 18.540 | 19.740 | 2.832 | 4 | | | | |
| ASW Control | 18.910 | 1.0000 | 18.910 | 17.940 | 19.460 | 3.524 | 4 | * | | 19.115 | 1.0000 |
| 1.6 | 19.320 | 1.0217 | 19.320 | 19.020 | 19.500 | 1.189 | 4 | 22.00 | 11.00 | 19.115 | 1.0000 |
| 3.1 | 17.035 | 0.9008 | 17.035 | 15.180 | 19.660 | 12.756 | 4 | 15.00 | 11.00 | 17.035 | 0.8912 |
| 6.3 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.922824 | 0.859 | 0.434392 | 1.39274 |
| Bartlett's Test indicates unequal variances (p = 6.44E-03) | 10.09018 | 9.21034 | | |
| The control means are not significantly different (p = 0.45) | 0.812782 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.2892 | 0.4105 | 1.7736 | 3.7690 | 0.6877 |
| IC10 | 2.9785 | 0.3201 | 1.9716 | 3.6153 | -0.3632 |
| IC15 | 3.2479 | 0.2088 | 2.4093 | 3.7135 | -0.8045 |
| IC20 | 3.4274 | 0.1640 | 2.9009 | 3.8657 | -0.3162 |
| IC25 | 3.6070 | 0.1522 | 3.1145 | 4.0178 | -0.2622 |
| IC40 | 4.1456 | 0.1218 | 3.7516 | 4.4742 | -0.2622 |
| IC50 | 4.5046 | 0.1015 | 4.1763 | 4.7785 | -0.2622 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 17/09/2024 19:00 | Test ID: | PR2234/41 | Sample ID: | YO110924 |
| End Date: | 14/09/2024 20:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | 11/09/2024 | Protocol: | ESA 122 | Test Species: | Lates calcarifer |
| Comments: | PFW | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 19.26 | 18.54 | 19.74 | 0.55 | 3.83 | 4 |
| ASW Control | | 18.91 | 17.94 | 19.46 | 0.67 | 4.32 | 4 |
| 1.6 | | 19.32 | 19.02 | 19.50 | 0.23 | 2.48 | 4 |
| 3.1 | | 17.04 | 15.18 | 19.66 | 2.17 | 8.65 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| 25 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 50 | | 6.60 | 6.60 | 6.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 25 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| 50 | | 35.30 | 35.30 | 35.30 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 101.30 | 101.30 | 101.30 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.90 | 100.90 | 100.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.70 | 100.70 | 100.70 | 0.00 | 0.00 | 1 |
| 25 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 50 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 19:30 | Test ID: | P2234/21 | Sample ID: | PFW |
| End Date: | 17/09/2024 19:30 | Lab ID: | 11710 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.0000 | 0.4000 | 0.4000 | 0.2000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

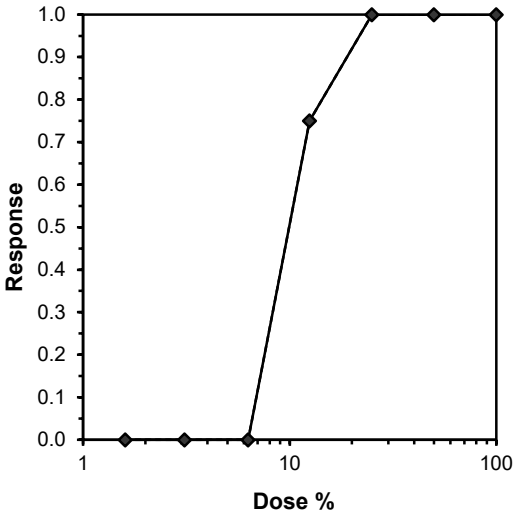
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *12.5 | 0.2500 | 0.2500 | 0.5146 | 0.2255 | 0.6847 | 42.578 | 4 | 10.00 | 10.00 | 0.2500 | 0.2500 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.577304 | 0.905 | -1.28154 | 7.355779 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

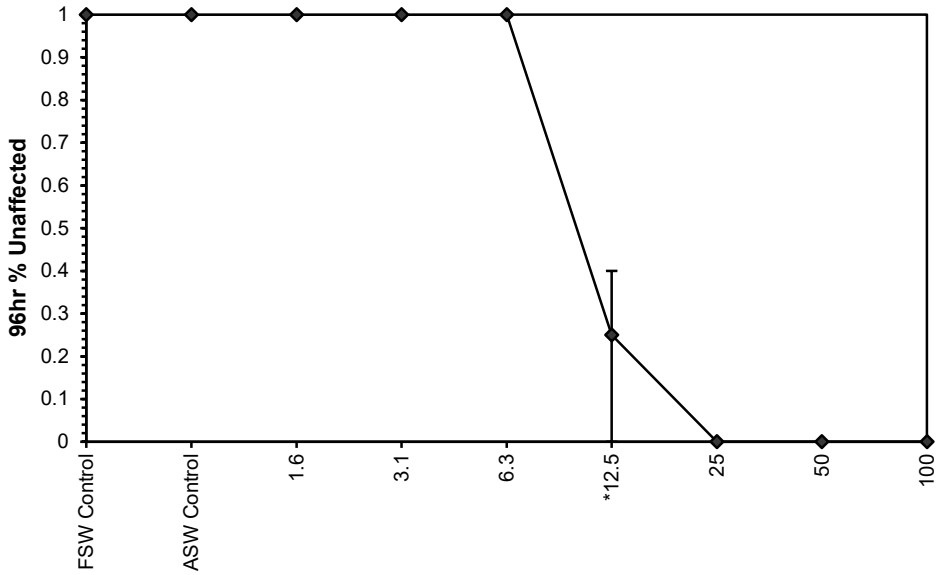
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 9.608 | 0.311 | 8.630 | 10.071 | -3.2859 |
| IC10 | 10.091 | 0.361 | 8.952 | 10.634 | -3.2559 |
| IC15 | 10.401 | 0.394 | 9.156 | 10.997 | -3.2372 |
| IC20 | 10.641 | 0.420 | 9.312 | 11.278 | -3.2232 |
| IC25 | 10.842 | 0.442 | 9.443 | 11.514 | -3.2117 |
| IC40 | 11.342 | 0.497 | 9.764 | 12.104 | -3.1838 |
| IC50 | 11.644 | 0.531 | 9.957 | 12.461 | -3.1675 |



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 19:30 | Test ID: | P2234/21 | Sample ID: | PFW |
| End Date: | 17/09/2024 19:30 | Lab ID: | 11710 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 19:30 | Test ID: | P2234/21 | Sample ID: | PFW |
| End Date: | 17/09/2024 19:30 | Lab ID: | 11710 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 25.00 | 0.00 | 40.00 | 19.15 | 17.50 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | Do (%) | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 19:30 | Test ID: | P2234/21 | Sample ID: | PFW |
| End Date: | 17/09/2024 19:30 | Lab ID: | 11710 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.0000 | 0.4000 | 0.4000 | 0.2000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

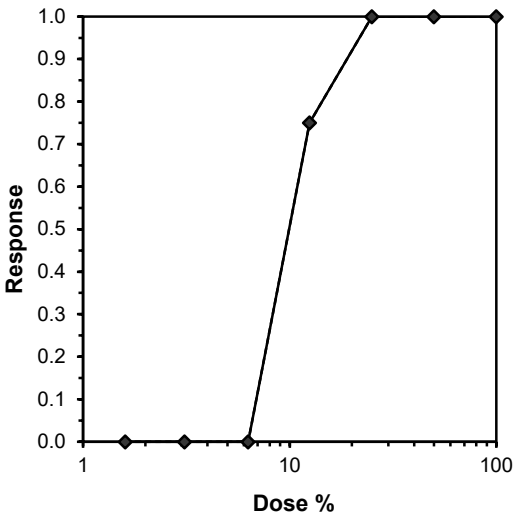
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *12.5 | 0.2500 | 0.2500 | 0.5146 | 0.2255 | 0.6847 | 42.578 | 4 | 10.00 | 10.00 | 15 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.577304 | 0.905 | -1.28154 | 7.355779 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

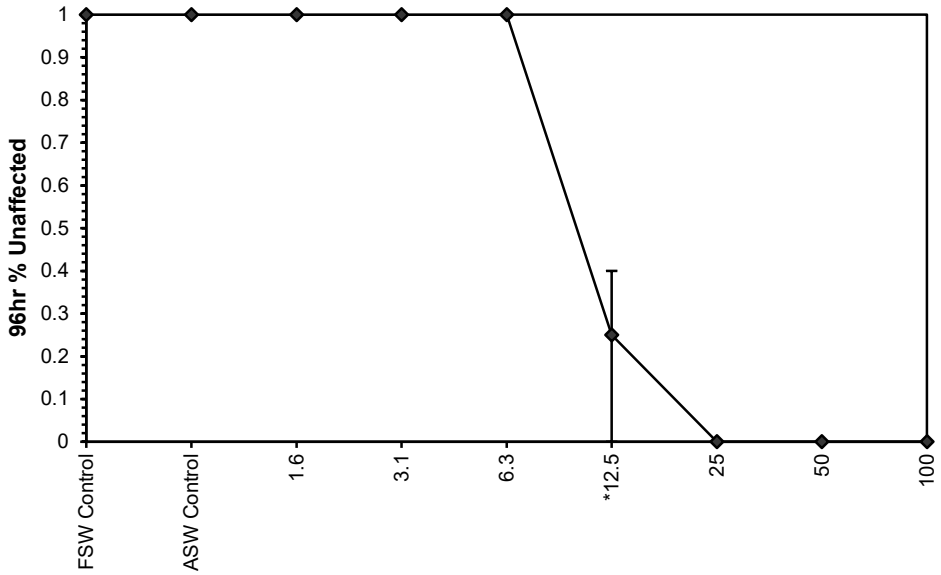
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 10.543 | 9.226 | 12.048 |
| 5.0% | 10.367 | 8.962 | 11.992 |
| 10.0% | 10.211 | 8.746 | 11.922 |
| 20.0% | 9.986 | 8.521 | 11.704 |
| Auto-0.0% | 10.543 | 9.226 | 12.048 |



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 19:30 | Test ID: | P2234/21 | Sample ID: | PFW |
| End Date: | 17/09/2024 19:30 | Lab ID: | 11710 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 19:30 | Test ID: | P2234/21 | Sample ID: | PFW |
| End Date: | 17/09/2024 19:30 | Lab ID: | 11710 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 25.00 | 0.00 | 40.00 | 19.15 | 17.50 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | Do (%) | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 15:30 | Test ID: | P2234/16 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9500 | 0.9600 | 0.9900 |
| ASW Control | 0.9800 | 1.0000 | 0.9600 | 0.9900 |
| 1.6 | 0.9800 | 0.9600 | 0.9500 | 1.0000 |
| 3.1 | 0.9300 | 0.9700 | 0.9600 | 0.9400 |
| 6.3 | 0.5600 | 0.9800 | 0.7300 | 0.6900 |
| 12.5 | 0.0300 | 0.0500 | 0.1000 | 0.0300 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

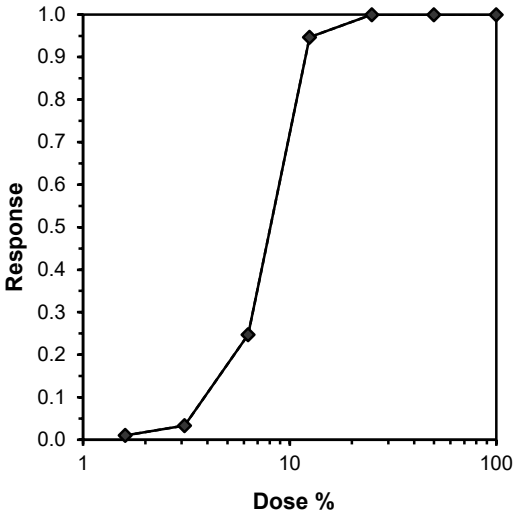
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9700 | 0.9873 | 1.4036 | 1.3453 | 1.4706 | 4.051 | 4 | | | | |
| ASW Control | 0.9825 | 1.0000 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | * | | 0.9825 | 1.0000 |
| 1.6 | 0.9725 | 0.9898 | 1.4161 | 1.3453 | 1.5208 | 5.517 | 4 | 15.50 | 10.00 | 0.9725 | 0.9898 |
| 3.1 | 0.9500 | 0.9669 | 1.3481 | 1.3030 | 1.3967 | 3.165 | 4 | 11.50 | 10.00 | 0.9500 | 0.9669 |
| 6.3 | 0.7400 | 0.7532 | 1.0698 | 0.8455 | 1.4289 | 23.482 | 4 | 11.50 | 10.00 | 0.7400 | 0.7532 |
| *12.5 | 0.0525 | 0.0534 | 0.2239 | 0.1741 | 0.3218 | 31.100 | 4 | 10.00 | 10.00 | 0.0525 | 0.0534 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.855421 | 0.905 | 1.46479 | 5.317971 |
| Bartlett's Test indicates equal variances (p = 0.02) | 11.4256 | 13.2767 | | |
| The control means are not significantly different (p = 0.35) | 1.023618 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Log-Logit Interpolation (200 Resamples)

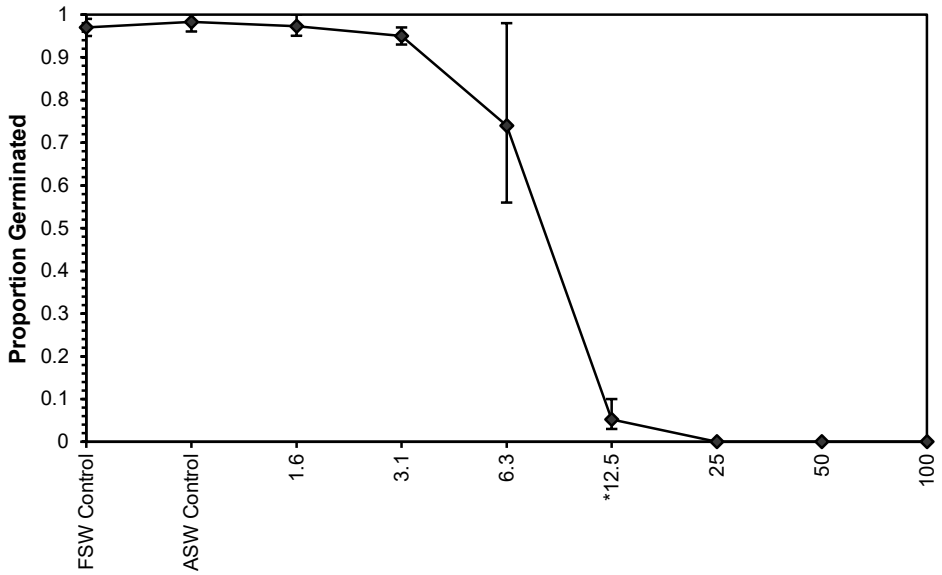
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.4978 | 0.4223 | 2.6103 | 4.7671 | 3.0763 |
| IC10 | 4.4079 | 0.5482 | 3.5056 | 7.3710 | 2.1540 |
| IC15 | 5.1271 | 0.6021 | 4.0103 | 7.5733 | 1.3300 |
| IC20 | 5.7557 | 0.5812 | 4.4392 | 7.7031 | 0.7798 |
| IC25 | 6.3185 | 0.5241 | 4.8372 | 7.8289 | 0.5007 |
| IC40 | 7.1226 | 0.4083 | 6.1021 | 8.5728 | 0.7298 |
| IC50 | 7.6417 | 0.3884 | 6.6355 | 8.9646 | 0.6615 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 15:30 | Test ID: | P2234/16 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 15:30 | Test ID: | P2234/16 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Germination, % | 97.00 | 95.00 | 99.00 | 1.83 | 1.39 | 4 |
| ASW Control | | 98.25 | 96.00 | 100.00 | 1.71 | 1.33 | 4 |
| 1.6 | | 97.25 | 95.00 | 100.00 | 2.22 | 1.53 | 4 |
| 3.1 | | 95.00 | 93.00 | 97.00 | 1.83 | 1.42 | 4 |
| 6.3 | | 74.00 | 56.00 | 98.00 | 17.57 | 5.66 | 4 |
| 12.5 | | 5.25 | 3.00 | 10.00 | 3.30 | 34.62 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 15:30 | Test ID: | P2234/16 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9500 | 0.9600 | 0.9900 |
| ASW Control | 0.9800 | 1.0000 | 0.9600 | 0.9900 |
| 1.6 | 0.9800 | 0.9600 | 0.9500 | 1.0000 |
| 3.1 | 0.9300 | 0.9700 | 0.9600 | 0.9400 |
| 6.3 | 0.5600 | 0.9800 | 0.7300 | 0.6900 |
| 12.5 | 0.0300 | 0.0500 | 0.1000 | 0.0300 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

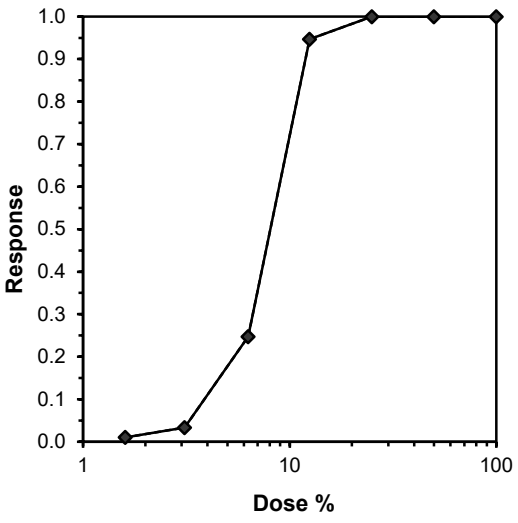
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | | Resp | Number |
| FSW Control | 0.9700 | 0.9873 | 1.4036 | 1.3453 | 1.4706 | 4.051 | 4 | | | | | |
| ASW Control | 0.9825 | 1.0000 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | * | | | 7 | 400 |
| 1.6 | 0.9725 | 0.9898 | 1.4161 | 1.3453 | 1.5208 | 5.517 | 4 | 15.50 | 10.00 | 0.098217 | 11 | 400 |
| 3.1 | 0.9500 | 0.9669 | 1.3481 | 1.3030 | 1.3967 | 3.165 | 4 | 11.50 | 10.00 | 0.074855 | 20 | 400 |
| 6.3 | 0.7400 | 0.7532 | 1.0698 | 0.8455 | 1.4289 | 23.482 | 4 | 11.50 | 10.00 | 0.251902 | 104 | 400 |
| *12.5 | 0.0525 | 0.0534 | 0.2239 | 0.1741 | 0.3218 | 31.100 | 4 | 10.00 | 10.00 | 0.091976 | 379 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.855421 | 0.905 | 1.46479 | 5.317971 |
| Bartlett's Test indicates equal variances (p = 0.02) | 11.4256 | 13.2767 | | |
| The control means are not significantly different (p = 0.35) | 1.023618 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Trimmed Spearman-Karber

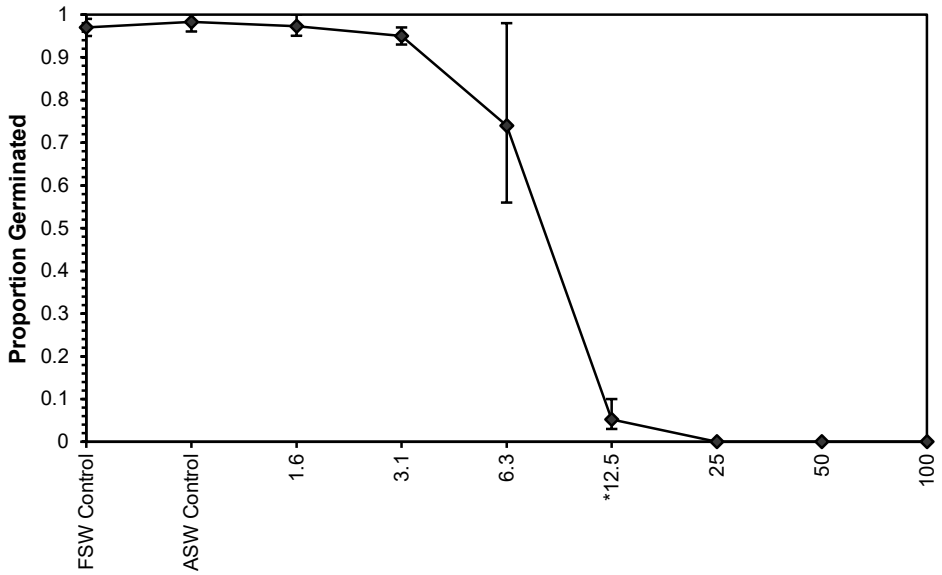
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 7.6768 | 7.4115 | 7.9517 |
| 10.0% | 7.8221 | 7.5122 | 8.1448 |
| 20.0% | 8.0381 | 7.5318 | 8.5784 |
| Auto-1.0% | 7.5854 | 7.3117 | 7.8694 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 15:30 | Test ID: | P2234/16 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 15:30 | Test ID: | P2234/16 | Sample ID: | PFW |
| End Date: | 16/09/2024 16:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Germination, % | 97.00 | 95.00 | 99.00 | 1.83 | 1.39 | 4 |
| ASW Control | | 98.25 | 96.00 | 100.00 | 1.71 | 1.33 | 4 |
| 1.6 | | 97.25 | 95.00 | 100.00 | 2.22 | 1.53 | 4 |
| 3.1 | | 95.00 | 93.00 | 97.00 | 1.83 | 1.42 | 4 |
| 6.3 | | 74.00 | 56.00 | 98.00 | 17.57 | 5.66 | 4 |
| 12.5 | | 5.25 | 3.00 | 10.00 | 3.30 | 34.62 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 50 | | 97.90 | 97.90 | 97.90 | 0.00 | 0.00 | 1 |
| 100 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 21:00 | Test ID: | P2234/27 | Sample ID: | PFW |
| End Date: | 16/09/2024 21:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 16.970 | 16.170 | 17.870 | 17.170 | 18.070 | 16.470 | 17.670 | 17.570 |
| ASW Control | 16.870 | 16.370 | 18.570 | 17.170 | | | | |
| 1.6 | 17.870 | 16.570 | 16.370 | 18.270 | | | | |
| 3.1 | 16.970 | 17.970 | 17.170 | 17.370 | | | | |
| 6.3 | 18.270 | 16.670 | 17.170 | 17.370 | | | | |
| 12.5 | 18.170 | 17.070 | 16.970 | 17.670 | | | | |
| 25 | 4.870 | 6.670 | 3.770 | 4.570 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

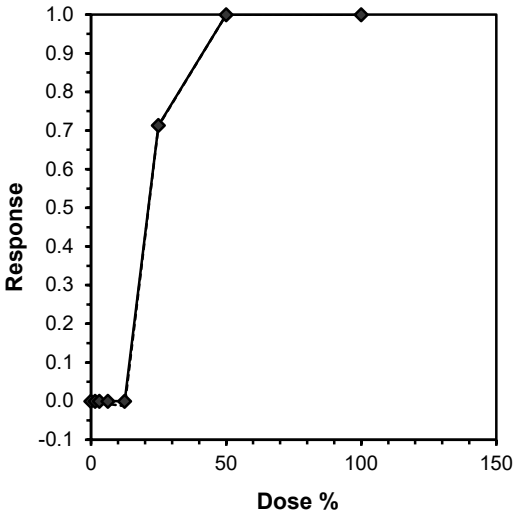
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 17.245 | 1.0000 | 17.245 | 16.170 | 18.070 | 3.918 | 8 | | | | | |
| ASW Control | 17.245 | 1.0000 | 17.245 | 16.370 | 18.570 | 5.468 | 4 | * | | | 17.345 | 1.0000 |
| 1.6 | 17.270 | 1.0014 | 17.270 | 16.370 | 18.270 | 5.452 | 4 | -0.042 | 2.410 | 1.430 | 17.345 | 1.0000 |
| 3.1 | 17.370 | 1.0072 | 17.370 | 16.970 | 17.970 | 2.487 | 4 | -0.211 | 2.410 | 1.430 | 17.345 | 1.0000 |
| 6.3 | 17.370 | 1.0072 | 17.370 | 16.670 | 18.270 | 3.848 | 4 | -0.211 | 2.410 | 1.430 | 17.345 | 1.0000 |
| 12.5 | 17.470 | 1.0130 | 17.470 | 16.970 | 18.170 | 3.204 | 4 | -0.379 | 2.410 | 1.430 | 17.345 | 1.0000 |
| *25 | 4.970 | 0.2882 | 4.970 | 3.770 | 6.670 | 24.641 | 4 | 20.693 | 2.410 | 1.430 | 4.970 | 0.2866 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.952632 | 0.916 | 0.644165 | -0.16823 |
| Bartlett's Test indicates equal variances (p = 0.60) | 3.63613 | 15.08627 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 12.5 | 25 | 17.67767 | 8 | 1.429589 | 0.082897 | 102.1198 | 0.70375 | 6.8E-14 | 5, 18 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 13.376 | 1.136 | 12.094 | 13.470 | -8.0034 |
| IC10 | 14.252 | 0.246 | 13.044 | 14.441 | -1.3351 |
| IC15 | 15.128 | 0.244 | 14.012 | 15.411 | -1.0607 |
| IC20 | 16.004 | 0.250 | 14.924 | 16.381 | -0.7234 |
| IC25 | 16.880 | 0.264 | 15.812 | 17.352 | -0.3912 |
| IC40 | 19.508 | 0.336 | 18.376 | 20.289 | 0.2493 |
| IC50 | 21.260 | 0.402 | 20.078 | 22.240 | 0.4277 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 13/09/2024 21:00 | Test ID: | P2234/27 | Sample ID: | PFW |
| End Date: | 16/09/2024 21:00 | Lab ID: | 11710 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Cell Yield | 17.25 | 16.17 | 18.07 | 0.68 | 4.77 | 8 |
| ASW Control | | 17.25 | 16.37 | 18.57 | 0.94 | 5.63 | 4 |
| 1.6 | | 17.27 | 16.37 | 18.27 | 0.94 | 5.62 | 4 |
| 3.1 | | 17.37 | 16.97 | 17.97 | 0.43 | 3.78 | 4 |
| 6.3 | | 17.37 | 16.67 | 18.27 | 0.67 | 4.71 | 4 |
| 12.5 | | 17.47 | 16.97 | 18.17 | 0.56 | 4.28 | 4 |
| 25 | | 4.97 | 3.77 | 6.67 | 1.22 | 22.27 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 25 | | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 | 1 |
| 50 | | 6.70 | 6.70 | 6.70 | 0.00 | 0.00 | 1 |
| 100 | | 5.80 | 5.80 | 5.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 25 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 50 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report

**November 2024**

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ABN 95 619 426 201

# Toxicity Test Report: TR2293/1



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2293<br>07 November 2024<br>14 November 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00091633 | **ESA Quote #:** | PL2293_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11798 | Y0071124 | Aqueous sample, pH 6.3*, salinity 20.4‰*, total ammonia 14.6mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20.0±1.0°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 20 November 2024 at 1810h |

| Sample 11798*: Y0071124* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control 90.8 ± 1.7 | | |
| ASW Control 91.5 ± 2.7 | | |
| 0.05 91.5 ± 2.1 | | |
| 0.1 85.3 ± 6.6 | | |
| 0.2 36.0 ± 18.7 * | | |
| 0.4 4.5 ± 3.1 * | | |
| 0.8 0.0 ± 0.0 | | |
| 1.6 0.0 ± 0.0 | | |
| 3.1 0.0 ± 0.0 | | |
| **IC10 = 0.1 (0.09-0.11)%** | | |
| **EC50 = 0.18 (0.17-0.19)%** | | |
| **NOEC = 0.1%** | | |
| **LOEC = 0.2%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2293/1



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 90.8% | Yes |
| Reference Toxicant within cusum chart limits | 55.0-58.1µg Cu/L | 56.8µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 November 2024

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Document Change Control:**

Test Report TR2234/1 replaced with TR2234/1_R01 to correct a typographic error for the test commencement time.

**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.



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# Toxicity Test Report: TR2293/2



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2293<br>07 November 2024<br>14 November 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00091633 | **ESA Quote #:** | PL2293_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11798 | Y0071124 | Aqueous sample, pH 6.3*, salinity 20.4‰*, total ammonia 14.6mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20.0±1.0°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 20 November 2024 at 1630h |

| Sample 11798*: Y0071124* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control 97.3 ± 1.0 | | |
| ASW Control 96.0 ± 2.9 | | |
| 0.05 96.8 ± 1.5 | | |
| 0.1 94.3 ± 2.2 | | |
| 0.2 32.3 ± 10.4* | | |
| 0.4 0.0 ± 0.0 | | |
| 0.8 0.0 ± 0.0 | | |
| 1.6 0.0 ± 0.0 | | |
| 3.1 0.0 ± 0.0 | | |
| **72-hr EC10 = 0.1 (0.11-0.14)%** | | |
| **72-hr EC50 = 0.2 (0.17-0.19)%** | | |
| **NOEC = 0.1%** | | |
| **LOEC = 0.2%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 97.3% | Yes |
| Reference Toxicant within cusum chart limits | 10.7-11.2µg Cu/L | 10.7µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 November 2024

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR2293/3



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2293<br>07 November 2024<br>14 November 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00091633 | **ESA Quote #:** | PL2293_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11798 | Y0071124 | Aqueous sample, pH 6.3*, salinity 20.4‰*, total ammonia 14.6mg/L*. Sample received at 9ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Test duration extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Spencer Gulf, SA |
| **Test Initiated:** | 20 November 2024 at 1730h |

| Sample 11798*: Y0071124* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Normal larvae (Mean ± SD)** | | |
| FSW Control | 73.8 ± 4.6 | | |
| ASW Control | 72.0 ± 2.7 | | |
| 0.05 | 72.8 ± 4.9 | | |
| 0.1 | 70.8 ± 3.6 | | |
| 0.2 | 45.8 ± 12.9 * | | |
| 0.4 | 0.0 ± 0.0 | | |
| 0.8 | 0.0 ± 0.0 | | |
| 1.6 | 0.0 ± 0.0 | | |
| 3.1 | 0.0 ± 0.0 | | |
| **72-hr IC10 = 0.1 (0.10-0.15)%**<br>**72-hr EC50 = 0.2 (0.21-0.22)%**<br>**NOEC = 0.1%**<br>**LOEC = 0.2%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 73.8% | Yes |
| Reference Toxicant within cusum chart limits | 8.9-11.8µg Cu/L | 9.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 November 2024

Results are based on the samples in the condition as received by ESA.

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**Document Change Control:**

Test Report TR2234/3 replaced with TR2234/3_R01 to correct a typographic error for the test duration of the EC10 and EC50 endpoints.

**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.

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# Toxicity Test Report: TR2293/4



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2293<br>07 November 2024<br>14 November 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00091633 | **ESA Quote #:** | PL2293_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11798 | Y0071124 | Aqueous sample, pH 6.3, salinity 20.4‰, total ammonia 14.6mg/L. Sample received at 9ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Test Initiated:** | 20 November 2024 at 1900h |

| Sample 11798*: Y0071124* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 0.05: 100 ± 0.0 | | |
| 0.1: 100 ± 0.0 | | |
| 0.2: 100 ± 0.0 | | |
| 0.4: 100 ± 0.0 | | |
| 0.8: 100 ± 0.0 | | |
| 1.6: 35.0 ± 10.0* | | |
| 3.1: 0.0 ± 0.0 | | |
| **96-hr IC10 = 1.3 (1.32-1.36)%** | | |
| **96-hr EC50 = 1.4 (1.24-1.66)%** | | |
| **NOEC = 0.8%** | | |
| **LOEC = 1.6%** | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR2293/4



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 9.7-107.3mg $NH_4^+$/L | 34.5mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 29 November 2024

Results are based on the samples in the condition as received by ESA.
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**Animal Ethics Approval:**

Animal Research Authority CSB V20/10359 issued by the Animal Care and Ethics Committee of The Secretary, Department of Regional NSW, NSW Department of Primary Industries, valid from 11 May 2023 to 11 May 2028.

**Citations:**

ESA (2017) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR2293/5



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:** | PR2293 |
| | | **Date Sampled:** | 07 November 2024 |
| | | **Date Received:** | 14 November 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00091633 | **ESA Quote #:** | PL2293_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11798 | Y0071124 | Aqueous sample, pH 6.3, salinity 20.4‰, total ammonia 14.6mg/L. Sample received at 9ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Sizw of Test Organisms:** | 14mm |
| **Test Initiated:** | 20 November 2024 at 2000h |

Sample 11798*: Y0071124*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 0.05 | 100 ± 0.0 |
| 0.1 | 100 ± 0.0 |
| 0.2 | 100 ± 0.0 |
| 0.4 | 100 ± 0.0 |
| 0.8 | 0.0 ± 0.0 |
| 1.6 | 0.0 ± 0.0 |
| 3.1 | 0.0 ± 0.0 |

**7 day IC50 (unaffected) = 0.6%***
**NOEC = 0.2%**
**LOEC = 0.3%**

Sample 11798*: Y0071124*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** |
|---|---|
| FSW Control | 18.6 ± 0.6 |
| ASW Control | 17.8 ± 0.3 |
| 0.05 | 18.5 ± 1.1 |
| 0.1 | 17.9 ± 2.2 |
| 0.2 | 17.1 ± 1.8 |
| 0.4 | 15.0 ± 0.8 ** |
| 0.8 | 0.0 ± 0.0 |
| 1.6 | 0.0 ± 0.0 |
| 3.1 | 0.0 ± 0.0 |

**7 day IC10 (biomass) = 0.3 (0.00-0.35)%**
**7 day IC50 (biomass) = 0.6 (0.54-0.58)%**
**NOEC = 0.2%**
**LOEC = 0.4%**

*95% confidence limits not determinable
**Significantly lower biomass compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 21.6% | Yes |
| Reference Toxicant within cusum chart limits | 9.7-107.3mg $NH_4^+$/L | 34.5mg $NH_4^+$/L | Yes |

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# Toxicity Test Report: TR2293/5



Test Report Authorised by: Dr Rick Krassoi, Director on 29 November 2024

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Animal Ethics Approval:**

Animal Research Authority CSB V20/10359 issued by the Animal Care and Ethics Committee of The Secretary, Department of Regional NSW, NSW Department of Primary Industries, valid from 11 May 2023 to 11 May 2028.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

# Toxicity Test Report: TR2293/6



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2293<br>07 November 2024<br>14 November 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00091633 | **ESA Quote #:** | PL2293_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11798 | Y0071124 | Aqueous sample, pH 6.3, salinity 20.4‰, total ammonia 14.6mg/L. Sample received at 9ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 20 November 2024 at 1930h |

| Sample 11798*: Y0071124* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 0.05: 100 ± 0.0 | | |
| 0.1: 100 ± 0.0 | | |
| 0.2: 100 ± 0.0 | | |
| 0.4: 70.0 ± 11.6 * | | |
| 0.8: 5.0 ± 10.0 * | | |
| 1.6: 0.0 ± 0.0 | | |
| 3.1: 0.0 ± 0.0 | | |
| **96-hr IC10 = 0.3 (0.22-0.38)%** | | |
| **96-hr IC50 = 0.5 (0.40-0.56)%** | | |
| **NOEC = 0.2%** | | |
| **LOEC = 0.4%** | | |

*Significantly lower percentage of unaffected amphipods compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 1.5-7.9.4mg SDS/L | 3.8mg SDS/L | Yes |

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# Toxicity Test Report: TR2293/6



Test Report Authorised by: Dr Rick Krassoi, Director on 29 November 2024

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR2293/7



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2293<br>07 November 2024<br>14 November 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00091633 | **ESA Quote #:** | PL2293_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11798 | Y0071124 | Aqueous sample, pH 6.3, salinity 20.4‰, total ammonia 14.6mg/L. Sample received at 9ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 20 November 2024 at 1630h |

| Sample 11798*: Y0071124* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **% Germination (Mean ± SD)** | |
| FSW Control | 95.8 ± 1.0 | |
| ASW Control | 97.3 ± 1.7 | |
| 0.05 | 95.3 ± 2.5 | |
| 0.1 | 92.0 ± 1.8 | |
| 0.2 | 92.8 ± 1.7 | |
| 0.4 | 85.0 ± 8.0 * | |
| 0.8 | 25.0 ± 3.4 * | |
| 1.6 | 12.0 ± 6.7 * | |
| 3.1 | 0.0 ± 0.0 | |
| **72-hr IC10 = 0.3 (0.15-0.46)%** | | |
| **72-hr EC50 = 0.7 (0.50-0.88)%** | | |
| **NOEC = 0.2%** | | |
| **LOEC = 0.4%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 95.8% | Yes |
| Reference Toxicant within cusum chart limits | 156.0-212.9µg Cu/L | 159.8µg Cu/L | Yes |

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ABN 95 619 426 201

# Toxicity Test Report: TR2293/7



Test Report Authorised by: Dr Rick Krassoi, Director on 29 November 2024

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR2293/8 (Page 1 of 2)

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Limited<br>Level 15, 150 Lonsdale Street<br>Melbourne VIC 3000 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR2293<br>07 November 2024<br>14 November 2024 |
| **Attention:** | Ronie Magcamit | **Sampled By:** | Client |
| **Client Ref:** | PO: BE00091633 | **ESA Quote #:** | PL2293_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 11798 | Y0071124 | Aqueous sample, pH 6.3, salinity 20.4‰, total ammonia 14.6mg/L. Sample received at 9ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 20 November 2024 at 1900h |

| Sample 11798*: Y0071124* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** | **Cell Yield (Mean number of cells/mL x10⁴ ± SD)** | |
| FSW Control | 17.5 ± 1.0 | |
| ASW Control | 17.3 ± 0.8 | |
| 0.05 | 17.7 ± 0.5 | |
| 0.1 | 17.5 ± 0.6 | |
| 0.2 | 16.3 ± 2.3 | |
| 0.4 | 13.6 ± 0.6 * | |
| 0.8 | 6.8 ± 1.7 * | |
| 1.6 | 1.1 ± 1.7 * | |
| 3.1 | 0.0 ± 0.0 | |
| **72-hr IC10 = 0.3 (0.11-0.32)%** | | |
| **72-hr IC50 = 0.7 (0.60-0.80)%** | | |
| **NOEC = 0.2%** | | |
| **LOEC = 0.4%** | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x10⁴ cells/mL | 17.5x10⁴ cells/mL | Yes |
| Control coefficient of variation | <20% | 3.8% | Yes |
| Reference Toxicant within cusum chart limits | 3.7-8.7µg Cu/L | 6.0µg Cu/L | Yes |

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ABN 95 619 426 201

# Toxicity Test Report: TR2293/8 (Page 2 of 2)

Test Report Authorised by: Dr Rick Krassoi, Director on 29 November 2024

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Ronie Magcamit

**Client** : Beach Energy Limited
Level 15, 150 Lonsdale Street
Melbourne VIC 3000

**Email** : ronie.magcamit@beachenergy.com.au
**Telephone** :
**Facsimile** :

**Date** : 15/11/2024

**Re** : Receipt of Samples **Pages : 2**

**ESA Project** : PR2293 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples: YES**
**Samples received in apparent good condition and correctly bottled: YES**
**Security seals on sample bottles and esky intact: YES**

**Date samples received** : 14/11/2024
**Time samples received** : 9:40
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 6-10°C

**Comments** : 4 x 2.5L sample received at 9 degrees C in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

ecotox SERVICES AUSTRALIA

Datasheet ID: 601.1
Last Revised: 14 December 2022

Customer: Beach Energy
Contact Name: Ronie Magcamit
Phone: 0427 760 486 Email: ronie.magcamit@beachenergy.com.au
Purchase Order:

Ship To: Ecotox Services Australia
Attention: Dr Rick Krassoi
(please provide an email address for sample receipt notification)

Samples taken during descale unload on Y4.

*Toxicity Testing per PL2293

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | Comments / Instructions |
|---|---|---|---|---|---|---|
| 07/11/24 | 11:00 | Y0071124-1 | Grab | 4 x 2.5lts | Toxicity Testing per PL2293 | |
| | | Y0071124-2 | | | | |
| | | Y0071124-3 | | | | |
| | | Y0071124-4 | | | | |

Comments / Instructions

**Note that testing will be delayed if an incomplete chain of custody is received**

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

*Note: An MSDS must be attached if Available*

**ESA Project Number: PR** 2293

9°C.
11798

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| A.EVANS | 13.11.24 | | 14/11/24 | | | | |
| Of: Beach Energy | Time: 09:00 | Of: ESA | Time: 0940 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

# Statistical Printouts for the Sea Urchin Fertilisation Test

## -Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 18:10 | Test ID: | PR2293/03 | Sample ID: | Y0071124 |
| End Date: | 20/11/2024 19:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

| Conc-ug/L | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9100 | 0.8900 | 0.9300 | 0.9000 |
| ASW Control | 0.9200 | 0.9000 | 0.9500 | 0.8900 |
| 0.05 | 0.9400 | 0.9100 | 0.8900 | 0.9200 |
| 0.1 | 0.8500 | 0.7600 | 0.9000 | 0.9000 |
| 0.2 | 0.2700 | 0.5900 | 0.1600 | 0.4200 |
| 0.4 | 0.0300 | 0.0900 | 0.0400 | 0.0200 |
| 0.8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.6 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-ug/L | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9075 | 0.9918 | 1.2627 | 1.2327 | 1.3030 | 2.386 | 4 | | | | | |
| ASW Control | 0.9150 | 1.0000 | 1.2778 | 1.2327 | 1.3453 | 3.900 | 4 | * | | | 34 | 400 |
| 0.05 | 0.9150 | 1.0000 | 1.2766 | 1.2327 | 1.3233 | 2.957 | 4 | 0.016 | 2.360 | 0.1785 | 34 | 400 |
| 0.1 | 0.8525 | 0.9317 | 1.1825 | 1.0588 | 1.2490 | 7.602 | 4 | 1.260 | 2.360 | 0.1785 | 59 | 400 |
| *0.2 | 0.3600 | 0.3934 | 0.6347 | 0.4115 | 0.8759 | 31.606 | 4 | 8.503 | 2.360 | 0.1785 | 256 | 400 |
| *0.4 | 0.0450 | 0.0492 | 0.2055 | 0.1419 | 0.3047 | 34.280 | 4 | 14.178 | 2.360 | 0.1785 | 382 | 400 |
| 0.8 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 1.6 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 3.1 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

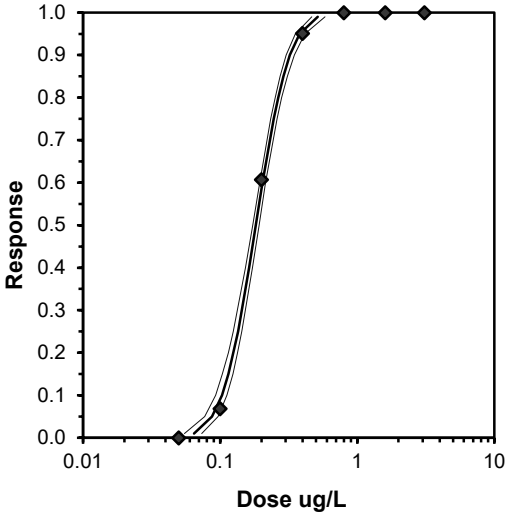
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.952363 | 0.905 | 0.147345 | 2.104759 |
| Bartlett's Test indicates equal variances (p = 0.05) | 9.357854 | 13.2767 | | |
| The control means are not significantly different (p = 0.62) | 0.516755 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 0.1 | 0.2 | 0.141421 | | 0.122888 | 0.134074 | 0.915821 | 0.011439 | 6.2E-10 | 4, 15 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 5.155594 | 0.29436 | 4.578649 | 5.732539 | 0.085 | 2.773175 | 11.0705 | 0.73 | -0.73931 | 0.193964 | 3 |
| Intercept | 8.811607 | 0.211112 | 8.397828 | 9.225386 | | | | | | | |
| TSCR | 0.081322 | 0.009733 | 0.062245 | 0.1004 | | | | | | | |

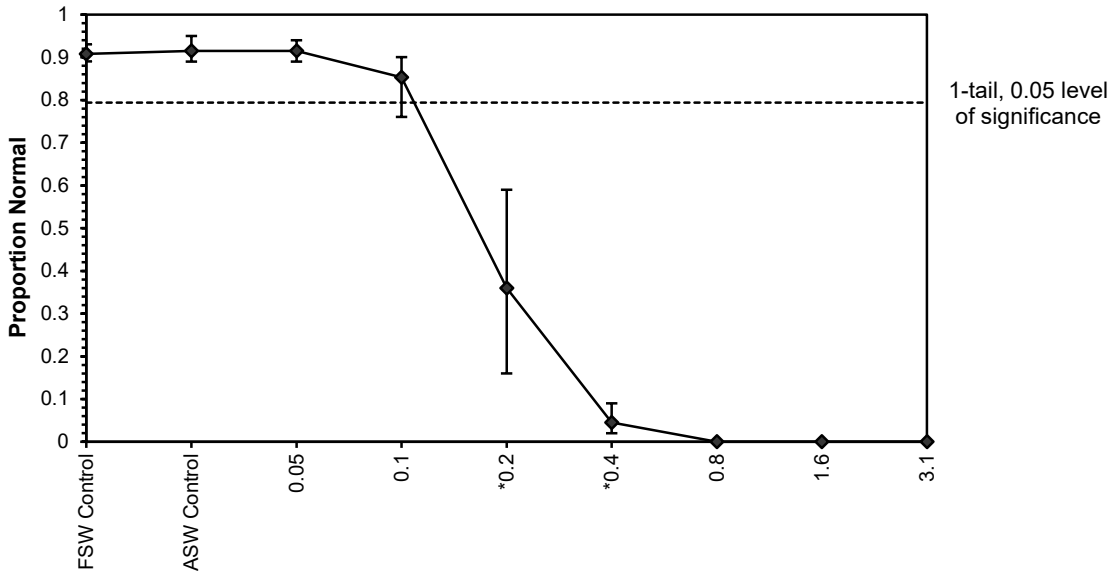
| Point | Probits | ug/L | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 0.064485 | 0.054942 | 0.073413 |
| EC05 | 3.355 | 0.087426 | 0.077192 | 0.09679 |
| EC10 | 3.718 | 0.102828 | 0.092463 | 0.112242 |
| EC15 | 3.964 | 0.114724 | 0.104386 | 0.124101 |
| EC20 | 4.158 | 0.125153 | 0.114903 | 0.134468 |
| EC25 | 4.326 | 0.134852 | 0.124717 | 0.144106 |
| EC40 | 4.747 | 0.162759 | 0.15296 | 0.171978 |
| EC50 | 5.000 | 0.182257 | 0.172514 | 0.191758 |
| EC60 | 5.253 | 0.204092 | 0.19404 | 0.214395 |
| EC75 | 5.674 | 0.246327 | 0.234259 | 0.259928 |
| EC80 | 5.842 | 0.265417 | 0.251859 | 0.281222 |
| EC85 | 6.036 | 0.289545 | 0.273692 | 0.308658 |
| EC90 | 6.282 | 0.323043 | 0.303405 | 0.347544 |
| EC95 | 6.645 | 0.379951 | 0.35273 | 0.415254 |
| EC99 | 7.326 | 0.515126 | 0.466163 | 0.582025 |



## -Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 18:10 | Test ID: | PR2293/03 | Sample ID: | Y0071124 |
| End Date: | 20/11/2024 19:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Dose-Response Plot**



## -Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 18:10 | Test ID: | PR2293/03 | Sample ID: | Y0071124 |
| End Date: | 20/11/2024 19:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-ug/L | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 90.75 | 89.00 | 93.00 | 1.71 | 1.44 | 4 |
| ASW Control | | 91.50 | 89.00 | 95.00 | 2.65 | 1.78 | 4 |
| 0.05 | | 91.50 | 89.00 | 94.00 | 2.08 | 1.58 | 4 |
| 0.1 | | 85.25 | 76.00 | 90.00 | 6.60 | 3.01 | 4 |
| 0.2 | | 36.00 | 16.00 | 59.00 | 18.67 | 12.00 | 4 |
| 0.4 | | 4.50 | 2.00 | 9.00 | 3.11 | 39.18 | 4 |
| 0.8 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 16:30 | Test ID: | PR2293/01 | Sample ID: | Y0771124 |
| End Date: | 23/11/2024 16:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9800 | 0.9700 |
| ASW Control | 0.9600 | 1.0000 | 0.9500 | 0.9300 |
| 0.05 | 0.9800 | 0.9600 | 0.9500 | 0.9800 |
| 0.1 | 0.9600 | 0.9500 | 0.9100 | 0.9500 |
| 0.2 | 0.4300 | 0.2100 | 0.3900 | 0.2600 |
| 0.4 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.6 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9725 | 1.0130 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3846 | 1.3030 | 1.5208 | 6.848 | 4 | * | | | 16 | 400 |
| 0.05 | 0.9675 | 1.0078 | 1.3931 | 1.3453 | 1.4289 | 3.048 | 4 | -0.150 | 2.290 | 0.1296 | 13 | 400 |
| 0.1 | 0.9425 | 0.9818 | 1.3315 | 1.2661 | 1.3694 | 3.385 | 4 | 0.938 | 2.290 | 0.1296 | 23 | 400 |
| *0.2 | 0.3225 | 0.3359 | 0.6002 | 0.4760 | 0.7152 | 18.849 | 4 | 13.860 | 2.290 | 0.1296 | 271 | 400 |
| 0.4 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 0.8 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 1.6 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 3.1 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

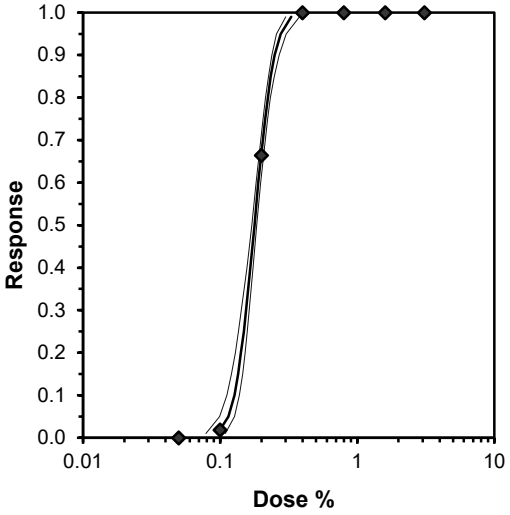
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.976044 | 0.887 | 0.291588 | -0.36885 |
| Bartlett's Test indicates equal variances (p = 0.30) | 3.648114 | 11.34487 | | |
| The control means are not significantly different (p = 0.68) | 0.431113 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 0.1 | 0.2 | 0.141421 | 1000 | 0.062181 | 0.064387 | 0.595214 | 0.006406 | 1.4E-08 | 3, 12 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 8.660661 | 0.92245 | 6.852659 | 10.46866 | 0.04 | 1.026847 | 11.0705 | 0.96 | -0.74963 | 0.115465 | 4 |
| Intercept | 11.49229 | 0.654868 | 10.20875 | 12.77583 | | | | | | | |
| TSCR | 0.037965 | 0.006461 | 0.025302 | 0.050628 | | | | | | | |

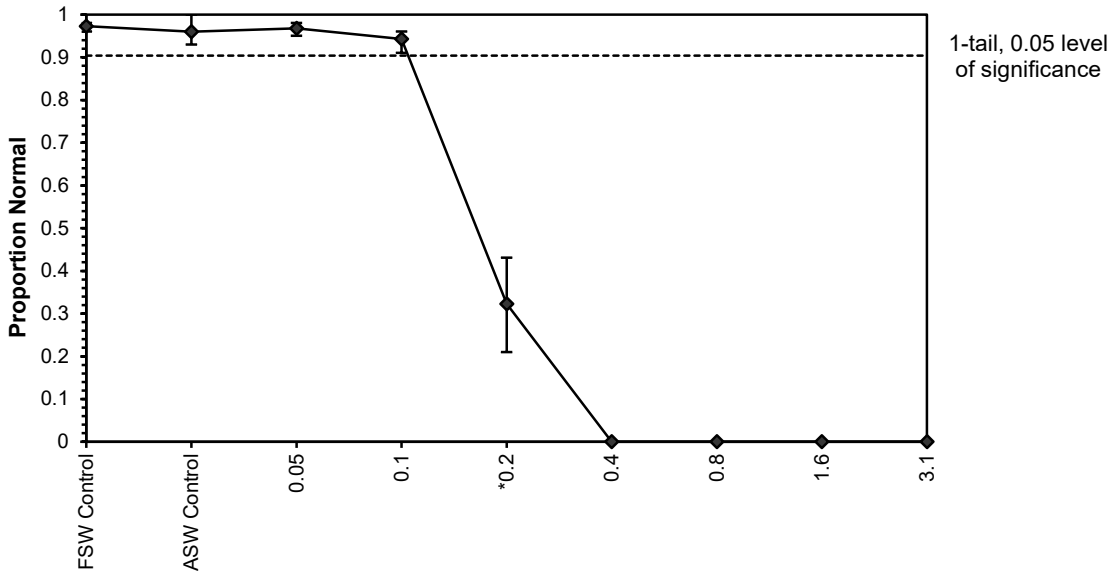
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 0.095887 | 0.078743 | 0.109226 |
| EC05 | 3.355 | 0.114934 | 0.098887 | 0.127042 |
| EC10 | 3.718 | 0.126589 | 0.111614 | 0.137749 |
| EC15 | 3.964 | 0.135114 | 0.121083 | 0.145515 |
| EC20 | 4.158 | 0.142296 | 0.129149 | 0.152033 |
| EC25 | 4.326 | 0.148762 | 0.136465 | 0.157893 |
| EC40 | 4.747 | 0.166386 | 0.15653 | 0.173968 |
| EC50 | 5.000 | 0.17798 | 0.169619 | 0.184827 |
| EC60 | 5.253 | 0.190381 | 0.183177 | 0.197033 |
| EC75 | 5.674 | 0.212936 | 0.205643 | 0.221811 |
| EC80 | 5.842 | 0.222612 | 0.214427 | 0.233437 |
| EC85 | 6.036 | 0.234445 | 0.224719 | 0.248227 |
| EC90 | 6.282 | 0.250233 | 0.237949 | 0.268651 |
| EC95 | 6.645 | 0.275609 | 0.258498 | 0.302647 |
| EC99 | 7.326 | 0.330355 | 0.301134 | 0.379473 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 16:30 | Test ID: | PR2293/01 | Sample ID: | Y0771124 |
| End Date: | 23/11/2024 16:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 16:30 | Test ID: | PR2293/01 | Sample ID: | Y0771124 |
| End Date: | 23/11/2024 16:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 97.25 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| ASW Control | | 96.00 | 93.00 | 100.00 | 2.94 | 1.79 | 4 |
| 0.05 | | 96.75 | 95.00 | 98.00 | 1.50 | 1.27 | 4 |
| 0.1 | | 94.25 | 91.00 | 96.00 | 2.22 | 1.58 | 4 |
| 0.2 | | 32.25 | 21.00 | 43.00 | 10.44 | 10.02 | 4 |
| 0.4 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 0.8 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 17:30 | Test ID: | PR2293/04 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 17:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7300 | 0.6800 | 0.7500 | 0.7900 |
| ASW Control | 0.7300 | 0.6800 | 0.7400 | 0.7300 |
| 0.05 | 0.7000 | 0.6800 | 0.7400 | 0.7900 |
| 0.1 | 0.7600 | 0.6800 | 0.6900 | 0.7000 |
| 0.2 | 0.5300 | 0.4100 | 0.3000 | 0.5900 |
| 0.4 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.6 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

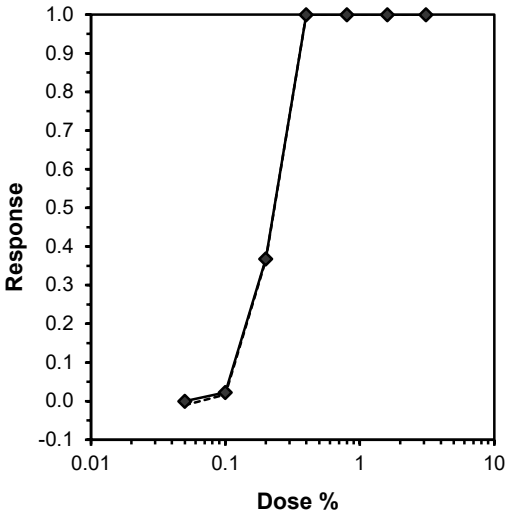
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7375 | 1.0243 | 1.0340 | 0.9695 | 1.0948 | 5.030 | 4 | | | | | |
| ASW Control | 0.7200 | 1.0000 | 1.0135 | 0.9695 | 1.0357 | 2.941 | 4 | * | | | 0.7238 | 1.0000 |
| 0.05 | 0.7275 | 1.0104 | 1.0228 | 0.9695 | 1.0948 | 5.410 | 4 | -0.174 | 2.290 | 0.1224 | 0.7238 | 1.0000 |
| 0.1 | 0.7075 | 0.9826 | 1.0000 | 0.9695 | 1.0588 | 4.023 | 4 | 0.254 | 2.290 | 0.1224 | 0.7075 | 0.9775 |
| *0.2 | 0.4575 | 0.6354 | 0.7415 | 0.5796 | 0.8759 | 17.738 | 4 | 5.089 | 2.290 | 0.1224 | 0.4575 | 0.6321 |
| 0.4 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 0.8 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 1.6 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 3.1 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.953923 | 0.887 | -0.29972 | 1.530792 |
| Bartlett's Test indicates equal variances (p = 0.07) | 6.957132 | 11.34487 | | |
| The control means are not significantly different (p = 0.52) | 0.682648 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 0.1 | 0.2 | 0.141421 | 1000 | 0.115383 | 0.160192 | 0.073589 | 0.005717 | 4.6E-04 | 3, 12 |

### Log-Logit Interpolation (200 Resamples)

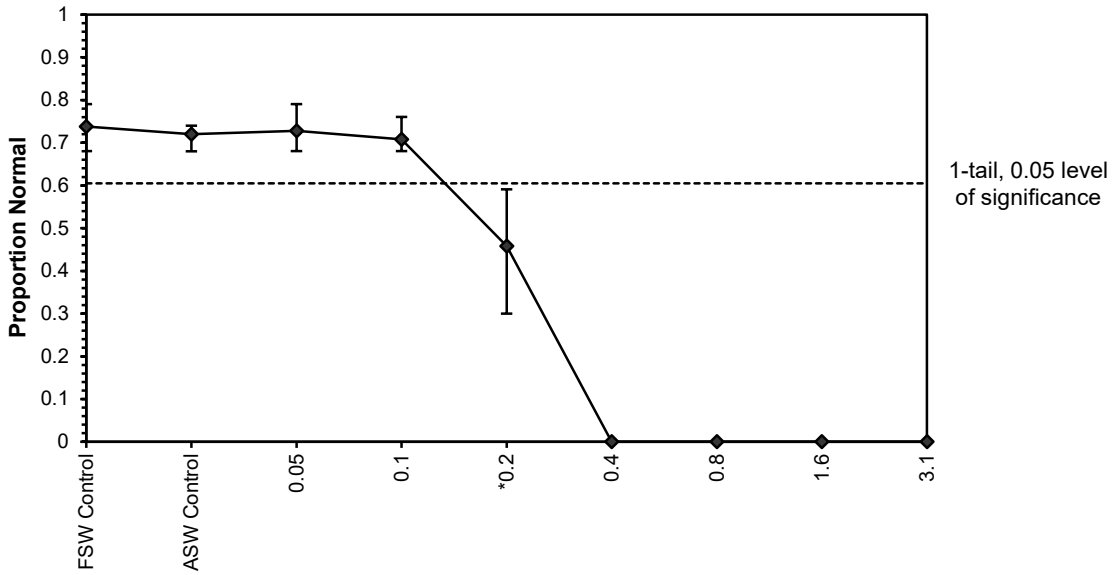
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 0.1086 | 0.0115 | 0.0650 | 0.1271 | -1.8093 |
| IC10 | 0.1237 | 0.0084 | 0.1001 | 0.1525 | 0.7522 |
| IC15 | 0.1383 | 0.0110 | 0.1130 | 0.1773 | 1.0806 |
| IC20 | 0.1525 | 0.0140 | 0.1240 | 0.2089 | 0.9655 |
| IC25 | 0.1666 | 0.0158 | 0.1319 | 0.2220 | 0.5429 |
| IC40 | 0.2019 | 0.0092 | 0.1586 | 0.2143 | -1.2545 |
| IC50 | 0.2081 | 0.0049 | 0.1899 | 0.2201 | -0.7911 |



**Bivalve Acute Toxicity Tests-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 17:30 | Test ID: | PR2293/04 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 17:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 17:30 | Test ID: | PR2293/04 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 17:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 73.75 | 68.00 | 79.00 | 4.57 | 2.90 | 4 |
| ASW Control | | 72.00 | 68.00 | 74.00 | 2.71 | 2.29 | 4 |
| 0.05 | | 72.75 | 68.00 | 79.00 | 4.86 | 3.03 | 4 |
| 0.1 | | 70.75 | 68.00 | 76.00 | 3.59 | 2.68 | 4 |
| 0.2 | | 45.75 | 30.00 | 59.00 | 12.89 | 7.85 | 4 |
| 0.4 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 0.8 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 17:30 | Test ID: | PR2293/04 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 17:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7300 | 0.6800 | 0.7500 | 0.7900 |
| ASW Control | 0.7300 | 0.6800 | 0.7400 | 0.7300 |
| 0.05 | 0.7000 | 0.6800 | 0.7400 | 0.7900 |
| 0.1 | 0.7600 | 0.6800 | 0.6900 | 0.7000 |
| 0.2 | 0.5300 | 0.4100 | 0.3000 | 0.5900 |
| 0.4 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.6 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

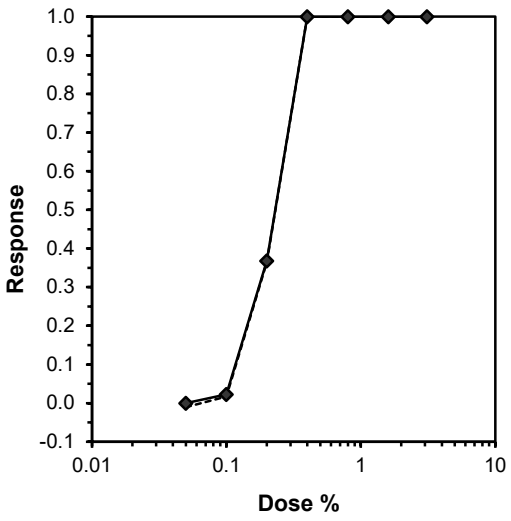
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7375 | 1.0243 | 1.0340 | 0.9695 | 1.0948 | 5.030 | 4 | | | | | |
| ASW Control | 0.7200 | 1.0000 | 1.0135 | 0.9695 | 1.0357 | 2.941 | 4 | * | | | 112 | 400 |
| 0.05 | 0.7275 | 1.0104 | 1.0228 | 0.9695 | 1.0948 | 5.410 | 4 | -0.174 | 2.290 | 0.1224 | 109 | 400 |
| 0.1 | 0.7075 | 0.9826 | 1.0000 | 0.9695 | 1.0588 | 4.023 | 4 | 0.254 | 2.290 | 0.1224 | 117 | 400 |
| *0.2 | 0.4575 | 0.6354 | 0.7415 | 0.5796 | 0.8759 | 17.738 | 4 | 5.089 | 2.290 | 0.1224 | 217 | 400 |
| 0.4 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 0.8 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 1.6 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 3.1 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.953923 | 0.887 | -0.29972 | 1.530792 |
| Bartlett's Test indicates equal variances (p = 0.07) | 6.957132 | 11.34487 | | |
| The control means are not significantly different (p = 0.52) | 0.682648 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 0.1 | 0.2 | 0.141421 | 1000 | 0.115383 | 0.160192 | 0.073589 | 0.005717 | 4.6E-04 | 3, 12 |

### Trimmed Spearman-Karber

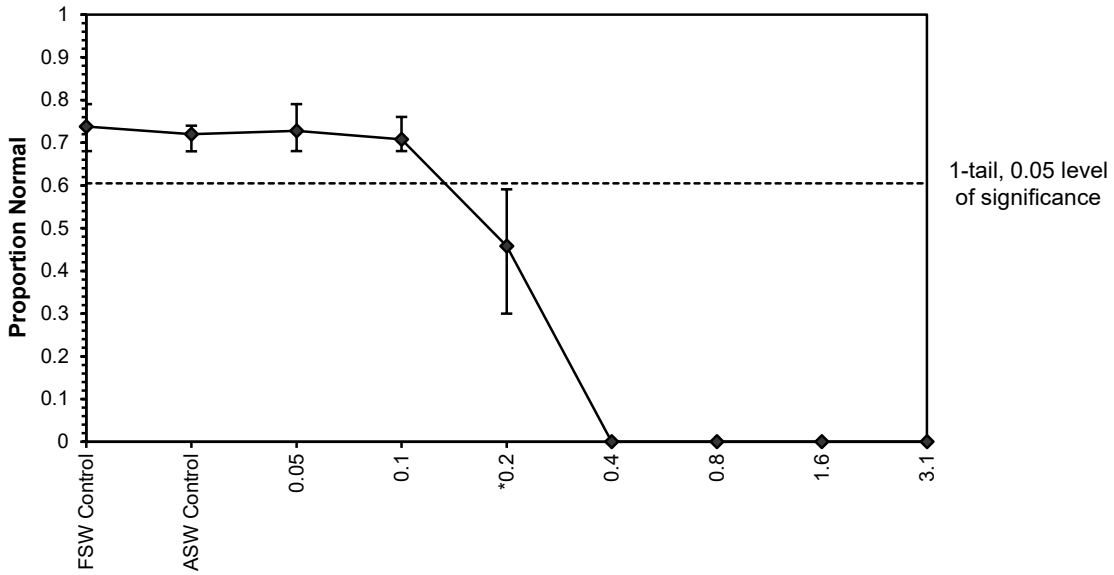
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 0.2158 | 0.2084 | 0.2235 |
| 5.0% | 0.2197 | 0.2116 | 0.2280 |
| 10.0% | 0.2219 | 0.2127 | 0.2316 |
| 20.0% | 0.2263 | 0.2130 | 0.2404 |
| Auto-0.0% | 0.2158 | 0.2084 | 0.2235 |



**Bivalve Acute Toxicity Tests-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 17:30 | Test ID: | PR2293/04 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 17:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 17:30 | Test ID: | PR2293/04 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 17:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 73.75 | 68.00 | 79.00 | 4.57 | 2.90 | 4 |
| ASW Control | | 72.00 | 68.00 | 74.00 | 2.71 | 2.29 | 4 |
| 0.05 | | 72.75 | 68.00 | 79.00 | 4.86 | 3.03 | 4 |
| 0.1 | | 70.75 | 68.00 | 76.00 | 3.59 | 2.68 | 4 |
| 0.2 | | 45.75 | 30.00 | 59.00 | 12.89 | 7.85 | 4 |
| 0.4 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 0.8 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/12 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.05 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.2 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 0.4000 | 0.4000 | 0.2000 | 0.4000 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

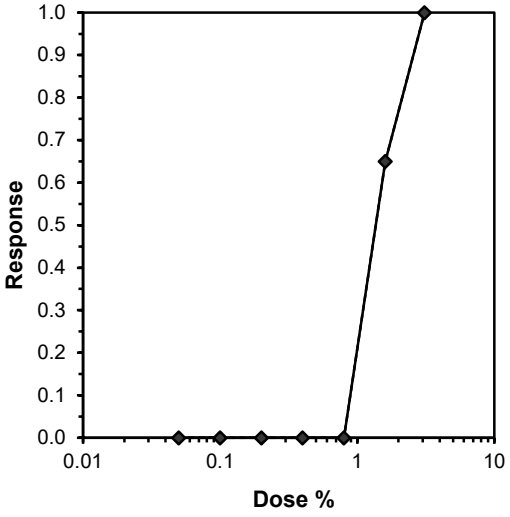
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 0.05 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 0.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 0.2 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 0.4 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 0.8 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *1.6 | 0.3500 | 0.3500 | 0.6295 | 0.4636 | 0.6847 | 17.561 | 4 | 10.00 | 10.00 | 0.3500 | 0.3500 |
| 3.1 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.433732 | 0.924 | -3.23077 | 16.31077 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 0.8 | 1.6 | 1.131371 | 125 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

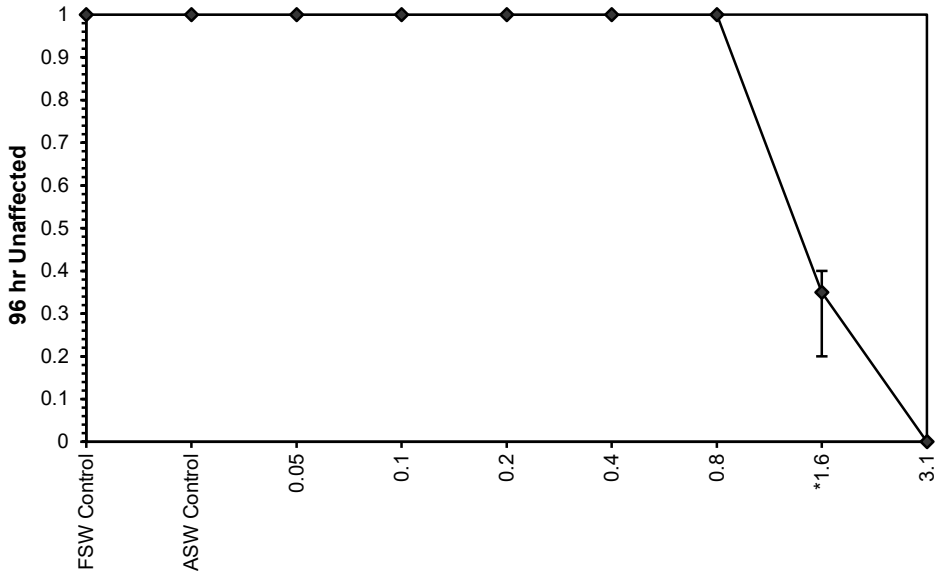
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.2755 | 0.0098 | 1.2557 | 1.2945 | -0.6409 |
| IC10 | 1.3400 | 0.0113 | 1.3172 | 1.3619 | -0.6394 |
| IC15 | 1.3809 | 0.0123 | 1.3561 | 1.4046 | -0.6385 |
| IC20 | 1.4121 | 0.0130 | 1.3859 | 1.4373 | -0.6378 |
| IC25 | 1.4382 | 0.0136 | 1.4107 | 1.4646 | -0.6372 |
| IC40 | 1.5022 | 0.0152 | 1.4716 | 1.5316 | -0.6359 |
| IC50 | 1.5405 | 0.0161 | 1.5080 | 1.5717 | -0.6351 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/12 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/12 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.05 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.2 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.4 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.8 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 35.00 | 20.00 | 40.00 | 10.00 | 9.04 | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/12 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.05 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.2 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 0.4000 | 0.4000 | 0.2000 | 0.4000 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

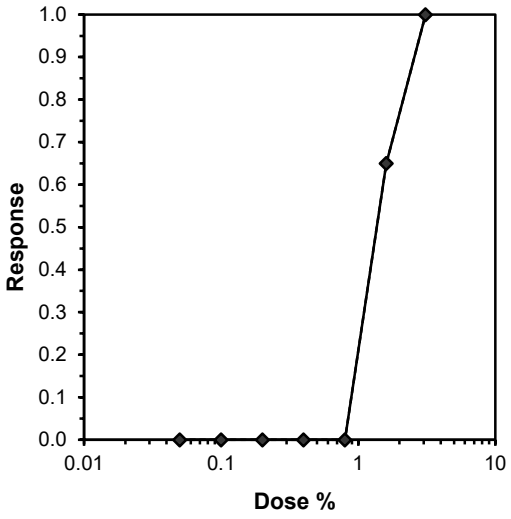
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 0.05 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.2 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.4 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.8 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *1.6 | 0.3500 | 0.3500 | 0.6295 | 0.4636 | 0.6847 | 17.561 | 4 | 10.00 | 10.00 | 13 | 20 |
| 3.1 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.433732 | 0.924 | -3.23077 | 16.31077 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 0.8 | 1.6 | 1.131371 | 125 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

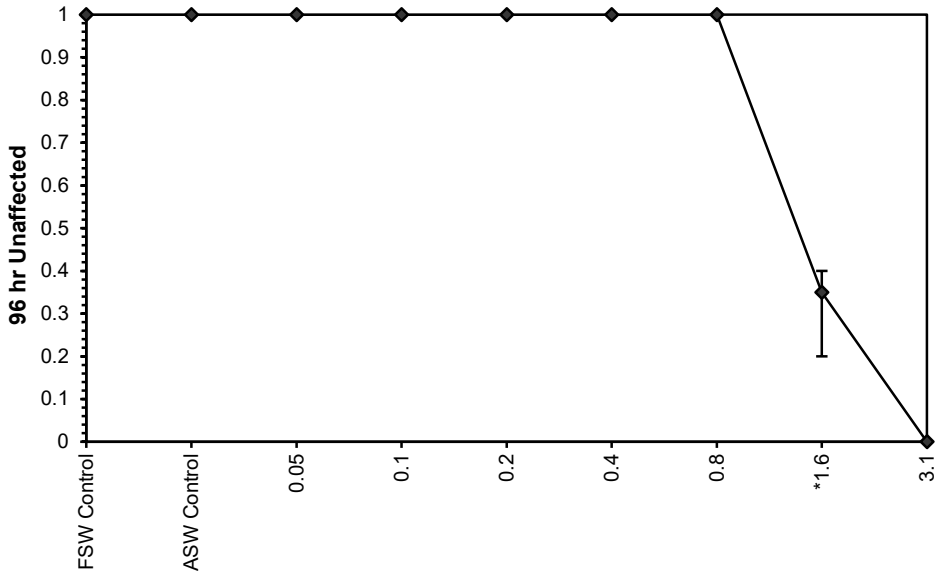
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 1.4340 | 1.2411 | 1.6569 |
| 5.0% | 1.4208 | 1.2114 | 1.6663 |
| 10.0% | 1.4081 | 1.1813 | 1.6783 |
| 20.0% | 1.3847 | 1.1179 | 1.7152 |
| Auto-0.0% | 1.4340 | 1.2411 | 1.6569 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/12 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/12 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.05 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.2 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.4 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.8 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 35.00 | 20.00 | 40.00 | 10.00 | 9.04 | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 20:00 | Test ID: | PR2296/53 | Sample ID: | YO071124 |
| End Date: | 23/11/2024 20:00 | Lab ID: | 11798 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | EPAM 94 | Test Species: | MI |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW | 17.980 | 19.160 | 18.920 | 18.120 |
| ASW | 18.080 | 17.460 | 17.580 | 17.940 |
| 0.05 | 19.020 | 19.480 | 16.880 | 18.440 |
| 0.1 | 19.560 | 19.760 | 14.960 | 17.480 |
| 0.2 | 16.880 | 19.740 | 15.980 | 15.900 |
| 0.4 | 14.900 | 14.020 | 16.080 | 14.960 |
| 0.8 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1.6 | 0.000 | 0.000 | 0.000 | 0.000 |
| 3.1 | 0.000 | 0.000 | 0.000 | 0.000 |

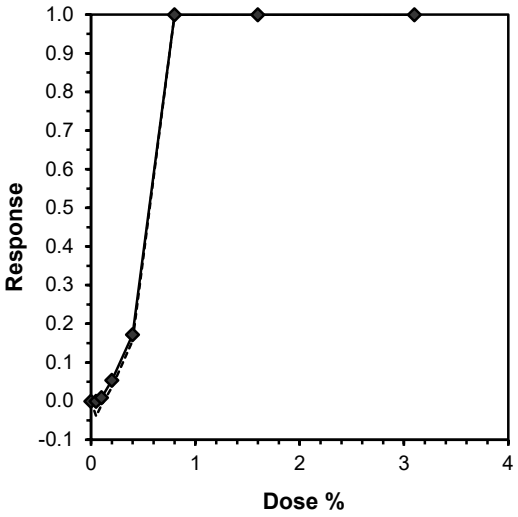
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW | 18.545 | 1.0439 | 18.545 | 17.980 | 19.160 | 3.142 | 4 | | | | | |
| ASW | 17.765 | 1.0000 | 17.765 | 17.460 | 18.080 | 1.648 | 4 | * | | | 18.110 | 1.0000 |
| 0.05 | 18.455 | 1.0388 | 18.455 | 16.880 | 19.480 | 6.139 | 4 | -0.679 | 2.360 | 2.398 | 18.110 | 1.0000 |
| 0.1 | 17.940 | 1.0099 | 17.940 | 14.960 | 19.760 | 12.476 | 4 | -0.172 | 2.360 | 2.398 | 17.940 | 0.9906 |
| 0.2 | 17.125 | 0.9640 | 17.125 | 15.900 | 19.740 | 10.505 | 4 | 0.630 | 2.360 | 2.398 | 17.125 | 0.9456 |
| *0.4 | 14.990 | 0.8438 | 14.990 | 14.020 | 16.080 | 5.632 | 4 | 2.731 | 2.360 | 2.398 | 14.990 | 0.8277 |
| 0.8 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 1.6 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 3.1 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.979251 | 0.905 | -0.11286 | 0.730358 |
| Bartlett's Test indicates equal variances (p = 0.06) | 8.966372 | 13.2767 | | |
| The control means are significantly different (p = 0.05) | 2.39218 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test Treatments vs ASW | 0.2 | 0.4 | 0.282843 | 500 | 2.398411 | 0.135008 | 7.31645 | 2.065633 | 0.031673 | 4, 15 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 0.1902 | 0.0530 | 0.0030 | 0.2952 | 0.0458 |
| IC10 | 0.2774 | 0.0548 | 0.0000 | 0.3519 | -0.7644 |
| IC15 | 0.3622 | 0.0392 | 0.1959 | 0.4354 | -0.4669 |
| IC20 | 0.4134 | 0.0139 | 0.3402 | 0.4416 | -1.4381 |
| IC25 | 0.4376 | 0.0096 | 0.4030 | 0.4640 | 0.0080 |
| IC40 | 0.5100 | 0.0077 | 0.4824 | 0.5312 | 0.0080 |
| IC50 | 0.5584 | 0.0064 | 0.5354 | 0.5760 | 0.0080 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 20:00 | Test ID: | PR2296/53 | Sample ID: | YO071124 |
| End Date: | 23/11/2024 20:00 | Lab ID: | 11798 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | EPAM 94 | Test Species: | MI |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.05 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.2 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.4 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.8 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW | Biomass | 18.55 | 17.98 | 19.16 | 0.58 | 4.12 | 4 |
| ASW | | 17.77 | 17.46 | 18.08 | 0.29 | 3.05 | 4 |
| 0.05 | | 18.46 | 16.88 | 19.48 | 1.13 | 5.77 | 4 |
| 0.1 | | 17.94 | 14.96 | 19.76 | 2.24 | 8.34 | 4 |
| 0.2 | | 17.13 | 15.90 | 19.74 | 1.80 | 7.83 | 4 |
| 0.4 | | 14.99 | 14.02 | 16.08 | 0.84 | 6.13 | 4 |
| 0.8 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW | % DO | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 20:00 | Test ID: | PR2296/53 | Sample ID: | YO071124 |
| End Date: | 23/11/2024 20:00 | Lab ID: | 11798 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | EPAM 94 | Test Species: | MI |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.05 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.2 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.6 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

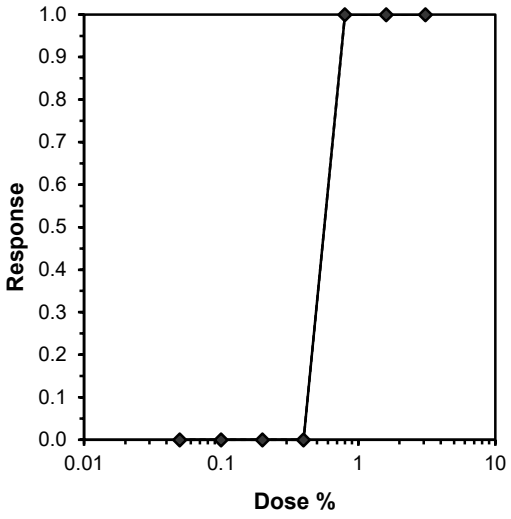
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 0.05 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.2 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.4 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.8 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 1.6 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 3.1 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 1 | 0.905 | | |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 0.4 | 0.8 | 0.565685 | 250 |
| Treatments vs ASW | | | | |

### Graphical Method

| Trim Level | EC50 |
|---|---|
| 0.0% | 0.5657 |
| | 0.5657 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 20:00 | Test ID: | PR2296/53 | Sample ID: | YO071124 |
| End Date: | 23/11/2024 20:00 | Lab ID: | 11798 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | EPAM 94 | Test Species: | MI |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.05 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.2 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.4 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.8 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW | Biomass | 18.55 | 17.98 | 19.16 | 0.58 | 4.12 | 4 |
| ASW | | 17.77 | 17.46 | 18.08 | 0.29 | 3.05 | 4 |
| 0.05 | | 18.46 | 16.88 | 19.48 | 1.13 | 5.77 | 4 |
| 0.1 | | 17.94 | 14.96 | 19.76 | 2.24 | 8.34 | 4 |
| 0.2 | | 17.13 | 15.90 | 19.74 | 1.80 | 7.83 | 4 |
| 0.4 | | 14.99 | 14.02 | 16.08 | 0.84 | 6.13 | 4 |
| 0.8 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.40 | 7.40 | 7.40 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW | Salinity | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW | % DO | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:30 | Test ID: | PR2293/07 | Sample ID: | Y0071124 |
| End Date: | 24/11/2024 19:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.05 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.2 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 0.4 | 0.8000 | 0.6000 | 0.6000 | 0.8000 |
| 0.8 | 0.2000 | 0.0000 | 0.0000 | 0.0000 |
| 1.6 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 0.05 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 0.2 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *0.4 | 0.7000 | 0.7000 | 0.9966 | 0.8861 | 1.1071 | 12.807 | 4 | 10.00 | 10.00 | 6 | 20 |
| *0.8 | 0.0500 | 0.0500 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 19 | 20 |
| 1.6 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 3.1 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

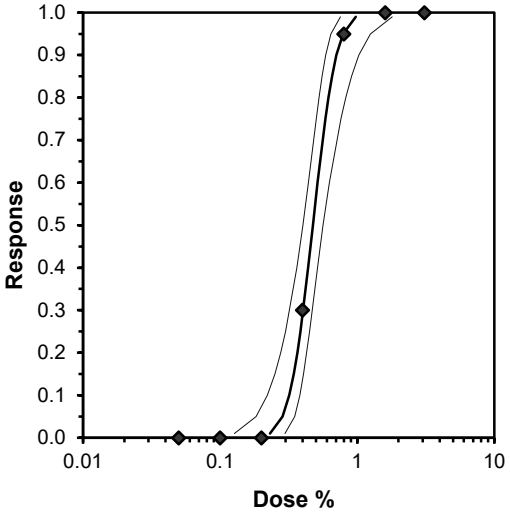
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.770387 | 0.916 | 0.958748 | 2.472429 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 0.2 | 0.4 | 0.282843 | 500 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 7.430774 | 1.675159 | 4.147462 | 10.71409 | 0 | 0.070131 | 11.0705 | 1 | -0.3235 | 0.134575 | 3 |
| Intercept | 7.403824 | 0.60252 | 6.222885 | 8.584764 | | | | | | | |
| TSCR | | | | | | | | | | | |

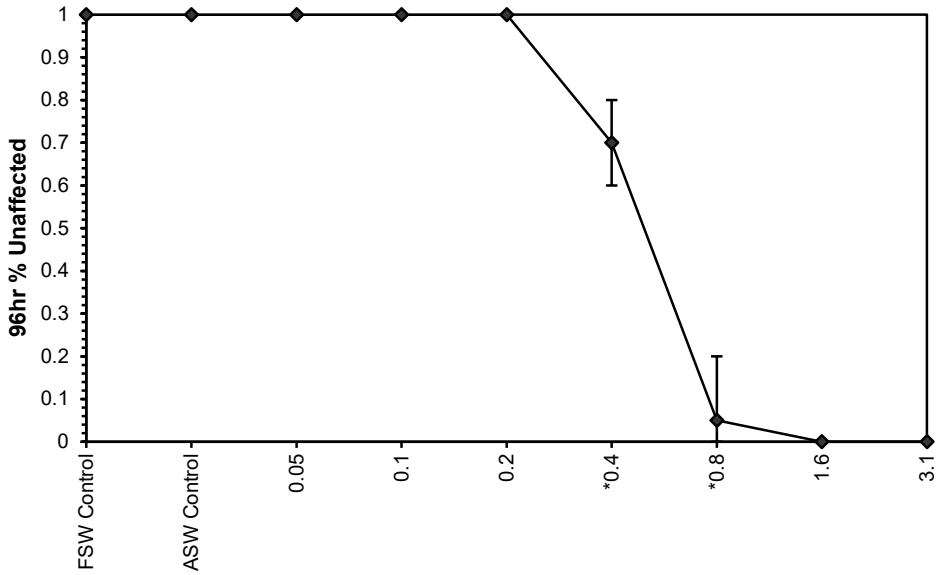
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 0.230906 | 0.126976 | 0.297322 |
| EC05 | 3.355 | 0.285198 | 0.183018 | 0.348641 |
| EC10 | 3.718 | 0.319182 | 0.221458 | 0.381142 |
| EC15 | 3.964 | 0.34437 | 0.251117 | 0.405958 |
| EC20 | 4.158 | 0.365799 | 0.276804 | 0.427897 |
| EC25 | 4.326 | 0.385243 | 0.300208 | 0.44873 |
| EC40 | 4.747 | 0.438945 | 0.36319 | 0.513006 |
| EC50 | 5.000 | 0.474793 | 0.402067 | 0.563235 |
| EC60 | 5.253 | 0.513569 | 0.440307 | 0.62512 |
| EC75 | 5.674 | 0.585159 | 0.501743 | 0.75873 |
| EC80 | 5.842 | 0.616262 | 0.525712 | 0.823601 |
| EC85 | 6.036 | 0.65461 | 0.553692 | 0.908555 |
| EC90 | 6.282 | 0.706268 | 0.589327 | 1.030959 |
| EC95 | 6.645 | 0.790426 | 0.64383 | 1.248338 |
| EC99 | 7.326 | 0.976278 | 0.754464 | 1.800478 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:30 | Test ID: | PR2293/07 | Sample ID: | Y0071124 |
| End Date: | 24/11/2024 19:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:30 | Test ID: | PR2293/07 | Sample ID: | Y0071124 |
| End Date: | 24/11/2024 19:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.05 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.2 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 0.4 | | 70.00 | 60.00 | 80.00 | 11.55 | 4.85 | 4 |
| 0.8 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 1.6 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 16:30 | Test ID: | PR2293/08 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 16:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9700 | 0.9600 | 0.9500 |
| ASW Control | 0.9700 | 0.9900 | 0.9800 | 0.9500 |
| 0.05 | 0.9800 | 0.9600 | 0.9500 | 0.9200 |
| 0.1 | 0.9400 | 0.9100 | 0.9300 | 0.9000 |
| 0.2 | 0.9200 | 0.9500 | 0.9300 | 0.9100 |
| 0.4 | 0.7600 | 0.8100 | 0.8900 | 0.9400 |
| 0.8 | 0.2100 | 0.2600 | 0.2400 | 0.2900 |
| 1.6 | 0.1200 | 0.1400 | 0.1900 | 0.0300 |
| 3.1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9575 | 0.9846 | 1.3642 | 1.3453 | 1.3967 | 1.796 | 4 | | | | | |
| ASW Control | 0.9725 | 1.0000 | 1.4104 | 1.3453 | 1.4706 | 3.751 | 4 | * | | | 11 | 400 |
| 0.05 | 0.9525 | 0.9794 | 1.3569 | 1.2840 | 1.4289 | 4.419 | 4 | 1.026 | 2.451 | 0.1278 | 19 | 400 |
| 0.1 | 0.9200 | 0.9460 | 1.2854 | 1.2490 | 1.3233 | 2.636 | 4 | 2.398 | 2.451 | 0.1278 | 32 | 400 |
| 0.2 | 0.9275 | 0.9537 | 1.2996 | 1.2661 | 1.3453 | 2.614 | 4 | 2.125 | 2.451 | 0.1278 | 29 | 400 |
| *0.4 | 0.8500 | 0.8740 | 1.1837 | 1.0588 | 1.3233 | 9.946 | 4 | 4.349 | 2.451 | 0.1278 | 60 | 400 |
| *0.8 | 0.2500 | 0.2571 | 0.5229 | 0.4760 | 0.5687 | 7.455 | 4 | 17.022 | 2.451 | 0.1278 | 300 | 400 |
| *1.6 | 0.1200 | 0.1234 | 0.3406 | 0.1741 | 0.4510 | 34.714 | 4 | 20.519 | 2.451 | 0.1278 | 352 | 400 |
| 3.1 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.976765 | 0.924 | -0.37237 | 0.962355 |
| Bartlett's Test indicates equal variances (p = 0.15) | 9.520569 | 16.81189 | | |
| The control means are not significantly different (p = 0.16) | 1.584895 | 2.446912 | | |

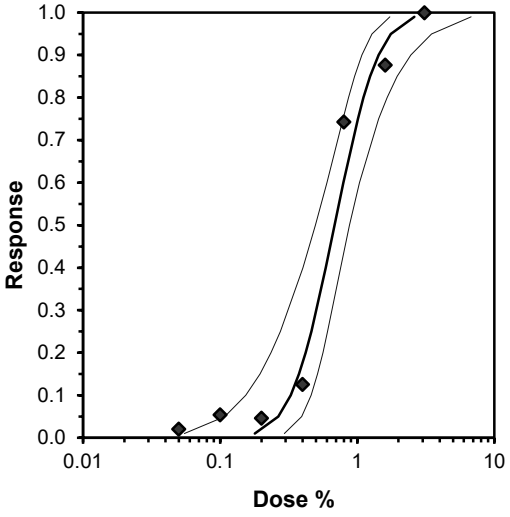
| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 0.2 | 0.4 | 0.282843 | 500 | 0.055285 | 0.056732 | 0.760239 | 0.005436 | 8.1E-16 | 6, 21 |
| Treatments vs ASW Control | | | | | | | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 3.997977 | 0.671279 | 2.272399 | 5.723555 | 0.0275 | 64.1563 | 11.0705 | 1.7E-12 | -0.16542 | 0.250127 | 5 |
| Intercept | 5.661355 | 0.18333 | 5.190089 | 6.13262 | | | | | | | |
| TSCR | 0.050289 | 0.021132 | -0.00403 | 0.104609 | | | | | | | |

| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 0.178935 | 0.054835 | 0.294109 |
| EC05 | 3.355 | 0.264945 | 0.10778 | 0.392642 |
| EC10 | 3.718 | 0.326609 | 0.153836 | 0.460072 |
| EC15 | 3.964 | 0.37613 | 0.194984 | 0.513545 |
| EC20 | 4.158 | 0.42079 | 0.234799 | 0.561887 |
| EC25 | 4.326 | 0.463308 | 0.274688 | 0.608492 |
| EC40 | 4.747 | 0.590485 | 0.401401 | 0.755832 |
| EC50 | 5.000 | 0.683247 | 0.495615 | 0.876219 |
| EC60 | 5.253 | 0.790581 | 0.60042 | 1.035271 |
| EC75 | 5.674 | 1.007594 | 0.788068 | 1.431713 |
| EC80 | 5.842 | 1.109403 | 0.865739 | 1.651132 |
| EC85 | 6.036 | 1.24113 | 0.959082 | 1.963721 |
| EC90 | 6.282 | 1.429314 | 1.082299 | 2.461965 |
| EC95 | 6.645 | 1.761973 | 1.281034 | 3.478718 |
| EC99 | 7.326 | 2.60891 | 1.726342 | 6.773648 |

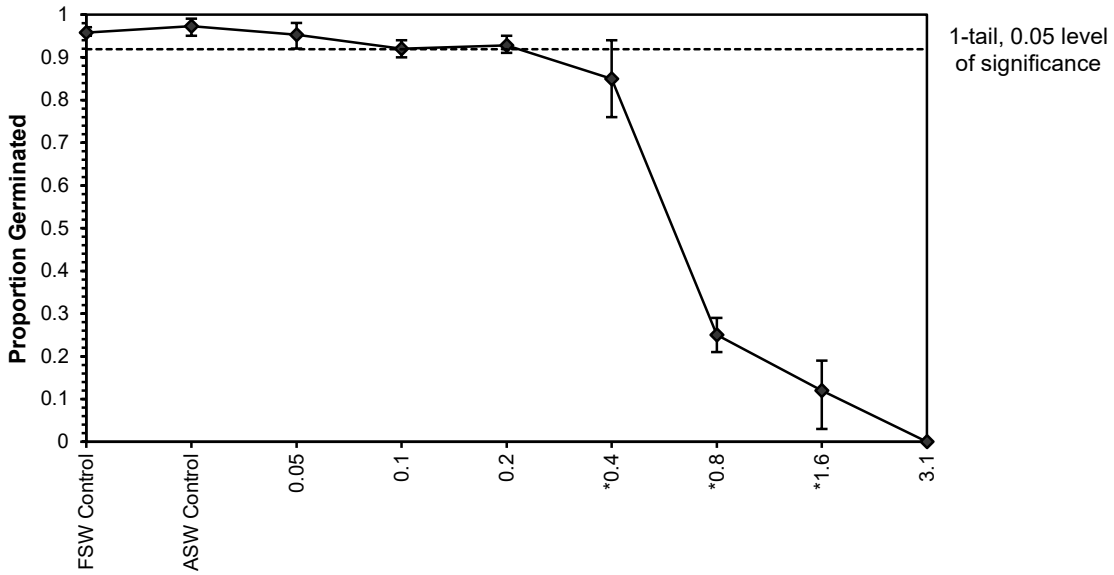
Significant heterogeneity detected (p = 1.68E-12)



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 16:30 | Test ID: | PR2293/08 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 16:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 16:30 | Test ID: | PR2293/08 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 16:30 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Germination, % | 95.75 | 95.00 | 97.00 | 0.96 | 1.02 | 4 |
| ASW Control | | 97.25 | 95.00 | 99.00 | 1.71 | 1.34 | 4 |
| 0.05 | | 95.25 | 92.00 | 98.00 | 2.50 | 1.66 | 4 |
| 0.1 | | 92.00 | 90.00 | 94.00 | 1.83 | 1.47 | 4 |
| 0.2 | | 92.75 | 91.00 | 95.00 | 1.71 | 1.41 | 4 |
| 0.4 | | 85.00 | 76.00 | 94.00 | 8.04 | 3.34 | 4 |
| 0.8 | | 25.00 | 21.00 | 29.00 | 3.37 | 7.34 | 4 |
| 1.6 | | 12.00 | 3.00 | 19.00 | 6.68 | 21.54 | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.30 | 97.30 | 97.30 | 0.00 | 0.00 | 1 |
| 0.05 | | 100.10 | 100.10 | 100.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 0.2 | | 100.50 | 100.50 | 100.50 | 0.00 | 0.00 | 1 |
| 0.4 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 0.8 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/11 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 18.003 | 18.703 | 16.903 | 17.003 | 19.103 | 17.403 | 16.703 | 16.503 |
| ASW Control | 17.103 | 16.503 | 18.403 | 17.103 | | | | |
| 0.05 | 17.903 | 18.103 | 17.703 | 17.003 | | | | |
| 0.1 | 17.203 | 16.803 | 18.103 | 17.703 | | | | |
| 0.2 | 15.503 | 13.903 | 16.903 | 19.403 | | | | |
| 0.4 | 14.103 | 13.103 | 14.203 | 13.003 | | | | |
| 0.8 | 4.703 | 8.403 | 6.103 | 8.003 | | | | |
| 1.6 | 0.000 | 3.503 | 1.103 | 0.000 | | | | |
| 3.1 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

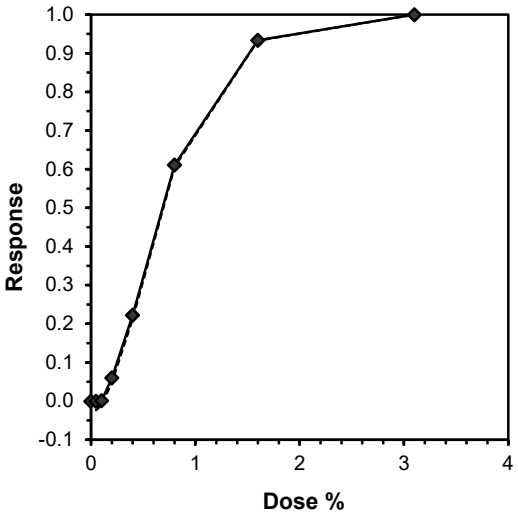
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 17.541 | 1.0152 | 17.541 | 16.503 | 19.103 | 5.493 | 8 | | | | | |
| ASW Control | 17.278 | 1.0000 | 17.278 | 16.503 | 18.403 | 4.639 | 4 | * | | | 17.478 | 1.0000 |
| 0.05 | 17.678 | 1.0232 | 17.678 | 17.003 | 18.103 | 2.708 | 4 | -0.419 | 2.451 | 2.338 | 17.478 | 1.0000 |
| 0.1 | 17.453 | 1.0101 | 17.453 | 16.803 | 18.103 | 3.258 | 4 | -0.184 | 2.451 | 2.338 | 17.453 | 0.9986 |
| 0.2 | 16.428 | 0.9508 | 16.428 | 13.903 | 19.403 | 14.192 | 4 | 0.891 | 2.451 | 2.338 | 16.428 | 0.9399 |
| *0.4 | 13.603 | 0.7873 | 13.603 | 13.003 | 14.203 | 4.688 | 4 | 3.854 | 2.451 | 2.338 | 13.603 | 0.7783 |
| *0.8 | 6.803 | 0.3937 | 6.803 | 4.703 | 8.403 | 25.318 | 4 | 10.984 | 2.451 | 2.338 | 6.803 | 0.3892 |
| *1.6 | 1.152 | 0.0666 | 1.152 | 0.000 | 3.503 | 143.432 | 4 | 16.910 | 2.451 | 2.338 | 1.152 | 0.0659 |
| 3.1 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.971582 | 0.924 | 0.389829 | 0.915301 |
| Bartlett's Test indicates equal variances (p = 0.07) | 11.57445 | 16.81189 | | |
| The control means are not significantly different (p = 0.65) | 0.466978 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 0.2 | 0.4 | 0.282843 | 500 | 2.337803 | 0.135304 | 167.245 | 1.818894 | 5.7E-14 | 6, 21 |

### Linear Interpolation (200 Resamples)

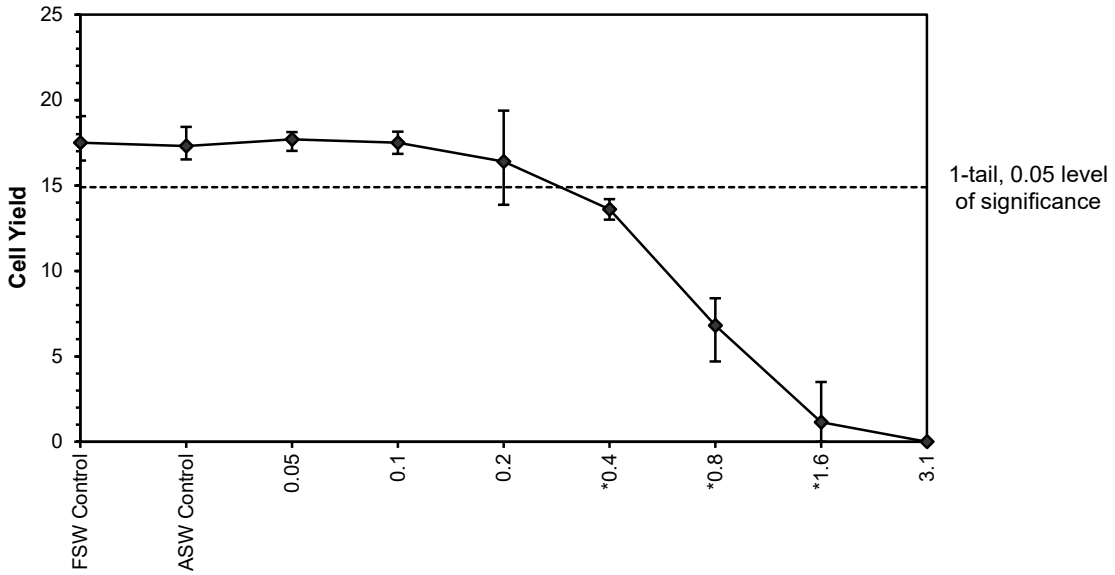
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 0.1828 | 0.0452 | 0.0841 | 0.2814 | 0.1357 |
| IC10 | 0.2494 | 0.0464 | 0.1057 | 0.3228 | -0.3111 |
| IC15 | 0.3113 | 0.0449 | 0.1216 | 0.3668 | -0.9744 |
| IC20 | 0.3731 | 0.0319 | 0.2205 | 0.4226 | -1.5908 |
| IC25 | 0.4291 | 0.0192 | 0.3672 | 0.4747 | -0.2315 |
| IC40 | 0.5833 | 0.0232 | 0.5226 | 0.6641 | 0.4097 |
| IC50 | 0.6861 | 0.0319 | 0.5953 | 0.8039 | 0.4818 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/11 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

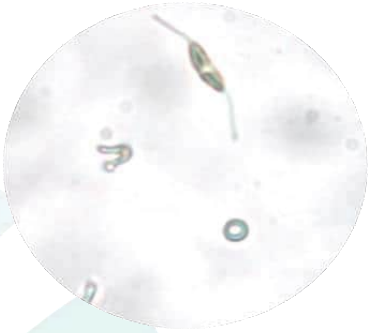
| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 20/11/2024 19:00 | Test ID: | PR2293/11 | Sample ID: | Y0071124 |
| End Date: | 23/11/2024 19:00 | Lab ID: | 11798 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Cell Yield | 17.54 | 16.50 | 19.10 | 0.96 | 5.60 | 8 |
| ASW Control | | 17.28 | 16.50 | 18.40 | 0.80 | 5.18 | 4 |
| 0.05 | | 17.68 | 17.00 | 18.10 | 0.48 | 3.91 | 4 |
| 0.1 | | 17.45 | 16.80 | 18.10 | 0.57 | 4.32 | 4 |
| 0.2 | | 16.43 | 13.90 | 19.40 | 2.33 | 9.29 | 4 |
| 0.4 | | 13.60 | 13.00 | 14.20 | 0.64 | 5.87 | 4 |
| 0.8 | | 6.80 | 4.70 | 8.40 | 1.72 | 19.29 | 4 |
| 1.6 | | 1.15 | 0.00 | 3.50 | 1.65 | 111.60 | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 0.05 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.1 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 0.2 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| 0.4 | | 7.50 | 7.50 | 7.50 | 0.00 | 0.00 | 1 |
| 0.8 | | 7.30 | 7.30 | 7.30 | 0.00 | 0.00 | 1 |
| 1.6 | | 7.10 | 7.10 | 7.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 6.80 | 6.80 | 6.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 0.05 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.1 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.2 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.4 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 0.8 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.10 | 35.10 | 35.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.20 | 35.20 | 35.20 | 0.00 | 0.00 | 1 |

# Appendix C

## ESA Toxicity Test Factsheets

# TOXICITY TEST FACT SHEET #3 – Freshwater & Marine



## Chronic Toxicity Test With Algae

The chronic toxicity test using the micro alga measures the effect of test materials on growth over a 72 hour period. The test can be run using the freshwater green algae Selenastrum capricornutum, the marine diatom Nitzschia closterium or the marine flagellate Isochrysis aff. Galbana

Algae are primary producers of organic matter upon which animals depend either directly or indirectly through the food chain. In Australia, the test using the freshwater S. capricornutum has been widely used in toxicity assessment of sewage treatment plant effluents discharging into freshwater streams and rivers. The tests using the marine algae have been widely used along side invertebrate toxicity tests.

In summary, this test involves exposing laboratory cultured algae to the test material for 72 hours. The test is usually undertaken on a range of concentrations of a test material, eg 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, algae cell yield is determined.

Statistical analyses are then applied to the test data to determine for example, the concentration of the test material causing 50% inhibition in algal cell yield in the test population (IC50 estimate). The test data can then be used to estimate concentrations of the test material likely to cause chronic toxicity in the environment.

The algae growth test may be used to assess the toxicity of:

- Chemicals
- Effluents
- Leachates and groundwater
- Sediments

If toxicity is detected using the chronic algae test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

| Chronic Toxicity Test With Micro Algae | |
|---|---|
| **Test type** | Chronic static |
| **Test end-point** | Cell yield |
| **Test duration** | 72 hours |
| **Test Temperature** | 18 ± 1ºC or 25 ± 1ºC |
| **Sample volume required** | 1 litre for full EC50 determination |
| **Test availability** | 24hrs notice requested |
| **Test turnaround time** | Advised within 72 hours of test initiation |

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# TOXICITY TEST FACT SHEET #5 – Marine

## Chronic Toxicity Test With Sea Urchin fertilisation test

Sea urchins and other echinoderms constitute a diverse and widely distributed group of marine animals. and are both ecologically and economically important. Toxicity tests utilising the short-term exposure of gametes are of comparable or greater sensitivity to many contaminants than other marine test species and life stages.

This test is commonly used throughout North America using USEPA protocols and is an important test in US effluent discharge licensing programme. In Australia, gametes of the sea urchin Heliocidaris tuberculata has also become widely used in toxicity assessment programs.

In summary, this test involves exposing urchin gametes (both sperm and eggs) to the test material for 1hour 20min. The test is usually undertaken on a range of concentrations of a test material, eg 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the percentage of fertilised egg is determined.

Statistical analyses are then applied to the test data to determine for example, the concentration of the test material causing 50% inhibition fertilisation rate in the test population (EC50 estimate). The test data can then be used to estimate concentrations of the test material likely to cause chronic toxicity in the environment.

The Urchin Fertilisation test may be used to assess the toxicity of:

- Chemicals
- Effluents
- Leachates and groundwater
- Sediments

If toxicity is detected using the chronic Urchin Fertilisation test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

| Chronic Toxicity Test With the Urchin fertilisation test | |
|---|---|
| **Test type** | Chronic static |
| **Test end-point** | Fertilisation rate |
| **Test duration** | 1hr20min |
| **Test Temperature** | 25 ± 1ºC |
| **Sample volume required** | 1 litre for full EC50 determination |
| **Test availability** | 24hrs notice requested |
| **Test turnaround time** | Advised within 72 hours of test initiation |

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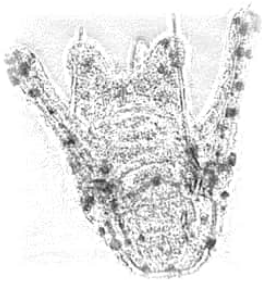
# TOXICITY TEST FACT SHEET #6 – Marine

## Chronic Toxicity Test With Sea Urchin Larval Development Test



Sea urchins and other echinoderms constitute a diverse and widely distributed group of marine animals. and are both ecologically and economically important. Toxicity tests utilising the short-term exposure of embryos are of comparable or greater sensitivity to many contaminants than other marine test species and life stages.

This test is commonly used throughout North America using APHA and ASTM protocols. In Australia, embryos of the sea urchin Heliocidaris tuberculata have been increasingly used in toxicity assessment programs.

In summary, this test involves exposing developing urchin embryos to the test material for 72hours. The test is usually undertaken on a range of concentrations of a test material, eg 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the number of normally developed and abnormal larvae are counted.

Statistical analyses are then applied to the test data to determine for example, the concentration of the test material causing 50% inhibition in larval development in the test population (EC50 estimate). The test data can then be used to estimate concentrations of the test material likely to cause chronic toxicity in the environment.

The Urchin Larval Development test may be used to assess the toxicity of:

- Chemicals
- Effluents
- Leachates and groundwater
- Sediments

If toxicity is detected using the chronic Urchin Larval Development test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

| Chronic Toxicity Test With the Urchin Larval Development test | |
|---|---|
| **Test type** | Chronic static |
| **Test end-point** | Normal development rate |
| **Test duration** | 72 hours |
| **Test Temperature** | 20 ± 1ºC |
| **Sample volume required** | 1 litre for full EC50 determination |
| **Test availability** | 24hrs notice requested |
| **Test turnaround** | Advised within 72 hours of test initiation |

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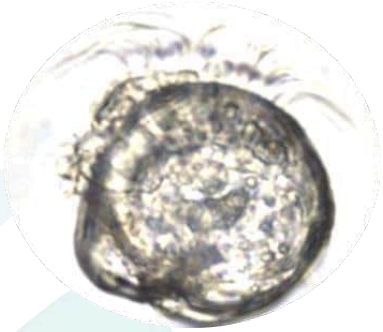
ABN 95 619 426 201

# TOXICITY TEST FACT SHEET #7 – Marine

## Chronic Toxicity Test Using Bivalve Larval Development



Bivalve molluscs such as oysters, scallops, mussels and clams constitute a diverse and widely distributed group of marine animals which are both ecologically and economically important. Toxicity tests utilising the short-term exposure of embryos are of comparable or greater sensitivity to many contaminants than other marine test species and life stages

This test is commonly used throughout North America using APHA and ASTM protocols. In Australia, embryos of the rock oyster Saccostrea glomerata, the milky oyster Saccostrea echinata the pacific oyster Crassostrea gigas, the doughboy scallop Mimachlamys asperrima and the mussel Mytilus edulis galloprovincialis have been increasingly used in toxicity assessment programs.

In summary, this test involves exposing developing bivalve embryos to the test item for 48 hours (or up to 72 hours). For an effluent sample, the test is usually undertaken on a range of concentrations of a test material, eg 100, 50, 25, 12.5 and 6.3%. At the end of the exposure period, the number of normally developed and abnormal larvae are counted.

Statistical analyses are then applied to the test data to determine for example, the concentration of the test material causing 50% inhibition in larval development in the test population (EC50 estimate). The test data can then be used to estimate concentrations of the test material likely to cause chronic toxicity in the environment.

The Bivalve Larval Development test may be used to assess the toxicity of:

- Chemicals
- Effluents
- Leachates and groundwater
- Sediments

If toxicity is detected using the chronic Bivalve Larval Development test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

| Chronic Toxicity Test With Bivalve Larval Development test | |
|---|---|
| **Test type** | Chronic static |
| **Test end-point** | Normal development rate |
| **Test duration** | 48 hours (nut can be extended to 72 hrs) |
| **Test Temperature** | 25±1°C (rock oyster); 29±1°C (milky oyster); 18±1°C (scallop); 20±1°C(mussel) |
| **Sample volume required** | 1 L |
| **Test availability** | 48hrs notice requested. Subject to season |
| **Test turnaround** | Advised within 72 hours of test initiation |

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# TOXICITY TEST FACT SHEET #9 – Marine

## Acute Toxicity Test With Amphipods

The acute toxicity test using amphipods is used for the assessment of potential harm posed by contaminant to aquatic ecosystems. A number of species of epifaunal amphipods have been used for toxicity assessments, however the most commonly used species in Australia is Melita plumulosa and Allorchestes compressa

Marine amphipods are a diverse and widely distributed group of animals are an important food source for other invertebrates, fish and birds as well as being re-workers of seagrasses and seaweeds. The acute toxicity test uses mainly laboratory reared juvenile amphipods and is based on USEPA test method for mysid shrimp and USEPA OPPTS850.1020 guideline for gammarid amphipods.

In summary, this test involves exposing juvenile amphipods to the test material and assessing survival over a 96 hour period. The test is usually undertaken on a range of concentrations of a test material, eg 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the number of surviving amhipod is recorded.

Statistical analyses are then applied to the test data to determine for example, the concentration of the test material causing 50% reduction in amphipods survival in the test population (EC50 estimate). The test data can then be used to estimate concentrations of the test material likely to cause acute toxicity in the environment.

The Acute Amphipod Test may be used to assess the toxicity of:

- Chemicals
- Effluents
- Leachates and groundwater
- Sediments

If toxicity is detected using the Acute Amphipod Test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

| Acute Toxicity Test With Amphipod | |
|---|---|
| **Test type** | Acute static |
| **Test end-point** | Survival |
| **Test duration** | 96 hours |
| **Test Temperature** | 25±1°C (or 20±1°C) |
| **Sample volume required** | 4 litre for full EC50 determination |
| **Test availability** | 24hrs notice requested |
| **Test turnaround time** | Advised within 72 hours of test initiation |

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# TOXICITY TEST FACT SHEET #11 – Freshwater & Marine

## Acute Toxicity Test with Fish larvae

A number of species of fish have been used for toxicity assessments. The species commonly used in our laboratory are the Rainbowfish (*Melanotaenia splendida*) and the zebra fish (*Zebra danio*). The most commonly used marine species in Australia are the Barramundi (*Lates calcarifer*), the Bass (*Macquaria novemaculeata*) , the australasian snapper (*Pagrus auratus*) and the Kingfish (*Seriola lalandis lalandis*).

Fish are both ecologically and economically important. The acute toxicity test uses externally sourced and laboratory reared fish larvae and is based on USEPA test method for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms (2002).

In summary, this test involves exposing fish larvae to the test material for 96 hours. The test is usually undertaken on a range of concentrations of a test material, eg 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the number of balanced and the number of un-balanced fish larvae are recorded.

Statistical analyses are then applied to the test data to determine for example, the concentration of the test material causing 50% reduction in unbalanced fish in the test population (EC50 estimate). The test data can then be used to estimate concentrations of the test material likely to cause acute toxicity in the environment.

The Acute Fish Test may be used to assess the toxicity of:

- Chemicals
- Effluents
- Leachates and groundwater
- Sediments

The Acute Fish test exposure period can be extended to 7 days. If toxicity is detected using the Acute Fish Test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

| Acute Toxicity Test Using Fish Larvae | |
|---|---|
| **Test type** | Acute static |
| **Test end-point** | Imbalance |
| **Test duration** | 96 hours |
| **Test Temperature** | 25 ± 2ºC or 20 ± 2ºC |
| **Sample quantity required** | 4 L |
| **Test availability** | 7 days notice requested |
| **Test turnaround time** | Advised within 72 hours of test initiation |

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# TOXICITY TEST FACT SHEET #12 – Marine

## Chronic Toxicity Test with Macroalgae

Two species of macroalgae, sometimes known as seaweed, are commonly used for toxicity assessments: The Neptune Necklace (*Hormosira banksii*) and the Brown Kelp (*Ecklonia radiata*). They play an important role in aquatic ecosystem by providing food to a wide range of marine organisms.

The macroalgae are sourced externally and spawned in the laboratory the day of testing following techniques described by Kevekordes and Clayton (1996), Bidwell (1998) and Burridge (1999).

In summary, this test involves exposing macroalgae zygotes or zoospores to the test material for 72 hours. The test is usually undertaken on a range of concentrations of a test material, eg 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the number of germinated individuals are recorded.

Statistical analyses are then applied to the test data to determine for example, the concentration of the test material causing 50% reduction in germinated macroalgae in the test population (EC50 estimate). The test data can then be used to estimate concentrations of the test material likely to cause chronic toxicity in the environment.

The Chronic Macroalgae Test may be used to assess the toxicity of:

- Chemicals
- Effluents
- Leachates and groundwater
- Sediments

The Macroalgae test can also be extended to 14 days. The solutions are renewed every week and the length of the germinated individuals is determined by digital analysis at the end of the exposure period.

If toxicity is detected using the Macroalgae Test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

| Chronic Toxicity Test Using Macroalgae | |
|---|---|
| **Test type** | Chronic static |
| **Test end-point** | Germination |
| **Test duration** | 72 hours |
| **Test Temperature** | 18 ± 1ºC |
| **Sample quantity required** | 1 L |
| **Test availability** | 7 days notice requested |
| **Test turnaround time** | Advised within 72 hours of test initiation |

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# TOXICITY TEST FACT SHEET #14 – Marine

## 7-d Imbalance & Growth Toxicity Test with Marine Fish

A number of species of fish have been used for toxicity assessments. The 7-day fish imbalance and growth test ues either the spiny damselfish (*Acanthochromis polyacanthus*), which are bred in house, or the barramundi (*Lates calcarifer*), which are purchased from a commercial hatchery.

Fish are both ecologically and economically important. The 7-day imbalance and growth test is similar to USEPA test Method USEPA (2002) *Sheepshead minnow*, *Cyprinodon variegatus*, larval survival and growth test. Method 1004.0, but with some modifications.

In summary, this test involves exposing fish fry or fingerlings to the test material for 7 days. The test is usually undertaken on a range of concentrations of a test material, eg 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the number of balanced and the number of un-balanced fish larvae are recorded. The weight of the fish is also recorded in order to determine the biomass.

Statistical analyses are then applied to the test data to determine for example, the concentration of the test material causing 50% reduction in unbalanced fish or reduction in biomass (reduction in growth) in the test population (EC50 estimate). The test data can then be used to estimate concentrations of the test material likely to cause chronic toxicity in the environment and for SSD calulations without the need for an acute:chronic application factor

The fish imbalance and growth test may be used to assess the toxicity of:

- Chemicals
- Effluents
- Leachates and groundwater
- Sediments

| 7-day Toxicity Test Using Juvenile Fish | |
|---|---|
| **Test type** | Chronic non-renewal static or renewal static |
| **Test end-point** | Imbalance (loss of swimming ability, Biomass |
| **Test duration** | 7 days |
| **Test Temperature** | 25 ± 2ºC |
| **Sample quantity required** | 4 L |
| **Test availability** | 7 days notice requested. Subject to availability of fish larvae |
| **Test turnaround time** | Adviced within 72 hours of test initiation |

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# Appendix D

## Ecotoxicity Data Information Summary

| Batch | Lab ID | Sample Name | Lab ID | Sample Name | Test Report | pH | Salinity (ppt) | Total Ammonia (mg/L) | Temperature | Species | Plant (P) or Non-Plant (NP) | Life stage | Exposure Duration | Toxicity Endpoint & Definition | Media Used | Salinity (ppt) | Temperature (of test chamber/ room) | Controls | Exposure type | QA QC Parameter & Criterion | Criterion met? | Reference Toxicant used | No. of Test & Control replicates | Protocol | Toxicity Estimate | Toxicity Value: PFW Concentration (%) and Variability * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Oct'19 - Round 1** | 9252 | Y0250919 | 9252 | Y0250919 | TR1858/1 | 6.3 | 17.3 | 32 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | EC10 | 1.6% (* the 95% confidence limits are not reliable) |
| | | | 9252 | Y0250919 | TR1858/2 | 6.3 | 17.3 | 32 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 3.0 (2.78-3.22)% |
| | | | 9252 | Y0250919 | TR1858/3 | 6.3 | 17.3 | 32 | 12°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | EC10 | 2.0 (1.87-2.21)% |
| | | | 9252 | Y0250919 | TR1858/4 | 6.3 | 17.3 | 32 | 12°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | EC10 | 3.4(2.27-4.39)% |
| | | | 9252 | Y0250919 | TR1858/5 | 6.3 | 17.3 | 32 | 12°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x$10^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 3.7 (3.33-3.80)% |
| | | | 9252 | Y0250919 | TR1858/6 | 6.3 | 17.3 | 32 | 12°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 7.9 (5.58-9.79)% |
| | | | 9252 | Y0250919 | TR1858/7 | 6.3 | 17.3 | 32 | 12°C | Macquaria novemaculeata (fish, Australian Bass) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Copper | 4 replicates | ESA SOP 117 (ESA 2016), based on USEPA (2002) | IC10 | 2.1% (* the 95% confidence limits are not reliable) |
| | | | 9252 | Y0250919 | TR1858/8 | 6.3 | 17.3 | 32 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | EC10 | 2.7 (2.62-2.76)% |
| | | | 9252 | Y0250919 | TR1858/8 | 6.3 | 17.3 | 32 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | No (fish available for testing at 27 Sept were older and at a relatively lower growth phase than with younger fish) | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 1.7% (* the 95% confidence limits are not reliable) |
| **Oct'19 - Round 2** | 9259 | Y0021019 | 9259 | Y0021019 | TR1858/9 | 6.5 | 17.7 | 32.6 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 2.5 (2.09-3.30)% |
| | | | 9259 | Y0021019 | TR1858/10 | 6.5 | 17.7 | 32.6 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 3.0 (2.23-3.41)% |
| | | | 9259 | Y0021019 | TR1858/11 | 6.5 | 17.7 | 32.6 | 12°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | EC10 | 2.3 (1.80-3.57)% |
| | | | 9259 | Y0021019 | TR1858/12 | 6.5 | 17.7 | 32.6 | 12°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | EC10 | 7.9 (6.35-10.73)% |
| | | | 9259 | Y0021019 | TR1858/13 | 6.5 | 17.7 | 32.6 | 12°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x$10^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 2.0 (1.89-2.32)% |
| | | | 9259 | Y0021019 | TR1858/14 | 6.5 | 17.7 | 32.6 | 12°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 13.3 (12.37-14.03)% |
| | | | 9259 | Y0021019 | TR1858/15 | 6.5 | 17.7 | 32.6 | 12°C | Macquaria novemaculeata (fish, Australian Bass) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Copper | 4 replicates | ESA SOP 117 (ESA 2016), based on USEPA (2002) | IC10 | 4.1% (* the 95% confidence limits are not reliable) |
| | | | 9259 | Y0021019 | TR1858/8 | 6.5 | 17.7 | 32.6 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 4.1% (* the 95% confidence limits are not reliable) |
| | | | 9259 | Y0021019 | TR1858/8 | 6.5 | 17.7 | 32.6 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | No | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 3.2 (0.98-3.52)% |
| **Oct'19 - Round 3** | 9262 | A1-5327 | 9262 | A1-5327 | TR1858/17 | 6.9 | 18.5 | 31.4 | 14°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 3.9 (3.77-4.07)% |
| | | | 9262 | A1-5327 | TR1858/18 | 6.9 | 18.5 | 31.4 | 14°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 8.8 (7.73-9.70)% |
| | | | 9262 | A1-5327 | TR1858/19 | 6.9 | 18.5 | 31.4 | 14°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | EC10 | 7.4 (6.85-7.80)% |
| | | | 9262 | A1-5327 | TR1820/20 | 6.9 | 18.5 | 31.4 | 14°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 11.1 (10.8-11.6)% |
| | | | 9262 | A1-5327 | TR1858/21 | 6.9 | 18.5 | 31.4 | 14°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x$10^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 12.3 (8.33-13.88)% |
| | | | 9262 | A1-5327 | TR1858/22 | 6.9 | 18.5 | 31.4 | 14°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 12.7 (10.17-13.86)% |
| | | | 9262 | A1-5327 | TR1858/23 | 6.9 | 18.5 | 31.4 | 14°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Copper | 4 replicates | ESA SOP 117 (ESA 2016), based on USEPA (2002) | IC10 | 4.8 (3.26-5.76)% |
| | | | 9262 | A1-5327 | TR1858/24 | 6.9 | 18.5 | 31.4 | 14°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 6.6 (5.72-9.21)% |
| | | | 9262 | A1-5327 | TR1858/24 | 6.9 | 18.5 | 31.4 | 14°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | No (fish available for testing at 22 Oct were older and at a relatively lower growth phase than with younger fish) | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 3.1 (2.40-5.92)% |

| Batch | Lab ID | Sample Name | Lab ID | Sample Name | Test Report | pH | Salinity (ppt) | Total Ammonia (mg/L) | Temperature | Species | Plant (P) or Non-Plant (NP) | Life stage | Exposure Duration | Toxicity Endpoint & Definition | Media Used | Salinity (ppt) | Temperature (of test chamber/ room) | Controls | Exposure type | QA QC Parameter & Criterion | Criterion met? | Reference Toxicant used | No. of Test & Control replicates | Protocol | Toxicity Estimate | Toxicity Value: PFW Concentration (%) and Variability * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feb - Mar'21 | 9939 | Y0160221 | 9939 | Y0160221 | TR1978/1 | 6.1 | 16.9 | 24.4 | 8°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 4.8 (4.22-6.35)% |
| | | | 9939 | Y0160221 | TR1978/2 | 6.1 | 16.9 | 24.4 | 8°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 7.5 (7.25-7.67)% |
| | | | 9939 | Y0160221 | TR1978/3 | 6.1 | 16.9 | 24.4 | 8°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 48 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | IC10 | 6.4 (6.26-6.46)% |
| | | | 9939 | Y0160221 | TR1978/4 | 6.1 | 16.9 | 24.4 | 8°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 11.6 (10.76-12.40)% |
| | | | 9939 | Y0160221 | TR1978/5 | 6.1 | 16.9 | 24.4 | 8°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | EC10 | 6.6 (4.50-8.10)% |
| | | | 9939 | Y0160221 | TR1978/6 | 6.1 | 16.9 | 24.4 | 8°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 7.4 (6.79-7.72)% |
| | | | 9939 | Y0160221 | TR1978/7 | 6.1 | 16.9 | 24.4 | 8°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | EC10 | 3.9 (2.63-4.84)% |
| | | | 9939 | Y0160221 | TR1978/8 | 6.1 | 16.9 | 24.4 | 8°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | EC10 | 3.4 (2.52-3.97)% |
| | | | 9939 | Y0160221 | TR1978/8 | 6.1 | 16.9 | 24.4 | 8°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 3.3 (3.02-3.51)% |
| | 9966 | Y0230221 | 9966 | Y0230221 | TR1978/9 | 6.1 | 16.1 | 24.4 | 9°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | EC10 | 3.9 (2.81-4.49)% |
| | | | 9966 | Y0230221 | TR1978/10 | 6.1 | 16.1 | 24.4 | 9°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | IC10 | 6.8 (6.62-6.91)% |
| | | | 9966 | Y0230221 | TR1978/11 | 6.1 | 16.1 | 24.4 | 9°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 48 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | IC10 | 6.4 (5.36-6.50)% |
| | | | 9966 | Y0230221 | TR1978/12 | 6.1 | 16.1 | 24.4 | 9°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 7.8 (6.29-9.04)% |
| | | | 9966 | Y0230221 | TR1978/13 | 6.1 | 16.1 | 24.4 | 9°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 7.8 (6.08-11.82)% |
| | | | 9966 | Y0230221 | TR1978/14 | 6.1 | 16.1 | 24.4 | 9°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 7.1 (6.36-7.62)% |
| | | | 9966 | Y0230221 | TR1978/15 | 6.1 | 16.1 | 24.4 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | IC10 | 6.3 (5.62-9.38)% |
| | | | 9966 | Y0230221 | TR1978/16 | 6.1 | 16.1 | 24.4 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | EC10 | 2.7 (1.83-3.34)% |
| | | | 9966 | Y0230221 | TR1978/16 | 6.1 | 16.1 | 24.4 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 3.2% (* the 95% confidence limits are not reliable) |
| | 9983 | Y020321 | 9983 | Y020321 | TR1978/17 | 6.3 | 16.2 | 29.4 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 4.3 (3.73-5.70)% |
| | | | 9983 | Y020321 | TR1978/18 | 6.3 | 16.2 | 29.4 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | IC10 | 2.6 (2.24-3.11)% |
| | | | 9983 | Y020321 | TR1978/19 | 6.3 | 16.2 | 29.4 | 12°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 48 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | IC10 | 2.1 (1.89-2.19)% |
| | | | 9983 | Y020321 | TR1978/20 | 6.3 | 16.2 | 29.4 | 12°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 9.9 (8.67-11.81)% |
| | | | 9983 | Y020321 | TR1978/21 | 6.3 | 16.2 | 29.4 | 12°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | EC10 | 7.4 (5.01-8.86)% |
| | | | 9983 | Y020321 | TR1978/22 | 6.3 | 16.2 | 29.4 | 12°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 3.8 (3.30-4.20)% |
| | | | 9983 | Y020321 | TR1978/23 | 6.3 | 16.2 | 29.4 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | EC10 | 4.7 (3.74-5.06)% |
| | | | 9983 | Y020321 | TR1978/24 | 6.3 | 16.2 | 29.4 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 3.1 (2.80-4.71)% |
| | | | 9983 | Y020321 | TR1978/24 | 6.3 | 16.2 | 29.4 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 3.0 (1.85-3.67)% |

| Batch | Lab ID | Sample Name | Lab ID | Sample Name | Test Report | pH | Salinity (ppt) | Total Ammonia (mg/L) | Temperature | Species | Plant (P) or Non-Plant (NP) | Life stage | Exposure Duration | Toxicity Endpoint & Definition | Media Used | Salinity (ppt) | Temperature (of test chamber/ room) | Controls | Exposure type | QA QC Parameter & Criterion | Criterion met? | Reference Toxicant used | No. of Test & Control replicates | Protocol | Toxicity Estimate | Toxicity Value: PFW Concentration (%) and Variability * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jul - Aug'21 | 10165 | MI-5327 | 10165 | MI-5327 | TR2029/1 | 6 | 16.1 | 24 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 2.2 (2.00-2.33)% |
| | | | 10165 | MI-5327 | TR2029/2 | 6 | 16.1 | 24 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 3.7 (3.45-3.95)% |
| | | | 10165 | MI-5327 | TR2029/3 | 6 | 16.1 | 24 | 12°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | EC10 | 3.6 (3.34-3.68)% |
| | | | 10165 | MI-5327 | TR2029/4 | 6 | 16.1 | 24 | 12°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 11.8 (11.16-12.42)% |
| | | | 10165 | MI-5327 | TR2029/5 | 6 | 16.1 | 24 | 12°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 10.7 (9.94-11.07)% |
| | | | 10165 | MI-5327 | TR2029/6 | 6 | 16.1 | 24 | 12°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 5.6 (4.66-6.92)% |
| | | | 10165 | MI-5327 | TR2029/7 | 6 | 16.1 | 24 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | EC10 | 4.9 (3.61-5.25)% |
| | | | 10165 | MI-5327 | TR2029/8 | 6 | 16.1 | 24 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 4.1 (3.1-6.3)% |
| | | | 10165 | MI-5327 | TR2029/8 | 6 | 16.1 | 24 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | No (fish available at the time of testing were 10mm in length, smaller than 12-16mm to which this criterion typically applies) | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 2.2% (* the 95% confidence limits are not reliable) |
| | 10167 | Y003082021 | 10167 | Y003082021 | TR2029/9 | 6.1 | 15.7 | 29 | 10°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 4.7 (3.97-5.80)% |
| | | | 10167 | Y003082021 | TR2029/10 | 6.1 | 15.7 | 29 | 10°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 3.9 (3.59-4.14)% |
| | | | 10167 | Y003082021 | TR2029/11 | 6.1 | 15.7 | 29 | 10°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | IC10 | 4.2 (3.73-5.10)% |
| | | | 10167 | Y003082021 | TR2029/12 | 6.1 | 15.7 | 29 | 10°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 9.4 (8.04-10.59)% |
| | | | 10167 | Y003082021 | TR2029/13 | 6.1 | 15.7 | 29 | 10°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 11.1 (10.42-12.03)% |
| | | | 10167 | Y003082021 | TR2029/6 | 6.1 | 15.7 | 29 | 10°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 4.2 (3.83-4.86)% |
| | | | 10167 | Y003082021 | TR2029/15 | 6.1 | 15.7 | 29 | 10°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | EC10 | 5.0 (4.74-5.30)% |
| | | | 10167 | Y003082021 | TR2029/16 | 6.1 | 15.7 | 29 | 10°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 4.1 (3.1-6.3)% |
| | | | 10167 | Y003082021 | TR2029/16 | 6.1 | 15.7 | 29 | 10°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 2.5 (1.60-3.48)% |
| | 10178 | A1-5327 | 10178 | A1-5327 | TR2029/17 | 6.5 | 15.9 | 15.6 | 10°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 7.1 (6.84-7.19)% |
| | | | 10178 | A1-5327 | TR2029/18 | 6.5 | 15.9 | 15.6 | 10°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | IC10 | 7.5 (6.04-9.18)% |
| | | | 10178 | A1-5327 | TR2029/19 | 6.5 | 15.9 | 15.6 | 10°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | IC10 | 3.7 (5.62-6.42)% |
| | | | 10178 | A1-5327 | TR2029/20 | 6.5 | 15.9 | 15.6 | 10°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 3 - 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | IC10 | 14.4 (13.92-14.64)% |
| | | | 10178 | A1-5327 | TR2029/21 | 6.5 | 15.9 | 15.6 | 10°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 11.7 (10.95-13.02)% |
| | | | 10178 | A1-5327 | TR2029/22 | 6.5 | 15.9 | 15.6 | 10°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 7 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 4.2 (3.64-4.50)% |
| | | | 10178 | A1-5327 | TR2029/23 | 6.5 | 15.9 | 15.6 | 10°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | IC10 | 5.9 (5.38-7.00)% |
| | | | 10178 | A1-5327 | TR2029/24 | 6.5 | 15.9 | 15.6 | 10°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 5.7 (5.40-6.01)% |
| | | | 10178 | A1-5327 | TR2029/24 | 6.5 | 15.9 | 15.6 | 10°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 3.9 (3.61-4.10)% |

| Batch | Lab ID | Sample Name | Lab ID | Sample Name | Test Report | pH | Salinity (ppt) | Total Ammonia (mg/L) | Temperature | Species | Plant (P) or Non-Plant (NP) | Life stage | Exposure Duration | Toxicity Endpoint & Definition | Media Used | Salinity (ppt) | Temperature (of test chamber/ room) | Controls | Exposure type | QA QC Parameter & Criterion | Criterion met? | Reference Toxicant used | No. of Test & Control replicates | Protocol | Toxicity Estimate | Toxicity Value: PFW Concentration (%) and Variability * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sep-22** | 10677 | Y03/0822-1 | | | TR2113/1 | 8.3 | 12.9 | 12.9 | 9°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21.2±0.2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 2.0 (1.86-2.22)% |
| | | | | | TR2113/2 | 8.3 | 12.9 | 12.9 | 9°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18.8-21.6°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 2.1 (1.88-2.70)% |
| | | | | | TR2113/3 | 8.3 | 12.9 | 12.9 | 9°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18.8-21.6°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | EC10 | 2.0 (1.87-2.16)% |
| | | | | | TR2113/4 | 8.3 | 12.9 | 12.9 | 9°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 3.8% (* the 95% confidence limits are not reliable) |
| | | | | | TR2113/5 | 8.3 | 12.9 | 12.9 | 9°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 5.0 (3.92-7.19)% |
| | | | | | TR2113/6 | 8.3 | 12.9 | 12.9 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | EC10 | 10.9 (10.51-11.41)% |
| | | | | | TR2113/7 | 8.3 | 12.9 | 12.9 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | EC10 | 6.3 (5.3-9.4)% |
| | | | | | TR2113/7 | 8.3 | 12.9 | 12.9 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 4.9 (3.40-7.51)% |
| | | | | | TR2113/8 | 8.3 | 12.9 | 12.9 | 9°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 10.1 (9.39-10.63)% |
| **Sep-23** | 11237 | Y0230823 | | | TR2187/1 | 6 | 17.1 | 25.5 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 4.1 (3.76-4.64)% |
| | | | | | TR2187/2 | 6 | 17.1 | 25.5 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 8.6 (7.83-8.94)% |
| | | | | | TR2187/3 | 6 | 17.1 | 25.5 | 12ºC | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | EC10 | 5.1% (* the 95% confidence limits are not reliable) |
| | | | | | TR2187/4 | 6 | 17.1 | 25.5 | 12ºC | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | EC10 | 20.3 (19.54-21.05)% |
| | | | | | PR2187/08 (Test ID) [2] | Not reported[1] | Not reported[1] | Not reported[1] | Not reported[1] | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | Not reported | 35 -35.6 [2] | Not reported | FSW and ASW tested concurrently | Static | Not reported | Not reported | Not reported | 4 replicates | Not reported | IC10 | 10.44 (5.36-13.30)% |
| | | | | | TR2187/6 | Not reported[1] | Not reported[1] | Not reported[1] | Not reported[1] | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 25.0 (22.27-37.16)% |
| | | | | | TR2187/7 | 6 | 17.1 | 25.5 | 12ºC | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | EC10 | 16.4 (15.01-17.62)% |
| | | | | | TR2187/8 | 6 | 17.1 | 25.5 | 12ºC | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 8.3 (7.01-9.31)% |
| **Sep-24** | 11710 | Y0110924 | 11710 | Y0110924 | TR2234/1_R01 | 5.9 | 10 | 21.4 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 4.2 (3.77-4.46)% |
| | | | 11710 | Y0110924 | TR2234/2 | 5.9 | 10 | 21.4 | 12°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 5.0 (4.61-5.42)% |
| | | | 11710 | Y0110924 | TR2234/3_R01 | 5.9 | 10 | 21.4 | 12°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | EC10 | 3.4 (2.92-3.59)% |
| | | | 11710 | Y0110924 | TR2234/4 | 5.9 | 10 | 21.4 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | EC10 | 5.0 (3.57-5.39)% |
| | | | 11710 | Y0110924 | TR2234/5 | 5.9 | 10 | 21.4 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 4.1 (4.11-4.11)% |
| | | | 11710 | Y0110924 | TR2234/5 | 5.9 | 10 | 21.4 | 12°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 10.4 (5.36-13.30)% |
| | | | 11710 | Y0110924 | TR2187/6 | 5.9 | 10 | 21.4 | 12°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 10.1 (8.95-10.63)% |
| | | | 11710 | Y0110924 | TR2234/7 | 5.9 | 10 | 21.4 | 12°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | IC10 | 4.4 (3.51-7.37)% |
| | | | 11710 | Y0110924 | TR2234/8 | 5.9 | 10 | 21.4 | 12°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 14.3 (13.04-14.44)% |

| Batch | Lab ID | Sample Name | Lab ID | Sample Name | Test Report | pH | Salinity (ppt) | Total Ammonia (mg/L) | Temperature | Species | Plant (P) or Non-Plant (NP) | Life stage | Exposure Duration | Toxicity Endpoint & Definition | Media Used | Salinity (ppt) | Temperature (of test chamber/ room) | Controls | Exposure type | QA QC Parameter & Criterion | Criterion met? | Reference Toxicant used | No. of Test & Control replicates | Protocol | Toxicity Estimate | Toxicity Value: PFW Concentration (%) and Variability * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nov-24** | 11798 | Y0071124 | 11798 | Y0071124 | TR2293/1 | 6.3 | 20.4 | 14.6 | 9°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Gametes (both sperm and eggs) | 1 hr | Fertilisation success; % Fertilised eggs | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % fertilised eggs ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | IC10 | 0.1 (0.09-0.11)% |
| | | | 11798 | Y0071124 | TR2293/2 | 6.3 | 20.4 | 14.6 | 9°C | Heliocidaris tuberculata (sea urchin) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % normal larvae ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | EC10 | 0.1 (0.11-0.14)% |
| | | | 11798 | Y0071124 | TR2293/3 | 6.3 | 20.4 | 14.6 | 9°C | Mytilus galloprovincialis (mussel) | NP | Macroinvertebrate; Developing embryo | 72 hr | Larval development; % Normal larvae | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | FSW Control mean % normal ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | IC10 | 0.1 (0.10-0.15)% |
| | | | 11798 | Y0071124 | TR2293/4 | 6.3 | 20.4 | 14.6 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Larvae | 96 hr | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 117 (ESA 2017), based on USEPA (2002) | IC10 | 1.3 (1.32-1.36)% |
| | | | 11798 | Y0071124 | TR2293/5 | 6.3 | 20.4 | 14.6 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Fish imbalance; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 80% | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | NOEC [3] | 0.20% |
| | | | 11798 | Y0071124 | TR2293/5 | 6.3 | 20.4 | 14.6 | 9°C | Lates calcarifer (fish, Barramundi) | NP | Fish; Juvenile | 7 day | Biomass; Biomass (mg) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 25±2°C (stated only) | FSW and ASW tested concurrently | Static | Control mean growth >20% of initial weight | Yes | Ammonium | 4 replicates | ESA SOP 122 (ESA 2017), based on USEPA (2002) | IC10 | 0.3 (0.00-0.35)% |
| | | | 11798 | Y0071124 | TR2293/6 | 6.3 | 20.4 | 14.6 | 9°C | Allorchestes compressa (amphipod) | NP | Macroinvertebrate; Juvenile | 96 hr | Survival; % Unaffected | FSW | Adjusted to 35±1 ppt to match seawater salinity | 20±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % unaffected ≥ 90% | Yes | SDS | 4 replicates | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | IC10 | 0.3 (0.22-0.38)% |
| | | | 11798 | Y0071124 | TR2293/7 | 6.3 | 20.4 | 14.6 | 9°C | Hormosira banksii (macroalgae seaweed) | P | Macroalgae; Zygotes or zoospores | 72 hr | Macroalgal germination success; % Germination | FSW | Adjusted to 35±1 ppt to match seawater salinity | 18±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean % germination ≥ 70% | Yes | Copper | 4 replicates | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | IC10 | 0.3 (0.15-0.46)% |
| | | | 11798 | Y0071124 | TR2293/8 | 6.3 | 20.4 | 14.6 | 9°C | Nitzschia closterium (marine microalgae) | P | Microalgae; Life stage not applicable | 72 hr | Algal growth; Cell yield (cells/mL) | FSW | Adjusted to 35±1 ppt to match seawater salinity | 21±1°C (stated only) | FSW and ASW tested concurrently | Static | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Yes | Copper | 4 - 8 replicates | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | IC10 | 0.3 (0.11-0.32)% |

**Notes:**

ppt - parts per thousand
FSW - Filtered seawater
ASW - Artificial seawater
CV - coefficient of variation
* Variability presented in parentheses are 95% confidence limits
1 - These parameters for the September 2023 PFW Sample were not reported in the ecotoxicology laboratory report for this WET test, however are assumed to be the same as for other tests upon Sample 11237
2 - Recorded from the 'Statistical Printout' report for this test for the for the September 2023 PFW Sample. Refer Appendix B
3 - The laboratory was unable to report an EC/IC10 value for the November 2024 7-day fish imbalance test, although IC50 and NOEC values were reported. The NOEC was adopted for further data assessment in the SSD calculation (as per Warne et al. 2018 guidance on preferred hierarchy of estimates of toxicity).

# Appendix E

## Ecotoxicity Data Quality Scores

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9252, Y0250919, TR1858/1, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 94 | 86 | **91** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 1.6% (* the 95% confidence limits are not reliable) | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9252, Y0250919, TR1858/2, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 3.0 (2.78-3.22)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9252, Y0250919, TR1858/3, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 2.0 (1.87-2.21)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9252, Y0250919, TR1858/4, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 3.4(2.27-4.39)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9252, Y0250919, TR1858/5, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 3.7 (3.33-3.80)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9252, Y0250919, TR1858/6, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 7.9 (5.58-9.79)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9252, Y0250919, TR1858/7, Macqauria novemaculeata (fish, Australian Bass), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 94 | 86 | **91** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 117 (ESA 2016), based on USEPA (2002) | 2.1% (* the 95% confidence limits are not reliable) | Yes | Yes | Yes | 25±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9252, Y0250919, TR1858/8, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 2.7 (2.62-2.76)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9252, Y0250919, TR1858/8, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 94 | 86 | **91** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 1.7% (* the 95% confidence limits are not reliable) | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9259, Y0021019, TR1858/9, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 2.5 (2.09-3.30)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9259, Y0021019, TR1858/10, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 3.0 (2.23-3.41)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9259, Y0021019, TR1858/11, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 2.3 (1.80-3.57)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9259, Y0021019, TR1858/12, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 7.9 (6.35-10.73)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9259, Y0021019, TR1858/13, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 2.0 (1.89-2.32)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9259, Y0021019, TR1858/14, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 13.3 (12.37-14.03)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9259, Y0021019, TR1858/15, Macqauria novemaculeata (fish, Australian Bass), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 94 | 86 | **91** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 117 (ESA 2016), based on USEPA (2002) | 4.1% (* the 95% confidence limits are not reliable) | Yes | Yes | Yes | 25±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9259, Y0021019, TR1858/8, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 94 | 86 | **91** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 4.1% (* the 95% confidence limits are not reliable) | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9259, Y0021019, TR1858/8, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **Unacceptable[1]** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 3.2 (0.98-3.52)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9262, A1-5327, TR1858/17, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 3.9 (3.77-4.07)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9262, A1-5327, TR1858/18, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 8.8 (7.73-9.70)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9262, A1-5327, TR1858/19, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 7.4 (6.85-7.80)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9262, A1-5327, TR1820/20, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 11.1 (10.8-11.6)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9262, A1-5327, TR1858/21, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 12.3 (8.33-13.88)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9262, A1-5327, TR1858/22, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 12.7 (10.17-13.86)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9262, A1-5327, TR1858/23, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 117 (ESA 2016), based on USEPA (2002) | 4.8 (3.26-5.76)% | Yes | Yes | Yes | 25±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9262, A1-5327, TR1858/24, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 6.6 (5.72-9.21)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9262, A1-5327, TR1858/24, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 3.1 (2.40-5.92)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9939, Y0160221, TR1978/1, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 4.8 (4.22-6.35)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9939, Y0160221, TR1978/2, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 7.5 (7.25-7.67)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9939, Y0160221, TR1978/3, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 48 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 6.4 (6.26-6.46)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9939, Y0160221, TR1978/4, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 11.6 (10.76-12.40)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9939, Y0160221, TR1978/5, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 6.6 (4.50-8.10)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9939, Y0160221, TR1978/6, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 7.4 (6.79-7.72)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9939, Y0160221, TR1978/7, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 3.9 (2.63-4.84)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9939, Y0160221, TR1978/8, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 3.4 (2.52-3.97)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9939, Y0160221, TR1978/8, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 3.3 (3.02-3.51)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9966, Y0230221, TR1978/9, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 3.9 (2.81-4.49)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9966, Y0230221, TR1978/10, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 6.8 (6.62-6.91)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9966, Y0230221, TR1978/11, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 48 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 6.4 (5.36-6.50)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9966, Y0230221, TR1978/12, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 7.8 (6.29-9.04)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9966, Y0230221, TR1978/13, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 7.8 (6.08-11.82)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9966, Y0230221, TR1978/14, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 7.1 (6.36-7.62)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9966, Y0230221, TR1978/15, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 6.3 (5.62-9.38)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9966, Y0230221, TR1978/16, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 2.7 (1.83-3.34)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9966, Y0230221, TR1978/16, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 94 | 86 | **91** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 3.2% (* the 95% confidence limits are not reliable) | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9983, Y020321, TR1978/17, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 4.3 (3.73-5.70)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9983, Y020321, TR1978/18, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 2.6 (2.24-3.11)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9983, Y020321, TR1978/19, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 48 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 2.1 (1.89-2.19)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9983, Y020321, TR1978/20, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 9.9 (8.67-11.81)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9983, Y020321, TR1978/21, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 7.4 (5.01-8.86)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9983, Y020321, TR1978/22, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x10⁴ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 3.8 (3.30-4.20)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9983, Y020321, TR1978/23, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 4.7 (3.74-5.06)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9983, Y020321, TR1978/24, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 3.1 (2.80-4.71)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 9983, Y020321, TR1978/24, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 3.0 (1.85-3.67)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10165, MI-5327, TR2029/1, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 2.2 (2.00-2.33)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10165, MI-5327, TR2029/2, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 3.7 (3.45-3.95)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10165, MI-5327, TR2029/3, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 3.6 (3.34-3.68)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10165, MI-5327, TR2029/4, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 11.8 (11.16-12.42)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10165, MI-5327, TR2029/5, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 10.7 (9.94-11.07)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10165, MI-5327, TR2029/6, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x10$^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 5.6 (4.66-6.92)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10165, MI-5327, TR2029/7, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 4.9 (3.61-5.25)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10165, MI-5327, TR2029/8, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 4.1 (3.1-6.3)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10165, MI-5327, TR2029/8, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 94 | 86 | **91** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 2.2% (* the 95% confidence limits are not reliable) | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10167, Y003082021, TR2029/9, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 4.7 (3.97-5.80)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10167, Y003082021, TR2029/10, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 3.9 (3.59-4.14)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10167, Y003082021, TR2029/11, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 4.2 (3.73-5.10)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10167, Y003082021, TR2029/12, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 9.4 (8.04-10.59)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10167, Y003082021, TR2029/13, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 11.1 (10.42-12.03)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10167, Y003082021, TR2029/6, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 4.2 (3.83-4.86)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10167, Y003082021, TR2029/15, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 5.0 (4.74-5.30)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10167, Y003082021, TR2029/16, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 4.1 (3.1-6.3)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10167, Y003082021, TR2029/16, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 2.5 (1.60-3.48)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10178, A1-5327, TR2029/17, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 7.1 (6.84-7.19)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10178, A1-5327, TR2029/18, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 7.5 (6.04-9.18)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10178, A1-5327, TR2029/19, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 3.7 (5.62-6.42)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10178, A1-5327, TR2029/20, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | IC | 10% Effect | FSW and ASW tested concurrently. | 3 - 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 14.4 (13.92-14.64)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10178, A1-5327, TR2029/21, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 11.7 (10.95-13.02)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10178, A1-5327, TR2029/22, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 7 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 4.2 (3.64-4.50)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10178, A1-5327, TR2029/23, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 5.9 (5.38-7.00)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10178, A1-5327, TR2029/24, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 5.7 (5.40-6.01)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10178, A1-5327, TR2029/24, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 3.9 (3.61-4.10)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10677, Y03/0822-1, TR2113/1, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 2.0 (1.86-2.22)% | Yes | Yes | Yes | 21.2±0.2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10677, Y03/0822-1, TR2113/2, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 2.1 (1.88-2.70)% | Yes | Yes | Yes | 18.8-21.6°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10677, Y03/0822-1, TR2113/3, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 2.0 (1.87-2.16)% | Yes | Yes | Yes | 18.8-21.6°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10677, Y03/0822-1, TR2113/4, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 91 | 86 | **95** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 3.8% (* the 95% confidence limits are not reliable) | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10677, Y03/0822-1, TR2113/5, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 5.0 (3.92-7.19)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10677, Y03/0822-1, TR2113/6, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 10.9 (10.51-11.41)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10677, Y03/0822-1, TR2113/7, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 6.3 (5.3-9.4)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10677, Y03/0822-1, TR2113/7, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 4.9 (3.40-7.51)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 10677, Y03/0822-1, TR2113/8, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | No | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 10.1 (9.39-10.63)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11237, Y0230823, TR2187/1, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Not measured | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 0 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 88 | **94** | **Acceptable[2]** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Not measured | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) | 4.1 (3.76-4.64)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11237, Y0230823, TR2187/2, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Not measured | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 0 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 88 | **94** | **Acceptable[2]** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Not measured | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle et al. (2003) | 8.6 (7.83-8.94)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11237, Y0230823, TR2187/3, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Not measured | Yes | Yes | Yes | No | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 0 | 4 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 3 | 94 | 84 | **89** | **Acceptable[2]** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Not measured | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 5.1 (* the 95% confidence limits are not reliable)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11237, Y0230823, TR2187/4, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Not measured | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 0 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 88 | **94** | **Acceptable[2]** |
| | Details | 96 hr | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Not measured | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 20.3 (19.54-21.05)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11237, Y0230823, TR2187/6, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Not measured | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 0 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 88 | **94** | **Acceptable[2]** |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Not measured | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) | 25.0 (22.27-37.16)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11237, Y0230823, TR2187/7, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Not measured | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 0 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 88 | **97** | **Acceptable[2]** |
| | Details | 72 hr | Macroalgal germination success; % Germination | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Not measured | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe et al. (1997) | 16.4 (15.01-17.62)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11237, Y0230823, TR2187/8, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Not measured | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 0 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 94 | 85 | **90** | **Acceptable[2]** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x$10^4$ cells/mL and Control coefficient of variation <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Not measured | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 8.3 (7.01-9.31)% | Yes | No | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11237, Y0230823, PR2187/08 (Test ID), Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Not stated OR inferred | Yes | No | Yes | Not measured | No | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Not measured OR stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 0 | 5 | 0 | 4 | 0 | 0 | 4 | 4 | 4 | 3 | 3 | 3 | 0 | 3 | 94 | 73 | **78** | **Unacceptable[3]** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Not reported | Juveniles | Not reported | Static | Not measured | Not reported | Dose-response plot shown | Linear interpolation | 10.44 (5.36-13.30) | Yes | Yes | Yes | Not reported | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11710, Y0110924, TR2234/1_R01, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 4.2 (3.77-4.46)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11710, Y0110924, TR2234/2, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 5.0 (4.61-5.42)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11710, Y0110924, TR2234/3_R01, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 3.4 (2.92-3.59)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11710, Y0110924, TR2234/4, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Fish imbalance; % Unaffected | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 5.0 (3.57-5.39)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11710, Y0110924, TR2234/5, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 4.1 (4.11-4.11)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11710, Y0110924, TR2234/5, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 10.4 (5.36-13.30)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11710, Y0110924, TR2187/6, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 94 | 90 | **96** | **High** |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 10.1 (8.95-10.63)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11710, Y0110924, TR2234/7, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | 91 | 90 | **99** | **High** |
| | Details | 72 hr | Macroalgal germination success; % Germination | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 4.4 (3.51-7.37)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11710, Y0110924, TR2234/8, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | | | | |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | 91 | 87 | **96** | **High** |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x10$^4$ cells/mL & Control CV <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 14.3 (13.04-14.44)% | Yes | Yes | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11798, Y0071124, TR2293/1, Heliocidaris tuberculata (sea urchin), Fertilisation | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | 94 | 90 | **96** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | | | | |
| | Details | 1 hr | Fertilisation success; % Fertilised eggs | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % fertilised eggs ≥ 70% | Gametes (both sperm and eggs) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 104 (ESA 2014), based on USEPA (2002) & Simon & Laginestra (1996) | 0.1 (0.09-0.11)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11798, Y0071124, TR2293/2, Heliocidaris tuberculata (sea urchin), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | 94 | 90 | **96** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | | | | |
| | Details | 72 hr | Larval development; % Normal larvae | EC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % normal larvae ≥ 70% | Developing embryos | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon & Laginestra (1996) & Doyle et al. (2003) | 0.1 (0.11-0.14)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11798, Y0071124, TR2293/3, Mytilus galloprovincialis (mussel), Larval development | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | 94 | 90 | **96** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | | | | |
| | Details | 72 hr | Larval development; % Normal larvae | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | FSW Control mean % normal ≥ 70% | Developing embryo | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 106 (ESA 2016), based on APHA (1998) & USEPA (1996) | 0.1 (0.10-0.15)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11798, Y0071124, TR2293/4, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | 94 | 90 | **96** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | | | | |
| | Details | 96 hr | Fish imbalance; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Larvae | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 117 (ESA 2017), based on USEPA (2002) | 1.3 (1.32-1.36)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11798, Y0071124, TR2293/5, Lates calcarifer (fish, Barramundi), Fish imbalance | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | 94 | 90 | **96** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | | | | |
| | Details | 7 day | Fish imbalance; % Unaffected | NOEC | NOEC ^ | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 80% | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 0.2% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11798, Y0071124, TR2293/5, Lates calcarifer (fish, Barramundi), Biomass | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | 94 | 90 | **96** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | | | | |
| | Details | 7 day | Biomass; Biomass (mg) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean growth >20% of initial weight | Juveniles | FSW | Static | Measured once | Ammonium | Dose-response plot shown | ESA SOP 122 (ESA 2017), based on USEPA (2002) | 0.3 (0.00-0.35)% | Yes | Yes | Yes | 25±2°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

| Sample & Test ID | Questions | Was the duration of the exposure stated? | Was the biological endpoint stated and defined? | Was the biological effect stated (e.g. LC or NOEC)? | Was the biological effect quantified (e.g. 50% effect)? | Were appropriate controls used? | Were each control and contaminant concentration at least duplicated? | Were the test acceptability criteria stated? OR, Were test acceptability criteria inferred? Note: Data that fail the acceptability criteria are automatically deemed to be of unacceptable quality and must not be used. | Were the characteristics of the test organism (e.g. length, mass, age) stated? | Was the type of test media used stated? | Was the type of exposure (e.g. static, flow-through) stated? | Were contaminant concentrations measured at the beginning and end of the exposure? Note: If concentrations were not measured then automatically the data cannot be high quality. | Were parallell reference toxicity tests conducted? | Was there a concentration- response relationship either observalble or stated? | Was an appropriate statistical method or model used to determine the toxicity? | For the LC/ EC/ BEC data, was an estimate of variability provided? OR, For NOEC/ LOEC data was the significance level 0.05 or less? | Was the Conductivity / Salinity measured and stated? | Was the Dissolved Oxygen measured and stated? | Was the pH measured and stated? | Was the temperature measured and stated? Award 1 mark if the temperature was measured but not stated, or if only the temperature of the room or chamber are stated. | Were test solutions, blanks and/ or controls tested for contamination OR were analytical reagent grade or the highest possible purity chemicals used? | Total Max Possible Score (91 for plants, 94 for non-plants) | Total score | Quality Score (%) | Overall Data Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11798, Y0071124, TR2293/6, Allorchestes compressa (amphipod), Acute toxicity (survival) | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | 94 | 90 | **96** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | | | | |
| | Details | 96 hr | Survival; % Unaffected | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % unaffected ≥ 90% | Juveniles | FSW | Static | Measured once | SDS | Dose-response plot shown | ESA SOP 108 (ESA 2017), based on USEPA (2002) & Department of Transport & Communications (1990) | 0.3 (0.22-0.38)% | Yes | Yes | Yes | 20±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11798, Y0071124, TR2293/7, Hormosira banksii (macroalgae seaweed), Macroalgal germination | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Measured AND stated | Measured AND stated | Measured or stated | Yes | 91 | 90 | **99** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 3 | | | | |
| | Details | 72 hr | Macroalgal germination success; % Germination | IC | 10% Effect | FSW and ASW tested concurrently. | 4 replicates | Control mean % germination ≥ 70% | Zygotes or zoospores | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 116 (ESA 2014), based on Kevekordes & Clayton (1996) & Gunthorpe et al. (1997) | 0.3 (0.15-0.46)% | Yes | Yes | Yes | 18±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |
| 11798, Y0071124, TR2293/8, Nitzschia closterium (marine microalgae), Algal growth | Answers | Yes | Stated AND defined | Yes | Yes | Yes | Yes | Stated | Yes | Yes | Yes | Measured once | Yes | Yes | Yes | Yes | Measured AND stated | Not applicable | Measured AND stated | Measured or stated | Yes | 91 | 87 | **96** | **High** |
| | Scores | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | - | 3 | 1 | 3 | | | | |
| | Details | 72 hr | Algal growth; Cell yield (cells/mL) | IC | 10% Effect | FSW and ASW tested concurrently. | 4 - 8 replicates | Control mean cell density ≥16.0x10⁴ cells/mL & Control CV <20% | Lab-cultured; 4-7 days old (log-growth phase) | FSW | Static | Measured once | Copper | Dose-response plot shown | ESA SOP 110 (ESA 2016), based on Stauber et al. (1994) | 0.3 (0.11-0.32)% | Yes | Yes | Yes | 21±1°C (Temperature of test chamber/room stated only) | Test solutions prepared using Analytical Reagent grade chemicals. | | | | |

*Notes*

*1 - although receiving a 'high' quality score of ≥ 80%, this datapoint was deemed 'unacceptable' as the WET test did not pass the QA/QC criterion of >20% fish growth in controls (Warne et al, 2018)*

*2 - although receiving a 'high' quality score of ≥ 80%, these datapoints were deemed only as 'acceptable' as this is the maximum quality score that can be applied to a test for which contaminant concentrations are not measured (Warne et al, 2018)*

*3 - although receiving an 'acceptable' quality score of ≥50 to <80%, this datapoint was deemed 'unacceptable' as the complete laboratory test report was not available (i.e. missing pages), thus it could be determined whether the QA/QC criterion was met.*

^ - The laboratory was unable to report an EC/IC10 value for the November 2024 (Sample and Test ID 11798, Y0071124, TR2293/5) 7-day fish imbalance test, although IC50 and NOEC values were reported. The NOEC was adopted for further data assessment in the SSD calculation (as per Warne et al. 2018 guidance on preferred hierarchy of estimates of toxicity).

# Appendix F

## Selection of Input Toxicity Data for Burrlioz 2.0

**PFW Samples (September 2019 - November 2024)**

| Test Species | Toxicity Endpoint | Exposure Duration | Period | Toxicity Estimate | Toxicty Value: PFW Concentration (%) and Variability (95% Confidence Intervals)^ | Toxicty Value (only): PFW Concentration (%) | Acute / Chronic classification in accordance with Warne et al. (2018) | Acute-to-Chronic Conversion Ratio | Geometric Mean for each combination of Species + Endpoint + Duration | Lowest toxicity value for each combination of Species + Endpoint | Burrlioz Input Toxicity Value, i.e. Lowest toxicity value for each Species |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Allorchestes compressa* (amphipod) | Survival | 96 hr | 25-Sep-19 | EC10 | 3.4 (2.27-4.39)% | 3.4 | Acute | 10 | 0.927 | 0.927 | 0.927 |
| | | | 2-Oct-19 | EC10 | 7.9 (6.35-10.73)% | 7.9 | | | | | |
| | | | 9-Oct-19 | IC10 | 11.1 (10.8-11.6)% | 11.1 | | | | | |
| | | | 16-Feb-21 | EC10 | 6.6 (4.50-8.10)% | 6.6 | | | | | |
| | | | 23-Feb-21 | IC10 | 7.8 (6.08-11.82)% | 7.8 | | | | | |
| | | | 2-Mar-21 | EC10 | 7.4 (5.01-8.86)% | 7.4 | | | | | |
| | | | 28-Jul-21 | IC10 | 10.7 (9.94-11.07)% | 10.7 | | | | | |
| | | | 3-Aug-21 | IC10 | 11.1 (10.42-12.03)% | 11.1 | | | | | |
| | | | 18-Aug-21 | IC10 | 11.7 (10.95-13.02)% | 11.7 | | | | | |
| | | | 31-Aug-22 | IC10 | 10.1 (9.39-10.63)% | 10.1 | | | | | |
| | | | 23-Aug-23 | IC10 | 25.0 (22.27-37.16)% | 25 | | | | | |
| | | | 11-Sep-24 | IC10 | 10.1 (8.95-10.63)% | 10.1 | | | | | |
| *Heliocidaris tuberculata* (sea urchin) | Fertilisation | 1 hr | 25-Sep-19 | EC10 | 1.6% (* 95% CL are not reliable) | 1.6 | Chronic | 1 | 3.482 | 3.482 | 3.482 |
| | | | 2-Oct-19 | IC10 | 2.5 (2.09-3.30)% | 2.5 | | | | | |
| | | | 9-Oct-19 | IC10 | 3.9 (3.77-4.07)% | 3.9 | | | | | |
| | | | 16-Feb-21 | IC10 | 4.8 (4.22-6.35)% | 4.8 | | | | | |
| | | | 23-Feb-21 | EC10 | 3.9 (2.81-4.49)% | 3.9 | | | | | |
| | | | 2-Mar-21 | IC10 | 4.3 (3.73-5.70)% | 4.3 | | | | | |
| | | | 28-Jul-21 | IC10 | 2.2 (2.00-2.33)% | 2.2 | | | | | |
| | | | 3-Aug-21 | IC10 | 4.7 (3.97-5.80)% | 4.7 | | | | | |
| | | | 18-Aug-21 | IC10 | 7.1 (6.84-7.19)% | 7.1 | | | | | |
| | | | 31-Aug-22 | IC10 | 2.0 (1.86-2.22)% | 2 | | | | | |
| | | | 23-Aug-23 | IC10 | 4.1 (3.76-4.64)% | 4.1 | | | | | |
| | | | 11-Sep-24 | IC10 | 4.2 (3.77-4.46)% | 4.2 | | | | | |
| | Larval development | 72 hr | 25-Sep-19 | EC10 | 3.0 (2.78-3.22)% | 3 | Chronic | 1 | 4.652 | 4.652 | |
| | | | 2-Oct-19 | EC10 | 3.0 (2.23-3.41)% | 3 | | | | | |
| | | | 9-Oct-19 | EC10 | 8.8 (7.73-9.70)% | 8.8 | | | | | |
| | | | 16-Feb-21 | EC10 | 7.5 (7.25-7.67)% | 7.5 | | | | | |
| | | | 23-Feb-21 | IC10 | 6.8 (6.62-6.91)% | 6.8 | | | | | |
| | | | 2-Mar-21 | IC10 | 2.6 (2.24-3.11)% | 2.6 | | | | | |
| | | | 28-Jul-21 | EC10 | 3.7 (3.45-3.95)% | 3.7 | | | | | |
| | | | 3-Aug-21 | EC10 | 3.9 (3.59-4.14)% | 3.9 | | | | | |
| | | | 18-Aug-21 | IC10 | 7.5 (6.04-9.18)% | 7.5 | | | | | |
| | | | 31-Aug-22 | EC10 | 2.1 (1.88-2.70)% | 2.1 | | | | | |
| | | | 23-Aug-23 | EC10 | 8.6 (7.83-8.94)% | 8.6 | | | | | |
| | | | 11-Sep-24 | EC10 | 5.0 (4.61-5.42)% | 5 | | | | | |
| *Hormosira banksii* (macroalgae seaweed) | Macroalgal germination | 72 hr | 25-Sep-19 | EC10 | 7.9 (5.58-9.79)% | 7.9 | Chronic | 1 | 9.475 | 9.475 | 9.475 |
| | | | 2-Oct-19 | EC10 | 13.3 (12.37-14.03)% | 13.3 | | | | | |
| | | | 9-Oct-19 | EC10 | 12.7 (10.17-13.86)% | 12.7 | | | | | |
| | | | 16-Feb-21 | EC10 | 11.6 (10.76-12.40)% | 11.6 | | | | | |
| | | | 23-Feb-21 | EC10 | 7.8 (6.29-9.04)% | 7.8 | | | | | |
| | | | 2-Mar-21 | EC10 | 9.9 (8.67-11.81)% | 9.9 | | | | | |
| | | | 28-Jul-21 | EC10 | 11.8 (11.16-12.42)% | 11.8 | | | | | |
| | | | 3-Aug-21 | EC10 | 9.4 (8.04-10.59)% | 9.4 | | | | | |
| | | | 18-Aug-21 | IC10 | 14.4 (13.92-14.64)% | 14.4 | | | | | |
| | | | 31-Aug-22 | EC10 | 3.8% (* 95% CL are not reliable) | 3.8 | | | | | |
| | | | 23-Aug-23 | EC10 | 16.4 (15.01-17.62)% | 16.4 | | | | | |
| | | | 11-Sep-24 | IC10 | 4.4 (3.51-7.37)% | 4.4 | | | | | |
| *Lates calcarifer* (fish, Barramundi) | Biomass | 7 day * | 25-Sep-19 | IC10 | 1.7% (* 95% CL are not reliable) | 1.7 | Acute | 10 | 0.336 | 0.336 | 0.336 |
| | | | 2-Oct-19 | IC10 # | 3.2 (0.98-3.52)% | - | | | | | |
| | | | 9-Oct-19 | IC10 | 3.1 (2.40-5.92)% | 3.1 | | | | | |
| | | | 16-Feb-21 | IC10 | 3.3 (3.02-3.51)% | 3.3 | | | | | |
| | | | 23-Feb-21 | IC10 | 3.2% (* 95% CL are not reliable) | 3.2 | | | | | |
| | | | 2-Mar-21 | IC10 | 3.0 (1.85-3.67)% | 3 | | | | | |
| | | | 28-Jul-21 | IC10 | 2.2% (* 95% CL are not reliable) | 2.2 | | | | | |
| | | | 3-Aug-21 | IC10 | 2.5 (1.60-3.48)% | 2.5 | | | | | |
| | | | 18-Aug-21 | IC10 | 3.9 (3.61-4.10)% | 3.9 | | | | | |
| | | | 31-Aug-22 | IC10 | 4.9 (3.40-7.51)% | 4.9 | | | | | |
| | | | 23-Aug-23 | IC10 # | 10.4 (5.36-13.30)% | - | | | | | |
| | | | 11-Sep-24 | IC10 | 10.4 (5.36-13.30)% | 10.4 | | | | | |
| | Fish imbalance | 96 hr | 9-Oct-19 | IC10 | 4.8 (3.26-5.76)% | 4.8 | Acute | 10 | 0.623 | 0.409 | |
| | | | 16-Feb-21 | EC10 | 3.9 (2.63-4.84)% | 3.9 | | | | | |
| | | | 23-Feb-21 | IC10 | 6.3 (5.62-9.38)% | 6.3 | | | | | |
| | | | 2-Mar-21 | EC10 | 4.7 (3.74-5.06)% | 4.7 | | | | | |
| | | | 28-Jul-21 | EC10 | 4.9 (3.61-5.25)% | 4.9 | | | | | |
| | | | 3-Aug-21 | EC10 | 5.0 (4.74-5.30)% | 5 | | | | | |
| | | | 18-Aug-21 | IC10 | 5.9 (5.38-7.00)% | 5.9 | | | | | |
| | | | 31-Aug-22 | EC10 | 10.9 (10.51-11.41)% | 10.9 | | | | | |
| | | | 23-Aug-23 | EC10 | 20.3 (19.54 - 21.05)% | 20.3 | | | | | |
| | | | 11-Sep-24 | EC10 | 5.0 (3.57-5.39)% | 5 | | | | | |
| | | 7 day * | 25-Sep-19 | EC10 | 2.7 (2.62-2.76)% | 2.7 | Acute | 10 | 0.409 | | |
| | | | 2-Oct-19 | IC10 | 4.1% (* 95% CL are not reliable) | 4.1 | | | | | |
| | | | 9-Oct-19 | IC10 | 6.6 (5.72-9.21)% | 6.6 | | | | | |
| | | | 16-Feb-21 | EC10 | 3.4 (2.52-3.97)% | 3.4 | | | | | |
| | | | 23-Feb-21 | EC10 | 2.7 (1.83-3.34)% | 2.7 | | | | | |
| | | | 2-Mar-21 | IC10 | 3.1 (2.80-4.71)% | 3.1 | | | | | |
| | | | 28-Jul-21 | IC10 | 4.1 (3.1-6.3)% | 4.1 | | | | | |
| | | | 3-Aug-21 | IC10 | 4.1 (3.1-6.3)% | 4.1 | | | | | |
| | | | 18-Aug-21 | IC10 | 5.7 (5.40-6.01)% | 5.7 | | | | | |
| | | | 31-Aug-22 | EC10 | 6.3 (5.3-9.4)% | 6.6 | | | | | |
| | | | 11-Sep-24 | IC10 | 4.1 (4.11-4.11)% | 4.1 | | | | | |
| *Macquaria novemaculeata* (fish, Australian Bass) | Fish imbalance | 96 hr | 25-Sep-19 | IC10 | 2.1% (* 95% CL are not reliable) | 2.1 | Acute | 10 | 0.293 | 0.293 | 0.293 |
| | | | 2-Oct-19 | IC10 | 4.1% (* 95% CL are not reliable) | 4.1 | | | | | |
| *Mytilus galloprovincialis* (mussel) | Larval development | 48 hr | 16-Feb-21 | IC10 | 6.4 (6.26-6.46)% | 6.4 | Chronic | 1 | 4.414 | 3.432 | 3.432 |
| | | | 23-Feb-21 | IC10 | 6.4 (5.36-6.50)% | 6.4 | | | | | |
| | | | 2-Mar-21 | IC10 | 2.1 (1.89-2.19)% | 2.1 | | | | | |
| | | 72 hr | 25-Sep-19 | EC10 | 2.0 (1.87-2.21)% | 2 | | | 3.432 | | |
| | | | 2-Oct-19 | EC10 | 2.3 (1.80-3.57)% | 2.3 | | | | | |
| | | | 9-Oct-19 | EC10 | 7.4 (6.85-7.80)% | 7.4 | | | | | |
| | | | 28-Jul-21 | EC10 | 3.6 (3.34-3.68)% | 3.6 | | | | | |
| | | | 3-Aug-21 | IC10 | 4.2 (3.73-5.10)% | 4.2 | | | | | |
| | | | 18-Aug-21 | IC10 | 3.7 (5.62-6.42)% | 3.7 | | | | | |
| | | | 31-Aug-22 | EC10 | 2.0 (1.87-2.16)% | 2 | | | | | |
| | | | 23-Aug-23 | EC10 | 5.1% (*95% CL are not reliable) | 5.1 | | | | | |
| | | | 11-Sep-24 | EC10 | 3.4 (2.92-3.59)% | 3.4 | | | | | |
| *Nitzschia closterium* (marine microalgae) | Algal growth | 72 hr | 25-Sep-19 | IC10 | 3.7 (3.33-3.80)% | 3.7 | Chronic | 1 | 5.653 | 5.653 | 5.653 |
| | | | 2-Oct-19 | IC10 | 2.0 (1.89-2.32)% | 2 | | | | | |
| | | | 9-Oct-19 | IC10 | 12.3 (8.33-13.88)% | 12.3 | | | | | |
| | | | 16-Feb-21 | IC10 | 7.4 (6.79-7.72)% | 7.4 | | | | | |
| | | | 23-Feb-21 | IC10 | 7.1 (6.36-7.62)% | 7.1 | | | | | |
| | | | 2-Mar-21 | IC10 | 3.8 (3.30-4.20)% | 3.8 | | | | | |
| | | | 28-Jul-21 | IC10 | 5.6 (4.66-6.92)% | 5.6 | | | | | |
| | | | 3-Aug-21 | IC10 | 4.2 (3.83-4.86)% | 4.2 | | | | | |
| | | | 18-Aug-21 | IC10 | 4.2 (3.64-4.50)% | 4.2 | | | | | |
| | | | 31-Aug-22 | IC10 | 5.0 (3.92-7.19)% | 5 | | | | | |
| | | | 23-Aug-23 | IC10 | 8.3 (7.01-9.31)% | 8.3 | | | | | |
| | | | 11-Sep-24 | IC10 | 14.3 (13.04-14.44)% | 14.3 | | | | | |

**Notes:**

^ Variability presented in parentheses are 95% confidence limits

CL - confidence limits

* - The 7-day fish biomass and imbalance tests were considered as chronic tests by ESA in accordance with the ESA test factsheets, however, these tests have been conservatively classified by AECOM as acute tests on the basis of Warne et al. (2018) which recommends that all tests conducted on juvenile or adult fish for durations less than 21 days are considered as acute tests

# - IC10 data for 7-day fish biomass tests undertaken on PFW samples from 02-Oct-2019 and 23-Oct-2023 were excluded from the data selection process as they were deemed to be of 'unacceptable' quality, due to quality control criteria not being me (or not confirmed to be met).

| GLDA-PFW Sample (November 2024) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Test Species** | **Toxicity Endpoint** | **Exposure Duration** | **Period** | **Toxicity Estimate** | **Toxicty Value: PFW Concentration (%) and Variability (95% Confidence Intervals)^** | **Toxicty Value (only): PFW Concentration (%)** | **Acute / Chronic classification in accordance with Warne et al. (2018)** | **Acute-to-Chronic Conversion Ratio** | **Geometric Mean for each combination of Species + Endpoint + Duration** | **Lowest toxicity value for each combination of Species + Endpoint** | **Burrlioz Input Toxicity Value, i.e. Lowest toxicity value for each Species** |
| *Allorchestes compressa* (amphipod) | Survival | 96 hr | 7-Nov-24 | IC10 | 0.3 (0.22-0.38)% | 0.3 | Acute | 10 | 0.030 | 0.030 | 0.030 |
| *Heliocidaris tuberculata* (sea urchin) | Fertilisation | 1 hr | 7-Nov-24 | IC10 | 0.1 (0.09-0.11)% | 0.1 | Chronic | 1 | 0.100 | 0.100 | 0.100 |
| | Larval development | 72 hr | 7-Nov-24 | EC10 | 0.1 (0.11-0.14)% | 0.1 | Chronic | 1 | 0.100 | 0.100 | |
| *Hormosira banksii* (macroalgae seaweed) | Macroalgal germination | 72 hr | 7-Nov-24 | IC10 | 0.3 (0.15-0.46)% | 0.3 | Chronic | 1 | 0.300 | 0.300 | 0.300 |
| *Lates calcarifer* (fish, Barramundi) | Biomass | 7 day * | 7-Nov-24 | IC10 | 0.3 (0.00-0.35)% | 0.3 | Acute | 10 | 0.030 | 0.030 | 0.020 |
| | Fish imbalance | 96 hr | 7-Nov-24 | IC10 | 1.3 (1.32-1.36)% | 1.3 | Acute | 10 | 0.130 | 0.020 | |
| | | 7 day * | 7-Nov-24 | NOEC ^ | 0.2% (* 95% CL are not determinable) | 0.2 | Acute | 10 | 0.020 | | |
| *Mytilus galloprovincialis* (mussel) | Larval development | 72 hr | 7-Nov-24 | IC10 | 0.1 (0.10-0.15)% | 0.1 | Chronic | 1 | 0.100 | 0.100 | 0.100 |
| *Nitzschia closterium* (marine microalgae) | Algal growth | 72 hr | 7-Nov-24 | IC10 | 0.3 (0.11-0.32)% | 0.3 | Chronic | 1 | 0.300 | 0.300 | 0.300 |

**Notes:**

^ Variability presented in parentheses are 95% confidence limits

CL - confidence limits

* - The 7-day fish biomass and imbalance tests were considered as chronic tests by ESA in accordance with the ESA test factsheets, however, these tests have been conservatively classified by AECOM as acute tests on the basis of Warne et al. (2018) which recommends that all tests conducted on juvenile or adult fish for durations less than 21 days are considered as acute tests

^ - The laboratory was unable to report an EC/IC10 value for the November 2024 7-day fish imbalance test on Lates calcarifer (fish, Barramundi), although IC50 and NOEC values were reported. The NOEC was adopted as the toxicity estimate herein, based on Warne et al. 2018 guidance on preferred hierarchy of estimates of toxicity.

# Appendix G

## Burrlioz 2.0 Statistical Output - Species Sensitivity Distribution

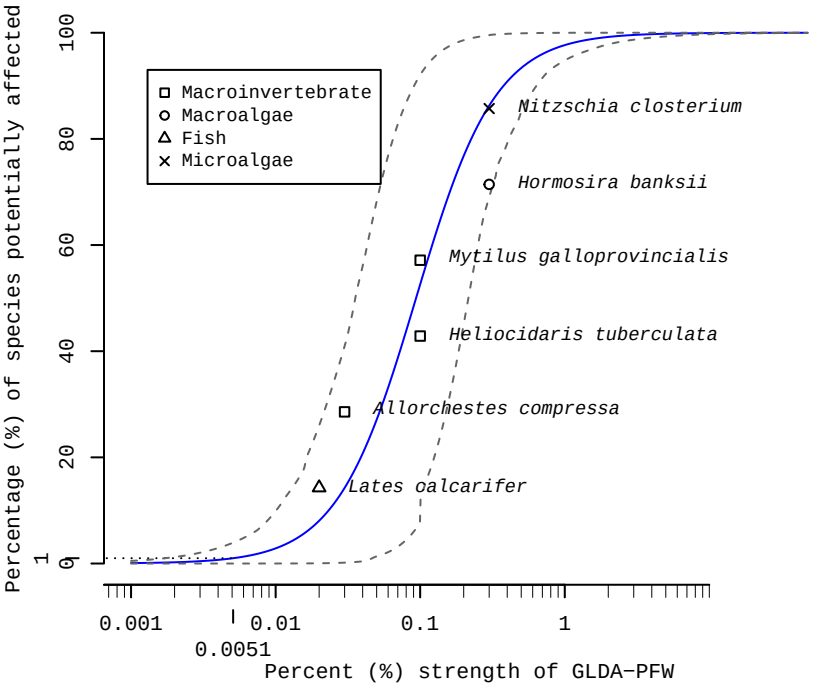
# Burrlioz 2.0 report

Toxicant: GLDA−PFW
Input file: C:\Users\LathS\OneDrive − AECOM\Beach\2025 Report\App G − Burrlioz Output\Ref
Time read: Thu Feb 13 17:34:42 2025
Units: percent (%)
Model: log logistic

Protection level information

| Protect. level | Guideline Value | lower 95% CI | upper 95% CI |
|---|---|---|---|
| 99% | 0.0051 | 0.0017 | 0.053 |
| 95% | 0.014 | 0.0062 | 0.089 |
| 90% | 0.023 | 0.01 | 0.11 |
| 80% | 0.039 | 0.016 | 0.15 |

notes: Nov 2024 sample WET−tested



Data:

| Toxicity_Data | Species | Species_Type | Taxa | Data_Type |
|---|---|---|---|---|
| 0.03 | Allorchestes compressa | Amphipod | Macroinvertebrate | Converted Chronic |
| 0.1 | Heliocidaris tuberculata | Sea urchin | Macroinvertebrate | Actual Chronic |
| 0.3 | Hormosira banksii | Macroalgae seaweed | Macroalgae | Actual Chronic |
| 0.02 | Lates calcarifer | Barramundi fish | Fish | Converted Chronic |
| 0.1 | Mytilus galloprovincialis | Mussel bivalve | Macroinvertebrate | Actual Chronic |
| 0.3 | Nitzschia closterium | Marine microalgae | Microalgae | Actual Chronic |

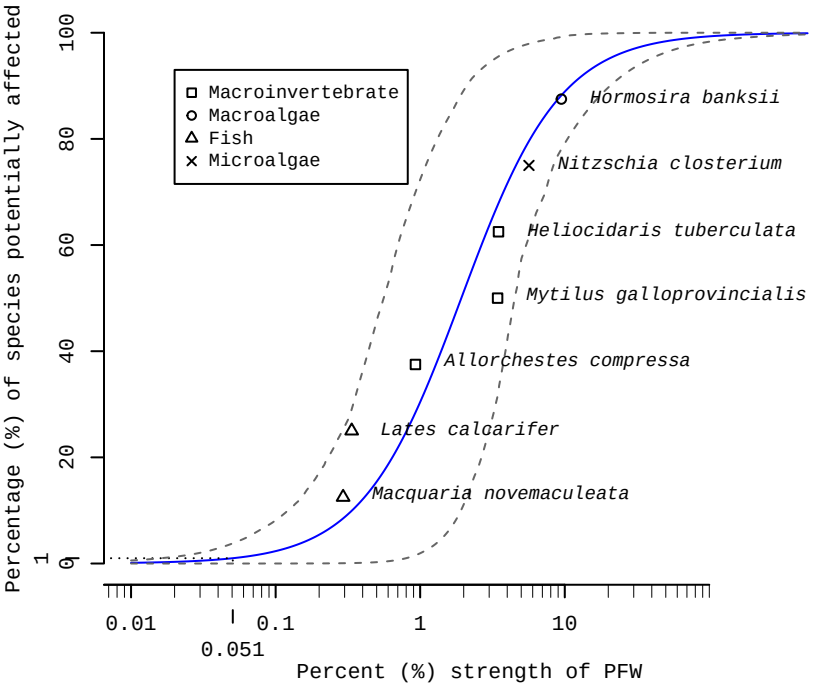
# Burrlioz 2.0 report

Toxicant: PFW
Input file: C:\Users\LathS\OneDrive - AECOM\Beach\2025 Report\App G - Burrlioz Output\In
Time read: Thu Feb 13 16:59:41 2025
Units: percent (%)
Model: log logistic

Protection level information

| Protect. level | Guideline Value | lower 95% CI | upper 95% CI |
|---|---|---|---|
| 99% | 0.051 | 0.017 | 0.87 |
| 95% | 0.19 | 0.067 | 1.6 |
| 90% | 0.34 | 0.13 | 2 |
| 80% | 0.64 | 0.23 | 2.8 |

notes: Sept 2019 to Sept 2024 samples WET-tested



Data:

| Toxicity_Data | Species | Species_Type | Taxa | Data_Type |
|---|---|---|---|---|
| 0.927 | Allorchestes compressa | Amphipod | Macroinvertebrate | Converted Chronic |
| 3.482 | Heliocidaris tuberculata | Sea urchin | Macroinvertebrate | Actual Chronic |
| 9.475 | Hormosira banksii | Macroalgae seaweed | Macroalgae | Actual Chronic |
| 0.336 | Lates calcarifer | Barramundi fish | Fish | Converted Chronic |
| 0.293 | Macquaria novemaculeata | Bass fish | Fish | Converted Chronic |
| 3.432 | Mytilus galloprovincialis | Mussel bivalve | Macroinvertebrate | Actual Chronic |
| 5.653 | Nitzschia closterium | Marine microalgae | Microalgae | Actual Chronic |

# Appendix H

## Beach Yolla Platform Produced Water Dispersion Far-Field Modelling Study (RPS, 2020)

# BEACH YOLLA PLATFORM

## Produced Water Dispersion Far-Field Modelling Study

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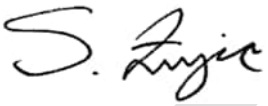
MAQ0975J
Beach Yolla Platform PW
Rev0
23 September 2020

rpsgroup.com

## Document status

| Version | Purpose of document | Authored by | Reviewed by | Approved by | Review date |
|---|---|---|---|---|---|
| RevA | Draft issued for internal review | Dr Ryan Dunn | Dr Sasha Zigic | Dr Sasha Zigic | 23 September 2020 |
| Rev0 | Draft issued for client review | Dr Sasha Zigic | Dr Sasha Zigic | Dr Sasha Zigic | 23 September 2020 |

## Approval for issue

Dr Sasha Zigic  23 September 2020

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# Contents

**1.0 PROJECT BACKGROUND ..... 1**

**2.0 SCOPE OF WORK ..... 3**

**3.0 REGIONAL CURRENTS ..... 4**

3.1 Tidal currents – HYDROMAP ..... 6

3.1.1 Grid Setup ..... 6

3.1.2 Tidal Conditions ..... 8

3.1.3 Surface Elevation Validation ..... 8

3.2 Ocean currents – HYCOM ..... 11

3.3 Current Speeds at the Release Site ..... 12

**4.0 WATER TEMPERATURE AND SALINITY ..... 14**

**5.0 REPORTING CRITERIA ..... 16**

**6.0 DISPERSION MODELLING ..... 18**

6.1 Model Description ..... 18

6.2 Discharge Input Data ..... 18

6.3 MUDMAP Mixing Parameters ..... 19

6.4 MUDMAP Grid Configuration ..... 19

**7.0 MODELLING RESULTS ..... 20**

7.1 Predicted Zones of Dilution ..... 20

**8.0 REFERENCES ..... 25**

## Tables

Table 1.1 Yolla Platform used as the release location for the produced formation water dispersion modelling study. ..... 1

Table 3.1 Statistical comparison between the observed and HYDROMAP predicted surface elevations. ..... 9

Table 3.2 Predicted monthly average and maximum surface current speeds nearby the Yolla release site. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2008–2012 (inclusive). ..... 12

Table 4.1 Monthly average sea surface temperature and salinity nearby the release location. ..... 14

Table 5.1 Summary of produced water contaminants and trigger values (source: RPS, 2017). ..... 17

Table 6.1 Summary of the far-field model inputs used to simulate the PW discharges at the Yolla platform. ..... 19

Table 7.1 Maximum horizontal distance from the discharge point to varying dilutions (1:x) for each case. ..... 21

## Figures

Figure 1.1 Map showing the location of the Yolla Platform used as the release location for the produced formation water dispersion modelling study. ..... 2

Figure 3.1 Example HYCOM averaged seasonal surface drift currents during summer and winter. ..... 5

Figure 3.2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh. ..... 7

Figure 3.3 Bathymetry defined throughout the tidal model domain. ..... 7

Figure 3.4 Location of the tide stations used in the surface elevation validation. ..... 9

DRAFT

Figure 3.5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image). ..... 10
Figure 3.6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image). ..... 11
Figure 3.7 Monthly surface current rose plots nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The month of May used as model input for the far-field dispersion modelling is indicated for ease of reference ..... 13
Figure 4.1 Temperature and salinity profiles nearby the release location. May conditions were used as the model input. ..... 15
Figure 7.1 Predicted zones of dilution for the whole PW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 100 $m^3$/day over 31-days during May conditions representing design operation (Case 1). ..... 22
Figure 7.2 Predicted zones of dilution or the whole PFW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 200 $m^3$/day over 31-days during May conditions representing typical operation (Case2). ..... 23
Figure 7.3 Predicted zones of dilution or the whole PFW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 300 $m^3$/day over 31-days during May conditions representing worst case operation (Case 3). ..... 24

DRAFT

# 1.0 PROJECT BACKGROUND

Beach Energy Limited (Beach) is the operator the Yolla Platform which is located within the production license T/L1 approximately 100 km offshore from mainland Victoria in the Bass Strait (Table 1.1 and Figure 1.1). The water depth in the vicinity of the platform is approximately 80 m.

In 2017, RPS was commissioned to undertake a near-field produced water (PW) dispersion modelling study (MAQ0573) for the Yolla Platform based on the following three cases: Case 1- Design (100 $m^3$/day); Case 2 - Typical (200 $m^3$/day; and Case 3- Worst Case (300 $m^3$/day). The cases and in turn discharge rates are based on the original PW design flow rate, expected operation post-debottlenecking and end of field life, respectively. The study findings revealed that the furthest distance travelled by the plume was 70 m and achieved a 1:1,000 dilution for Case 3 under high current speeds. (RPS, 2017).

Subsequently, Beach has requested modelling to assess the zones of dilution for the average (1:3,482) and maximum (1:5,400) total recoverable hydrocarbons (TRH) based on ANZECC guidelines. As well as reporting the distance to achieve the 1:62.5 dilution for the three cases.

**Table 1.1 Yolla Platform used as the release location for the produced formation water dispersion modelling study.**

| Release location | Latitude | Longitude | Water Depth (m) |
|---|---|---|---|
| Yolla Platform | 39° 50' 39.5" S | 145° 49' 5.9" E | 80 |

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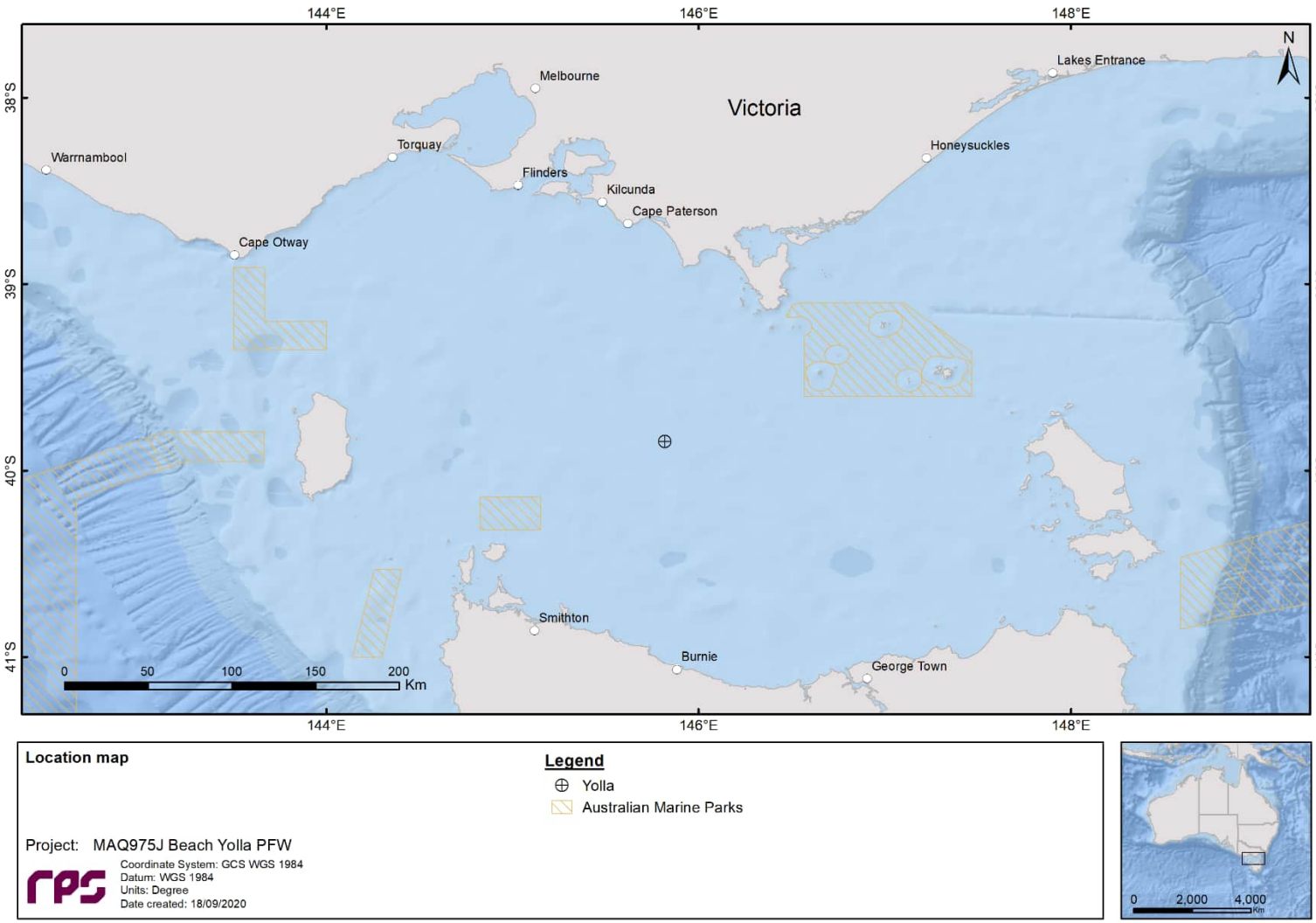


**Figure 1.1 Map showing the location of the Yolla Platform used as the release location for the produced formation water dispersion modelling study.**

# 2.0 SCOPE OF WORK

The physical mixing of the PW stream can be separated into two distinct zones: (a) near-field; and (b) far-field. The limits of the near-field zone are defined by the area where the levels of mixing and dilution are controlled by the plume's initial jet momentum and the buoyancy flux, resulting from the density difference. When the plume encounters a boundary such as the water surface, or loses its buoyancy, the near-field mixing is complete, and the far-field mixing begins.

This study utilises the findings from the previously completed near-field modelling to accurately assess the predicted far-field plume dynamics. Therefore, the scope of work included the following components:

1. Generate a 5-year 3-dimensional current data set (2008-2012) that included the combined influence of ocean and tidal currents;

2. Determine the least energetic month and lower current speeds for input into the far-field three-dimensional dispersion model. This approach provides a conservative approach in estimating the level of mixing and dispersion.

3. Generate vertical profiles of salinity and water temperature for the identified period;

4. Model the far-field mixing of the PW discharge based on each of the three operational discharge rates (i.e., 100 $m^3$/day, 200 $m^3$/day and 300 $m^3$/day) over a 31-day period using time-varying current data;

5. Generate plots illustrating the predicted zones of dilution for the whole PW stream for each discharge rate based on dilutions of 1:62.5, 1:3,482.4 dilutions (TRH average) and 1:5,400 dilutions (TRH maximum); and

6. Generate a summary table presenting the maximum horizontal distance from the discharge point to predicted PW plume dilutions.

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# 3.0 REGIONAL CURRENTS

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area off the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the straight are driven by tides, winds, incident continental shelf waves and density driven flows. High winds and strong tidal currents are frequent within the area (Jones, 1980).

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 3.1 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with surface tidal currents developed by RPS. The following sections provide a summary of the hybrid regional data set.

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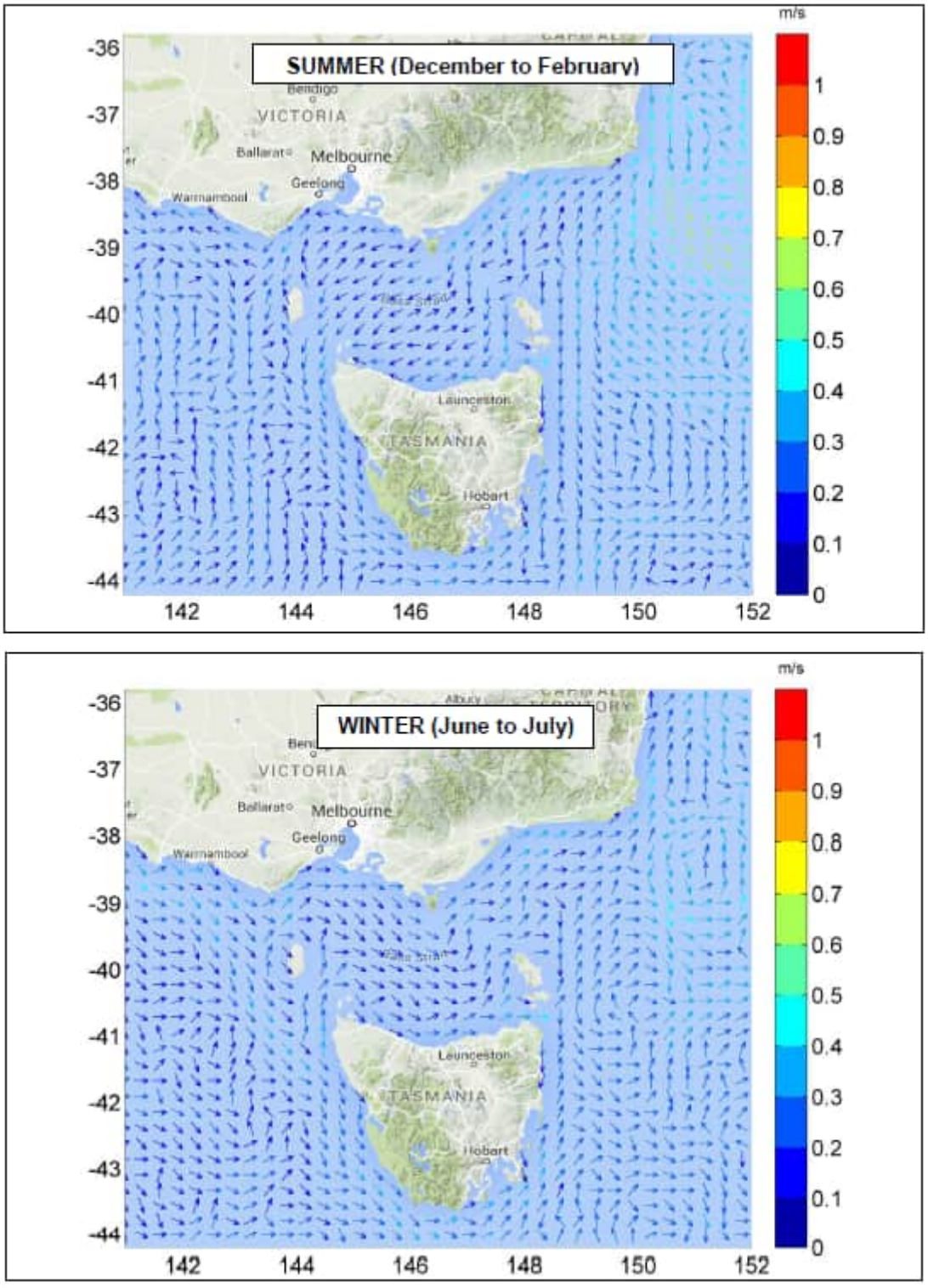


**Figure 3.1 Example HYCOM averaged seasonal surface drift currents during summer and winter.**

## 3.1 Tidal currents – HYDROMAP

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for over 30 years (Isaji and Spaulding, 1984; Isaji et al., 2001; Zigic et al., 2003). In fact, HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) oil spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a, 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

### 3.1.1 Grid Setup

The model is sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids are progressively allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3.2 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 3.3). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

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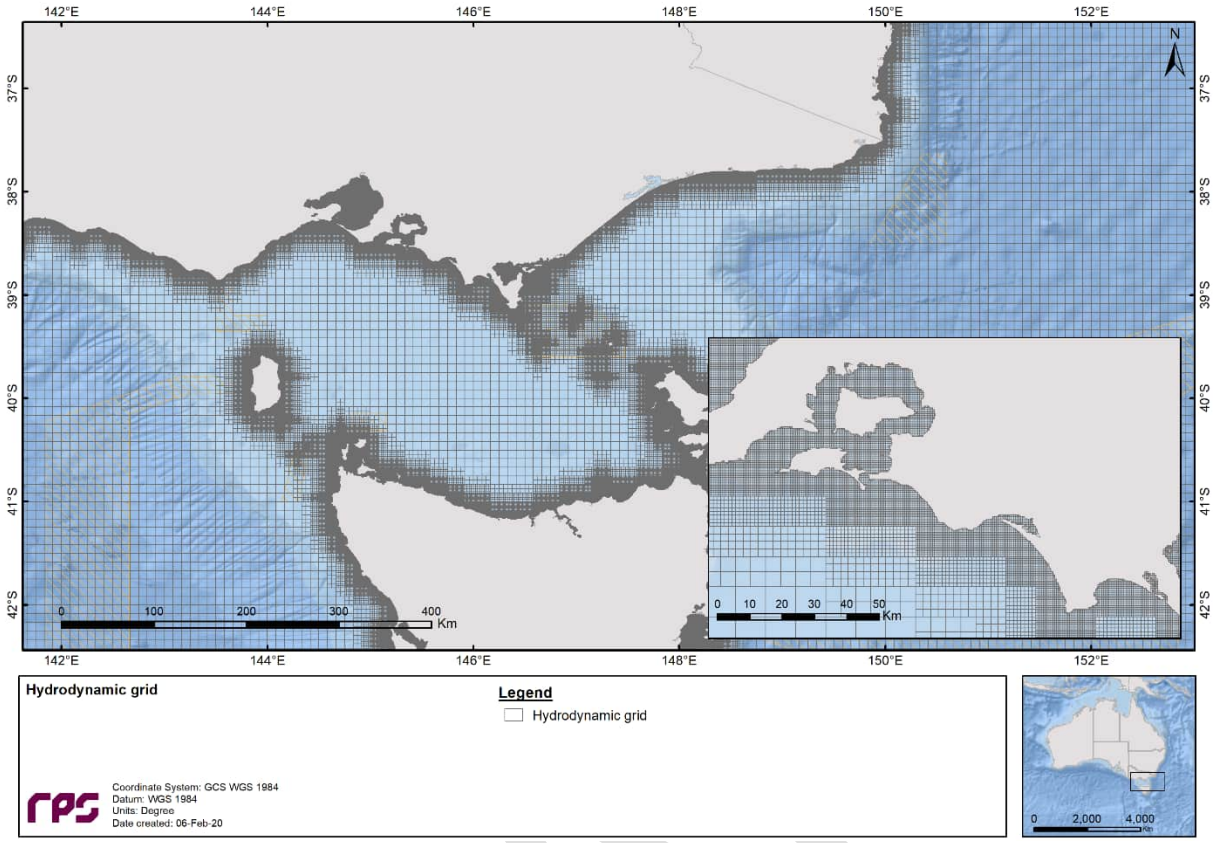


**Figure 3.2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.**

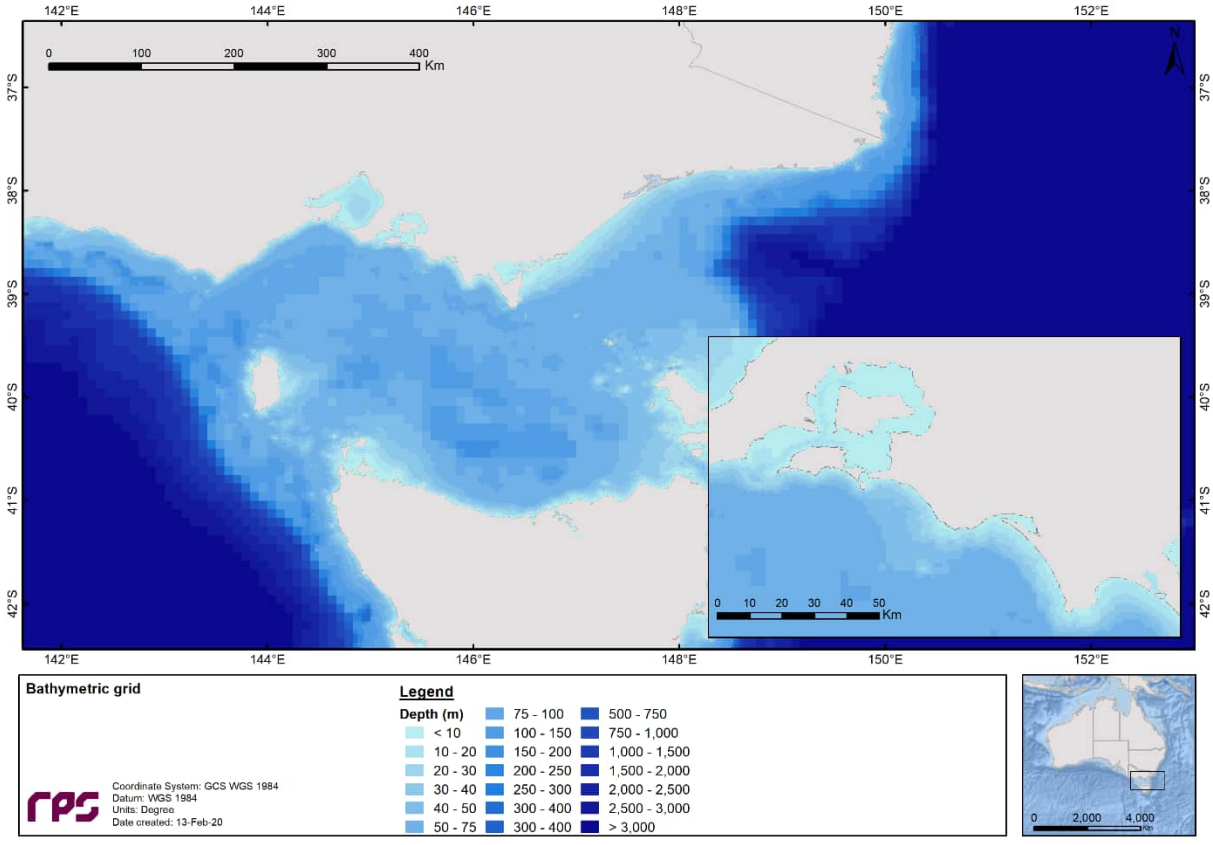


**Figure 3.3 Bathymetry defined throughout the tidal model domain.**

### 3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 8.0) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were $K_2$, $S_2$, $M_2$, $N_2$, $K_1$, $P_1$, $O_1$ and $Q_1$. Using the tidal data, time series surface heights were calculated along the open boundaries for the simulation period.

The Topex/Poseidon satellite data has a resolution of 0.25 degrees globally, with higher resolution in coastal regions, and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The data capturing satellites, equipped with two altimeters capable of taking sea level measurements accurate to less than ± 5 cm, measured oceanic surface elevations (and the resultant tides) for the period 1992–2005. In total these satellites carried out 62,000 orbits of the planet. The Topex-Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen 2010). The Topex/Poseidon tidal data is considered suitably accurate for this study.

### 3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at a location situated within the study area (Figure 3.4).

To provide a statistical measure of the model performance, the Index of Agreement (IOA – Willmott, 1981) and the Mean Absolute Error (MAE – Willmott, 1982; Willmott & Matsuura, 2005) were used.

The MAE (Eq.1) is simply the average of the absolute values of the difference between the model-predicted (P) and observed (O) variables. It is a more natural measure of the average error (Willmott and Matsuura, 2005) and more readily understood. The MAE is determined by:

$$MAE = N^{-1} \sum_{i=1}^{N} |P_i - O_i| \qquad \text{Eq.1}$$

Where: $N$ = Number of observations

$P_i$ = Model predicted surface elevation

$O_i$ = Observed surface elevation

The Index of Agreement (IOA; Eq. 2) in contrast, gives a non-dimensional measure of model accuracy or performance. A perfect agreement between the model predicted and observed surface elevations exists if the index gives an agreement value of 1, and complete disagreement between model and observed surface elevations will produce an index measure of 0 (Wilmott, 1981). Willmott et al (1985) also suggests that values larger than 0.5 may represent good model performance. The IOA is determined by:

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: $X_{model}$ = Model predicted surface elevation

$X_{obs}$ = Observed surface elevation

Clearly, a greater IOA and lower MAE represent a better model performance.



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Figure 3.5 and Figure 3.6 illustrate a comparison of the predicted and observed surface elevations in February 2017. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

Table 3.1 shows the IOA and MAE values for the selected tide station locations indicating that the model is performing well.

**Table 3.1 Statistical comparison between the observed and HYDROMAP predicted surface elevations.**

| Tide Station | IOA | MAE (m) |
|---|---|---|
| Gabo Island | 0.98 | 0.08 |
| Port MacDonnell | 0.98 | 0.05 |
| Port Welshpool | 0.92 | 0.30 |
| Portland | 0.97 | 0.07 |
| Stack Island | 0.96 | 0.22 |

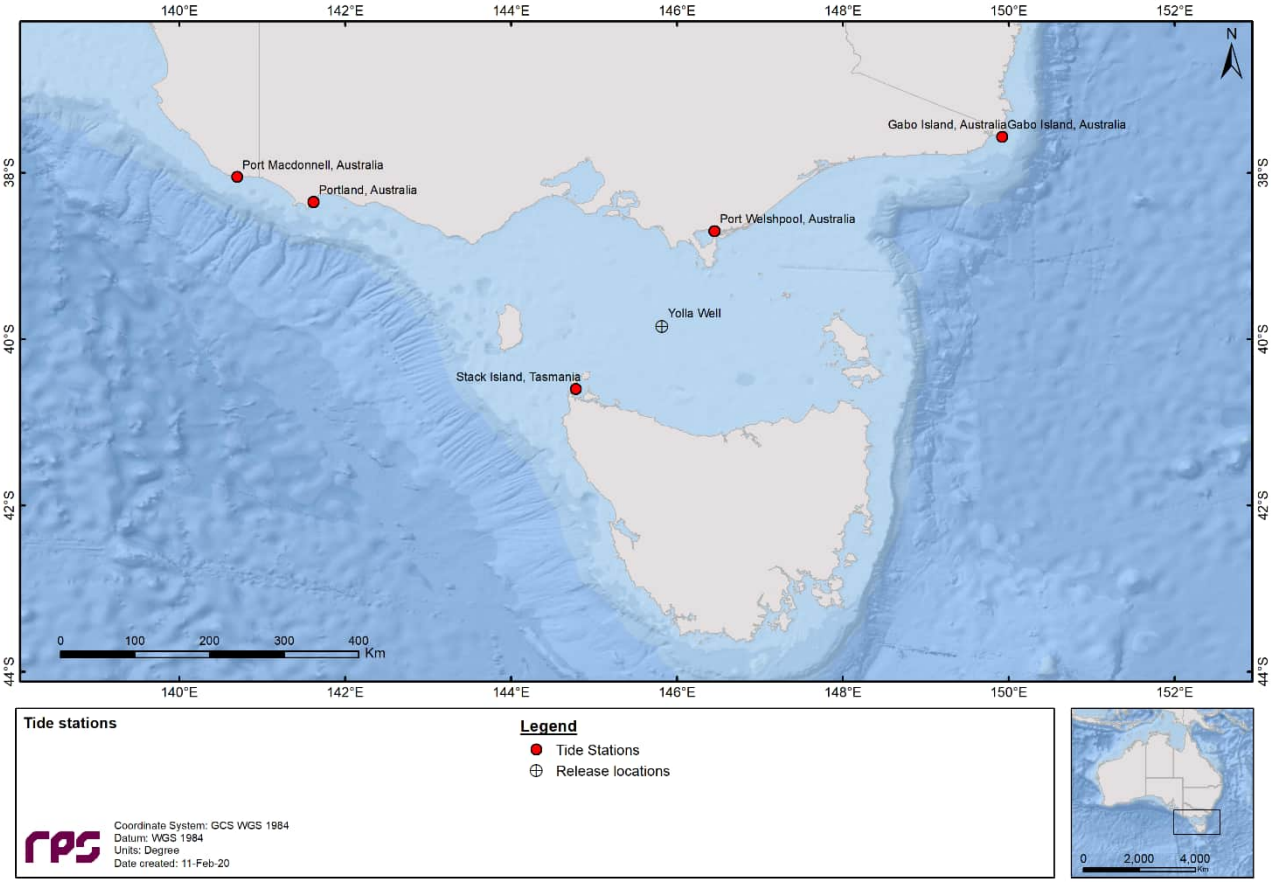


**Figure 3.4 Location of the tide stations used in the surface elevation validation.**

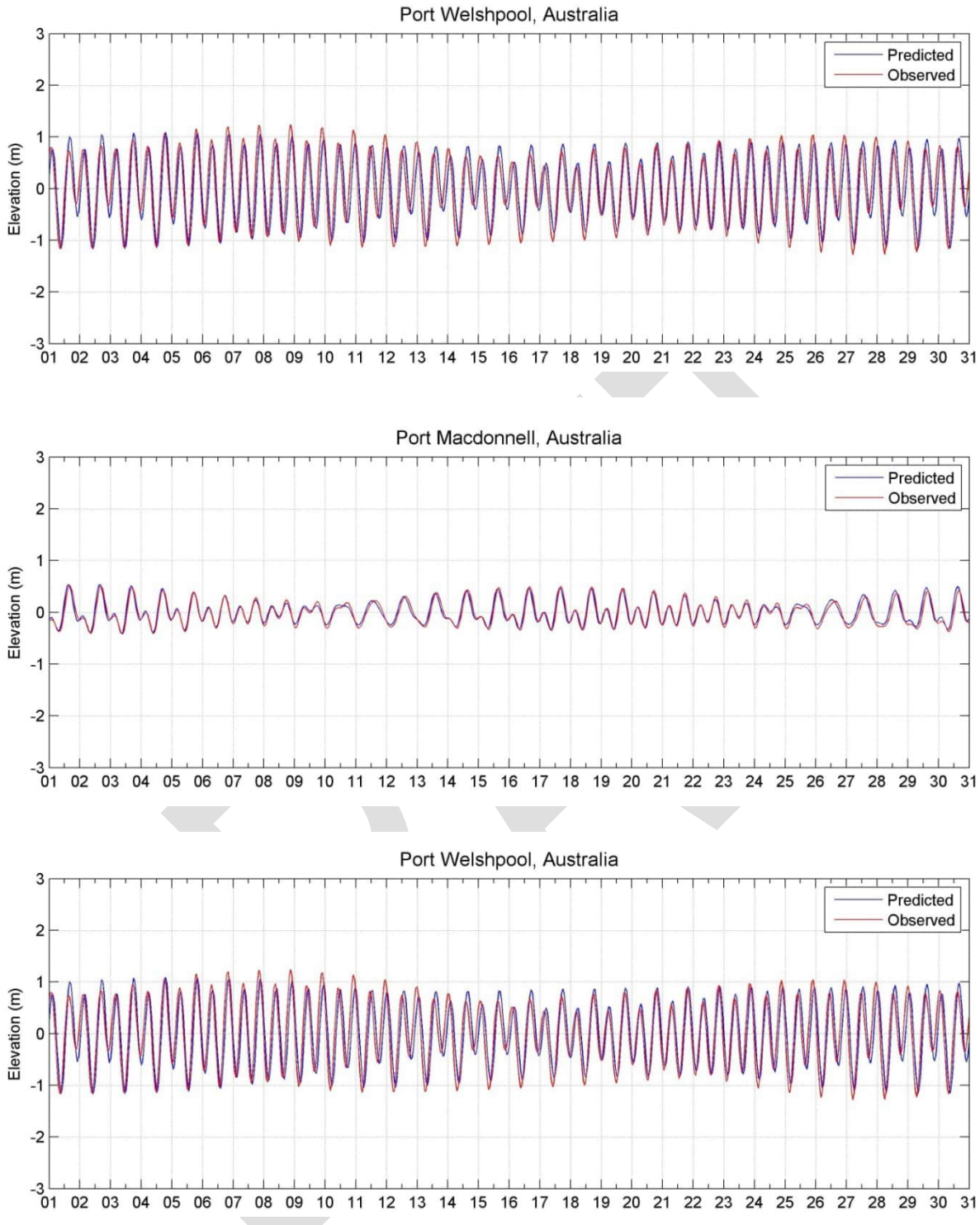


**Figure 3.5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).**

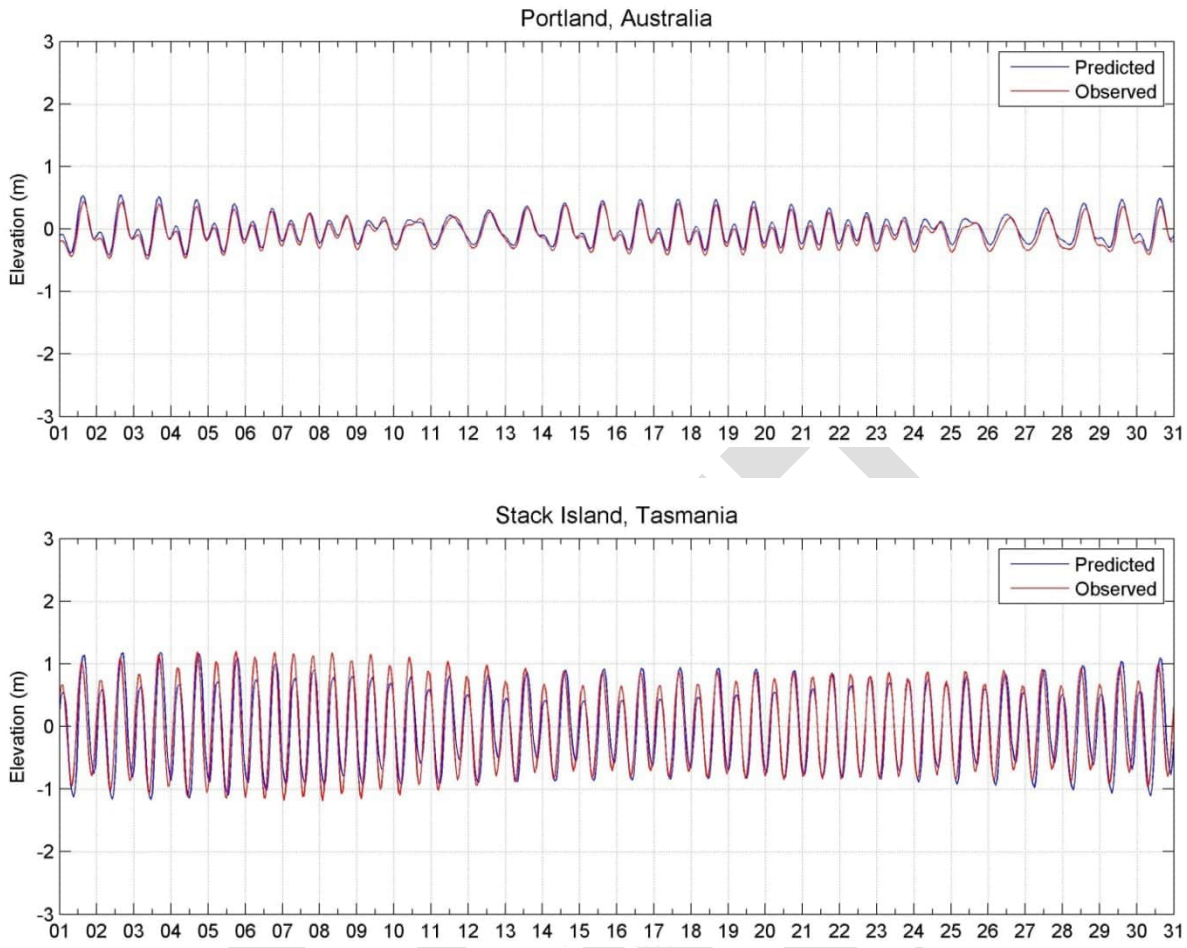


**Figure 3.6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).**

## 3.2 Ocean currents – HYCOM

The ocean currents (non-tidal) were represented by the output from a third-party three-dimensional ocean model, HYCOM (HYbrid Coordinate Ocean Model) (Wallcraft et al. 2003; Chassignet et al. 2007, 2009). HYCOM is operated by the HYCOM Consortium and sponsored by the Global Ocean Data Assimilation Experiment (GODAE). It uses an array of measured data as input to understand the current state of the water body, including time-varying observations of sea-surface height, sea-surface temperature and *in situ* temperature and salinity measurements (Chassignet et al. 2009). Numerical modelling is then employed to determine how the sea-state evolves between the measurement points. The HYCOM predictions are three-dimensional with a horizontal resolution of approximately 8.25 km and are recorded once per day. Hence, the data provides estimates of meso-scale ocean circulation, with horizontal resolution suitable to resolve eddies of approximately 20 kilometres in diameter, as well as connecting stream currents of similar spatial scale. HYCOM provides a comprehensive dataset spanning decades, with increasing data quality over more recent years through the increased availability of ocean observations from satellite and sensor data.

For this study, the HYCOM hindcast currents were obtained for the years 2008 to 2012 (inclusive). The ocean current data was retrieved at 10 m depth layers (0 – 80 m).

## 3.3 Current Speeds at the Release Site

Figure 3.7 presents the monthly current rose distributions resulting from the combination of HYCOM ocean current data and HYDROMAP tidal data nearby the Yolla release site.

Note the convention for defining current direction is the direction the current flows towards, which is used to reference current direction throughout this report. Each branch of the rose represents the currents flowing to that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.1 m/s are predominantly used in these current roses. The length of each coloured segment is relative to the proportion of currents flowing within the corresponding speed and direction.

Table 3.2 presents the average and maximum net current speeds from combined HYCOM and tidal currents nearby the Yolla release site. Monthly current spends varied throughout the years ranging between 0.16 m/s (January) and 0.22 m/s (August). The dominant direction of surface currents was predominantly eastward.

The least energetic month of the current data was May 2011, which had an average monthly surface current speed of 0.13 m/s.

**Table 3.2 Predicted monthly average and maximum surface current speeds nearby the Yolla release site. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2008–2012 (inclusive).**

| Month | Average current speed (m/s) | Maximum current speed (m/s) | General direction |
|---|---|---|---|
| January | 0.16 | 0.48 | Variable |
| February | 0.18 | 0.66 | Variable |
| March | 0.18 | 0.68 | East-northeast |
| April | 0.17 | 0.98 | East |
| May | 0.16 | 0.73 | East |
| June | 0.19 | 0.85 | East-southeast |
| July | 0.20 | 1.02 | East-southeast |
| August | 0.22 | 0.99 | East-southeast |
| September | 0.21 | 0.73 | East-southeast |
| October | 0.16 | 0.54 | East-northeast |
| November | 0.17 | 0.61 | East |
| December | 0.18 | 0.48 | East |
| **Minimum** | **0.16** | **0.48** | |
| **Maximum** | **0.22** | **1.02** | |

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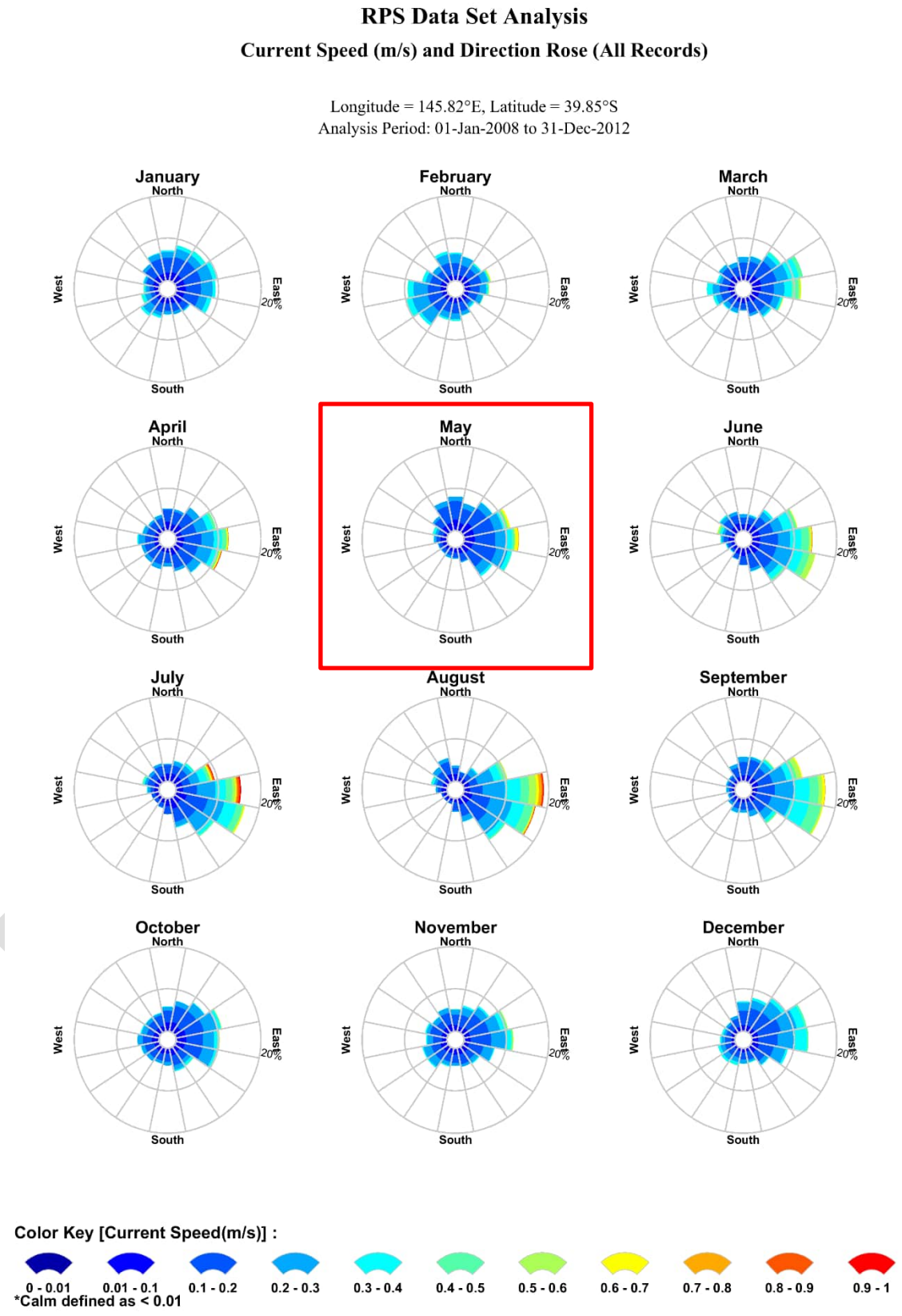


**Figure 3.7 Monthly surface current rose plots nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The month of May used as model input for the far-field dispersion modelling is indicated for ease of reference**

# 4.0 WATER TEMPERATURE AND SALINITY

To account for depth-varying sea temperature and salinity, data was obtained from the World Ocean Atlas 2013 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Center for Oceanography (see Levitus et al., 2013).

Table 4.1 presents the sea temperature and salinity of the surface layer nearby the release sites.

The monthly average sea surface temperatures ranged between 12.7°C and 18.1°C, while the salinity values remain relatively consistent ranging between 24.9 and 35.5 psu. Water temperature and salinity during May conditions was 17ºC and 35.4 PSU, respectively.

Figure 4.1 illustrates the vertical profile of sea temperature and salinity.

**Table 4.1 Monthly average sea surface temperature and salinity nearby the release location.**

| | Jan | Feb | Mar | Apr | May* | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (ºC) | 17.1 | 18.0 | 18.1 | 17.0 | 17.3 | 13.0 | 12.7 | 13.2 | 13.1 | 14.3 | 15.7 | 15.1 |
| Salinity (PSU) | 35.3 | 35.3 | 35.5 | 35.5 | 35.4 | 34.9 | 35.2 | 35.1 | 35.3 | 35.5 | 35.5 | 35.3 |

* Far-field dispersion modelling month

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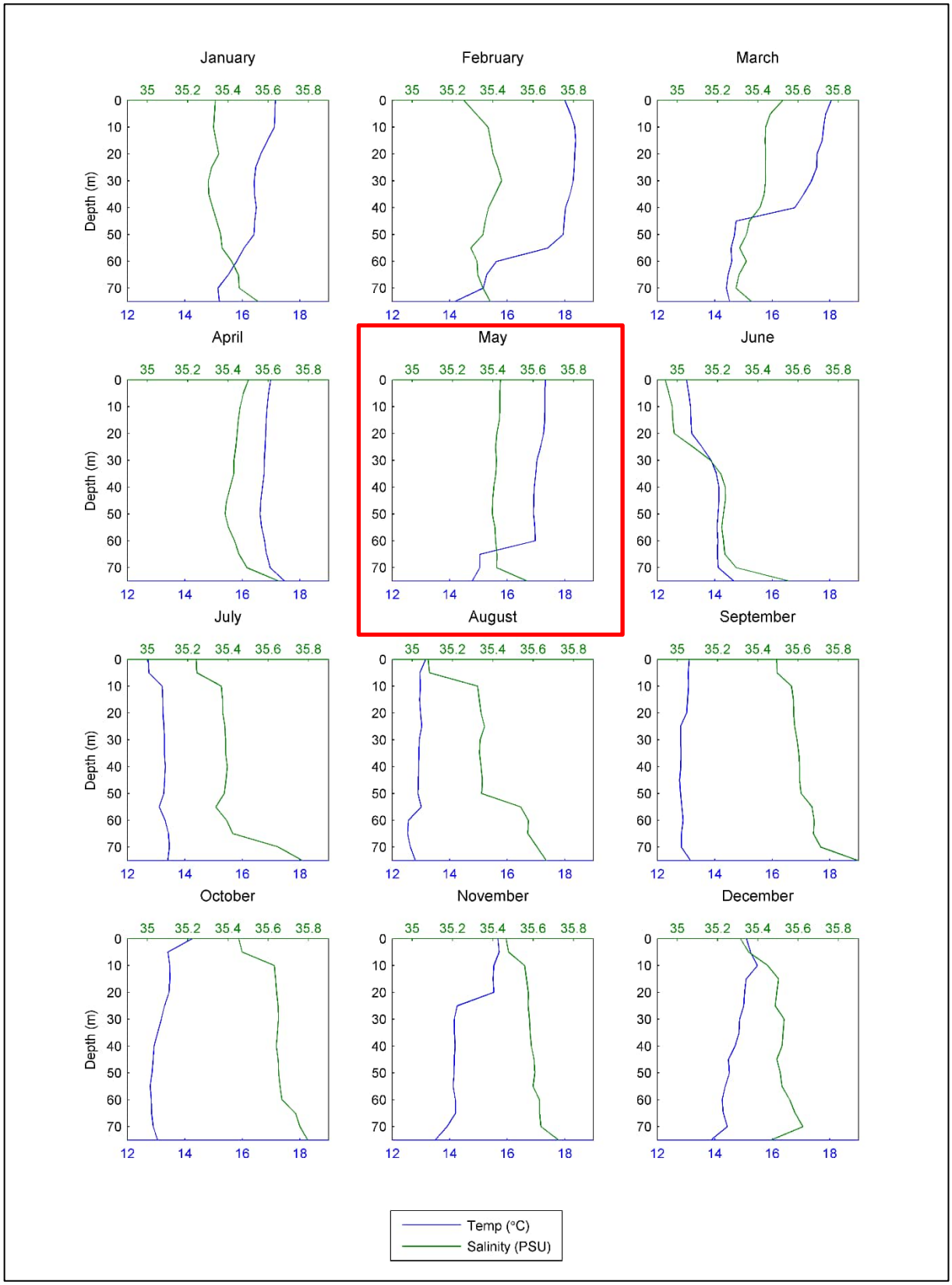


**Figure 4.1 Temperature and salinity profiles nearby the release location. May conditions were used as the model input.**

# 5.0 REPORTING CRITERIA

The area of exposure was determined based on dilutions of the whole PW discharge stream. Reported dilutions are based on the predicted instantaneous maximum concentrations and thus represent the predicted minimum dilution within any given grid cell over the duration of the 31-day model simulation.

A list of measured contaminant levels and trigger values for 99% species protection is shown in (Table 5.1), which were adopted as part of the near-field modelling study (RPS, 2017). As shown, the majority of the contaminants require a dilution factor of less than 1:75. Furthermore, as part of the near-field modelling study maximum dilutions of 1:1,000 were reported.

In line with ANZECC requirements, this modelling assessment reports the predicted zones of dilutions for 1:3,482.4 (TRH average) and 1:5,400 (TRH maximum).

The following dilutions (1:x) were also presented for completeness; 60, 62.5, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 3482.4 and 5400.

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**Table 5.1 Summary of produced water contaminants and trigger values (source: RPS, 2017).**

| Component | Max recorded produced water concentration (µg/L) | 99% Species protection trigger value (µg/L) | Required dilution factor to achieve 99% trigger value |
|---|---|---|---|
| Aluminium | 3,200 | 27* | 119 |
| Arsenic | BD | 1 | - |
| Boron | 3,400 | 90* | 38 |
| Barium | 13,000 | NL | - |
| Chromium | 1 | 0.14 | 7.1 |
| Iron | 4,300 | ID | - |
| Lead | BD | 1 | - |
| Mercury | 29 | 0.1 | 290 |
| Manganese | 30 | 1200* | NR (<1) |
| Molydenum | 1 | ID | - |
| Nickel | 10 | 7 | 1.4 |
| Selenium | 1 | 5* | NR (<1) |
| Strontium | 810 | NL | - |
| Zinc | 90 | 7 | 12.9 |
| Benzene | 12,000 | 500 | 24 |
| Toluene | 14,000 | 110* | 127 |
| Ethylbenzene | 450 | 50* | 90 |
| o-Xylene | 1,600 | 200* | 8 |
| m&p-Xylene | 5,200 | 50* | 104 |
| Napthalene | 1,000 | 50 | 20 |
| Phenol | 64,000 | 270 | 237 |
| Cresols | 75,000 | NL | - |
| 2,4-Dimethyl Phenol | 8,700 | NL | - |
| Oil & Petroleum Hydrocarbons | <30,000 (current discharge limit) | 70 | 428 |
| Glycol | 2 vol% (20,000,000 µg/L) | 50,000^ | 400 |

^ = Guideline for working limits only, insufficient data to determine level of species protection
* = Taken from data for 99% species protection in fresh water systems ANZECC
BD = Historical testing shows these contaminants are below the limit of detection of 0.001 mg/L
ID = Insufficient data to determine a trigger value for marine or freshwater environment
NL = Component not listed in ANZECC guidelines
NR = Dilution not required, below ANZECC guideline concentration at point of discharge

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# 6.0 DISPERSION MODELLING

## 6.1 Model Description

The MUDMAP model is an industry standard computerised modelling system, which has been applied throughout the world to predict the dispersion of sediment (cuttings and muds) and liquid (produced water) discharges since 1994 (Spaulding, 1994). The model is a development of the Offshore Operators Committee (OOC) model and like the OOC model calculates the fates of discharges through three known distinct integrated stages (Koh and Chang, 1973; Khondaker, 2000; Brandsma and Sauer, 1983a, 1983b).

The produced formation water release is represented by placing a fixed number of “particles” at the release location on each time-step. These particles are moved on each subsequent time-step according to the horizontal and vertical components from the hydrodynamic model. The plume spread is dependent on the horizontal and vertical mixing coefficients.

The MUDMAP system is based on a conservative tracer (no reaction or decay), constituting a “worst case” scenario, to examine the mixing and dilution of effluent plumes. The concentration distribution of the constituent in water is estimated using a counting grid. The number of particles in a grid square over a depth interval from the water surface down to a specified depth is counted, giving the mass of the constituent in a known volume, and therefore concentration.

The system has been extensively validated and applied for discharge operations in Australian waters (e.g. Burns et. al., 1999; King and McAllister, 1998, 1997).

## 6.2 Discharge Input Data

The detailed input data used in the far-field discharge model setup included:

- The relative temperatures and salinities of the PFW plume and receiving waters;
- The PFW rate of discharge;
- The height of the discharge point relative to mean sea level; and
- Current data to represent local physical forcing.

The PW stream, consists of both PW and water of condensation, is discharged vertically downwards through a discharge caisson at a depth of 45 meters below mean sea level (MSL) from a 0.73 m diameter outlet. The depth of the surrounding water is approximately 80 m.

The PW discharge properties are summarised in Table 6.1. The PW plume is slightly hotter (1°C above ambient at 45 m below MSL) and less saline than the receiving waters, resulting in a positively buoyant plume.

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**Table 6.1 Summary of the far-field model inputs used to simulate the PW discharges at the Yolla platform.**

| Parameter | Design Operation | Typical Operation | Worst Case Operation |
|---|---|---|---|
| **Month and year simulated** | | May conditions 2011 | |
| **PW discharge flow rate ($m^3$/day)** | 100 | 200 | 300 |
| **Discharge type** | Continuous | Continuous | Continuous |
| **Period of discharge (days)** | 31 | 31 | 31 |
| **Discharge water temperature (ºC)** | 13.8 – 16.8 | 13.8 – 16.8 | 13.8 – 16.8 |
| **Discharge water salinity (PSU)** | 0.14 | 11.9 | 14.7 |
| **Depth of discharge (m)** | 45 | 45 | 45 |

## 6.3 MUDMAP Mixing Parameters

The horizontal and vertical dispersion coefficients represent the mixing and diffusion caused by turbulence, both of which are sub-grid processes. Both of these coefficients are expressed in units of rate of area change (i.e. $m^2$/s). Increasing the horizontal dispersion coefficient will increase the horizontal spread of the discharge plume and decrease the centreline concentrations. Increasing the vertical dispersion coefficient spreads the discharge across the vertical layers.

Spatially constant, conservative horizontal and vertical dispersion coefficients of 0.2 $m^2$/s and 0.0001 $m^2$/s were used to control the exchange of the PW in the horizontal and vertical directions respectively. Each of the mixing parameters was selected following an extensive sensitivity testing to recreate plume characteristics with respect to the near-field plume behaviour (see RPS, 2017).

## 6.4 MUDMAP Grid Configuration

MUDMAP uses a three-dimensional grid to represent the water depth and bathymetric profiles of the study area. Due to the rapid mixing and small-scale influences of the discharge, it was necessary to use a very fine grid with a resolution of 5 m x 5 m x 2 m (x, y and z) to track the movement and fate of the plume. The extent of the grid region measured 5 km (longitude or x-axis) x 5 km (latitude or y-axis).

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# 7.0 MODELLING RESULTS

## 7.1 Predicted Zones of Dilution

Figure 7.1 to Figure 7.3 present the predicted zones of dilution for the whole PFW stream up to a 1:5,400 for each of the three cases over the 31 day simulation period:

- Case 1: Design operation: 100 $m^3$/day
- Case 2: Typical operation: 200 $m^3$/day
- Case 3: Worst case operation: 300 $m^3$/day

Table 7.1 presents the maximum horizontal distance from the discharge point to varying dilutions (1:x) for each for design (i.e. Cases 1, 2 and 3). Dilutions achieved at horizontal distance sub-grid cell size (i.e. 5 m) are denoted < 5m.

The 1:62.5 dilution was achieved within <5 m from the release location for all three cases. Dilutions of 1:3,482.4 (TRH average) and 1:5,400 (TRH maximum), were achieved at maximum horizontal distances from the release location of 133 m to 485 m and 292 m to 693 m, respectively (Figure 7.1 to Figure 7.3 and **Error! Reference source not found.**).

The 1:500 dilution was achieved within 70 m of the release location for all three cases. While the 1:1,000 dilution was reached 69 m, 73 m and 121 m from the release location under Case 1 (100 $m^3$/day), Case 2 (200 $m^3$/day) and Case 3 (300 $m^3$/day) operational rates, respectively.

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**Table 7.1 Maximum horizontal distance from the discharge point to varying dilutions (1:x) for each case.**

| Dilution (1:x) | Maximum horizontal distance (m) | | |
|---|---|---|---|
| | Case 1 Design Operation | Case 2 Typical Operation | Case 3 Worst Case Operation |
| 60 | <5 m | <5 m | <5 m |
| 62.5 | <5 m | <5 m | <5 m |
| 70 | <5 m | <5 m | 26 |
| 80 | <5 m | <5 m | 26 |
| 90 | <5 m | <5 m | 26 |
| 100 | <5 m | 26 | 26 |
| 200 | 39 | 64 | 64 |
| 300 | 39 | 64 | 64 |
| 400 | 64 | 64 | 64 |
| 500 | 69 | 64 | 64 |
| 600 | 69 | 64 | 64 |
| 700 | 69 | 64 | 114 |
| 800 | 69 | 64 | 114 |
| 900 | 69 | 64 | 118 |
| 1,000 | 69 | 73 | 121 |
| 3,482.4 | 133 | 295 | 485 |
| 5,400 | 292 | 490 | 693 |

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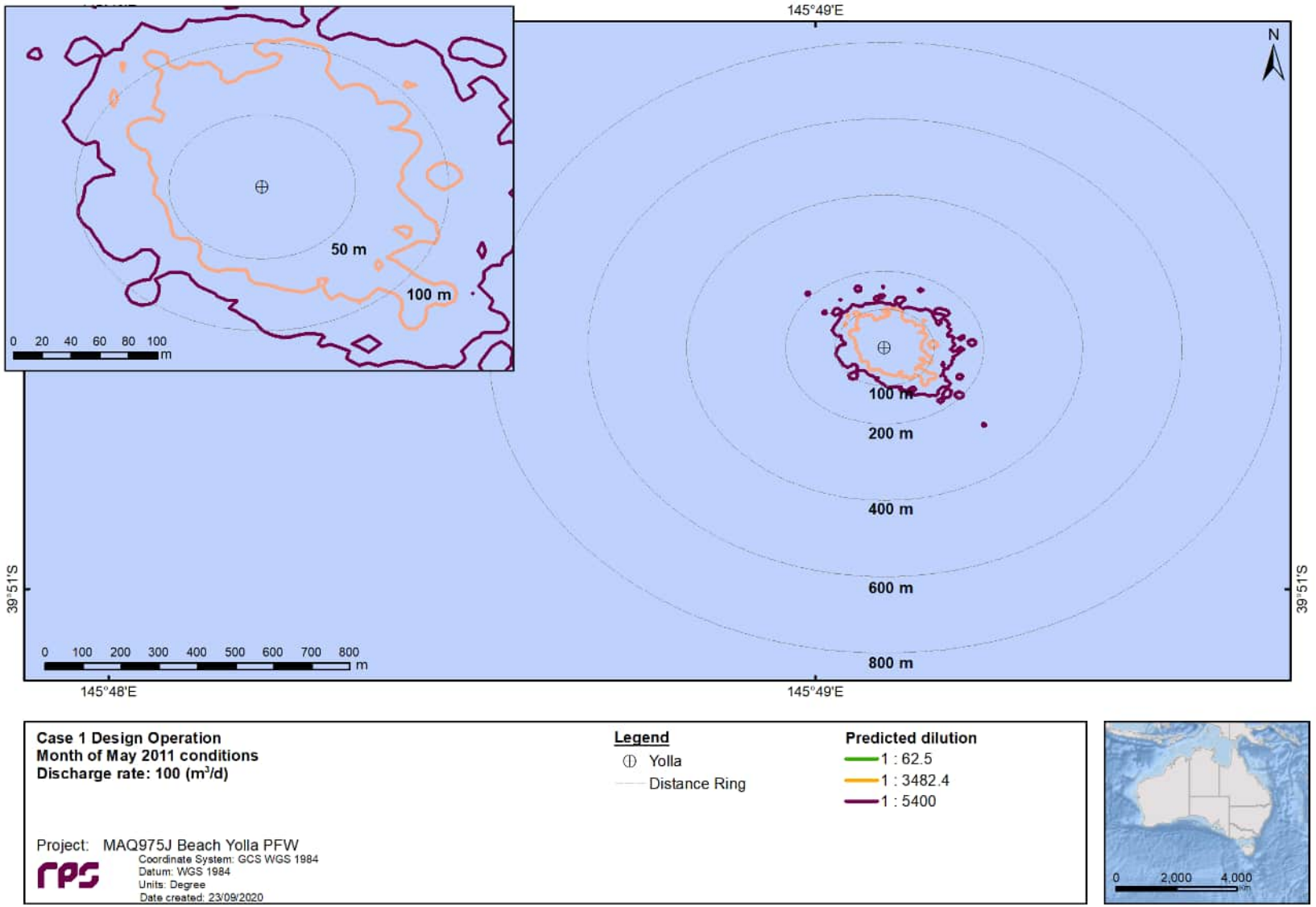


**Figure 7.1 Predicted zones of dilution for the whole PW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 100 m$^3$/day over 31-days during May conditions representing design operation (Case 1).**

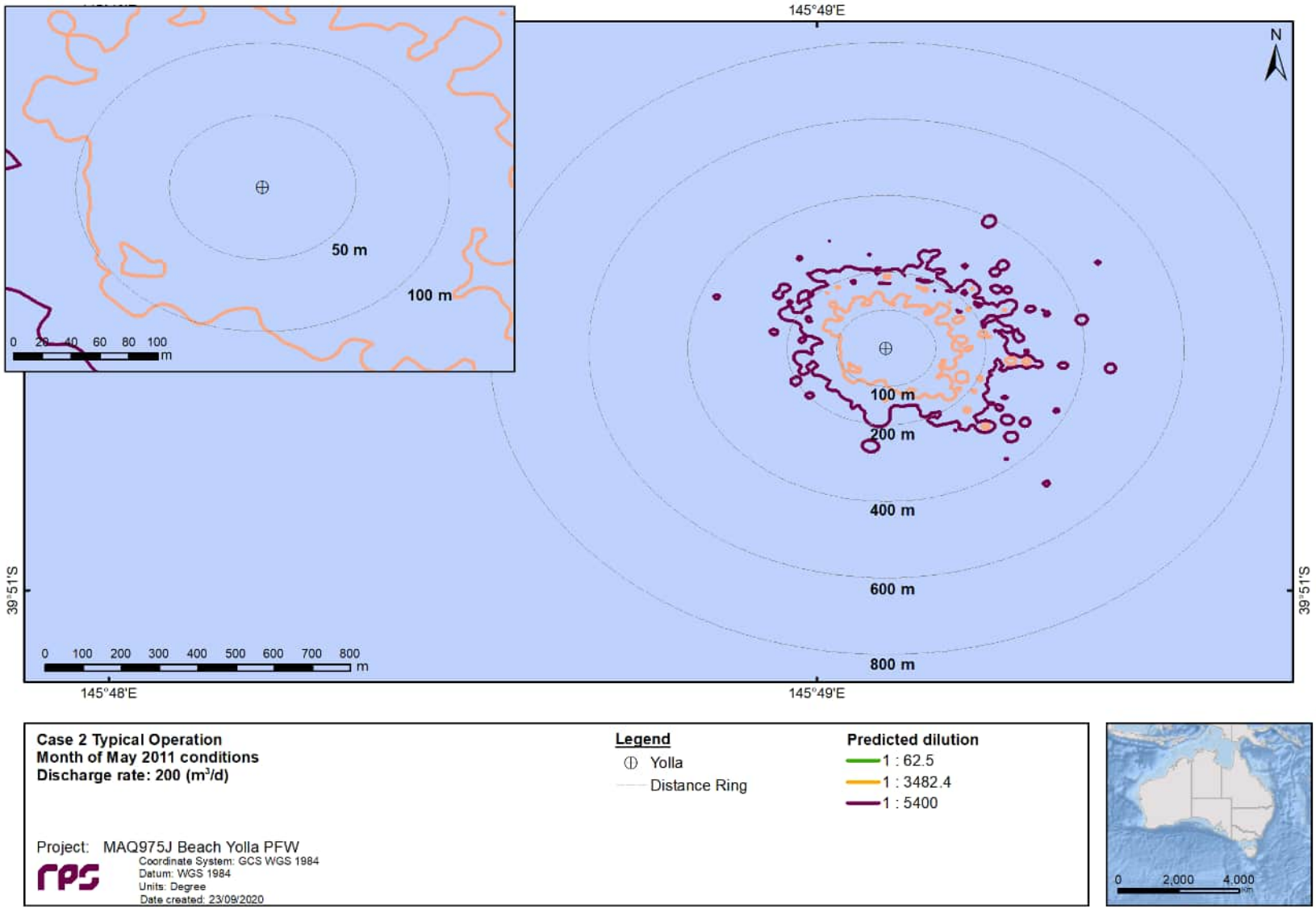


**Figure 7.2 Predicted zones of dilution for the whole PFW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 200 m$^3$/day over 31-days during May conditions representing typical operation (Case2).**

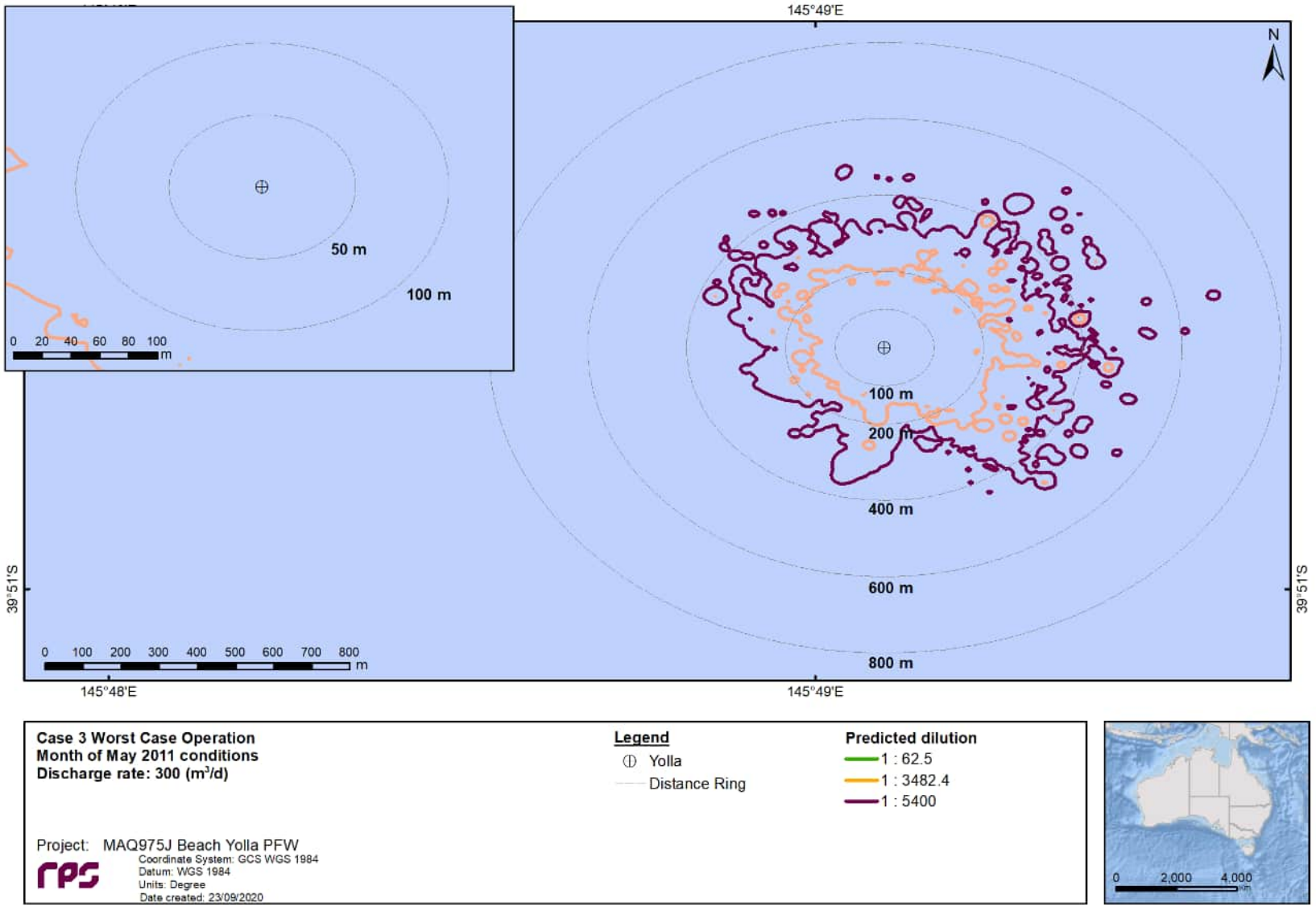


**Figure 7.3 Predicted zones of dilution for the whole PFW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 300 m$^3$/day over 31-days during May conditions representing worst case operation (Case 3).**

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# Appendix I

## Beach Yolla Platform Produced Water Dispersion Modelling (RPS, 2025)

# YOLLA PLATFORM

## Produced Water Dispersion Modelling

GOC384054
23 May 2025
Rev 2

rpsgroup.com

## Document status

| Version | Purpose of document | Authored by | Reviewed by | Approved by | Review date |
|---|---|---|---|---|---|
| Rev A | Internal Draft | L. Perez | N. Benfer | N. Benfer | 4/04/2025 |
| Rev 0 | Draft issued to client | | | N. Benfer | 4/04/2025 |
| Rev 1 | Additional scenario added | L. Perez<br>N. Benfer | L. Perez | N. Benfer | 30/04/2025 |
| Rev 2 | Assessed new thresholds | L. Perez | | N. Benfer | 23/05/2025 |

## Approval for issue

| | | |
|---|---|---|
| Nathan Benfer | | 23 May 2025 |

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# Contents

**EXECUTIVE SUMMARY** ..... **V**
Near-Field Modelling ..... v
Far-Field Modelling ..... v

**1 INTRODUCTION** ..... **1**
1.1 Background ..... 1

**2 SCOPE OF WORK** ..... **3**

**3 DESCALING ACTIVITIES DISCHARGE IMPACT** ..... **4**

**4 MODELLING METHODOLOGY** ..... **5**
4.1 Near-Field Modelling ..... 5
4.1.1 Overview ..... 5
4.1.2 Description of Near-Field Model: CORMIX ..... 5
4.1.3 Setup of Near-Field Model ..... 6
4.2 Far-Field Modelling ..... 9
4.2.1 Overview ..... 9
4.2.2 Description of Far-Field Model: MUDMAP ..... 9
4.2.3 Stochastic Modelling ..... 9
4.2.4 Setup of Far-Field Model ..... 10
4.2.5 Regional Ocean Currents ..... 12

**5 MODELLING RESULTS** ..... **19**
5.1 Near-Field Modelling ..... 19
5.1.1 Overview ..... 19
5.2 Far-Field Modelling ..... 27
5.2.1 Overview ..... 27
5.2.2 Stochastic Analysis ..... 27

**6 REFERENCES** ..... **1**

# Tables

Table 1-1 Location of the Yolla Platform used as the release site for the PFW dispersion modelling assessment. ....1
Table 4-1 CORMIX mixing zones. ....5
Table 4-2 Summary of the PFW discharge characteristics. ....7
Table 4-3 Average seasonal temperature and salinity levels adjacent to the Yolla Platform location. ....7
Table 4-4 Adopted ambient current conditions adjacent to the Yolla Platform location. ....8
Table 4-5 Summary of PFW discharge modelling assumed for far-field modelling. ....10
Table 4-6 Predicted monthly average and maximum surface current speeds close to the release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2010-2019. ....16
Table 5-3 Maximum distance from the PFW discharge location to achieve threshold dilutions. ....27

# Figures

Figure 1-1 Location of the Yolla Platform. ....2
Figure 3-1 Time-series of density and oil in water measurements taken in the PFW outlet during normal and descaling activities. Image provided by Beach. ....4
Figure 4-1 Conceptual diagram showing the general behaviour of a positively buoyant discharge discharged vertically into receiving water moving due to current. ....6
Figure 4-2 Monthly salinity and temperature profiles at the Yolla Platform ....8
Figure 4-3 Example HYCOM averaged seasonal surface drift currents during summer (top) and winter (bottom). ....13
Figure 4-4 Zoomed in view of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh. ....14
Figure 4-5 Bathymetry defined throughout the tidal model domain. ....15
Figure 4-6 Monthly surface current rose distributions at the release location derived from the 2010 to 2019 modelled dataset. ....17
Figure 4-7 Total surface current rose plot at the release location derived from the 2010 to 2019 modelled dataset. ....18
Figure 5-1 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....21
Figure 5-2 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....21
Figure 5-3 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....22
Figure 5-4 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....22
Figure 5-5 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....23
Figure 5-6 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 200 $m^3$/d at discharge height of 45 m below the sea surface. ....23
Figure 5-7 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....24
Figure 5-8 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....24
Figure 5-9 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....25
Figure 5-10 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....25
Figure 5-11 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. ....26

Figure 5-12 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 300 $m^3$/d at discharge height of 45 m below the sea surface. .....26
Figure 5-13 95$^{th}$ percentile dilution for a PFW discharge at 200 $m^3$/d. Results refer to annual conditions. .....28
Figure 5-14 95$^{th}$ percentile dilution for a PFW discharge at 300 $m^3$/d. Results refer to annual conditions. .....29

# EXECUTIVE SUMMARY

Beach Energy (Beach) is updating their Environment Plan (EP) for operations in the Yolla field. This field is situated within production licence T/L1, located 147 km south of Kilcunda (Victoria) in Bass Strait.

As part of their operations Beach is discharging produced formation water (PFW) continuously into the ocean. The PFW is water from the reservoir that is intimately mixed with oil and various organic and inorganic compounds such as heavy metals and minerals from the geological formations. Additionally, Beach will be periodically injecting a descaling agent (GLDA) into the reservoir to reduce resistance in the flowlines.

Whole effluent toxicity testing was carried for the PFW stream both with and without the presence of the GLDA, and the 99% species protection dilution thresholds were determined to be 1,961 and 19,608 dilutions, respectively. In order to achieve 95% species protection dilution thresholds decreased to 526 and 7,143 respectively.

RPS was commissioned to conduct a dispersion modelling study considering both the base case (200 $m^3$/day) and future case (300 $m^3$/day) discharge of PFW at a depth of 45 m below mean sea level.

To accurately determine the dilution of the PFW discharge and the total potential area of influence the effect of initial mixing generated by the discharge jet and buoyancy effects (near-field mixing) must be considered first. Subsequent dispersion of the remnant plume by ambient currents and turbulent forces in the water column (far-field dispersion) must then be considered where near-field mixing is inadequate to meet required dilutions. Different modelling approaches are required for calculating near-field and far-field dilutions due to the differing time and space scales that are involved. Rates of both near-field mixing and far-field dispersion will vary with prevailing currents. Hence, calculations must assess for variability in prevailing currents around the discharge site.

The potential area that may be influenced by the PFW discharge stream was assessed on an annual basis. The following details summarise the findings of this study.

## Near-Field Modelling

- Under strong currents, the distance where the lower dilution threshold of 526 was reached ranged from 55 m to 62 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 850 m to 1,230 m.
- Under moderate currents, the distance where the lower dilution threshold of 526 was reached ranged from 27 m to 30 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 475 m to 1,400 m.
- Under low currents, the distance where the lower dilution threshold of 526 was reached ranged from 11 m to 12 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 580 m to 1,600 m.

## Far-Field Modelling

- The lower dilution threshold (526) was observed within approximately 10 m and 12 m for the Base Case and Future Case, respectively.
- The dilution threshold of 7,143 was observed within approximately 29 m and 37 m for the Base Case and Future Case, respectively.
- The dilution threshold of 1,961 was observed within approximately 41 m and 61 m for the Base Case and Future Case, respectively.
- The upper dilution threshold (19,608) was observed within approximately 163 m and 247 m for the Base Case and Future Case, respectively.

# 1 INTRODUCTION

## 1.1 Background

Beach Energy (Beach) is updating their Environment Plan (EP) for operations in the Yolla field. This field is situated within production licence T/L1, located 147 km south of Kilcunda (Victoria) in Bass Strait.

As part of their operations Beach is discharging produced formation water (PFW) continuously into the ocean. The PFW is water from the reservoir that is intimately mixed with oil and various organic and inorganic compounds such as heavy metals and minerals from the geological formations. Additionally, Beach will be periodically injecting a descaling agent (GLDA) into the reservoir to reduce resistance in the flowlines.

Whole effluent toxicity testing was carried for the PFW stream both with and without the presence of the GLDA, and the 99% species protection dilution thresholds were determined to be 1,961 and 19,608 dilutions, respectively. In order to achieve 95% species protection dilution thresholds decreased to 526 and 7,143 respectively.

RPS was commissioned to conduct a dispersion modelling study considering both the base case (200 $m^3$/day) and future case (300 $m^3$/day) discharge of PFW at a depth of 45 m below mean sea level.

**Table 1-1 Location of the Yolla Platform used as the release site for the PFW dispersion modelling assessment.**

| Release Site | Latitude (S) | Longitude (E) | Water Depth (m) |
|---|---|---|---|
| Yolla Platform | 39° 50’ 39.5” | 145° 49’ 5.9” | 80 |

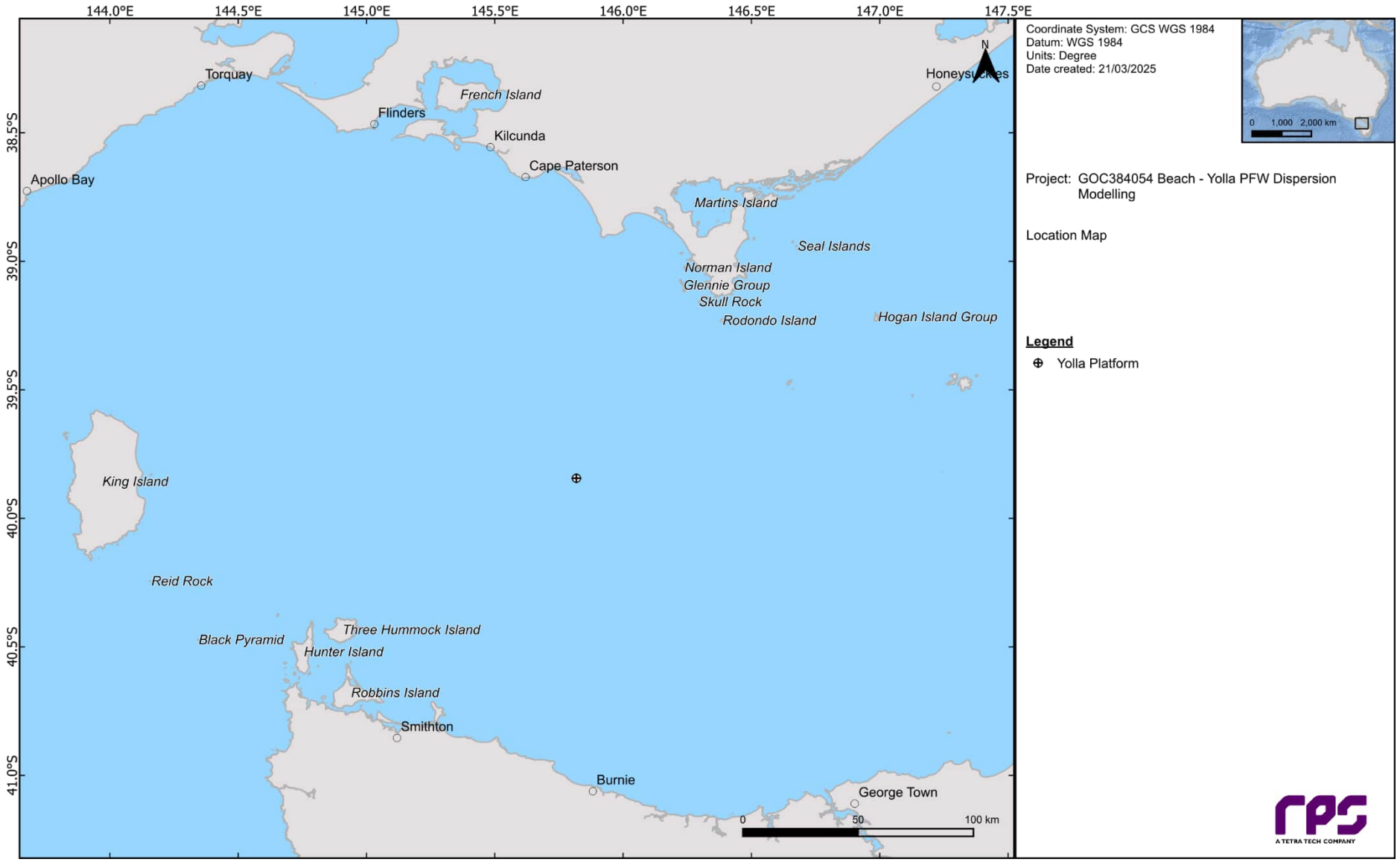


**Figure 1-1 Location of the Yolla Platform.**

# 2 SCOPE OF WORK

The physical mixing and dilution of PFW with receiving waters occur through a series of processes. Initial mixing is generated during what is referred to as the “near-field” mixing zone, which occurs within metres of the discharge and within seconds to minutes. The near-field mixing is strongly affected by characteristics of the discharge configuration. Initial mixing is generated by turbulence generated as the discharge, ejected vertically and downwards, plunges due to momentum. As the plume descends, momentum will be lost due to the energy required to displace receiving water. If there is a lateral current, the centreline of the plume will bend in the direction of the current flow. Once downward momentum is lost, the fate of the plume will depend upon the plume density. If the plume remains buoyant relative to receiving water (i.e. warmer and/or at lower salinity than the receiving water), the plume will rise, undergoing further mixing by entrainment of ambient water, until either neutral density is reached or the plume collapses into a layer below the water surface. At this point, the plume is considered to enter the far-field mixing zone, where subsequent mixing is generated by water currents and turbulence in the water column.

The following scope of work was completed to assess dilution through near-field and far-field dilution phases:

- Collation of three-dimensional, spatially varying, current data for the waters surrounding the release location. Data spanning ten-years (2010-2019) was compiled by combining a hindcast from an ocean circulation model (HYCOM) with a high-resolution tidal model (HYDROMAP). The current dataset included the combined influence of drift and tidal currents and was suitably long as to be indicative of interannual variability in ocean currents.

- Derivation of statistical distributions for the current speed and directions for use in the near-field modelling. Analyses included percentile distributions and development of current roses. This analysis was important to ensure that current data samples applied in the dispersion model were statistically representative.

- Collation of vertical water density profiles at the Yolla Platform location for use as input to the dispersion models.

- Near-field modelling conducted for each unique discharge to assess the initial mixing of the discharge due to turbulence and subsequent entrainment of ambient water. This modelling was conducted at high spatial and temporal resolution (scales of metres and seconds, respectively).

- Outcomes from the near-field modelling included estimates of the width, shape and orientation of the plumes, and resulting contaminant concentrations and dilutions, for each discharge at a range of incident current speeds.

- Establishment of a far-field dispersion model to calculate dispersive mixing and dilution under currents and turbulence.

- Calculations for the transport and dispersive mixing of the remnant plume (remaining beyond the near-field zone) under a wide range of local current conditions by stochastic modelling (i.e. repeated simulations with each simulation using a unique time-sequence of current flow, chosen at random from the 10-year time series of current data).

- Analysis and mapping of areas that might be exposed to different levels of dilution.

# 3 DESCALING ACTIVITIES DISCHARGE IMPACT

Descaling involves the use of a chemical for the removal of scale deposits that accumulate in the wellbore and production equipment and pipelines due to the high mineral content of the PFW. Whilst the flowback of descaling activities is an isolated non-continuous discharge, contrasting with the PFW discharge, its impact on the surrounding waters was initially assessed through in-situ measurements taken at the PFW outlet. Even though the descaling chemical is not a hydrocarbon, it has a fluorescence which triggers the oil in water (OIW) instrumentation.

Measurements taken during activities conducted in November 2024 revealed changes in both density and OIW measurements, which were validated by samples of the stream. Density and OIW time-series showed a peak occurring immediately after the discharge, followed by a decay back to baseline readings approximately 13 hours later. WET tests performed to the samples collected in the same period also align with the peak OIW and density in-situ measurements. The density and OIW time-series are depicted in Figure 3-1.

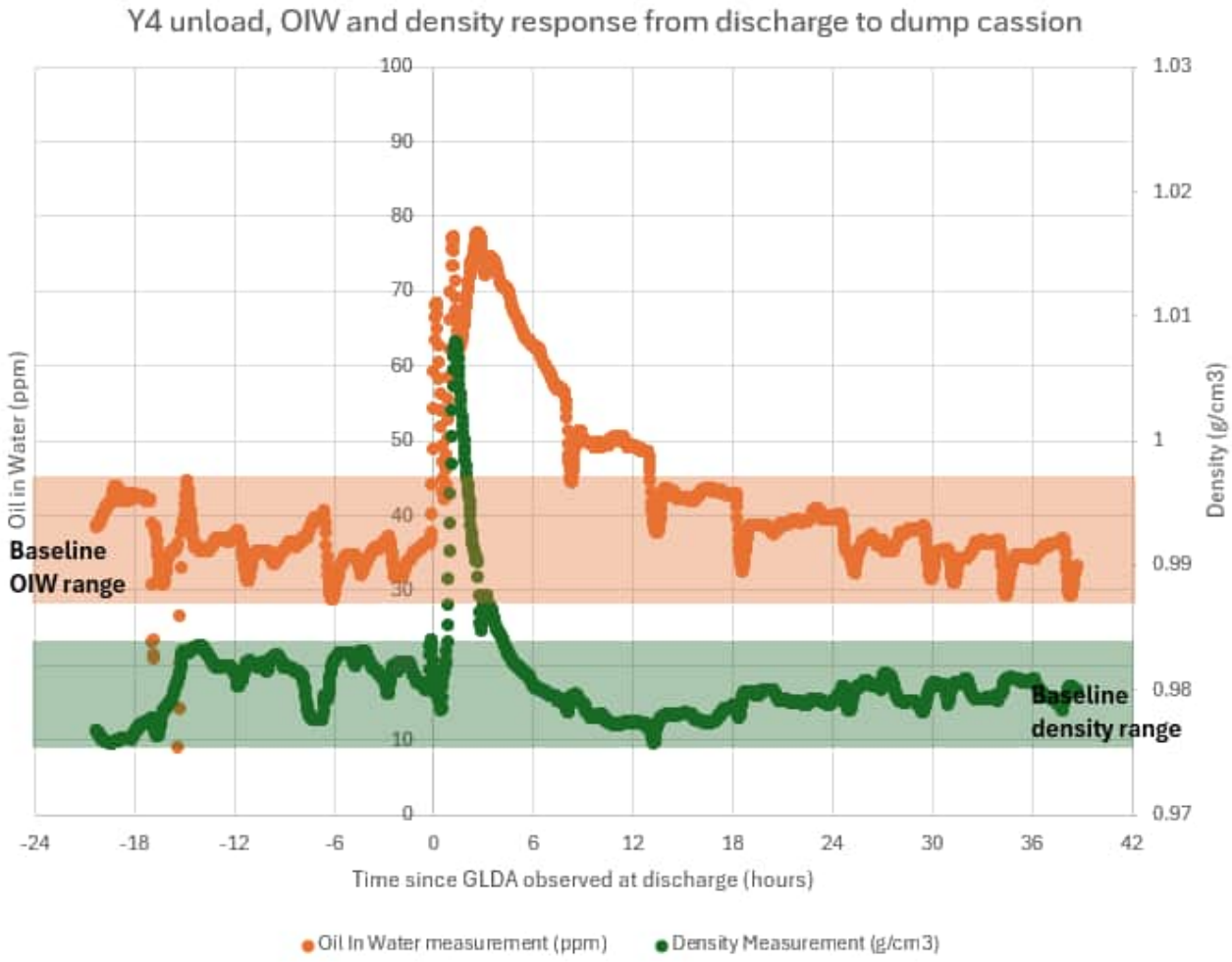


**Figure 3-1 Time-series of density and oil in water measurements taken in the PFW outlet during normal and descaling activities. Image provided by Beach.**

# 4 MODELLING METHODOLOGY

## 4.1 Near-Field Modelling

### 4.1.1 Overview

Numerical modelling was applied to quantify the area of influence of PFW discharges, in terms of the distribution of the minimum dilutions that might occur with distance from the source given defined discharge configurations, source concentrations, and the range of metocean conditions that affect the discharge location.

The dispersion of the PFW discharge will depend, initially, on the geometry and hydrodynamics of the discharges themselves, where the induced momentum and buoyancy effects dominate over background processes. This region is generally referred to as the near-field zone and is characterised by variations over short time and space scales. As the discharges mix with the ambient waters, the momentum and buoyancy signatures are eroded, and the background – or ambient – processes become dominant.

The shape and orientation of the discharged water plumes, and hence the distribution and dilution rate of the plume, will vary significantly with natural variation in prevailing water currents. Therefore, to best calculate the likely outcomes of the discharges, it is necessary to simulate discharge under a range of current speeds statistically representative of the Yolla Platform location.

### 4.1.2 Description of Near-Field Model: CORMIX

The near-field mixing and dispersion of the outfall was simulated using the three-dimensional flow model, CORMIX. CORMIX is a mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones. CORMIX contains a series of elements for the analysis and design of single or multi-port discharges. Discharges may be submerged or above surface, buoyant or denser than receiving water and the receiving water may be stratified or unstratified. The emphasis of the model is the influence of the geometry and dilution characteristics on the initial mixing zone (Doneker and Jirka, 1990; Jirka et al., 1991). CORMIX is widely applied worldwide and has been validated in many independent studies (http://www.cormix.info/validations.php).

CORMIX is a collection of analytic solutions to simplified forms of the mathematical equations describing transport and dispersion of water borne constituents. The simplifications come about through a range of assumptions about the source configuration, source characteristics (discharge and buoyancy) and the ambient environment. These assumptions effectively limit the domain within which the analytic solutions apply. For the typical outfall source flow, two main zones can be defined as described in Table 4-1.

Although CORMIX does calculate far-field dispersion, the assumptions of the algorithms limit application to homogeneous environments with no eddies in the ambient flow and little recirculation. For this reason, the CORMIX component of the calculations for this study were limited to the near-field zone.

**Table 4-1 CORMIX mixing zones.**

| Zone | Description |
|---|---|
| Near-field | Jet characteristics, momentum flux, buoyancy flux and outfall geometry influence the plume's trajectory and mixing. |
| Far-field | Ambient conditions control the plume's trajectory and dilution due to density current buoyant spreading and ambient turbulence. |

CORMIX specifies the average dilution or bulk dilution (flux averaged) as 1.7 times the centreline dilution. The centreline is defined by the points of maximum concentration (maximum temperature, minimum dilution etc) at each vertical section along the longitudinal axis. Accordingly, centreline depth is defined as the depth of the maximum concentration point (maximum temperature, minimum dilution) along the longitudinal axis.

Figure 4-1 shows a conceptual diagram of the dispersion and fates of a positively buoyant discharge and the idealised representation of the discharge phases.

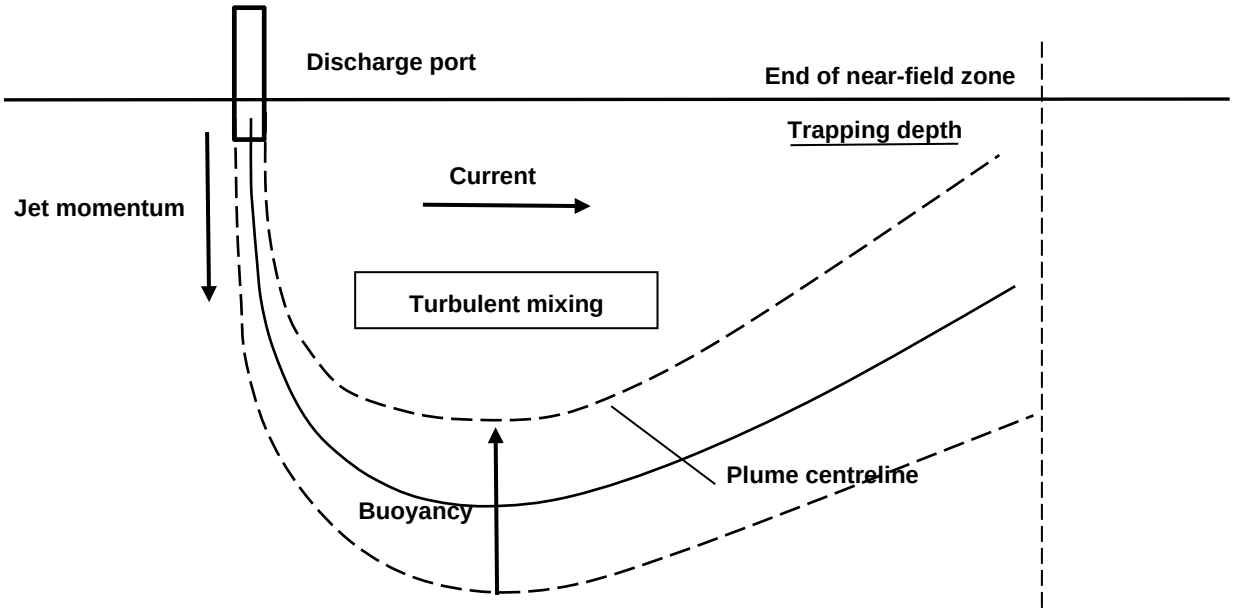


**Figure 4-1 Conceptual diagram showing the general behaviour of a positively buoyant discharge discharged vertically into receiving water moving due to current.**

### 4.1.3 Setup of Near-Field Model

#### 4.1.3.1 Discharge Characteristics

The PFW discharge characteristics for the discharge case are summarised in Table 4-2. The discharge is assumed to occur from the Yolla Platform at a discharge rate of either 200 $m^3$/day or 300 $m^3$/day. The PFW is discharged from a 0.73 m diameter pipe pointed vertically downwards and ending 45 m below the water surface. The discharge was assumed to have an average temperature and salinity of 15.3°C and 14.7 parts per thousand (ppt), respectively.

**Table 4-2 Summary of the PFW discharge characteristics.**

| Parameter | Base Case | Maximum Case |
|---|---|---|
| Flow rate ($m^3/d$) | 200 | 300 |
| Location | Yolla Platform | Yolla Platform |
| Duration (min) | Continuous | Continuous |
| Outlet pipe internal diameter (m) | 0.73 | 0.73 |
| Number of Ports | 1 | 1 |
| Outlet pipe orientation | Vertical (downwards) | Vertical (downwards) |
| Discharge Depth (m) | 45 (below MSL) | 45 (below MSL) |
| Discharge salinity (ppt) | 14.7 | 14.7 |
| Discharge temperature (°C) | 15.3 (average) | 15.3 (average) |

### 4.1.3.2 Ambient Environmental Conditions

Inputs of ambient environmental conditions to the CORMIX model included vertical profiles of temperature and salinity for winter (April to October) and summer (November to March) seasons, along with constant current speeds and general direction (per simulation). The temperature and salinity profiles are required to accurately account for the relative buoyancy of the diluting plume, while the current speeds control the intensity of initial mixing and the deflection of the PFW plume. These inputs are described in the following sections.

#### 4.1.3.2.1 Ambient Temperature and Salinity

Temperature and salinity data applied to the near-field modelling were sourced from the World Ocean Atlas 2018 (WOA18) database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration, NOAA) and its co-located World Data Center for Oceanography (Levitus *et al.*, 2013).

Figure 4-2 shows the vertical profiles of temperature and salinity for each month at Yolla Platform. Table 4-3 shows the average water temperature and salinity near surface and seabed at the Yolla Platform location for summer and winter.

**Table 4-3 Average seasonal temperature and salinity levels adjacent to the Yolla Platform location.**

| Season | Depth | Temperature (°C) | Salinity (PSU) |
|---|---|---|---|
| Summer | Near surface | 17.3 | 35.4 |
| | Near seabed | 15.8 | 35.3 |
| Winter | Near surface | 14.4 | 35.4 |
| | Near seabed | 14.4 | 35.4 |

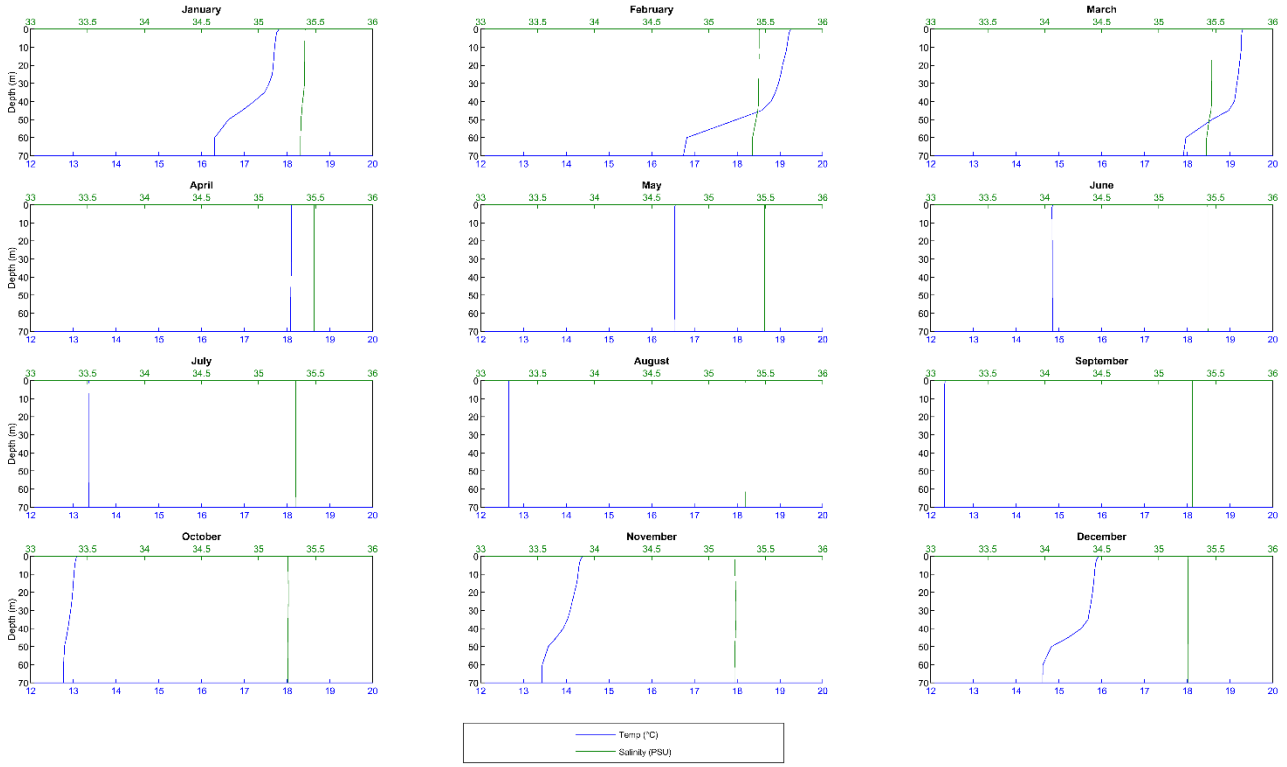


**Figure 4-2 Monthly salinity and temperature profiles at the Yolla Platform**

### 4.1.3.2.2 Ambient Current

Ocean current data was sourced from a ten-year hindcast data set of combined large-scale ocean (HYCOM) and tidal currents. The data was statistically analysed to determine the 5$^{th}$, 50$^{th}$ and 95$^{th}$ percentile current speeds. These statistical current speeds can be considered representative of annual conditions at the location as current speeds did not reveal to be substantially sensitive to seasonality.

Table 4-4 presents the annual steady-state, unidirectional, current speeds at varying depths used as input to the near-field model as forcing for each discharge case:

- 5$^{th}$ percentile current speed: weak currents, low dilution and slow advection.
- 50$^{th}$ percentile (median) current speed: average currents, moderate dilution and advection.
- 95$^{th}$ percentile current speed: strong currents, high dilution and rapid advection to nearby areas.

The 5$^{th}$, 50$^{th}$ and 95$^{th}$ percentile values are referenced as weak, medium and strong current speeds, respectively.

**Table 4-4 Adopted ambient current conditions adjacent to the Yolla Platform location.**

| Season | 5$^{th}$ Percentile (Weak) Current Speed (m/s) | 50$^{th}$ Percentile (Medium) Current Speed (m/s) | 95$^{th}$ Percentile (Strong) Current Speed (m/s) |
|---|---|---|---|
| Annual | 0.04 | 0.17 | 0.42 |

## 4.2 Far-Field Modelling

### 4.2.1 Overview

The far-field modelling expands on the near-field work by allowing the time-varying nature of currents to be included, with the potential for localised build-up when current speeds are low (e.g. at the turning of the tide) and recirculation of the plume back to the discharge location might occur. In this case, concentrations near the discharge point can be increased due to the discharge plume mixing with the remnant plume from an earlier time. This may be a potential source of episodic increases in pollutant concentrations in the receiving waters.

### 4.2.2 Description of Far-Field Model: MUDMAP

The mixing and dispersion of the produced formation water discharges beyond the near-field zone was predicted using the three-dimensional discharge and plume behaviour model, MUDMAP (Koh & Chang, 1973; Khondaker, 2000). MUDMAP predicts the transport and passive dispersion of the discharged material due to the local currents and dispersive forces in the water column. Dispersion of the discharged material will be enhanced with increased current speeds, greater variation in current direction over time and increased wave energy.

The passive dispersion stage employs a particle-based, random walk, procedure. Constituents within the discharge stream are represented by a sample of Lagrangian particles. These particles are moved in three dimensions over each subsequent time step according to the prevailing local current data as well as horizontal and vertical mixing coefficients. Seabed deposition patterns are calculated for particulate sinking material, with sinking rates varying by particle size.

MUDMAP treats the Lagrangian particles as conservative tracers (i.e. they are not removed over time to account for chemical interactions, decay or precipitation). Predicted concentrations will therefore be conservative overestimates where these processes do occur. Each particle represents a proportion of the discharge, by mass, and particles are released at a given rate to represent the rate of the discharge (mass per unit time). Concentrations of constituents are predicted over time by counting the number of particles that occur within a given depth level and grid square and converting this value to mass per unit volume.

The system has been extensively validated and applied for discharge operations in Australian waters for other PFW discharges (e.g. Burns et al., 1999; King & McAllister, 1997, 1998).

### 4.2.3 Stochastic Modelling

A stochastic modelling procedure was applied in the far-field modelling to sample a representative set of conditions that could affect the distribution of constituents. This approach involves 100 simulations of a given discharge, with each simulation representing discharge for 5 days under a different, randomly selected, sequence of current speed and direction data. These sequences were selected at random from the 10-year database of current data for the site. The initial dilution and shape of the discharge was set by the results of the near-field results described in Section 4.1. This methodology ensures that the calculated movement and fate of each discharge is representative of the passive dispersive forces for the range of prevailing currents that occur at the discharge location. Assumed PFW characteristics are summarised in Table 4-5.

Once the stochastic modelling was complete, all simulations were statistically analysed to map distributions of possible outcomes based on likelihood. The stochastic simulations were jointly processed annually (100 replicate simulations). The analysis calculated the frequency of occurrence of a given dilution level, by horizontal location, at surrounding locations. Results were summarised for the 95$^{th}$ percentile dilution over time.

The 95$^{th}$ percentile dilution values do not represent the instantaneous spatial extent of the plume at any single point in time. Instead, they provide a spatially aggregated statistical summary across all model simulations. Specifically, the 95$^{th}$ percentile dilution map shows the minimum dilution level that is met or exceeded 95% of the time during the simulations. In other words, dilution is lower than the mapped values for only 5% of the simulation periods.

This percentile-based approach is particularly relevant for environmental impact assessments. Instantaneous worst-case dilution values can be misleading, as they capture only brief (i.e. less than 1 hr), potentially rare events that are not representative of sustained environmental conditions. Since ecotoxicological studies—such as those used to establish safe concentration thresholds—are based on time-averaged exposure scenarios, a

percentile-based metric like the 95th percentile provides a more meaningful and conservative estimate of potential environmental harm. It aligns more closely with chronic exposure levels rather than transient extremes, making it more suitable for regulatory comparison and ecological risk evaluation.

### 4.2.4 Setup of Far-Field Model

#### 4.2.4.1 Discharge Characteristics

The MUDMAP model simulated the discharge into a time-varying current field with the initial dilution and shape of the discharge set by the near-field results described in Section 4.1. The PFW discharge scenario was modelled as a continuous discharge under time-varying current assuming the initial dilution and density change imposed by the near-field mixing (detailed in Section 5.1).

Table 4-5 presents a summary of the far-field model inputs used to calculate the transport and mixing of the chemical treatment by the ambient currents. As previously mentioned, 100 simulations were run as a representation on annual conditions and each simulation had a different start time, which ensured a range of current conditions were sampled.

**Table 4-5 Summary of PFW discharge modelling assumed for far-field modelling.**

| Parameter | Base Case | Future Case |
|---|---|---|
| Hindcast modelling period | 2010-2019 | 2010-2019 |
| Seasons | Annual | Annual |
| Flow rate ($m^3/d$) | 200 | 300 |
| Initial depth of centreline (m) | 45 | 45 |
| Number of simulations | 100 | 100 |
| Simulated discharge type | Continuous | Continuous |
| Simulated discharge period (days) | 5 | 5 |

### 4.2.4.2 Mixing Parameters

Horizontal and vertical dispersion coefficients in dispersion modelling represent turbulence-driven mixing and diffusion, which occur at sub-grid scales relative to the model's hydrodynamics. These coefficients, expressed in m²/s, govern the rate of area change per second. Increasing the horizontal dispersion coefficient enhances lateral plume spread, reducing centreline concentrations, while increasing the vertical coefficient accelerates downward mixing into the water column.

Horizontal turbulent diffusion depends on metocean conditions (wind, waves and currents) and the plume's scale relative to oceanic dispersion processes. For plumes 10–100 m wide, small-scale swirling motions and vertical mixing dominate, with horizontal dispersion rates near 0.1 m²/s. As the plume's width expands to 1–10 km, mesoscale eddies drive dispersion rates of a few to tens of m²/s. At scales exceeding mesoscale eddies, eddy mixing dominates with dispersion rates of 100–1,000 m²/s.

A spatially uniform and conservative dispersion coefficient of 0.2 m²/s (horizontal) and 0.0001 m²/s (vertical) was applied to control produced water plume spreading. These values were selected through extensive sensitivity testing, ensuring conservative concentration estimates, as in-situ mixing under average and high-energy conditions is expected to be at least an order of magnitude greater (King & McAllister, 1997, 1998).

### 4.2.4.3 Grid Configuration

MUDMAP uses a three-dimensional grid to represent the geographic region under study (water depth and bathymetric profiles). The model was setup, and analysed and mapped on two grid scales, representing the aqueous and particulates components, respectively. Due to the rapid mixing and small-scale effect of the effluent discharge, it was necessary to use a fine grid with a resolution of 5 m x 5 m to track the movement and fate of the aqueous PFW discharge plume. The extent of the grid region measured approximately 5 km (longitude or x-axis) by 5 km (latitude or y-axis), which was subdivided horizontally into approximately 1,000 x 1,000 cells. The vertical resolution was set to 5 m.

## 4.2.5 Regional Ocean Currents

### 4.2.5.1 Background

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area off the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the strait are driven by tides, winds, incident continental shelf waves and density driven flows. High winds and strong tidal currents are frequent within the area (Jones, 1980).

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 4-3 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with surface tidal currents developed by RPS. The following sections provide a summary of the hybrid regional data set.

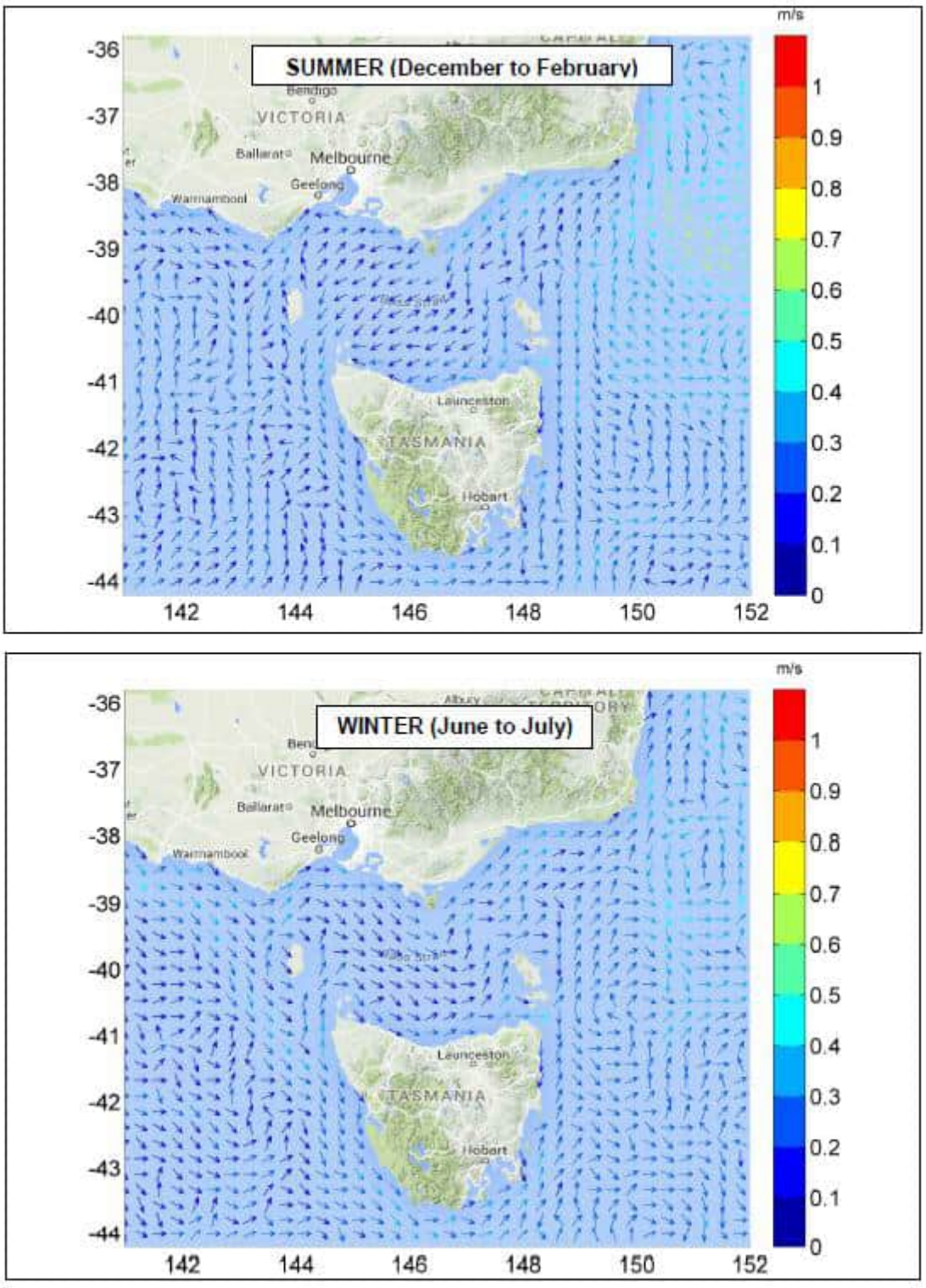


**Figure 4-3 Example HYCOM averaged seasonal surface drift currents during summer (top) and winter (bottom).**

### 4.2.5.1 Tidal Currents

Tidal current data were generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world over the past 38 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data have been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

### 4.2.5.2 Grid Setup

The tidal model domain has been sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids were allocated in a step-wise fashion to resolve flows more accurately along the coastline, around islands and over regions with more complex bathymetry. Figure 4-4 shows the tidal model grid resolutions.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 4-5). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

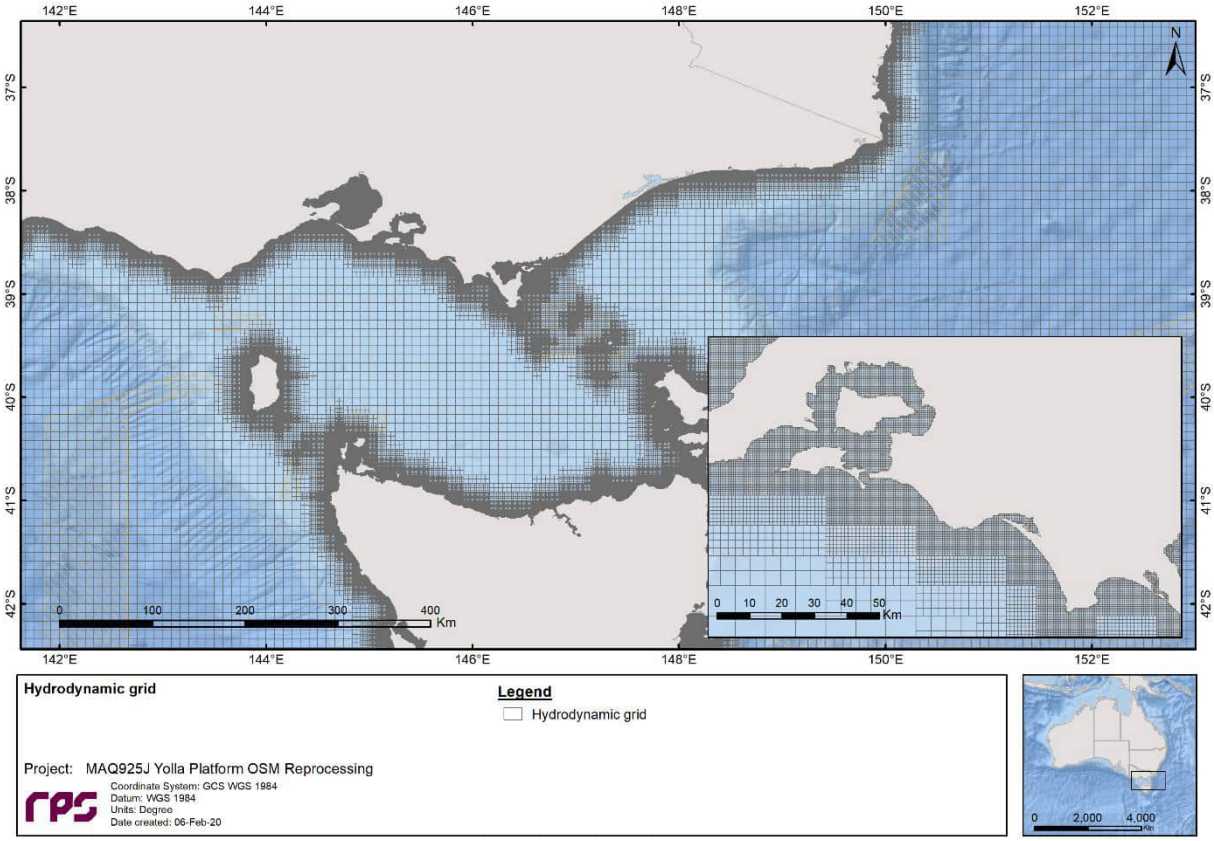


**Figure 4-4 Zoomed in view of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.**

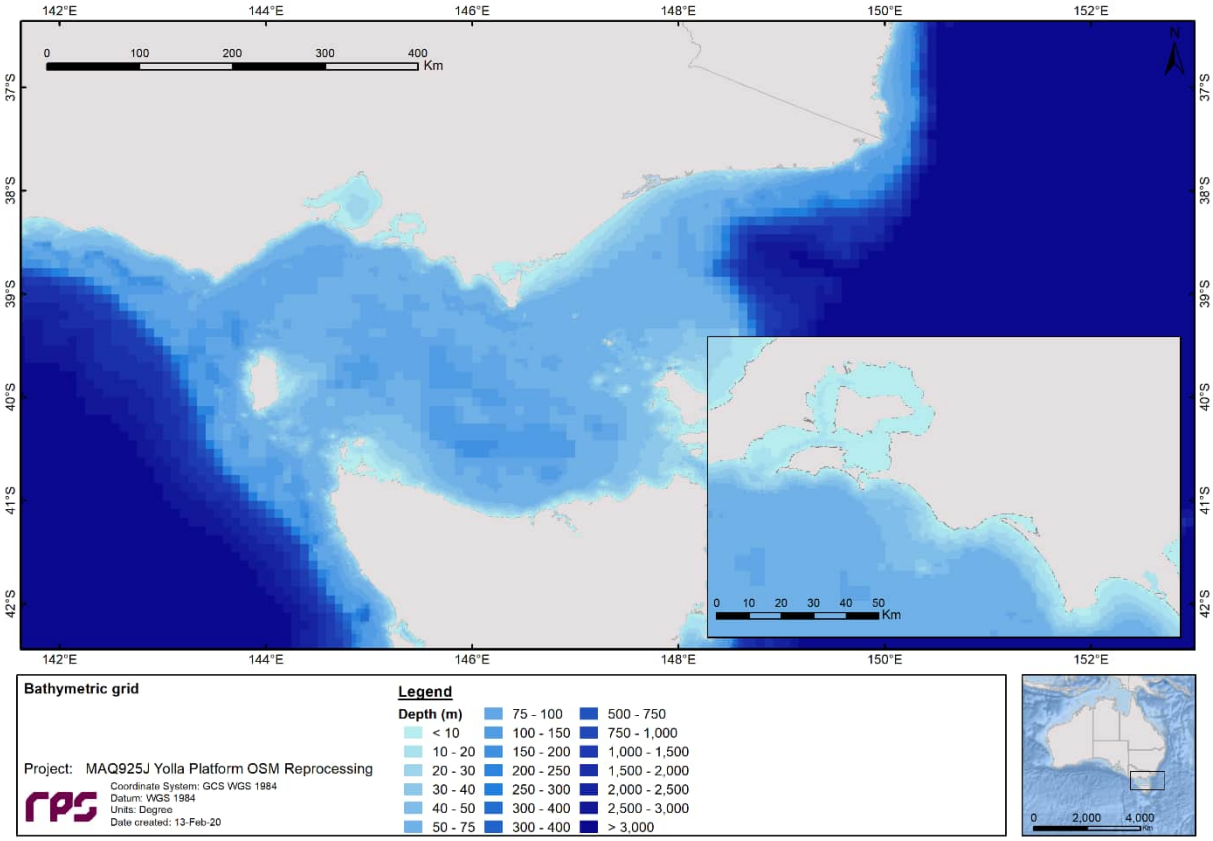


**Figure 4-5 Bathymetry defined throughout the tidal model domain.**

### 4.2.5.3 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 7.2) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were $K_2$, $S_2$, $M_2$, $N_2$, $K_1$, $P_1$, $O_1$ and $Q_1$. Using the tidal data, surface heights were firstly calculated along the open boundaries, at each time step in the model.

The TOPEX/Poseidon satellite data have a global resolution of 0.25 degrees and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The satellites equipped with two highly accurate altimeters and capable of taking sea level measurements with an accuracy of ± 5 cm measured oceanic surface elevations (and the resultant tides) for over 13 years (1992–2005). In total, these satellites carried out 62,000 orbits of the planet.

The TOPEX/Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk and Tangdong, 2004; Qiu and Chen 2010). As such the TOPEX/Poseidon tidal data is considered suitably accurate for this study.

### 4.2.5.4 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the National Ocean Partnership Program (NOPP), as part of the U.S. Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12$^{th}$ of a degree) over the region, at a frequency of every 3 hours. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

For this study, the HYCOM hindcast currents were obtained for the years 2010 to 2019 (inclusive).

Note the convention for defining current direction throughout this report is the direction the current flows towards. Each branch of the current rose distribution represents the currents flowing to that direction, with north to the top of the diagram. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.1 m/s are typically used in these current roses. The length of each coloured segment within a branch is proportional to the frequency of currents flowing within the corresponding speed and direction.

### 4.2.5.5 Surface Currents

Table 4-6 presents the predicted average and maximum monthly surface current speeds at the release location.

Current speeds near the Yolla Platform varied throughout the year with monthly maximum current speeds ranging between 0.61 m/s (January) and 0.98 m/s (July). The dominant surface current directions throughout the year were identified as (towards) the east and east-southeast.

Figure 4-6 and Figure 4-7 present the monthly and total current rose distributions, respectively.

**Table 4-6 Predicted monthly average and maximum surface current speeds close to the release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2010-2019.**

| Month | Average current speed (m/s) | Maximum current speed (m/s) | General direction (towards) |
|---|---|---|---|
| January | 0.18 | 0.61 | Varied |
| February | 0.18 | 0.65 | East-west axis |
| March | 0.17 | 0.75 | East |
| April | 0.17 | 0.75 | East-southeast |
| May | 0.20 | 0.96 | East |
| June | 0.19 | 0.80 | East-southeast |
| July | 0.23 | 0.98 | East-southeast |
| August | 0.21 | 0.91 | East |
| September | 0.20 | 0.78 | East |
| October | 0.18 | 0.70 | East |
| November | 0.18 | 0.67 | East-northeast |
| December | 0.19 | 0.63 | East-northeast |
| **Minimum** | **0.17** | **0.61** | - |
| **Maximum** | **0.23** | **0.98** | - |

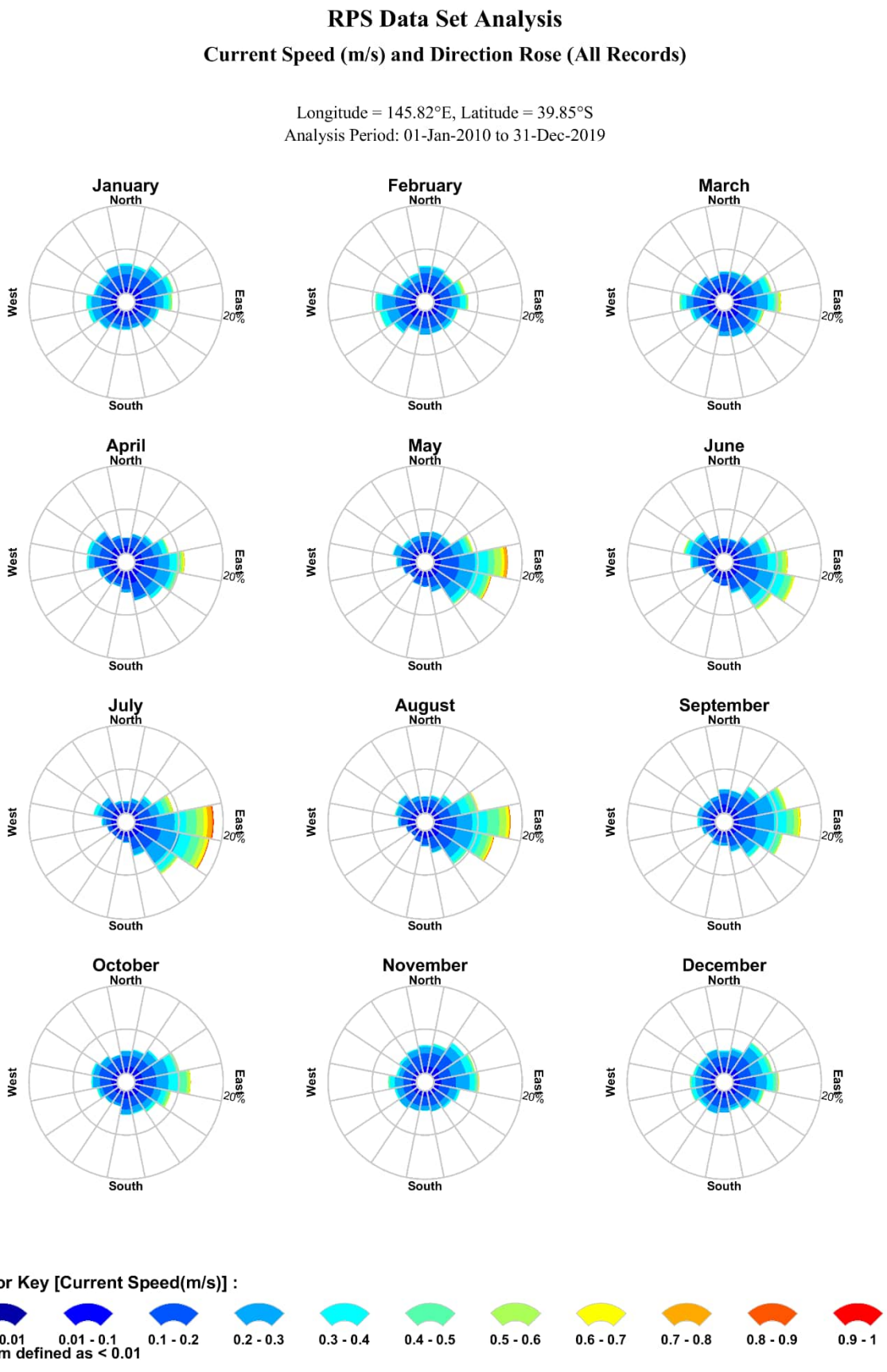


**Figure 4-6 Monthly surface current rose distributions at the release location derived from the 2010 to 2019 modelled dataset.**

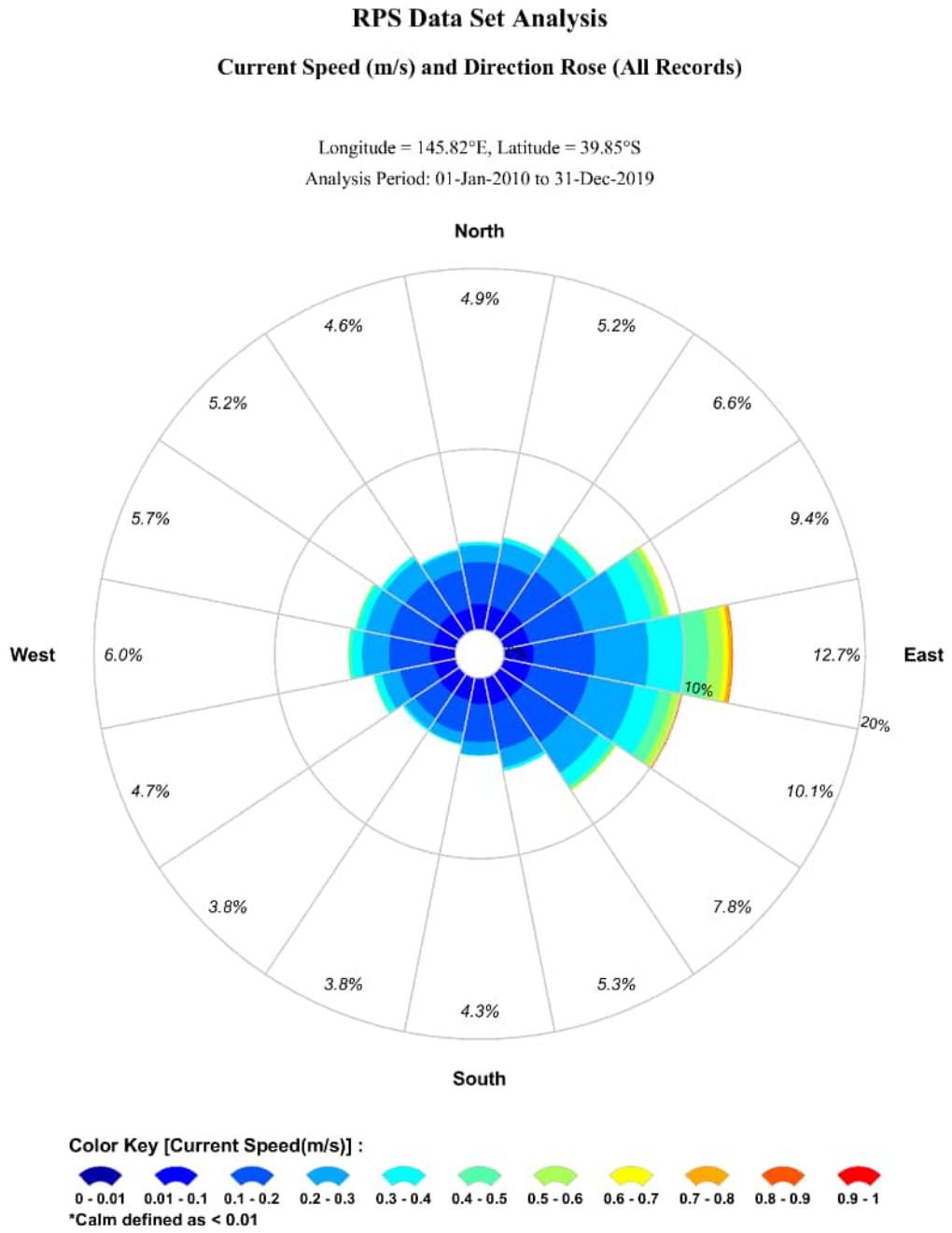


**Figure 4-7 Total surface current rose plot at the release location derived from the 2010 to 2019 modelled dataset.**

# 5 MODELLING RESULTS

## 5.1 Near-Field Modelling

### 5.1.1 Overview

Figure 5-1 to Figure 5-12show the change in minimum dilution of the plume under varying seasons and current speeds (weak, medium and strong). The figures show the predicted horizontal distance travelled by the plume before the trapping depth is reached (i.e. before the plume becomes neutrally buoyant). Please note the differing x-axis and y-axis aspect ratios between the cases to best highlight details for each case.

The plots show the general shape expected for the plume given the discharge characteristics and different current speeds. The downward directed jet is forecasted to briefly plunge and rapidly dilute due to the initial momentum of the discharge, then rise to the water surface.

The plots also show the expected bending of the plume to align with the current direction over the plunge and rise phase. Faster currents speeds are forecasted to result in the plume aligning to the current direction more quickly, commencing during the plunge phase and continuing during the buoyant rise phase.

Under strong currents, the distance where the lower dilution threshold of 526 was reached ranged from 55 m to 62 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 850 m to 1,230 m.

Under moderate currents, the distance where the lower dilution threshold of 526 was reached ranged from 27 m to 30 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 475 m to 1,400 m.

Under low currents, the distance where the lower dilution threshold of 526 was reached ranged from 11 m to 12 m across the different seasons and flow rates, while the higher dilution threshold (19,608) was reached within 580 m to 1,600 m.

Table 5-1 and Table 5-2 summarise the distances from the release location for the threshold dilutions to be reached under high, medium and low currents for each season and flow case.

**Table 5-1 Distances from release location to reach threshold dilutions for the 200 $m^3$/day base case.**

| Current speed condition | Summer | | | | Winter | | | |
|---|---|---|---|---|---|---|---|---|
| | 526 dilutions | 1,961 dilutions | 7,143 dilutions | 19,608 dilutions | 526 dilutions | 1,961 dilutions | 7,143 dilutions | 19,608 dilutions |
| High | 55 | 161 | 400 | 1,230 | 55 | 145 | 400 | 900 |
| Medium | 28 | 83 | 400 | 1,100 | 27 | 73 | 198 | 475 |
| Low | 11 | 27 | 500 | 1,220 | 11 | 27 | 65 | 580 |

**Table 5-2 Distances from release location to reach threshold dilutions for the 300 $m^3$/day future case.**

| Current speed condition | Summer | | | | Winter | | | |
|---|---|---|---|---|---|---|---|---|
| | 526 dilutions | 1,961 dilutions | 7,143 dilutions | 19,608 dilutions | 526 dilutions | 1,961 dilutions | 7,143 dilutions | 19,608 dilutions |
| High | 62 | 182 | 410 | 850 | 58 | 162 | 446 | 1.030 |
| Medium | 30 | 95 | 560 | 1,400 | 29 | 80 | 220 | 503 |
| Low | 12 | 32 | 675 | 1,600 | 12 | 30 | 100 | 981 |

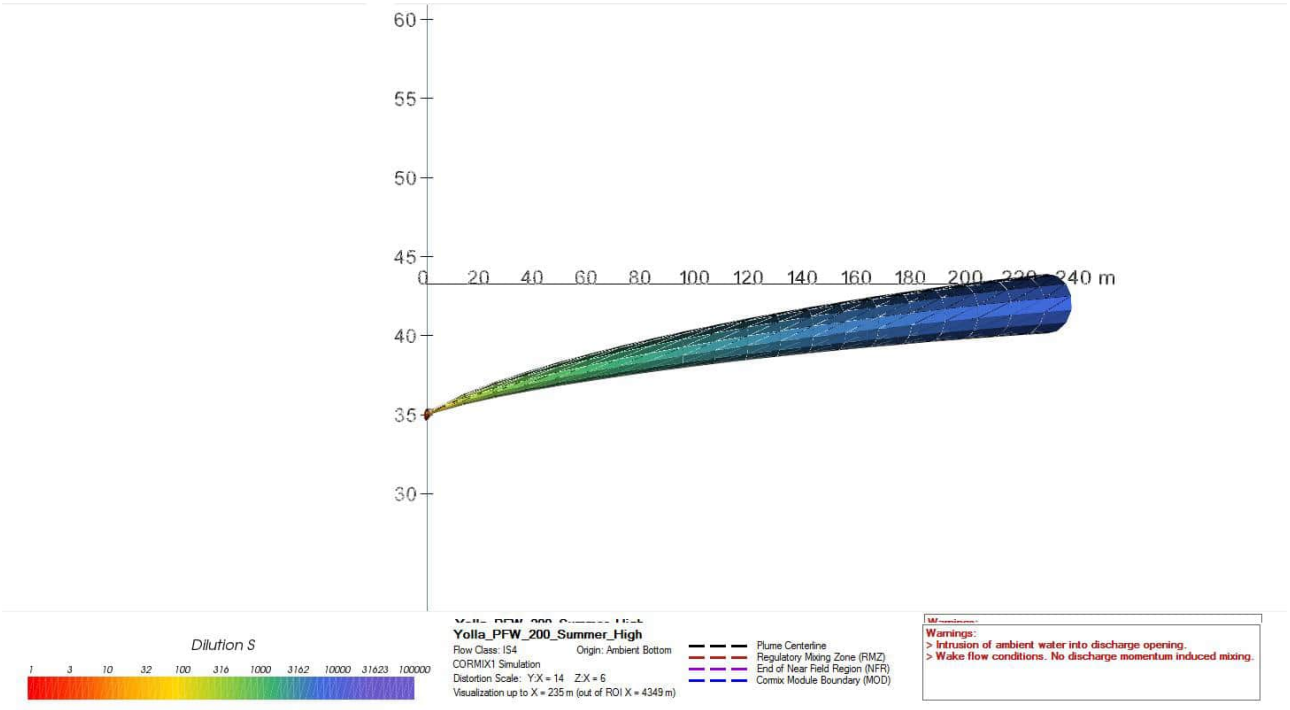


**Figure 5-1 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

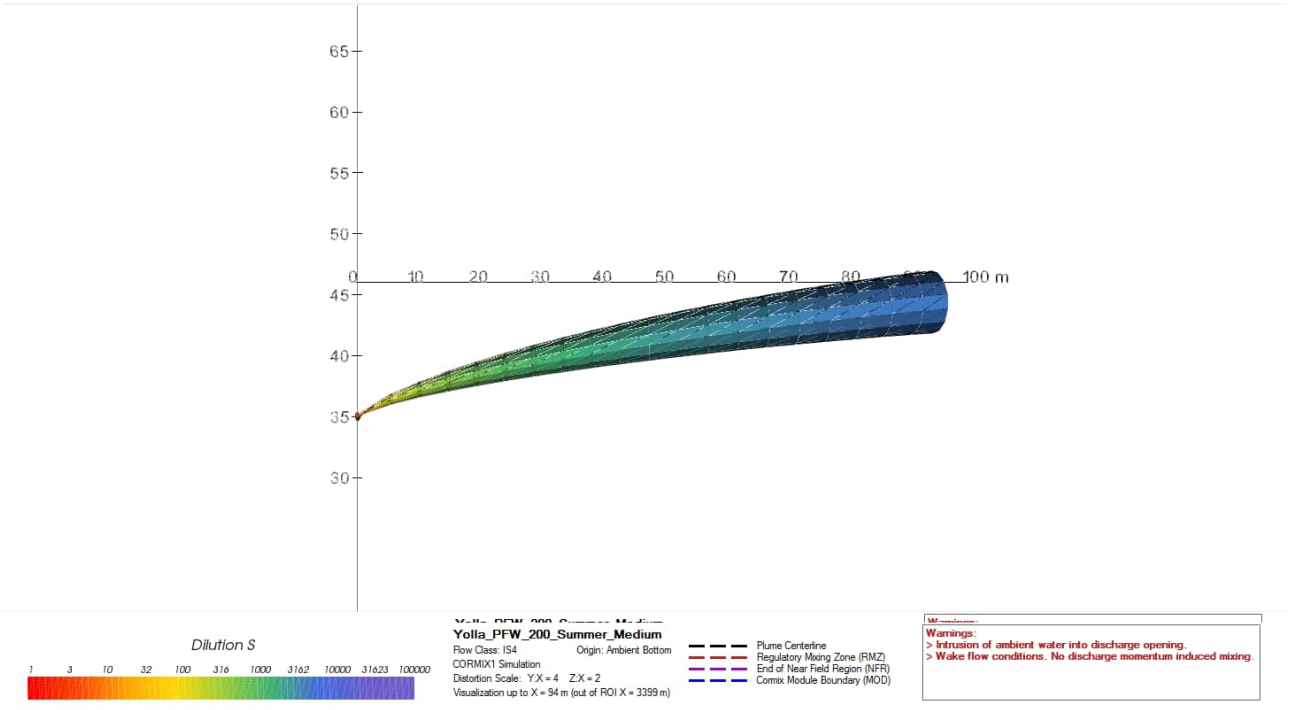


**Figure 5-2 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

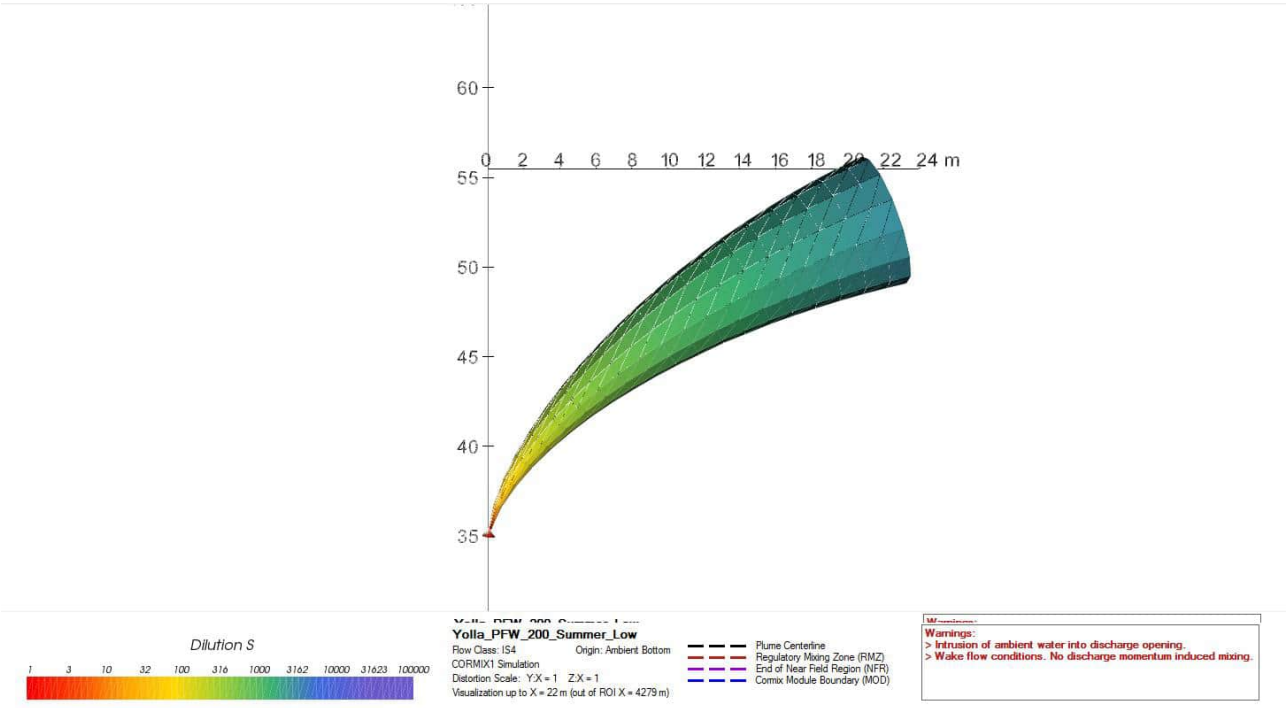


**Figure 5-3 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

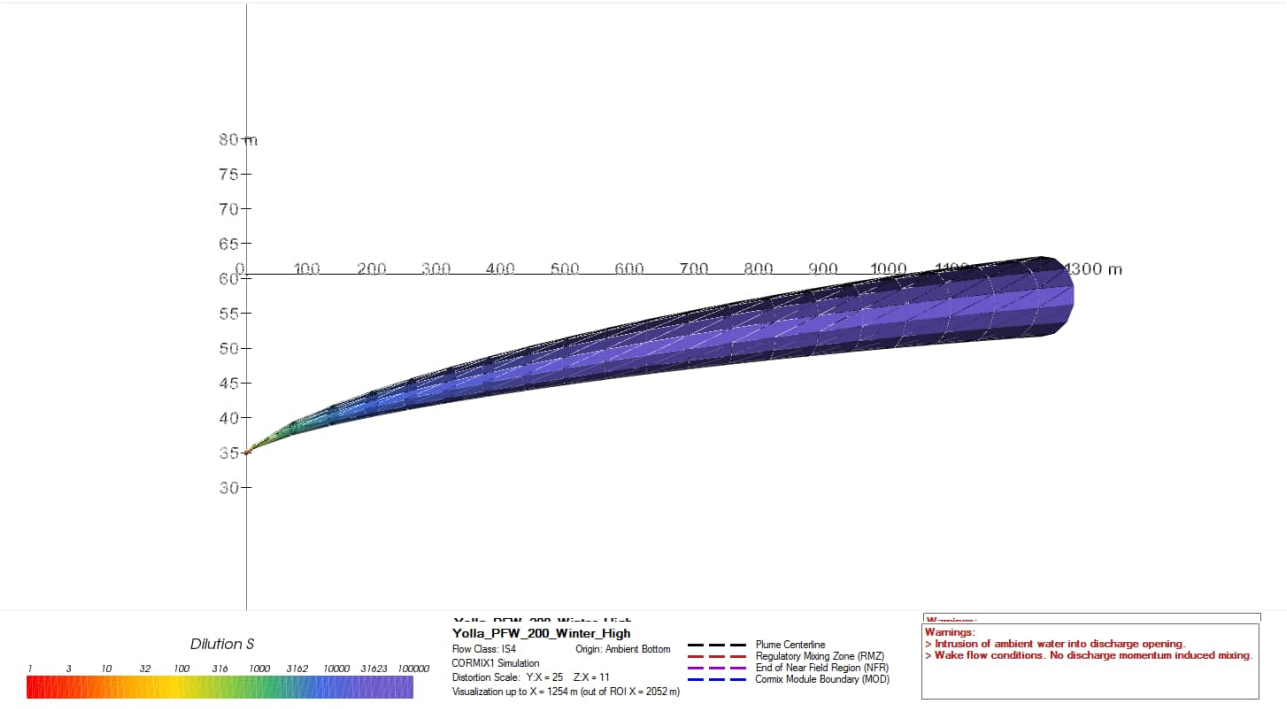


**Figure 5-4 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

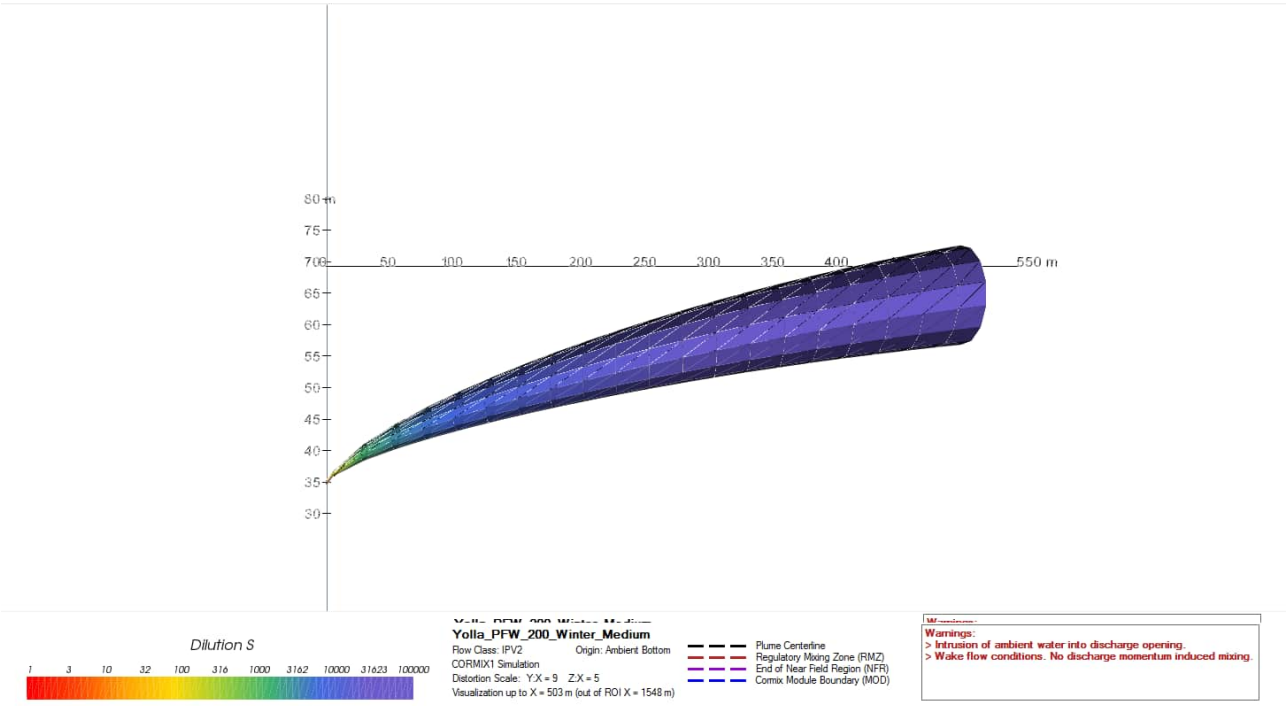


**Figure 5-5 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

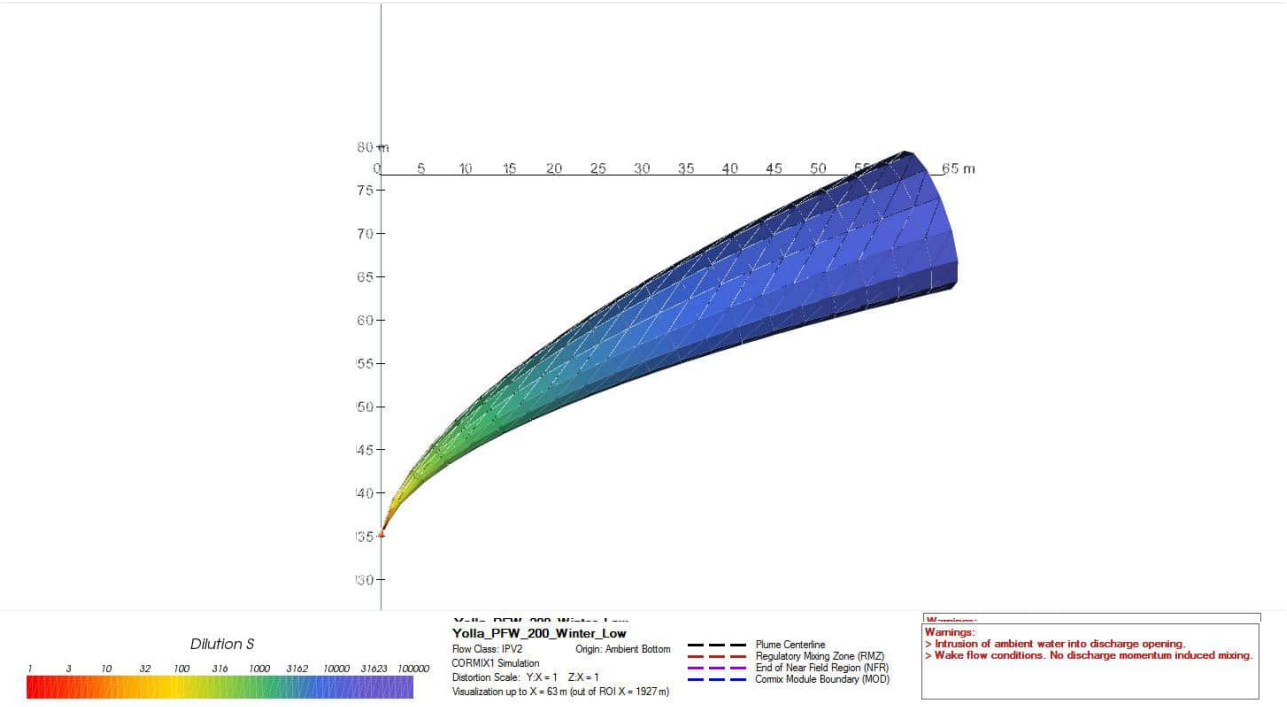


**Figure 5-6 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 200 m$^3$/d at discharge height of 45 m below the sea surface.**

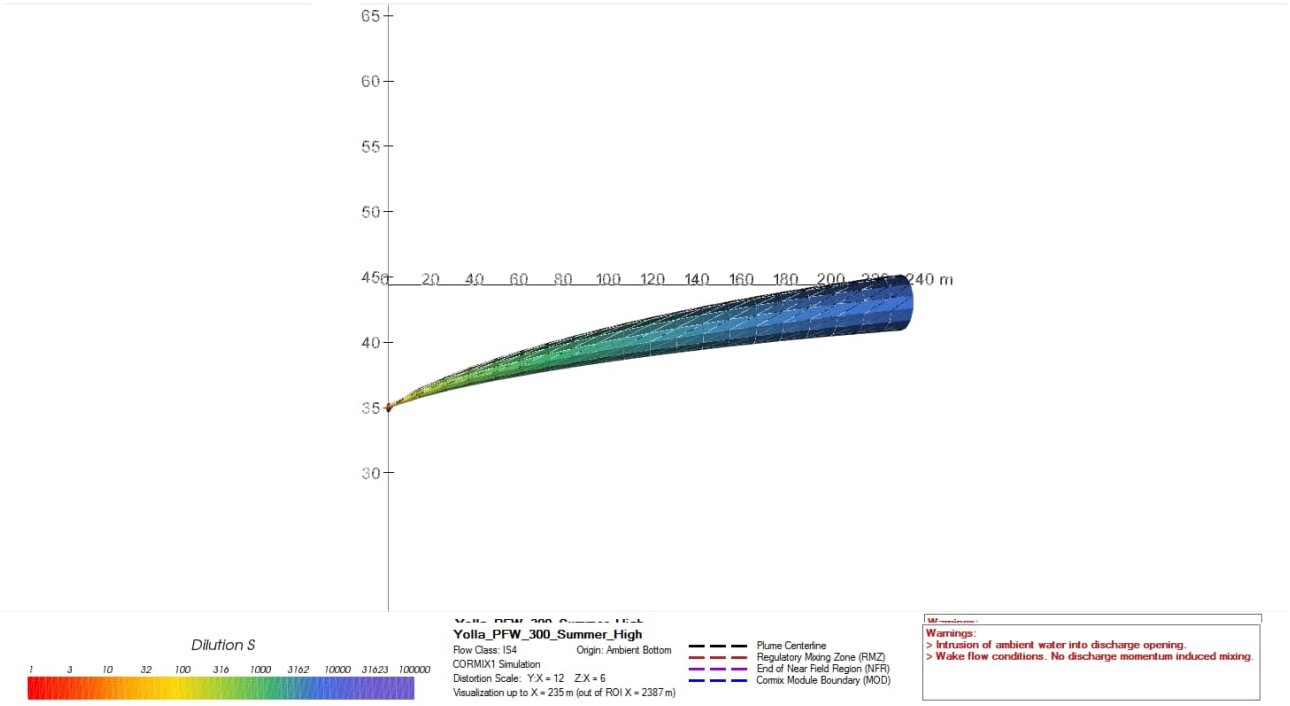


**Figure 5-7 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

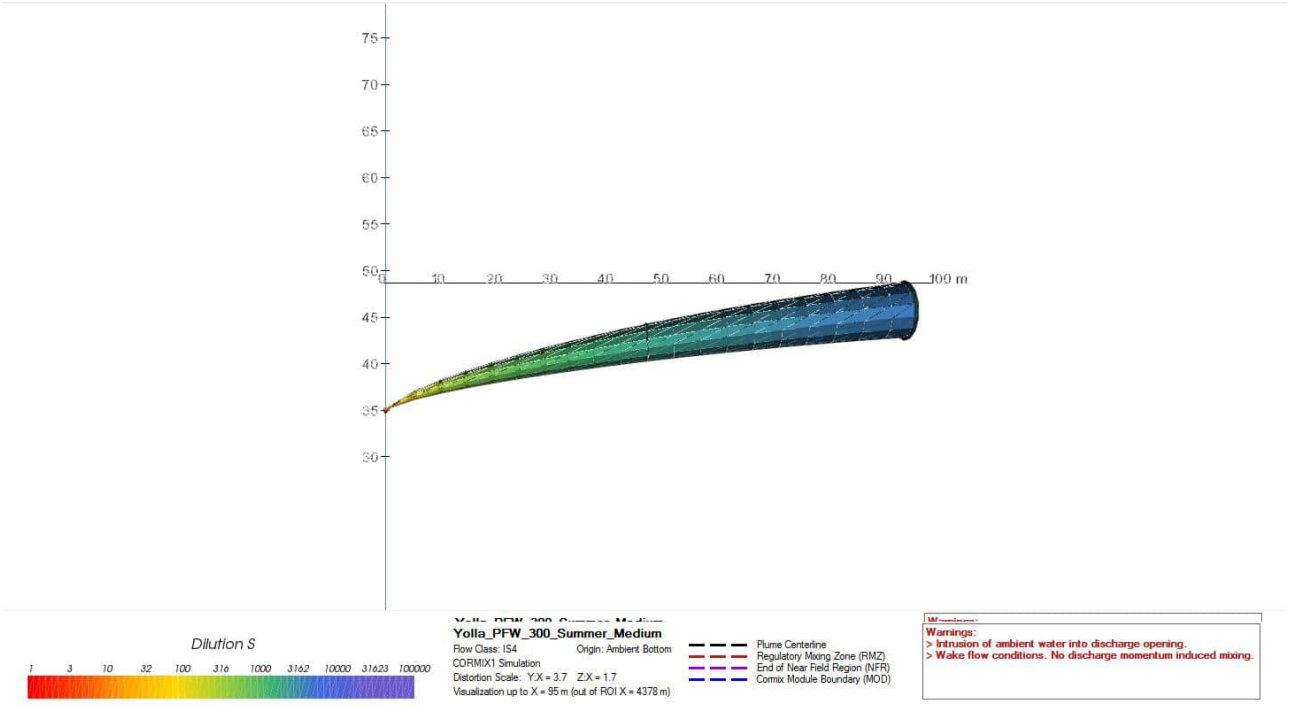


**Figure 5-8 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

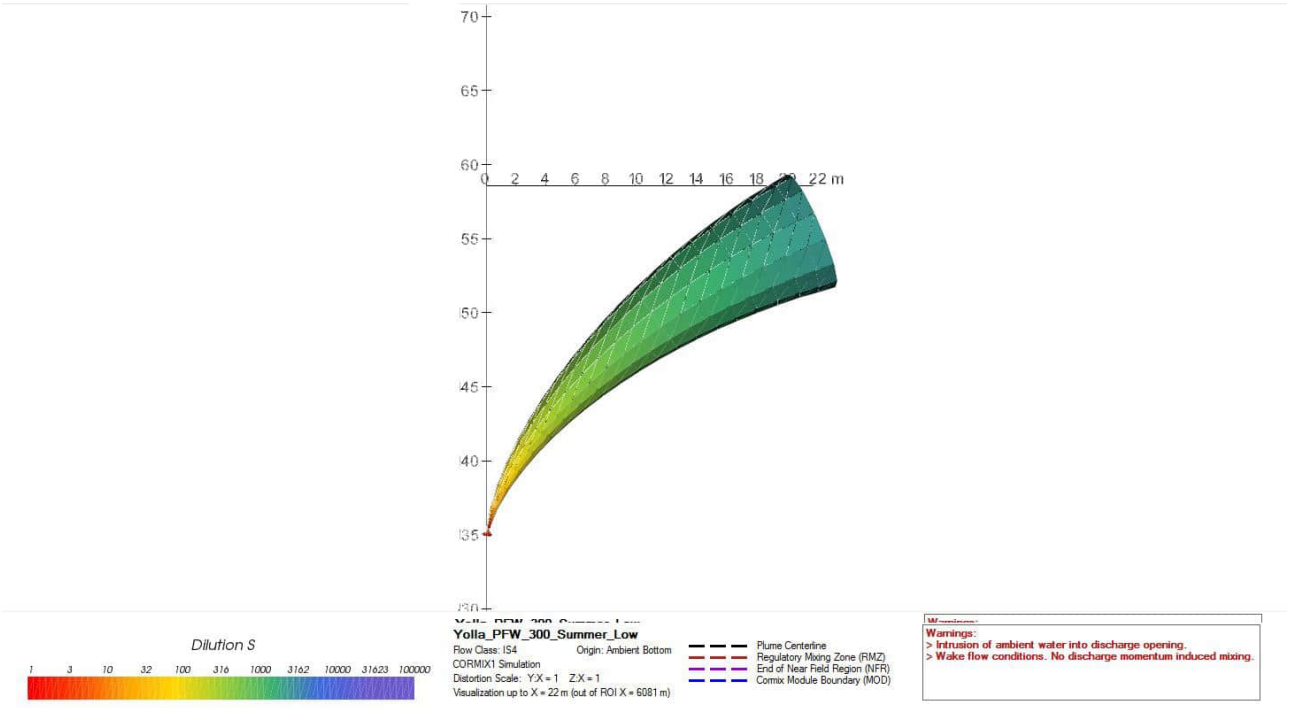


**Figure 5-9 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.**

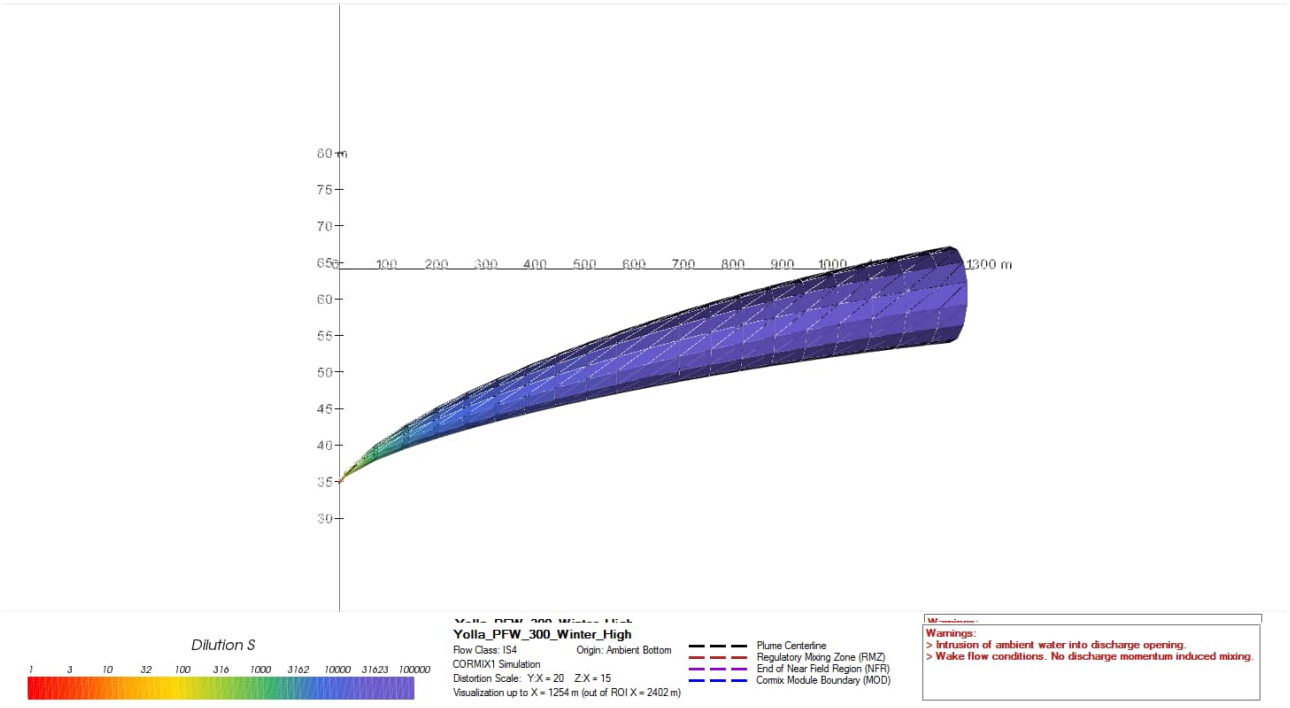


**Figure 5-10 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.**

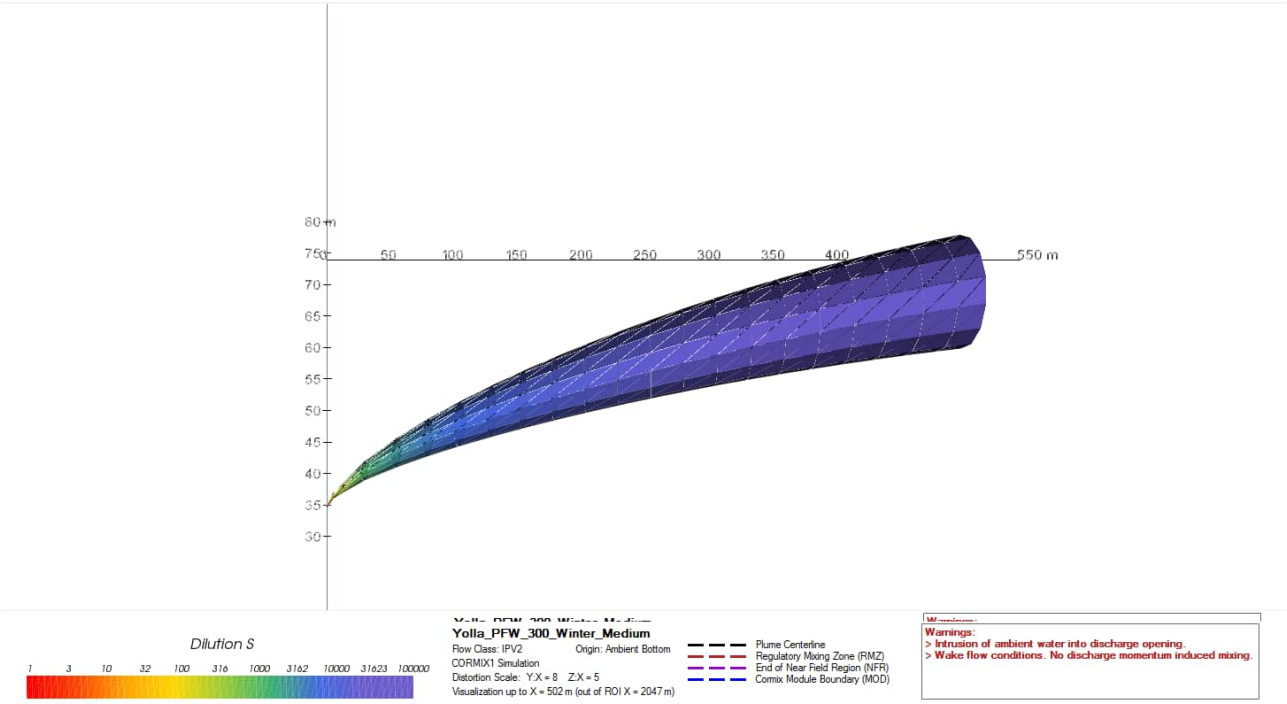


**Figure 5-11 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

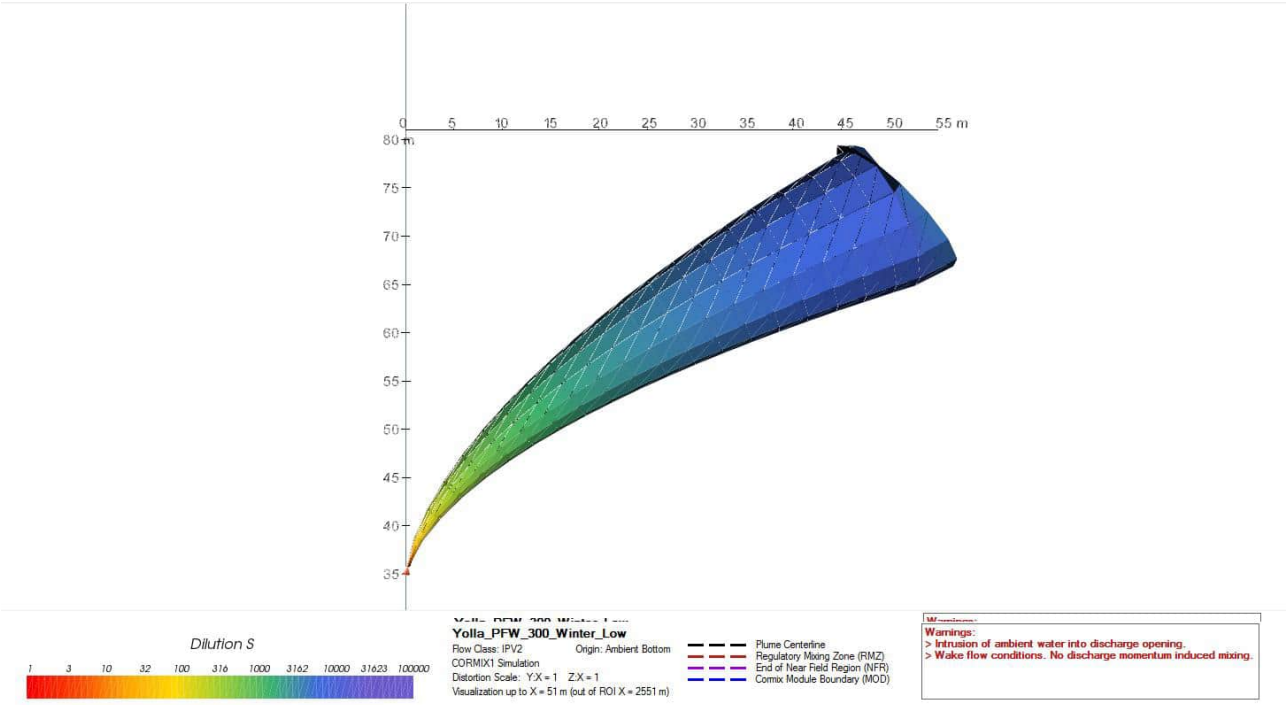


**Figure 5-12 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 300 m$^3$/d at discharge height of 45 m below the sea surface.**

## 5.2 Far-Field Modelling

### 5.2.1 Overview

Near-field and far-field modelling describe different processes at different scales, so their results may not always align where the two overlap near the discharge location. Far-field modelling accounts for time-varying currents, which can sometimes lead to plume pooling at the release site under weak currents. When this pooled plume is later carried away, it can result in lower dilutions (higher concentrations) migrating farther from the discharge point.

### 5.2.2 Stochastic Analysis

The model outputs over the ten-year hindcast period (2010-2019) were combined and analysed on an annual basis.

Table 5-3 summarises the maximum distances from the discharge location to achieve various dilution levels, ranging between 500 and 20,000 dilutions, for the 95$^{th}$ percentile.

The lower dilution threshold (526) was observed within approximately 10 m and 12 m for the Base Case and Future Case, respectively.

The dilution threshold of 7,143 was observed within approximately 29 m and 37 m for the Base Case and Future Case, respectively.

The dilution threshold of 1,961 was observed within approximately 41 m and 61 m for the Base Case and Future Case, respectively.

The upper dilution threshold (19,608) was observed within approximately 163 m and 247 m for the Base Case and Future Case, respectively.

The dilution maps for the 95$^{th}$ percentile for each discharge case is depicted in Figure 5-13 and Figure 5-14, along with contours illustrating the lower and upper dilution thresholds.

**Table 5-3 Maximum distance from the PFW discharge location to achieve threshold dilutions.**

| Statistic | Dilutions (1:X) | Maximum distance (m) from discharge location to achieve given dilution for the Base Case (200 m$^3$/day) | Maximum distance (m) from discharge location to achieve given dilution for the Future Case (300 m$^3$/day) |
|---|---|---|---|
| 95$^{th}$ Percentile | 500 | 10 | 12 |
| | **526** | **10** | **12** |
| | **1,961** | **29** | **37** |
| | 2,000 | 29 | 36 |
| | 4,000 | 30 | 38 |
| | **7,143** | **41** | **61** |
| | 8,000 | 43 | 74 |
| | 10,000 | 64 | 125 |
| | 12,500 | 100 | 152 |
| | 15,000 | 126 | 182 |
| | 17,500 | 160 | 232 |
| | **19,608** | **163** | **247** |
| | 20,000 | 165 | 253 |

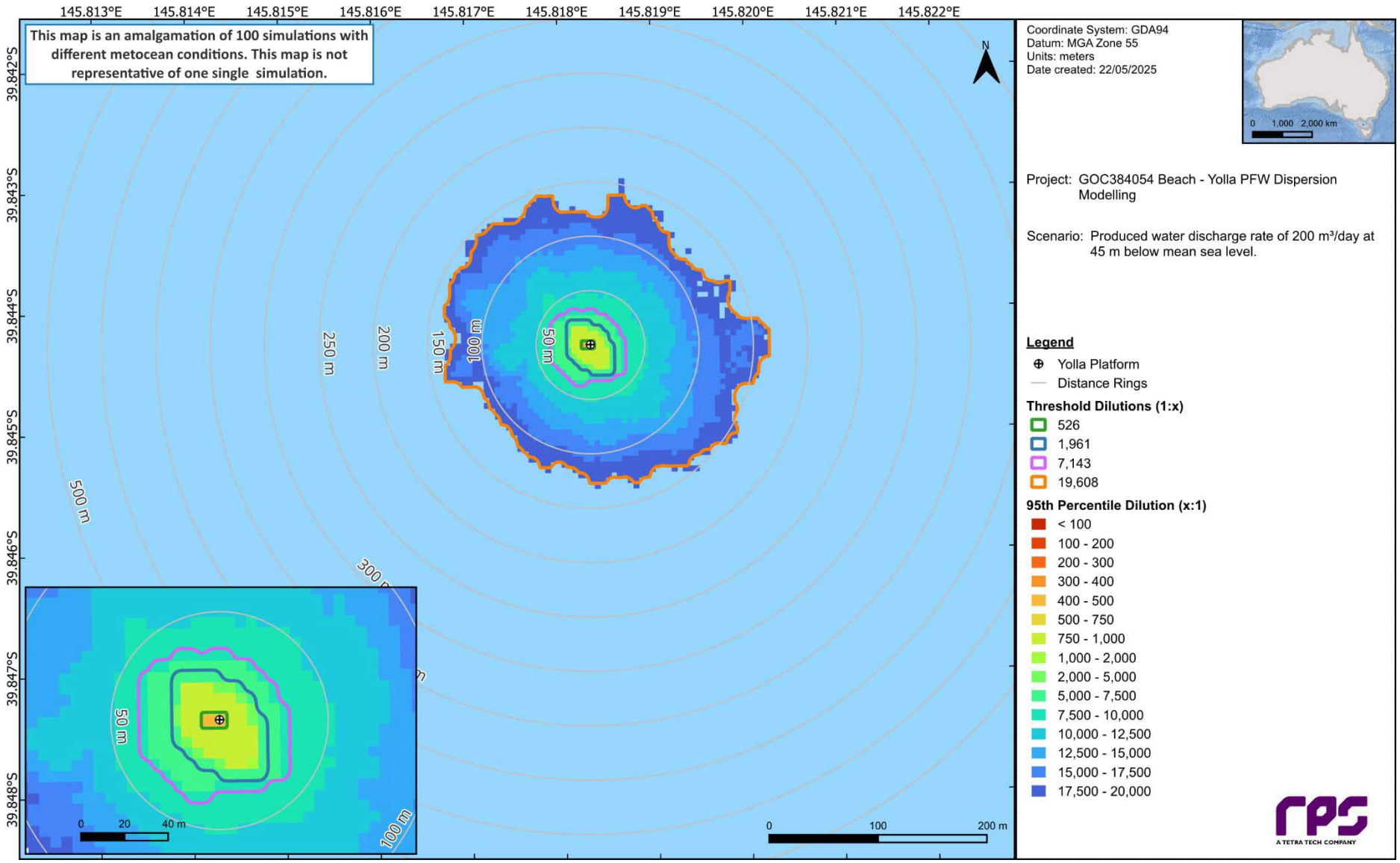


**Figure 5-13 95th percentile dilution for a PFW discharge at 200 m³/d. Results refer to annual conditions.**

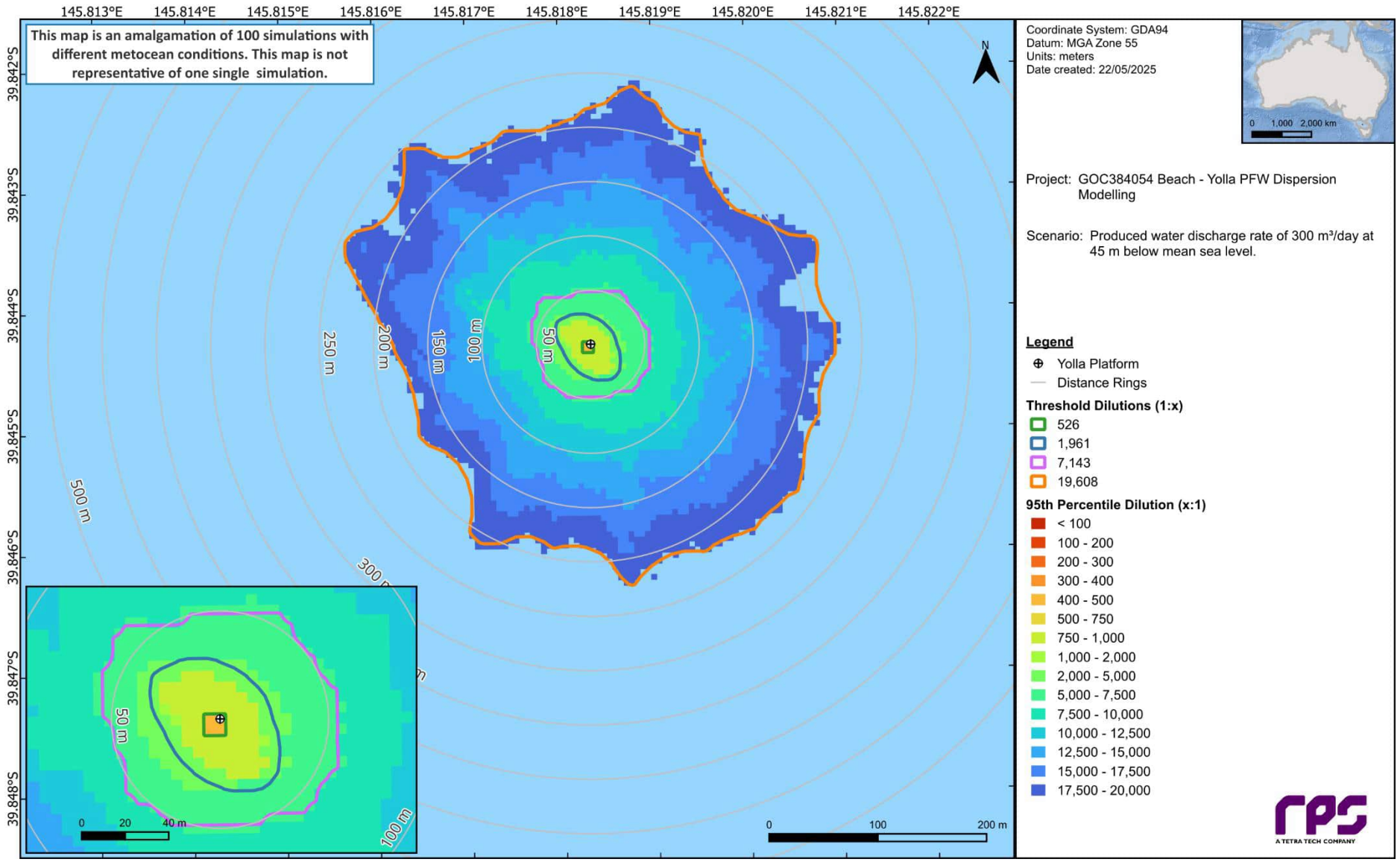


**Figure 5-14 95th percentile dilution for a PFW discharge at 300 m³/d. Results refer to annual conditions.**

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ABN: 20 007 617 969

AECOM

# ALARP Assessment of removing calcite scale from the production system at BassGas

27-Oct-2025

# ALARP Assessment of removing calcite scale from the production system at BassGas

Calcite scale removal ALARP

Client: Beach Energy Ltd.

ABN: 20 007 617 969

Prepared by

**AECOM Australia Pty Ltd**
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| Document | ALARP Assessment of removing calcite scale from the production system at BassGas |
| Ref | 60731020_3 |
| | I:\legacy\projects\607x\60731020_beach_ecotox_data_review\500_deliverables\507_alarp\rev2\60731020_beach_glda_alarp_rev2.docx |
| Date | 27-Oct-2025 |
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**Revision History**

| Rev | Revision Date | Details | Approved | |
|---|---|---|---|---|
| | | | Name/Position | Signature |
| A | 12-Sep-2025 | Draft | Jason Crisp Principal Marine Scientist | |
| 0 | 13-Oct-2025 | Final | Jason Crisp Principal Marine Scientist | |
| 1 | 27-Oct-2025 | Final Submission | Jason Crisp Principal Marine Scientist | |
| 2 | 31-Oct-2025 | Final Report | Jason Crisp Principal Marine Scientist | |

# Table of Contents


1.0 Introduction 1
1.1 Background 1
1.2 Selection of GLDA as the Preferred Descaling Chemical 1
1.3 Objectives and Scope 2
2.0 Site Setting and Operations 3
2.1 Environment Plan 3
2.2 Environmental Setting 3
2.3 Environmental Risks 4
3.0 Existing PFW management 6
3.1 Routine PFW Characterisation 6
3.1.1 PFW processing 6
3.1.2 Oil in Water Analysers 7
3.1.3 Weekly Dispersed Oil and BTEX monitoring 7
4.0 GLDA Field Trials 10
4.1 GLDA Field Trials (2024-2025) 10
4.2 Toxicant screening 11
5.0 Updated SSDF plume models 13
6.0 Regulatory Context 14
6.1 NOPSEMA Guidance 14
6.2 Approach 14
7.0 ALARP Assessment 15
7.1 Environmental risks 16
7.2 Elimination 16
7.2.1 Primary PFW treatment prior to discharge 16
7.2.2 Reinjection 16
7.2.3 Discharge through a pipeline for onshore management 16
7.3 Substitution 17
7.3.1 Alternative chemicals 17
7.3.2 Wireline drift runs 17
7.4 Engineering controls 17
7.4.1 Reduction of GLDA concentration applied 17
7.4.2 Reduction of GLDA and well cleaning byproduct concentrations discharged 17
8.0 Risk Assessment 19
9.0 Synthesis 21
10.0 References 23

Appendix A
Yolla Platform ALARP Assessment (AECOM 2019) A


## List of Figures


Figure 1 Yolla-A Platform location at the BassGas Development facility. 1
Figure 2 Schematic of Yolla-A PFW processing system 6
Figure 3 Correlation between OSPAR dispersed Oil and OIW analyser outputs 7
Figure 4 PFW Water Quality readings for Y4 and Y6 wells treated in June and July 2025 respectively 8
Figure 5 PFW hydrocarbon levels between June 2024 to August 2025 9


## List of Tables


Table 1 PFW Characterisation (ACS Laboratories non-NATA) 8
Table 2 GLDA-PFW Samples collected post-descaling events (Nov 2024 - Aug 2025) 11
Table 3 Environmental Risk Assessment of Descaling Activity 20
Table 4 ALARP Assessment Synthesis 22

# 1.0 Introduction

Beach Energy Ltd (Beach) has commissioned AECOM Australia Pty Ltd (AECOM) to undertake an assessment of the proposed use of descaling chemical glutamic acid-N,N-diacetate (GLDA) at the Yolla-A facility, to redress falling production flow rates of gas. The objective of the assessment is to demonstrate that any potential impacts to the receiving marine environment from the use of GLDA have been reduced to as low as reasonably practicable (ALARP).

The assessment was led by Ian Baxter, CEnvP, of SEAPEN Marine Environmental Services and was prepared in collaboration with Dr Bryant Gagliardi (Principal Ecological Risk Assessor, Environment) and Dr Supriya Lath (Senior Environmental Scientist) from AECOM. Technical review was undertaken by Tania Liaghati (Technical Director, Environment), and the project was managed by Dr Jason Crisp (Principal Marine Scientist, Environment), both of AECOM.

## 1.1 Background

The BassGas Development facility is an offshore gas facility located in Bass Strait operated by Beach, which produces natural gas and condensate from the Yolla gas field in the Bass Strait. The gas field is serviced by the Yolla-A offshore platform, and an approximately 147 km subsea pipeline that transports the gas and liquids from the platform to the Victorian mainland. The location of the Yolla-A platform and pipeline is presented in Figure 1 below.

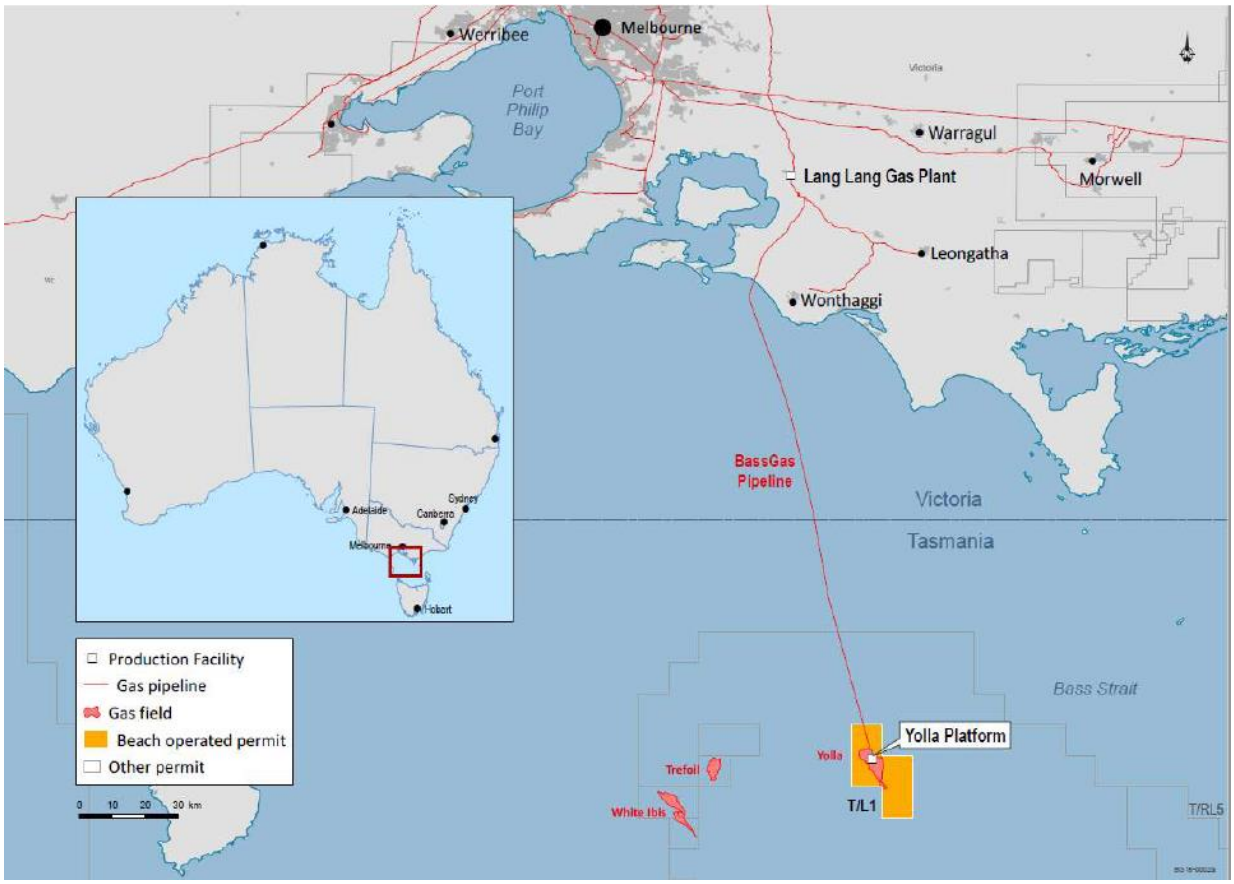


**Figure 1 Yolla-A Platform location at the BassGas Development facility.**

Yolla-A Platform is fed by four separate production wells (Y3, Y4, Y5 and Y6) via umbilicals laid over the seabed, from which gas is processed onboard Yolla-A and exported via the BassGas pipeline to shore. Treated Produced Formation Water (PFW) is released to the sea at the platform.

## 1.2 Selection of GLDA as the Preferred Descaling Chemical

In 2023, Beach observed a significant decline in well performance at Yolla-A, with export rates declining to 5-6Tj/d, approaching non-commercial levels (Beach pers comms). This prompted an investigation

into the source(s) of the loss of net well productivity, which identified Y-4 and Y-6 wells as being particularly impacted. A wireline intervention in Y-6 identified a downhole obstruction, which was subsequently sampled and analysed for constituents. This sample was found to primarily consist of calcite scale. Additionally, produced formation water (PFW) samples were collected from the field (at surface facilities) and analysed to determine chemical constituent profiles and concentrations.

A specialist production chemist was engaged by Beach, and a scale study was completed and found that the current downhole conditions at Y-6 well had resulted in calcite scale forming in the downhole completion and near wellbore of the wells (Gunn and Hobbs, 2024). A project was initiated to identify a suitable treatment method for the downhole scale removal, with industry experts and service companies engaged. Hydrochloric Acid (HCl) and a specialist chelating agent, GLDA, were both assessed as treatments for the calcite scale. However, HCl was found to be unsuitable due to its corrosive impact on metallurgy and seals, particularly under high temperature conditions. Additionally, any increase in pH during flow back can result in the redeposition of the scale, as calcium and iron scales solubility are pH dependent. HCl use also poses the risk of mobilising fines in the reservoir, leading to production impairment. Given these concerns, GLDA was selected as the lowest risk option for effectively treating the scale (Gunn and Hobbs, 2024). This synthetic product, derived from a naturally occurring amino acid (L-glutamic acid), has been used in the North Sea to treat scale and is known to be less corrosive on well and facilities metallurgy (as opposed to harsh acids) compared to strong acids. Furthermore, GLDA holds a GOLD rating under the OSPAR/CHARM framework, the highest classification on the CEFAS register, based on its favourable toxicity, biodegradability, and bioaccumulation characteristics (Backus, 2024; Backus, 2025; Nouryon, 2019).

## 1.3 Objectives and Scope

This report presents an assessment of the proposed removal of calcite scale from the BassGas Production system, with the objective of demonstrating that the potential environmental impacts within the receiving marine environment associated with the use of GLDA have been reduced to a level that is As Low As Reasonably Practicable (ALARP).

In order to assist Beach in developing a suitable ALARP case for consideration by the regulator, AECOM has undertaken the following scope of work:

- Reviewed the previous ALARP assessment (AECOM, 2019) undertaken in 2019.
- Evaluated learnings from the 2025 SSDF and Mixing Zone report (AECOM 2025), Whole Effluent Toxicity (WET) testing, available ecotoxicology data reports for GLDA use at Yolla-A.
- Considered technical information provided by Beach engineers to better understand intended use of GLDA at the Yolla-A production wells.
- Prepared this updated ALARP assessment report to consider the inclusion of GLDA in the production process.

# 2.0 Site Setting and Operations

## 2.1 Environment Plan

The BassGas Offshore Operations Environment Plan (henceforth EP) is being implemented to manage potential environmental impacts and risks associated with the operation of the BassGas Development facility, which includes Yolla-A as a key offshore production and processing asset. In accordance with the *Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E))*, and the Victorian *Offshore Petroleum and Greenhouse Gas Storage (OPGGS) Regulations 2011*, which have since been updated, Beach previously submitted a five-yearly update of the EP (Aventus, 2020) to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment on 20 September 2019. The EP was accepted by NOPSEMA on 23 December 2020 (Beach, 2020; NOPSEMA 2020).

In accordance with current regulations, EPs for long-term offshore activities must be revised every five years. This obligation is set out under the following Regulations:

- Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023 (Australian Government, 2023)
- Offshore Petroleum and Greenhouse Gas Storage Regulations 2021 (Victorian Government, 2021)

Beach is currently undertaking another five-year review of the Bass Gas Offshore Operations EP to cover ongoing production operations, with public consultation open until 10 October 2025. The revised EP will be re-submitted to NOPSEMA for approval. The revised EP's scope is intended to include the operation of the offshore wells, Yolla Platform and pipeline, and the ongoing maintenance and inspections to ensure safe ongoing field operations (Beach, 2025). The EP will also detail control measures to reduce and manage environmental impacts and potential risks to ALARP and acceptable levels (Beach, 2025).

## 2.2 Environmental Setting

The Yolla-A platform stands in approximately 80 m water depth and is located some 93 km south-west of Wilson's Promontory in Victoria and 109 km north-west of the Tasmanian mainland. The facility was installed in 2004 and has been in production since 2006. Product is transported from the platform via a 147 km subsea pipeline extending from the platform to the mainland shore crossing near Kilcunda, Victoria.

The following marine environmental receptors are considered likely to be present, or have the potential to be present, in the general vicinity of the PFW discharge:

- Benthic assemblages – surveys of the seabed near the Yolla-A platform prior to drilling and construction identified sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and predatory snails (whelks).
- Plankton - both phytoplankton (e.g. diatoms, flagellates and cyanobacteria) and zooplankton (e.g. krill, polychaetes, fish eggs and fish larvae) are commonly found throughout Bass Strait.
- Marine flora – Due to the depth of the seabed in the vicinity of Yolla-A, marine plant life is likely confined to the shallower areas of the platform structure. These communities are expected to consist primarily of various species of brown, red, and green algae.
- Seabirds – a search of the *Environment Protection and Biodiversity Conservation Act 1999* protected matters database ('EPBC database') in October 2025 identified 29 species of seabirds whose habitat may occur within the general vicinity of the PFW discharge. Of these, three are listed as critically endangered, five as endangered and 21 as vulnerable. However, the critically endangered species are a curlew, a sandpiper and a parrot; none of these species are at risk of impacts from the PFW discharge, which does not have the potential to impact upon their habitats or to have effects upon their trophic chain. Each of the endangered species (three albatross and two petrels) has the potential to be exposed to effects from the PFW plume, either by direct contact (e.g during feeding or resting on the sea surface) or via trophic chain effects. Similarly, 19 of the

vulnerable species have the potential to be exposed to effects from the PFW plume (12 albatross, four petrels, a prion, a shearwater and a tern).

- Cetaceans – the EPBC database search identified two endangered whale species (blue [*Balaenoptera musculus]* and southern right *[Eubalena australis]*) and two vulnerable whale species (fin [*Balaenoptera physalus*] and sei [*Balaenoptera borealis*]) that may have the potential to occur within the general vicinity of the Yolla field. There are no records in the Victorian Biodiversity Atlas (VBA) or the Atlas of Living Australia (ALA) of observations of these species within hundreds of kilometres of the Yolla field, there may be the potential for them to occur in the area at certain times of the year, or to transit through the area during annual migrations. The non-threatened cetacean species protected under the EPBC Act that were identified in the database search as potentially occurring in the vicinity of the Yolla field comprised six whale species and four dolphin species.
- Pinnipeds – two pinniped species (the Australian fur seal [*Arctocephalus pusillus*] and the long-nosed fur seal [*Arctocephalus forsteri]*) were identified in the EPBC database as potentially occurring in the vicinity of the Yolla field; both of these species are listed as marine, not threatened, species. The VBA and the ALA only contain records of the former species within 100 km of the Yolla field, though the potential for the latter species to also be present cannot be discounted.
- Fish – it is estimated that there are over 500 species of fish found in the waters of Bass Strait, including a number of species of importance to commercial and recreational fisheries. One vulnerable shark species (great white [*Carcharodon carcharias*]) and two conservation dependent fish species (a trevally [blue warehou, *Seriolella brama]* and the eastern school shark [*Galeorhinus galeus*]) were identified in the EPBC database as potentially occurring in the vicinity of the Yolla field. All three species are included in the ALA as having been recorded in the vicinity of the Yolla field.
- Reptiles – two endangered species of marine turtle (leatherback [*Dermochelys coriacea*] and loggerhead [*Caretta caretta*] and one vulnerable species (green [*Chelonia mydas*]) are identified in the EPBC database as potentially being present in the vicinity of the Yolla field. While the VBA and ALA have records of only the leatherback occurring within hundreds of kilometres of the field, the potential for the other two species to occur cannot be discounted.
- Individuals of the these cetacean, pinniped, fish and reptile species that may be present, even seasonally, within the vicinity of the Yolla field will have the potential to be exposed to the PFW plume, or for the PFW discharge to affect their trophic chains.
- Introduced Marine Species – several introduced species are known to occur in Bass Strait, include the Pacific oyster (*Magallana gigas*), northern Pacific sea star (*Asterias amurensis*), New Zealand screw shell (*Maoricolpus roseus*), European shore crab (*Carcinus maenas*), and the alga ‘dead man’s fingers’ (*Codium fragile*). It is not known if any of these species are present in the vicinity of the Yolla field.

## 2.3 Environmental Risks

The key risks to the receiving marine environment arising from the use of GLDA and its discharge within the PFW stream relate to potential toxic effects on marine biota from:

- Residual GLDA and/or degraded constituents of GLDA.
- Byproducts generated during the descaling process (indicated from initial field tests as primarily metals).

These two sources of potential impact are inherently mixed within the PFW stream and may interact in either synergistic or antagonistic ways.

Modelling indicates that, upon discharge into the marine environment, the PFW forms a buoyant plume which is carried away from the platform in the direction of the prevailing current (AECOM 2025). The PFW is progressively diluted within the plume as it moves away from the platform until the constituents reach concentrations that are considered to no longer have the potential to impact upon marine receptors (i.e. the ‘edge of the mixing zone’).

As part of this ALARP assessment, it is important to demonstrate that all feasible control measures aimed at minimising the dimensions of the mixing zone have been evaluated, therefore, supporting the conclusion that the mixing zone itself meets ALARP criteria. However, the precise determination of actual mixing zone dimensions falls outside the scope of this ALARP assessment. This aspect was addressed separately through direct toxicity assessments (DTAs) of PFW containing GLDA and its associated byproducts, as documented in the SSDF and mixing zone report (AECOM 2025).

# 3.0 Existing PFW management

## 3.1 Routine PFW Characterisation

Beach undertakes the following PFW monitoring:

- Weekly sampling: Samples are collected and analysed for dispersed oil (un-dissolved oil) and BTEX. These analyses are performed using OSPAR approved methods in a non-NATA accredited laboratory.
- Biannual Comprehensive Analysis: In accordance with the approved EP, Beach undertakes twice yearly sampling for comprehensive chemical analysis at a NATA accredited laboratory.
- Sampling Locations: All samples are collected via the two in-line oil-in-water analysers (AIT 5327 & 5328), positioned upstream of the Dump Caisson. This location is critical, as the PFW discharged from the Dump Caisson represents the actual discharge point into the mixing zone surrounding the Yolla platform.

### 3.1.1 PFW processing

A schematic of the Yolla-A PFW treatment system is shown in Figure 2.

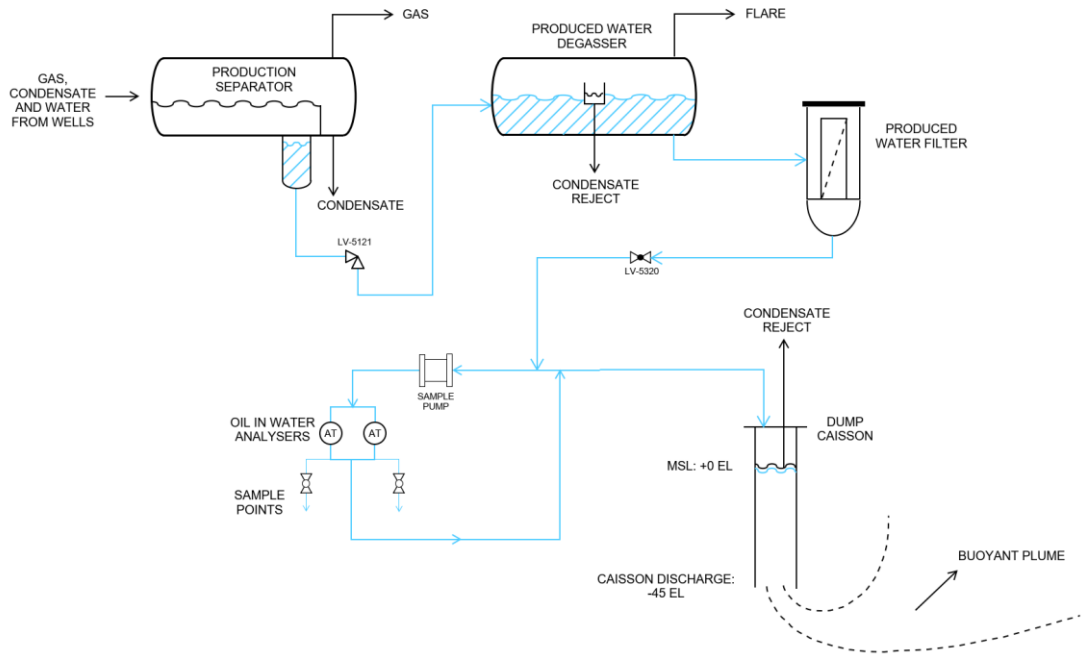


**Figure 2** Schematic of Yolla-A PFW processing system

The production fluids from the wells are passed through the Production Separator where gas is separated from the oil and water mixture. Dissolved gas is then removed in the Degasser, with the discharged water passing through a filter to remove any solid particulates remaining in the stream. The water is then discharged to the Dump Caisson via a liquid leg.

The Dump Caisson is constructed as part of the Platform jacket. It allows recovery of hydrocarbon liquid that may be present in the feed stream from the open drains system, PFW, or a spill. The hydrocarbon liquid is captured via gravity separation and accumulates at the top of the Caisson and can be pumped to the Flare Knock Out Drum. Water flows from the bottom of the Caisson at a depth of 45 m below sea level.

The segregated open drain and PFW feed to the Caisson are routed below the minimum sea water depth to ensure a liquid seal is achieved, which enables effective containment of vapours. These vapours are safely vented via the designated atmospheric outlets. Additionally, the Caisson is equipped with a vent line to a safe location, fitted with a flame arrestor to mitigate ignition risks.

The Dump Caisson is provided with a pneumatically operated Dump Caisson Pump to recover oil and condensate. Level indication, spared for redundancy, and alarms are also provided to assist with the operation of the Dump Caisson Pump and to provide an indication of the liquid hydrocarbon level within the Caisson. The pump has flexible connections and can deliver a nominal flow rate of 1 $m^3$/h from the liquid surface of the water within the Dump Caisson and pump the fluid into the Flare Knock Out Drum for reprocessing. The pump is operated by fuel gas and can be operated remotely from the Lang Lang Gas Plant onshore.

### 3.1.2 Oil in Water Analysers

Beach has attempted to develop correlations between the OIW analysers and dispersed oil, as shown in Figure 3 (OIW analysers) (BassGasLIMS Rev3). The correlation is difficult to establish.

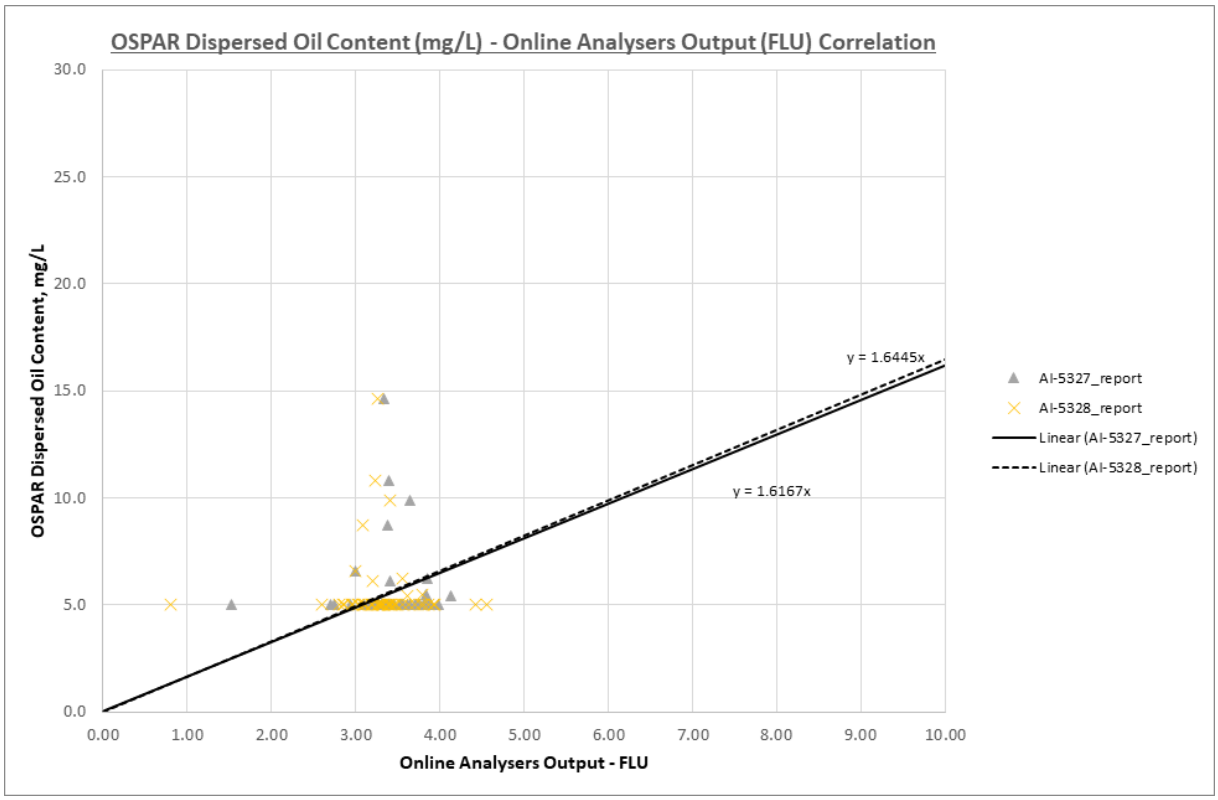


**Figure 3 Correlation between OSPAR dispersed Oil and OIW analyser outputs**

### 3.1.3 Weekly Dispersed Oil and BTEX monitoring

The following summary presents analytical data collected over the 12 month period (BassGasLIMS Rev3). (11 July 2024 - 31 August 2025)

**Table 1 PFW Characterisation (ACS Laboratories non-NATA)**

| | BTEX (GCMS) mg/L | Dispersed Oil (C7-C40 Aliphatic) mg/L | Total Oil (Mixed) mg/L |
|---|---|---|---|
| Average | 82 | 18 | 100 |
| Max | 163 | 75 | 197 |
| Min | 27.2 | 0.6 | 38 |

Note: 75 test results; 5 results >30ppm, 1 result>50ppm

The data demonstrate that the existing system is effective at removing the dispersed oil, with at least 93% of the test results consistently meeting the adopted criteria of 30 mg/L, and 98.7% within the 50ppm maximum concentration. . Total Oil refers to the combined concentration of dispersed oil and BTEX compounds. The results also show that BTEX constitutes the dominant fraction of the Total Oil measurement.

Figure 4 below shows physicochemical water quality readings for Yolla PFW samples, measured before and after GLDA injection, for the two trials (5/7/2025 for Y4, 4/8/2025 for Y6).

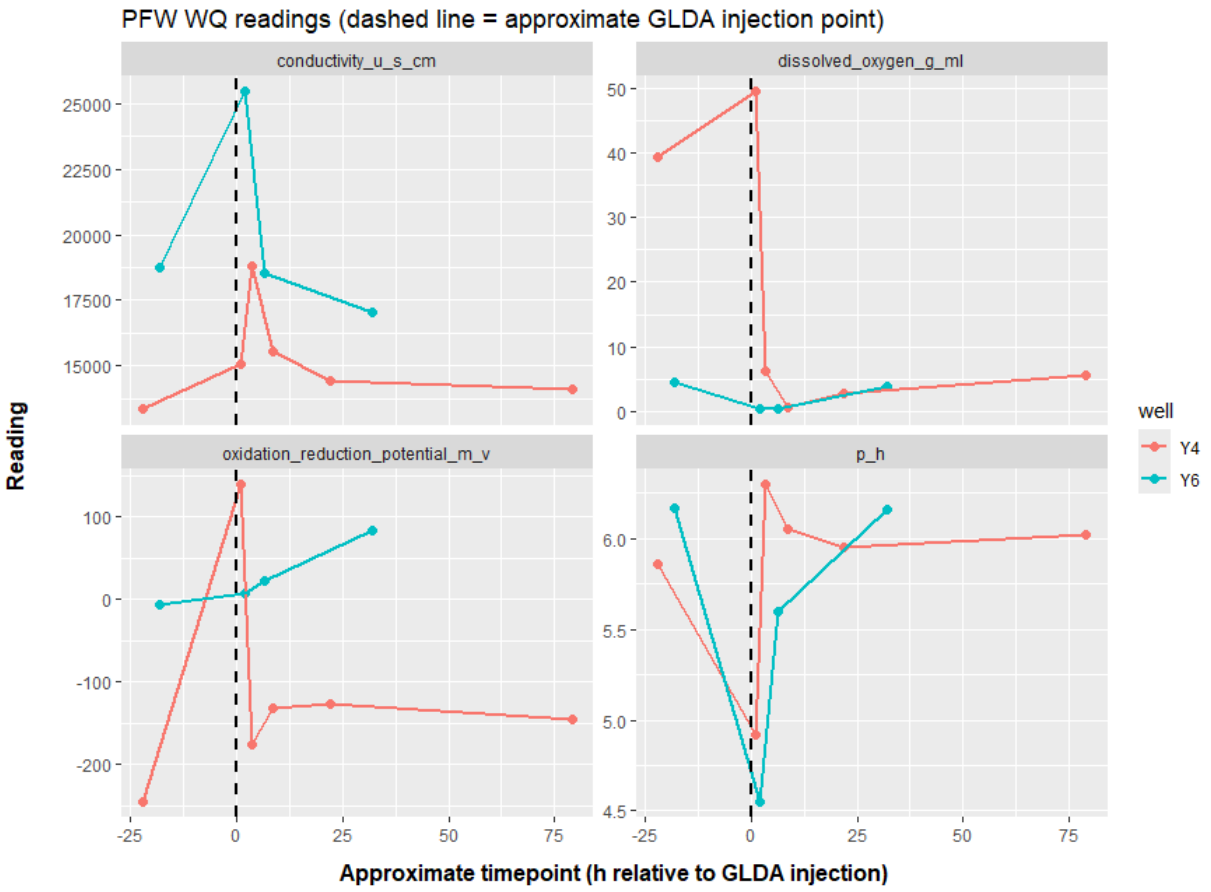


**Figure 4 PFW Water Quality readings for Y4 and Y6 wells treated in June and July 2025 respectively**

Figure 4 indicates that for conductivity and pH for both wells' injections, an initial shift associated with GLDA injection but a relatively rapid return to background levels, within approximately 2-3 hours. This also is the case for DO levels associated with the Y6 trial. For the other parameters / trials, there appears to be a longer shift in water quality, which may or may not be associated with GLDA injections.

Overall, the OIW/TPH/BTEX trends from July 2024 (GLDA first trial) to latest descaling (Y6 in Aug 2025) are summarised in Figure 5 below.

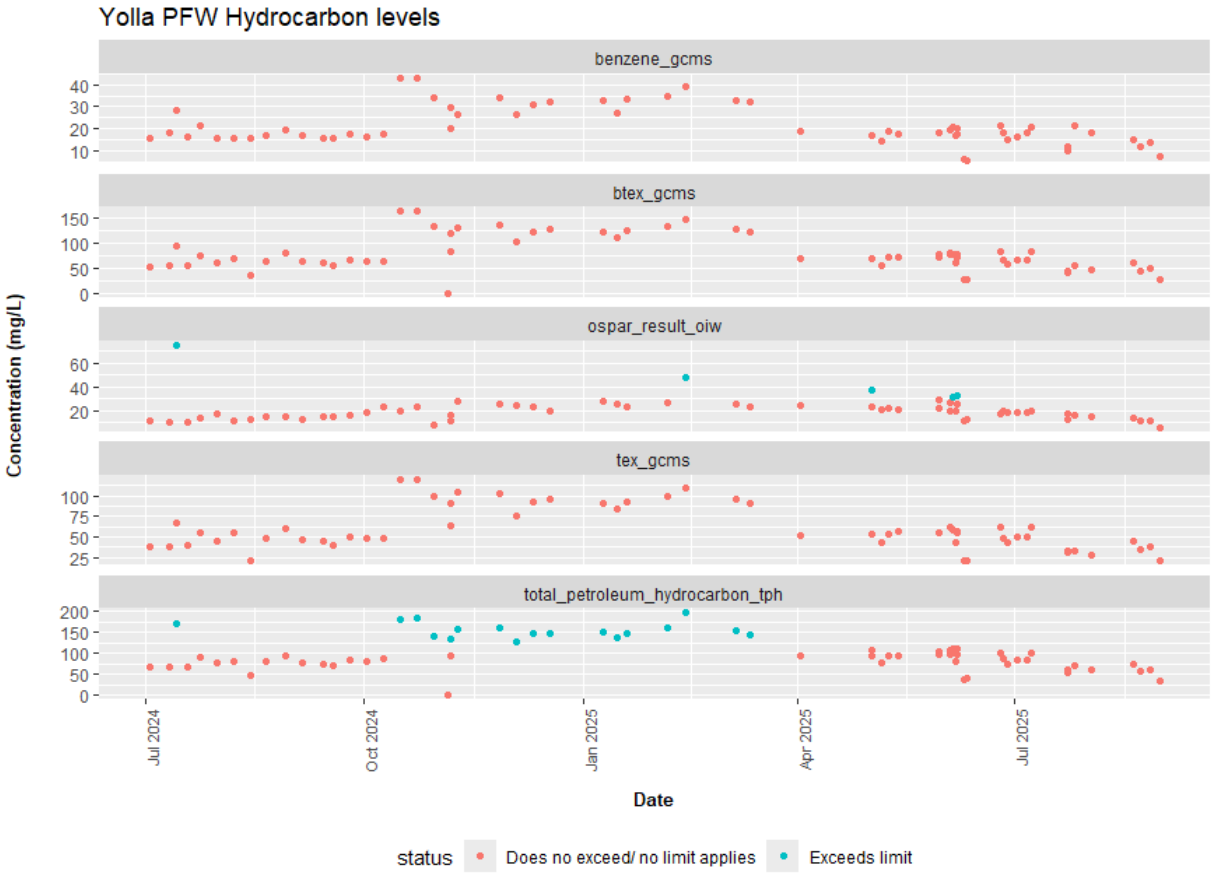


**Figure 5 PFW hydrocarbon levels between June 2024 to August 2025**

Figure 5 above shows a potential elevation in some hydrocarbon results from approximately late 2024 to approximately early 2025, however this potential elevation does not to appear to temporally coincide with GLDA trials, and readings appear to have since restored to approximately background levels.

# 4.0 GLDA Field Trials

## 4.1 GLDA Field Trials (2024-2025)

In July 2024, Beach conducted an initial field trial involving the application of GLDA in a batch soak treatment at the Y-6 well, which had been identified as experiencing severe scaling. GLDA, diluted with produced water, was introduced into the well and allowed to soak for at least 24 hours before being unloaded. Following the treatment, the well was brought back online, and a significant improvement in rates was observed, indicating that near-wellbore productivity impairment had been largely resolved (Beach, pers. comms). Subsequently, further trials were executed in November 2024 on other wells in the field (Y-4, Y-5, Y-3), with WET testing and sample screening completed during the Y-4 descaling only. Trials were repeated in July and August 2025 with further WET testing and repeated-sample water quality screening conducted for the tests.

WET Testing includes chronic and acute toxicity tests. Chronic toxicity testing includes: 1-hr sea urchin fertilisation success, 72-hr sea urchin larval development, 72-hr marine algal growth, 48-hr larval development, 72-hr macroalgal germination success. Acute toxicity testing includes 96-hr fish imbalance toxicity and 96-hr acute toxicity test using amphipod. Samples are shipped to Ecotox for analysis.

The PFW Water Quality analysis (analysed by Eurofins) includes:

- Physical screening for Conductivity, ph, total phosphate (as P), total Nitrogen (as N), Total Suspended Solids (TSS),
- Heavy Metals such as Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Zinc (Zn), In 2025 screening additional metals such as Aluminium (Al), Barium (Ba), Cobalt (Co), Iron (Fe), Manganese (Mn), Selenium (Se), Silver (Ag), Vanadium (Va) were also analysed.
- Potassium (K),
- Total Petroleum Hydrocarbons (1999 & 2013 NEPM).
- Benzene, Toluene, Ethylbenzene and Xylenes (BTEX),
- Plycyclic Aromatic Hydrcarbons (PAH).
- Phenols (Halogenated and non-Halogenated).

During GLDA trials, the OIW/TPH readings were recorded by the OIW analysers and samples were collected during the GLDA treatment in July 2024 (Y-4) and Aug 2025 (Y-6). Samples were collected prior and post GLDA unloading at different time intervals. These samples are sent to ACS (main laboratory) and SGS (as secondary laboratory). Results were recorded in the LIMS.

Based on the performance of GLDA treatments to date and the requirement to maintain production rates at commercial levels, timing of future treatments to each production well have been predicted to be repeated every ~2-6 months per well (Beach pers comms). Currently only Y-4 and Y-6 are receiving treatments on this frequency. Based on the scale modelling completed and inherent high tendency of the reservoir to scale, scale treatments are expected to be required on all operational wells for the remaining field life.

**The enhancement of well productivity is essential for prolonging the productive life of the Yolla field.**

Current management practices for analysing well performance, including monitoring by real time surveillance of well head and downhole pressures, temperatures and flow will be included as part of the review process for determining treatment frequency.

## 4.2 Toxicant screening

Analysis of the toxicant profiles and WET test results from three descaling events was conducted to determine whether the characteristics of PFW are changed as a result of treatment. Results showed that the treatment process may cause a temporary increase in PFW toxicity, potentially altering the extent of the mixing zone from the PFW only measures. It should also be noted that although no end point was established during these trials, dispersion modelling shown in the SSDF report highlighted that an initial spike in toxicity resulting from unloading of descalant by-products may then be sufficiently diluted over a time period < 5 days, to a point where the mixing zone boundary is maintained (AECOM 2025).

In terms of WET test results to date, Table 2 below demonstrates potential variability in the toxicity of PFW due to the treatments. Each test event sampled the PFW approximately 1 hr after unloading commenced, representing the peak toxicity of the PFW-GLDA. Toxicity values in Table 2 below show the most toxicity occurs with the lowest values. These results indicate two potential outcomes of the GLDA use:

1. Repeated treatment of the Y4 well over an ~8 month period may substantially decrease overall toxicity of well toxicants.
2. Subsequent treatment of the Y6 well after the repeated treatment of the Y4 well also produced lower toxicity than the first Y4 well treatment.

These results are caveated by the fact that even minor changes to the sampling regime of the PFW and flow rates of PFW mixes that was subsequently used for WET testing can produce differing net toxicities of PFW. However, of all three WET test results profiles, the first test in November 2024, which was used as part of the SSDF calculations, appears the most conservative to date.

**Table 2 GLDA-PFW Samples collected post-descaling events (Nov 2024 - Aug 2025)**

| Test Species | Toxicity Endpoint | Exposure Duration | Sample Date | Well descaled | Toxicity Estimate | Toxicty Value: PFW Concentration (%) and Variability (95% Confidence Intervals)^ | Toxicty Value (only): PFW Concentration (%) |
|---|---|---|---|---|---|---|---|
| Allorchestes compressa (amphipod) | Survival | 96 hr | 7-Nov-24 | Y4 | IC10 | 0.3 (0.22-0.38)% | 0.3 |
| | | | 5-Jul-25 | Y4 | IC10 | 5.1 (4.93-5.31)% | 5.1 |
| | | | 4-Aug-25 | Y6 | EC10 | 0.2 (0.14-0.24)% | 0.2 |
| Heliocidaris tuberculata (sea urchin) | Fertilisation | 1 hr | 7-Nov-24 | Y4 | IC10 | 0.1 (0.09-0.11)% | 0.1 |
| | | | 5-Jul-25 | Y4 | IC10 | 1.1 (0.97-1.27)% | 1.1 |
| | | | 4-Aug-25 | Y6 | EC10 | 0.4 (0.34-0.40)% | 0.4 |
| | Larval development | 72 hr | 7-Nov-24 | Y4 | EC10 | 0.1 (0.11-0.14)% | 0.1 |
| | | | 5-Jul-25 | Y4 | IC10 | 1.1 (0.87-1.29)% | 1.1 |
| | | | 4-Aug-25 | Y6 | EC10 | 0.2 (0.22-0.26)% | 0.2 |
| *Hormosira banksii* (macroalgae seaweed) | Macroalgal germination | 72 hr | 7-Nov-24 | Y4 | IC10 | 0.3 (0.15-0.46)% | 0.3 |
| | | | 5-Jul-25 | Y4 | EC10 | 1.6 (0.99-2.13)% | 1.6 |
| | | | 4-Aug-25 | Y6 | EC10 | 0.6 (0.33-0.77)% | 0.6 |
| *Lates calcarifer* (fish, Barramundi) | Biomass | 7 day * | 7-Nov-24 | Y4 | IC10 | 0.3 (0.00-0.35)% | 0.3 |
| | | | 5-Jul-25 | Y4 | IC10 | 3.4 (1.02-3.42)% | 3.4 |
| | | | 4-Aug-25 | Y6 | - | - | - |
| | Fish imbalance | 96 hr | 7-Nov-24 | Y4 | IC10 | 1.3 (1.32-1.36)% | 1.3 |
| | | | 5-Jul-25 | Y4 | IC10 | 5.3 (5.21-5.50)% | 5.3 |
| | | | 4-Aug-25 | Y6 | - | - | - |

| Test Species | Toxicity Endpoint | Exposure Duration | Sample Date | Well descaled | Toxicity Estimate | Toxicty Value: PFW Concentration (%) and Variability (95% Confidence Intervals)^ | Toxicty Value (only): PFW Concentration (%) |
|---|---|---|---|---|---|---|---|
| | | 7 day * | 7-Nov-24 | Y4 | NOEC ^ | 0.2% (* 95% CL are not determinable) | 0.2 |
| | | | 5-Jul-25 | Y4 | IC10 | 2.9 (2.91-2.91)% | 2.9 |
| | | | 4-Aug-25 | Y6 | - | - | - |
| Macquaria novemaculeata (fish, Bass) | Fish imbalance & Larval dvlpt (only 1 end point calculated for 4-Aug-25) | 7 day # | 7-Nov-24 | Y4 | - | - | - |
| | | | 5-Jul-25 | Y4 | - | - | - |
| | | | 4-Aug-25 | Y6 | IC10 | 0.2 (0.02-0.28)% | 0.2 |
| | Fish imbalance | 96 hr | 7-Nov-24 | Y4 | - | - | - |
| | | | 5-Jul-25 | Y4 | - | - | - |
| | | | 4-Aug-25 | Y6 | IC10 | 0.2 (0.02-0.25)% | 0.2 |
| Mytilus galloprovincialis (mussel) | Larval development | 72 hr | 7-Nov-24 | Y4 | IC10 | 0.1 (0.10-0.15)% | 0.1 |
| | | | 5-Jul-25 | Y4 | IC10 | 1.0 (0.91-1.34)% | 1 |
| | | | 4-Aug-25 | Y6 | EC10 | 0.2 (0.17-0.21)% | 0.2 |
| *Nitzschia closterium* (marine microalgae) | Algal growth | 72 hr | 7-Nov-24 | Y4 | IC10 | 0.3 (0.11-0.32)% | 0.3 |
| | | | 5-Jul-25 | Y4 | IC10 | 1.6 (1.17-1.91)% | 1.6 |
| | | | 4-Aug-25 | Y6 | IC10 | 0.2 (1.16-0.24)% | 0.2 |

* - The 7-day fish biomass and imbalance tests were considered as chronic tests by ESA in accordance with the ESA test factsheets, however, these tests have been conservatively classified by AECOM as acute tests on the basis of Warne et al. (2018) which recommends that all tests conducted on juvenile or adult fish for durations less than 21 days are considered as acute tests

^ - The laboratory was unable to report an EC/IC10 value for the November 2024 7-day fish imbalance test on *Lates calcarifer* (fish, Barramundi), although IC50 and NOEC values were reported. The NOEC was adopted as the toxicity estimate herein, based on Warne et al. 2018 guidance on preferred hierarchy of estimates of toxicity.

# - The laboratory was unable to report two end points for an EC/IC10 value for the August 2025 7-day fish imbalance test, as *Lates calcarifer* (fish, Barramundi) were unavailable for use and were substituted with Australian Bass (*Percalates novemaculeata*). This impacted the ability to calculate biomass effects, as the Bass tested were newly hatched larvae, which were too small to determine biomass at Day 7.

# 5.0 Updated SSDF plume models

The objective of the most recent SSDF report produced by AECOM (2025b), was to assess WET and analytical chemistry PFW data, using samples obtained before and immediately after (during the unloading process) GLDA treatment. Samples were taken from PFW in September 2024, then again during unloading of GLDA during the first Y4 well treatment in November 2024. The GLDA toxicity was reviewed as part of an update to the mixing zone boundaries previously assessed in 2021. In summary:

- WET testing data were considered to be of suitable quality and quantity to derive the SSDFs in accordance with the ANZG (2018) species sensitivity distribution (SSD) statistical method on the basis of the following:
  - The minimum WET data requirements to derive the SSDF using SSD modelling techniques were exceeded, and the dataset was classified as 'adequate', including measurement of both chronic and acute endpoints.
  - Data quality complied with the conditions for test characteristics set out in Warne et al. (2018) relating to experimental design, duration of exposure and toxicological endpoints.
  - Data quality scores for 114 of 116 WET tests exceeded the requisite score of 80% to classified as 'acceptable' to 'high' quality. Data from the remaining two tests were excluded from the SSDF derivation due to them not passing internal laboratory quality assurance / quality control criteria.
- For PFW, a concentration (strength) of 0.051% based on an SSDF of 1:1,961 is estimated to be required to achieve 99% species protection (spp.) in the receiving environment. However, for GLDA-PFW, a concentration (strength) of 0.0051% based on an SSDF of 1:19,608 is estimated to be required to achieve 99% spp. Based on the available data, the SSDF of GLDA-PFW is 10 times greater than the SSDF of PFW. In other words, operational injection of GLDA at the volume used in this sample enhances effluent toxicity by approximately 10-fold. These SSDFs are considered to be of 'moderate reliability', and hence suitable for application in environmental protection, in accordance with the classification process outlined in Batley et al. (2018).

In addition, this study also incorporated a mixing zone update from the previous SSDF assessment, and based on modelling outputs provided by RPS 2025:

- Under the maximum and 'worst case' PFW discharge scenario of 300 $m^3$ per day, modelling identified a 'mixing zone' boundary of 37 m for PFW alone, and 247 m for PFW+GLDA. Beyond these distances from the discharge point, 99% of marine species are expected to be protected from chronic toxicity effects.
- Previous models that did not incorporate stochastic methods for deriving metocean conditions used to assess plume dispersion, produced significantly larger mixing zone boundaries compared to earlier, more rudimentary models that employed single-speed current inputs. The stochastic approach was considered more representative of natural variability in oceanographic conditions and was applied to simulate dispersion over a five-day period, the timeframe during which GLDA was predicted to influence the specific gravity of the PFW.

# 6.0 Regulatory Context

## 6.1 NOPSEMA Guidance

In its guideline document *Environment Plan decision making* (document N-04750-GL1721 A524696 10/1/2024), NOPSEMA outlines its expectation under Criterion (34b) for ALARP, which provides the following:

*Reducing impacts and risks to ALARP is based on the concept of reasonable practicability; the weighing up of the magnitude of impact or risk reduction against the cost of that reduction. The 'cost' in this context means the sacrifice associated with implementing a control measure which includes an evaluation of the benefits versus the impost such as money, time and/or effort required to implement a particular control measure. The titleholder must adopt additional control measures or increase effectiveness of existing control measures if the cost of doing so is not grossly disproportionate to the environmental benefit gained.*

Therefore, ALARP can be defined as a level of risk that is not intolerable, and cannot be further reduced without the incurring costs that are grossly disproportionate to the benefit gained from the reduction.

When making a decision regarding whether an Environment Plan (EP) demonstrates that the environmental impacts and risks of the activity will be reduced to ALARP, the guideline indicates that NOPSEMA will consider the following:

- Whether all control measures that could reasonably be considered are evaluated, particularly for higher order impacts and risks. For higher order impacts and risks the exploration of alternative, additional, or improved control measures should be evident.
- Whether the evaluation of impacts and risks has informed the selection of suitable control measures to either reduce the consequence/severity or likelihood of impacts and risks.
- Whether enough detail of the control measure is provided to demonstrate that the control measure will be effective in reducing impacts and/or risks for the duration of the EP. The control measure should be evaluated for its functionality, availability, reliability, survivability, independence and compatibility with other control measures.
- The method of evaluating whether or not a control measure is adopted is based on environmental benefit versus costs of implementing that control measure.
- The method of evaluation is systematic, applied thoroughly, defensible and reproducible.
- That information provided during relevant person consultation is incorporated, considered and evaluated where applicable.

In this ALARP assessment, the specific subject is the release of all byproducts as a result of descaling treatment in PFW discharged from the Yolla-A Platform.

## 6.2 Approach

The ALARP assessment steps through a classic 'hierarchy of controls' for reducing the risk of impacts associated with the use of GLDA to the receiving marine environment. The hierarchy, ranked from most to least effective, includes:

- Elimination – design processes to remove the source of the risk.
- Substitution – use alternative measures in place of the source of the risk.
- Engineering controls – reduce exposure of the environment to the risk through additional equipment, treatment, etc.
- Administrative controls – implement additional procedures, monitoring and training associated with management of the source of the risk.

# 7.0 ALARP Assessment

In its guideline document *Environment plan decision making* (GL1721-Rev5 June 2018), in discussing the ALARP criterion, NOPSEMA provides the following:

*Sub-regulation 10A(b) requires that an EP demonstrate that the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable (ALARP). The question that needs to be answered to meet this criterion is 'has the titleholder done enough to reduce the impacts and risks of the activity?' Reducing impacts and risks to ALARP is based on the concept of reasonable practicability; the weighing up of the magnitude of impact or risk reduction against the cost of that reduction[4]. In this context, a titleholder is required to implement all available control measures where the cost is not grossly disproportionate to the environmental benefit gained from implementing the control measure*.

In this ALARP assessment, the subject is the discharge of PFW+GLDA from the Yolla-A Platform.

NOPSEMA (Article published in the Regulator, Issue 3: 2014) has provided further commentary in relation to ALARP and PFW as a whole.

*The repeal of regulations 29 and 29A is a notable change brought about through the 28 February 2014 amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Environment Regulations). The Regulations previously set a limit of 30 mg/L of petroleum (averaged over 24 hours) in any produced formation water (PFW) discharged to the sea, and also outlined associated testing requirements for equipment used to monitor oil-in-water (OIW).*

*The 30 mg/L limit was a legacy of the former 'Schedule of Specific Requirements as to Offshore Petroleum Exploration and Production 1995', and stemmed from an engineering specification used in the Gulf of Mexico in the 1970s. This was considered to be the limit at which a visible sheen could not be observed and was as low as the available water treatment and analysis technology of the day could achieve.*

*Regulations 29 and 29A were prescriptive within the wider 'objective-based' context of the Environment Regulations, and were inconsistent with the principles of risk management as found in ISO 31000, especially given OIW is only one class of contaminants associated with PFW mixtures discharged to the sea.*

*Under the amended Environment Regulations, discharges of PFW are to be assessed and managed in the same way as other emissions and discharges from offshore petroleum facilities. That is, it needs to be demonstrated that the impacts and risks will be of an acceptable level and reduced to as low as reasonably practicable (ALARP). It should be noted that while OIW limits may remain a valid control, the risk assessment process must address all impacts and risks. It may therefore be necessary to consider a range of other factors, including the PFW discharge regime, chemical composition, toxicity, extent of dispersion and fate (including potential for accumulation in sediments and biota).*

*Further, the Environment Regulations also require an appropriate implementation strategy with provisions for the monitoring of emissions and discharges, and reporting arrangements to facilitate assessment of whether environmental performance outcomes and standards are being met and control measures are effective. Together, these elements of the implementation strategy aim to ensure that all reasonable action is being taken to keep the impacts and risks from the discharge of PFW acceptable and ALARP.*

Therefore, this proposed calcite removal method should include a risk assessment of the environmental impacts. Each assessment should assess the likelihood of an impact occurring and the severity of the impact as part of the risk assessment, including the capacity of the environment to recover from the activity. Management of these environmental risks are conventionally assessed by a combination of risk levels, feasibility in delivery and cost effectiveness. Potential methods are assessed primarily as a waste hierarchy (see Appendix A and sections 7.2-7.4), which include cascading steps from elimination, to substitution and finally engineering controls.

## 7.1 Environmental risks

A risk assessment was completed by Beach ahead of the trial on the Y4 well in 2024; this covered all risks, including the potential environmental impact of the discharge of GLDA in PFW. Subsequent to the trial, a study was initiated in 2024 to review the impact of the batch dosing of the wells and flowing this back along with PFW to the Yolla-A discharge point (dump caisson). Field samples were taken and evaluated as per EP requirements (whole effluent toxicity [WET] testing and PFW quality parameters); this information was interpreted and modelled with supporting consultants. Further field samples were taken in mid-2025 (July and August) in accordance with Beach's adaptive management framework (refer to current EP) and were used to better inform the initial risk assessment undertaken prior to the commencement of descaling trials. An updated interpretation of the risk assessment incorporating this assessment is presented below:

## 7.2 Elimination

Various potential options were assessed for eliminating the discharge of PFW containing residual GLDA and well cleaning byproducts into the marine environment. These options are listed below:

- A 'No Treatment' option has been considered; however, severely scaled wells as had been observed prior to the first treatment will lead to early cessation of production within 12-24 months of ceasing current descaling operations.
- Primary PFW treatment methods, such as reverse osmosis, were ruled out due to lack of a viable disposal route for the concentrated waste stream and prohibitive costs.
- The Installation of a separate export pipeline to transport PFW to shore was also economically unfeasible and posed a high corrosion risk.
- Reinjection was considered but would require drilling new well(s), which is similarly uneconomical.

### 7.2.1 Primary PFW treatment prior to discharge

Options for removing GLDA from the PFW, including reverse osmosis treatment, were evaluated. These were ultimately ruled out due to the lack of a practical and economically viable method for disposing of the resulting supernatant.

### 7.2.2 Reinjection

PFW injection into either a capped well that is abandoned, or a new well was considered. All wells feeding back to the Yolla-A platform are required for production, thus a new well would be required to receive the PFW with GLDA and byproducts. An evaluation of sub-surface geological structures would be necessary, at an approximate cost in the order of $A120-150M, this is not economically viable.

A re-injection well has other complications and associated risks. There would need to be space on the Yolla-A platform to service the additional well, which would also require a conductor (i.e. pipe in casings that goes from deck level to below seabed), a hydraulic control system, injection pumps and a Xmas tree.

There is a potential risk that the reinjection well will also scale if it is targeting similar reservoirs/conditions to the production wells in the Yolla field.

### 7.2.3 Discharge through a pipeline for onshore management

This option involves no separation of PFW on the platform, but discharge to the onshore BassGas facility. There would be the need for substantial chemical injection (Mono Ethylene Glycol - MEG) and corrosion inhibitors. The supply of MEG to the platform would require either a pipeline or routine delivery by boat. The PFW would be separated at the onshore facility and would require on land management potentially through evaporation ponds. It would be necessary to obtain an EPA works approval as well as other approvals. This option would have high capital and operating costs (e.g. MEG Pipeline: $116M capital, $0.2M annual operating cost; MEG Boat delivery: $55M, capital $9.5M annual operating cost).

## 7.3 Substitution

### 7.3.1 Alternative chemicals

The substitution of GLDA with acid treatment could significantly increase the risk of corrosion to well and facilities metallurgy, thereby elevating the likelihood of containment loss and associated environmental impacts. Additionally, acid use would pose greater health and safety risks to personnel due to its hazardous nature.

### 7.3.2 Wireline drift runs

An alternative method of removing scale from the wellbore would be to conduct regular wireline drift runs and re-perforations, with runs required approximately every three months on wells with scale. Due to the high frequency, the practical application would involve permanent installation of an offshore wireline unit on Yolla-A. The efficacy of this solution has not been tested and may not be as effective at scale removal as using GLDA. This wireline work would also introduce a number of additional risks, including:

- Temporary well barriers, with increased risk of loss of well containment.
- Personnel exposure to risks associated with wireline work.
- Potential for stuck tools during each wireline run, with subsequent risk of damage to the asset and loss of the well.

Regular wireline drift runs would require Yolla-A to be permanently manned, introducing significant additional operational cost to the asset. Under Beach's risk assessment matrix, this would be ranked as "Major" cost impact (estimated between $10-$100M). Similarly, the installation of permanent wireline infrastructure, tools and associated crew mobilisation, would also be considered "Major" under the matrix ($10-$100M). Given these financial and logistical implications, regular wireline drift runs are not considered ALARP when compared to chemical descaling methods.

## 7.4 Engineering controls

The following potential engineering control measures (additional to those implemented during existing operations) were considered during the ALARP assessment.

### 7.4.1 Reduction of GLDA concentration applied

Guidance from the chemical supplier is that the optimum concentration of GLDA in the wellbore is 40% - 50% of their product and trials to date have aligned with this guidance. Typically, the chemical is batch delivered into the well in a diluted form, with the intent of achieving concentrations of ~40% GLDA/Water mix in the wellbore. Beach has completed one trial with lower concentrations of GLDA (20%) in the wellbore and noted poorer performance of the descaling, as observed via well behaviour post treatment.

Beach will continue to optimise the dosing strategy, with the aim of treating the wellbore scale effectively, and minimising any impacts on the produced water.

### 7.4.2 Reduction of GLDA and well cleaning byproduct concentrations discharged

#### 7.4.2.1 Steam stripper

The steam stripper was previously assessed as part of the 2019 ALARP assessment for PFW management. The proposed system included a demineralised water package, steam stripper unit and associated pumps, tie ins and demolition of some elements on the platform. The screening level estimated capital cost is $18.2M, operating cost has not been estimated. The power consumption estimate is equivalent to 400 kW using fuel gas. Despite these considerations, steam stripping has been assessed as a non-viable option, given available space, safety risks onboard the platform and need to transport supernatant off the platform to shore.

#### 7.4.2.2 MPPE

The MPPE system was previously assessed for the PFW ALARP in 2019 and comprises of a demineralised water package and ion exchange beds, pumps, the MPPE unit, tie ins and demolition. The estimated capital cost is $15.4M, operating cost has not been estimated. The power consumption estimate is 75 kW. Despite these, MPPE has been assessed as a non-viable option, given available space, safety risks onboard the platform and need to transport supernatant off the platform to shore.

#### 7.4.2.3 Increased pumping of raw seawater mix

This is considered a potentially viable option to reduce concentrations at the point of discharge, by introducing additional raw seawater into the PFW just prior to discharge. Options for obtaining seawater supply for dilution of PFW were assessed by Beach engineers, who concluded that only the firefighting line was in a suitable location on the platform to provide the quantities of raw seawater required. Given the risks to safety on board the platform though, this option was deemed unsuitable and would not meet thresholds for Safety Case approval.

# 8.0 Risk Assessment

Risk assessment of the descaling process have been compared to the previously approved ALARP for the PFW discharge on the Yolla-A platform (see Appendix B). These risk (and impact) assessments were also included as part of the existing EP (see table 7.26 of the EP for details).

We have identified further risks to the environment from the proposed action above those for PFW, which include:

- Changes in PFW characteristics resulting from increased scale minerals (metals and metalloids) and GDLA reagent constituents during unloading.
- Changes to buoyancy and dispersion characteristics of PFW in receiving waters resulting in increased mixing zone boundaries.
- Changes to toxicity of PFW as whole effluent toxicity (WET) resulting in increased toxicity.

A more recent assessment incorporating GLDA into the site-specific dilution factor and updated mixing zone boundaries (AECOM 2025) found:

- No changes to the buoyancy characteristics of the PFW discharge with the inclusion of GLDA. This has been modelled to an extent that no change in mixing zone boundaries is expected to occur as a result of buoyancy changes and is therefore not further considered in the risk assessment.
- Minor adjustments to the mixing zone boundaries using updated calculation methods and inputs, resulting in a mixing zone boundary that remains broadly consistent with historical delineations.

Based on the risk assessment, the key additional mitigating measures involve implementing appropriate online and/or routine total hydrocarbon monitoring systems. AECOM (2019) found that the ongoing discharge of PFW continues to have effects on the receiving environment and concluded that:

- "*Due to the small zone of impact associated with the PFW mixing zone, it is concluded that there is a negligible risk of the PFW having a significant impact upon the marine ecosystem within the receiving environment. It is reasonable to conclude that any impacts that may occur would be localised to those biological communities present in those habitats with long-term exposure to the PFW plume, which represent only a very small proportion of the total available similar habitat (i.e. other platform legs or subsea infrastructure). Any indirect impacts would be localised to those species that forage on the biota within the habitats that experience long-term exposure to the PFW plume*."

The risk analysis, evaluation and treatment are presented in Table 3. Key outcomes include:

- Given the expected changes to PFW profiles, it is expected that existing monitoring controls and implementation of Beach's adaptive management framework will likely maintain environmental quality of the receiving environment without significant changes to existing conditions.
- It is also important to note that GLDA is a gold CHARM rated chemical. Gold CHARM chemicals are currently approved for use in the existing EP (see table 7.26 of the EP for details), therefore the impacts from toxicant dispersion into receiving waters and subsequent changes to mixing zone boundaries from changes to PFW profiles remain the primary risk to existing approved activities.

**Table 3 Environmental Risk Assessment of Descaling Activity**

| Objective(s) | Potential Impact | Current Controls | Effectiveness of Controls | Current Risk | Additional Mitigation Measures | Residual Risk |
|---|---|---|---|---|---|---|
| To maintain the quality of water, sediment and biota so that environmental values are protected. | Acute adverse impact on the marine environment from PFW during unloading of descaling treatment above current accepted levels. Acute changes to mixing zone toxicity were modelled to occur within a 5-day period RPS 2025). Impacts included increase in the size of the mixing zone and higher concentrations of toxicant constituents in the mixing zone during the unloading phase. Ongoing impacts due to persistent elevated toxicant levels not expected after 5 days, when sufficient dilution is expected to occur. | Routine monitoring of the PFW on a weekly basis (BTEX and dispersed oil) and six-monthly comprehensive analysis. Implementation of the Adaptive Management Framework (AMF). | Currently effective in managing PFW discharge. Review of this data using the adaptive management framework should result in a response if necessary. e.g. re-evaluation of impact assessment and development of mitigating measures. | Potential adverse impact on the marine environment beyond accepted levels, potential non-compliance to EP conditions and NOPSEMA consents. Moderate / Unlikely **MEDIUM RISK** | Use GLDA at lowest effective concentration. Incorporate additional PFW sampling and analysis program in accordance with the Adaptive Management Framework to continue to assess possible changes in PFW toxicity. | Highly Unlikely / Moderate **LOW RISK** |

# 9.0 Synthesis

NOPSEMA (2024) provides guidance on the application of the ALARP principle in environmental impact and risk management, highlighting the importance of reasonable practicability in decision-making:

- Reducing impacts and risks to ALARP is based on the concept of reasonable practicability; the weighing up of the magnitude of impact or risk reduction against the cost of that reduction.
- The titleholder must adopt additional control measures or increase effectiveness of existing control measures if the cost of doing so is not grossly disproportionate to the environmental benefit gained.

**Based on the assessments undertaken on PFW toxicity changes from descaling activities, and in comparison to existing management frameworks, it is likely that existing control measures will be appropriate to manage risks to the receiving marine environment from the presence of residual GLDA and well cleaning byproducts within the PFW discharge to a level that is ALARP.**

It is considered that the costs and risks of implementing any measures to further reduce the risk of impacts to the receiving marine environment would be grossly disproportionate to any potential environmental benefit. The rationale supporting this conclusion, summarised in Table 4, is based upon the following considerations:

- The reinjection and onshore discharge via pipeline would eliminate discharge to the marine environment and rank highly on the hierarchy of controls. However, the pipeline option introduces land-based PFW disposal challenges, and both options would increase energy consumption, though not significantly, except for ship-based MEG supply.
- The substitution of GLDA with acid or increasing the frequency of wireline drift runs could introduce significant risks, including potential loss of well containment, that are disproportionately high relative to the potential reduction in risk of environmental impacts attendant to the inclusion of GLDA and well cleaning byproducts within the existing PFW discharge.
- Reducing the concentration of GLDA applied to the wells would compromise cleaning effectiveness, requiring more frequent application of GLDA to maintain well performance. This could result in annual discharge loads of GLDA and cleaning byproducts into the marine environment to greater than those under the existing cleaning regime.
- Diluting PFW with additional raw seawater prior to discharge would reduce constituent concentrations but would not eliminate the discharge itself.
- Technologies such as filtration, steam stripping, and MPPE are deemed unviable due to a combination of safety risks and prohibitive costs.
- Many alternative options would increase operational complexity, elevating health and safety risks and maintenance demands. While these could be managed within existing systems, they still represent a notable increase in operational burden.
- Capital costs for these alternatives are considered disproportionately high relative to the potential environmental gains, and substantial operating costs, many of which remain undefined, would also be incurred.

**Table 4 ALARP Assessment Synthesis**

| Control Measure | Hierarchy | Reduced Net Risk? | Cost Effective? | Adopted? | Justification |
|---|---|---|---|---|---|
| Reinjection of PFW containing GLDA | Elimination | No | No | No | The costs and environmental risks and impacts associated with drilling of a reinjection well, and with the reinjection process, would be grossly disproportionate to the environmental benefit potentially gained. |
| PFW containing GLDA transferred to shore via pipeline for onshore treatment and disposal | Elimination | No | No | No | Transfers increase the risks of spills and leaks. The costs and environmental impacts associated with construction of a pipeline to shore, and construction and operation of an onshore treatment facility, would be grossly disproportionate to the environmental benefit potentially gained. |
| PFW containing GLDA treated using Reverse Osmosis (RO) filtration | Elimination | No | No | No | Creates large amounts of supernatant that cannot be viably transferred to shore, hence would require dumping at sea. This negates all benefits of the treatment. Limited space aboard the Yolla-A platform may inhibit installation and safe use of an RO plant. |
| Use alternative chemical to GLDA | Substitution | No | Potentially | No | Chemical treatments with harsh acids (i.e. Hydrochloric Acid) are less desirable due to the increased risk to personnel (exposure), increased risk of corrosion of wells and facilities (with an attendant increased potential for loss of containment) and increased potential for environmental impact. |
| Implement wireline drift runs | Substitution | No | No | No | Frequent wireline drift runs would introduce additional risks, including increased potential for loss of well containment, personnel exposure, asset damage and well loss. The costs associated with the establishment and operation of a wireline unit would be grossly disproportionate to the environmental benefit potentially gained. |
| Reduction of GLDA concentration applied to the lowest effective level | Engineering | Yes | Yes | Yes | Use of Beach adaptive management framework including assessment of well performance after treatment and PFW toxicity profiles from existing screening procedures. |
| Reduction of GLDA and well cleaning products in PFW stream through re-engineering equipment. | Engineering | Yes | No | No | Costs associated with re-engineering of equipment would be grossly disproportionate to the environmental benefit potentially gained.<br>Use of existing equipment (i.e. fire water system) ruled out due to Safety Case considerations. |
| PFW toxicant monitoring | Administrative | N/A | N/A | Retained existing system | There is an existing PFW management system and monitoring plan, using certified equipment and standard processes, which demonstrates that the ongoing PFW discharge meets accepted toxicant thresholds. |

# 10.0 References

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# Appendix A

## Yolla Platform ALARP Assessment (AECOM 2019)

| Supplier | Cetco | ET Ventures | Symons | CWSL | Veolia | Mycelx | ABS Materials |
|---|---|---|---|---|---|---|---|
| Technology | Abs. | Abs.+Ads. | Absorption | Oxidation | Abs. | Abs. | Abs |
| Model | CruSorp | ET#1 | OPS RM25 Medium | AquaPurge | MPPE | Mycelx | PW Unit 1 |
| Capacity | Up to 2x67 $m^3$/hr | 2.3 $m^3$/hr (example not the max) | 1.3 $m^3$/hr (example not the max) | Up to 100 $m^3$/hr | Up to 70 $m^3$/hr | 66 $m^3$/hr | 14.3 $m^3$/hr |
| Weight | 2 tonnes for 2x1.2 $m^3$/hr; 32.3 tonnes for 67 $m^3$/hr | n/a | | 3 tonnes for 2$m^3$/hr or 5 tonnes for 66 $m^3$/hr | 1.5 tonnes for 1 $m^3$/hr or 2 tonnes for 6$m^3$/hr) | 770 kg for 66 $m^3$/hr | 3.4 tonnes (only the treating equipment |
| Footprint | 1.7x2x2.1 for 2x1.2 $m^3$/hr or 6.6x3x4 (60 $m^3$/hr capacity) | n/a | 2x3x? | 2x1.5x2 for 2 $m^3$/hr or 3x1x2 for 66 $m^3$/hr capacity | 1x1.5x1.7 for 1 $m^3$/hr or 1x1.7x2 for 60 $m^3$/hr capacity | 2.6x0.8x2.4 | 12.2x6.1 |
| Removal efficiency | 90% (from 100 mg/l to 10 mg/l) | 99% (from 150 ppm to 1.1 ppm) | 94% (from 80-180mg/l to average 5 mg/l with a maximum outlet concentration of 11 ppm | 50% - 60 % (from 50 ppm to 20 ppm) | 50 to 99% | 96% (from 121 to less than 5 ppm) | 99.9% (277 ppm to 0.1 ppm) |
| Applications and field trial | Several offshore, see [58] | Only trial onshore [57] | Several offshore, see [59] | A few field trials offshore and onshroe | Several offshore and onshore, see [60] | Field trial on shore, see [43] | Onshore pilot trial. Lab trials |

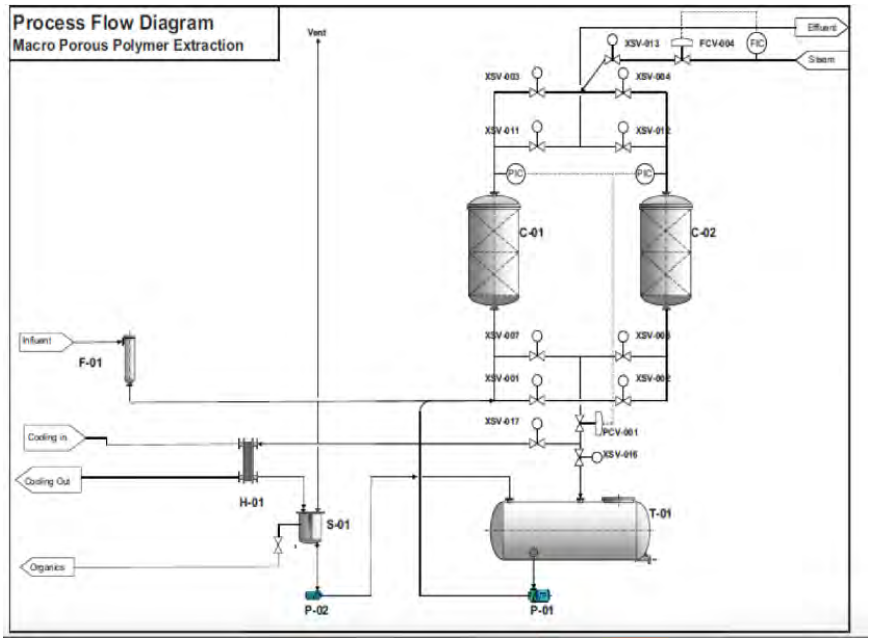
**Removal of dissolved and dispersed hydrocarbons from oil and gas produced water with Macro Porous Polymer Extraction (MPPE) to reduce toxicity and allow water reuse** (Dick Meijer and Chris Madin APPEA Journal 2010).

This technology (supplied by Veolia Water Solutions) has been used off shore at a number of locations. It is reported to remove (recover) dissolved hydrocarbons and BTEX to in excess of 99%. These hydrocarbons are recovered and can be re-injected with the gas/condensate stream sent on shore.

### 3.2.1.1 Conclusion – overseas technology review

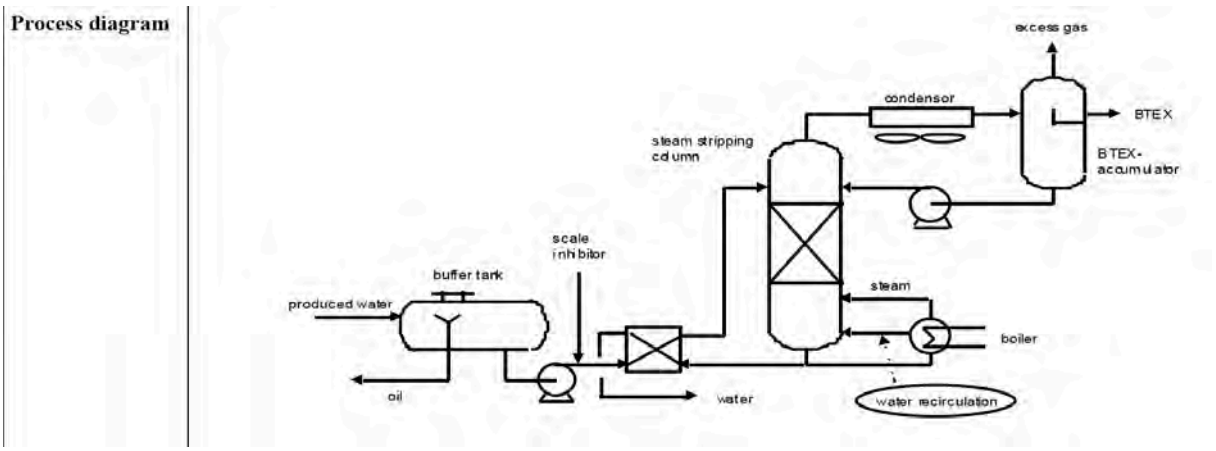
Based on the review of overseas experience, the suitable technologies that would be considered BAT and that could enhance the removal of the dissolved hydrocarbons and BTEX are steam stripping and MPPE. OSPAR (2012) provided the following process descriptions for these options.

#### 3.2.1.1.1 MPPE Information (OSPAR 2012)



| | Per Unit | Minimum | Maximum |
|---|---|---|---|
| **Technical details** | Treatment capacity ($m^3$ PW per hour) | 0.3-15 | 150 |
| | Gross Package volume (LxWxH) | 6.2 x 4 x 3 m | 10 x 6 x 12 m |
| | Operating weight | 10 ton | 250 ton |
| **Critical operational parameters** | | The main critical parameter is the measured outlet concentration vs. discharge limit. If this comes close to the discharge limit the MPPE material needs to be replaced. This is a very slow process (years) and can be done say on a weekly basis. The reduction performance is very stable and does not change overnight. | |
| **Operational reliability including information on downtime** | | The MPPE unit is fully automatic and remote controlled and has been in operation on an unmanned platform. | |

#### 3.2.1.1.2 Steam Stripper Information (OSPAR 2012)




| | Platform | Gas 1 (small) | Gas 2 (large) | Oil 1 |
|---|---|---|---|---|
| **Technical details** | PW volume (design) | 1 $m^3/h$ | 6 $m^3/h$ | N/A |
| | Required area (LxWxH) | 3 x 2 x 5 m | 6 x 3 x 5 m | |
| | Mass (filled) | 12 tonnes | 20 tonnes | |
| **Critical operational parameters** | | Since PW usually contains salts and solid particles, problems with depositions (scale) may occur in the boiler and the heat exchanger. In order to prevent concentration of salts in the boiler, it is recommended to create a slight throughput by means of a re-circulation line from the boiler to the column. The steam line must be large enough in order to allow for equal levels in boiler and column (and above the bundle of the boiler). In order to guarantee a constant | | |

| | Platform | Gas 1 (small) | Gas 2 (large) | Oil 1 |
|---|---|---|---|---|
| | | throughput, a buffer tank is required. This also provides the possibility to skim off oil, avoiding disruption of the process in the column. | | |
| **Operational reliability** | | When the PW contains large amounts of salts,<br>the installation will need to be shut down regularly to enable removal of salt depositions. | | |

The expected removal efficiency for BTEX is high: reduction from 50 mg/L to < 6 mg/L, aliphatic hydrocarbons from 30 mg/L to <3 mg/L. Removal efficiencies of >90% for dissolved oil, BTEX, benzene and PAHs.

### 3.2.2 PFW Management on Platforms in Australian waters

Current PFW treatment systems used on Oil and Gas platforms in Australian waters are summarised in Table 8. This is based on a review of publicly available documents provided on the NOPSEMA web site.

Two of the systems use injection wells, the others use subsurface marine discharges similar to Yolla. Most of the sites use simple oil water separation systems; e.g. degasser with additional treatment with flotation units. Two of the sites, in addition, use MPPE.

Where nominated, the PFW discharge rates are much higher than from the Yolla platform, resulting in larger plumes.

The systems used on the Yolla platform to treat the PFW (see section 2.0) are generally similar to most of the other platforms used in Australian Waters (Table 8). The monitoring results demonstrate that the Yolla system is effective in removing dispersed oil (Section 2.2). None of the other platforms report using a BTEX stripper, while two platforms use MPPE (refer Section 3.2.1.1.1 for process details).

Based on local experience it can be concluded that further consideration should be given to the options of injection wells and MPPE for management of PFW from the Yolla platform.

### 3.2.3 Best Practice Review Conclusion

Based on the review of overseas and local experience the following best practice options should be considered for the ALARP assessment:

- Reinjection Wells
- A steam Stripper
- MPPE.

**Table 8 PFW treatment and disposal on Oil and Gas Industry platforms in Australian waters.**

| Platform | Treatment | Discharge | Reference |
|---|---|---|---|
| Ngujima-Yin (NY) Floating Production Storage and Offloading Facility | PW treatment begins in one of two HP separators, with chemical injection, then enters a coagulation vessel and through to a hydro-cyclone unit. From the hydro-cyclone, the PW is directed through one of the PW filters continues on through to the PW degasser. The degasser is fitted with an internal oil skimming facility to remove residual oil build-up in the degasser vessel. | Injection Wells | Ngujima-Yin Floating Production Storage and Offloading Facility Operations Environment Plan Summary. Woodside, December 2018 |
| Angel Operations | The PW system is designed to direct streams from the process areas to the PW degasser to remove dissolved gas and condensate before disposal overboard above the water line at +8 m LAT. | Marine subsurface | Angel Operations Environment Plan Summary. Woodside, December 2018 |
| Goodwyn Alpha (GWA) Facility | The PW system directs all PW streams from the process areas to the PW degasser. Adsorbent hydrocarbon filters to remove dispersed oil from the PW stream are installed on GWA. The system is used sparingly and primarily to manage OIW upsets. | Marine subsurface | Goodwyn Alpha (GWA) Facility Operations Environment Plan Summary. Woodside, October 2018 |
| Ichthys Project Offshore Facility | Use primary PW treatment system to reduce OIW concentrations. Use MPPE as a secondary PW treatment system. During normal operations, use of primary and secondary PW treatment systems to achieve OIW discharge, to meet ≤30 mg/L, on a rolling 24-hour average. Whether this was total hydrocarbons was not specified. | Marine subsurface | Ichthys Project Offshore Facility (Operation) Environment Plan Summary |
| Esso Bass Strait | PFW is separated from crude oil and then treated by dissolved gas flotation and/or hydro-cyclones to remove oil to below 30 mg/L before discharge to the ocean. Whether this was total hydrocarbons was not specified. | Marine subsurface | Esso Bass Strait Operations EMP |
| Prelude FLNG | Oil Water Separation and MPPE. | Marine subsurface | Prelude FLNG Environment Plan Summary. Shell |
| Pyrenees Operations | PFW and slops water is discharge to the sea from the Compact Flotation Unit (CFU) and Dissolved Gas Flotation unit (DGF) if not greater than an average of 30 mg/L over any rolling period of 24 hours. | Under normal operating conditions, 90% of PFW will be re-injected. | Pyrenees Operations Environment Plan (Commonwealth Summary) BHP 2019 |
| *North Rankin Complex* | The PW system directs all PW streams from the process to the PW degasser to remove dissolved gas. The degasser allows mixing and provides a hold-up volume for the control of a uniform feed to the PW centrifuge(s), thus ensuring efficiency of the centrifuge is not affected by gas breakout. The system also returns water to the degasser. | Marine subsurface | North Rankin Complex Operations Environment Plan Summary. Woodside, September 2019 |

## 3.3 ALARP Assessment

Based on the best practice review discussed in Section 3.2 and an assessment of land management undertaken by Beach (BassGas Raw Gas Pipeline Feasibility Study, Worley Parsons May 2009), the below options were identified for the ALARP assessment. Two approaches were then taken to ALARP assessment, one based on the waste hierarchy and the second based on selected criteria.

- **Reinjection**

In consideration of PFW injection into a well, all four wells on Yolla are required for production. Therefore, it would require a new well. It would be necessary to evaluate a sub-surface structure that could accept the PFW, but may require a new well (roughly circa $A40 million excluding rig mobilisation/demobilisation cost), injection pumps and Xmas tree.

A re-injection well has other complications. There would need to be space on the platform for the additional well, which would also require a conductor (i.e. pipe in casings that goes from deck level to below seabed), hydraulic control system etc. The Xmas tree should be a fair bit smaller than the existing trees given the PFW volumes involved.

- **Discharge through the pipeline for on shore management**

This option involves no separation of PFW on the platform, but discharge to the on shore BassGass facility. There would be the need for substantial chemical injection (Mono Ethylene Glycol - MEG) and corrosion inhibitors. The supply of MEG to the platform would require either a pipeline or routine delivery by boat. The PFW would be separated at the LLGP and would require on land management potentially through evaporation ponds. It would be necessary to obtain an EPA works approval as well as other approvals. This option was rejected in 2009 due to the high capital and operating cost (MEG Pipeline: $116M capital, $0.2M annual operating cost; MEG Boat delivery: $55M, capital $9.5M annual operating cost).

- **Steam stripper**

Two stripping options were considered by Advisian (Yolla Produced Water Improvement TIC estimated Dec 2019 included in **Appendix D**) - a gas stripper and a steam stripper. More details are provided in that report. The gas stripper utilises the fuel gas produced in the platform to strip volatiles from the PFW. This system was available for use from 2006-2009 but was removed due to its inefficiency for removal of BTEX. This option was not considered further in this assessment. The steam stripper comprises of a demineralised water package, a steam stripper and associated pumps, tie ins and demolition of some elements on the platform. The screening level estimated capital cost is $18.2 M, operating cost has not been estimated. The power consumption estimate is equivalent to 400 kW using fuel gas.

- **MPPE**

The MPPE system comprises of a demineralised water package and ion exchange beds, pumps, the MPPE unit, tie ins and demolition (see **Appendix D**). The screening level estimated capital cost is $15.4 M, operating cost has not been estimated. The power consumption estimate is 75 kW.

### 3.3.1 ALARP Assessment based on the Waste Hierarchy

The comparison of the four options based on the waste hierarchy is presented in Table 9.

Avoidance is generally considered to mean eliminating the source. In this case avoidance of discharging to the marine environment is addressed through a change in the processing/ discharge regime.

The outcome of the comparison is that, based on the waste hierarchy, reinjection would be preferable, although a new injection well would be required, with an associated high cost (estimated at more the $40M for the drilling and up to an additional $40M for mobilisation/demobilisation). The suitability of the geological strata is yet to be confirmed.

**Table 9 Assessment of the Options using the Waste Hierarchy**

| Criteria | Option 1 Reinjection | Option 2 Pipeline discharge | Option 3 Steam Stripping | Option 4 MPPE | Current System |
|---|---|---|---|---|---|
| Avoidance | This avoids discharge to the sea. However, it will require additional treatment and use of chemicals. It may be necessary to drill a new injection bore | This avoids discharge to the sea but requires significant additional chemical usage in terms of corrosion inhibiters. It moves management of the PFW to a land-based system | This does not avoid discharges but allows recovery of hydrocarbons | This does not avoid discharges but allows recovery of hydrocarbons | This does not avoid discharges |
| Reuse/Recycling | N/A | Given the saline nature of the PFW, reuse and recycling are not feasible | This does not facilitate reuse of water but recovery of some hydrocarbons | This does not facilitate reuse of water but recovery of some hydrocarbons | This does not facilitate reuse of water or recovery of some hydrocarbons |
| Recovery of Energy | This will require energy for pumped reinjection, and an additional injection well | N/A | This requires additional energy for steam production and pumping | This requires additional energy for steam production and pumping | N/A |
| Treatment | Additional treatment is required | Land based treatment and disposal would need to occur | This is a treatment option | This is a treatment option | This is a treatment option |
| Containment | This involves containment in the geological substrata. | N/A | N/A | N/A | N/A |

### 3.3.2 ALARP Assessment based on Selected Criteria

The assessment of the four options against the base case (current situation) for the selected criteria is presented in Table 10.

The proposed option of reinjection and pipeline discharge would result in no discharge to the marine environment and hence is high on the waste hierarchy. The pipeline option would result in PFW disposal issues on land. The four options will increase energy consumption but are not major contributors (other than a ship-based supply of MEG to the platform in the case of the pipeline option and the steam stripping). The four options produce some minor waste streams.

The increased complexity relating to the operations increases the health and safety risk profile and increased operations and maintenance requirements. Both of these aspects should be manageable under existing systems.

Implementation timeframes are estimated in the range up to 2.5 years with possible additional time for government approvals.

In all cases, including the base case, an update of the EP will be required as well as other approvals for modifications to the platform, an injection well or EPA Works Approval for land-based modification for the pipeline option.

The capital costs are in the range of $15.4M - $55M+; operating costs have not been defined for all options.

The capacity of the platform with respect to weight and area has not been assessed for the MPPE and steam stripper options.

As noted in Table 10,the options would eliminate the impacts or reduce the mixing zone from 7 m to less than 3.5 m. Eliminating the mixing zone would cost between $55M capital and $9.5M annual for the pipeline options, and more than $40M for the reinjection option, if found to be feasible.

## 3.4 ALARP Conclusion

Given the discussion of ALARP presented by NOPSEMA:

*Reducing impacts and risks to ALARP is based on the concept of reasonable practicability; the weighing up of the magnitude of impact or risk reduction against the cost of that reduction[4]. In this context, a titleholder is required to implement all available control measures where the cost is not grossly disproportionate to the environmental benefit gained from implementing the control measure.*

It is concluded that the cost of implementing any of the four options is grossly disproportionate to the environmental benefit of implementing any of four options. This is because:

- the PFW flow is relatively low (compared to other platforms)
- the toxicity (as measured by the WET testing) can be managed with low dilutions
- the extent of the mixing zone is very small (less than 7.3 m based on the WET testing and plume modelling).

Therefore, it is concluded that it has been demonstrated that the current system represents an ALARP solution. The risk of impacts on the environment can be considered minimal and, therefore, acceptable.

**Table 10 Options Assessment**

| Criteria | Option 1 Reinjection | Option 2 Pipeline Discharge | Option 3 Steam Stripping | Option 4 MPPE | Current System (base case) |
|---|---|---|---|---|---|
| Marine Emissions | No discharges to the marine environment | No discharges to the marine environment | Extent of mixing zone reduced by 50% or more to less than 3.5 m | Extent of mixing zone reduced by 50% or more to less than 3.5 m | Mixing zone impact (NOEC) less than 7.3 m from discharge. |
| Air impacts | No impact | No impact | No impact | No impact | No impact |
| Energy/Greenhouse Gas | Additional energy consumption/greenhouse gas emissions through drilling and additional treatment and pumping to well | Additional energy consumption/greenhouse gas emissions due to chemical dosing on platform and additional PFW management on shore (overall energy consumption not estimated in the Worley 2009 study) | Additional energy/greenhouse gas emissions (400 kW equivalent from gas usage) for treatment and steam production | Additional energy/greenhouse gas emissions (75 kW gas/electricity usage) for treatment and steam production | No additional energy/greenhouse gas emissions |
| Other Waste streams | Minor waste streams from additional treatment | Minor waste streams from additional treatment, plus management of MEG | No additional waste streams other than steam related blowdown | No additional waste streams other than steam related blowdown | No additional waste streams |
| Waste hierarchy | Eliminates/Avoids discharge to the marine environment | Eliminates/Avoids discharge to the marine environment | Enhanced Treatment of the PFW with recovery of hydrocarbons | Enhanced Treatment of the PFW with recovery of hydrocarbons | Treatment with no recovery of hydrocarbons |
| Health and Safety | Some additional complexity of operation unlikely to significantly change the H&S risk profile | Some additional complexity of operation unlikely to significantly change the H&S risk profile | Additional complexity with added PFW processing, including steam generation, likely to increase the H&S risk profile | Additional complexity with added PFW processing, including steam generation, likely increase the H&S risk profile | No change in risk profile. |

| Criteria | Option 1 Reinjection | Option 2 Pipeline Discharge | Option 3 Steam Stripping | Option 4 MPPE | Current System (base case) |
|---|---|---|---|---|---|
| Capital cost | $40M+ (2019$), plus up to $40M for movilisation/demobilisation | $55-116M (2009$) depending on the MEG supply option. | $18.2M (2019$) | $15.4M (2019$) | No increase |
| Operating cost | Not assessed | $9.5-$0.2M (2009$) depending on the MEG supply option | Not assessed | Not assessed | No increase |
| Operations and Maintenance Availability | Increased operations and maintenance due to additional treatment, pumping pipeline and well | Increased operations and maintenance due to additional treatment, MEG management and on shore PFW management | Increased operations and maintenance due to additional treatment including steam generation | Increased operations and maintenance due to additional treatment including steam generation | No change in O&M activities |
| Licencing/approvals | Additional approvals would be required for an injection well | The EP would need to be updated and approvals for new processes required. An EPA works approval for the onshore activities would be required. | The EP would need to be updated and approvals for new processes required. | The EP would need to be updated and approvals for new processes required | No change |

# 4.0 Risk Assessment

## 4.1 Methodology

The risk assessment methodology is consistent with the proposed methodology included in NOPSEMA documentation (e.g. Oil Pollution Risk Management Guidance Note Feb 2018 Doc. A382148; Environment plan content requirements Guidance note N-04750-GN1344 Revision 4 - 17 April 2019 Doc. A339814) and Beach risk management procedures (see **Appendix E**).

## 4.2 Establish the Context

The context of the assessment is the response to the NOPSEMA EIN issued on the 27th August 2019 and the need to update the EP. The scope of the assessment is the discharge of hydrocarbons in the PFW into the marine environment. The marine environment is described in detail in Section 5 (Existing Environment) of the EP. The current system for managing PFW is described in Section 2.0 of this report. The characteristics of the PFW are described in Sections 2.1 and 2.2 of this report. The assessment of the current PFW treatment system, and of the risk of impacts from which it is concluded that it represents an ALARP solution, is presented in Section 3.3. In a recent meeting NOPSEMA raised the issue of impact on marine life e.g. seals. In response AECOM prepared the memo Potential Impact of Yolla Platform PFW Discharge on Marine Life which is included as **Appendix F** (AECOM 2019).

## 4.3 Risk Identification

The identified risks in relation to the impact of hydrocarbons discharged with the PFW were:

- Failure of oil water separation resulting in the increased discharge of dispersed oil.

The monitoring data indicate that the oil water separation system is effective in removing dispersed oil. The current on-line monitors appear to be adequate for assessing peak and daily average results relative to criteria. Failure of the separation systems would result in increased impact on the marine environment.

- Changes in PFW characteristics resulting in increased hydrocarbons, particularly dissolved hydrocarbons including BTEX.

In comparing historical data with data from the past 2-3 years there has been an increase in some constituents. These have the potential to change impacts on the marine environment. Current on-line monitoring does not provide this data while routine monitoring does.

- Failure of existing OIW monitoring systems to adequately monitor dispersed oil.

The current on-line monitors appear to be adequate for assessing peak and daily average results relative to criteria. If they were to fail then discharges exceeding criteria would not be identified.

- Inadequate total hydrocarbon monitoring.

Currently no routine total hydrocarbon monitoring occurs other than the six-monthly comprehensive analysis. The current assessment concludes that the PFW systems are at ALARP and the risks of impacts are minimal and acceptable. Should the characteristics of the PFW increase suddenly (which is not considered likely) there is potential for increased impacts (i.e. greater plume size).

## 4.4 Risk Analysis, Evaluation and Treatment

The risk analysis, evaluation and treatment are presented in Table 11.

Based on the risk assessment, the key additional mitigating measures are implementing suitable on line and/or routine total hydrocarbon monitoring systems. In addition, incorporation of annual WET testing of the PFW to confirm the findings to date. With respect to impacts on marine life AECOM (2019) concluded

*Due to the small zone of impact associated with the PFW mixing zone, it is concluded that there is a negligible risk of the PFW having a significant impact upon the marine ecosystem within the receiving environment. It is reasonable to conclude that any impacts that may occur would be localised to those biological communities present in those habitats with long-term exposure to the PFW plume, which represent only a very small proportion of the total available similar habitat (i.e. other platform legs or subsea infrastructure). Any indirect impacts would be localised to those species that forage on the biota within the habitats that experience long-term exposure to the PFW plume.*

As the risk was considered negligible the impact was not considered further.

**Table 11 Risk Analysis, Evaluation and treatment**

| Risk Issue | Impact | Current Controls | Effectiveness of Controls | Consequence | Likeli-hood | Risk | Additional Mitigation Measures | Residual Risk |
|---|---|---|---|---|---|---|---|---|
| Failure of oil water separation resulting in the increased discharge of dispersed oil. | Adverse impact on the marine environment through increase in the size of the mixing zone and higher concentrations of hydrocarbons in the mixing zone. Non-compliance with the EP and regulations | Routine system maintenance, monitoring and alarms from OIW monitoring system, should the OIW monitoring exceed 20 mg/L daily sampling of PFW discharges is commenced. | Maintenance systems are considered effective, the OIW monitoring systems are problematic. There are two monitors such that redundancy is provided. The OIW systems may be adequate for monitoring dispersed oil but are not effective for total hydrocarbons. Based on the weekly monitoring data (e.g. Table 2) there have been no exceedances of 30/50 mg/L dispersed oil historically | Potential adverse impact on the marine environment, NOPSEMA Notice or Fine<br>**Consequence: Moderate- Serious** | Unlikely | Medium | Improved Monitoring of dispersed oil | Highly unlikely/ Moderate:<br>**Low Risk** |
| Changes in PFW characteristics resulting in increased hydrocarbons particularly dissolved hydrocarbons including BTEX | Adverse impact on the marine environment through the increase in the size of the mixing zone and higher concentrations of hydrocarbons in the mixing zone if not detected and addressed. Non-compliance with the EP and regulations. The review included in this report indicates that characteristics have | Routine monitoring of the PFW on a weekly basis (BTEX and Dispersed oil) and six-monthly comprehensive analysis | It is not a control as such. The review of this data should result in a response if necessary. e.g. re-evaluation of impact assessment and development of mitigating measures. | It is likely that dissolved hydrocarbons and BTEX increases would occur gradually rather than suddenly unless there was a significant change in operations e.g. an additional well. This type of event would be addressed through Management of Change procedures. Potential adverse impact on the marine environment, NOPSEMA Notice or Fine<br>**Consequence:** | Possible | Medium | Implementation of suitable on-line total hydrocarbon monitoring, weekly monitoring for total hydrocarbons (as well as BTEX and dispersed oil), annual WET testing | Highly unlikely/ Moderate<br>**Low risk** |

| Risk Issue | Impact | Current Controls | Effectiveness of Controls | Consequence | Likeli-hood | Risk | Additional Mitigation Measures | Residual Risk |
|---|---|---|---|---|---|---|---|---|
| | changed with increases in BTEX in particular. However, the assessment of the impact found that it is small (mixing zone of <7.3 m) | | | **Moderate** | | | | |
| Failure of existing OIW monitoring systems to adequately monitor dispersed oil | Adverse impact on the marine environment through increase in the size of the mixing zone and higher concentrations of hydrocarbons in the mixing zone if not detected and addressed. Non-compliance with the EP and regulations. | Routine system maintenance, monitoring and alarms from OIW monitoring system, should the OIW monitoring exceed 20 mg/L daily sampling of PFW discharges is commenced. | The inline monitoring is maintained and are routinely calibrated. There are two monitors such that redundancy is provided. The OIW systems may be adequate for monitoring dispersed oil but are not effective for total hydrocarbons. Based on the weekly monitoring data (e.g. Table 2) there have been no exceedances of 30/50 mg/L dispersed oil historically | The lack of reliable data means that operators do not know whether the discharge complies with the requirements. Potential adverse impact on the marine environment, NOPSEMA Notice or Fine **Consequence: Moderate- Serious** | Possible | Medium | Reassessment of the suitability of the on-line monitors - if requiring replacement, implement the recommended actions | Highly unlikely/ Moderate **Low risk** |
| Inadequate total hydrocarbon monitoring | Adverse impact on the marine environment through increase in the size of the mixing zone and higher concentrations of hydrocarbons in the mixing zone if not detected and addressed. Non- | Routine monitoring of the PFW on a weekly basis (BTEX and Dispersed oil) and six-monthly comprehensive analysis) | It is not a control as such. The review of this data should result in a response if necessary. e.g. re-evaluation of impact assessment. Development of mitigating measures. | The lack of reliable data means that operators do not know whether the discharge complies with the requirements potential adverse impact on the marine environment, NOPSEMA Notice or Fine **Consequence: Moderate** | Likely | Medium | Implementation of suitable on-line total Hydrocarbon Monitoring, weekly monitoring for total hydrocarbons (as well as BTEX and dispersed oil), annual WET testing | Highly unlikely /Moderate **Low risk** |

| Risk Issue | Impact | Current Controls | Effectiveness of Controls | Consequence | Likeli-hood | Risk | Additional Mitigation Measures | Residual Risk |
|---|---|---|---|---|---|---|---|---|
| | compliance with the EP and regulations. The review included in this report indicates that characteristics have changed with increases in BTEX in particular. However, the assessment of the impact found that it is small (mixing zone of <7.3 m). | | | | | | | |

# 5.0 Discussion, conclusions and recommendations

## 5.1 Introduction

The NOPSEMA EIN indicates:

*The following action must be taken by the titleholder within the period specified above:*

*5.1. Implement produced water treatment and monitoring measures to ensure that levels of total petroleum hydrocarbons are not greater than 50 mg/L at any time, and that there is an average of less than 30 mg/L over any period of 24 hours as described in the Bass Gas Offshore Environment Plan; or*

*5.2. Comply with regulation 7 by any other suitable means as required to remove the threat, such as demonstrate that impacts and risks from the discharge of produced water will be reduced to a level that is acceptable and as low as reasonably practicable (ALARP).*

The following discussion, conclusions and recommendations address both clauses 5.1 and 5.2 of the NOPSEMA EIN. It is noted that the notice advises that clause 5.1 or 5.2 could be addressed to demonstrate compliance. Based on this report, clause 5.2 has been addressed fully and demonstrates compliance. In relation to clause 5.1, see the discussion below.

## 5.2 Response to Clause 5.1

As noted in this report and documentation for NOPSEMA, the 30 mg/L and 50 mg/L criteria derive from dispersed oil criteria ("Oil in Water"). This was then adopted as *30 mg/L and 50 mg/L of petroleum using an oil in water monitor*. The NOPSEMA notice and inspection report interpret this as being total hydrocarbons. The EP describes OIW as *including soluble and insoluble hydrocarbons.* NOPSEMA has also indicated (see clause 5.2 above) that ALARP needs to be demonstrated (see section 5.3 below) and *OIW may remain a valid control*. To date, the weekly monitoring includes BTEX and dispersed oil and the six-monthly comprehensive monitoring includes all hydrocarbons (as total petroleum hydrocarbons).

The recent results are summarised in the following Table 12.These results demonstrate the effectiveness of the PFW treatment system for removing dispersed oil. They also indicate that total hydrocarbons have been found at up to 140 mg/L.

The WET testing found that for 110-120 mg/L hydrocarbons (Sept -Oct 2019), 1.6% dilution provides a NOEC for all species tested. Plume modelling has found that this results in an impacted mixing zone of up to 7.3 m from the discharge point.

The approach used is consistent with ANZG guidelines for site-specific development of compliance criteria and with the OSPAR approach (OSPAR Commission 2012, OSPAR Recommendation 2012/5) to impact assessment. It is not currently proposed to undertake field testing of the plume as two different dispersion models were used giving similar results and this is a valid validation mechanism.

In relation to impact on marine life, due to the small zone of impact associated with the PFW mixing zone, it is concluded that there is a negligible risk of the PFW having a significant impact upon the marine ecosystem within the receiving environment.

In relation to OIW as a valid control, AECOM proposes the following to be incorporated into the EP:

- The 30 mg/L and 50 mg/L remain as a control point as currently monitored.
- Beach to implement enhanced monitoring of total hydrocarbons, either on line and/or routinely (e.g. weekly).
- The data should be reviewed in line with monthly reporting requirements.
- Total produced water discharge not to exceed 300$m^3$ per day.

In the context of the existing systems being ALARP, as discussed in Section 5.3 below, the proposed control points can address the potential risks and impacts and provide an expanded monitoring program.

**Table 12 Comparison of weekly analyses and comprehensive analysis.**

| | ACS (OSPAR,Non-NATA) | | ALS/Eurofins (NATA) | |
|---|---|---|---|---|
| Date | Dispersed Oil (C7-C40) mg/L | BTEX (mg/L) | Total Hydrocarbons (C6-C36/40) (mg/L) includes BTEX | BTEX (mg/L) |
| 5-Dec-17 | 6 | | | |
| 10-Dec-17 | | | 51 | 31 |
| 12-Dec-17 | 12 | | | |
| 5-Jun-18 | 14.6 | | | |
| 12-Jun-18 | 9 | | 143 | 51.9 |
| 19-Jun-18 | 17.1 | | | |
| 5-Dec-18 | 5 | 52.5 | | |
| 11-Dec-18 | 6.1 | 49.9 | 137 | 92 |
| 12-Aug-19 | 5 | 77 | | |
| 15-Aug-19 | | | 135 | 54 |
| 27-Aug-19 | 5 | 68 | | |
| 15-Sep-19 | <5 | 67 | | |
| 25-Sep-19 | | | 71.3-80.3 | 53 |
| 29-Sep-19 | <5 | 60 | | |
| 2-Oct-19 | | | 115-127 | 63.1 |
| 7-Oct-19 | <5 | 54 | | |
| 10-Oct-19 | | | 113-127 | 55.9 |

## 5.3 Response to clause 5.2

The discussion of ALARP presented by NOPSEMA is as follows:

*Reducing impacts and risks to ALARP is based on the concept of reasonable practicability; the weighing up of the magnitude of impact or risk reduction against the cost of that reduction[4]. In this context, a titleholder is required to implement all available control measures where the cost is not grossly disproportionate to the environmental benefit gained from implementing the control measure.*

It was concluded that the cost of implementing any of the four options is grossly disproportionate to the environmental benefit of implementing any of four options. This is because:

- the PFW flow is relatively low (compared to other platforms)
- the toxicity (as measured by the WET testing) can be managed with low dilutions
- the extent of the mixing zone is very small (less than 7.3 m based on the WET testing and plume modelling.

Therefore, it is concluded that it has been demonstrated that the current system represents an ALARP solution. The risk of impacts on the environment can be considered as minimal and, therefore, acceptable.

Additional monitoring has been recommended to provide the operator with information on the total hydrocarbons being discharged to ensure the PW discharge properties are still valid to the ALARP assessment.

# 6.0 References

ACS Laboratories –Lab Reports 2017-2019

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# 7.0 Limitations

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Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

# Appendix A

## Wet Test Chemical Analyses Reports

**Beach Energy Limited**
**5775 South Gippsland Highway**
**Lang Lang**
**VIC 3984**

**NATA Accredited**
**Accreditation Number 1261**
**Site Number 18217**

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

**Attention:** **Adrian Cukovski**

**Report** **679568-W**
Project name 1858
Received Date Sep 27, 2019

| **Client Sample ID** | | | **Y0250919-3** |
|---|---|---|---|
| **Sample Matrix** | | | **Water** |
| **Eurofins Sample No.** | | | **S19-Se42146** |
| **Date Sampled** | | | **Sep 27, 2019** |
| Test/Reference | LOR | Unit | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | |
| TRH C6-C9 | 0.02 | mg/L | 71 |
| TRH C10-C14 | 0.05 | mg/L | 0.33 |
| TRH C15-C28 | 0.1 | mg/L | < 0.1 |
| TRH C29-C36 | 0.1 | mg/L | < 0.1 |
| TRH C10-C36 (Total) | 0.1 | mg/L | 0.33 |
| **BTEX** | | | |
| Benzene | 0.001 | mg/L | 14 |
| Toluene | 0.001 | mg/L | 25 |
| Ethylbenzene | 0.001 | mg/L | 0.94 |
| m&p-Xylenes | 0.002 | mg/L | 10 |
| o-Xylene | 0.001 | mg/L | 2.7 |
| Xylenes - Total | 0.003 | mg/L | 13 |
| 4-Bromofluorobenzene (surr.) | 1 | % | 89 |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | |
| Naphthalene[N02] | 0.01 | mg/L | 0.63 |
| TRH C6-C10 | 0.02 | mg/L | 80 |
| TRH C6-C10 less BTEX (F1)[N04] | 0.02 | mg/L | 27 |
| TRH >C10-C16 | 0.05 | mg/L | 0.33 |
| TRH >C10-C16 less Naphthalene (F2)[N01] | 0.05 | mg/L | - |
| TRH >C16-C34 | 0.1 | mg/L | < 0.1 |
| TRH >C34-C40 | 0.1 | mg/L | < 0.1 |
| TRH >C10-C40 (total)* | 0.1 | mg/L | 0.33 |
| **Polycyclic Aromatic Hydrocarbons** | | | |
| Acenaphthene | 0.001 | mg/L | < 0.001 |
| Acenaphthylene | 0.001 | mg/L | < 0.001 |
| Anthracene | 0.001 | mg/L | < 0.001 |
| Benz(a)anthracene | 0.001 | mg/L | < 0.001 |
| Benzo(a)pyrene | 0.001 | mg/L | < 0.001 |
| Benzo(b&j)fluoranthene[N07] | 0.001 | mg/L | < 0.001 |
| Benzo(g.h.i)perylene | 0.001 | mg/L | < 0.001 |
| Benzo(k)fluoranthene | 0.001 | mg/L | < 0.001 |
| Chrysene | 0.001 | mg/L | < 0.001 |
| Dibenz(a.h)anthracene | 0.001 | mg/L | < 0.001 |
| Fluoranthene | 0.001 | mg/L | < 0.001 |
| Fluorene | 0.001 | mg/L | < 0.001 |
| Indeno(1.2.3-cd)pyrene | 0.001 | mg/L | < 0.001 |

| Client Sample ID | | | Y0250919-3 |
|---|---|---|---|
| Sample Matrix | | | Water |
| Eurofins Sample No. | | | S19-Se42146 |
| Date Sampled | | | Sep 27, 2019 |
| Test/Reference | LOR | Unit | |
| **Polycyclic Aromatic Hydrocarbons** | | | |
| Naphthalene | 0.001 | mg/L | 0.002 |
| Phenanthrene | 0.001 | mg/L | < 0.001 |
| Pyrene | 0.001 | mg/L | < 0.001 |
| Total PAH* | 0.001 | mg/L | 0.002 |
| 2-Fluorobiphenyl (surr.) | 1 | % | 107 |
| p-Terphenyl-d14 (surr.) | 1 | % | 119 |
| **Glycols*** | | | |
| Di-Ethylene Glycol* | 20 | mg/L | < 20 |
| Ethylene glycol* | 20 | mg/L | < 20 |
| Propylene glycol* | 20 | mg/L | < 20 |
| Triethylene glycol* | 20 | mg/L | < 20 |
| **Phenols (Halogenated)** | | | |
| 2-Chlorophenol | 0.003 | mg/L | < 0.003 |
| 2.4-Dichlorophenol | 0.003 | mg/L | < 0.003 |
| 2.4.5-Trichlorophenol | 0.01 | mg/L | < 0.01 |
| 2.4.6-Trichlorophenol | 0.01 | mg/L | < 0.01 |
| 2.6-Dichlorophenol | 0.003 | mg/L | < 0.003 |
| 4-Chloro-3-methylphenol | 0.01 | mg/L | < 0.01 |
| Pentachlorophenol | 0.01 | mg/L | < 0.01 |
| Tetrachlorophenols - Total | 0.03 | mg/L | < 0.03 |
| Total Halogenated Phenol* | 0.01 | mg/L | < 0.01 |
| **Phenols (non-Halogenated)** | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | 0.1 | mg/L | < 0.1 |
| 2-Methyl-4.6-dinitrophenol | 0.03 | mg/L | < 0.03 |
| 2-Methylphenol (o-Cresol) | 0.003 | mg/L | 0.12 |
| 2-Nitrophenol | 0.01 | mg/L | < 0.01 |
| 2.4-Dimethylphenol | 0.003 | mg/L | 0.049 |
| 2.4-Dinitrophenol | 0.03 | mg/L | < 0.03 |
| 3&4-Methylphenol (m&p-Cresol) | 0.006 | mg/L | 0.10 |
| 4-Nitrophenol | 0.03 | mg/L | < 0.03 |
| Dinoseb | 0.1 | mg/L | < 0.1 |
| Phenol | 0.003 | mg/L | 0.19 |
| Total Non-Halogenated Phenol* | 0.1 | mg/L | 0.459 |
| Phenol-d6 (surr.) | 1 | % | 48 |
| | | | |
| Chloride | 1 | mg/L | 11000 |
| Conductivity (at 25°C) | 1 | uS/cm | 29000 |
| Nitrate & Nitrite (as N) | 0.05 | mg/L | < 0.05 |
| pH (at 25°C) | 0.1 | pH Units | 6.7 |
| Total Combined Nitrogen (as N) | 0.2 | mg/L | 27 |
| Total Kjeldahl Nitrogen (as N) | 0.2 | mg/L | 27 |
| Total Suspended Solids Dried at 103–105°C | 1 | mg/L | 2.0 |
| **Heavy Metals** | | | |
| Aluminium | 0.05 | mg/L | < 0.05 |
| Antimony | 0.005 | mg/L | < 0.005 |
| Arsenic | 0.001 | mg/L | 0.003 |
| Barium | 0.02 | mg/L | 52 |
| Beryllium | 0.001 | mg/L | < 0.001 |
| Boron | 0.05 | mg/L | 13 |

| Client Sample ID | | | Y0250919-3 |
|---|---|---|---|
| **Sample Matrix** | | | **Water** |
| **Eurofins Sample No.** | | | **S19-Se42146** |
| **Date Sampled** | | | **Sep 27, 2019** |
| Test/Reference | LOR | Unit | |
| **Heavy Metals** | | | |
| Cadmium | 0.0002 | mg/L | < 0.0002 |
| Chromium | 0.001 | mg/L | < 0.001 |
| Cobalt | 0.001 | mg/L | < 0.001 |
| Iron | 0.05 | mg/L | 1.2 |
| Lead | 0.001 | mg/L | < 0.001 |
| Manganese | 0.005 | mg/L | 0.029 |
| Mercury | 0.0001 | mg/L | 0.0060 |
| Molybdenum | 0.005 | mg/L | < 0.005 |
| Nickel | 0.001 | mg/L | < 0.001 |
| Selenium | 0.001 | mg/L | < 0.001 |
| Silver | 0.005 | mg/L | < 0.005 |
| Strontium | 0.005 | mg/L | 3.1 |
| Thallium | 0.005 | mg/L | < 0.005 |
| Tin | 0.005 | mg/L | < 0.005 |
| Titanium | 0.005 | mg/L | < 0.005 |
| Vanadium | 0.005 | mg/L | < 0.005 |
| Zinc | 0.005 | mg/L | 0.017 |
| **Alkali Metals** | | | |
| Potassium | 0.5 | mg/L | 60 |

## Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

| Description | Testing Site | Extracted | Holding Time |
|---|---|---|---|
| Total Recoverable Hydrocarbons - 1999 NEPM Fractions | Melbourne | Oct 01, 2019 | 7 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Total Recoverable Hydrocarbons - 2013 NEPM Fractions | Melbourne | Oct 01, 2019 | 7 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Total Recoverable Hydrocarbons - 2013 NEPM Fractions | Melbourne | Oct 01, 2019 | |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| BTEX and Naphthalene | | | |
| BTEX | Melbourne | Oct 01, 2019 | 14 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Polycyclic Aromatic Hydrocarbons | Melbourne | Oct 01, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |
| Glycols* | Melbourne | Oct 01, 2019 | 7 Days |
| - Method: GLYCOLS- US EPA SW846 METHOD 8000 GC-FID. | | | |
| Chloride | Melbourne | Oct 01, 2019 | 28 Days |
| - Method: LTM-INO-4090 Chloride by Discrete Analyser | | | |
| Conductivity (at 25°C) | Melbourne | Oct 01, 2019 | 28 Days |
| - Method: LTM-INO-4030 Conductivity | | | |
| Nitrate & Nitrite (as N) | Melbourne | Oct 01, 2019 | 28 Days |
| - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA | | | |
| pH (at 25°C) | Melbourne | Oct 01, 2019 | 0 Hours |
| - Method: LTM-GEN-7090 pH in water by ISE | | | |
| Total Kjeldahl Nitrogen (as N) | Melbourne | Oct 01, 2019 | 7 Days |
| - Method: LTM-INO-4310 TKN in Waters & Soils by FIA | | | |
| Total Suspended Solids Dried at 103–105°C | Melbourne | Oct 01, 2019 | 7 Days |
| - Method: LTM-INO-4070 Analysis of Suspended Solids in Water by Gravimetry | | | |
| Heavy Metals | Melbourne | Oct 02, 2019 | 180 Days |
| - Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS | | | |
| Alkali Metals | Melbourne | Oct 01, 2019 | 180 Days |
| - Method: LTM-MET-3010 Alkali Metals S Si and P by ICP-AES | | | |
| Phenols (IWRG 621) | | | |
| Phenols (Halogenated) | Melbourne | Oct 01, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |
| Phenols (non-Halogenated) | Melbourne | Oct 01, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |

eurofins | Environment Testing

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NATA # 1261
Site # 23736

**Company Name:** Beach Energy Limited
**Address:** 5775 South Gippsland Highway
Lang Lang
VIC 3984

**Project Name:** 1858

**Order No.:** PO#BE00016911
**Report #:** 679568
**Phone:** 03 5654 9103
**Fax:** 03 5659 0178

**Received:** Sep 27, 2019 3:55 PM
**Due:** Oct 4, 2019
**Priority:** 5 Day
**Contact Name:** Adrian Cukovski

**Eurofins Analytical Services Manager : Michael Morrison**

| Sample Detail | | | | | | Aluminium | Antimony | Arsenic | Barium | Beryllium | Boron | Cadmium | Chloride | Chromium | Cobalt | Conductivity (at 25°C) | Iron | Lead | Manganese | Mercury | Molybdenum | Nickel | Nitrate & Nitrite (as N) | pH (at 25°C) | Potassium | Selenium | Silver | Strontium | Thallium | Tin | Titanium | Total Combined Nitrogen (as N) | Total Kjeldahl Nitrogen (as N) | Total Suspended Solids Dried at 103–105°C | Vanadium | Zinc | Polycyclic Aromatic Hydrocarbons | Glycols* | Phenols (IWRG 621) | BTEX and Naphthalene | Total Recoverable Hydrocarbons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Melbourne Laboratory - NATA Site # 1254 & 14271** | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Sydney Laboratory - NATA Site # 18217** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Brisbane Laboratory - NATA Site # 20794** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Perth Laboratory - NATA Site # 23736** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **External Laboratory** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **No** | **Sample ID** | **Sample Date** | **Sampling Time** | **Matrix** | **LAB ID** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Y0250919-3 | Sep 27, 2019 | | Water | S19-Se42146 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Test Counts** | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## Internal Quality Control Review and Glossary

### General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

### Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

### Units

**mg/kg:** milligrams per kilogram

**mg/L:** milligrams per litre

**ug/L:** micrograms per litre

**ppm:** Parts per million

**ppb:** Parts per billion

**%:** Percentage

**org/100mL:** Organisms per 100 millilitres

**NTU:** Nephelometric Turbidity Units

**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

### Terms

| | |
|---|---|
| **Dry** | Where a moisture has been determined on a solid sample the result is expressed on a dry basis. |
| **LOR** | Limit of Reporting. |
| **SPIKE** | Addition of the analyte to the sample and reported as percentage recovery. |
| **RPD** | Relative Percent Difference between two Duplicate pieces of analysis. |
| **LCS** | Laboratory Control Sample - reported as percent recovery. |
| **CRM** | Certified Reference Material - reported as percent recovery. |
| **Method Blank** | In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water. |
| **Surr - Surrogate** | The addition of a like compound to the analyte target and reported as percentage recovery. |
| **Duplicate** | A second piece of analysis from the same sample and reported in the same units as the result to show comparison. |
| **USEPA** | United States Environmental Protection Agency |
| **APHA** | American Public Health Association |
| **TCLP** | Toxicity Characteristic Leaching Procedure |
| **COC** | Chain of Custody |
| **SRA** | Sample Receipt Advice |
| **QSM** | US Department of Defense Quality Systems Manual Version 5.3 |
| **CP** | Client Parent - QC was performed on samples pertaining to this report |
| **NCP** | Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within. |
| **TEQ** | Toxic Equivalency Quotient |

### QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

### QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

**Quality Control Results**

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| **Method Blank** | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | | | | |
| TRH C6-C9 | mg/L | < 0.02 | | | 0.02 | Pass | |
| TRH C10-C14 | mg/L | < 0.05 | | | 0.05 | Pass | |
| TRH C15-C28 | mg/L | < 0.1 | | | 0.1 | Pass | |
| TRH C29-C36 | mg/L | < 0.1 | | | 0.1 | Pass | |
| **Method Blank** | | | | | | | |
| **BTEX** | | | | | | | |
| Benzene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Toluene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Ethylbenzene | mg/L | < 0.001 | | | 0.001 | Pass | |
| m&p-Xylenes | mg/L | < 0.002 | | | 0.002 | Pass | |
| o-Xylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Xylenes - Total | mg/L | < 0.003 | | | 0.003 | Pass | |
| **Method Blank** | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | | | | |
| Naphthalene | mg/L | < 0.01 | | | 0.01 | Pass | |
| TRH C6-C10 | mg/L | < 0.02 | | | 0.02 | Pass | |
| TRH >C10-C16 | mg/L | < 0.05 | | | 0.05 | Pass | |
| TRH >C16-C34 | mg/L | < 0.1 | | | 0.1 | Pass | |
| TRH >C34-C40 | mg/L | < 0.1 | | | 0.1 | Pass | |
| **Method Blank** | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | |
| Acenaphthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Acenaphthylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benz(a)anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(a)pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(b&j)fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(g.h.i)perylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(k)fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Chrysene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Dibenz(a.h)anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Fluorene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Indeno(1.2.3-cd)pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Naphthalene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Phenanthrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| **Method Blank** | | | | | | | |
| **Glycols*** | | | | | | | |
| Di-Ethylene Glycol* | mg/L | < 20 | | | 20 | Pass | |
| Ethylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| Propylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| Triethylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| **Method Blank** | | | | | | | |
| **Phenols (Halogenated)** | | | | | | | |
| 2-Chlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |
| 2.4-Dichlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |
| 2.4.5-Trichlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.4.6-Trichlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.6-Dichlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| 4-Chloro-3-methylphenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| Pentachlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| Tetrachlorophenols - Total | mg/L | < 0.03 | | | 0.03 | Pass | |
| **Method Blank** | | | | | | | |
| **Phenols (non-Halogenated)** | | | | | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | mg/L | < 0.1 | | | 0.1 | Pass | |
| 2-Methyl-4.6-dinitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| 2-Methylphenol (o-Cresol) | mg/L | < 0.003 | | | 0.003 | Pass | |
| 2-Nitrophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.4-Dimethylphenol | mg/L | < 0.003 | | | 0.003 | Pass | |
| 2.4-Dinitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| 3&4-Methylphenol (m&p-Cresol) | mg/L | < 0.006 | | | 0.006 | Pass | |
| 4-Nitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| Dinoseb | mg/L | < 0.1 | | | 0.1 | Pass | |
| Phenol | mg/L | < 0.003 | | | 0.003 | Pass | |
| **Method Blank** | | | | | | | |
| Chloride | mg/L | < 1 | | | 1 | Pass | |
| Nitrate & Nitrite (as N) | mg/L | < 0.05 | | | 0.05 | Pass | |
| Total Kjeldahl Nitrogen (as N) | mg/L | < 0.2 | | | 0.2 | Pass | |
| Total Suspended Solids Dried at 103–105°C | mg/L | < 1 | | | 1 | Pass | |
| **Method Blank** | | | | | | | |
| **Heavy Metals** | | | | | | | |
| Aluminium | mg/L | < 0.05 | | | 0.05 | Pass | |
| Antimony | mg/L | < 0.005 | | | 0.005 | Pass | |
| Arsenic | mg/L | < 0.001 | | | 0.001 | Pass | |
| Barium | mg/L | < 0.02 | | | 0.02 | Pass | |
| Beryllium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Boron | mg/L | < 0.05 | | | 0.05 | Pass | |
| Cadmium | mg/L | < 0.0002 | | | 0.0002 | Pass | |
| Chromium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Cobalt | mg/L | < 0.001 | | | 0.001 | Pass | |
| Iron | mg/L | < 0.05 | | | 0.05 | Pass | |
| Lead | mg/L | < 0.001 | | | 0.001 | Pass | |
| Manganese | mg/L | < 0.005 | | | 0.005 | Pass | |
| Mercury | mg/L | < 0.0001 | | | 0.0001 | Pass | |
| Molybdenum | mg/L | < 0.005 | | | 0.005 | Pass | |
| Nickel | mg/L | < 0.001 | | | 0.001 | Pass | |
| Selenium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Silver | mg/L | < 0.005 | | | 0.005 | Pass | |
| Strontium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Thallium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Tin | mg/L | < 0.005 | | | 0.005 | Pass | |
| Titanium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Vanadium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Zinc | mg/L | < 0.005 | | | 0.005 | Pass | |
| **Method Blank** | | | | | | | |
| **Alkali Metals** | | | | | | | |
| Potassium | mg/L | < 0.5 | | | 0.5 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | | | | |
| TRH C6-C9 | % | 91 | | | 70-130 | Pass | |
| TRH C10-C14 | % | 77 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **BTEX** | | | | | | | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| Benzene | % | 93 | | | 70-130 | Pass | |
| Toluene | % | 87 | | | 70-130 | Pass | |
| Ethylbenzene | % | 88 | | | 70-130 | Pass | |
| m&p-Xylenes | % | 86 | | | 70-130 | Pass | |
| Xylenes - Total | % | 87 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | | | | |
| Naphthalene | % | 86 | | | 70-130 | Pass | |
| TRH C6-C10 | % | 91 | | | 70-130 | Pass | |
| TRH >C10-C16 | % | 72 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | |
| Acenaphthene | % | 81 | | | 70-130 | Pass | |
| Acenaphthylene | % | 85 | | | 70-130 | Pass | |
| Anthracene | % | 95 | | | 70-130 | Pass | |
| Benz(a)anthracene | % | 75 | | | 70-130 | Pass | |
| Benzo(a)pyrene | % | 79 | | | 70-130 | Pass | |
| Benzo(b&j)fluoranthene | % | 80 | | | 70-130 | Pass | |
| Benzo(g.h.i)perylene | % | 77 | | | 70-130 | Pass | |
| Benzo(k)fluoranthene | % | 88 | | | 70-130 | Pass | |
| Chrysene | % | 82 | | | 70-130 | Pass | |
| Dibenz(a.h)anthracene | % | 72 | | | 70-130 | Pass | |
| Fluoranthene | % | 89 | | | 70-130 | Pass | |
| Fluorene | % | 85 | | | 70-130 | Pass | |
| Indeno(1.2.3-cd)pyrene | % | 76 | | | 70-130 | Pass | |
| Naphthalene | % | 83 | | | 70-130 | Pass | |
| Phenanthrene | % | 93 | | | 70-130 | Pass | |
| Pyrene | % | 97 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Glycols*** | | | | | | | |
| Ethylene glycol* | % | 77 | | | 70-130 | Pass | |
| Propylene glycol* | % | 88 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Phenols (Halogenated)** | | | | | | | |
| 2-Chlorophenol | % | 92 | | | 30-130 | Pass | |
| 2.4-Dichlorophenol | % | 88 | | | 30-130 | Pass | |
| 2.4.5-Trichlorophenol | % | 107 | | | 30-130 | Pass | |
| 2.4.6-Trichlorophenol | % | 117 | | | 30-130 | Pass | |
| 2.6-Dichlorophenol | % | 94 | | | 30-130 | Pass | |
| 4-Chloro-3-methylphenol | % | 89 | | | 30-130 | Pass | |
| Pentachlorophenol | % | 90 | | | 30-130 | Pass | |
| Tetrachlorophenols - Total | % | 88 | | | 30-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Phenols (non-Halogenated)** | | | | | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | % | 62 | | | 30-130 | Pass | |
| 2-Methyl-4.6-dinitrophenol | % | 80 | | | 30-130 | Pass | |
| 2-Methylphenol (o-Cresol) | % | 101 | | | 30-130 | Pass | |
| 2-Nitrophenol | % | 99 | | | 30-130 | Pass | |
| 2.4-Dimethylphenol | % | 113 | | | 30-130 | Pass | |
| 2.4-Dinitrophenol | % | 43 | | | 30-130 | Pass | |
| 3&4-Methylphenol (m&p-Cresol) | % | 83 | | | 30-130 | Pass | |
| 4-Nitrophenol | % | 51 | | | 30-130 | Pass | |
| Dinoseb | % | 106 | | | 30-130 | Pass | |
| Phenol | % | 59 | | | 30-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| Chloride | % | 73 | | | 70-130 | Pass | |
| Nitrate & Nitrite (as N) | % | 102 | | | 70-130 | Pass | |
| Total Kjeldahl Nitrogen (as N) | % | 91 | | | 70-130 | Pass | |
| Total Suspended Solids Dried at 103–105°C | % | 93 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Heavy Metals** | | | | | | | |
| Aluminium | % | 105 | | | 80-120 | Pass | |
| Antimony | % | 102 | | | 80-120 | Pass | |
| Arsenic | % | 101 | | | 80-120 | Pass | |
| Barium | % | 101 | | | 80-120 | Pass | |
| Beryllium | % | 106 | | | 80-120 | Pass | |
| Boron | % | 104 | | | 80-120 | Pass | |
| Cadmium | % | 99 | | | 80-120 | Pass | |
| Chromium | % | 99 | | | 80-120 | Pass | |
| Cobalt | % | 103 | | | 80-120 | Pass | |
| Iron | % | 102 | | | 80-120 | Pass | |
| Lead | % | 103 | | | 80-120 | Pass | |
| Manganese | % | 103 | | | 80-120 | Pass | |
| Mercury | % | 98 | | | 75-125 | Pass | |
| Molybdenum | % | 101 | | | 80-120 | Pass | |
| Nickel | % | 102 | | | 80-120 | Pass | |
| Selenium | % | 100 | | | 80-120 | Pass | |
| Silver | % | 98 | | | 80-120 | Pass | |
| Strontium | % | 102 | | | 80-120 | Pass | |
| Thallium | % | 100 | | | 80-120 | Pass | |
| Tin | % | 102 | | | 80-120 | Pass | |
| Titanium | % | 99 | | | 80-120 | Pass | |
| Vanadium | % | 100 | | | 80-120 | Pass | |
| Zinc | % | 102 | | | 80-120 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Alkali Metals** | | | | | | | |
| Potassium | % | 96 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| **Spike - % Recovery** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | Result 1 | | | | | |
| TRH C6-C9 | S19-Se40921 | NCP | % | 91 | | | 70-130 | Pass | |
| TRH C10-C14 | M19-Se42608 | NCP | % | 78 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **BTEX** | | | | Result 1 | | | | | |
| Benzene | S19-Se40921 | NCP | % | 88 | | | 70-130 | Pass | |
| Toluene | S19-Se40921 | NCP | % | 86 | | | 70-130 | Pass | |
| Ethylbenzene | S19-Se40921 | NCP | % | 86 | | | 70-130 | Pass | |
| m&p-Xylenes | S19-Se40921 | NCP | % | 82 | | | 70-130 | Pass | |
| o-Xylene | S19-Se40921 | NCP | % | 86 | | | 70-130 | Pass | |
| Xylenes - Total | S19-Se40921 | NCP | % | 83 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | Result 1 | | | | | |
| Naphthalene | S19-Se40921 | NCP | % | 86 | | | 70-130 | Pass | |
| TRH C6-C10 | S19-Se40921 | NCP | % | 92 | | | 70-130 | Pass | |
| TRH >C10-C16 | M19-Se42608 | NCP | % | 71 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| | | | | Result 1 | | | | | |
| Chloride | M19-Se42641 | NCP | % | 103 | | | 70-130 | Pass | |
| Nitrate & Nitrite (as N) | M19-Se42266 | NCP | % | 103 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| **Spike - % Recovery** | | | | | | | | | |
| **Heavy Metals** | | | | Result 1 | | | | | |
| Boron | M19-Oc03140 | NCP | % | 81 | | | 75-125 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Alkali Metals** | | | | Result 1 | | | | | |
| Potassium | S19-Se42146 | CP | % | 115 | | | 70-130 | Pass | |
| **Test** | **Lab Sample ID** | **QA Source** | **Units** | **Result 1** | | | **Acceptance Limits** | **Pass Limits** | **Qualifying Code** |
| **Duplicate** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | Result 1 | Result 2 | RPD | | | |
| TRH C6-C9 | W19-Se41107 | NCP | mg/L | < 0.02 | < 0.02 | <1 | 30% | Pass | |
| TRH C10-C14 | M19-Se42607 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| TRH C15-C28 | M19-Se42607 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| TRH C29-C36 | M19-Se42607 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **BTEX** | | | | Result 1 | Result 2 | RPD | | | |
| Benzene | W19-Se41107 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Toluene | W19-Se41107 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Ethylbenzene | W19-Se41107 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| m&p-Xylenes | W19-Se41107 | NCP | mg/L | < 0.002 | < 0.002 | <1 | 30% | Pass | |
| o-Xylene | W19-Se41107 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Xylenes - Total | W19-Se41107 | NCP | mg/L | < 0.003 | < 0.003 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | Result 1 | Result 2 | RPD | | | |
| Naphthalene | W19-Se41107 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| TRH C6-C10 | W19-Se41107 | NCP | mg/L | < 0.02 | < 0.02 | <1 | 30% | Pass | |
| TRH >C10-C16 | M19-Se42607 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| TRH >C16-C34 | M19-Se42607 | NCP | mg/L | < 0.1 | | <1 | 30% | Pass | |
| TRH >C34-C40 | M19-Se42607 | NCP | mg/L | < 0.1 | | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Glycols*** | | | | Result 1 | Result 2 | RPD | | | |
| Di-Ethylene Glycol* | M19-Se36023 | NCP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Ethylene glycol* | M19-Se36023 | NCP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Propylene glycol* | M19-Se36023 | NCP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Triethylene glycol* | M19-Se36023 | NCP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| | | | | Result 1 | Result 2 | RPD | | | |
| Chloride | P19-Se40555 | NCP | mg/L | 140 | 140 | 2.0 | 30% | Pass | |
| Conductivity (at 25°C) | N19-Se40057 | NCP | uS/cm | 280 | 290 | 1.0 | 30% | Pass | |
| Nitrate & Nitrite (as N) | M19-Se42266 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| pH (at 25°C) | N19-Se40057 | NCP | pH Units | 8.0 | 7.9 | pass | 30% | Pass | |
| Total Suspended Solids Dried at 103–105°C | M19-Se39441 | NCP | mg/L | 140 | 130 | 9.0 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Heavy Metals** | | | | Result 1 | Result 2 | RPD | | | |
| Boron | M19-Oc03140 | NCP | mg/L | 0.17 | 0.15 | 12 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Alkali Metals** | | | | Result 1 | Result 2 | RPD | | | |
| Potassium | S19-Se42146 | CP | mg/L | 60 | 63 | 6.0 | 30% | Pass | |

## Comments

## Sample Integrity

| | |
|---|---|
| Custody Seals Intact (if used) | N/A |
| Attempt to Chill was evident | Yes |
| Sample correctly preserved | Yes |
| Appropriate sample containers have been used | Yes |
| Sample containers for volatile analysis received with minimal headspace | Yes |
| Samples received within HoldingTime | Yes |
| Some samples have been subcontracted | No |

## Qualifier Codes/Comments

| Code | Description |
|---|---|
| N01 | F2 is determined by arithmetically subtracting the "naphthalene" value from the ">C10-C16" value. The naphthalene value used in this calculation is obtained from volatiles (Purge & Trap analysis). |
| N02 | Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid. |
| N04 | F1 is determined by arithmetically subtracting the "Total BTEX" value from the "C6-C10" value. The "Total BTEX" value is obtained by summing the concentrations of BTEX analytes. The "C6-C10" value is obtained by quantitating against a standard of mixed aromatic/aliphatic analytes. |
| N07 | Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs |

## Authorised By

| | |
|---|---|
| Michael Morrison | Analytical Services Manager |
| Emily Rosenberg | Senior Analyst-Metal (VIC) |
| Harry Bacalis | Senior Analyst-Volatile (VIC) |
| Joseph Edouard | Senior Analyst-Organic (VIC) |
| Julie Kay | Senior Analyst-Inorganic (VIC) |

**Glenn Jackson**

**General Manager**

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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**Beach Energy Limited**
**5775 South Gippsland Highway**
**Lang Lang**
**VIC 3984**

**NATA Accredited**
**Accreditation Number 1261**
**Site Number 18217**

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The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

**Attention:** **Shane Reynolds**

**Report** **680827-W**
Project name ADRIAN CUKOVSKI
Received Date Oct 04, 2019

| **Client Sample ID** | | | **Y0021019** |
|---|---|---|---|
| **Sample Matrix** | | | **Water** |
| **Eurofins Sample No.** | | | **S19-Oc07916** |
| **Date Sampled** | | | **Oct 03, 2019** |
| Test/Reference | LOR | Unit | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | |
| TRH C6-C9 | 0.02 | mg/L | 82 |
| TRH C10-C14 | 0.05 | mg/L | 32 |
| TRH C15-C28 | 0.1 | mg/L | 0.2 |
| TRH C29-C36 | 0.1 | mg/L | < 0.1 |
| TRH C10-C36 (Total) | 0.1 | mg/L | 32.2 |
| **BTEX** | | | |
| Benzene | 0.001 | mg/L | 17 |
| Toluene | 0.001 | mg/L | 30 |
| Ethylbenzene | 0.001 | mg/L | 1.1 |
| m&p-Xylenes | 0.002 | mg/L | 12 |
| o-Xylene | 0.001 | mg/L | 3.2 |
| Xylenes - Total | 0.003 | mg/L | 15 |
| 4-Bromofluorobenzene (surr.) | 1 | % | 132 |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | |
| Naphthalene[N02] | 0.01 | mg/L | < 5 |
| TRH C6-C10 | 0.02 | mg/L | 92 |
| TRH C6-C10 less BTEX (F1)[N04] | 0.02 | mg/L | 29 |
| TRH >C10-C16 | 0.05 | mg/L | 35 |
| TRH >C10-C16 less Naphthalene (F2)[N01] | 0.05 | mg/L | 35 |
| TRH >C16-C34 | 0.1 | mg/L | < 0.1 |
| TRH >C34-C40 | 0.1 | mg/L | < 0.1 |
| TRH >C10-C40 (total)* | 0.1 | mg/L | 35 |
| **Polycyclic Aromatic Hydrocarbons** | | | |
| Acenaphthene | 0.001 | mg/L | < 0.001 |
| Acenaphthylene | 0.001 | mg/L | < 0.001 |
| Anthracene | 0.001 | mg/L | < 0.001 |
| Benz(a)anthracene | 0.001 | mg/L | < 0.001 |
| Benzo(a)pyrene | 0.001 | mg/L | < 0.001 |
| Benzo(b&j)fluoranthene[N07] | 0.001 | mg/L | < 0.001 |
| Benzo(g.h.i)perylene | 0.001 | mg/L | < 0.001 |
| Benzo(k)fluoranthene | 0.001 | mg/L | < 0.001 |
| Chrysene | 0.001 | mg/L | < 0.001 |
| Dibenz(a.h)anthracene | 0.001 | mg/L | < 0.001 |
| Fluoranthene | 0.001 | mg/L | < 0.001 |
| Fluorene | 0.001 | mg/L | 0.001 |
| Indeno(1.2.3-cd)pyrene | 0.001 | mg/L | < 0.001 |

| Client Sample ID | | | Y0021019 |
|---|---|---|---|
| Sample Matrix | | | Water |
| Eurofins Sample No. | | | S19-Oc07916 |
| Date Sampled | | | Oct 03, 2019 |
| Test/Reference | LOR | Unit | |
| **Polycyclic Aromatic Hydrocarbons** | | | |
| Naphthalene | 0.001 | mg/L | 0.36 |
| Phenanthrene | 0.001 | mg/L | < 0.001 |
| Pyrene | 0.001 | mg/L | < 0.001 |
| Total PAH* | 0.001 | mg/L | 0.361 |
| 2-Fluorobiphenyl (surr.) | 1 | % | 76 |
| p-Terphenyl-d14 (surr.) | 1 | % | 85 |
| **Glycols*** | | | |
| Di-Ethylene Glycol* | 20 | mg/L | < 20 |
| Ethylene glycol* | 20 | mg/L | < 20 |
| Propylene glycol* | 20 | mg/L | < 20 |
| Triethylene glycol* | 20 | mg/L | < 20 |
| **Phenols (Halogenated)** | | | |
| 2-Chlorophenol | 0.003 | mg/L | < 0.003 |
| 2.4-Dichlorophenol | 0.003 | mg/L | < 0.003 |
| 2.4.5-Trichlorophenol | 0.01 | mg/L | < 0.01 |
| 2.4.6-Trichlorophenol | 0.01 | mg/L | < 0.01 |
| 2.6-Dichlorophenol | 0.003 | mg/L | < 0.003 |
| 4-Chloro-3-methylphenol | 0.01 | mg/L | < 0.01 |
| Pentachlorophenol | 0.01 | mg/L | < 0.01 |
| Tetrachlorophenols - Total | 0.03 | mg/L | < 0.03 |
| Total Halogenated Phenol* | 0.01 | mg/L | < 0.01 |
| **Phenols (non-Halogenated)** | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | 0.1 | mg/L | < 0.1 |
| 2-Methyl-4.6-dinitrophenol | 0.03 | mg/L | < 0.03 |
| 2-Methylphenol (o-Cresol) | 0.003 | mg/L | 14 |
| 2-Nitrophenol | 0.01 | mg/L | < 0.01 |
| 2.4-Dimethylphenol | 0.003 | mg/L | 5.3 |
| 2.4-Dinitrophenol | 0.03 | mg/L | < 0.03 |
| 3&4-Methylphenol (m&p-Cresol) | 0.006 | mg/L | 10 |
| 4-Nitrophenol | 0.03 | mg/L | < 0.03 |
| Dinoseb | 0.1 | mg/L | < 0.1 |
| Phenol | 0.003 | mg/L | 7.7 |
| Total Non-Halogenated Phenol* | 0.1 | mg/L | 37 |
| Phenol-d6 (surr.) | 1 | % | 47 |
| | | | |
| Chloride | 1 | mg/L | 9800 |
| Conductivity (at 25°C) | 10 | uS/cm | 29000 |
| Nitrate & Nitrite (as N) | 0.05 | mg/L | < 0.05 |
| pH (at 25°C) | 0.1 | pH Units | 6.9 |
| Total Kjeldahl Nitrogen (as N) | 0.2 | mg/L | 51 |
| Total Nitrogen (as N) | 0.2 | mg/L | 51 |
| Total Suspended Solids Dried at 103–105°C | 1 | mg/L | 4.7 |
| **Heavy Metals** | | | |
| Aluminium | 0.05 | mg/L | < 0.05 |
| Antimony | 0.005 | mg/L | < 0.005 |
| Arsenic | 0.001 | mg/L | 0.002 |
| Barium | 0.02 | mg/L | 40 |
| Beryllium | 0.001 | mg/L | < 0.001 |
| Boron | 0.05 | mg/L | 11 |

| Client Sample ID | | | Y0021019 |
|---|---|---|---|
| **Sample Matrix** | | | **Water** |
| **Eurofins Sample No.** | | | **S19-Oc07916** |
| **Date Sampled** | | | **Oct 03, 2019** |
| Test/Reference | LOR | Unit | |
| **Heavy Metals** | | | |
| Cadmium | 0.0002 | mg/L | < 0.0002 |
| Chromium | 0.001 | mg/L | 0.001 |
| Cobalt | 0.001 | mg/L | < 0.001 |
| Copper | 0.001 | mg/L | < 0.001 |
| Iron | 0.05 | mg/L | 1.0 |
| Lead | 0.001 | mg/L | < 0.001 |
| Manganese | 0.005 | mg/L | 0.028 |
| Mercury | 0.0001 | mg/L | 0.0059 |
| Molybdenum | 0.005 | mg/L | < 0.005 |
| Nickel | 0.001 | mg/L | < 0.001 |
| Selenium | 0.001 | mg/L | < 0.001 |
| Silver | 0.005 | mg/L | < 0.005 |
| Strontium | 0.005 | mg/L | 3.1 |
| Thallium | 0.005 | mg/L | < 0.005 |
| Tin | 0.005 | mg/L | < 0.005 |
| Titanium | 0.005 | mg/L | < 0.005 |
| Vanadium | 0.005 | mg/L | < 0.005 |
| Zinc | 0.005 | mg/L | 0.011 |
| **Alkali Metals** | | | |
| Potassium | 0.5 | mg/L | 67 |

## Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

| Description | Testing Site | Extracted | Holding Time |
|---|---|---|---|
| Eurofins \| mgt Suite B1 | | | |
| Total Recoverable Hydrocarbons - 1999 NEPM Fractions | Melbourne | Oct 07, 2019 | 7 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| BTEX | Melbourne | Oct 07, 2019 | 14 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Total Recoverable Hydrocarbons - 2013 NEPM Fractions | Melbourne | Oct 07, 2019 | 7 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Total Recoverable Hydrocarbons - 2013 NEPM Fractions | Melbourne | Oct 07, 2019 | |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Polycyclic Aromatic Hydrocarbons | Melbourne | Oct 07, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |
| Glycols* | Melbourne | Oct 07, 2019 | 7 Days |
| - Method: GLYCOLS- US EPA SW846 METHOD 8000 GC-FID. | | | |
| Chloride | Melbourne | Oct 07, 2019 | 28 Days |
| - Method: LTM-INO-4090 Chloride by Discrete Analyser | | | |
| Conductivity (at 25°C) | Melbourne | Oct 07, 2019 | 28 Days |
| - Method: LTM-INO-4030 Conductivity | | | |
| pH (at 25°C) | Melbourne | Oct 07, 2019 | 0 Hours |
| - Method: LTM-GEN-7090 pH in water by ISE | | | |
| Total Suspended Solids Dried at 103–105°C | Melbourne | Oct 07, 2019 | 7 Days |
| - Method: LTM-INO-4070 Analysis of Suspended Solids in Water by Gravimetry | | | |
| Heavy Metals | Melbourne | Oct 08, 2019 | 180 Days |
| - Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS | | | |
| Alkali Metals | Melbourne | Oct 07, 2019 | 180 Days |
| - Method: LTM-MET-3010 Alkali Metals S Si and P by ICP-AES | | | |
| Phenols (IWRG 621) | | | |
| Phenols (Halogenated) | Melbourne | Oct 07, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |
| Phenols (non-Halogenated) | Melbourne | Oct 07, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |
| Total Nitrogen Set (as N) | | | |
| Nitrate & Nitrite (as N) | Melbourne | Oct 07, 2019 | 28 Days |
| - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA | | | |
| Total Kjeldahl Nitrogen (as N) | Melbourne | Oct 07, 2019 | 7 Days |
| - Method: LTM-INO-4310 TKN in Waters & Soils by FIA | | | |

eurofins | Environment Testing

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Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

**Company Name:** Beach Energy Limited
**Address:** 5775 South Gippsland Highway
Lang Lang
VIC 3984

**Project Name:** ADRIAN CUKOVSKI

**Order No.:** BE00016911
**Report #:** 680827
**Phone:** 03 5654 9103
**Fax:** 03 5659 0178

**Received:** Oct 4, 2019 1:54 PM
**Due:** Oct 14, 2019
**Priority:** 5 Day
**Contact Name:** Shane Reynolds

**Eurofins Analytical Services Manager : Michael Morrison**

| Sample Detail | | | | | | Aluminium | Antimony | Arsenic | Barium | Beryllium | Boron | Cadmium | Chloride | Chromium | Cobalt | Conductivity (at 25°C) | Copper | Iron | Lead | Manganese | Mercury | Molybdenum | Nickel | pH (at 25°C) | Potassium | Selenium | Silver | Strontium | Thallium | Tin | Titanium | Total Suspended Solids Dried at 103–105°C | Vanadium | Zinc | Polycyclic Aromatic Hydrocarbons | Glycols* | Phenols (IWRG 621) | Total Nitrogen Set (as N) | Eurofins \| mgt Suite B1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Melbourne Laboratory - NATA Site # 1254 & 14271** | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Sydney Laboratory - NATA Site # 18217** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Brisbane Laboratory - NATA Site # 20794** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Perth Laboratory - NATA Site # 23736** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **External Laboratory** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **No** | **Sample ID** | **Sample Date** | **Sampling Time** | **Matrix** | **LAB ID** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Y0021019 | Oct 03, 2019 | | Water | S19-Oc07916 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Test Counts** | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## Internal Quality Control Review and Glossary

### General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

### Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

### Units

**mg/kg:** milligrams per kilogram

**mg/L:** milligrams per litre

**ug/L:** micrograms per litre

**ppm:** Parts per million

**ppb:** Parts per billion

**%:** Percentage

**org/100mL:** Organisms per 100 millilitres

**NTU:** Nephelometric Turbidity Units

**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

### Terms

| | |
|---|---|
| **Dry** | Where a moisture has been determined on a solid sample the result is expressed on a dry basis. |
| **LOR** | Limit of Reporting. |
| **SPIKE** | Addition of the analyte to the sample and reported as percentage recovery. |
| **RPD** | Relative Percent Difference between two Duplicate pieces of analysis. |
| **LCS** | Laboratory Control Sample - reported as percent recovery. |
| **CRM** | Certified Reference Material - reported as percent recovery. |
| **Method Blank** | In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water. |
| **Surr - Surrogate** | The addition of a like compound to the analyte target and reported as percentage recovery. |
| **Duplicate** | A second piece of analysis from the same sample and reported in the same units as the result to show comparison. |
| **USEPA** | United States Environmental Protection Agency |
| **APHA** | American Public Health Association |
| **TCLP** | Toxicity Characteristic Leaching Procedure |
| **COC** | Chain of Custody |
| **SRA** | Sample Receipt Advice |
| **QSM** | US Department of Defense Quality Systems Manual Version 5.3 |
| **CP** | Client Parent - QC was performed on samples pertaining to this report |
| **NCP** | Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within. |
| **TEQ** | Toxic Equivalency Quotient |

### QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

### QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

**Quality Control Results**

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| **Method Blank** | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | | | | |
| TRH C6-C9 | mg/L | < 0.02 | | | 0.02 | Pass | |
| TRH C10-C14 | mg/L | < 0.05 | | | 0.05 | Pass | |
| TRH C15-C28 | mg/L | < 0.1 | | | 0.1 | Pass | |
| TRH C29-C36 | mg/L | < 0.1 | | | 0.1 | Pass | |
| **Method Blank** | | | | | | | |
| **BTEX** | | | | | | | |
| Benzene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Toluene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Ethylbenzene | mg/L | < 0.001 | | | 0.001 | Pass | |
| m&p-Xylenes | mg/L | < 0.002 | | | 0.002 | Pass | |
| o-Xylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Xylenes - Total | mg/L | < 0.003 | | | 0.003 | Pass | |
| **Method Blank** | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | | | | |
| Naphthalene | mg/L | < 0.01 | | | 0.01 | Pass | |
| TRH C6-C10 | mg/L | < 0.02 | | | 0.02 | Pass | |
| TRH >C10-C16 | mg/L | < 0.05 | | | 0.05 | Pass | |
| TRH >C16-C34 | mg/L | < 0.1 | | | 0.1 | Pass | |
| TRH >C34-C40 | mg/L | < 0.1 | | | 0.1 | Pass | |
| **Method Blank** | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | |
| Acenaphthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Acenaphthylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benz(a)anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(a)pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(b&j)fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(g.h.i)perylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(k)fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Chrysene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Dibenz(a.h)anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Fluorene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Indeno(1.2.3-cd)pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Naphthalene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Phenanthrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| **Method Blank** | | | | | | | |
| **Glycols*** | | | | | | | |
| Di-Ethylene Glycol* | mg/L | < 20 | | | 20 | Pass | |
| Ethylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| Propylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| Triethylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| **Method Blank** | | | | | | | |
| **Phenols (Halogenated)** | | | | | | | |
| 2-Chlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |
| 2.4-Dichlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |
| 2.4.5-Trichlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.4.6-Trichlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.6-Dichlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| 4-Chloro-3-methylphenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| Pentachlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| Tetrachlorophenols - Total | mg/L | < 0.03 | | | 0.03 | Pass | |
| **Method Blank** | | | | | | | |
| **Phenols (non-Halogenated)** | | | | | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | mg/L | < 0.1 | | | 0.1 | Pass | |
| 2-Methyl-4.6-dinitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| 2-Nitrophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.4-Dinitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| 4-Nitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| Dinoseb | mg/L | < 0.1 | | | 0.1 | Pass | |
| **Method Blank** | | | | | | | |
| Chloride | mg/L | < 1 | | | 1 | Pass | |
| Conductivity (at 25°C) | uS/cm | < 10 | | | 10 | Pass | |
| Nitrate & Nitrite (as N) | mg/L | < 0.05 | | | 0.05 | Pass | |
| Total Kjeldahl Nitrogen (as N) | mg/L | < 0.2 | | | 0.2 | Pass | |
| Total Suspended Solids Dried at 103–105°C | mg/L | < 1 | | | 1 | Pass | |
| **Method Blank** | | | | | | | |
| **Heavy Metals** | | | | | | | |
| Aluminium | mg/L | < 0.05 | | | 0.05 | Pass | |
| Antimony | mg/L | < 0.005 | | | 0.005 | Pass | |
| Arsenic | mg/L | < 0.001 | | | 0.001 | Pass | |
| Barium | mg/L | < 0.02 | | | 0.02 | Pass | |
| Beryllium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Boron | mg/L | < 0.05 | | | 0.05 | Pass | |
| Cadmium | mg/L | < 0.0002 | | | 0.0002 | Pass | |
| Chromium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Cobalt | mg/L | < 0.001 | | | 0.001 | Pass | |
| Copper | mg/L | < 0.001 | | | 0.001 | Pass | |
| Iron | mg/L | < 0.05 | | | 0.05 | Pass | |
| Lead | mg/L | < 0.001 | | | 0.001 | Pass | |
| Manganese | mg/L | < 0.005 | | | 0.005 | Pass | |
| Mercury | mg/L | < 0.0001 | | | 0.0001 | Pass | |
| Molybdenum | mg/L | < 0.005 | | | 0.005 | Pass | |
| Nickel | mg/L | < 0.001 | | | 0.001 | Pass | |
| Selenium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Silver | mg/L | < 0.005 | | | 0.005 | Pass | |
| Strontium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Thallium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Tin | mg/L | < 0.005 | | | 0.005 | Pass | |
| Titanium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Vanadium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Zinc | mg/L | < 0.005 | | | 0.005 | Pass | |
| **Method Blank** | | | | | | | |
| **Alkali Metals** | | | | | | | |
| Potassium | mg/L | < 0.5 | | | 0.5 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | | | | |
| TRH C6-C9 | % | 97 | | | 70-130 | Pass | |
| TRH C10-C14 | % | 121 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **BTEX** | | | | | | | |
| Benzene | % | 96 | | | 70-130 | Pass | |
| Toluene | % | 94 | | | 70-130 | Pass | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| Ethylbenzene | % | 94 | | | 70-130 | Pass | |
| m&p-Xylenes | % | 95 | | | 70-130 | Pass | |
| Xylenes - Total | % | 94 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | | | | |
| Naphthalene | % | 99 | | | 70-130 | Pass | |
| TRH C6-C10 | % | 97 | | | 70-130 | Pass | |
| TRH >C10-C16 | % | 110 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | |
| Acenaphthene | % | 99 | | | 70-130 | Pass | |
| Acenaphthylene | % | 93 | | | 70-130 | Pass | |
| Anthracene | % | 87 | | | 70-130 | Pass | |
| Benz(a)anthracene | % | 88 | | | 70-130 | Pass | |
| Benzo(a)pyrene | % | 73 | | | 70-130 | Pass | |
| Benzo(b&j)fluoranthene | % | 100 | | | 70-130 | Pass | |
| Benzo(g.h.i)perylene | % | 74 | | | 70-130 | Pass | |
| Benzo(k)fluoranthene | % | 88 | | | 70-130 | Pass | |
| Chrysene | % | 88 | | | 70-130 | Pass | |
| Dibenz(a.h)anthracene | % | 87 | | | 70-130 | Pass | |
| Fluoranthene | % | 99 | | | 70-130 | Pass | |
| Fluorene | % | 106 | | | 70-130 | Pass | |
| Indeno(1.2.3-cd)pyrene | % | 88 | | | 70-130 | Pass | |
| Naphthalene | % | 103 | | | 70-130 | Pass | |
| Phenanthrene | % | 97 | | | 70-130 | Pass | |
| Pyrene | % | 102 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Glycols*** | | | | | | | |
| Ethylene glycol* | % | 103 | | | 70-130 | Pass | |
| Propylene glycol* | % | 106 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Phenols (Halogenated)** | | | | | | | |
| 2-Chlorophenol | % | 90 | | | 30-130 | Pass | |
| 2.4-Dichlorophenol | % | 58 | | | 30-130 | Pass | |
| 2.4.5-Trichlorophenol | % | 66 | | | 30-130 | Pass | |
| 2.4.6-Trichlorophenol | % | 73 | | | 30-130 | Pass | |
| 2.6-Dichlorophenol | % | 100 | | | 30-130 | Pass | |
| 4-Chloro-3-methylphenol | % | 49 | | | 30-130 | Pass | |
| Pentachlorophenol | % | 41 | | | 30-130 | Pass | |
| Tetrachlorophenols - Total | % | 61 | | | 30-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Phenols (non-Halogenated)** | | | | | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | % | 64 | | | 30-130 | Pass | |
| 2-Methyl-4.6-dinitrophenol | % | 77 | | | 30-130 | Pass | |
| 2-Nitrophenol | % | 82 | | | 30-130 | Pass | |
| 2.4-Dinitrophenol | % | 40 | | | 30-130 | Pass | |
| 4-Nitrophenol | % | 123 | | | 30-130 | Pass | |
| Dinoseb | % | 95 | | | 30-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| Chloride | % | 116 | | | 70-130 | Pass | |
| Conductivity (at 25°C) | % | 101 | | | 70-130 | Pass | |
| Nitrate & Nitrite (as N) | % | 95 | | | 70-130 | Pass | |
| Total Kjeldahl Nitrogen (as N) | % | 85 | | | 70-130 | Pass | |
| Total Suspended Solids Dried at 103–105°C | % | 116 | | | 70-130 | Pass | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| **LCS - % Recovery** | | | | | | | |
| **Heavy Metals** | | | | | | | |
| Aluminium | % | 104 | | | 80-120 | Pass | |
| Antimony | % | 97 | | | 80-120 | Pass | |
| Arsenic | % | 93 | | | 80-120 | Pass | |
| Barium | % | 103 | | | 80-120 | Pass | |
| Beryllium | % | 102 | | | 80-120 | Pass | |
| Boron | % | 90 | | | 80-120 | Pass | |
| Cadmium | % | 98 | | | 80-120 | Pass | |
| Chromium | % | 96 | | | 80-120 | Pass | |
| Cobalt | % | 93 | | | 80-120 | Pass | |
| Copper | % | 87 | | | 80-120 | Pass | |
| Iron | % | 94 | | | 80-120 | Pass | |
| Lead | % | 94 | | | 80-120 | Pass | |
| Manganese | % | 97 | | | 80-120 | Pass | |
| Mercury | % | 90 | | | 75-125 | Pass | |
| Molybdenum | % | 93 | | | 80-120 | Pass | |
| Nickel | % | 93 | | | 80-120 | Pass | |
| Selenium | % | 100 | | | 80-120 | Pass | |
| Silver | % | 90 | | | 80-120 | Pass | |
| Strontium | % | 99 | | | 80-120 | Pass | |
| Thallium | % | 90 | | | 80-120 | Pass | |
| Tin | % | 96 | | | 80-120 | Pass | |
| Titanium | % | 98 | | | 80-120 | Pass | |
| Vanadium | % | 97 | | | 80-120 | Pass | |
| Zinc | % | 85 | | | 80-120 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Alkali Metals** | | | | | | | |
| Potassium | % | 103 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| **Spike - % Recovery** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | Result 1 | | | | | |
| TRH C6-C9 | M19-Oc09876 | NCP | % | 110 | | | 70-130 | Pass | |
| TRH C10-C14 | M19-Oc15416 | NCP | % | 85 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **BTEX** | | | | Result 1 | | | | | |
| Benzene | M19-Oc09876 | NCP | % | 109 | | | 70-130 | Pass | |
| Toluene | M19-Oc09876 | NCP | % | 105 | | | 70-130 | Pass | |
| Ethylbenzene | M19-Oc09876 | NCP | % | 110 | | | 70-130 | Pass | |
| m&p-Xylenes | M19-Oc09876 | NCP | % | 107 | | | 70-130 | Pass | |
| o-Xylene | M19-Oc09876 | NCP | % | 105 | | | 70-130 | Pass | |
| Xylenes - Total | M19-Oc09876 | NCP | % | 106 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | Result 1 | | | | | |
| Naphthalene | M19-Oc09876 | NCP | % | 100 | | | 70-130 | Pass | |
| TRH C6-C10 | M19-Oc09876 | NCP | % | 109 | | | 70-130 | Pass | |
| TRH >C10-C16 | M19-Oc15416 | NCP | % | 80 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | Result 1 | | | | | |
| Acenaphthene | M19-Se38500 | NCP | % | 127 | | | 70-130 | Pass | |
| Acenaphthylene | M19-Se38500 | NCP | % | 125 | | | 70-130 | Pass | |
| Anthracene | M19-Se38500 | NCP | % | 79 | | | 70-130 | Pass | |
| Benz(a)anthracene | M19-Se38500 | NCP | % | 87 | | | 70-130 | Pass | |
| Benzo(a)pyrene | M19-Se38500 | NCP | % | 102 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| Benzo(b&j)fluoranthene | M19-Se38500 | NCP | % | 122 | | | 70-130 | Pass | |
| Benzo(g.h.i)perylene | M19-Se38500 | NCP | % | 112 | | | 70-130 | Pass | |
| Benzo(k)fluoranthene | M19-Se38500 | NCP | % | 126 | | | 70-130 | Pass | |
| Chrysene | M19-Se38500 | NCP | % | 97 | | | 70-130 | Pass | |
| Dibenz(a.h)anthracene | M19-Se38500 | NCP | % | 113 | | | 70-130 | Pass | |
| Fluoranthene | M19-Se38500 | NCP | % | 125 | | | 70-130 | Pass | |
| Fluorene | M19-Se38500 | NCP | % | 112 | | | 70-130 | Pass | |
| Indeno(1.2.3-cd)pyrene | M19-Se38500 | NCP | % | 94 | | | 70-130 | Pass | |
| Naphthalene | M19-Se38500 | NCP | % | 122 | | | 70-130 | Pass | |
| Phenanthrene | M19-Se38500 | NCP | % | 123 | | | 70-130 | Pass | |
| Pyrene | M19-Se38500 | NCP | % | 127 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Phenols (Halogenated)** | | | | Result 1 | | | | | |
| 2-Chlorophenol | M19-Se38500 | NCP | % | 116 | | | 30-130 | Pass | |
| 2.4-Dichlorophenol | M19-Se38500 | NCP | % | 103 | | | 30-130 | Pass | |
| 2.4.5-Trichlorophenol | M19-Se38500 | NCP | % | 120 | | | 30-130 | Pass | |
| 2.4.6-Trichlorophenol | M19-Se38500 | NCP | % | 96 | | | 30-130 | Pass | |
| 2.6-Dichlorophenol | M19-Se38500 | NCP | % | 98 | | | 30-130 | Pass | |
| 4-Chloro-3-methylphenol | M19-Se38500 | NCP | % | 111 | | | 30-130 | Pass | |
| Pentachlorophenol | M19-Se38500 | NCP | % | 95 | | | 30-130 | Pass | |
| Tetrachlorophenols - Total | M19-Se38500 | NCP | % | 97 | | | 30-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Phenols (non-Halogenated)** | | | | Result 1 | | | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | M19-Se38500 | NCP | % | 91 | | | 30-130 | Pass | |
| 2-Methyl-4.6-dinitrophenol | M19-Se38500 | NCP | % | 69 | | | 30-130 | Pass | |
| 2-Nitrophenol | M19-Se38500 | NCP | % | 120 | | | 30-130 | Pass | |
| 2.4-Dinitrophenol | M19-Se38500 | NCP | % | 35 | | | 30-130 | Pass | |
| Dinoseb | M19-Se38500 | NCP | % | 90 | | | 30-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| | | | | Result 1 | | | | | |
| Chloride | P19-Oc05832 | NCP | % | 70 | | | 70-130 | Pass | |
| Nitrate & Nitrite (as N) | M19-Oc14161 | NCP | % | 100 | | | 70-130 | Pass | |
| Total Kjeldahl Nitrogen (as N) | M19-Oc10062 | NCP | % | 84 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Heavy Metals** | | | | Result 1 | | | | | |
| Aluminium | M19-Oc12418 | NCP | % | 112 | | | 75-125 | Pass | |
| Antimony | M19-Oc12418 | NCP | % | 100 | | | 70-130 | Pass | |
| Arsenic | M19-Oc12418 | NCP | % | 98 | | | 75-125 | Pass | |
| Barium | M19-Oc12418 | NCP | % | 100 | | | 75-125 | Pass | |
| Beryllium | M19-Oc12418 | NCP | % | 103 | | | 75-125 | Pass | |
| Boron | M19-Oc12418 | NCP | % | 104 | | | 75-125 | Pass | |
| Cadmium | M19-Oc12418 | NCP | % | 96 | | | 75-125 | Pass | |
| Chromium | M19-Oc12418 | NCP | % | 101 | | | 75-125 | Pass | |
| Cobalt | M19-Oc12418 | NCP | % | 101 | | | 75-125 | Pass | |
| Copper | M19-Oc12418 | NCP | % | 94 | | | 75-125 | Pass | |
| Iron | M19-Oc12418 | NCP | % | 102 | | | 75-125 | Pass | |
| Lead | M19-Oc12418 | NCP | % | 98 | | | 75-125 | Pass | |
| Manganese | M19-Oc12418 | NCP | % | 103 | | | 75-125 | Pass | |
| Mercury | M19-Oc12418 | NCP | % | 87 | | | 70-130 | Pass | |
| Molybdenum | M19-Oc12418 | NCP | % | 99 | | | 75-125 | Pass | |
| Nickel | M19-Oc12418 | NCP | % | 100 | | | 75-125 | Pass | |
| Selenium | M19-Oc12418 | NCP | % | 102 | | | 75-125 | Pass | |
| Silver | M19-Oc12418 | NCP | % | 96 | | | 75-125 | Pass | |
| Strontium | M19-Oc12418 | NCP | % | 101 | | | 75-125 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| Thallium | M19-Oc12418 | NCP | % | 89 | | | 75-125 | Pass | |
| Tin | M19-Oc12418 | NCP | % | 100 | | | 75-125 | Pass | |
| Titanium | M19-Oc12418 | NCP | % | 101 | | | 75-125 | Pass | |
| Vanadium | M19-Oc12418 | NCP | % | 101 | | | 75-125 | Pass | |
| Zinc | M19-Oc12418 | NCP | % | 97 | | | 75-125 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Alkali Metals** | | | | Result 1 | | | | | |
| Potassium | S19-Oc07916 | CP | % | 119 | | | 70-130 | Pass | |
| **Test** | **Lab Sample ID** | **QA Source** | **Units** | **Result 1** | | | **Acceptance Limits** | **Pass Limits** | **Qualifying Code** |
| **Duplicate** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | Result 1 | Result 2 | RPD | | | |
| TRH C6-C9 | M19-Oc10323 | NCP | mg/L | < 0.02 | < 0.02 | <1 | 30% | Pass | |
| TRH C10-C14 | N19-Oc13992 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| TRH C15-C28 | N19-Oc13992 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| TRH C29-C36 | N19-Oc13992 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **BTEX** | | | | Result 1 | Result 2 | RPD | | | |
| Benzene | M19-Oc10323 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Toluene | M19-Oc10323 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Ethylbenzene | M19-Oc10323 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| m&p-Xylenes | M19-Oc10323 | NCP | mg/L | < 0.002 | < 0.002 | <1 | 30% | Pass | |
| o-Xylene | M19-Oc10323 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Xylenes - Total | M19-Oc10323 | NCP | mg/L | < 0.003 | < 0.003 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | Result 1 | Result 2 | RPD | | | |
| Naphthalene | M19-Oc10323 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| TRH C6-C10 | M19-Oc10323 | NCP | mg/L | < 0.02 | < 0.02 | <1 | 30% | Pass | |
| TRH >C10-C16 | N19-Oc13992 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| TRH >C16-C34 | N19-Oc13992 | NCP | mg/L | < 0.1 | | <1 | 30% | Pass | |
| TRH >C34-C40 | N19-Oc13992 | NCP | mg/L | < 0.1 | | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | Result 1 | Result 2 | RPD | | | |
| Acenaphthene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Acenaphthylene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Anthracene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benz(a)anthracene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benzo(a)pyrene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benzo(b&j)fluoranthene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benzo(g.h.i)perylene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benzo(k)fluoranthene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Chrysene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Dibenz(a.h)anthracene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Fluoranthene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Fluorene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Indeno(1.2.3-cd)pyrene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Naphthalene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Phenanthrene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Pyrene | M19-Oc02904 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Glycols*** | | | | Result 1 | Result 2 | RPD | | | |
| Di-Ethylene Glycol* | S19-Oc07916 | CP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Ethylene glycol* | S19-Oc07916 | CP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Propylene glycol* | S19-Oc07916 | CP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Triethylene glycol* | S19-Oc07916 | CP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Duplicate** | | | | | | | | | |
| **Phenols (Halogenated)** | | | | Result 1 | Result 2 | RPD | | | |
| 2-Chlorophenol | M19-Oc02904 | NCP | mg/L | < 0.003 | < 0.003 | <1 | 30% | Pass | |
| 2.4-Dichlorophenol | M19-Oc02904 | NCP | mg/L | < 0.003 | < 0.003 | <1 | 30% | Pass | |
| 2.4.5-Trichlorophenol | M19-Oc02904 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| 2.4.6-Trichlorophenol | M19-Oc02904 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| 2.6-Dichlorophenol | M19-Oc02904 | NCP | mg/L | < 0.003 | < 0.003 | <1 | 30% | Pass | |
| 4-Chloro-3-methylphenol | M19-Oc02904 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| Pentachlorophenol | M19-Oc02904 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| Tetrachlorophenols - Total | M19-Oc02904 | NCP | mg/L | < 0.03 | < 0.03 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Phenols (non-Halogenated)** | | | | Result 1 | Result 2 | RPD | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | M19-Oc02904 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| 2-Methyl-4.6-dinitrophenol | M19-Oc02904 | NCP | mg/L | < 0.03 | < 0.03 | <1 | 30% | Pass | |
| 2-Nitrophenol | M19-Oc02904 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| 2.4-Dinitrophenol | M19-Oc02904 | NCP | mg/L | < 0.03 | < 0.03 | <1 | 30% | Pass | |
| 4-Nitrophenol | M19-Oc02904 | NCP | mg/L | < 0.03 | < 0.03 | <1 | 30% | Pass | |
| Dinoseb | M19-Oc02904 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| | | | | Result 1 | Result 2 | RPD | | | |
| Chloride | P19-Oc05831 | NCP | mg/L | 390 | 520 | 27 | 30% | Pass | |
| Conductivity (at 25°C) | M19-Oc08930 | NCP | uS/cm | 210 | 210 | 1.0 | 30% | Pass | |
| Nitrate & Nitrite (as N) | M19-Oc14161 | NCP | mg/L | 0.13 | 0.12 | 6.0 | 30% | Pass | |
| pH (at 25°C) | M19-Oc08930 | NCP | pH Units | 7.8 | 7.7 | pass | 30% | Pass | |
| Total Kjeldahl Nitrogen (as N) | M19-Oc10005 | NCP | mg/L | 110 | 100 | 6.6 | 30% | Pass | |
| Total Suspended Solids Dried at 103–105°C | M19-Oc10005 | NCP | mg/L | 510 | 530 | 4.0 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Heavy Metals** | | | | Result 1 | Result 2 | RPD | | | |
| Aluminium | M19-Oc12418 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| Antimony | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Arsenic | M19-Oc12418 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Barium | M19-Oc12418 | NCP | mg/L | < 0.02 | < 0.02 | <1 | 30% | Pass | |
| Beryllium | M19-Oc12418 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Boron | M19-Oc12418 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| Cadmium | M19-Oc12418 | NCP | mg/L | < 0.0002 | < 0.0002 | <1 | 30% | Pass | |
| Chromium | M19-Oc12418 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Cobalt | M19-Oc12418 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Copper | M19-Oc12418 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Iron | M19-Oc12418 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| Lead | M19-Oc12418 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Manganese | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Mercury | M19-Oc12418 | NCP | mg/L | < 0.0001 | < 0.0001 | <1 | 30% | Pass | |
| Molybdenum | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Nickel | M19-Oc12418 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Selenium | M19-Oc12418 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Silver | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Strontium | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Thallium | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Tin | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Titanium | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Vanadium | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Zinc | M19-Oc12418 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Alkali Metals** | | | | Result 1 | Result 2 | RPD | | | |
| Potassium | S19-Oc07916 | CP | mg/L | 67 | 62 | 7.0 | 30% | Pass | |

## Comments

## Sample Integrity

| | |
|---|---|
| Custody Seals Intact (if used) | N/A |
| Attempt to Chill was evident | Yes |
| Sample correctly preserved | Yes |
| Appropriate sample containers have been used | Yes |
| Sample containers for volatile analysis received with minimal headspace | Yes |
| Samples received within HoldingTime | Yes |
| Some samples have been subcontracted | No |

## Qualifier Codes/Comments

| Code | Description |
|---|---|
| N01 | F2 is determined by arithmetically subtracting the "naphthalene" value from the ">C10-C16" value. The naphthalene value used in this calculation is obtained from volatiles (Purge & Trap analysis). |
| N02 | Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid. |
| N04 | F1 is determined by arithmetically subtracting the "Total BTEX" value from the "C6-C10" value. The "Total BTEX" value is obtained by summing the concentrations of BTEX analytes. The "C6-C10" value is obtained by quantitating against a standard of mixed aromatic/aliphatic analytes. |
| N07 | Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs |

## Authorised By

| | |
|---|---|
| Michael Morrison | Analytical Services Manager |
| Emily Rosenberg | Senior Analyst-Metal (VIC) |
| Harry Bacalis | Senior Analyst-Volatile (VIC) |
| Joseph Edouard | Senior Analyst-Organic (VIC) |
| Julie Kay | Senior Analyst-Inorganic (VIC) |

**Glenn Jackson**

**General Manager**

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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**Beach Energy Limited**
**5775 South Gippsland Highway**
**Lang Lang**
**VIC 3984**

**NATA Accredited**
**Accreditation Number 1261**
**Site Number 18217**

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

**Attention:** **Adrian Cukovski**

**Report** **681835-W**
Project name PRODUCED WATER A15327 DISCHARGE
Received Date Oct 10, 2019

| **Client Sample ID** | | | **A1-5327** |
|---|---|---|---|
| **Sample Matrix** | | | **Water** |
| **Eurofins Sample No.** | | | **S19-Oc15765** |
| **Date Sampled** | | | **Oct 10, 2019** |
| Test/Reference | LOR | Unit | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | |
| TRH C6-C9 | 0.02 | mg/L | 80 |
| TRH C10-C14 | 0.05 | mg/L | 32 |
| TRH C15-C28 | 0.1 | mg/L | 1.0 |
| TRH C29-C36 | 0.1 | mg/L | < 0.1 |
| TRH C10-C36 (Total) | 0.1 | mg/L | 33 |
| **BTEX** | | | |
| Benzene | 0.001 | mg/L | 15 |
| Toluene | 0.001 | mg/L | 27 |
| Ethylbenzene | 0.001 | mg/L | 0.93 |
| m&p-Xylenes | 0.002 | mg/L | 10 |
| o-Xylene | 0.001 | mg/L | 2.7 |
| Xylenes - Total | 0.003 | mg/L | 13 |
| 4-Bromofluorobenzene (surr.) | 1 | % | 105 |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | |
| Naphthalene[N02] | 0.01 | mg/L | < 5 |
| TRH C6-C10 | 0.02 | mg/L | 90 |
| TRH C6-C10 less BTEX (F1)[N04] | 0.02 | mg/L | 34 |
| TRH >C10-C16 | 0.05 | mg/L | 37 |
| TRH >C10-C16 less Naphthalene (F2)[N01] | 0.05 | mg/L | 37 |
| TRH >C16-C34 | 0.1 | mg/L | 0.8 |
| TRH >C34-C40 | 0.1 | mg/L | < 0.1 |
| TRH >C10-C40 (total)* | 0.1 | mg/L | 37.8 |
| **Polycyclic Aromatic Hydrocarbons** | | | |
| Acenaphthene | 0.001 | mg/L | < 0.001 |
| Acenaphthylene | 0.001 | mg/L | < 0.001 |
| Anthracene | 0.001 | mg/L | < 0.001 |
| Benz(a)anthracene | 0.001 | mg/L | < 0.001 |
| Benzo(a)pyrene | 0.001 | mg/L | < 0.001 |
| Benzo(b&j)fluoranthene[N07] | 0.001 | mg/L | < 0.001 |
| Benzo(g.h.i)perylene | 0.001 | mg/L | < 0.001 |
| Benzo(k)fluoranthene | 0.001 | mg/L | < 0.001 |
| Chrysene | 0.001 | mg/L | < 0.001 |
| Dibenz(a.h)anthracene | 0.001 | mg/L | < 0.001 |
| Fluoranthene | 0.001 | mg/L | < 0.001 |
| Fluorene | 0.001 | mg/L | < 0.001 |
| Indeno(1.2.3-cd)pyrene | 0.001 | mg/L | < 0.001 |

| Client Sample ID | | | A1-5327 |
|---|---|---|---|
| Sample Matrix | | | Water |
| Eurofins Sample No. | | | S19-Oc15765 |
| Date Sampled | | | Oct 10, 2019 |
| Test/Reference | LOR | Unit | |
| **Polycyclic Aromatic Hydrocarbons** | | | |
| Naphthalene | 0.001 | mg/L | 0.14 |
| Phenanthrene | 0.001 | mg/L | < 0.001 |
| Pyrene | 0.001 | mg/L | < 0.001 |
| Total PAH* | 0.001 | mg/L | 0.14 |
| 2-Fluorobiphenyl (surr.) | 1 | % | 63 |
| p-Terphenyl-d14 (surr.) | 1 | % | 65 |
| **Glycols*** | | | |
| Di-Ethylene Glycol* | 20 | mg/L | < 20 |
| Ethylene glycol* | 20 | mg/L | < 20 |
| Propylene glycol* | 20 | mg/L | < 20 |
| Triethylene glycol* | 20 | mg/L | < 20 |
| **Phenols (Halogenated)** | | | |
| 2-Chlorophenol | 0.003 | mg/L | < 0.003 |
| 2.4-Dichlorophenol | 0.003 | mg/L | < 0.003 |
| 2.4.5-Trichlorophenol | 0.01 | mg/L | < 0.01 |
| 2.4.6-Trichlorophenol | 0.01 | mg/L | < 0.01 |
| 2.6-Dichlorophenol | 0.003 | mg/L | < 0.003 |
| 4-Chloro-3-methylphenol | 0.01 | mg/L | < 0.01 |
| Pentachlorophenol | 0.01 | mg/L | < 0.01 |
| Tetrachlorophenols - Total | 0.03 | mg/L | < 0.03 |
| Total Halogenated Phenol* | 0.01 | mg/L | < 0.01 |
| **Phenols (non-Halogenated)** | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | 0.1 | mg/L | < 0.1 |
| 2-Methyl-4.6-dinitrophenol | 0.03 | mg/L | < 0.03 |
| 2-Methylphenol (o-Cresol) | 0.003 | mg/L | 13 |
| 2-Nitrophenol | 0.01 | mg/L | < 0.01 |
| 2.4-Dimethylphenol | 0.003 | mg/L | 4.3 |
| 2.4-Dinitrophenol | 0.03 | mg/L | < 0.03 |
| 3&4-Methylphenol (m&p-Cresol) | 0.006 | mg/L | 12 |
| 4-Nitrophenol | 0.03 | mg/L | < 0.03 |
| Dinoseb | 0.1 | mg/L | < 0.1 |
| Phenol | 0.003 | mg/L | 8.4 |
| Total Non-Halogenated Phenol* | 0.1 | mg/L | 37.7 |
| Phenol-d6 (surr.) | 1 | % | 37 |
| | | | |
| Chloride | 1 | mg/L | 12000 |
| Conductivity (at 25°C) | 10 | uS/cm | 31000 |
| Nitrate & Nitrite (as N) | 0.05 | mg/L | < 0.05 |
| pH (at 25°C) | 0.1 | pH Units | 7.1 |
| Phosphate total (as P) | 0.01 | mg/L | 0.03 |
| Total Combined Nitrogen (as N) | 0.2 | mg/L | 34 |
| Total Kjeldahl Nitrogen (as N) | 0.2 | mg/L | 34 |
| Total Suspended Solids Dried at 103–105°C | 1 | mg/L | 5.1 |
| **Heavy Metals** | | | |
| Aluminium | 0.05 | mg/L | < 0.05 |
| Antimony | 0.005 | mg/L | < 0.005 |
| Arsenic | 0.001 | mg/L | 0.003 |
| Barium | 0.02 | mg/L | 46 |
| Beryllium | 0.001 | mg/L | < 0.001 |

| Client Sample ID | | | A1-5327 |
|---|---|---|---|
| **Sample Matrix** | | | **Water** |
| **Eurofins Sample No.** | | | **S19-Oc15765** |
| **Date Sampled** | | | **Oct 10, 2019** |
| Test/Reference | LOR | Unit | |
| **Heavy Metals** | | | |
| Boron | 0.05 | mg/L | 13 |
| Cadmium | 0.0002 | mg/L | < 0.0002 |
| Chromium | 0.001 | mg/L | < 0.001 |
| Cobalt | 0.001 | mg/L | < 0.001 |
| Copper | 0.001 | mg/L | 0.005 |
| Iron | 0.05 | mg/L | 0.86 |
| Lead | 0.001 | mg/L | < 0.001 |
| Manganese | 0.005 | mg/L | 0.028 |
| Mercury | 0.0001 | mg/L | 0.0054 |
| Molybdenum | 0.005 | mg/L | < 0.005 |
| Nickel | 0.001 | mg/L | < 0.001 |
| Selenium | 0.001 | mg/L | < 0.001 |
| Silver | 0.005 | mg/L | < 0.005 |
| Strontium | 0.005 | mg/L | 3.1 |
| Thallium | 0.005 | mg/L | < 0.005 |
| Tin | 0.005 | mg/L | < 0.005 |
| Titanium | 0.005 | mg/L | < 0.005 |
| Vanadium | 0.005 | mg/L | < 0.005 |
| Zinc | 0.005 | mg/L | 0.019 |
| **Alkali Metals** | | | |
| Potassium | 0.5 | mg/L | 74 |

## Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

| Description | Testing Site | Extracted | Holding Time |
|---|---|---|---|
| Total Recoverable Hydrocarbons - 1999 NEPM Fractions | Melbourne | Oct 14, 2019 | 7 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Total Recoverable Hydrocarbons - 2013 NEPM Fractions | Melbourne | Oct 14, 2019 | 7 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Total Recoverable Hydrocarbons - 2013 NEPM Fractions | Melbourne | Oct 14, 2019 | |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| BTEX and Naphthalene | | | |
| BTEX | Melbourne | Oct 14, 2019 | 14 Days |
| - Method: LTM-ORG-2010 TRH C6-C40 | | | |
| Polycyclic Aromatic Hydrocarbons | Melbourne | Oct 14, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |
| Glycols* | Melbourne | Oct 14, 2019 | 7 Days |
| - Method: GLYCOLS- US EPA SW846 METHOD 8000 GC-FID. | | | |
| Chloride | Melbourne | Oct 14, 2019 | 28 Days |
| - Method: LTM-INO-4090 Chloride by Discrete Analyser | | | |
| Conductivity (at 25°C) | Melbourne | Oct 14, 2019 | 28 Days |
| - Method: LTM-INO-4030 Conductivity | | | |
| Nitrate & Nitrite (as N) | Melbourne | Oct 17, 2019 | 28 Days |
| - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA | | | |
| pH (at 25°C) | Melbourne | Oct 14, 2019 | 0 Hours |
| - Method: LTM-GEN-7090 pH in water by ISE | | | |
| Phosphate total (as P) | Melbourne | Oct 14, 2019 | 28 Days |
| - Method: APHA 4500-P E. Phosphorus | | | |
| Total Kjeldahl Nitrogen (as N) | Melbourne | Oct 14, 2019 | 7 Days |
| - Method: LTM-INO-4310 TKN in Waters & Soils by FIA | | | |
| Total Suspended Solids Dried at 103–105°C | Melbourne | Oct 14, 2019 | 7 Days |
| - Method: LTM-INO-4070 Analysis of Suspended Solids in Water by Gravimetry | | | |
| Heavy Metals | Melbourne | Oct 15, 2019 | 180 Days |
| - Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS | | | |
| Metals M8 | Melbourne | Oct 15, 2019 | 180 Days |
| - Method: | | | |
| Alkali Metals | Melbourne | Oct 14, 2019 | 180 Days |
| - Method: LTM-MET-3010 Alkali Metals S Si and P by ICP-AES | | | |
| Phenols (IWRG 621) | | | |
| Phenols (Halogenated) | Melbourne | Oct 14, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |
| Phenols (non-Halogenated) | Melbourne | Oct 14, 2019 | 7 Days |
| - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water | | | |

eurofins | Environment Testing

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NATA # 1261
Site # 23736

| | | | | | |
|---|---|---|---|---|---|
| **Company Name:** | Beach Energy Limited | **Order No.:** | PO# BE 00016911 | **Received:** | Oct 10, 2019 11:12 AM |
| **Address:** | 5775 South Gippsland Highway<br>Lang Lang<br>VIC 3984 | **Report #:** | 681835 | **Due:** | Oct 17, 2019 |
| | | **Phone:** | 03 5654 9103 | **Priority:** | 5 Day |
| | | **Fax:** | 03 5659 0178 | **Contact Name:** | Adrian Cukovski |
| **Project Name:** | PRODUCED WATER A15327 DISCHARGE | | | | |

**Eurofins Analytical Services Manager : Michael Morrison**

| Sample Detail | | | | | | Aluminium | Antimony | Barium | Beryllium | Boron | Chloride | Cobalt | Conductivity (at 25°C) | Iron | Manganese | Molybdenum | Nitrate & Nitrite (as N) | pH (at 25°C) | Phosphate total (as P) | Potassium | Selenium | Silver | Strontium | Thallium | Tin | Titanium | Total Combined Nitrogen (as N) | Total Kjeldahl Nitrogen (as N) | Total Suspended Solids Dried at 103–105°C | Vanadium | Polycyclic Aromatic Hydrocarbons | Glycols* | Metals M8 | Phenols (IWRG 621) | BTEX and Naphthalene | Total Recoverable Hydrocarbons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Melbourne Laboratory - NATA Site # 1254 & 14271** | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Sydney Laboratory - NATA Site # 18217** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Brisbane Laboratory - NATA Site # 20794** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Perth Laboratory - NATA Site # 23736** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **External Laboratory** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **No** | **Sample ID** | **Sample Date** | **Sampling Time** | **Matrix** | **LAB ID** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | A1-5327 | Oct 10, 2019 | | Water | S19-Oc15765 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Test Counts** | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## Internal Quality Control Review and Glossary

### General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

### Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

### Units

**mg/kg:** milligrams per kilogram

**mg/L:** milligrams per litre

**ug/L:** micrograms per litre

**ppm:** Parts per million

**ppb:** Parts per billion

**%:** Percentage

**org/100mL:** Organisms per 100 millilitres

**NTU:** Nephelometric Turbidity Units

**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

### Terms

| | |
|---|---|
| **Dry** | Where a moisture has been determined on a solid sample the result is expressed on a dry basis. |
| **LOR** | Limit of Reporting. |
| **SPIKE** | Addition of the analyte to the sample and reported as percentage recovery. |
| **RPD** | Relative Percent Difference between two Duplicate pieces of analysis. |
| **LCS** | Laboratory Control Sample - reported as percent recovery. |
| **CRM** | Certified Reference Material - reported as percent recovery. |
| **Method Blank** | In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water. |
| **Surr - Surrogate** | The addition of a like compound to the analyte target and reported as percentage recovery. |
| **Duplicate** | A second piece of analysis from the same sample and reported in the same units as the result to show comparison. |
| **USEPA** | United States Environmental Protection Agency |
| **APHA** | American Public Health Association |
| **TCLP** | Toxicity Characteristic Leaching Procedure |
| **COC** | Chain of Custody |
| **SRA** | Sample Receipt Advice |
| **QSM** | US Department of Defense Quality Systems Manual Version 5.3 |
| **CP** | Client Parent - QC was performed on samples pertaining to this report |
| **NCP** | Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within. |
| **TEQ** | Toxic Equivalency Quotient |

### QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

### QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

**Quality Control Results**

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| **Method Blank** | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | | | | |
| TRH C6-C9 | mg/L | < 0.02 | | | 0.02 | Pass | |
| TRH C10-C14 | mg/L | < 0.05 | | | 0.05 | Pass | |
| TRH C15-C28 | mg/L | < 0.1 | | | 0.1 | Pass | |
| TRH C29-C36 | mg/L | < 0.1 | | | 0.1 | Pass | |
| **Method Blank** | | | | | | | |
| **BTEX** | | | | | | | |
| Benzene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Toluene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Ethylbenzene | mg/L | < 0.001 | | | 0.001 | Pass | |
| m&p-Xylenes | mg/L | < 0.002 | | | 0.002 | Pass | |
| o-Xylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Xylenes - Total | mg/L | < 0.003 | | | 0.003 | Pass | |
| **Method Blank** | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | | | | |
| Naphthalene | mg/L | < 0.01 | | | 0.01 | Pass | |
| TRH C6-C10 | mg/L | < 0.02 | | | 0.02 | Pass | |
| TRH >C10-C16 | mg/L | < 0.05 | | | 0.05 | Pass | |
| TRH >C16-C34 | mg/L | < 0.1 | | | 0.1 | Pass | |
| TRH >C34-C40 | mg/L | < 0.1 | | | 0.1 | Pass | |
| **Method Blank** | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | |
| Acenaphthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Acenaphthylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benz(a)anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(a)pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(b&j)fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(g.h.i)perylene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Benzo(k)fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Chrysene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Dibenz(a.h)anthracene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Fluoranthene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Fluorene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Indeno(1.2.3-cd)pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Naphthalene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Phenanthrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| Pyrene | mg/L | < 0.001 | | | 0.001 | Pass | |
| **Method Blank** | | | | | | | |
| **Glycols*** | | | | | | | |
| Di-Ethylene Glycol* | mg/L | < 20 | | | 20 | Pass | |
| Ethylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| Propylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| Triethylene glycol* | mg/L | < 20 | | | 20 | Pass | |
| **Method Blank** | | | | | | | |
| **Phenols (Halogenated)** | | | | | | | |
| 2-Chlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |
| 2.4-Dichlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |
| 2.4.5-Trichlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.4.6-Trichlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.6-Dichlorophenol | mg/L | < 0.003 | | | 0.003 | Pass | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| 4-Chloro-3-methylphenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| Pentachlorophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| Tetrachlorophenols - Total | mg/L | < 0.03 | | | 0.03 | Pass | |
| **Method Blank** | | | | | | | |
| **Phenols (non-Halogenated)** | | | | | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | mg/L | < 0.1 | | | 0.1 | Pass | |
| 2-Methyl-4.6-dinitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| 2-Nitrophenol | mg/L | < 0.01 | | | 0.01 | Pass | |
| 2.4-Dinitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| 4-Nitrophenol | mg/L | < 0.03 | | | 0.03 | Pass | |
| Dinoseb | mg/L | < 0.1 | | | 0.1 | Pass | |
| **Method Blank** | | | | | | | |
| Chloride | mg/L | < 1 | | | 1 | Pass | |
| Conductivity (at 25°C) | uS/cm | < 10 | | | 10 | Pass | |
| Nitrate & Nitrite (as N) | mg/L | < 0.05 | | | 0.05 | Pass | |
| Phosphate total (as P) | mg/L | < 0.01 | | | 0.01 | Pass | |
| Total Kjeldahl Nitrogen (as N) | mg/L | < 0.2 | | | 0.2 | Pass | |
| Total Suspended Solids Dried at 103–105°C | mg/L | < 1 | | | 1 | Pass | |
| **Method Blank** | | | | | | | |
| **Heavy Metals** | | | | | | | |
| Aluminium | mg/L | < 0.05 | | | 0.05 | Pass | |
| Antimony | mg/L | < 0.005 | | | 0.005 | Pass | |
| Arsenic | mg/L | < 0.001 | | | 0.001 | Pass | |
| Barium | mg/L | < 0.02 | | | 0.02 | Pass | |
| Beryllium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Boron | mg/L | < 0.05 | | | 0.05 | Pass | |
| Cadmium | mg/L | < 0.0002 | | | 0.0002 | Pass | |
| Chromium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Cobalt | mg/L | < 0.001 | | | 0.001 | Pass | |
| Copper | mg/L | < 0.001 | | | 0.001 | Pass | |
| Iron | mg/L | < 0.05 | | | 0.05 | Pass | |
| Lead | mg/L | < 0.001 | | | 0.001 | Pass | |
| Manganese | mg/L | < 0.005 | | | 0.005 | Pass | |
| Mercury | mg/L | < 0.0001 | | | 0.0001 | Pass | |
| Molybdenum | mg/L | < 0.005 | | | 0.005 | Pass | |
| Nickel | mg/L | < 0.001 | | | 0.001 | Pass | |
| Selenium | mg/L | < 0.001 | | | 0.001 | Pass | |
| Silver | mg/L | < 0.005 | | | 0.005 | Pass | |
| Strontium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Thallium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Tin | mg/L | < 0.005 | | | 0.005 | Pass | |
| Titanium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Vanadium | mg/L | < 0.005 | | | 0.005 | Pass | |
| Zinc | mg/L | < 0.005 | | | 0.005 | Pass | |
| **Method Blank** | | | | | | | |
| **Alkali Metals** | | | | | | | |
| Potassium | mg/L | < 0.5 | | | 0.5 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | | | | |
| TRH C6-C9 | % | 113 | | | 70-130 | Pass | |
| TRH C10-C14 | % | 119 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **BTEX** | | | | | | | |
| Benzene | % | 109 | | | 70-130 | Pass | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| Toluene | % | 112 | | | 70-130 | Pass | |
| Ethylbenzene | % | 117 | | | 70-130 | Pass | |
| m&p-Xylenes | % | 111 | | | 70-130 | Pass | |
| Xylenes - Total | % | 112 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | | | | |
| Naphthalene | % | 106 | | | 70-130 | Pass | |
| TRH C6-C10 | % | 116 | | | 70-130 | Pass | |
| TRH >C10-C16 | % | 112 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | |
| Acenaphthene | % | 99 | | | 70-130 | Pass | |
| Acenaphthylene | % | 94 | | | 70-130 | Pass | |
| Anthracene | % | 64 | | | 70-130 | Fail | Q08 |
| Benz(a)anthracene | % | 81 | | | 70-130 | Pass | |
| Benzo(a)pyrene | % | 89 | | | 70-130 | Pass | |
| Benzo(b&j)fluoranthene | % | 93 | | | 70-130 | Pass | |
| Benzo(g.h.i)perylene | % | 112 | | | 70-130 | Pass | |
| Benzo(k)fluoranthene | % | 102 | | | 70-130 | Pass | |
| Chrysene | % | 98 | | | 70-130 | Pass | |
| Dibenz(a.h)anthracene | % | 121 | | | 70-130 | Pass | |
| Fluoranthene | % | 98 | | | 70-130 | Pass | |
| Fluorene | % | 99 | | | 70-130 | Pass | |
| Indeno(1.2.3-cd)pyrene | % | 105 | | | 70-130 | Pass | |
| Naphthalene | % | 98 | | | 70-130 | Pass | |
| Phenanthrene | % | 96 | | | 70-130 | Pass | |
| Pyrene | % | 99 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Glycols*** | | | | | | | |
| Ethylene glycol* | % | 119 | | | 70-130 | Pass | |
| Propylene glycol* | % | 108 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Phenols (Halogenated)** | | | | | | | |
| 2-Chlorophenol | % | 87 | | | 30-130 | Pass | |
| 2.4-Dichlorophenol | % | 78 | | | 30-130 | Pass | |
| 2.4.5-Trichlorophenol | % | 63 | | | 30-130 | Pass | |
| 2.4.6-Trichlorophenol | % | 78 | | | 30-130 | Pass | |
| 2.6-Dichlorophenol | % | 90 | | | 30-130 | Pass | |
| 4-Chloro-3-methylphenol | % | 72 | | | 30-130 | Pass | |
| Pentachlorophenol | % | 50 | | | 30-130 | Pass | |
| Tetrachlorophenols - Total | % | 90 | | | 30-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Phenols (non-Halogenated)** | | | | | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | % | 55 | | | 30-130 | Pass | |
| 2-Methyl-4.6-dinitrophenol | % | 61 | | | 30-130 | Pass | |
| 2-Nitrophenol | % | 83 | | | 30-130 | Pass | |
| 2.4-Dinitrophenol | % | 31 | | | 30-130 | Pass | |
| 4-Nitrophenol | % | 35 | | | 30-130 | Pass | |
| Dinoseb | % | 51 | | | 30-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| Chloride | % | 103 | | | 70-130 | Pass | |
| Conductivity (at 25°C) | % | 101 | | | 70-130 | Pass | |
| Nitrate & Nitrite (as N) | % | 98 | | | 70-130 | Pass | |
| Phosphate total (as P) | % | 100 | | | 70-130 | Pass | |

| Test | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen (as N) | % | 91 | | | 70-130 | Pass | |
| Total Suspended Solids Dried at 103–105°C | % | 100 | | | 70-130 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Heavy Metals** | | | | | | | |
| Aluminium | % | 115 | | | 80-120 | Pass | |
| Antimony | % | 104 | | | 80-120 | Pass | |
| Arsenic | % | 93 | | | 80-120 | Pass | |
| Barium | % | 106 | | | 80-120 | Pass | |
| Beryllium | % | 99 | | | 80-120 | Pass | |
| Boron | % | 119 | | | 80-120 | Pass | |
| Cadmium | % | 92 | | | 80-120 | Pass | |
| Chromium | % | 88 | | | 80-120 | Pass | |
| Cobalt | % | 103 | | | 80-120 | Pass | |
| Copper | % | 89 | | | 80-120 | Pass | |
| Iron | % | 103 | | | 80-120 | Pass | |
| Lead | % | 88 | | | 80-120 | Pass | |
| Manganese | % | 108 | | | 80-120 | Pass | |
| Mercury | % | 91 | | | 75-125 | Pass | |
| Molybdenum | % | 98 | | | 80-120 | Pass | |
| Nickel | % | 90 | | | 80-120 | Pass | |
| Selenium | % | 108 | | | 80-120 | Pass | |
| Silver | % | 106 | | | 80-120 | Pass | |
| Strontium | % | 107 | | | 80-120 | Pass | |
| Thallium | % | 93 | | | 80-120 | Pass | |
| Tin | % | 103 | | | 80-120 | Pass | |
| Titanium | % | 104 | | | 80-120 | Pass | |
| Vanadium | % | 102 | | | 80-120 | Pass | |
| Zinc | % | 97 | | | 80-120 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| **Alkali Metals** | | | | | | | |
| Potassium | % | 103 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| **Spike - % Recovery** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | Result 1 | | | | | |
| TRH C10-C14 | M19-Oc17905 | NCP | % | 96 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | Result 1 | | | | | |
| TRH >C10-C16 | M19-Oc17905 | NCP | % | 87 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | Result 1 | | | | | |
| Acenaphthene | B19-Oc15953 | NCP | % | 75 | | | 70-130 | Pass | |
| Acenaphthylene | B19-Oc15953 | NCP | % | 73 | | | 70-130 | Pass | |
| Anthracene | B19-Oc15953 | NCP | % | 92 | | | 70-130 | Pass | |
| Benz(a)anthracene | B19-Oc15953 | NCP | % | 99 | | | 70-130 | Pass | |
| Benzo(a)pyrene | B19-Oc15953 | NCP | % | 75 | | | 70-130 | Pass | |
| Benzo(b&j)fluoranthene | B19-Oc15953 | NCP | % | 78 | | | 70-130 | Pass | |
| Benzo(g.h.i)perylene | B19-Oc15953 | NCP | % | 84 | | | 70-130 | Pass | |
| Benzo(k)fluoranthene | B19-Oc15953 | NCP | % | 85 | | | 70-130 | Pass | |
| Chrysene | B19-Oc15953 | NCP | % | 87 | | | 70-130 | Pass | |
| Dibenz(a.h)anthracene | B19-Oc15953 | NCP | % | 79 | | | 70-130 | Pass | |
| Fluoranthene | B19-Oc15953 | NCP | % | 72 | | | 70-130 | Pass | |
| Fluorene | B19-Oc15953 | NCP | % | 77 | | | 70-130 | Pass | |
| Indeno(1.2.3-cd)pyrene | B19-Oc15953 | NCP | % | 87 | | | 70-130 | Pass | |
| Naphthalene | B19-Oc15953 | NCP | % | 82 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| Phenanthrene | B19-Oc15953 | NCP | % | 71 | | | 70-130 | Pass | |
| Pyrene | B19-Oc15953 | NCP | % | 75 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Phenols (Halogenated)** | | | | Result 1 | | | | | |
| 2-Chlorophenol | B19-Oc15953 | NCP | % | 103 | | | 30-130 | Pass | |
| 2.4-Dichlorophenol | B19-Oc15953 | NCP | % | 83 | | | 30-130 | Pass | |
| 2.4.5-Trichlorophenol | B19-Oc15953 | NCP | % | 64 | | | 30-130 | Pass | |
| 2.4.6-Trichlorophenol | B19-Oc15953 | NCP | % | 81 | | | 30-130 | Pass | |
| 2.6-Dichlorophenol | B19-Oc15953 | NCP | % | 108 | | | 30-130 | Pass | |
| 4-Chloro-3-methylphenol | B19-Oc15953 | NCP | % | 73 | | | 30-130 | Pass | |
| Pentachlorophenol | B19-Oc15953 | NCP | % | 47 | | | 30-130 | Pass | |
| Tetrachlorophenols - Total | B19-Oc15953 | NCP | % | 93 | | | 30-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Phenols (non-Halogenated)** | | | | Result 1 | | | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | P19-Oc05826 | NCP | % | 114 | | | 30-130 | Pass | |
| 2-Methyl-4.6-dinitrophenol | M19-Oc19408 | NCP | % | 58 | | | 30-130 | Pass | |
| 2-Nitrophenol | B19-Oc15953 | NCP | % | 93 | | | 30-130 | Pass | |
| 2.4-Dinitrophenol | P19-Oc05826 | NCP | % | 112 | | | 30-130 | Pass | |
| 4-Nitrophenol | P19-Oc05826 | NCP | % | 72 | | | 30-130 | Pass | |
| Dinoseb | M19-Oc19408 | NCP | % | 60 | | | 30-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| | | | | Result 1 | | | | | |
| Chloride | M19-Oc13756 | NCP | % | 103 | | | 70-130 | Pass | |
| Nitrate & Nitrite (as N) | M19-Oc20348 | NCP | % | 101 | | | 70-130 | Pass | |
| Phosphate total (as P) | M19-Oc16057 | NCP | % | 88 | | | 70-130 | Pass | |
| Total Kjeldahl Nitrogen (as N) | M19-Oc22243 | NCP | % | 98 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Heavy Metals** | | | | Result 1 | | | | | |
| Aluminium | M19-Oc16016 | NCP | % | 124 | | | 75-125 | Pass | |
| Antimony | M19-Oc16016 | NCP | % | 97 | | | 70-130 | Pass | |
| Arsenic | M19-Oc16016 | NCP | % | 97 | | | 75-125 | Pass | |
| Barium | M19-Oc16016 | NCP | % | 108 | | | 75-125 | Pass | |
| Beryllium | M19-Oc16016 | NCP | % | 94 | | | 75-125 | Pass | |
| Boron | M19-Oc16098 | NCP | % | 117 | | | 75-125 | Pass | |
| Cadmium | M19-Oc16016 | NCP | % | 102 | | | 75-125 | Pass | |
| Chromium | M19-Oc16016 | NCP | % | 96 | | | 75-125 | Pass | |
| Cobalt | M19-Oc16016 | NCP | % | 98 | | | 75-125 | Pass | |
| Copper | M19-Oc16016 | NCP | % | 138 | | | 75-125 | Fail | Q08 |
| Iron | M19-Oc16016 | NCP | % | 112 | | | 75-125 | Pass | |
| Lead | M19-Oc16016 | NCP | % | 96 | | | 75-125 | Pass | |
| Manganese | M19-Oc16016 | NCP | % | 113 | | | 75-125 | Pass | |
| Molybdenum | M19-Oc16016 | NCP | % | 96 | | | 75-125 | Pass | |
| Nickel | M19-Oc16016 | NCP | % | 97 | | | 75-125 | Pass | |
| Selenium | M19-Oc16016 | NCP | % | 97 | | | 75-125 | Pass | |
| Silver | M19-Oc16016 | NCP | % | 90 | | | 75-125 | Pass | |
| Strontium | M19-Oc16016 | NCP | % | 130 | | | 75-125 | Fail | Q08 |
| Thallium | M19-Oc16016 | NCP | % | 84 | | | 75-125 | Pass | |
| Tin | M19-Oc16016 | NCP | % | 97 | | | 75-125 | Pass | |
| Titanium | M19-Oc16016 | NCP | % | 101 | | | 75-125 | Pass | |
| Vanadium | M19-Oc16016 | NCP | % | 98 | | | 75-125 | Pass | |
| Zinc | M19-Oc16016 | NCP | % | 107 | | | 75-125 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| **Alkali Metals** | | | | Result 1 | | | | | |
| Potassium | M19-Oc15760 | NCP | % | 94 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| **Duplicate** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 1999 NEPM Fractions** | | | | Result 1 | Result 2 | RPD | | | |
| TRH C10-C14 | S19-Oc13529 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| TRH C15-C28 | S19-Oc13529 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| TRH C29-C36 | S19-Oc13529 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Total Recoverable Hydrocarbons - 2013 NEPM Fractions** | | | | Result 1 | Result 2 | RPD | | | |
| TRH >C10-C16 | S19-Oc13529 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| TRH >C16-C34 | S19-Oc13529 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| TRH >C34-C40 | S19-Oc13529 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | | | | Result 1 | Result 2 | RPD | | | |
| Acenaphthene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Acenaphthylene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Anthracene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benz(a)anthracene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benzo(a)pyrene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benzo(b&j)fluoranthene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benzo(g.h.i)perylene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Benzo(k)fluoranthene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Chrysene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Dibenz(a.h)anthracene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Fluoranthene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Fluorene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Indeno(1.2.3-cd)pyrene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Naphthalene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Phenanthrene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Pyrene | B19-Oc15952 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Glycols*** | | | | Result 1 | Result 2 | RPD | | | |
| Di-Ethylene Glycol* | S19-Oc15765 | CP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Ethylene glycol* | S19-Oc15765 | CP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Propylene glycol* | S19-Oc15765 | CP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| Triethylene glycol* | S19-Oc15765 | CP | mg/L | < 20 | < 20 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Phenols (Halogenated)** | | | | Result 1 | Result 2 | RPD | | | |
| 2-Chlorophenol | B19-Oc15952 | NCP | mg/L | < 0.003 | < 0.003 | <1 | 30% | Pass | |
| 2.4-Dichlorophenol | B19-Oc15952 | NCP | mg/L | < 0.003 | < 0.003 | <1 | 30% | Pass | |
| 2.4.5-Trichlorophenol | B19-Oc15952 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| 2.4.6-Trichlorophenol | B19-Oc15952 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| 2.6-Dichlorophenol | B19-Oc15952 | NCP | mg/L | < 0.003 | < 0.003 | <1 | 30% | Pass | |
| 4-Chloro-3-methylphenol | B19-Oc15952 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| Pentachlorophenol | B19-Oc15952 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| Tetrachlorophenols - Total | B19-Oc15952 | NCP | mg/L | < 0.03 | < 0.03 | <1 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Phenols (non-Halogenated)** | | | | Result 1 | Result 2 | RPD | | | |
| 2-Cyclohexyl-4.6-dinitrophenol | B19-Oc15952 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |
| 2-Methyl-4.6-dinitrophenol | B19-Oc15952 | NCP | mg/L | < 0.03 | < 0.03 | <1 | 30% | Pass | |
| 2-Nitrophenol | B19-Oc15952 | NCP | mg/L | < 0.01 | < 0.01 | <1 | 30% | Pass | |
| 2.4-Dinitrophenol | B19-Oc15952 | NCP | mg/L | < 0.03 | < 0.03 | <1 | 30% | Pass | |
| 4-Nitrophenol | B19-Oc15952 | NCP | mg/L | < 0.03 | < 0.03 | <1 | 30% | Pass | |
| Dinoseb | B19-Oc15952 | NCP | mg/L | < 0.1 | < 0.1 | <1 | 30% | Pass | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Duplicate** | | | | | | | | | |
| | | | | Result 1 | Result 2 | RPD | | | |
| Chloride | M19-Oc15757 | NCP | mg/L | 1800 | 1900 | 4.0 | 30% | Pass | |
| Conductivity (at 25°C) | M19-Oc17733 | NCP | uS/cm | 3300 | 3300 | 1.0 | 30% | Pass | |
| Nitrate & Nitrite (as N) | M19-Oc20348 | NCP | mg/L | < 0.05 | < 0.05 | <1 | 30% | Pass | |
| pH (at 25°C) | M19-Oc17733 | NCP | pH Units | 8.3 | 8.4 | pass | 30% | Pass | |
| Phosphate total (as P) | M19-Oc16052 | NCP | mg/L | 0.14 | 0.14 | <1 | 30% | Pass | |
| Total Kjeldahl Nitrogen (as N) | M19-Oc14326 | NCP | mg/L | 36 | 40 | 9.7 | 30% | Pass | |
| Total Suspended Solids Dried at 103–105°C | M19-Oc23892 | NCP | mg/L | 140 | 130 | 3.0 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Heavy Metals** | | | | Result 1 | Result 2 | RPD | | | |
| Aluminium | M19-Oc16016 | NCP | mg/L | 0.34 | 0.34 | 1.0 | 30% | Pass | |
| Antimony | M19-Oc16016 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Arsenic | M19-Oc16016 | NCP | mg/L | 0.001 | 0.001 | 4.0 | 30% | Pass | |
| Barium | M19-Oc16016 | NCP | mg/L | 0.02 | 0.02 | 3.0 | 30% | Pass | |
| Beryllium | M19-Oc16016 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Boron | M19-Oc16098 | NCP | mg/L | < 0.5 | < 0.5 | <1 | 30% | Pass | |
| Cadmium | M19-Oc16016 | NCP | mg/L | 0.0015 | 0.0015 | 4.0 | 30% | Pass | |
| Chromium | M19-Oc16016 | NCP | mg/L | 0.002 | 0.002 | 2.0 | 30% | Pass | |
| Cobalt | M19-Oc16016 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Copper | M19-Oc16016 | NCP | mg/L | 0.11 | 0.11 | 1.0 | 30% | Pass | |
| Iron | M19-Oc16016 | NCP | mg/L | 0.33 | 0.34 | 3.0 | 30% | Pass | |
| Lead | M19-Oc16016 | NCP | mg/L | 0.005 | 0.005 | 1.0 | 30% | Pass | |
| Manganese | M19-Oc16016 | NCP | mg/L | 0.030 | 0.032 | 7.0 | 30% | Pass | |
| Molybdenum | M19-Oc16016 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Nickel | M19-Oc16016 | NCP | mg/L | 0.002 | 0.002 | 6.0 | 30% | Pass | |
| Selenium | M19-Oc16016 | NCP | mg/L | < 0.001 | < 0.001 | <1 | 30% | Pass | |
| Silver | M19-Oc16016 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Strontium | M19-Oc16016 | NCP | mg/L | 0.075 | 0.074 | 1.0 | 30% | Pass | |
| Thallium | M19-Oc16016 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Tin | M19-Oc16016 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Titanium | M19-Oc16016 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Vanadium | M19-Oc16016 | NCP | mg/L | < 0.005 | < 0.005 | <1 | 30% | Pass | |
| Zinc | M19-Oc16016 | NCP | mg/L | 0.030 | 0.031 | 3.0 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| **Alkali Metals** | | | | Result 1 | Result 2 | RPD | | | |
| Potassium | M19-Oc15760 | NCP | mg/L | 380 | 380 | 1.0 | 30% | Pass | |

## Comments

## Sample Integrity

| | |
|---|---|
| Custody Seals Intact (if used) | N/A |
| Attempt to Chill was evident | Yes |
| Sample correctly preserved | Yes |
| Appropriate sample containers have been used | Yes |
| Sample containers for volatile analysis received with minimal headspace | Yes |
| Samples received within HoldingTime | Yes |
| Some samples have been subcontracted | No |

## Qualifier Codes/Comments

| Code | Description |
|---|---|
| N01 | F2 is determined by arithmetically subtracting the "naphthalene" value from the ">C10-C16" value. The naphthalene value used in this calculation is obtained from volatiles (Purge & Trap analysis). |
| N02 | Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid. |
| N04 | F1 is determined by arithmetically subtracting the "Total BTEX" value from the "C6-C10" value. The "Total BTEX" value is obtained by summing the concentrations of BTEX analytes. The "C6-C10" value is obtained by quantitating against a standard of mixed aromatic/aliphatic analytes. |
| N07 | Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs |
| Q08 | The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference. |

## Authorised By

| | |
|---|---|
| Michael Morrison | Analytical Services Manager |
| Emily Rosenberg | Senior Analyst-Metal (VIC) |
| Harry Bacalis | Senior Analyst-Volatile (VIC) |
| Joseph Edouard | Senior Analyst-Organic (VIC) |
| Julie Kay | Senior Analyst-Inorganic (VIC) |

**Glenn Jackson**

**General Manager**

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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# Appendix B

## Wet Test Eco-testing Reports

# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report

**October 2019**

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# Toxicity Test Report: TR1858/1



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3*, salinity 17.3 ‰*, total ammonia 32.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 27 September 2019 at 1810h |

| Sample 9252*: Y0250919* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control 92.0 ± 1.8 | | |
| ASW Control 92.5 ± 1.7 | | |
| 1.6 87.8 ± 5.6 | | |
| 3.1 12.8 ± 9.5 * | | |
| 6.3 2.0 ± 1.4 * | | |
| 12.5 0.0 ± 0.0 | | |
| 25 0.0 ± 0.0 | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **EC10 = 1.6%**** | | |
| **EC50 = 2.4% **** | | |
| **NOEC = 1.6%** | | |
| **LOEC = 3.1%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)
** The 95% Confidence limits are not reliable.

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# Toxicity Test Report: TR1858/1



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 92.0% | Yes |
| Reference Toxicant within cusum chart limits | 48.7-66.6µg Cu/L | 56.9µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.

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# Toxicity Test Report: TR1858/2



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3*, salinity 17.3 ‰*, total ammonia 32.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 27 September 2019 at 1730h |

| Sample: **Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 95.3 ± 2.2 | | |
| ASW Control | 96.0 ± 2.6 | | |
| 1.6 | 96.3 ± 1.7 | | |
| 3.1 | 84.0 ± 4.7 * | | |
| 6.3 | 25.5 ± 10.3 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |

**72-hr EC10 = 3.0 (2.78-3.22)%**
**72-hr EC50 = 4.9 (4.66-5.08)%**
**NOEC = 1.6%**
**LOEC = 3.1%**

*Significantly lower percentage of normally developed larvae compared with the FSW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/2



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 95.3% | Yes |
| Reference Toxicant within cusum chart limits | 9.6-13.6µg Cu/L | 11.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR1858/3



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3*, salinity 17.3 ‰*, total ammonia 32.0mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | The test was extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 27 September 2019 at 1830 h |

| Sample 9252: *Y0250919* **Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 78.3 ± 4.0 | | |
| ASW Control | 76.5 ± 3.4 | | |
| 1.6 | 80.3 ± 4.4 | | |
| 3.1 | 48.0 ± 8.8 * | | |
| 6.3 | 0.0 ± 0.0 | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 =2.0 (1.87-2.21)%**<br>**72-hr EC50 =3.4 (3.28-3.50)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/3



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 78.3% | Yes |
| Reference Toxicant within cusum chart limits | 7.5-15.3µg Cu/L | 9.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.

# Toxicity Test Report: TR1858/4



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3 ‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 27 September 2019 at 1630h |

| Sample 9252: Y0250919<br>**Concentration (%)** | **% Unaffected (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 100 ± 0.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 90.0 ± 20.0 | | |
| 6.3 | 60.0 ± 16.3 * | | |
| 12.5 | 10.0 ± 11.6 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |

**96-hr EC10 = 3.4(2.27-4.39)%**
**96-hr EC50 = 6.6 (5.41-8.19)%**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/4



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.6-8.4mg SDS/L | 3.6mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

NATA WORLD RECOGNISED ACCREDITATION

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# Toxicity Test Report: TR1858/5



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 25 September 2019 |
| | | **Date Received:** | 26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3 ‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 27 September 2019 at 1930h |

| Sample 9252: *Y0250919*<br>**Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 18.1 ± 1.0 | | |
| ASW Control | 16.7 ± 0.6 | | |
| 1.6 | 19.0 ± 1.3 | | |
| 3.1 | 18.3 ± 1.8 | | |
| 6.3 | 8.2 ± 1.8 * | | |
| 12.5 | 2.6 ± 1.4 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr IC10 = 3.7 (3.33-3.80)%**<br>**72-hr IC50 = 6.0 (5.43-6.93)%**<br>**NOEC = 3.1%**<br>**LOEC = 6.3%** | | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/5



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean cell density | ≥16.0x10$^4$ cells/mL | 19.1x10$^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 5.5% | Yes |
| Reference Toxicant within cusum chart limits | 3.0-9.3µg Cu/L | 4.8µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR1858/6



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 25 September 2019 |
| | | **Date Received:** | 26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 27 September 2019 at 1930h |

| Sample 9252: *Y0250919* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control: 95.5 ± 2.7 | | |
| ASW Control: 95.8 ± 2.5 | | |
| 1.6: 94.8 ± 3.0 | | |
| 3.1: 95.5 ± 2.1 | | |
| 6.3: 93.5 ± 2.1 | | |
| 12.5: 57.5 ± 11.8 * | | |
| 25: 24.0 ± 11.5 * | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr EC10 = 7.9 (5.58-9.79)%** | | |
| **72-hr EC50 = 15.6 (13.3-18.1)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/6



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 95.5% | Yes |
| Reference Toxicant within cusum chart limits | 104.9-276.5µg Cu/L | 181.7µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR1858/7



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 25 September 2019 |
| | | **Date Received:** | 26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using the Bass *Macqauria novemaculeata.* |
| **Test Protocol:** | ESA SOP 117 (ESA 2016), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample |
| **Source of Test Organisms:** | In-house cultures |
| **Test Initiated:** | 27 September 2019 at 1900h |

| Sample 9252: *Y0250919* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control — 90.0 ± 11.6 | | |
| ASW Control — 90.0 ± 11.6 | | |
| 1.6 — 90.0 ± 11.6 | | |
| 3.1 — 60.0 ± 16.3 * | | |
| 6.3 — 0.0 ± 0.0 | | |
| 12.5 — 0.0 ± 0.0 | | |
| 25 — 0.0 ± 0.0 | | |
| 50 — 0.0 ± 0.0 | | |
| 100 — 0.0 ± 0.0 | | |
| **96-hr IC10 = 2.1%**** | | |
| **96-hr EC50 = 3.5 (3.04-4.06)%** | | |
| **NOEC = 1.6%** | | |
| **LOEC = 3.1%** | | |

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)
** The 95% Confidence Limits are not reliable.

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# Toxicity Test Report: TR1858/7



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 90.0% | Yes |
| Reference Toxicant within cusum chart limits | 76.3-2555.9µg Cu/L | 607.5µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 12. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR1858/8



Performed in compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>25 September 2019<br>26 September 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9252 | Y0250919 | Produced Formation Water, pH 6.3, salinity 17.3‰, total ammonia 32.0mg/L. Sample received at 12ºC in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Size of Test Organisms:** | 23mm |
| **Test Initiated:** | 27 September 2019 at 1930h |

Sample 9252: *Y0250919*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** | |
|---|---|---|
| FSW Control | 100 ± 0.0 | |
| ASW Control | 100 ± 0.0 | |
| 1.6 | 100 ± 0.0 | |
| 3.1 | 55.0 ± 10.0 | * |
| 6.3 | 0.0 ± 0.0 | |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day EC10 (unaffected) = 2.7 (2.62-2.76)%**
**7 day EC50 (unaffected) = 3.2 (2.79-3.78)%**
**NOEC = 1.6%**
**LOEC = 3.1%**

Sample 9252: *Y0250919*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** | |
|---|---|---|
| FSW Control | 22.4 ± 1.9 | |
| ASW Control | 22.1 ± 2.5 | |
| 1.6 | 20.6 ± 1.6 | |
| 3.1 | 10.8 ± 1.8 | ** |
| 6.3 | 0.0 ± 0.0 | |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day IC10 (biomass) = 1.7%*****
**7 day IC50 (biomass) =3.1 (2.69-3.67) %**
**NOEC = 1.6%**
**LOEC = 3.1%**

*Significantly lower percentage of unaffected larval fish compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)
**Significantly lower fish biomass compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)
***The 95% Confidence Limits are not reliable

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# Toxicity Test Report: TR1858/8



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | - | No* |
| Reference Toxicant within cusum chart limits | 10.7-114.8mg $NH_4^+$/L | 46.3mg $NH_4^+$/L | Yes |

*fish available for testing at 27 September were older and at a relatively lower growth phase than with younger fish

Test Report Authorised by: Dr Rick Krassoi, Director on 11 October 2019

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Peter Young

**Client** : AECOM Australia Pty Ltd
Level 6, 3 Forrest Place
Perth WA 6849

**Email** : peter.young@aecom.com
**Telephone** : 08 6208 0000
**Facsimile** :

**Date** : 2/10/2019

**Re** : Receipt of Samples **Pages :** **2**

**ESA Project** : PR1858 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples:** **YES**
**Samples received in apparent good condition and correctly bottled:** **YES**
**Security seals on sample bottles and esky intact:** **YES**

**Date samples received** : 26/10/2019
**Time samples received** : 8:45
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 11-15°C

**Comments** : 4 x 2.5L sample received at 12oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

ecotox SERVICES AUSTRALIA

Customer
Contact Name
Phone Email
Sampled by D MCLACHLAN

Ship To
Attention
(please provide an email address for sample receipt notification)

| Sample Date (day/month/year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | Comments / Instructions |
|---|---|---|---|---|---|---|
| 25/09/2014 | 08:30 | YO250919-1 | 1 x 2 SL | | | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 1858 |
| " | " | YO250919-2 | 1 x 2 SL | | | |
| " | " | YO250919-3 | 1 x 2 SL | | | |
| " | " | YO250919-4 | 1 x 2 L | | | |

12°C
G254

| 1) Released By | Date | 2) Received By | Date | 3) Released By | Date | 4) Received By | Date |
|---|---|---|---|---|---|---|---|
| D MCLACHLAN | 25/9/14 | | 26/9/14 | | | | |
| Of | Time 08:30 | Of ESA | Time 0845 | Of | Time | Of | Time |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

Ecotox Services Australia Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax: 61 2 9420-9484

# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9300 | 0.9800 | 0.9600 |
| ASW Control | 0.9500 | 0.9300 | 0.9900 | 0.9700 |
| 1.6 | 0.9400 | 0.9700 | 0.9600 | 0.9800 |
| 3.1 | 0.7900 | 0.8500 | 0.9000 | 0.8200 |
| 6.3 | 0.3600 | 0.1200 | 0.3000 | 0.2400 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3789 | 1.3030 | 1.4706 | 5.232 | 4 | * | | | 16 | 400 |
| 1.6 | 0.9625 | 1.0026 | 1.3796 | 1.3233 | 1.4289 | 3.240 | 4 | -0.012 | 2.290 | 0.1332 | 15 | 400 |
| *3.1 | 0.8400 | 0.8750 | 1.1624 | 1.0948 | 1.2490 | 5.681 | 4 | 3.723 | 2.290 | 0.1332 | 64 | 400 |
| *6.3 | 0.2550 | 0.2656 | 0.5222 | 0.3537 | 0.6435 | 23.840 | 4 | 14.729 | 2.290 | 0.1332 | 298 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

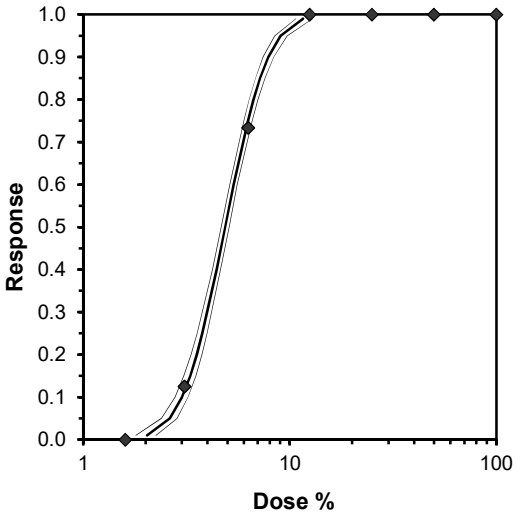
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.975273 | 0.887 | -0.42954 | 0.482187 |
| Bartlett's Test indicates equal variances (p = 0.41) | 2.877388 | 11.34487 | | |
| The control means are not significantly different (p = 0.64) | 0.498347 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.065634 | 0.068111 | 0.657642 | 0.006766 | 1.1E-08 | 3, 12 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 6.149576 | 0.334514 | 5.493928 | 6.805223 | 0.04 | 3.589738 | 11.0705 | 0.61 | 0.687311 | 0.162613 | 4 |
| Intercept | 0.773331 | 0.245685 | 0.291789 | 1.254874 | | | | | | | |
| TSCR | 0.039185 | 0.007027 | 0.025411 | 0.052959 | | | | | | | |

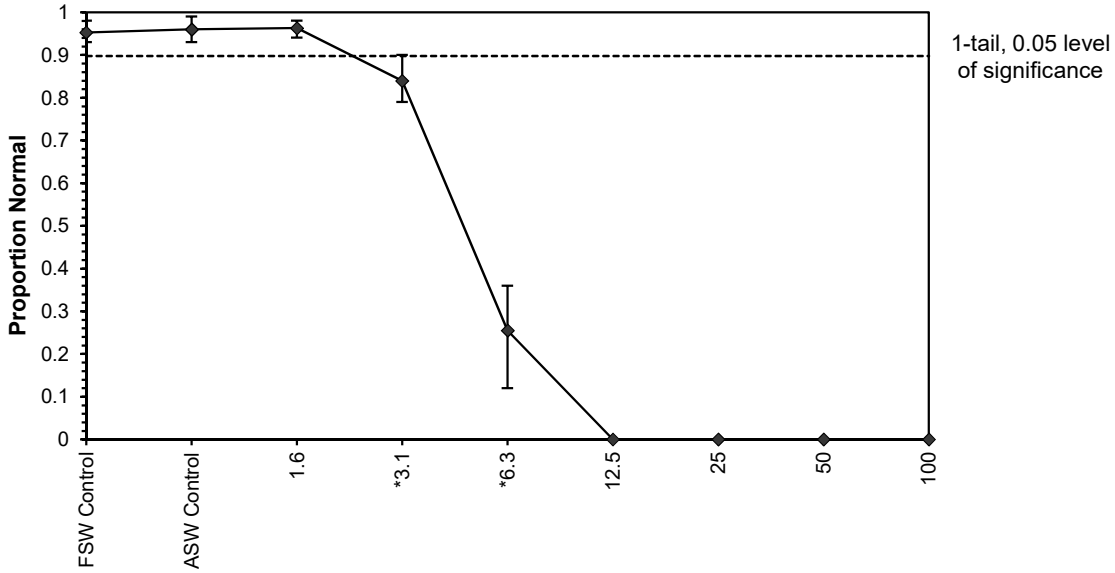
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.03712 | 1.801262 | 2.253447 |
| EC05 | 3.355 | 2.629277 | 2.390429 | 2.845354 |
| EC10 | 3.718 | 3.012408 | 2.777552 | 3.224509 |
| EC15 | 3.964 | 3.301971 | 3.07203 | 3.51023 |
| EC20 | 4.158 | 3.55183 | 3.326811 | 3.756811 |
| EC25 | 4.326 | 3.781202 | 3.560788 | 3.983656 |
| EC40 | 4.747 | 4.427037 | 4.216199 | 4.628583 |
| EC50 | 5.000 | 4.867552 | 4.656595 | 5.077419 |
| EC60 | 5.253 | 5.351901 | 5.131327 | 5.582442 |
| EC75 | 5.674 | 6.266013 | 5.997911 | 6.570449 |
| EC80 | 5.842 | 6.670664 | 6.370831 | 7.020684 |
| EC85 | 6.036 | 7.175431 | 6.828854 | 7.591264 |
| EC90 | 6.282 | 7.865156 | 7.444511 | 8.384187 |
| EC95 | 6.645 | 9.011248 | 8.448203 | 9.728514 |
| EC99 | 7.326 | 11.63067 | 10.68178 | 12.89303 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.25 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| ASW Control | | 96.00 | 93.00 | 99.00 | 2.58 | 1.67 | 4 |
| 1.6 | | 96.25 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 3.1 | | 84.00 | 79.00 | 90.00 | 4.69 | 2.58 | 4 |
| 6.3 | | 25.50 | 12.00 | 36.00 | 10.25 | 12.55 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9300 | 0.9800 | 0.9600 |
| ASW Control | 0.9500 | 0.9300 | 0.9900 | 0.9700 |
| 1.6 | 0.9400 | 0.9700 | 0.9600 | 0.9800 |
| 3.1 | 0.7900 | 0.8500 | 0.9000 | 0.8200 |
| 6.3 | 0.3600 | 0.1200 | 0.3000 | 0.2400 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3789 | 1.3030 | 1.4706 | 5.232 | 4 | * | | | 16 | 400 |
| 1.6 | 0.9625 | 1.0026 | 1.3796 | 1.3233 | 1.4289 | 3.240 | 4 | -0.012 | 2.290 | 0.1332 | 15 | 400 |
| *3.1 | 0.8400 | 0.8750 | 1.1624 | 1.0948 | 1.2490 | 5.681 | 4 | 3.723 | 2.290 | 0.1332 | 64 | 400 |
| *6.3 | 0.2550 | 0.2656 | 0.5222 | 0.3537 | 0.6435 | 23.840 | 4 | 14.729 | 2.290 | 0.1332 | 298 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

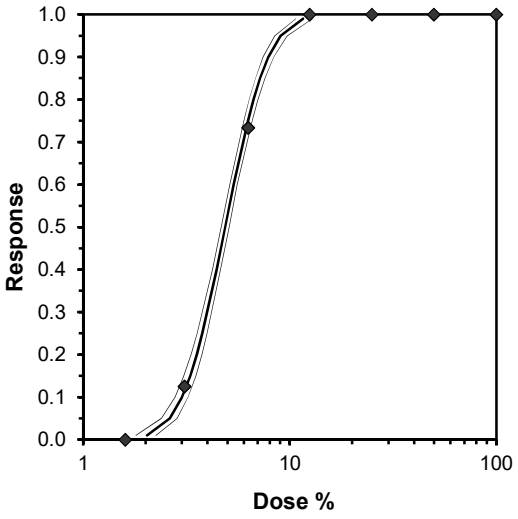
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.975273 | 0.887 | -0.42954 | 0.482187 |
| Bartlett's Test indicates equal variances (p = 0.41) | 2.877388 | 11.34487 | | |
| The control means are not significantly different (p = 0.64) | 0.498347 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.065634 | 0.068111 | 0.657642 | 0.006766 | 1.1E-08 | 3, 12 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 6.149576 | 0.334514 | 5.493928 | 6.805223 | 0.04 | 3.589738 | 11.0705 | 0.61 | 0.687311 | 0.162613 | 4 |
| Intercept | 0.773331 | 0.245685 | 0.291789 | 1.254874 | | | | | | | |
| TSCR | 0.039185 | 0.007027 | 0.025411 | 0.052959 | | | | | | | |

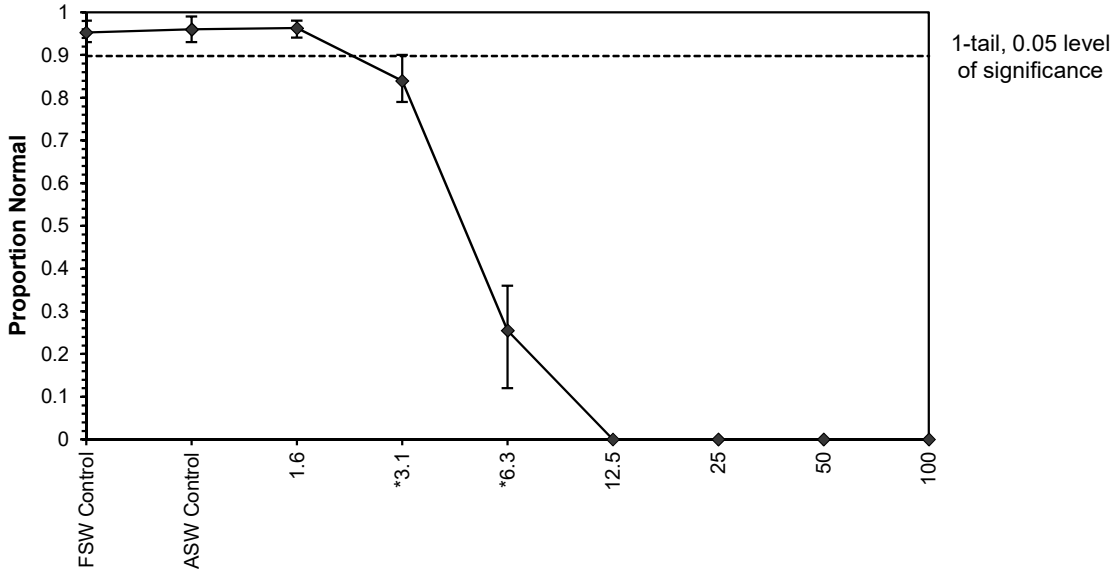
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.03712 | 1.801262 | 2.253447 |
| EC05 | 3.355 | 2.629277 | 2.390429 | 2.845354 |
| EC10 | 3.718 | 3.012408 | 2.777552 | 3.224509 |
| EC15 | 3.964 | 3.301971 | 3.07203 | 3.51023 |
| EC20 | 4.158 | 3.55183 | 3.326811 | 3.756811 |
| EC25 | 4.326 | 3.781202 | 3.560788 | 3.983656 |
| EC40 | 4.747 | 4.427037 | 4.216199 | 4.628583 |
| EC50 | 5.000 | 4.867552 | 4.656595 | 5.077419 |
| EC60 | 5.253 | 5.351901 | 5.131327 | 5.582442 |
| EC75 | 5.674 | 6.266013 | 5.997911 | 6.570449 |
| EC80 | 5.842 | 6.670664 | 6.370831 | 7.020684 |
| EC85 | 6.036 | 7.175431 | 6.828854 | 7.591264 |
| EC90 | 6.282 | 7.865156 | 7.444511 | 8.384187 |
| EC95 | 6.645 | 9.011248 | 8.448203 | 9.728514 |
| EC99 | 7.326 | 11.63067 | 10.68178 | 12.89303 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 17:30 | Test ID: | PR1858/12 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | HT-Heliocidaris tuberculata |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.25 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| ASW Control | | 96.00 | 93.00 | 99.00 | 2.58 | 1.67 | 4 |
| 1.6 | | 96.25 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 3.1 | | 84.00 | 79.00 | 90.00 | 4.69 | 2.58 | 4 |
| 6.3 | | 25.50 | 12.00 | 36.00 | 10.25 | 12.55 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 18:30 | Test ID: | PR1858/15 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 18:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7400 | 0.8300 | 0.8000 | 0.7600 |
| ASW Control | 0.7500 | 0.8100 | 0.7300 | 0.7700 |
| 1.6 | 0.7400 | 0.8400 | 0.8100 | 0.8200 |
| 3.1 | 0.4600 | 0.3900 | 0.4700 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

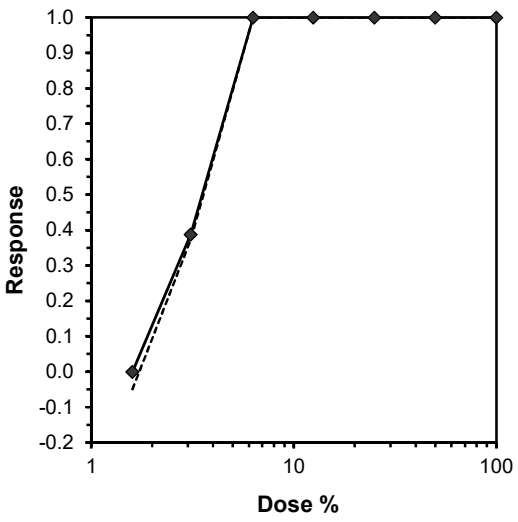
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7825 | 1.0229 | 1.0869 | 1.0357 | 1.1458 | 4.535 | 4 | | | | | |
| ASW Control | 0.7650 | 1.0000 | 1.0655 | 1.0244 | 1.1198 | 3.830 | 4 | * | | | 94 | 400 |
| 1.6 | 0.8025 | 1.0490 | 1.1119 | 1.0357 | 1.1593 | 4.799 | 4 | -1.024 | 2.180 | 0.0987 | 79 | 400 |
| *3.1 | 0.4800 | 0.6275 | 0.7653 | 0.6745 | 0.8861 | 11.522 | 4 | 6.633 | 2.180 | 0.0987 | 208 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.97222 | 0.859 | 0.428236 | 0.615081 |
| Bartlett's Test indicates equal variances (p = 0.44) | 1.627575 | 9.21034 | | |
| The control means are not significantly different (p = 0.53) | 0.668304 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.088191 | 0.115181 | 0.141556 | 0.004096 | 6.0E-05 | 2, 9 |

### Trimmed Spearman-Karber

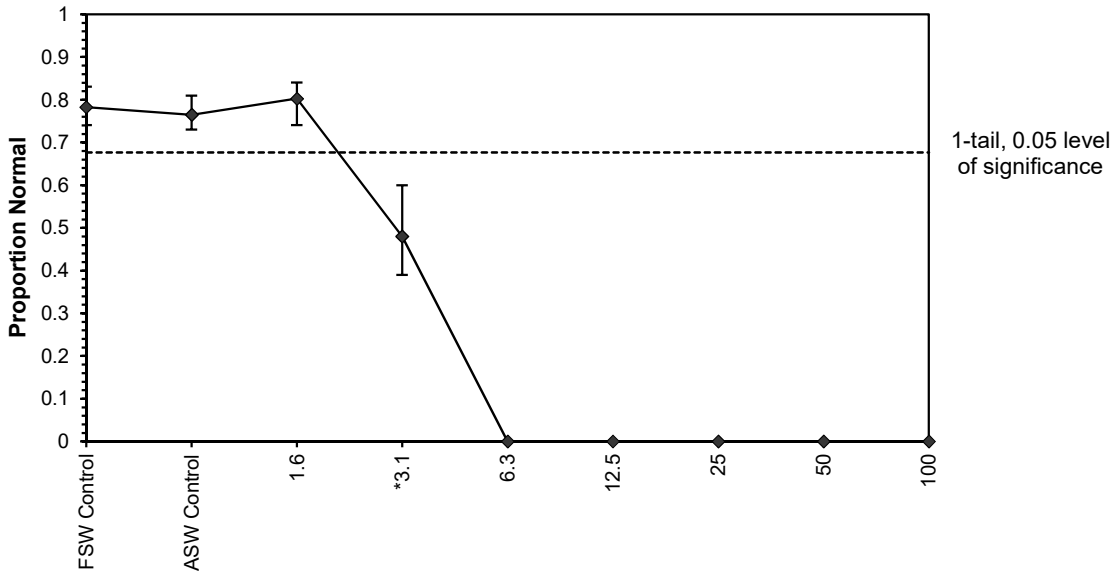
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.3885 | 3.2773 | 3.5036 |
| 5.0% | 3.4105 | 3.2858 | 3.5400 |
| 10.0% | 3.4323 | 3.2895 | 3.5813 |
| 20.0% | 3.4747 | 3.2733 | 3.6886 |
| Auto-0.0% | 3.3885 | 3.2773 | 3.5036 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 18:30 | Test ID: | PR1858/15 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 18:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 18:30 | Test ID: | PR1858/15 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 18:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 78.25 | 74.00 | 83.00 | 4.03 | 2.57 | 4 |
| ASW Control | | 76.50 | 73.00 | 81.00 | 3.42 | 2.42 | 4 |
| 1.6 | | 80.25 | 74.00 | 84.00 | 4.35 | 2.60 | 4 |
| 3.1 | | 48.00 | 39.00 | 60.00 | 8.76 | 6.16 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 18:30 | Test ID: | PR1858/15 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 18:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7400 | 0.8300 | 0.8000 | 0.7600 |
| ASW Control | 0.7500 | 0.8100 | 0.7300 | 0.7700 |
| 1.6 | 0.7400 | 0.8400 | 0.8100 | 0.8200 |
| 3.1 | 0.4600 | 0.3900 | 0.4700 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

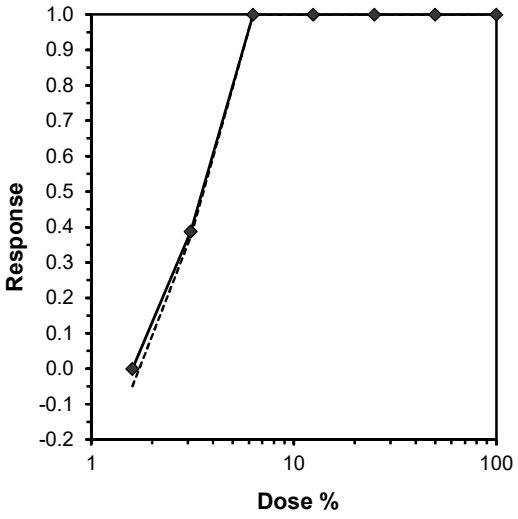
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7825 | 1.0229 | 1.0869 | 1.0357 | 1.1458 | 4.535 | 4 | | | | | |
| ASW Control | 0.7650 | 1.0000 | 1.0655 | 1.0244 | 1.1198 | 3.830 | 4 | * | | | 0.7838 | 1.0000 |
| 1.6 | 0.8025 | 1.0490 | 1.1119 | 1.0357 | 1.1593 | 4.799 | 4 | -1.024 | 2.180 | 0.0987 | 0.7838 | 1.0000 |
| *3.1 | 0.4800 | 0.6275 | 0.7653 | 0.6745 | 0.8861 | 11.522 | 4 | 6.633 | 2.180 | 0.0987 | 0.4800 | 0.6124 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.97222 | 0.859 | 0.428236 | 0.615081 |
| Bartlett's Test indicates equal variances (p = 0.44) | 1.627575 | 9.21034 | | |
| The control means are not significantly different (p = 0.53) | 0.668304 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.088191 | 0.115181 | 0.141556 | 0.004096 | 6.0E-05 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.7956 | 0.0668 | 1.7268 | 1.9051 | -10.9184 |
| IC10 | 1.9850 | 0.0560 | 1.8688 | 2.2077 | 0.3615 |
| IC15 | 2.1715 | 0.0825 | 1.9964 | 2.5128 | 0.9785 |
| IC20 | 2.3581 | 0.1116 | 2.1214 | 2.8245 | 1.1568 |
| IC25 | 2.5471 | 0.1401 | 2.2395 | 3.1471 | 1.0250 |
| IC40 | 3.1101 | 0.1053 | 2.6353 | 3.2456 | -1.0027 |
| IC50 | 3.1942 | 0.0411 | 3.0657 | 3.3281 | 0.1532 |



# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 16:30 | Test ID: | PR1858/02 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 16:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 0.6000 |
| 6.3 | 0.6000 | 0.8000 | 0.6000 | 0.4000 |
| 12.5 | 0.0000 | 0.2000 | 0.2000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 0.9000 | 0.9000 | 1.2305 | 0.8861 | 1.3453 | 18.660 | 4 | 16.00 | 10.00 | 2 | 20 |
| *6.3 | 0.6000 | 0.6000 | 0.8910 | 0.6847 | 1.1071 | 19.366 | 4 | 10.00 | 10.00 | 8 | 20 |
| *12.5 | 0.1000 | 0.1000 | 0.3446 | 0.2255 | 0.4636 | 39.900 | 4 | 10.00 | 10.00 | 18 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

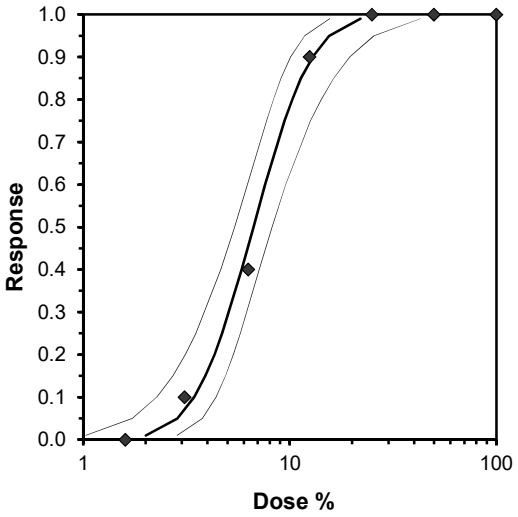
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.874764 | 0.905 | -1.01023 | 1.925233 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 4.476347 | 0.779411 | 2.948702 | 6.003993 | 0 | 0.752017 | 11.0705 | 0.98 | 0.823407 | 0.223396 | 3 |
| Intercept | 1.314144 | 0.671174 | -0.00136 | 2.629645 | | | | | | | |
| TSCR | | | | | | | | | | | |

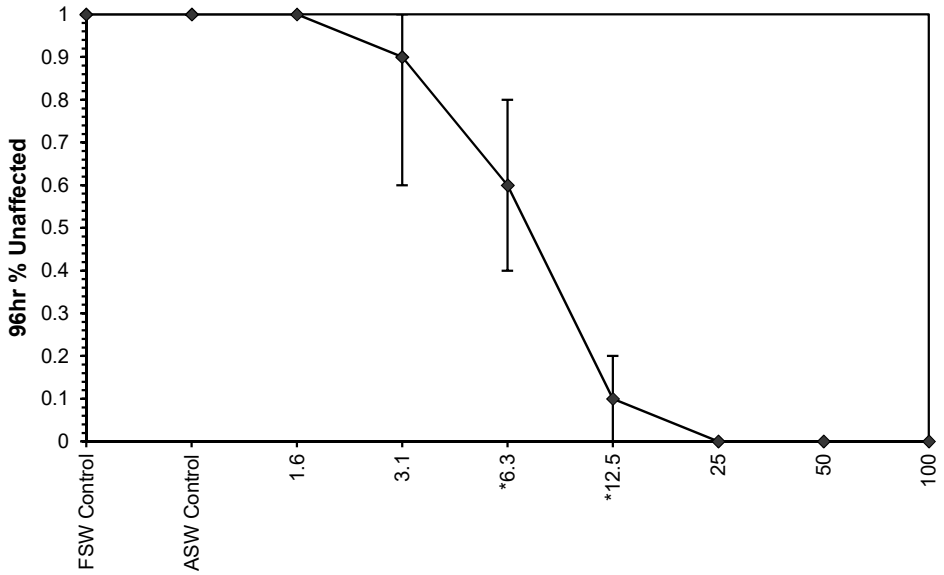
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 2.012376 | 1.034186 | 2.85415 |
| EC05 | 3.355 | 2.857278 | 1.733282 | 3.765561 |
| EC10 | 3.718 | 3.444395 | 2.271134 | 4.387061 |
| EC15 | 3.964 | 3.907252 | 2.716143 | 4.87997 |
| EC20 | 4.158 | 4.319085 | 3.122326 | 5.326055 |
| EC25 | 4.326 | 4.706828 | 3.509488 | 5.756475 |
| EC40 | 4.747 | 5.845344 | 4.639124 | 7.111008 |
| EC50 | 5.000 | 6.658968 | 5.410339 | 8.189498 |
| EC60 | 5.253 | 7.585842 | 6.234193 | 9.545884 |
| EC75 | 5.674 | 9.420751 | 7.706435 | 12.60984 |
| EC80 | 5.842 | 10.26649 | 8.330809 | 14.17074 |
| EC85 | 6.036 | 11.3486 | 9.093906 | 16.28708 |
| EC90 | 6.282 | 12.87363 | 10.11726 | 19.4753 |
| EC95 | 6.645 | 15.51891 | 11.78891 | 25.51472 |
| EC99 | 7.326 | 22.03458 | 15.55582 | 42.75583 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 16:30 | Test ID: | PR1858/02 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 16:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 16:30 | Test ID: | PR1858/02 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 16:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 90.00 | 60.00 | 100.00 | 20.00 | 4.97 | 4 |
| 6.3 | | 60.00 | 40.00 | 80.00 | 16.33 | 6.74 | 4 |
| 12.5 | | 10.00 | 0.00 | 20.00 | 11.55 | 33.98 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/07 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 18.314 | 17.014 | 19.514 | 17.614 | 16.614 | 19.014 | 17.814 | 18.614 |
| ASW Control | 17.314 | 16.614 | 16.814 | 15.914 | | | | |
| 1.6 | 18.614 | 19.014 | 17.714 | 20.714 | | | | |
| 3.1 | 21.014 | 17.314 | 17.814 | 17.114 | | | | |
| 6.3 | 8.114 | 5.914 | 10.114 | 8.714 | | | | |
| 12.5 | 2.214 | 4.314 | 2.914 | 1.014 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

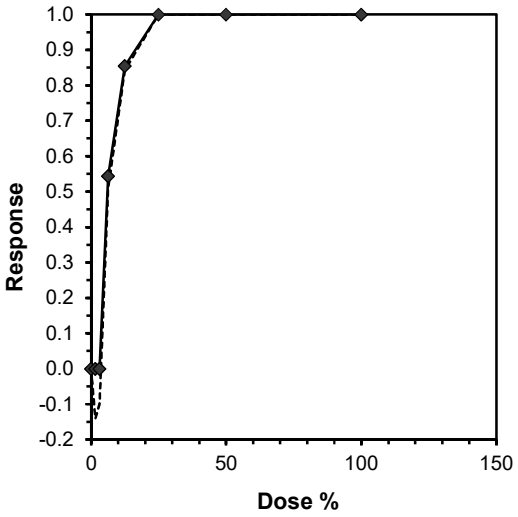
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 18.064 | 1.0840 | 18.064 | 16.614 | 19.514 | 5.472 | 8 | | | | | |
| ASW Control | 16.664 | 1.0000 | 16.664 | 15.914 | 17.314 | 3.482 | 4 | * | | | 17.997 | 1.0000 |
| 1.6 | 19.014 | 1.1410 | 19.014 | 17.714 | 20.714 | 6.611 | 4 | -2.327 | 2.360 | 2.383 | 17.997 | 1.0000 |
| 3.1 | 18.314 | 1.0990 | 18.314 | 17.114 | 21.014 | 9.959 | 4 | -1.634 | 2.360 | 2.383 | 17.997 | 1.0000 |
| *6.3 | 8.214 | 0.4929 | 8.214 | 5.914 | 10.114 | 21.273 | 4 | 8.368 | 2.360 | 2.383 | 8.214 | 0.4564 |
| *12.5 | 2.614 | 0.1569 | 2.614 | 1.014 | 4.314 | 52.734 | 4 | 13.914 | 2.360 | 2.383 | 2.614 | 0.1452 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.970155 | 0.905 | 0.427505 | -0.08268 |
| Bartlett's Test indicates equal variances (p = 0.51) | 3.267247 | 13.2767 | | |
| The control means are significantly different (p = 0.03) | 2.580344 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 2.383094 | 0.143009 | 208.6 | 2.039333 | 1.1E-10 | 4, 15 |

### Linear Interpolation (200 Resamples)

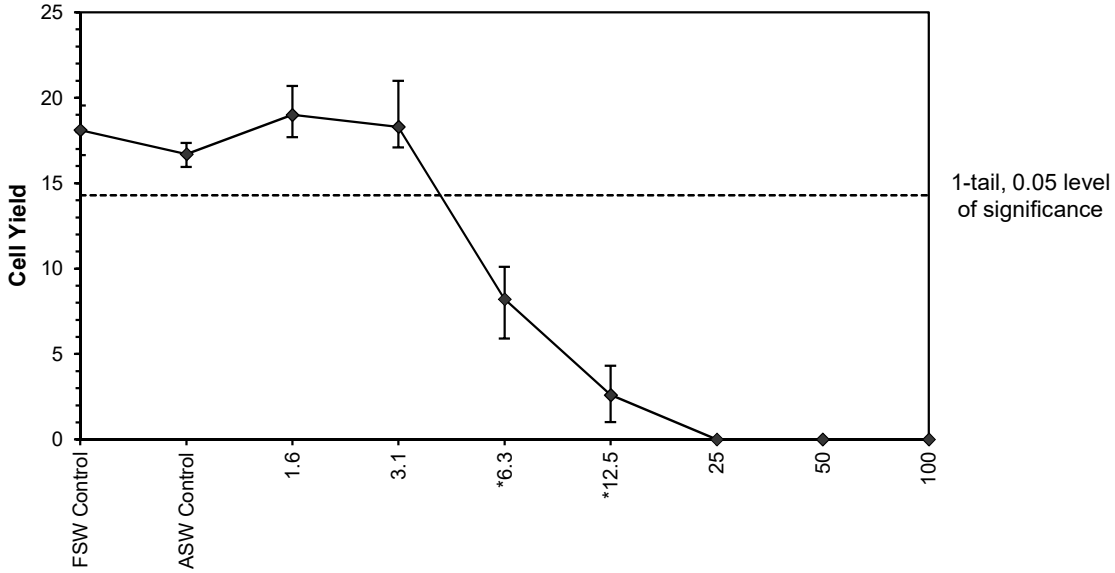
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.3943 | 0.0843 | 2.9935 | 3.4479 | -1.8951 |
| IC10 | 3.6887 | 0.0779 | 3.3296 | 3.8001 | -1.1331 |
| IC15 | 3.9830 | 0.0832 | 3.6401 | 4.1536 | -0.6121 |
| IC20 | 4.2773 | 0.0953 | 3.9400 | 4.5055 | -0.2673 |
| IC25 | 4.5717 | 0.1121 | 4.2001 | 4.8608 | -0.0793 |
| IC40 | 5.4547 | 0.1757 | 4.9306 | 5.9203 | 0.1581 |
| IC50 | 6.0433 | 0.2582 | 5.4339 | 6.9275 | 0.8476 |



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/07 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Dose-Response Plot



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/07 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 18.06 | 16.61 | 19.51 | 0.99 | 5.50 | 8 |
| ASW Control | | 16.66 | 15.91 | 17.31 | 0.58 | 4.57 | 4 |
| 1.6 | | 19.01 | 17.71 | 20.71 | 1.26 | 5.90 | 4 |
| 3.1 | | 18.31 | 17.11 | 21.01 | 1.82 | 7.37 | 4 |
| 6.3 | | 8.21 | 5.91 | 10.11 | 1.75 | 16.09 | 4 |
| 12.5 | | 2.61 | 1.01 | 4.31 | 1.38 | 44.92 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/03 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9800 | 0.9200 | 0.9700 |
| ASW Control | 0.9600 | 0.9500 | 0.9300 | 0.9900 |
| 1.6 | 0.9600 | 0.9100 | 0.9400 | 0.9800 |
| 3.1 | 0.9600 | 0.9300 | 0.9800 | 0.9500 |
| 6.3 | 0.9400 | 0.9100 | 0.9600 | 0.9300 |
| 12.5 | 0.6500 | 0.4100 | 0.6700 | 0.5700 |
| 25 | 0.3900 | 0.1200 | 0.1900 | 0.2600 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9550 | 0.9974 | 1.3637 | 1.2840 | 1.4289 | 4.643 | 4 | | | | | |
| ASW Control | 0.9575 | 1.0000 | 1.3721 | 1.3030 | 1.4706 | 5.188 | 4 | * | | | 17 | 400 |
| 1.6 | 0.9475 | 0.9896 | 1.3469 | 1.2661 | 1.4289 | 5.129 | 4 | 0.401 | 2.410 | 0.1513 | 21 | 400 |
| 3.1 | 0.9550 | 0.9974 | 1.3617 | 1.3030 | 1.4289 | 3.860 | 4 | 0.166 | 2.410 | 0.1513 | 18 | 400 |
| 6.3 | 0.9350 | 0.9765 | 1.3155 | 1.2661 | 1.3694 | 3.274 | 4 | 0.902 | 2.410 | 0.1513 | 26 | 400 |
| *12.5 | 0.5750 | 0.6005 | 0.8618 | 0.6949 | 0.9589 | 13.905 | 4 | 8.129 | 2.410 | 0.1513 | 170 | 400 |
| *25 | 0.2400 | 0.2507 | 0.5036 | 0.3537 | 0.6745 | 26.989 | 4 | 13.835 | 2.410 | 0.1513 | 304 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.981601 | 0.916 | -0.09971 | 0.299336 |
| Bartlett's Test indicates equal variances (p = 0.38) | 5.275941 | 15.08627 | | |
| The control means are not significantly different (p = 0.87) | 0.175539 | 2.446912 | | |

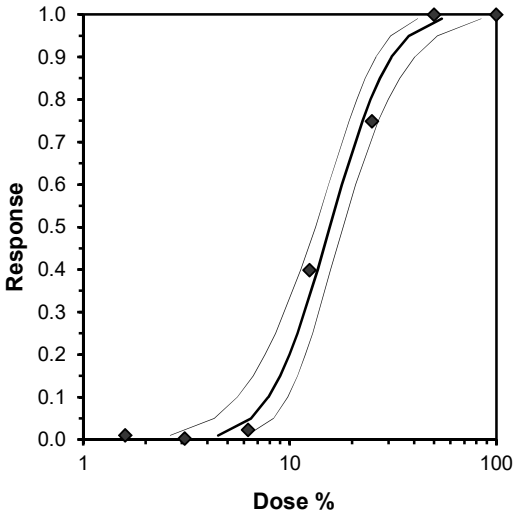
| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.078607 | 0.081794 | 0.526421 | 0.007882 | 5.5E-11 | 5, 18 |
| Treatments vs ASW Control | | | | | | | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 4.301535 | 0.44916 | 3.146931 | 5.456138 | 0.0425 | 23.77123 | 11.0705 | 2.4E-04 | 1.194433 | 0.232475 | 5 |
| Intercept | -0.1379 | 0.565265 | -1.59096 | 1.315165 | | | | | | | |
| TSCR | 0.044103 | 0.012778 | 0.011255 | 0.07695 | | | | | | | |

| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 4.504174 | 2.641494 | 6.197175 |
| EC05 | 3.355 | 6.487026 | 4.311699 | 8.334077 |
| EC10 | 3.718 | 7.879603 | 5.584404 | 9.785016 |
| EC15 | 3.964 | 8.984383 | 6.637686 | 10.9229 |
| EC20 | 4.158 | 9.971884 | 7.603767 | 11.93814 |
| EC25 | 4.326 | 10.90514 | 8.53209 | 12.90182 |
| EC40 | 4.747 | 13.66269 | 11.30799 | 15.82467 |
| EC50 | 5.000 | 15.64708 | 13.2775 | 18.05275 |
| EC60 | 5.253 | 17.91968 | 15.44643 | 20.786 |
| EC75 | 5.674 | 22.45098 | 19.42831 | 26.86441 |
| EC80 | 5.842 | 24.55214 | 21.13958 | 29.94037 |
| EC85 | 6.036 | 27.25074 | 23.244 | 34.09206 |
| EC90 | 6.282 | 31.07149 | 26.0878 | 40.30351 |
| EC95 | 6.645 | 37.74165 | 30.78708 | 51.93311 |
| EC99 | 7.326 | 54.35649 | 41.60597 | 84.35676 |

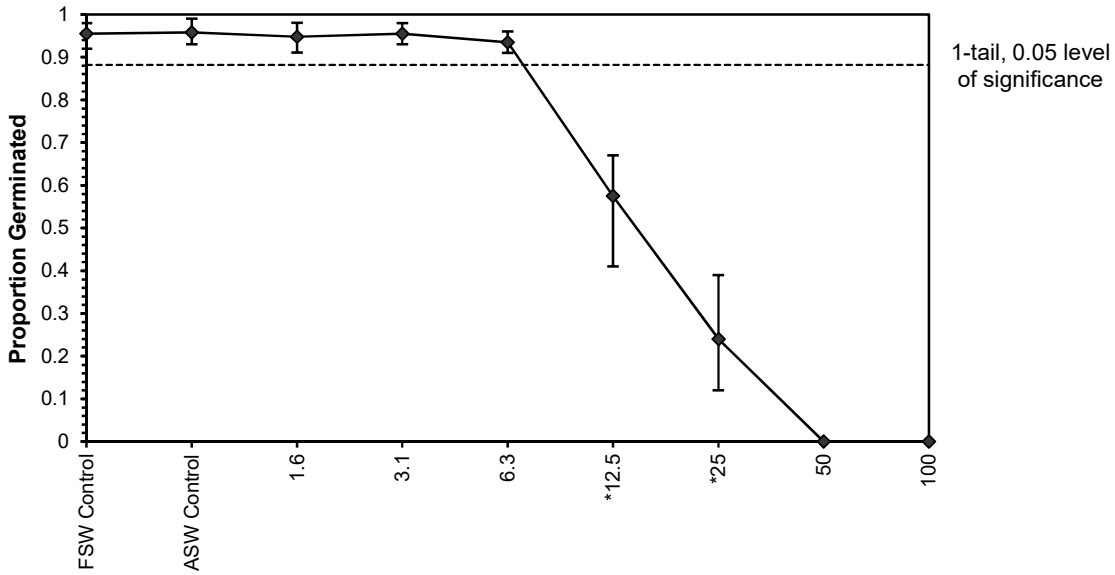
Significant heterogeneity detected (p = 2.40E-04)



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/03 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/03 | Sample ID: | Y0250919 |
| End Date: | 30/09/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Germination, % | 95.50 | 92.00 | 98.00 | 2.65 | 1.70 | 4 |
| ASW Control | | 95.75 | 93.00 | 99.00 | 2.50 | 1.65 | 4 |
| 1.6 | | 94.75 | 91.00 | 98.00 | 2.99 | 1.82 | 4 |
| 3.1 | | 95.50 | 93.00 | 98.00 | 2.08 | 1.51 | 4 |
| 6.3 | | 93.50 | 91.00 | 96.00 | 2.08 | 1.54 | 4 |
| 12.5 | | 57.50 | 41.00 | 67.00 | 11.82 | 5.98 | 4 |
| 25 | | 24.00 | 12.00 | 39.00 | 11.52 | 14.14 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:00 | Test ID: | PR1858/06 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | MN-Macquaria novemaculeata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| 1.6 | 0.8000 | 0.8000 | 1.0000 | 1.0000 |
| 3.1 | 0.6000 | 0.6000 | 0.8000 | 0.4000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

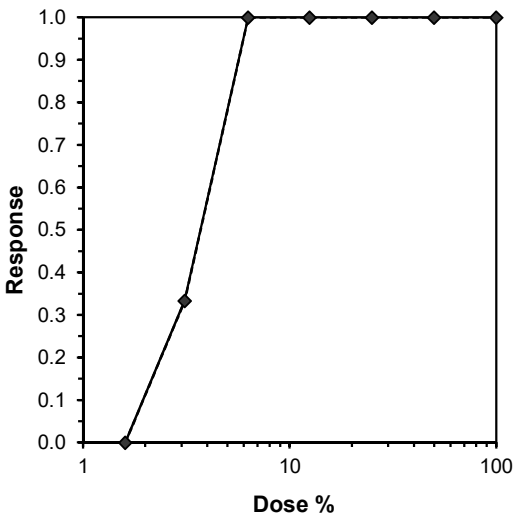
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | | | | | |
| ASW Control | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | * | | | 2 | 20 |
| 1.6 | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 0.000 | 2.180 | 0.2314 | 2 | 20 |
| *3.1 | 0.6000 | 0.6667 | 0.8910 | 0.6847 | 1.1071 | 19.366 | 4 | 3.159 | 2.180 | 0.2314 | 8 | 20 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.895444 | 0.859 | 0.057516 | -1.43497 |
| Bartlett's Test indicates equal variances (p = 0.91) | 0.187668 | 9.21034 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.182504 | 0.206012 | 0.149821 | 0.022526 | 0.016848 | 2, 9 |

### Trimmed Spearman-Karber

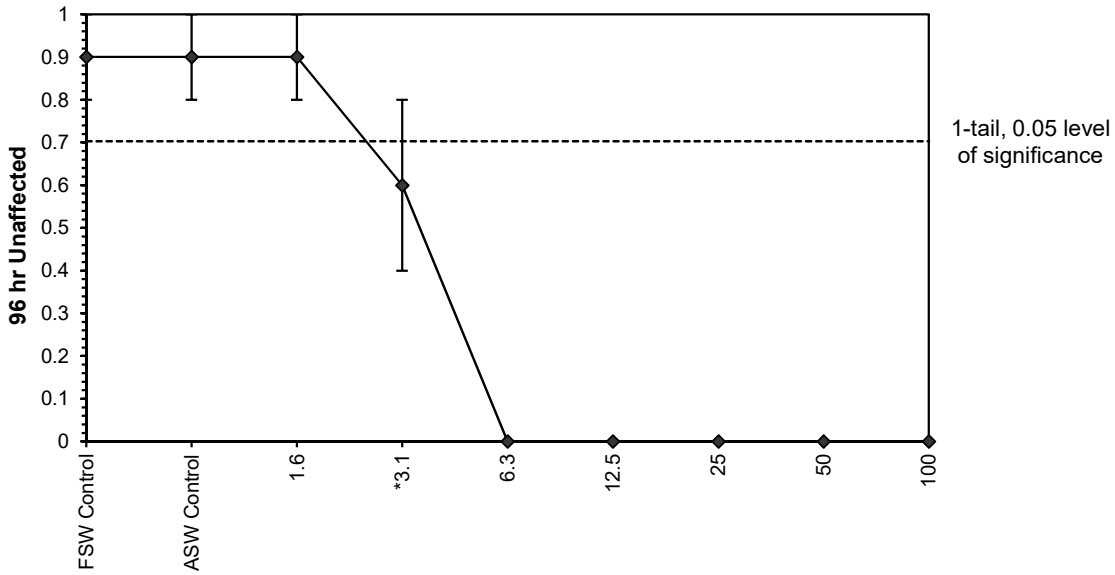
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.5168 | 3.0437 | 4.0634 |
| 5.0% | 3.5524 | 3.0218 | 4.1763 |
| 10.0% | 3.5872 | 2.9774 | 4.3219 |
| 20.0% | 3.6512 | 2.7833 | 4.7896 |
| Auto-0.0% | 3.5168 | 3.0437 | 4.0634 |



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:00 | Test ID: | PR1858/06 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | MN-Macquaria novemaculeata |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:00 | Test ID: | PR1858/06 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | MN-Macquaria novemaculeata |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| ASW Control | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 1.6 | | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| 3.1 | | 60.00 | 40.00 | 80.00 | 16.33 | 6.74 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Fish Acute Toxicity Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:00 | Test ID: | PR1858/06 | Sample ID: | Y0250919 |
| End Date: | 1/10/2019 19:00 | Lab ID: | 9252 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | MN-Macquaria novemaculeata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| 1.6 | 0.8000 | 0.8000 | 1.0000 | 1.0000 |
| 3.1 | 0.6000 | 0.6000 | 0.8000 | 0.4000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

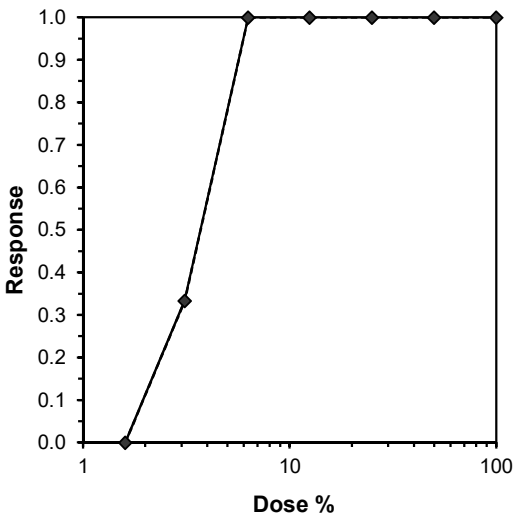
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | | | | | |
| ASW Control | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | * | | | 0.9000 | 1.0000 |
| 1.6 | 0.9000 | 1.0000 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | 0.000 | 2.180 | 0.2314 | 0.9000 | 1.0000 |
| *3.1 | 0.6000 | 0.6667 | 0.8910 | 0.6847 | 1.1071 | 19.366 | 4 | 3.159 | 2.180 | 0.2314 | 0.6000 | 0.6667 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.895444 | 0.859 | 0.057516 | -1.43497 |
| Bartlett's Test indicates equal variances (p = 0.91) | 0.187668 | 9.21034 | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.182504 | 0.206012 | 0.149821 | 0.022526 | 0.016848 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.8951 | 0.4157 | 0.0000 | 2.2252 | -0.9916 |
| IC10 | 2.1439 | 0.3236 | 0.8814 | 2.8397 | -0.4616 |
| IC15 | 2.3670 | 0.3059 | 1.0202 | 3.1809 | -0.2162 |
| IC20 | 2.5750 | 0.2961 | 1.4886 | 3.4503 | -0.2842 |
| IC25 | 2.7745 | 0.2697 | 1.7863 | 3.4026 | -0.3367 |
| IC40 | 3.1607 | 0.1279 | 2.5292 | 3.3745 | -1.5697 |
| IC50 | 3.2518 | 0.0790 | 3.0065 | 3.4562 | -0.6610 |



# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 0.6000 | 0.6000 | 0.4000 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

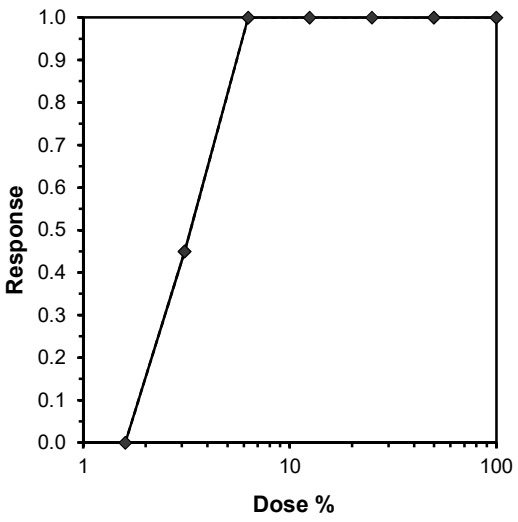
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 0 | 20 |
| *3.1 | 0.5500 | 0.5500 | 0.8357 | 0.6847 | 0.8861 | 12.047 | 4 | 10.00 | 11.00 | 9 | 20 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.633513 | 0.859 | -2.29783 | 7.088889 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 1.6 | 3.1 | 2.227106 | 62.5 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

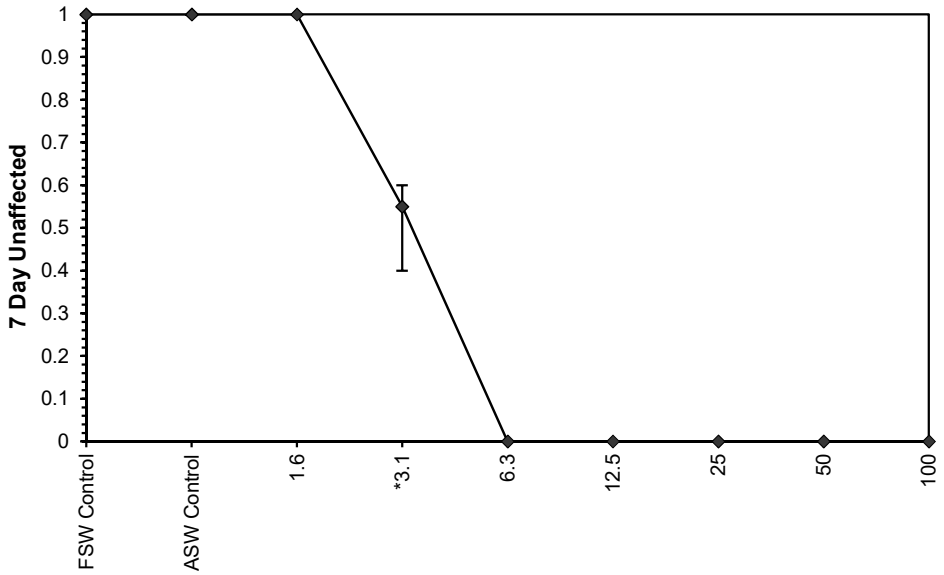
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.2466 | 2.7875 | 3.7813 |
| 5.0% | 3.2538 | 2.7460 | 3.8556 |
| 10.0% | 3.2611 | 2.6918 | 3.9508 |
| 20.0% | 3.2755 | 2.5232 | 4.2521 |
| Auto-0.0% | 3.2466 | 2.7875 | 3.7813 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Dose-Response Plot



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 55.00 | 40.00 | 60.00 | 10.00 | 5.75 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 22.40 | 20.18 | 24.20 | 1.89 | 6.13 | 4 |
| ASW Control | | 22.09 | 19.94 | 24.38 | 2.46 | 7.10 | 4 |
| 1.6 | | 20.58 | 18.98 | 22.16 | 1.57 | 6.10 | 4 |
| 3.1 | | 10.83 | 8.06 | 11.80 | 1.84 | 12.54 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 25 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 50 | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 102.10 | 102.10 | 102.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 100.60 | 100.60 | 100.60 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 100.40 | 100.40 | 100.40 | 0.00 | 0.00 | 1 |
| 25 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 50 | | 93.10 | 93.10 | 93.10 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 0.6000 | 0.6000 | 0.4000 | 0.6000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

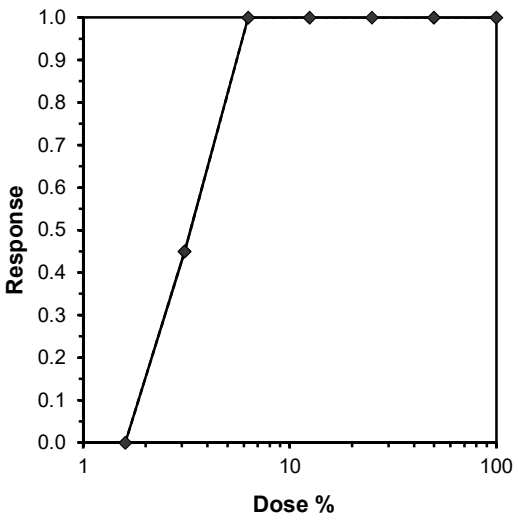
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| *3.1 | 0.5500 | 0.5500 | 0.8357 | 0.6847 | 0.8861 | 12.047 | 4 | 10.00 | 11.00 | 0.5500 | 0.5500 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.633513 | 0.859 | -2.29783 | 7.088889 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 1.6 | 3.1 | 2.227106 | 62.5 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.5690 | 0.0224 | 2.4923 | 2.6112 | -0.5832 |
| IC10 | 2.7064 | 0.0260 | 2.6174 | 2.7555 | -0.5813 |
| IC15 | 2.7941 | 0.0284 | 2.6970 | 2.8477 | -0.5801 |
| IC20 | 2.8615 | 0.0303 | 2.7581 | 2.9186 | -0.5792 |
| IC25 | 2.9180 | 0.0318 | 2.8094 | 2.9781 | -0.5785 |
| IC40 | 3.0578 | 0.0358 | 2.9357 | 3.1253 | -0.5768 |
| IC50 | 3.1507 | 0.0432 | 3.0061 | 3.2311 | -0.5273 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 27/09/2019 19:30 | Test ID: | PR1858/11 | Sample ID: | Y0250919 |
| End Date: | 4/10/2019 19:30 | Lab ID: | 9252 | Sample Type: | AQ-Aqueous |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 23.700 | 24.200 | 20.180 | 21.500 |
| ASW Control | 19.980 | 19.940 | 24.060 | 24.380 |
| 1.6 | 21.680 | 22.160 | 19.500 | 18.980 |
| 3.1 | 11.800 | 11.740 | 8.060 | 11.700 |
| 6.3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 22.395 | 1.0138 | 22.395 | 20.180 | 24.200 | 8.420 | 4 | | | | | |
| ASW Control | 22.090 | 1.0000 | 22.090 | 19.940 | 24.380 | 11.150 | 4 | * | | | 22.090 | 1.0000 |
| 1.6 | 20.580 | 0.9316 | 20.580 | 18.980 | 22.160 | 7.648 | 4 | 1.070 | 2.180 | 3.076 | 20.580 | 0.9316 |
| *3.1 | 10.825 | 0.4900 | 10.825 | 8.060 | 11.800 | 17.033 | 4 | 7.984 | 2.180 | 3.076 | 10.825 | 0.4900 |
| 6.3 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

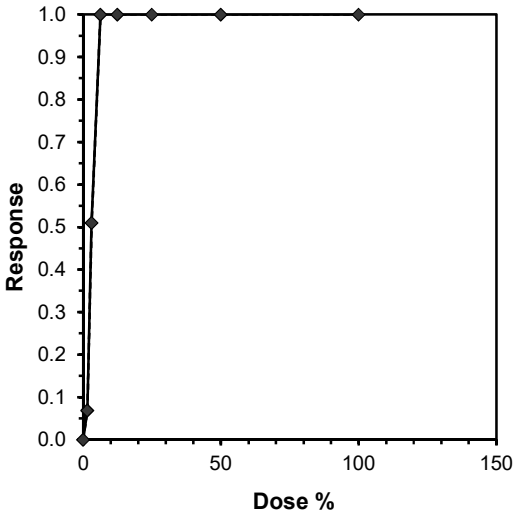
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.882251 | 0.859 | -0.34393 | -1.65716 |
| Bartlett's Test indicates equal variances (p = 0.76) | 0.551451 | 9.21034 | | |
| The control means are not significantly different (p = 0.85) | 0.196645 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 3.075745 | 0.139237 | 149.5602 | 3.981233 | 4.3E-05 | 2, 9 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05* | 1.1703 | 0.4380 | 0.0597 | 2.1276 | -0.1603 |
| IC10 | 1.7075 | 0.2517 | 0.4993 | 2.0752 | -1.4779 |
| IC15 | 1.8773 | 0.1593 | 1.1592 | 2.2431 | -1.0802 |
| IC20 | 2.0472 | 0.1365 | 1.5410 | 2.4110 | -0.5000 |
| IC25 | 2.2170 | 0.1298 | 1.7899 | 2.5792 | -0.3700 |
| IC40 | 2.7265 | 0.1259 | 2.3538 | 3.0930 | 0.0248 |
| IC50 | 3.0662 | 0.1740 | 2.6876 | 3.6711 | 0.5220 |

* indicates IC estimate less than the lowest concentration



# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report- Round 2

**October 2019**

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Lane Cove NSW 2066 Australia
www.ecotox.com.au
ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR1858/9



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 08 October 2019 at 1420h |

| Sample 9259*: Y0021019* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control — 95.3 ± 1.7 | | |
| ASW Control — 94.5 ± 1.3 | | |
| 1.6 — 94.8 ± 1.5 | | |
| 3.1 — 75.5 ± 13.3 * | | |
| 6.3 — 0.0 ± 0.0 | | |
| 12.5 — 0.0 ± 0.0 | | |
| 25 — 0.0 ± 0.0 | | |
| 50 — 0.0 ± 0.0 | | |
| 100 — 0.0 ± 0.0 | | |
| **IC10 = 2.5 (2.09-3.30)%**<br>**EC50 = 3.8 (3.74-3.96)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/9



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 95.3% | Yes |
| Reference Toxicant within cusum chart limits | 48.6-66.5µg Cu/L | 55.2µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.



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# Toxicity Test Report: TR1858/10



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 08 October 2019 at 1400h |

| Sample 9259: *Y0021019* **Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 94.0 ± 3.4 | | |
| ASW Control | 96.3 ± 1.0 | | |
| 1.6 | 95.0 ± 1.8 | | |
| 3.1 | 85.5 ± 9.0 * | | |
| 6.3 | 0.0 ± 0.0 | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |

**72-hr EC10 = 3.0 (2.23-3.41)%**
**72-hr EC50 = 4.1 (4.01-4.20)%**
**NOEC = 1.6%**
**LOEC = 3.1%**

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/10



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 94.0% | Yes |
| Reference Toxicant within cusum chart limits | 9.6-13.6µg Cu/L | 11.1µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR1858/11



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | The test was extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 04 October 2019 at 1600 h |

| Sample 9259: *Y0021019*<br>**Concentration (%)** | **% Normal larvae (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 78.8 ± 1.7 | | |
| ASW Control | 80.3 ± 3.3 | | |
| 1.6 | 81.0 ± 3.6 | | |
| 3.1 | 64.5 ± 10.2 * | | |
| 6.3 | 0.0 ± 0.0 | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 =2.3 (1.80-3.57)%**<br>**72-hr EC50 =3.9 (3.75-3.96)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/11



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 78.8% | Yes |
| Reference Toxicant within cusum chart limits | 7.5-15.3µg Cu/L | 10.4µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

This document shall not be reproduced except in full.

**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.

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# Toxicity Test Report: TR1858/12



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 04 October 2019 at 1830h |

| Sample 9259: *Y0021019*<br>**Concentration (%)** | **% Unaffected (Mean ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 100 ± 0.0 | | |
| ASW Control | 95.0 ± 10.0 | | |
| 1.6 | 100 ± 0.0 | | |
| 3.1 | 100 ± 0.0 | | |
| 6.3 | 100 ± 0.0 | | |
| 12.5 | 5.0 ± 10.0 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **96-hr EC10 = 7.9 (6.35-10.73)%**<br>**96-hr EC50 = 9.2 (8.59-9.83)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/12



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.5-8.6mg SDS/L | 3.3mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR1858/13



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 04 october 2019 at 1630h |

| Sample 9259: *Y0021019*<br>**Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 16.6 ± 0.9 | | |
| ASW Control | 15.8 ± 0.8 | | |
| 1.6 | 16.6 ± 1.0 | | |
| 3.1 | 10.7 ± 1.9 * | | |
| 6.3 | 1.1 ± 1.4 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr IC10 = 2.0 (1.89-2.32%**<br>**72-hr IC50 = 4.0 (3.31-4.54)%**<br>**NOEC = 1.6%**<br>**LOEC = 3.1%** | | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 17.7x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 5.3% | Yes |
| Reference Toxicant within cusum chart limits | 3.1-9.2µg Cu/L | 6.2µg Cu/L | Yes |

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# Toxicity Test Report: TR1858/13



Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

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# Toxicity Test Report: TR1858/14



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 04 October 2019 at 1630h |

| Sample 9259: *Y0021019* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control 94.0 ± 1.8 | | |
| ASW Control 93.0 ± 3.2 | | |
| 1.6 93.3 ± 2.5 | | |
| 3.1 92.8 ± 1.7 | | |
| 6.3 92.5 ± 2.1 | | |
| 12.5 87.3 ± 6.4 | | |
| 25 4.8 ± 2.8 * | | |
| 50 0.0 ± 0.0 | | |
| 100 0.0 ± 0.0 | | |
| **72-hr EC10 = 13.3 (12.37-14.03)%** | | |
| **72-hr EC50 = 17.6 (16.76-18.24)%** | | |
| **NOEC = 12.5%** | | |
| **LOEC = 25%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/14



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 94.0% | Yes |
| Reference Toxicant within cusum chart limits | 110.1-266.95µg Cu/L | 168.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR1858/15



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 2 October 2019 |
| | | **Date Received:** | 3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using the Bass Macqauria novemaculeata. |
| **Test Protocol:** | ESA SOP 117 (ESA 2016), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample |
| **Source of Test Organisms:** | In-house cultures |
| **Test Initiated:** | 03 October 2019 at 1700h |

| Sample 9259: *Y0021019* | *Vacant* | *Vacant* |
|---|---|---|

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 90.0 ± 11.6 |
| ASW Control | 95.0 ± 10.0 |
| 1.6 | 95.0 ± 10.0 |
| 3.1 | 95.0 ± 10.0 |
| 6.3 | 45.0 ± 25.2 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**96-hr IC10 = 4.1%***
**96-hr EC50 = 6.1 (5.26-7.18)%**
**NOEC =6.3%**
**LOEC = 12.5%**

**\ The 95% Confidence Limits are not reliable.

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 90.0% | Yes |
| Reference Toxicant within cusum chart limits | 85.9-2437.6µg Cu/L | 606.2µg Cu/L | Yes |

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# Toxicity Test Report: TR1858/15



Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA.
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**Citations:**

ESA (2016) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 12. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR1858/8



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>2 October 2019<br>3 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9259 | Y0021019 | Produced Formation Water, pH 6.5*, salinity 17.7 ‰*, total ammonia 32.6mg/L*. Sample received at 12ºC* in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Size of Test Organisms:** | 12-15mm |
| **Test Initiated:** | 04 October 2019 at 1800h |

Sample 9259: *Y0021019*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.6 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (unaffected) = 4.1%***
**7 day IC50 (unaffected) = 4.5%***
**NOEC = 3.1%**
**LOEC = 6.3%**

Sample 9259: *Y0021019*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** |
|---|---|
| FSW Control | 16.8 ± 1.0 |
| ASW Control | 17.6 ± 1.8 |
| 1.6 | 17.8 ± 1.0 |
| 3.1 | 16.4 ± 0.9 |
| 6.3 | 0.0 ± 0.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (biomass) = 3.2 (0.98-3.52)%**
**7 day IC50 (biomass) =4.6 (4.30-4.75) %**
**NOEC = 3.1%**
**LOEC = 6.3%**

*The 95% Confidence Limits are not available

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# Toxicity Test Report: TR1858/8



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | - | No |
| Reference Toxicant within cusum chart limits | 10.7-114.8mg $NH_4^+$/L | 46.3mg $NH_4^+$/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 25 October 2019

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Peter Young

**Client** : AECOM Australia Pty Ltd
Level 6, 3 Forrest Place
Perth WA 6849

**Email** : peter.young@aecom.com
**Telephone** : 08 6208 0000
**Facsimile** :

**Date** : 8/10/2019

**Re** : Receipt of Samples **Pages :** **2**

**ESA Project** : PR1858 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples:** **YES**
**Samples received in apparent good condition and correctly bottled:** **YES**
**Security seals on sample bottles and esky intact:** **YES**

**Date samples received** : 3/10/2019
**Time samples received** : 10:30
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 6-10°C

**Comments** : 4 x 2.5L sample received at 9oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

ecotox SERVICES AUSTRALIA

Customer: Beach Energy
Contact Name: Adrian Cukrowski
Phone:
Email: Adrian.cukrowski@beachenergy.com.au (please provide an email address for sample receipt notification)
X Sampled by: D. MCLACHLAN

Ship To: Ecotox Services Aust
Attention: Ruth Krassoi

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | | | | | | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 18558 |
| 9°C | | | | | | | | | | | |
| X 2/10/19 | X 06:00 | X YO021019-1 | Grab | 4 x 2.5L | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 9259 " | 06:00 | YO021019-2 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| " | 06:00 | YO021019-3 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| " | 06:00 | YO021019-4 | " | " | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| X D.MCLACHLAN | 2/10/19 | | 3/10/19 | | | | |
| Of: YOLLA | Time: 12:00 | Of: ESA | Time: 1030 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

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# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:20 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 15:40 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9300 | 0.9700 |
| ASW Control | 0.9500 | 0.9400 | 0.9300 | 0.9600 |
| 1.6 | 0.9400 | 0.9600 | 0.9300 | 0.9600 |
| 3.1 | 0.8600 | 0.7900 | 0.8100 | 0.5600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

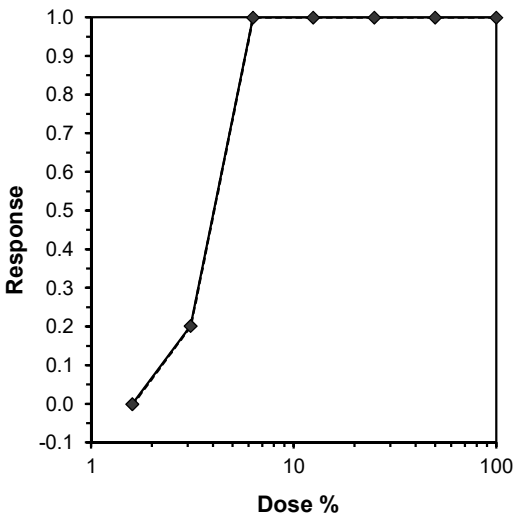
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9525 | 1.0079 | 1.3536 | 1.3030 | 1.3967 | 2.935 | 4 | | | | |
| ASW Control | 0.9450 | 1.0000 | 1.3353 | 1.3030 | 1.3694 | 2.140 | 4 | * | | 22 | 400 |
| 1.6 | 0.9475 | 1.0026 | 1.3413 | 1.3030 | 1.3694 | 2.499 | 4 | 19.00 | 11.00 | 21 | 400 |
| *3.1 | 0.7550 | 0.7989 | 1.0618 | 0.8455 | 1.1873 | 14.070 | 4 | 10.00 | 11.00 | 98 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.838216 | 0.859 | -1.60666 | 4.802703 |
| Bartlett's Test indicates equal variances (p = 0.01) | 8.495721 | 9.21034 | | |
| The control means are not significantly different (p = 0.48) | 0.749736 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 |

### Trimmed Spearman-Karber

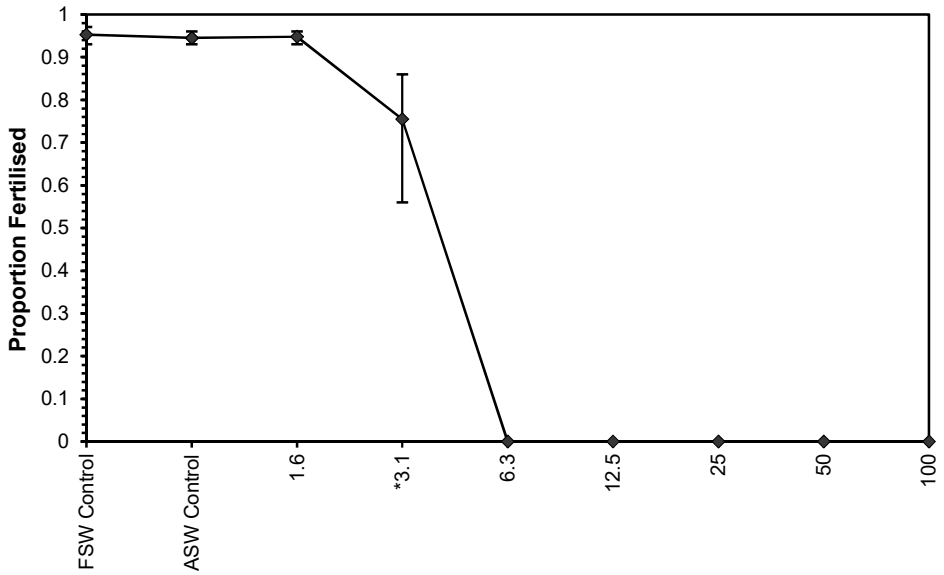
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.8477 | 3.7432 | 3.9550 |
| 5.0% | 3.9177 | 3.7966 | 4.0428 |
| 10.0% | 3.9774 | 3.8284 | 4.1322 |
| 20.0% | 4.0396 | 3.7814 | 4.3154 |
| Auto-0.0% | 3.8477 | 3.7432 | 3.9550 |



**Sea Urchin Fertilisation Test-Proportion Fertilised**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:20 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 15:40 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:20 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 15:40 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Fertilised | 95.25 | 93.00 | 97.00 | 1.71 | 1.37 | 4 |
| ASW Control | | 94.50 | 93.00 | 96.00 | 1.29 | 1.20 | 4 |
| 1.6 | | 94.75 | 93.00 | 96.00 | 1.50 | 1.29 | 4 |
| 3.1 | | 75.50 | 56.00 | 86.00 | 13.33 | 4.84 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 25 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 50 | | 89.10 | 89.10 | 89.10 | 0.00 | 0.00 | 1 |
| 100 | | 69.30 | 69.30 | 69.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Fertilisation Test-Proportion Fertilised

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:20 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 15:40 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 104 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9600 | 0.9300 | 0.9700 |
| ASW Control | 0.9500 | 0.9400 | 0.9300 | 0.9600 |
| 1.6 | 0.9400 | 0.9600 | 0.9300 | 0.9600 |
| 3.1 | 0.8600 | 0.7900 | 0.8100 | 0.5600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

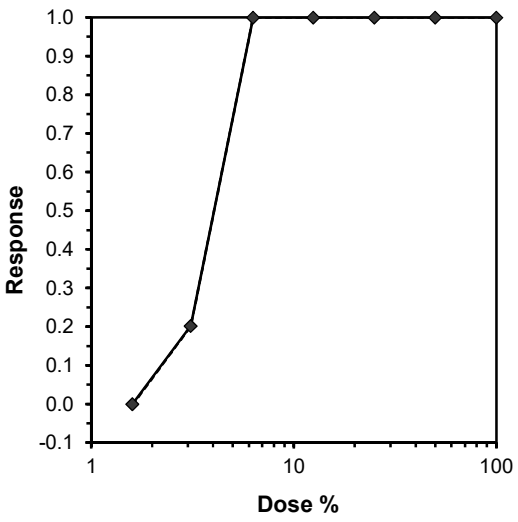
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9525 | 1.0079 | 1.3536 | 1.3030 | 1.3967 | 2.935 | 4 | | | | |
| ASW Control | 0.9450 | 1.0000 | 1.3353 | 1.3030 | 1.3694 | 2.140 | 4 | * | | 0.9463 | 1.0000 |
| 1.6 | 0.9475 | 1.0026 | 1.3413 | 1.3030 | 1.3694 | 2.499 | 4 | 19.00 | 11.00 | 0.9463 | 1.0000 |
| *3.1 | 0.7550 | 0.7989 | 1.0618 | 0.8455 | 1.1873 | 14.070 | 4 | 10.00 | 11.00 | 0.7550 | 0.7979 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.838216 | 0.859 | -1.60666 | 4.802703 |
| Bartlett's Test indicates equal variances (p = 0.01) | 8.495721 | 9.21034 | | |
| The control means are not significantly different (p = 0.48) | 0.749736 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.1079 | 0.1141 | 1.8191 | 2.5561 | 0.8421 |
| IC10 | 2.4849 | 0.2024 | 2.0934 | 3.2951 | 0.7723 |
| IC15 | 2.8027 | 0.2176 | 2.2448 | 3.3722 | 0.0347 |
| IC20 | 3.0884 | 0.1629 | 2.3634 | 3.3012 | -0.9995 |
| IC25 | 3.1533 | 0.1083 | 2.5887 | 3.3508 | -1.4413 |
| IC40 | 3.2999 | 0.0666 | 3.0669 | 3.4938 | -0.2953 |
| IC50 | 3.3921 | 0.0649 | 3.1638 | 3.5829 | -0.2576 |



# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:00 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 14:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9000 | 0.9300 | 0.9500 |
| ASW Control | 0.9700 | 0.9600 | 0.9500 | 0.9700 |
| 1.6 | 0.9600 | 0.9400 | 0.9300 | 0.9700 |
| 3.1 | 0.9500 | 0.7600 | 0.8000 | 0.9100 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

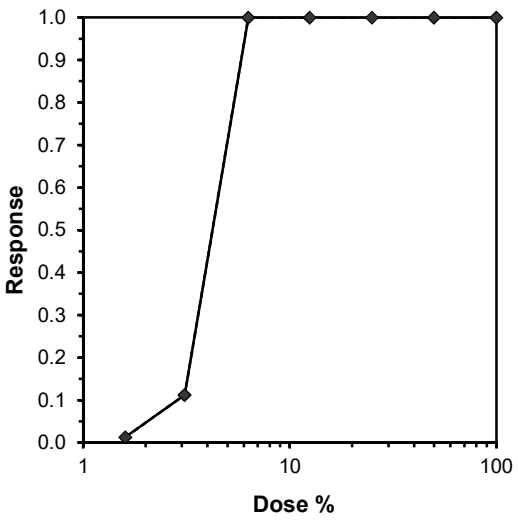
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9400 | 0.9766 | 1.3316 | 1.2490 | 1.4289 | 5.701 | 4 | | | | | |
| ASW Control | 0.9625 | 1.0000 | 1.3770 | 1.3453 | 1.3967 | 1.799 | 4 | * | | | 15 | 400 |
| 1.6 | 0.9500 | 0.9870 | 1.3481 | 1.3030 | 1.3967 | 3.165 | 4 | 0.496 | 2.180 | 0.1271 | 20 | 400 |
| *3.1 | 0.8550 | 0.8883 | 1.1943 | 1.0588 | 1.3453 | 11.223 | 4 | 3.133 | 2.180 | 0.1271 | 58 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.980881 | 0.859 | 0.172766 | 0.813745 |
| Bartlett's Test indicates equal variances (p = 0.03) | 7.189846 | 9.21034 | | |
| The control means are not significantly different (p = 0.30) | 1.13899 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.062402 | 0.064805 | 0.038577 | 0.0068 | 0.025469 | 2, 9 |

### Trimmed Spearman-Karber

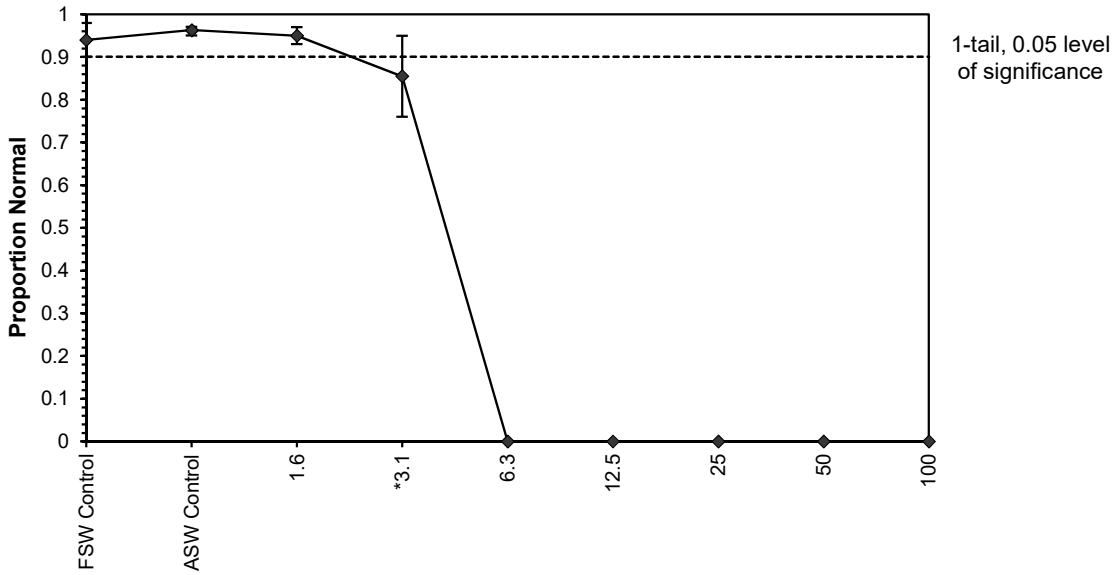
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 4.1742 | 4.0686 | 4.2825 |
| 10.0% | 4.2245 | 4.0713 | 4.3834 |
| 20.0% | 4.2266 | 4.1672 | 4.2868 |
| Auto-1.3% | 4.1036 | 4.0124 | 4.1970 |



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:00 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 14:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:00 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 14:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Normal | 94.00 | 90.00 | 98.00 | 3.37 | 1.95 | 4 |
| ASW Control | | 96.25 | 95.00 | 97.00 | 0.96 | 1.02 | 4 |
| 1.6 | | 95.00 | 93.00 | 97.00 | 1.83 | 1.42 | 4 |
| 3.1 | | 85.50 | 76.00 | 95.00 | 8.96 | 3.50 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 99.40 | 99.40 | 99.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 25 | | 99.90 | 99.90 | 99.90 | 0.00 | 0.00 | 1 |
| 50 | | 89.10 | 89.10 | 89.10 | 0.00 | 0.00 | 1 |
| 100 | | 69.30 | 69.30 | 69.30 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 8/10/2019 14:00 | Test ID: | PR1858/109 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 14:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9000 | 0.9300 | 0.9500 |
| ASW Control | 0.9700 | 0.9600 | 0.9500 | 0.9700 |
| 1.6 | 0.9600 | 0.9400 | 0.9300 | 0.9700 |
| 3.1 | 0.9500 | 0.7600 | 0.8000 | 0.9100 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

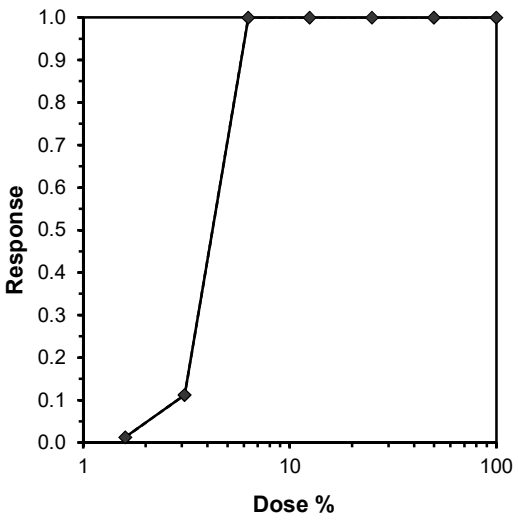
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9400 | 0.9766 | 1.3316 | 1.2490 | 1.4289 | 5.701 | 4 | | | | | |
| ASW Control | 0.9625 | 1.0000 | 1.3770 | 1.3453 | 1.3967 | 1.799 | 4 | * | | | 0.9625 | 1.0000 |
| 1.6 | 0.9500 | 0.9870 | 1.3481 | 1.3030 | 1.3967 | 3.165 | 4 | 0.496 | 2.180 | 0.1271 | 0.9500 | 0.9870 |
| *3.1 | 0.8550 | 0.8883 | 1.1943 | 1.0588 | 1.3453 | 11.223 | 4 | 3.133 | 2.180 | 0.1271 | 0.8550 | 0.8883 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.980881 | 0.859 | 0.172766 | 0.813745 |
| Bartlett's Test indicates equal variances (p = 0.03) | 7.189846 | 9.21034 | | |
| The control means are not significantly different (p = 0.30) | 1.13899 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.062402 | 0.064805 | 0.038577 | 0.0068 | 0.025469 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.2537 | 0.3023 | 1.7635 | 3.6583 | 1.0843 |
| IC10 | 2.9529 | 0.2325 | 2.2269 | 3.4099 | -0.5090 |
| IC15 | 3.1587 | 0.0989 | 2.7158 | 3.4119 | -1.5479 |
| IC20 | 3.2237 | 0.0656 | 3.0634 | 3.4755 | 0.2179 |
| IC25 | 3.2806 | 0.0640 | 3.1226 | 3.5305 | 0.3031 |
| IC40 | 3.4272 | 0.0620 | 3.2749 | 3.6710 | 0.3035 |
| IC50 | 3.5182 | 0.0607 | 3.3694 | 3.7574 | 0.3031 |



# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:00 | Test ID: | PR1858/104 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 16:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 103 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7900 | 0.8100 | 0.7800 | 0.7700 |
| ASW Control | 0.8000 | 0.8400 | 0.8100 | 0.7600 |
| 1.6 | 0.7600 | 0.8400 | 0.8100 | 0.8300 |
| 3.1 | 0.6400 | 0.7900 | 0.5900 | 0.5600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

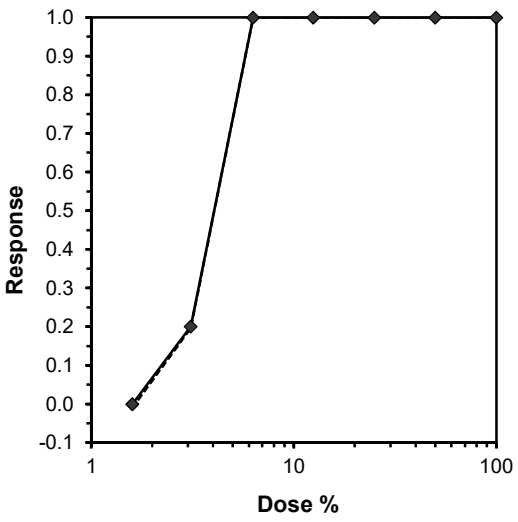
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7875 | 0.9813 | 1.0919 | 1.0706 | 1.1198 | 1.924 | 4 | | | | | |
| ASW Control | 0.8025 | 1.0000 | 1.1113 | 1.0588 | 1.1593 | 3.727 | 4 | * | | | 79 | 400 |
| 1.6 | 0.8100 | 1.0093 | 1.1209 | 1.0588 | 1.1593 | 3.972 | 4 | -0.187 | 2.180 | 0.1128 | 76 | 400 |
| *3.1 | 0.6450 | 0.8037 | 0.9359 | 0.8455 | 1.0948 | 11.879 | 4 | 3.390 | 2.180 | 0.1128 | 142 | 400 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.91614 | 0.859 | 1.075696 | 2.106456 |
| Bartlett's Test indicates equal variances (p = 0.18) | 3.381894 | 9.21034 | | |
| The control means are not significantly different (p = 0.44) | 0.832105 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.096583 | 0.120237 | 0.043396 | 0.005352 | 0.009694 | 2, 9 |

### Trimmed Spearman-Karber

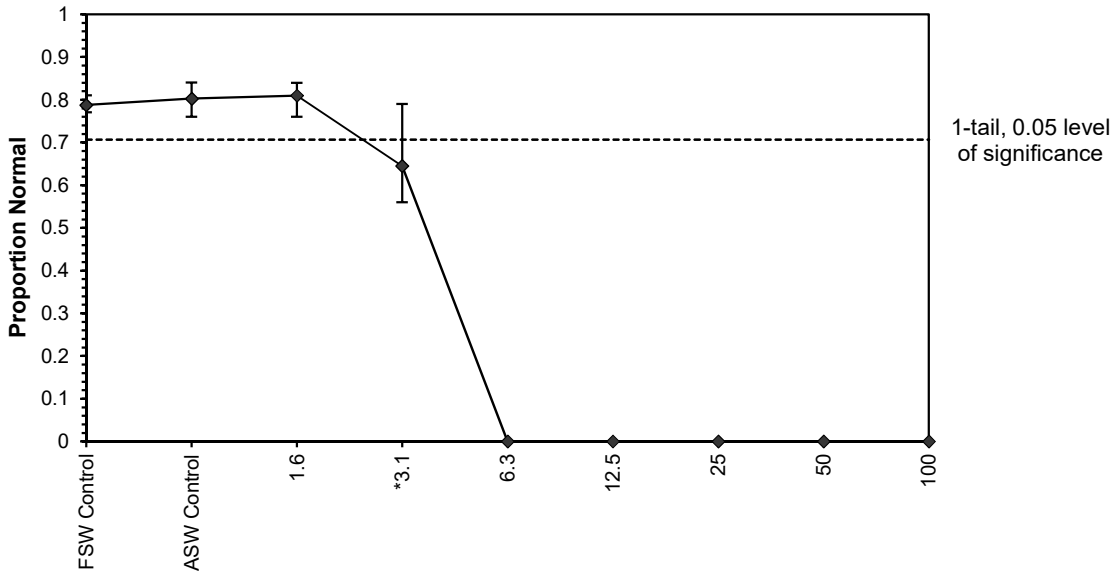
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 3.8533 | 3.7491 | 3.9603 |
| 5.0% | 3.9239 | 3.8029 | 4.0487 |
| 10.0% | 3.9837 | 3.8347 | 4.1385 |
| 20.0% | 4.0444 | 3.9558 | 4.1350 |
| Auto-0.0% | 3.8533 | 3.7491 | 3.9603 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:00 | Test ID: | PR1858/104 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 16:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 103 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:00 | Test ID: | PR1858/104 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 16:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 103 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 78.75 | 77.00 | 81.00 | 1.71 | 1.66 | 4 |
| ASW Control | | 80.25 | 76.00 | 84.00 | 3.30 | 2.27 | 4 |
| 1.6 | | 81.00 | 76.00 | 84.00 | 3.56 | 2.33 | 4 |
| 3.1 | | 64.50 | 56.00 | 79.00 | 10.21 | 4.96 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:00 | Test ID: | PR1858/104 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 16:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 103 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7900 | 0.8100 | 0.7800 | 0.7700 |
| ASW Control | 0.8000 | 0.8400 | 0.8100 | 0.7600 |
| 1.6 | 0.7600 | 0.8400 | 0.8100 | 0.8300 |
| 3.1 | 0.6400 | 0.7900 | 0.5900 | 0.5600 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

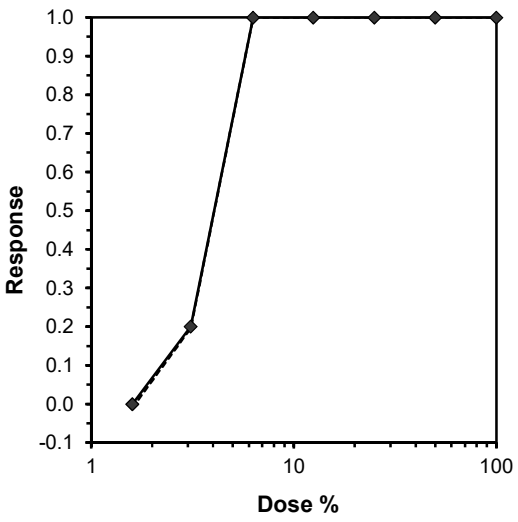
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7875 | 0.9813 | 1.0919 | 1.0706 | 1.1198 | 1.924 | 4 | | | | | |
| ASW Control | 0.8025 | 1.0000 | 1.1113 | 1.0588 | 1.1593 | 3.727 | 4 | * | | | 0.8063 | 1.0000 |
| 1.6 | 0.8100 | 1.0093 | 1.1209 | 1.0588 | 1.1593 | 3.972 | 4 | -0.187 | 2.180 | 0.1128 | 0.8063 | 1.0000 |
| *3.1 | 0.6450 | 0.8037 | 0.9359 | 0.8455 | 1.0948 | 11.879 | 4 | 3.390 | 2.180 | 0.1128 | 0.6450 | 0.8000 |
| 6.3 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.91614 | 0.859 | 1.075696 | 2.106456 |
| Bartlett's Test indicates equal variances (p = 0.18) | 3.381894 | 9.21034 | | |
| The control means are not significantly different (p = 0.44) | 0.832105 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 0.096583 | 0.120237 | 0.043396 | 0.005352 | 0.009694 | 2, 9 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.9671 | 0.1809 | 1.5409 | 2.5694 | 0.4629 |
| IC10 | 2.3356 | 0.2611 | 1.7986 | 3.5670 | 1.1566 |
| IC15 | 2.7114 | 0.2681 | 2.0993 | 3.4161 | 0.3344 |
| IC20 | 3.1000 | 0.1873 | 2.3245 | 3.2529 | -0.6488 |
| IC25 | 3.1417 | 0.0865 | 2.7349 | 3.2947 | -1.2942 |
| IC40 | 3.2628 | 0.0444 | 3.1507 | 3.4147 | 0.3545 |
| IC50 | 3.3457 | 0.0435 | 3.2374 | 3.4952 | 0.3551 |



# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.2000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

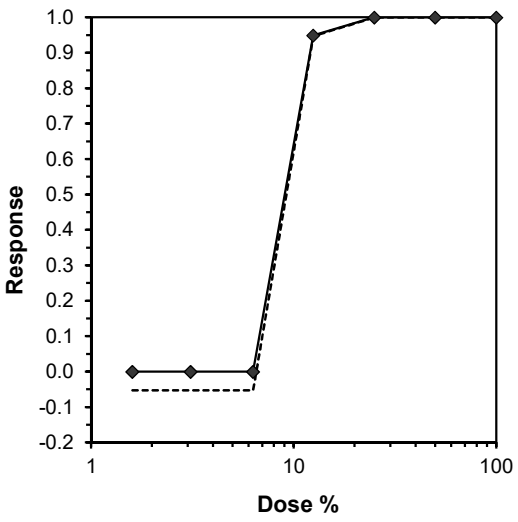
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | * | | 1 | 20 |
| 1.6 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0 | 20 |
| *12.5 | 0.0500 | 0.0526 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 19 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.811293 | 0.905 | -4.3E-14 | 4.066993 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 0.36) | 1 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

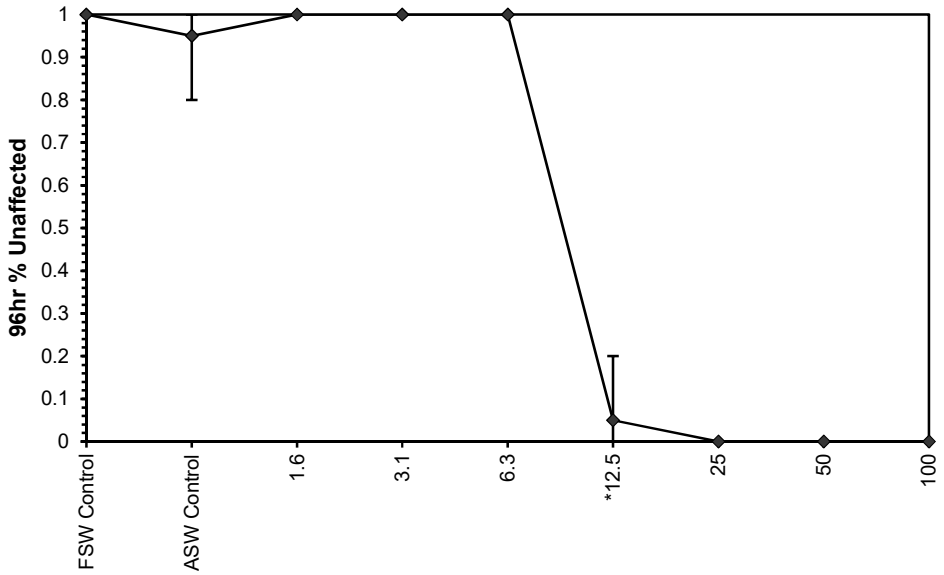
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 9.1892 | 8.5888 | 9.8316 |
| 5.0% | 9.0378 | 8.6976 | 9.3912 |
| 10.0% | 9.0378 | 8.7071 | 9.3809 |
| 20.0% | 9.0378 | 8.7071 | 9.3809 |
| Auto-0.0% | 9.1892 | 8.5888 | 9.8316 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.2000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

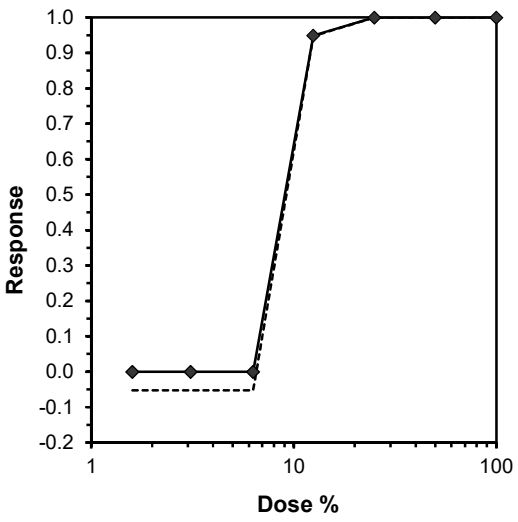
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | * | | 0.9875 | 1.0000 |
| 1.6 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0.9875 | 1.0000 |
| 3.1 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0.9875 | 1.0000 |
| 6.3 | 1.0000 | 1.0526 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 20.00 | 10.00 | 0.9875 | 1.0000 |
| *12.5 | 0.0500 | 0.0526 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 0.0500 | 0.0506 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.811293 | 0.905 | -4.3E-14 | 4.066993 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 0.36) | 1 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

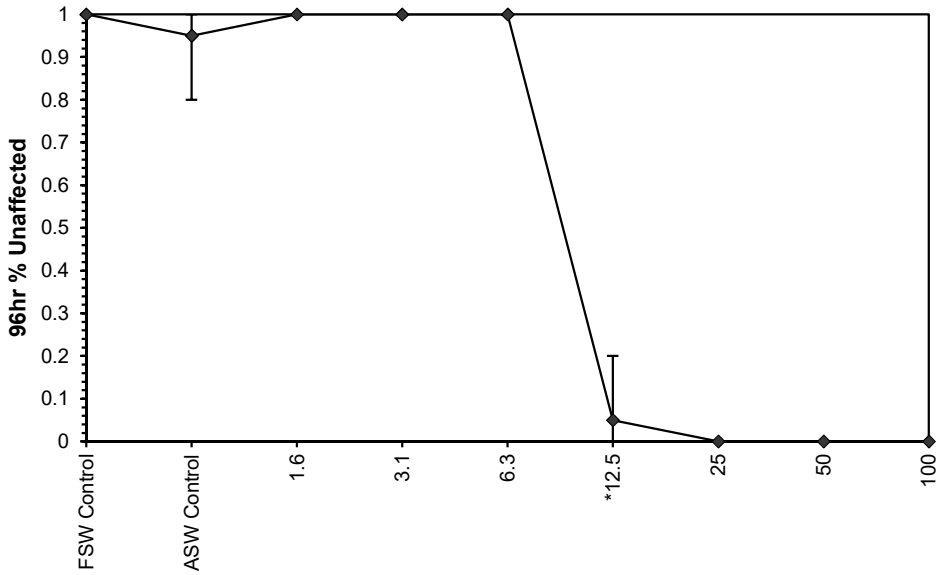
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.3866 | 0.8671 | 6.2975 | 10.3402 | 0.7131 |
| IC10 | 7.8507 | 0.8948 | 6.3541 | 10.7345 | 0.5631 |
| IC15 | 8.1722 | 0.9114 | 6.4007 | 10.9719 | 0.4202 |
| IC20 | 8.4291 | 0.9264 | 6.4397 | 11.1489 | 0.2870 |
| IC25 | 8.6502 | 0.9415 | 6.4736 | 11.2945 | 0.1633 |
| IC40 | 9.2135 | 0.9922 | 6.5588 | 11.6449 | -0.1592 |
| IC50 | 9.5622 | 1.0336 | 6.6092 | 11.8505 | -0.3403 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:30 | Test ID: | PR1858/108 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 18:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/102 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 16.994 | 16.560 | 15.260 | 17.210 | 15.585 | 16.452 | 17.969 | 17.102 |
| ASW Control | 15.369 | 14.935 | 16.777 | 15.910 | | | | |
| 1.6 | 16.344 | 17.860 | 15.585 | 16.452 | | | | |
| 3.1 | 8.219 | 11.360 | 10.494 | 12.769 | | | | |
| 6.3 | 0.000 | 1.394 | 0.000 | 3.019 | | | | |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

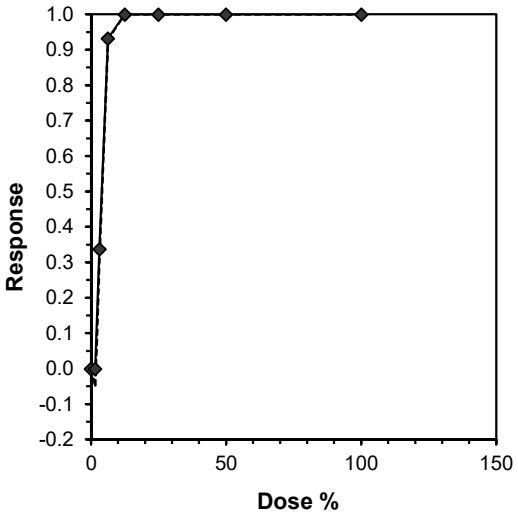
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 16.642 | 1.0568 | 16.642 | 15.260 | 17.969 | 5.320 | 8 | | | | | |
| ASW Control | 15.748 | 1.0000 | 15.748 | 14.935 | 16.777 | 5.040 | 4 | * | | | 16.154 | 1.0000 |
| 1.6 | 16.560 | 1.0516 | 16.560 | 15.585 | 17.860 | 5.728 | 4 | -0.855 | 2.290 | 2.177 | 16.154 | 1.0000 |
| *3.1 | 10.710 | 0.6801 | 10.710 | 8.219 | 12.769 | 17.809 | 4 | 5.299 | 2.290 | 2.177 | 10.710 | 0.6630 |
| *6.3 | 1.103 | 0.0700 | 1.103 | 0.000 | 3.019 | 130.194 | 4 | 15.405 | 2.290 | 2.177 | 1.103 | 0.0683 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.971959 | 0.887 | -0.01546 | 0.029112 |
| Bartlett's Test indicates equal variances (p = 0.49) | 2.424579 | 11.34487 | | |
| The control means are not significantly different (p = 0.12) | 1.699361 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 1.6 | 3.1 | 2.227106 | 62.5 | 2.177035 | 0.138244 | 201.9835 | 1.807548 | 4.9E-09 | 3, 12 |

### Linear Interpolation (200 Resamples)

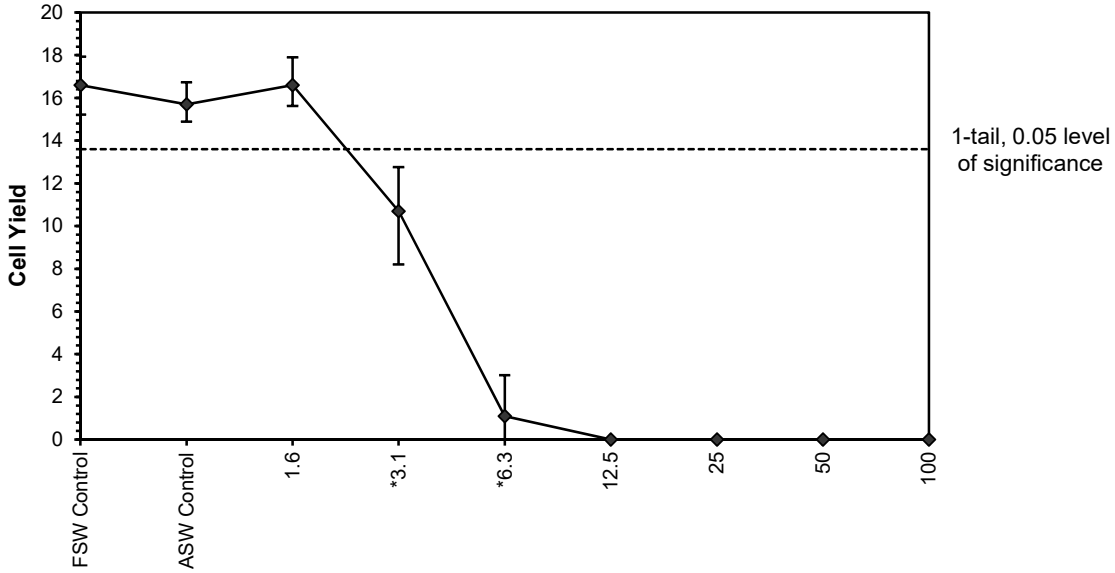
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 1.8226 | 0.0445 | 1.7147 | 1.9580 | -1.5970 |
| IC10 | 2.0451 | 0.0709 | 1.8906 | 2.3161 | 0.5371 |
| IC15 | 2.2677 | 0.1038 | 2.0359 | 2.6741 | 0.6902 |
| IC20 | 2.4902 | 0.1382 | 2.1812 | 3.0321 | 0.7386 |
| IC25 | 2.7128 | 0.1700 | 2.3266 | 3.3674 | 0.6835 |
| IC40 | 3.4390 | 0.2288 | 2.7656 | 4.0806 | -0.0785 |
| IC50 | 3.9771 | 0.2087 | 3.3138 | 4.5373 | -0.2787 |



**Microalgal Cell Yield-Cell Yield**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/102 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/102 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 16.64 | 15.26 | 17.97 | 0.89 | 5.65 | 8 |
| ASW Control | | 15.75 | 14.94 | 16.78 | 0.79 | 5.66 | 4 |
| 1.6 | | 16.56 | 15.59 | 17.86 | 0.95 | 5.88 | 4 |
| 3.1 | | 10.71 | 8.22 | 12.77 | 1.91 | 12.89 | 4 |
| 6.3 | | 1.10 | 0.00 | 3.02 | 1.44 | 108.64 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 2 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 1.06 | 2.85 | 2 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/107 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 16:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9500 | 0.9300 | 0.9600 | 0.9200 |
| ASW Control | 0.9700 | 0.9000 | 0.9100 | 0.9400 |
| 1.6 | 0.9400 | 0.9600 | 0.9300 | 0.9000 |
| 3.1 | 0.9200 | 0.9500 | 0.9100 | 0.9300 |
| 6.3 | 0.9200 | 0.9500 | 0.9300 | 0.9000 |
| 12.5 | 0.7900 | 0.8600 | 0.9400 | 0.9000 |
| 25 | 0.0300 | 0.0800 | 0.0600 | 0.0200 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9400 | 1.0108 | 1.3254 | 1.2840 | 1.3694 | 2.937 | 4 | | | | | |
| ASW Control | 0.9300 | 1.0000 | 1.3088 | 1.2490 | 1.3967 | 5.094 | 4 | * | | | 28 | 400 |
| 1.6 | 0.9325 | 1.0027 | 1.3112 | 1.2490 | 1.3694 | 3.805 | 4 | -0.055 | 2.410 | 0.1066 | 27 | 400 |
| 3.1 | 0.9275 | 0.9973 | 1.2996 | 1.2661 | 1.3453 | 2.614 | 4 | 0.208 | 2.410 | 0.1066 | 29 | 400 |
| 6.3 | 0.9250 | 0.9946 | 1.2954 | 1.2490 | 1.3453 | 3.096 | 4 | 0.304 | 2.410 | 0.1066 | 30 | 400 |
| 12.5 | 0.8725 | 0.9382 | 1.2136 | 1.0948 | 1.3233 | 7.976 | 4 | 2.153 | 2.410 | 0.1066 | 51 | 400 |
| *25 | 0.0475 | 0.0511 | 0.2126 | 0.1419 | 0.2868 | 31.205 | 4 | 24.790 | 2.410 | 0.1066 | 381 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

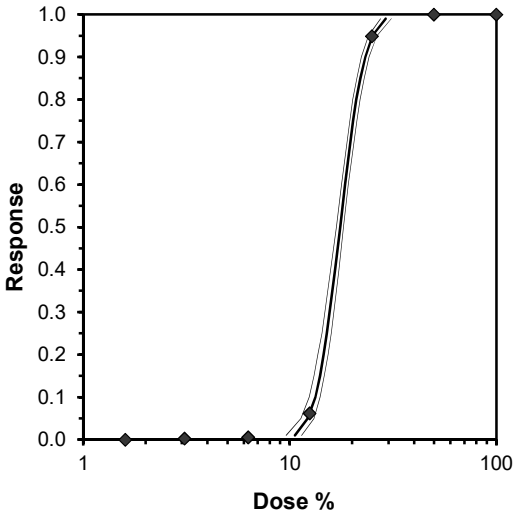
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.990604 | 0.916 | 0.038641 | -0.27548 |
| Bartlett's Test indicates equal variances (p = 0.57) | 3.828166 | 15.08627 | | |
| The control means are not significantly different (p = 0.68) | 0.431366 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 12.5 | 25 | 17.67767 | 8 | 0.062717 | 0.067227 | 0.773125 | 0.003911 | 4.5E-15 | 5, 18 |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 10.57689 | 0.637561 | 9.327272 | 11.82651 | 0.07 | 0.179704 | 11.0705 | 1 | 1.243463 | 0.094546 | 5 |
| Intercept | -8.15197 | 0.829675 | -9.77813 | -6.5258 | | | | | | | |
| TSCR | 0.07125 | 0.006431 | 0.058645 | 0.083855 | | | | | | | |

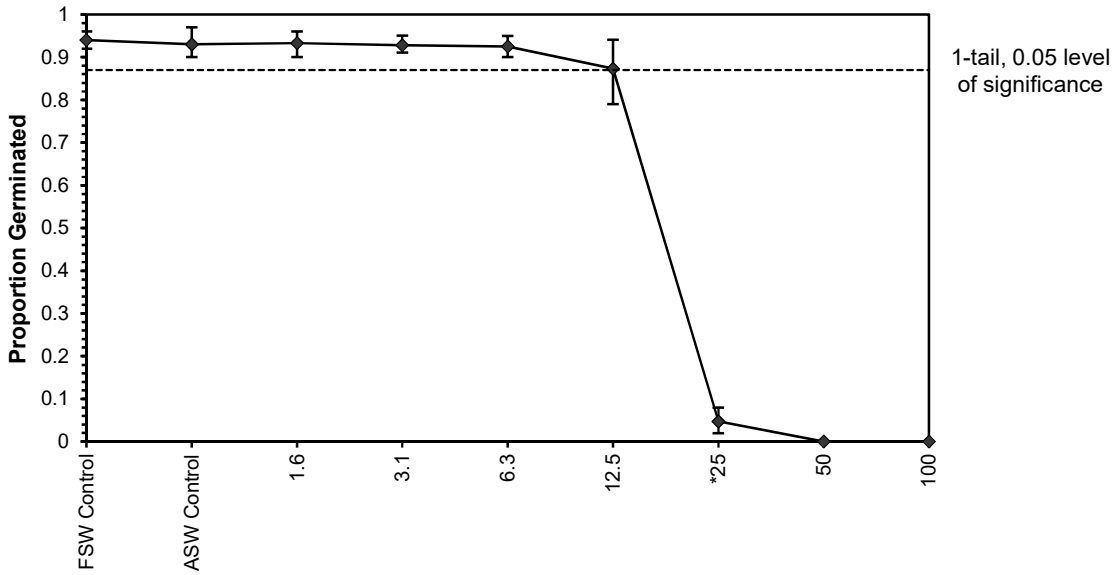
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 10.55641 | 9.597342 | 11.40222 |
| EC05 | 3.355 | 12.24471 | 11.32893 | 13.0509 |
| EC10 | 3.718 | 13.25248 | 12.37001 | 14.03231 |
| EC15 | 3.964 | 13.97887 | 13.12206 | 14.74019 |
| EC20 | 4.158 | 14.58448 | 13.7492 | 15.33156 |
| EC25 | 4.326 | 15.1249 | 14.30833 | 15.86081 |
| EC40 | 4.747 | 16.57714 | 15.80406 | 17.29447 |
| EC50 | 5.000 | 17.51711 | 16.76281 | 18.23531 |
| EC60 | 5.253 | 18.51038 | 17.76405 | 19.24429 |
| EC75 | 5.674 | 20.28769 | 19.51739 | 21.09522 |
| EC80 | 5.842 | 21.03944 | 20.24301 | 21.89683 |
| EC85 | 6.036 | 21.95093 | 21.11037 | 22.88333 |
| EC90 | 6.282 | 23.15409 | 22.23614 | 24.20815 |
| EC95 | 6.645 | 25.05973 | 23.98164 | 26.3519 |
| EC99 | 7.326 | 29.06758 | 27.54548 | 30.9977 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/107 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 16:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 16:30 | Test ID: | PR1858/107 | Sample ID: | Y0021019 |
| End Date: | 8/10/2019 16:30 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Germination, % | 94.00 | 92.00 | 96.00 | 1.83 | 1.44 | 4 |
| ASW Control | | 93.00 | 90.00 | 97.00 | 3.16 | 1.91 | 4 |
| 1.6 | | 93.25 | 90.00 | 96.00 | 2.50 | 1.70 | 4 |
| 3.1 | | 92.75 | 91.00 | 95.00 | 1.71 | 1.41 | 4 |
| 6.3 | | 92.50 | 90.00 | 95.00 | 2.08 | 1.56 | 4 |
| 12.5 | | 87.25 | 79.00 | 94.00 | 6.40 | 2.90 | 4 |
| 25 | | 4.75 | 2.00 | 8.00 | 2.75 | 34.94 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 3/10/2019 17:00 | Test ID: | PR1858/101 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | AB-Macquaria novemaculeata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 0.8000 | 1.0000 |
| 3.1 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 0.4000 | 0.4000 | 0.2000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

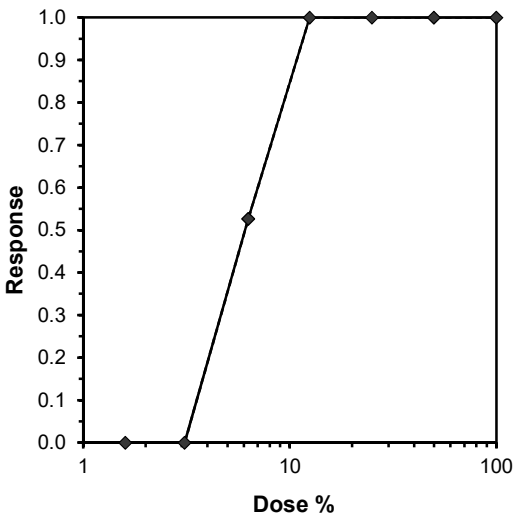
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9000 | 0.9474 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | * | | 1 | 20 |
| 1.6 | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 18.00 | 10.00 | 1 | 20 |
| 3.1 | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 18.00 | 10.00 | 1 | 20 |
| 6.3 | 0.4500 | 0.4737 | 0.7351 | 0.4636 | 1.1071 | 36.604 | 4 | 10.50 | 10.00 | 11 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.835925 | 0.887 | 0.351483 | 1.528959 |
| Bartlett's Test indicates equal variances (p = 0.37) | 3.147714 | 11.34487 | | |
| The control means are not significantly different (p = 0.54) | 0.654654 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Trimmed Spearman-Karber

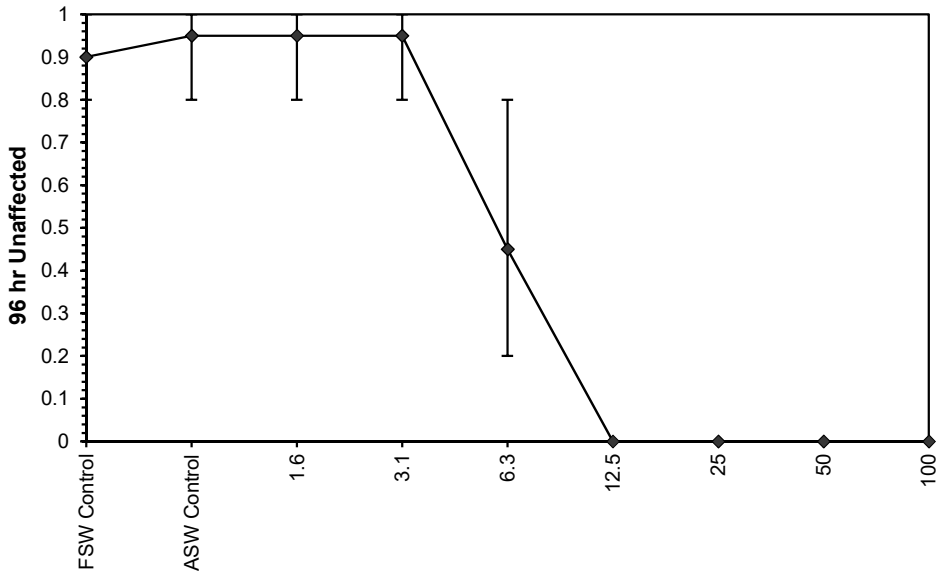
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 6.1485 | 5.2621 | 7.1842 |
| 5.0% | 6.1409 | 5.1663 | 7.2994 |
| 10.0% | 6.1334 | 5.0523 | 7.4458 |
| 20.0% | 6.1183 | 4.7374 | 7.9016 |
| Auto-0.0% | 6.1485 | 5.2621 | 7.1842 |



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 3/10/2019 17:00 | Test ID: | PR1858/101 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | AB-Macquaria novemaculeata |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 3/10/2019 17:00 | Test ID: | PR1858/101 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | AB-Macquaria novemaculeata |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 90.00 | 80.00 | 100.00 | 11.55 | 3.78 | 4 |
| ASW Control | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 1.6 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 3.1 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 6.3 | | 45.00 | 20.00 | 80.00 | 25.17 | 11.15 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 3/10/2019 17:00 | Test ID: | PR1858/101 | Sample ID: | Y0021019 |
| End Date: | 7/10/2019 17:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 117 | Test Species: | AB-Macquaria novemaculeata |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 0.8000 | 0.8000 | 1.0000 |
| ASW Control | 1.0000 | 0.8000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 0.8000 | 1.0000 |
| 3.1 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 0.4000 | 0.4000 | 0.2000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

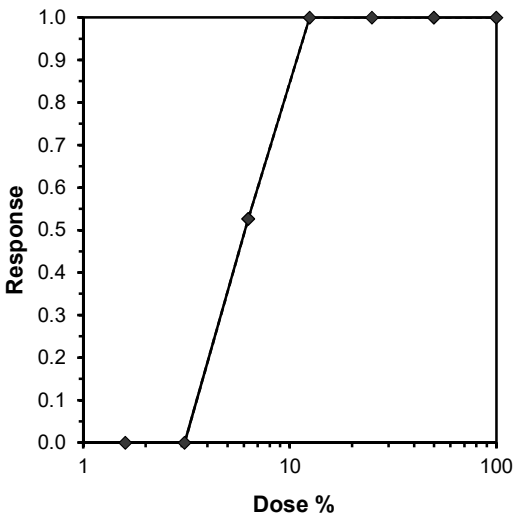
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9000 | 0.9474 | 1.2262 | 1.1071 | 1.3453 | 11.212 | 4 | | | | |
| ASW Control | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | * | | 0.9500 | 1.0000 |
| 1.6 | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 18.00 | 10.00 | 0.9500 | 1.0000 |
| 3.1 | 0.9500 | 1.0000 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 18.00 | 10.00 | 0.9500 | 1.0000 |
| 6.3 | 0.4500 | 0.4737 | 0.7351 | 0.4636 | 1.1071 | 36.604 | 4 | 10.50 | 10.00 | 0.4500 | 0.4737 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.835925 | 0.887 | 0.351483 | 1.528959 |
| Bartlett's Test indicates equal variances (p = 0.37) | 3.147714 | 11.34487 | | |
| The control means are not significantly different (p = 0.54) | 0.654654 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.6781 | 0.9144 | 0.0000 | 5.9060 | -0.6436 |
| IC10 | 4.0815 | 0.6744 | 1.4566 | 6.1294 | -0.4518 |
| IC15 | 4.4090 | 0.5479 | 2.3146 | 6.2321 | 0.4305 |
| IC20 | 4.6953 | 0.5263 | 2.9463 | 6.3223 | 0.3390 |
| IC25 | 4.9572 | 0.5140 | 3.4978 | 6.7261 | 0.4404 |
| IC40 | 5.6817 | 0.4782 | 4.4137 | 6.9915 | 0.1725 |
| IC50 | 6.1665 | 0.4013 | 4.7351 | 7.0016 | -0.3281 |



# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:00 | Test ID: | PR1858/111 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 18:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

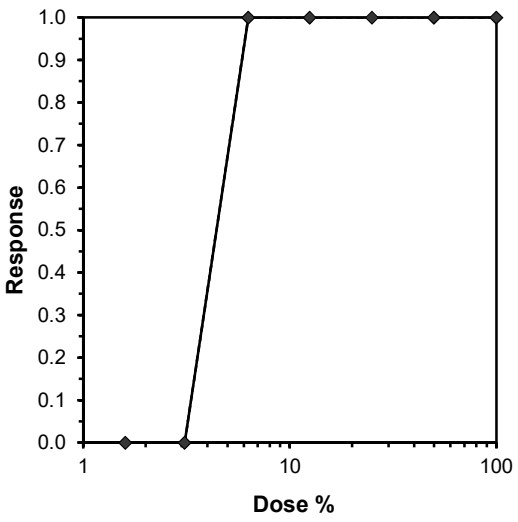
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 11.00 | 1.0000 | 1.0000 |
| 6.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 1 | 0.859 | | |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

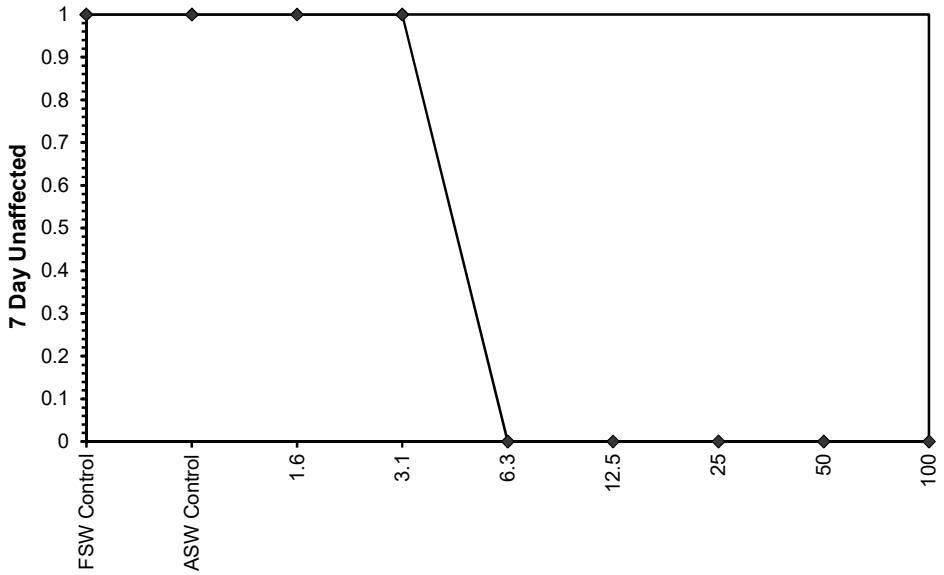
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 3.9889 | 0.0000 | 3.9889 | 3.9889 | 1.0076 |
| IC10 | 4.1070 | 0.0000 | 4.1070 | 4.1070 | -1.0076 |
| IC15 | 4.1816 | 0.0000 | 4.1816 | 4.1816 | -1.0076 |
| IC20 | 4.2384 | 0.0000 | 4.2384 | 4.2384 | 1.0076 |
| IC25 | 4.2858 | 0.0000 | 4.2858 | 4.2858 | #DIV/0! |
| IC40 | 4.4018 | 0.0000 | 4.4018 | 4.4018 | 1.0076 |
| IC50 | 4.4708 | 0.0000 | 4.4708 | 4.4708 | -1.0076 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:00 | Test ID: | PR1858/111 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 18:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:00 | Test ID: | PR1858/111 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 18:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 16.81 | 15.76 | 18.20 | 1.04 | 6.06 | 4 |
| ASW Control | | 17.64 | 15.98 | 19.98 | 1.76 | 7.52 | 4 |
| 1.6 | | 17.75 | 16.54 | 18.74 | 0.99 | 5.61 | 4 |
| 3.1 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 6.3 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.60 | 7.60 | 7.60 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 36.90 | 36.90 | 36.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.40 | 35.40 | 35.40 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.60 | 35.60 | 35.60 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| ASW Control | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 6.3 | | 100.20 | 100.20 | 100.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 25 | | 98.10 | 98.10 | 98.10 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 72.00 | 72.00 | 72.00 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/10/2019 18:00 | Test ID: | PR1858/111 | Sample ID: | Y0021019 |
| End Date: | 11/10/2019 18:00 | Lab ID: | 9259 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | EPAM 94 | Test Species: | MI |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 16.900 | 18.200 | 15.760 | 16.380 |
| ASW Control | 19.980 | 17.940 | 15.980 | 16.660 |
| 1.6 | 18.740 | 17.360 | 16.540 | 18.340 |
| 3.1 | 17.820 | 15.880 | 16.080 | 15.980 |
| 6.3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

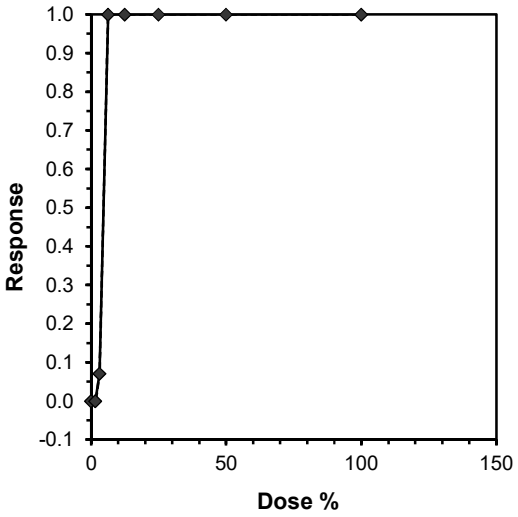
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 16.810 | 0.9529 | 16.810 | 15.760 | 18.200 | 6.170 | 4 | | | | | |
| ASW Control | 17.640 | 1.0000 | 17.640 | 15.980 | 19.980 | 9.971 | 4 | * | | | 17.693 | 1.0000 |
| 1.6 | 17.745 | 1.0060 | 17.745 | 16.540 | 18.740 | 5.583 | 4 | -0.116 | 2.180 | 1.976 | 17.693 | 1.0000 |
| 3.1 | 16.440 | 0.9320 | 16.440 | 15.880 | 17.820 | 5.618 | 4 | 1.324 | 2.180 | 1.976 | 16.440 | 0.9292 |
| 6.3 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.959799 | 0.859 | 0.631592 | -0.06225 |
| Bartlett's Test indicates equal variances (p = 0.50) | 1.404235 | 9.21034 | | |
| The control means are not significantly different (p = 0.45) | 0.812931 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 1.975752 | 0.112004 | 2.1027 | 1.642789 | 0.324187 | 2, 9 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.6594 | 0.6349 | 0.0000 | 3.5814 | -0.6979 |
| IC10 | 3.2006 | 0.3678 | 0.9839 | 3.5147 | -2.2527 |
| IC15 | 3.3728 | 0.1343 | 2.7574 | 3.6695 | -1.2580 |
| IC20 | 3.5450 | 0.1103 | 3.1021 | 3.8242 | -0.3437 |
| IC25 | 3.7172 | 0.1034 | 3.3019 | 3.9789 | -0.3437 |
| IC40 | 4.2337 | 0.0827 | 3.9016 | 4.4431 | -0.3437 |
| IC50 | 4.5781 | 0.0690 | 4.3013 | 4.7526 | -0.3437 |



# Toxicity Assessment of Produced Formation Water from the BASGAS Yolla Facility

## Beach Energy Ltd

## Test Report- Round 3

**October 2019**

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# Toxicity Test Report: TR1858/17 (Page 1 of 2)

Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:** | PR1858 |
| | | **Date Sampled:** | 9 October 2019 |
| | | **Date Received:** | 10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| Lab ID No.: | Sample Name: | Sample Description: |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9*, salinity 18.5 ‰*, total ammonia 31.4 mg/L*. Sample received at 14ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 1-hr sea urchin fertilisation success test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 104 (ESA 2014), based on USEPA (2002) and Simon and Laginestra (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 10 October 2019 at 1010h |

| Sample 9262*: A1-5327* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Fertilised Eggs (Mean ± SD)** | | |
| FSW Control | 94.5 ± 1.3 | | |
| ASW Control | 92.3 ± 2.6 | | |
| 1.6 | 94.8 ± 1.7 | | |
| 3.1 | 95.3 ± 1.7 | | |
| 6.3 | 35.3 ± 8.5 * | | |
| 12.5 | 0.0 ± 0.0 | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **IC10 = 3.9 (3.77-4.07)%** | | | |
| **EC50 = 5.7 (5.55-5.94)%** | | | |
| **NOEC = 3.1%** | | | |
| **LOEC = 6.3%** | | | |

*Significantly lower percentage fertilised eggs compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/17



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % fertilised eggs | ≥70.0% | 94.5% | Yes |
| Reference Toxicant within cusum chart limits | 48.7-66.5µg Cu/L | 56.2µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.

**NATA Accredited Laboratory Number: 14709**

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**Citations:**

ESA (2014) ESA SOP 104 - *Sea Urchin Fertilisation Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra ACT

USEPA (2002) Short-term methods for measuring the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third Edition. United States Environmental Protection Agency, Office of Water, Washington DC, EPA-821-R-02-014.



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# Toxicity Test Report: TR1858/18



Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9*, salinity 18.5 ‰*, total ammonia 31.4 mg/L *. Sample received at 14ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 72-hr sea urchin larval development test using *Heliocidaris tuberculata* |
| **Test Protocol:** | ESA SOP 105 (ESA 2016), based on APHA (1998), Simon and Laginestra (1996) and Doyle *et al*. (2003) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from South Maroubra, NSW. |
| **Test Initiated:** | 10 October 2019 at 1030h |

| Sample 9262*: A1-5327* | | *Vacant* | *Vacant* |
|---|---|---|---|
| **Concentration (%)** | **% Normal larvae (Mean ± SD)** | | |
| FSW Control | 95.3 ± 2.2 | | |
| ASW Control | 96.0 ± 1.8 | | |
| 1.6 | 95.8 ± 1.7 | | |
| 3.1 | 95.8 ± 2.2 | | |
| 6.3 | 95.5 ± 2.4 | | |
| 12.5 | 62.5 ± 9.0 * | | |
| 25 | 0.0 ± 0.0 | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr EC10 = 8.8 (7.73-9.70)%**<br>**72-hr EC50 = 13.9 (13.41-14.34)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/18



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % normal larvae | ≥70.0% | 95.3% | Yes |
| Reference Toxicant within cusum chart limits | 10.4-12.3µg Cu/L | 11.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) Method 8810 D. Echinoderm Embryo Development Test. In Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, USA.

Doyle, C.J., Pablo, F., Lim, R.P. and Hyne, R.V. (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. *Arch. Environ. Contam. Toxicology*, 44(3): 343-350.

ESA (2016) *ESA SOP 105 - Sea Urchin Larval Development Test*. Issue No. 11. Ecotox Services Australasia, Sydney NSW.

Simon, J. and Laginestra, E.(1997) Bioassay for testing sublethal toxicity in effluents, using gametes of sea urchin *Heliocidaris tuberculata*. National Pulp Mills Research Program Technical Report No. 20. CSIRO, Canberra, ACT.

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# Toxicity Test Report: TR1858/19 (Page 1 of 2)

Accredited for compliance with ISO/IEC 17025 - Testing

| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9*, salinity 18.5 ‰*, total ammonia 31.4 mg/L *. Sample received at 14ºC* in apparent good condition. |

*NATA accreditation does not cover the performance of this service

| | |
|---|---|
| **Test Performed:** | 48-hr larval development test using the mussel *Mytilus galloprovincialis* |
| **Test Protocol:** | ESA SOP 106 (ESA 2016), based on APHA (1998) and USEPA (1996) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | The test was extended to 72hr |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Farm-reared, Mercury Passage, TAS |
| **Test Initiated:** | 10 October 2019 at 1230 h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Normal larvae (Mean ± SD)** | | |
| FSW Control: 76.8 ± 3.3 | | |
| ASW Control: 74.3 ± 3.0 | | |
| 1.6: 79.3 ± 3.4 | | |
| 3.1: 78.0 ± 2.6 | | |
| 6.3: 77.5 ± 2.7 | | |
| 12.5: 37.0 ± 9.4 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **72-hr EC10 =7.4 (6.85-7.80)%**<br>**72-hr EC50 =12.3 (11.93-12.78)%**<br>**NOEC = 6.3%**<br>**LOEC = 12.5%** | | |

*Significantly lower percentage of normally developed larvae compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/19 (Page 2 of 2)

| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| FSW Control mean % normal | ≥70% | 76.8% | Yes |
| Reference Toxicant within cusum chart limits | 7.6-14.7µg Cu/L | 10.4µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.

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**Citations:**

APHA (1998) *Standard Methods for the Examination of Water and Wastewate*r. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC, USA.

ESA (2016) *Bivalve Larval Development Test*. Issue No. 15. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) *Bivalve acute toxicity test (embryo larval) OPPTS 850.1055. Ecological Effects Test Guidelines.* United States Environmental Protection Agency. Prevention, Pesticides and Toxic Substances. EPA/712/C-96/137.

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# Toxicity Test Report: TR1820/20



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr acute toxicity test using the amphipod *Allorchestes compressa* |
| **Test Protocol:** | ESA SOP 108 (ESA 2017), based on USEPA (2002) and Department of Transport and Communications (1990) |
| **Test Temperature:** | The test was performed at 20±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from Queenscliff, VIC |
| **Test Initiated:** | 22 October 2019 at 1530h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 100 ± 0.0 | | |
| 12.5: 65.0 ± 10.0 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 11.1 (10.8-11.6)%** | | |
| **96-hr EC50 = 13.9 (12.0-16.1)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percent unaffected compared with the ASW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥90.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 0.6-9.0mg SDS/L | 3.1mg SDS/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

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# Toxicity Test Report: TR1820/20



**Citations:**

Department of Transport and Communications (1990) Guidelines for Acceptance of Oil Spill Dispersants in Australian Waters. Pollution Prevention Section, Department of Transport and Communications, Canberra ACT.

ESA (2017) SOP 108 – *Amphipod Acute Toxicity Test*. Issue No 10. Ecotox Services Australia, Sydney, NSW.

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. United States Environmental Protection Agency, Office of Research and Development, Washington DC, EPA/600/4-90/027F.

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# Toxicity Test Report: TR1858/21



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr marine algal growth test using *Nitzschia closterium* |
| **Test Protocol:** | ESA SOP 110 (ESA 2016), based on Stauber *et al*. (1994) |
| **Test Temperature:** | The test was performed at 21±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was filtered to 0.45µm and serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | In-house culture, originally sourced from CSIRO Microalgae Supply Service, TAS |
| **Test Initiated:** | 22 October 2019 at 1430h |

| Sample 9262*: A1-5327*<br>**Concentration (%)** | **Cell Yield (Mean number of cells/mL x$10^4$ ± SD)** | *Vacant* | *Vacant* |
|---|---|---|---|
| FSW Control | 15.9 ± 0.9 | | |
| ASW Control | 15.0 ± 1.1 | | |
| 1.6 | 16.2 ± 0.7 | | |
| 3.1 | 15.5 ± 1.6 | | |
| 6.3 | 16.1 ± 0.8 | | |
| 12.5 | 14.1 ± 1.2 | | |
| 25 | 2.2 ± 2.3 * | | |
| 50 | 0.0 ± 0.0 | | |
| 100 | 0.0 ± 0.0 | | |
| **72-hr IC10 = 12.3 (8.33-13.88)%**<br>**72-hr IC50 = 19.0 (17.46-21.01)%**<br>**NOEC = 12.5%**<br>**LOEC = 25%** | | | |

*Significantly lower cell yield compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean cell density | ≥16.0x$10^4$ cells/mL | 16.9x$10^4$ cells/mL | Yes |
| Control coefficient of variation | <20% | 5.5% | Yes |
| Reference Toxicant within cusum chart limits | 3.2-9.2µg Cu/L | 5.2µg Cu/L | Yes |

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ECOTOX SERVICES AUSTRALIA PTY LIMITED
ABN 95 619 426 201

# Toxicity Test Report: TR1858/21



Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 110 – *Marine Algal Growth Test*. Issue No. 12. Ecotox Services Australasia, Sydney NSW

Stauber, J.L., Tsai, J., Vaughan, G.T., Peterson, S.M. and Brockbank, C.I. (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

NATA WORLD RECOGNISED ACCREDITATION

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# Toxicity Test Report: TR1858/22



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 72-hr macroalgal germination success test using *Hormosira banksii* |
| **Test Protocol:** | ESA SOP 116 (ESA 2014), based on Kevekordes and Clayton (1996) and Gunthorpe *et al*. (1997) |
| **Test Temperature:** | The test was performed at 18±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Field collected from Bilgola, NSW. |
| **Test Initiated:** | 10 October 2019 at 1330h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Germination (Mean ± SD)** | | |
| FSW Control — 97.3 ± 1.0 | | |
| ASW Control — 97.0 ± 2.5 | | |
| 1.6 — 97.3 ± 1.0 | | |
| 3.1 — 96.5 ± 1.3 | | |
| 6.3 — 98.3 ± 1.7 | | |
| 12.5 — 88.8 ± 5.4 * | | |
| 25 — 5.5 ± 3.4 * | | |
| 50 — 0.0 ± 0.0 | | |
| 100 — 0.0 ± 0.0 | | |
| **72-hr EC10 = 12.7 (10.17-13.86)%** | | |
| **72-hr EC50 = 17.3 (16.88-17.75)%** | | |
| **NOEC = 6.3%** | | |
| **LOEC = 12.5%** | | |

*Significantly lower percentage of germinated zygotes compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/22



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % germination | ≥70.0% | 97.3% | Yes |
| Reference Toxicant within cusum chart limits | 118.5-257.9µg Cu/L | 184.3µg Cu/L | Yes |

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

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**Citations:**

ESA (2014) *SOP 116 – Macroalgal Germination Success Test*. Issue No. 13. Ecotox Services Australasia, Sydney.

Gunthorpe L, Nottage M, Palmer D, and Wu R (1997) *Testing for Sublethal Toxicity Using Gametes of Hormosira banksii: protocol*. National Pulp Mills Research Program Technical Report No. 22, CSIRO, Canberra.

Kevekordes K and Clayton MN (1996) Using developing embryos of *Hormosira banksii* (Phaeophyta) as a marine bioassay system. *International Journal of Plant Science*, 157: 582-585.

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# Toxicity Test Report: TR1858/23



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 96-hr fish imbalance toxicity test using the Barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 117 (ESA 2016), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±1°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample |
| **Source of Test Organisms:** | In-house cultures |
| **Test Initiated:** | 22 October 2019 at 1430h |

| Sample 9262*: A1-5327* | *Vacant* | *Vacant* |
|---|---|---|
| **Concentration (%)** / **% Unaffected (Mean ± SD)** | | |
| FSW Control: 100 ± 0.0 | | |
| ASW Control: 100 ± 0.0 | | |
| 1.6: 100 ± 0.0 | | |
| 3.1: 100 ± 0.0 | | |
| 6.3: 65.0 ± 19.2 * | | |
| 12.5: 5.0 ± 10.0 * | | |
| 25: 0.0 ± 0.0 | | |
| 50: 0.0 ± 0.0 | | |
| 100: 0.0 ± 0.0 | | |
| **96-hr IC10 = 4.8 (3.26-5.76)%**<br>**96-hr EC50 = 7.2 (6.09-8.58)%**<br>**NOEC =3.1%**<br>**LOEC = 6.3%** | | |

| **QA/QC Parameter** | **Criterion** | **This Test** | **Criterion met?** |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Reference Toxicant within cusum chart limits | 10.7-117.39µg Cu/L | 36.5µg Cu/L | Yes |

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# Toxicity Test Report: TR1858/23



Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

Results are based on the samples in the condition as received by ESA.
This document shall not be reproduced except in full.

**Citations:**

ESA (2016) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 12. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Toxicity Test Report: TR1858/24



| | | | |
|---|---|---|---|
| **Client:** | Beach Energy Ltd<br>GPO Box 175<br>Adelaide SA 5002 | **ESA Job #:**<br>**Date Sampled:**<br>**Date Received:** | PR1858<br>9 October 2019<br>10 October 2019 |
| **Attention:** | Adrian Cukovski / John Peel | **Sampled By:** | Client |
| **Client Ref:** | BE00020689 | **ESA Quote #:** | PR1858_q01 |

| **Lab ID No.:** | **Sample Name:** | **Sample Description:** |
|---|---|---|
| 9262 | A1-5327 | Produced Formation Water, pH 6.9, salinity 18.5 ‰, total ammonia 31.4 mg/L. Sample received at 14º in apparent good condition. |

| | |
|---|---|
| **Test Performed:** | 7-day fish imbalance and biomass toxicity test using barramundi *Lates calcarifer* |
| **Test Protocol:** | ESA SOP 122 (ESA 2017), based on USEPA (2002) |
| **Test Temperature:** | The test was performed at 25±2°C. |
| **Deviations from Protocol:** | Nil |
| **Comments on Solution Preparation:** | The sample was adjusted to a salinity of 35±1‰ with modified GP2 artificial sea salts prior to testing.<br>The sample was serially diluted with filtered seawater (FSW) to achieve the test concentrations. A FSW control and an artificial seawater (ASW) control were tested concurrently with the sample. |
| **Source of Test Organisms:** | Hatchery reared, SA |
| **Age of Test Organisms:** | - |
| **Test Initiated:** | 22 October 2019 at 1430h |

Sample 9262: *A1-5327*

| **Concentration (%)** | **% Unaffected (Mean ± SD)** |
|---|---|
| FSW Control | 100 ± 0.0 |
| ASW Control | 100 ± 0.0 |
| 1.6 | 100 ± 0.0 |
| 3.1 | 100 ± 0.0 |
| 6.3 | 95.0 ± 10.0 |
| 12.5 | 0.0 ± 0.0 |
| 25 | 0.0 ± 0.0 |
| 50 | 0.0 ± 0.0 |
| 100 | 0.0 ± 0.0 |

**7 day IC10 (unaffected) = 6.6 (5.72-9.21)%**
**7 day IC50 (unaffected) = 8.6 (8.01-9.17)%**
**NOEC = 6.3%**
**LOEC = 12.5%**

Sample 9262: *A1-5327*

| **Concentration (%)** | **Biomass, mg (Mean ± SD)** | |
|---|---|---|
| FSW Control | 23.1 ± 0.8 | |
| ASW Control | 22.6 ± 0.7 | |
| 1.6 | 23.4 ± 2.0 | |
| 3.1 | 20.6 ± 0.6 | |
| 6.3 | 18.7 ± 1.9 | * |
| 12.5 | 0.0 ± 0.0 | |
| 25 | 0.0 ± 0.0 | |
| 50 | 0.0 ± 0.0 | |
| 100 | 0.0 ± 0.0 | |

**7 day IC10 (biomass) = 3.1 (2.40-5.92)%**
**7 day IC50 (biomass) = 8.7 (8.08-9.12) %**
**NOEC = 3.1%**
**LOEC = 6.3%**

*Significantly lower fish biomass compared with the ASW Control (Dunnett's Test, 1-tailed, P=0.05)

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# Toxicity Test Report: TR1858/24



| QA/QC Parameter | Criterion | This Test | Criterion met? |
|---|---|---|---|
| Control mean % unaffected | ≥80.0% | 100% | Yes |
| Control mean growth | ≥20% of initial weight | 17.1% | No* |
| Reference Toxicant within cusum chart limits | 10.7-117.4mg $NH_4^+$/L | 36.5mg $NH_4^+$/L | Yes |

*fish available for testing at 22 October were older and at a relatively lower growth phase than with younger fish

Test Report Authorised by: Dr Rick Krassoi, Director on 16 November 2019

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**Citations:**

ESA (2017) SOP 122 –*7-day Fish Imbalance and Growth Test*. Issue No 6. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Third edition EPA-821-R-02-014. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

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# Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 21 September 2018

# Sample Receipt Notification

**Attention** : Peter Young

**Client** : AECOM Australia Pty Ltd
Level 6, 3 Forrest Place
Perth WA 6849

**Email** : peter.young@aecom.com
**Telephone** : 08 6208 0000
**Facsimile** :

**Date** : 10/10/2019

**Re** : Receipt of Samples **Pages :** **2**

**ESA Project** : PR1858 ☑ For Review ☐ Additional Documentation Required - Please Respond

## *Sample Delivery Details*

**Completed Chain of Custody accompanied samples:** **YES**
**Samples received in apparent good condition and correctly bottled:** **YES**
**Security seals on sample bottles and esky intact:** **YES**

**Date samples received** : 10/10/2019
**Time samples received** : 8:30
**No. of samples received** : 1
**Sample matrix** : Aqueous
**Sample temperature** : 11-15°C

**Comments** : 4 x 2.5L sample received at 14oC in apparent good condition

## *Contact Details*

Projects Manager : Dr Rick Krassoi
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : rkrassoi@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

**Note that the chain-of-custody provides definitive information on the tests to be performed**

**Ecotox Services Australia**
ABN 95619426201
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

# Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 20 September 2018

ecotox SERVICES AUSTRALIA

Customer: Beach Energy
Contact Name: Adrian Cukrowski
Phone:
Email: Adrian.cukrowski@beachenergy.com.au (please provide an email address for sample receipt notification)
Sampled by: Rob McFadyen

Ship To: Ecotox Services Aust
Attention: Ruth Kreutz

| Sample Date (day/month /year) | Sample Time | Sample Name (exactly as written on the sample vessel) | Sample Method (eg. Grab, composite etc.) | Number and Volume of Containers (eg 2 x 1L) | Tests Requested (See reverse for guidance) | | | | | | Comments / Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 96 h Acute Toxicity Test 96 h Bass FIT | 72 h Algal Toxicity Test 72 h Algal Growth Inhibition | 48 h Daphnia Test 1 h Sperm Cell Toxicity Test | 72 h Seed Germination & Root Elongation | 7 d FIT & Growth | Sediment - Sampling for Freezing | **Note that testing will be delayed if an incomplete chain of custody is received**<br>• Additional treatment of samples (i.e. spiking)<br>• Sub-contracted services (i.e. chemical analyses)<br>• Dilutions required (if different than 100% down to 6.25%)<br>• Sample holding time restriction (if applicable)<br>• Sample used for litigation (if applicable)<br>*Note: An MSDS must be attached if Available*<br>**ESA Project Number: PR** 15583 |
| 14°C | | | | | | | | | | | |
| 9-10-19 | 0600 | Yolla-A, A1-5327 | Grab | 4 x 2.5L | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

| 1) Released By: | Date: | 2) Received By: | Date: | 3) Released By: | Date: | 4) Received By: | Date: |
|---|---|---|---|---|---|---|---|
| | 9-10-19 | | 10/10/19 | | | | |
| Of: | Time: | Of: ESA | Time: 0830 | Of: | Time: | Of: | Time: |

**Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.**

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# Statistical Printouts for the Sea Urchin Fertilisation Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9700 | 0.9500 | 0.9400 | 0.9800 |
| 1.6 | 0.9400 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9300 | 0.9700 | 0.9500 | 0.9800 |
| 6.3 | 0.9700 | 0.9800 | 0.9400 | 0.9300 |
| 12.5 | 0.7600 | 0.5900 | 0.5700 | 0.5800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

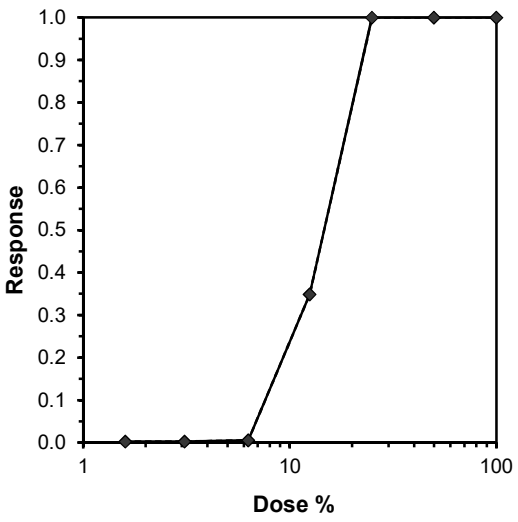
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3736 | 1.3233 | 1.4289 | 3.497 | 4 | * | | 16 | 400 |
| 1.6 | 0.9575 | 0.9974 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | 17.50 | 10.00 | 17 | 400 |
| 3.1 | 0.9575 | 0.9974 | 1.3685 | 1.3030 | 1.4289 | 4.062 | 4 | 17.50 | 10.00 | 17 | 400 |
| 6.3 | 0.9550 | 0.9948 | 1.3630 | 1.3030 | 1.4289 | 4.371 | 4 | 16.50 | 10.00 | 18 | 400 |
| *12.5 | 0.6250 | 0.6510 | 0.9140 | 0.8556 | 1.0588 | 10.600 | 4 | 10.00 | 10.00 | 150 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89649 | 0.905 | 0.91037 | 0.373947 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.205322 | 13.2767 | | |
| The control means are not significantly different (p = 0.65) | 0.471764 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Trimmed Spearman-Karber

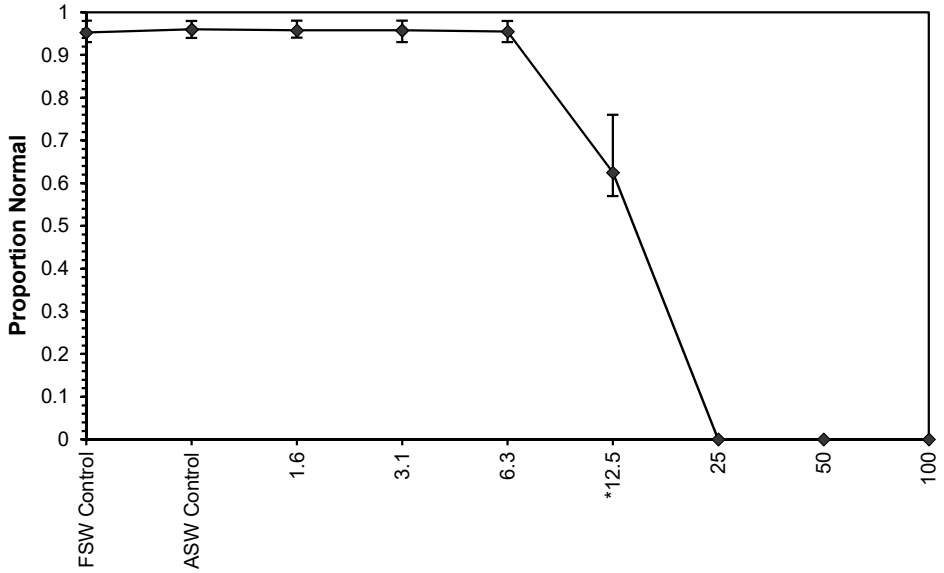
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 14.019 | 13.513 | 14.544 |
| 10.0% | 14.162 | 13.577 | 14.772 |
| 20.0% | 14.431 | 13.578 | 15.337 |
| Auto-0.3% | 13.869 | 13.412 | 14.340 |



**Sea Urchin Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.25 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| ASW Control | | 96.00 | 94.00 | 98.00 | 1.83 | 1.41 | 4 |
| 1.6 | | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 3.1 | | 95.75 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| 6.3 | | 95.50 | 93.00 | 98.00 | 2.38 | 1.62 | 4 |
| 12.5 | | 62.50 | 57.00 | 76.00 | 9.04 | 4.81 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.60 | 97.60 | 97.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9700 | 0.9500 | 0.9400 | 0.9800 |
| 1.6 | 0.9400 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9300 | 0.9700 | 0.9500 | 0.9800 |
| 6.3 | 0.9700 | 0.9800 | 0.9400 | 0.9300 |
| 12.5 | 0.7600 | 0.5900 | 0.5700 | 0.5800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

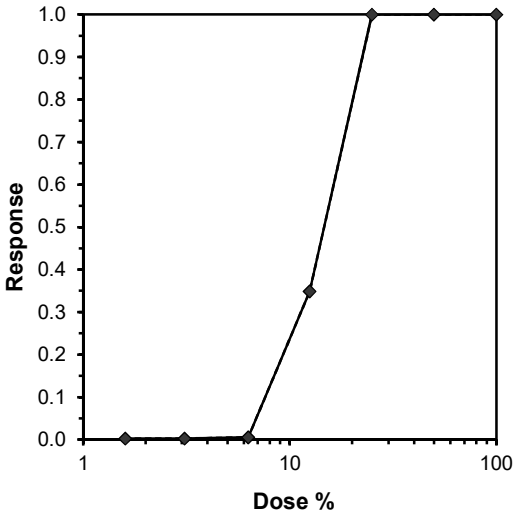
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3736 | 1.3233 | 1.4289 | 3.497 | 4 | * | | 0.9600 | 1.0000 |
| 1.6 | 0.9575 | 0.9974 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | 17.50 | 10.00 | 0.9575 | 0.9974 |
| 3.1 | 0.9575 | 0.9974 | 1.3685 | 1.3030 | 1.4289 | 4.062 | 4 | 17.50 | 10.00 | 0.9575 | 0.9974 |
| 6.3 | 0.9550 | 0.9948 | 1.3630 | 1.3030 | 1.4289 | 4.371 | 4 | 16.50 | 10.00 | 0.9550 | 0.9948 |
| *12.5 | 0.6250 | 0.6510 | 0.9140 | 0.8556 | 1.0588 | 10.600 | 4 | 10.00 | 10.00 | 0.6250 | 0.6510 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89649 | 0.905 | 0.91037 | 0.373947 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.205322 | 13.2767 | | |
| The control means are not significantly different (p = 0.65) | 0.471764 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.680 | 0.296 | 6.557 | 8.225 | -0.3105 |
| IC10 | 8.770 | 0.313 | 7.728 | 9.704 | 0.4079 |
| IC15 | 9.657 | 0.370 | 8.645 | 10.965 | 1.0192 |
| IC20 | 10.437 | 0.446 | 9.415 | 12.083 | 1.3913 |
| IC25 | 11.157 | 0.488 | 10.100 | 13.220 | 1.0515 |
| IC40 | 12.687 | 0.168 | 12.281 | 13.279 | 0.7576 |
| IC50 | 13.049 | 0.160 | 12.724 | 13.631 | 0.8966 |



# Statistical Printouts for the Sea Urchin Larval Development Test

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9700 | 0.9500 | 0.9400 | 0.9800 |
| 1.6 | 0.9400 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9300 | 0.9700 | 0.9500 | 0.9800 |
| 6.3 | 0.9700 | 0.9800 | 0.9400 | 0.9300 |
| 12.5 | 0.7600 | 0.5900 | 0.5700 | 0.5800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

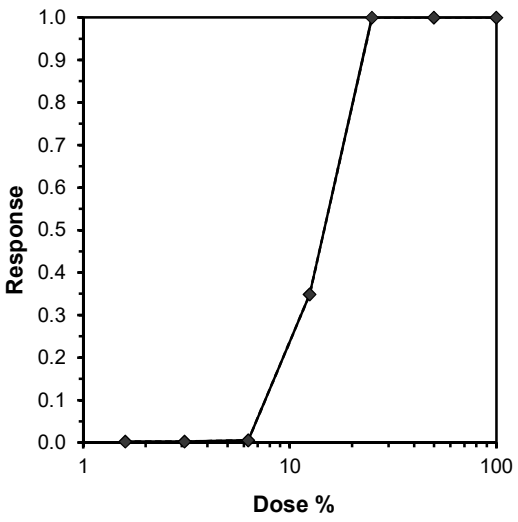
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3736 | 1.3233 | 1.4289 | 3.497 | 4 | * | | 16 | 400 |
| 1.6 | 0.9575 | 0.9974 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | 17.50 | 10.00 | 17 | 400 |
| 3.1 | 0.9575 | 0.9974 | 1.3685 | 1.3030 | 1.4289 | 4.062 | 4 | 17.50 | 10.00 | 17 | 400 |
| 6.3 | 0.9550 | 0.9948 | 1.3630 | 1.3030 | 1.4289 | 4.371 | 4 | 16.50 | 10.00 | 18 | 400 |
| *12.5 | 0.6250 | 0.6510 | 0.9140 | 0.8556 | 1.0588 | 10.600 | 4 | 10.00 | 10.00 | 150 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89649 | 0.905 | 0.91037 | 0.373947 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.205322 | 13.2767 | | |
| The control means are not significantly different (p = 0.65) | 0.471764 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Trimmed Spearman-Karber

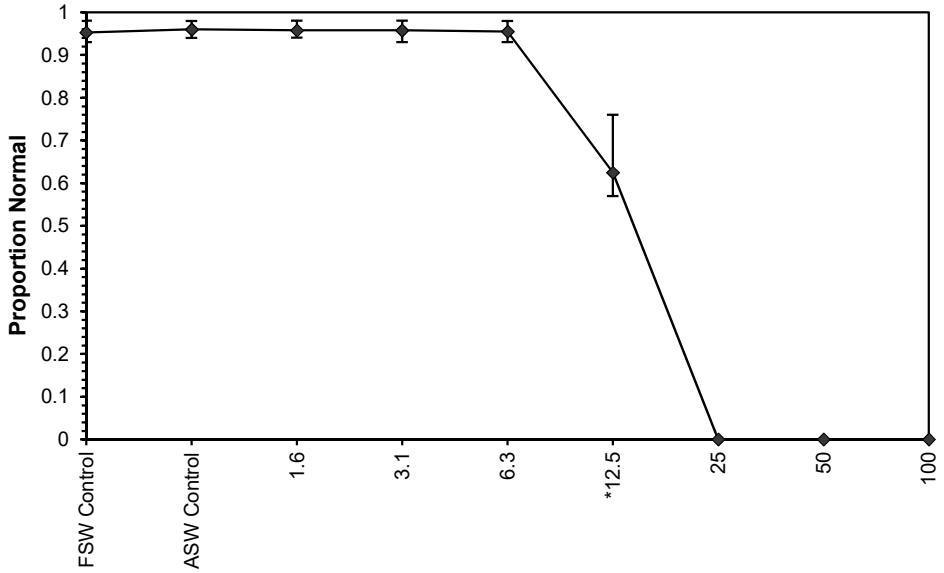
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | | | |
| 5.0% | 14.019 | 13.513 | 14.544 |
| 10.0% | 14.162 | 13.577 | 14.772 |
| 20.0% | 14.431 | 13.578 | 15.337 |
| Auto-0.3% | 13.869 | 13.412 | 14.340 |



**Sea Urchin Larval Development Test-Proportion Normal**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Dose-Response Plot**



## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 95.25 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| ASW Control | | 96.00 | 94.00 | 98.00 | 1.83 | 1.41 | 4 |
| 1.6 | | 95.75 | 94.00 | 98.00 | 1.71 | 1.36 | 4 |
| 3.1 | | 95.75 | 93.00 | 98.00 | 2.22 | 1.56 | 4 |
| 6.3 | | 95.50 | 93.00 | 98.00 | 2.38 | 1.62 | 4 |
| 12.5 | | 62.50 | 57.00 | 76.00 | 9.04 | 4.81 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.60 | 97.60 | 97.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Sea Urchin Larval Development Test-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 10:30 | Test ID: | PR1858/03 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 10:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 105 | Test Species: | -HELIOCIDARIS TUBERCULATA |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9400 | 0.9600 | 0.9800 | 0.9300 |
| ASW Control | 0.9700 | 0.9500 | 0.9400 | 0.9800 |
| 1.6 | 0.9400 | 0.9600 | 0.9800 | 0.9500 |
| 3.1 | 0.9300 | 0.9700 | 0.9500 | 0.9800 |
| 6.3 | 0.9700 | 0.9800 | 0.9400 | 0.9300 |
| 12.5 | 0.7600 | 0.5900 | 0.5700 | 0.5800 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

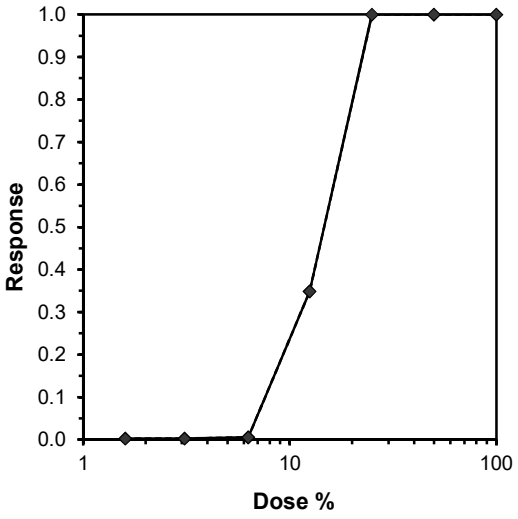
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 0.9525 | 0.9922 | 1.3562 | 1.3030 | 1.4289 | 4.120 | 4 | | | | |
| ASW Control | 0.9600 | 1.0000 | 1.3736 | 1.3233 | 1.4289 | 3.497 | 4 | * | | 0.9600 | 1.0000 |
| 1.6 | 0.9575 | 0.9974 | 1.3667 | 1.3233 | 1.4289 | 3.330 | 4 | 17.50 | 10.00 | 0.9575 | 0.9974 |
| 3.1 | 0.9575 | 0.9974 | 1.3685 | 1.3030 | 1.4289 | 4.062 | 4 | 17.50 | 10.00 | 0.9575 | 0.9974 |
| 6.3 | 0.9550 | 0.9948 | 1.3630 | 1.3030 | 1.4289 | 4.371 | 4 | 16.50 | 10.00 | 0.9550 | 0.9948 |
| *12.5 | 0.6250 | 0.6510 | 0.9140 | 0.8556 | 1.0588 | 10.600 | 4 | 10.00 | 10.00 | 0.6250 | 0.6510 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.89649 | 0.905 | 0.91037 | 0.373947 |
| Bartlett's Test indicates equal variances (p = 0.70) | 2.205322 | 13.2767 | | |
| The control means are not significantly different (p = 0.65) | 0.471764 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 7.680 | 0.296 | 6.557 | 8.225 | -0.3105 |
| IC10 | 8.770 | 0.313 | 7.728 | 9.704 | 0.4079 |
| IC15 | 9.657 | 0.370 | 8.645 | 10.965 | 1.0192 |
| IC20 | 10.437 | 0.446 | 9.415 | 12.083 | 1.3913 |
| IC25 | 11.157 | 0.488 | 10.100 | 13.220 | 1.0515 |
| IC40 | 12.687 | 0.168 | 12.281 | 13.279 | 0.7576 |
| IC50 | 13.049 | 0.160 | 12.724 | 13.631 | 0.8966 |



# Statistical Printouts for the Mussel Toxicity Tests

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 12:30 | Test ID: | PR1858/06 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 12:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7600 | 0.8100 | 0.7700 | 0.7300 |
| ASW Control | 0.7100 | 0.7300 | 0.7800 | 0.7500 |
| 1.6 | 0.7800 | 0.8400 | 0.7900 | 0.7600 |
| 3.1 | 0.7500 | 0.8100 | 0.7900 | 0.7700 |
| 6.3 | 0.7800 | 0.7600 | 0.7500 | 0.8100 |
| 12.5 | 0.2700 | 0.3100 | 0.4600 | 0.4400 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

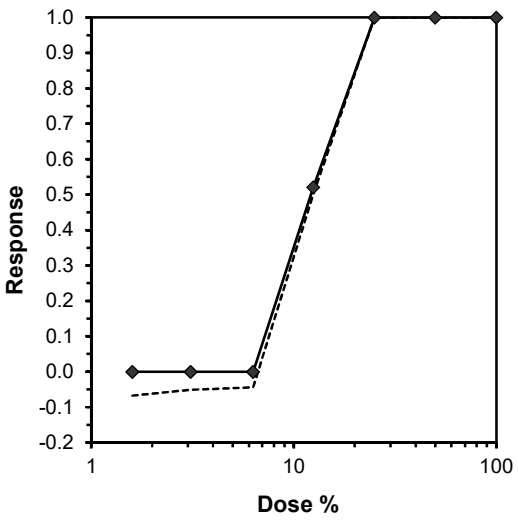
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.7675 | 1.0337 | 1.0684 | 1.0244 | 1.1198 | 3.694 | 4 | | | | | |
| ASW Control | 0.7425 | 1.0000 | 1.0391 | 1.0021 | 1.0826 | 3.306 | 4 | * | | | 103 | 400 |
| 1.6 | 0.7925 | 1.0673 | 1.0989 | 1.0588 | 1.1593 | 3.909 | 4 | -1.559 | 2.360 | 0.0905 | 83 | 400 |
| 3.1 | 0.7800 | 1.0505 | 1.0831 | 1.0472 | 1.1198 | 2.883 | 4 | -1.148 | 2.360 | 0.0905 | 88 | 400 |
| 6.3 | 0.7750 | 1.0438 | 1.0771 | 1.0472 | 1.1198 | 2.974 | 4 | -0.992 | 2.360 | 0.0905 | 90 | 400 |
| *12.5 | 0.3700 | 0.4983 | 0.6519 | 0.5464 | 0.7454 | 15.086 | 4 | 10.100 | 2.360 | 0.0905 | 252 | 400 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.979874 | 0.905 | 0.018979 | 0.115837 |
| Bartlett's Test indicates equal variances (p = 0.18) | 6.202708 | 13.2767 | | |
| The control means are not significantly different (p = 0.31) | 1.120964 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.082617 | 0.111203 | 0.144838 | 0.00294 | 1.9E-08 | 4, 15 |

### Trimmed Spearman-Karber

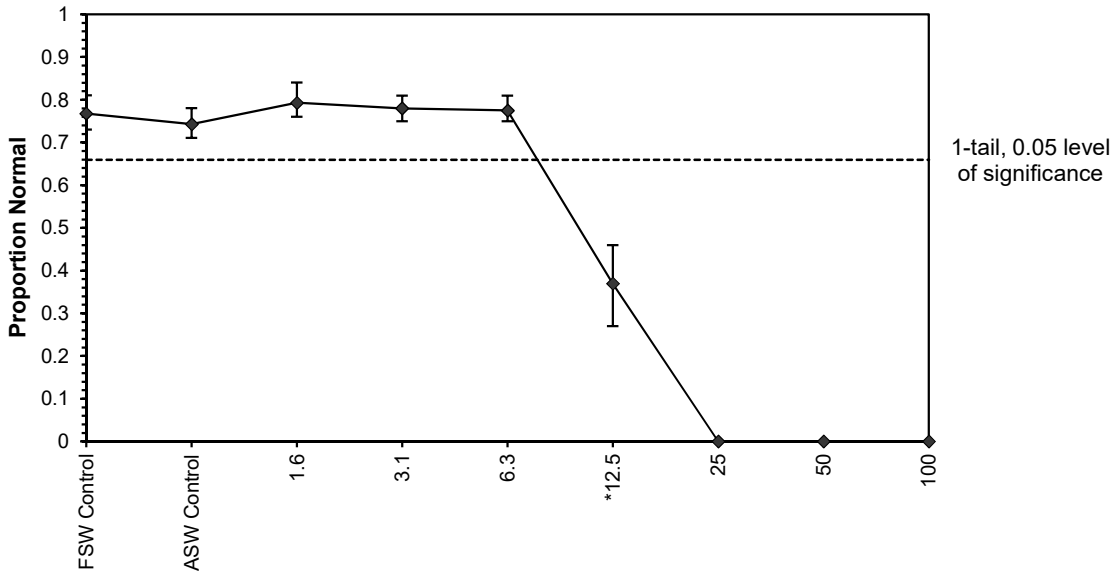
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 12.345 | 11.927 | 12.777 |
| 5.0% | 12.324 | 11.862 | 12.804 |
| 10.0% | 12.304 | 11.788 | 12.843 |
| 20.0% | 12.264 | 11.589 | 12.977 |
| Auto-0.0% | 12.345 | 11.927 | 12.777 |



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 12:30 | Test ID: | PR1858/06 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 12:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Dose-Response Plot**



## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 12:30 | Test ID: | PR1858/06 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 12:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Normal | 76.75 | 73.00 | 81.00 | 3.30 | 2.37 | 4 |
| ASW Control | | 74.25 | 71.00 | 78.00 | 2.99 | 2.33 | 4 |
| 1.6 | | 79.25 | 76.00 | 84.00 | 3.40 | 2.33 | 4 |
| 3.1 | | 78.00 | 75.00 | 81.00 | 2.58 | 2.06 | 4 |
| 6.3 | | 77.50 | 75.00 | 81.00 | 2.65 | 2.10 | 4 |
| 12.5 | | 37.00 | 27.00 | 46.00 | 9.42 | 8.29 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.60 | 97.60 | 97.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Bivalve Acute Toxicity Tests-Proportion Normal

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 12:30 | Test ID: | PR1858/06 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 12:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 106 | Test Species: | MG-Mytilus galloprovincialis |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.7600 | 0.8100 | 0.7700 | 0.7300 |
| ASW Control | 0.7100 | 0.7300 | 0.7800 | 0.7500 |
| 1.6 | 0.7800 | 0.8400 | 0.7900 | 0.7600 |
| 3.1 | 0.7500 | 0.8100 | 0.7900 | 0.7700 |
| 6.3 | 0.7800 | 0.7600 | 0.7500 | 0.8100 |
| 12.5 | 0.2700 | 0.3100 | 0.4600 | 0.4400 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

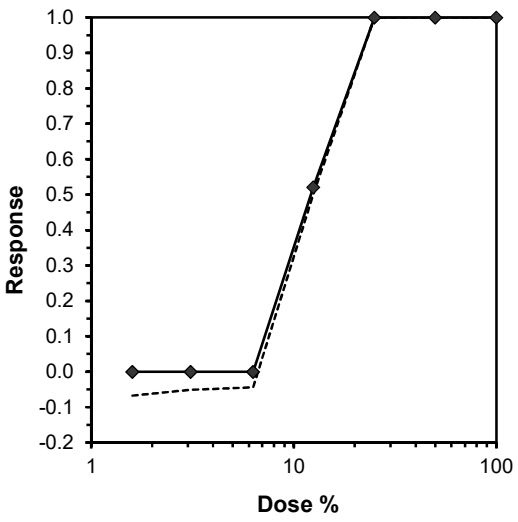
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.7675 | 1.0337 | 1.0684 | 1.0244 | 1.1198 | 3.694 | 4 | | | | | |
| ASW Control | 0.7425 | 1.0000 | 1.0391 | 1.0021 | 1.0826 | 3.306 | 4 | * | | | 0.7725 | 1.0000 |
| 1.6 | 0.7925 | 1.0673 | 1.0989 | 1.0588 | 1.1593 | 3.909 | 4 | -1.559 | 2.360 | 0.0905 | 0.7725 | 1.0000 |
| 3.1 | 0.7800 | 1.0505 | 1.0831 | 1.0472 | 1.1198 | 2.883 | 4 | -1.148 | 2.360 | 0.0905 | 0.7725 | 1.0000 |
| 6.3 | 0.7750 | 1.0438 | 1.0771 | 1.0472 | 1.1198 | 2.974 | 4 | -0.992 | 2.360 | 0.0905 | 0.7725 | 1.0000 |
| *12.5 | 0.3700 | 0.4983 | 0.6519 | 0.5464 | 0.7454 | 15.086 | 4 | 10.100 | 2.360 | 0.0905 | 0.3700 | 0.4790 |
| 25 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.979874 | 0.905 | 0.018979 | 0.115837 |
| Bartlett's Test indicates equal variances (p = 0.18) | 6.202708 | 13.2767 | | |
| The control means are not significantly different (p = 0.31) | 1.120964 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.082617 | 0.111203 | 0.144838 | 0.00294 | 1.9E-08 | 4, 15 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.852 | 0.101 | 6.358 | 7.035 | -0.5888 |
| IC10 | 7.392 | 0.137 | 6.852 | 7.803 | 0.1359 |
| IC15 | 7.927 | 0.190 | 7.255 | 8.596 | 0.4035 |
| IC20 | 8.465 | 0.254 | 7.675 | 9.405 | 0.5073 |
| IC25 | 9.014 | 0.325 | 8.071 | 10.231 | 0.5609 |
| IC40 | 10.792 | 0.587 | 9.285 | 13.051 | 0.6458 |
| IC50 | 12.177 | 0.545 | 10.209 | 13.116 | -0.4472 |



# Statistical Printouts for the Acute *Allorchestes* Toxicity Test

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 15:30 | Test ID: | PR1858/10 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 15:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.6000 | 0.8000 | 0.6000 | 0.6000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

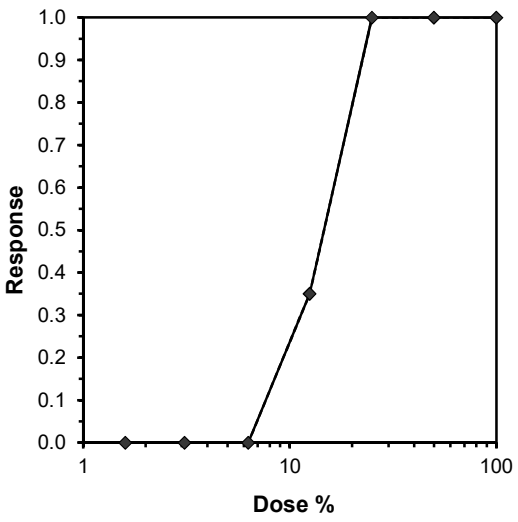
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *12.5 | 0.6500 | 0.6500 | 0.9413 | 0.8861 | 1.1071 | 11.742 | 4 | 10.00 | 10.00 | 7 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.508902 | 0.905 | 2.796235 | 11.6732 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

**Trimmed Spearman-Karber**

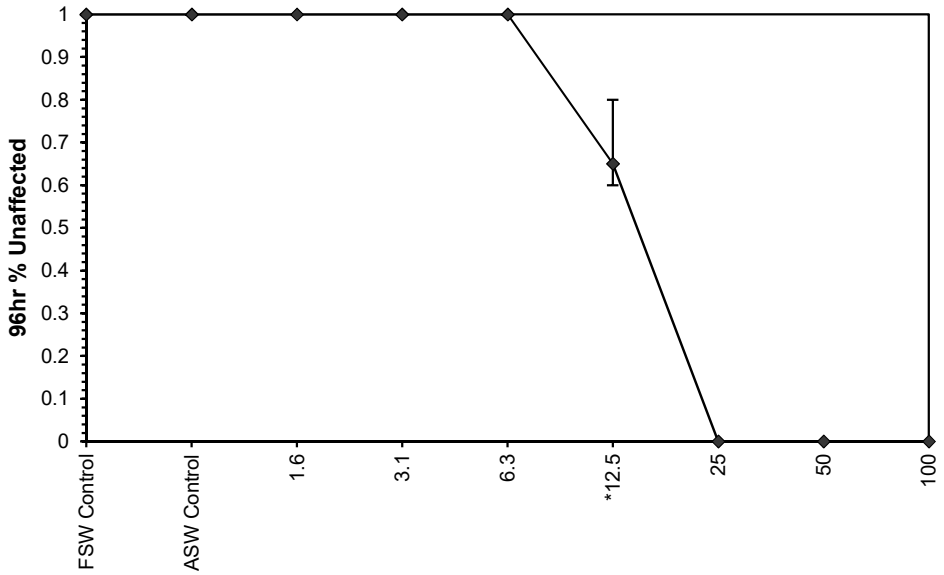
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 13.889 | 11.990 | 16.088 |
| 5.0% | 14.029 | 11.901 | 16.537 |
| 10.0% | 14.166 | 11.726 | 17.114 |
| 20.0% | 14.425 | 10.978 | 18.955 |
| Auto-0.0% | 13.889 | 11.990 | 16.088 |



**Amphipod Acute Toxicity Test-96hr % Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 15:30 | Test ID: | PR1858/10 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 15:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

**Dose-Response Plot**



## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 15:30 | Test ID: | PR1858/10 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 15:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | % Non-immobilised | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 12.5 | | 65.00 | 60.00 | 80.00 | 10.00 | 4.87 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 94.20 | 94.20 | 94.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| 25 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 50 | | 84.10 | 84.10 | 84.10 | 0.00 | 0.00 | 1 |
| 100 | | 79.30 | 79.30 | 79.30 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 25 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 50 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |

## Amphipod Acute Toxicity Test-96hr % Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 15:30 | Test ID: | PR1858/10 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 15:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 108 | Test Species: | AC-Allorchestes compressa |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.6000 | 0.8000 | 0.6000 | 0.6000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

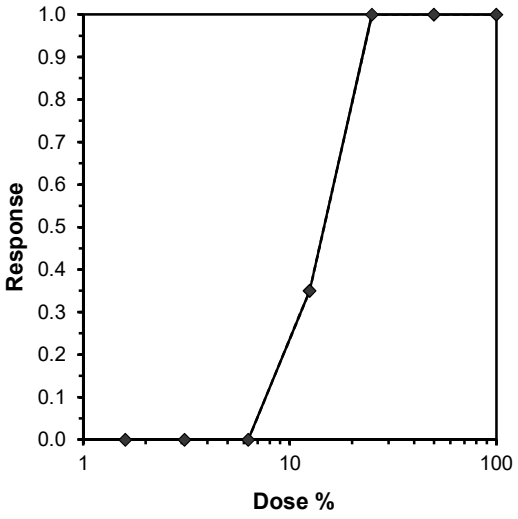
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| *12.5 | 0.6500 | 0.6500 | 0.9413 | 0.8861 | 1.1071 | 11.742 | 4 | 10.00 | 10.00 | 0.6500 | 0.6500 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.508902 | 0.905 | 2.796235 | 11.6732 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 10.430 | 0.113 | 10.233 | 10.922 | 0.6357 |
| IC10 | 11.058 | 0.133 | 10.825 | 11.639 | 0.6380 |
| IC15 | 11.464 | 0.147 | 11.207 | 12.105 | 0.6395 |
| IC20 | 11.779 | 0.158 | 11.503 | 12.467 | 0.6406 |
| IC25 | 12.045 | 0.167 | 11.753 | 12.773 | 0.6416 |
| IC40 | 12.694 | 0.166 | 12.384 | 13.357 | 0.4839 |
| IC50 | 13.069 | 0.163 | 12.764 | 13.721 | 0.4830 |



# Statistical Printouts for the *Nitzschia* Growth Inhibition Tests

## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/11 | Sample ID: | A1-5327 |
| End Date: | 25/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| FSW Control | 16.763 | 15.563 | 16.863 | 14.463 | 15.963 | 14.863 | 16.363 | 16.263 |
| ASW Control | 14.763 | 13.563 | 15.763 | 15.763 | | | | |
| 1.6 | 16.563 | 15.363 | 16.863 | 15.963 | | | | |
| 3.1 | 16.263 | 14.763 | 13.663 | 17.163 | | | | |
| 6.3 | 16.563 | 16.863 | 14.963 | 15.863 | | | | |
| 12.5 | 13.463 | 13.963 | 13.063 | 15.763 | | | | |
| 25 | 5.463 | 0.163 | 0.903 | 2.063 | | | | |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 | | | | |

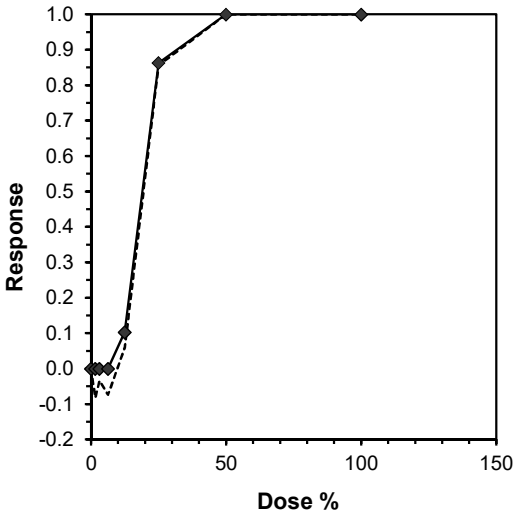
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 15.888 | 1.0618 | 15.888 | 14.463 | 16.863 | 5.464 | 8 | | | | | |
| ASW Control | 14.963 | 1.0000 | 14.963 | 13.563 | 15.763 | 6.988 | 4 | * | | | 15.669 | 1.0000 |
| 1.6 | 16.188 | 1.0819 | 16.188 | 15.363 | 16.863 | 4.109 | 4 | -1.247 | 2.410 | 2.368 | 15.669 | 1.0000 |
| 3.1 | 15.463 | 1.0334 | 15.463 | 13.663 | 17.163 | 10.061 | 4 | -0.509 | 2.410 | 2.368 | 15.669 | 1.0000 |
| 6.3 | 16.063 | 1.0735 | 16.063 | 14.963 | 16.863 | 5.258 | 4 | -1.120 | 2.410 | 2.368 | 15.669 | 1.0000 |
| 12.5 | 14.063 | 0.9399 | 14.063 | 13.063 | 15.763 | 8.474 | 4 | 0.916 | 2.410 | 2.368 | 14.063 | 0.8975 |
| *25 | 2.148 | 0.1435 | 2.148 | 0.163 | 5.463 | 109.152 | 4 | 13.043 | 2.410 | 2.368 | 2.148 | 0.1371 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.958622 | 0.916 | 0.688967 | 0.89182 |
| Bartlett's Test indicates equal variances (p = 0.36) | 5.505599 | 15.08627 | | |
| The control means are not significantly different (p = 0.13) | 1.633112 | 2.228139 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 12.5 | 25 | 17.67767 | 8 | 2.367933 | 0.158256 | 118.5836 | 1.930789 | 1.1E-10 | 5, 18 |

### Linear Interpolation (200 Resamples)

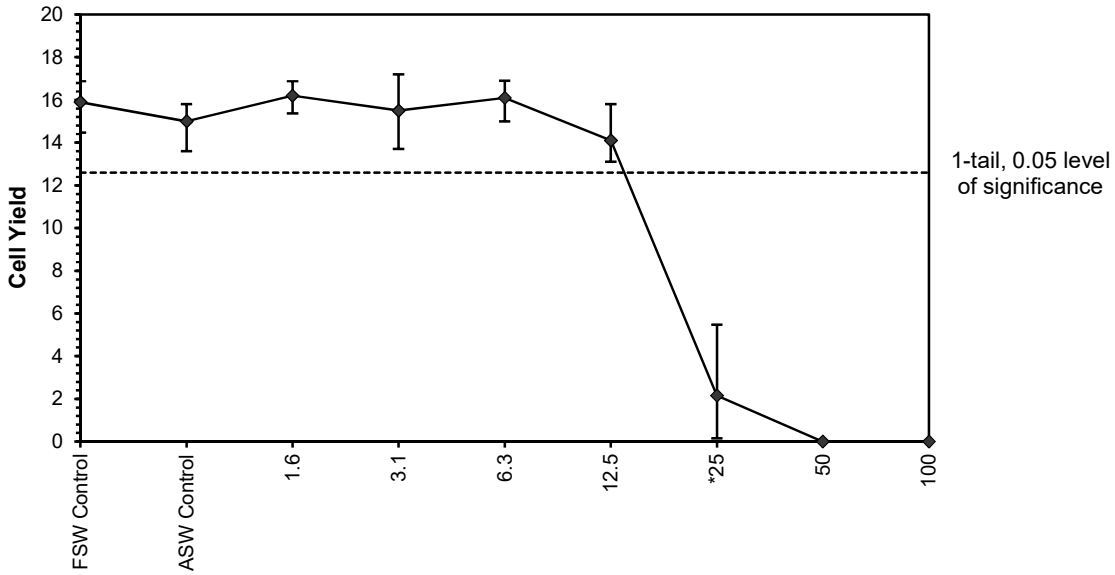
| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 9.324 | 1.595 | 4.966 | 14.219 | -0.7465 |
| IC10 | 12.348 | 1.105 | 8.325 | 13.878 | -0.2383 |
| IC15 | 13.281 | 0.566 | 11.506 | 14.673 | -0.0083 |
| IC20 | 14.103 | 0.510 | 12.737 | 15.539 | 0.5533 |
| IC25 | 14.924 | 0.505 | 13.615 | 16.409 | 0.6795 |
| IC40 | 17.390 | 0.565 | 15.933 | 18.952 | 0.7747 |
| IC50 | 19.034 | 0.654 | 17.457 | 21.013 | 0.7583 |



**Microalgal Cell Yield-Cell Yield**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/11 | Sample ID: | A1-5327 |
| End Date: | 25/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

**Dose-Response Plot**



## Microalgal Cell Yield-Cell Yield

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/11 | Sample ID: | A1-5327 |
| End Date: | 25/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 110 | Test Species: | NC-Nitzschia closterium |
| Comments: | | | | | |

### Auxiliary Data Summary

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | Cell Yield | 15.89 | 14.46 | 16.86 | 0.87 | 5.86 | 8 |
| ASW Control | | 14.96 | 13.56 | 15.76 | 1.05 | 6.83 | 4 |
| 1.6 | | 16.19 | 15.36 | 16.86 | 0.67 | 5.04 | 4 |
| 3.1 | | 15.46 | 13.66 | 17.16 | 1.56 | 8.07 | 4 |
| 6.3 | | 16.06 | 14.96 | 16.86 | 0.84 | 5.72 | 4 |
| 12.5 | | 14.06 | 13.06 | 15.76 | 1.19 | 7.76 | 4 |
| 25 | | 2.15 | 0.16 | 5.46 | 2.34 | 71.29 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 25 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 50 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the Acute *Hormosira* Cell Germination Test

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 13:30 | Test ID: | PR1858/07 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 13:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9700 | 0.9800 |
| ASW Control | 0.9400 | 0.9900 | 0.9600 | 0.9900 |
| 1.6 | 0.9800 | 0.9600 | 0.9800 | 0.9700 |
| 3.1 | 0.9600 | 0.9800 | 0.9500 | 0.9700 |
| 6.3 | 0.9900 | 0.9600 | 1.0000 | 0.9800 |
| 12.5 | 0.8100 | 0.9300 | 0.8900 | 0.9200 |
| 25 | 0.0400 | 0.0600 | 0.1000 | 0.0200 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

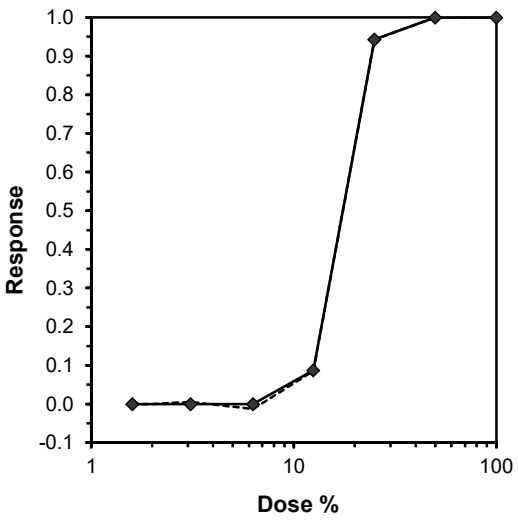
| | | | Transform: Arcsin Square Root | | | | | | 1-Tailed | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Resp | Number |
| FSW Control | 0.9725 | 1.0026 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | | | | | |
| ASW Control | 0.9700 | 1.0000 | 1.4085 | 1.3233 | 1.4706 | 5.265 | 4 | * | | | 12 | 400 |
| 1.6 | 0.9725 | 1.0026 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | 0.056 | 2.410 | 0.1084 | 11 | 400 |
| 3.1 | 0.9650 | 0.9948 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | 0.521 | 2.410 | 0.1084 | 14 | 400 |
| 6.3 | 0.9825 | 1.0129 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | -0.866 | 2.410 | 0.1084 | 7 | 400 |
| *12.5 | 0.8875 | 0.9149 | 1.2349 | 1.1198 | 1.3030 | 6.664 | 4 | 3.861 | 2.410 | 0.1084 | 45 | 400 |
| *25 | 0.0550 | 0.0567 | 0.2281 | 0.1419 | 0.3218 | 33.281 | 4 | 26.248 | 2.410 | 0.1084 | 378 | 400 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 400 | 400 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.968111 | 0.916 | -0.31998 | -0.64273 |
| Bartlett's Test indicates equal variances (p = 0.54) | 4.080333 | 15.08627 | | |
| The control means are not significantly different (p = 0.95) | 0.063348 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.045383 | 0.0466 | 0.900647 | 0.004045 | 1.6E-15 | 5, 18 |

### Trimmed Spearman-Karber

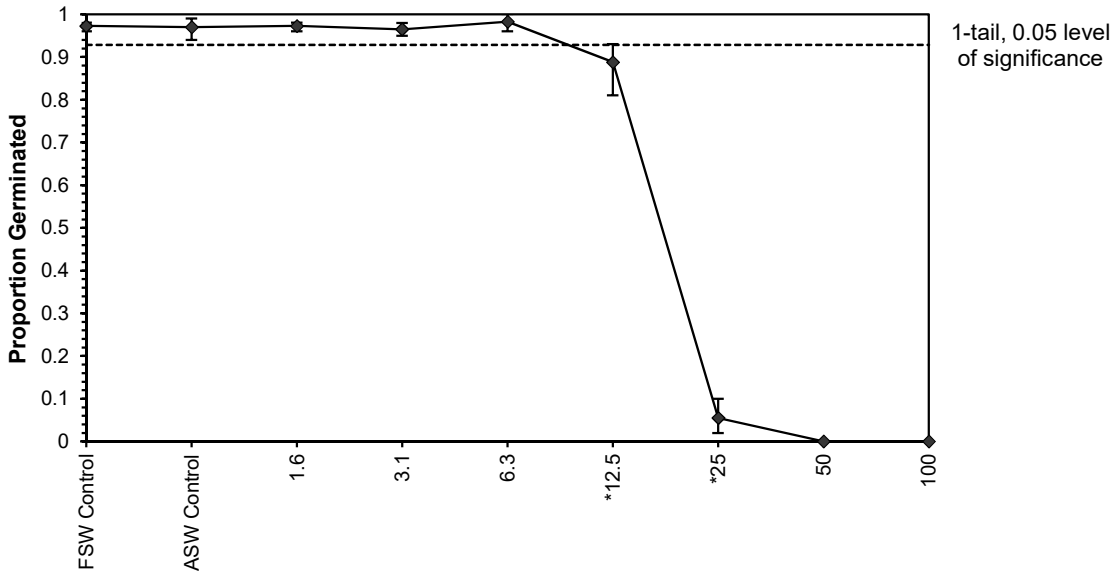
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 17.310 | 16.879 | 17.752 |
| 5.0% | 17.368 | 17.005 | 17.738 |
| 10.0% | 17.458 | 17.200 | 17.720 |
| 20.0% | 17.458 | 17.200 | 17.720 |
| Auto-0.0% | 17.310 | 16.879 | 17.752 |



**Macroalgal Germination Success Test-Proportion Germinated**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 13:30 | Test ID: | PR1858/07 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 13:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

**Dose-Response Plot**



## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 13:30 | Test ID: | PR1858/07 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 13:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| | | Auxiliary Data Summary | | | | | |
|---|---|---|---|---|---|---|---|
| **Conc-%** | **Parameter** | **Mean** | **Min** | **Max** | **SD** | **CV%** | **N** |
| FSW Control | Germination, % | 97.25 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| ASW Control | | 97.00 | 94.00 | 99.00 | 2.45 | 1.61 | 4 |
| 1.6 | | 97.25 | 96.00 | 98.00 | 0.96 | 1.01 | 4 |
| 3.1 | | 96.50 | 95.00 | 98.00 | 1.29 | 1.18 | 4 |
| 6.3 | | 98.25 | 96.00 | 100.00 | 1.71 | 1.33 | 4 |
| 12.5 | | 88.75 | 81.00 | 93.00 | 5.44 | 2.63 | 4 |
| 25 | | 5.50 | 2.00 | 10.00 | 3.42 | 33.60 | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.80 | 7.80 | 7.80 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.50 | 35.50 | 35.50 | 0.00 | 0.00 | 1 |
| 1.6 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 3.1 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 6.3 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 12.5 | | 35.90 | 35.90 | 35.90 | 0.00 | 0.00 | 1 |
| 25 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 50 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| ASW Control | | 97.60 | 97.60 | 97.60 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.50 | 99.50 | 99.50 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.70 | 99.70 | 99.70 | 0.00 | 0.00 | 1 |
| 6.3 | | 99.10 | 99.10 | 99.10 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 25 | | 98.90 | 98.90 | 98.90 | 0.00 | 0.00 | 1 |
| 50 | | 84.60 | 84.60 | 84.60 | 0.00 | 0.00 | 1 |
| 100 | | 80.20 | 80.20 | 80.20 | 0.00 | 0.00 | 1 |

## Macroalgal Germination Success Test-Proportion Germinated

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 10/10/2019 13:30 | Test ID: | PR1858/07 | Sample ID: | A1-5327 |
| End Date: | 13/10/2019 13:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 116 | Test Species: | HB-Hormosira banksii |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 0.9800 | 0.9600 | 0.9700 | 0.9800 |
| ASW Control | 0.9400 | 0.9900 | 0.9600 | 0.9900 |
| 1.6 | 0.9800 | 0.9600 | 0.9800 | 0.9700 |
| 3.1 | 0.9600 | 0.9800 | 0.9500 | 0.9700 |
| 6.3 | 0.9900 | 0.9600 | 1.0000 | 0.9800 |
| 12.5 | 0.8100 | 0.9300 | 0.8900 | 0.9200 |
| 25 | 0.0400 | 0.0600 | 0.1000 | 0.0200 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

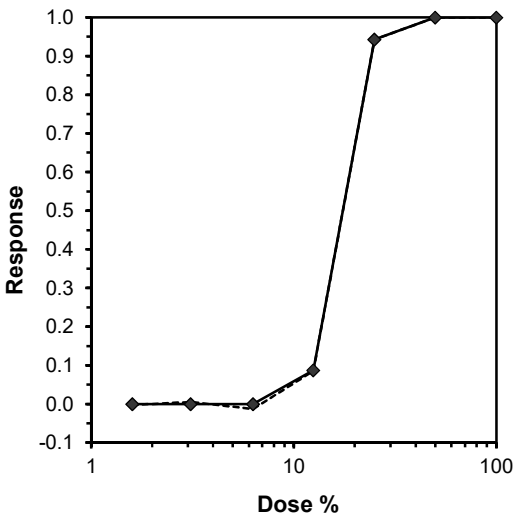
| | | | Transform: Arcsin Square Root | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 0.9725 | 1.0026 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | | | | | |
| ASW Control | 0.9700 | 1.0000 | 1.4085 | 1.3233 | 1.4706 | 5.265 | 4 | * | | | 0.9725 | 1.0000 |
| 1.6 | 0.9725 | 1.0026 | 1.4060 | 1.3694 | 1.4289 | 2.042 | 4 | 0.056 | 2.410 | 0.1084 | 0.9725 | 1.0000 |
| 3.1 | 0.9650 | 0.9948 | 1.3851 | 1.3453 | 1.4289 | 2.598 | 4 | 0.521 | 2.410 | 0.1084 | 0.9725 | 1.0000 |
| 6.3 | 0.9825 | 1.0129 | 1.4474 | 1.3694 | 1.5208 | 4.432 | 4 | -0.866 | 2.410 | 0.1084 | 0.9725 | 1.0000 |
| *12.5 | 0.8875 | 0.9149 | 1.2349 | 1.1198 | 1.3030 | 6.664 | 4 | 3.861 | 2.410 | 0.1084 | 0.8875 | 0.9126 |
| *25 | 0.0550 | 0.0567 | 0.2281 | 0.1419 | 0.3218 | 33.281 | 4 | 26.248 | 2.410 | 0.1084 | 0.0550 | 0.0566 |
| 50 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0500 | 0.0500 | 0.0500 | 0.000 | 4 | | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.968111 | 0.916 | -0.31998 | -0.64273 |
| Bartlett's Test indicates equal variances (p = 0.54) | 4.080333 | 15.08627 | | |
| The control means are not significantly different (p = 0.95) | 0.063348 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 6.3 | 12.5 | 8.87412 | 15.87302 | 0.045383 | 0.0466 | 0.900647 | 0.004045 | 1.6E-15 | 5, 18 |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 10.315 | 0.942 | 8.232 | 13.852 | 0.6791 |
| IC10 | 12.713 | 0.646 | 10.172 | 13.857 | -0.5679 |
| IC15 | 13.439 | 0.429 | 12.141 | 14.574 | -0.0023 |
| IC20 | 14.045 | 0.418 | 12.790 | 15.220 | 0.0216 |
| IC25 | 14.581 | 0.411 | 13.300 | 15.724 | 0.0335 |
| IC40 | 16.004 | 0.408 | 14.639 | 17.152 | 0.0041 |
| IC50 | 16.918 | 0.421 | 15.586 | 18.171 | -0.0635 |



# Statistical Printouts for the Larval Fish Imbalance Tests

## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 16:00 | Test ID: | PR1858/14 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 14:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.6000 | 0.4000 | 0.8000 | 0.8000 |
| 12.5 | 0.2000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| *6.3 | 0.6500 | 0.6500 | 0.9463 | 0.6847 | 1.1071 | 21.467 | 4 | 10.00 | 10.00 | 7 | 20 |
| *12.5 | 0.0500 | 0.0500 | 0.2850 | 0.2255 | 0.4636 | 41.771 | 4 | 10.00 | 10.00 | 19 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

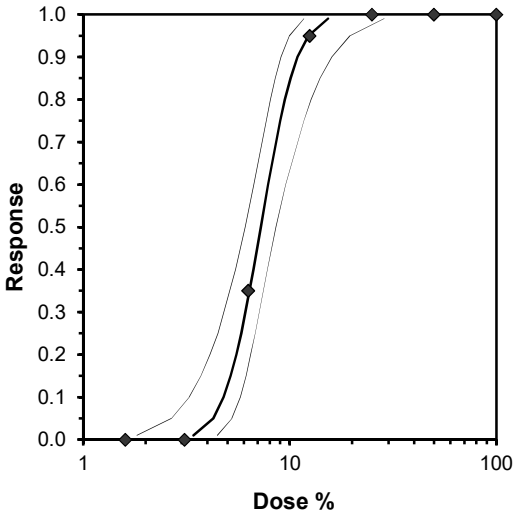
| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.772021 | 0.905 | -0.337 | 3.142347 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 3.1 | 6.3 | 4.419276 | 32.25806 |
| Treatments vs ASW Control | | | | |

### Maximum Likelihood-Probit

| Parameter | Value | SE | 95% Fiducial Limits | | Control | Chi-Sq | Critical | P-value | Mu | Sigma | Iter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope | 7.171209 | 1.622143 | 3.991809 | 10.35061 | 0 | 0.124313 | 11.0705 | 1 | 0.858989 | 0.139447 | 4 |
| Intercept | -1.15999 | 1.415627 | -3.93462 | 1.614642 | | | | | | | |
| TSCR | | | | | | | | | | | |

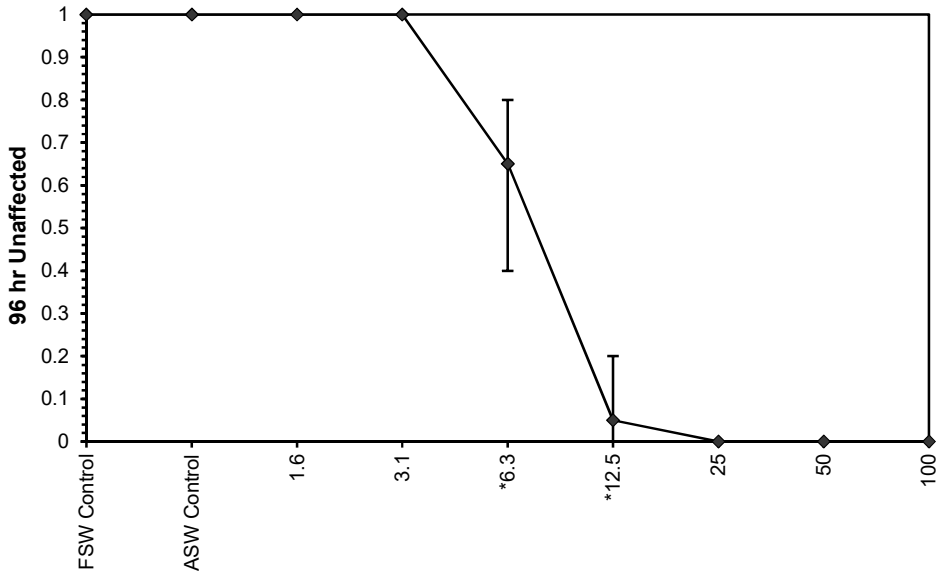
| Point | Probits | % | 95% Fiducial Limits | |
|---|---|---|---|---|
| EC01 | 2.674 | 3.424425 | 1.823373 | 4.459235 |
| EC05 | 3.355 | 4.262061 | 2.668168 | 5.253962 |
| EC10 | 3.718 | 4.789397 | 3.255165 | 5.757561 |
| EC15 | 3.964 | 5.181574 | 3.711936 | 6.141831 |
| EC20 | 4.158 | 5.516042 | 4.110225 | 6.481224 |
| EC25 | 4.326 | 5.820141 | 4.475316 | 6.80322 |
| EC40 | 4.747 | 6.662855 | 5.467963 | 7.796544 |
| EC50 | 5.000 | 7.22751 | 6.086886 | 8.575823 |
| EC60 | 5.253 | 7.840019 | 6.697982 | 9.542679 |
| EC75 | 5.674 | 8.975196 | 7.679833 | 11.65338 |
| EC80 | 5.842 | 9.469998 | 8.062462 | 12.68679 |
| EC85 | 6.036 | 10.08128 | 8.508998 | 14.04641 |
| EC90 | 6.282 | 10.90678 | 9.077873 | 16.01571 |
| EC95 | 6.645 | 12.25626 | 9.949011 | 19.53719 |
| EC99 | 7.326 | 15.25421 | 11.72327 | 28.58626 |



**Fish Imbalance Test-96 hr Unaffected**

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 16:00 | Test ID: | PR1858/14 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 14:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Dose-Response Plot**



## Fish Imbalance Test-96 hr Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 16:00 | Test ID: | PR1858/14 | Sample ID: | A1-5327 |
| End Date: | 26/10/2019 14:00 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 112 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % unaffected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 65.00 | 40.00 | 80.00 | 19.15 | 6.73 | 4 |
| 12.5 | | 5.00 | 0.00 | 20.00 | 10.00 | 63.25 | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity ppt | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 25 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 50 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | DO % | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 94.20 | 94.20 | 94.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| 25 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 50 | | 84.10 | 84.10 | 84.10 | 0.00 | 0.00 | 1 |
| 100 | | 79.30 | 79.30 | 79.30 | 0.00 | 0.00 | 1 |

# Statistical Printouts for the 7-d Larval Fish Growth Inhibition Tests

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

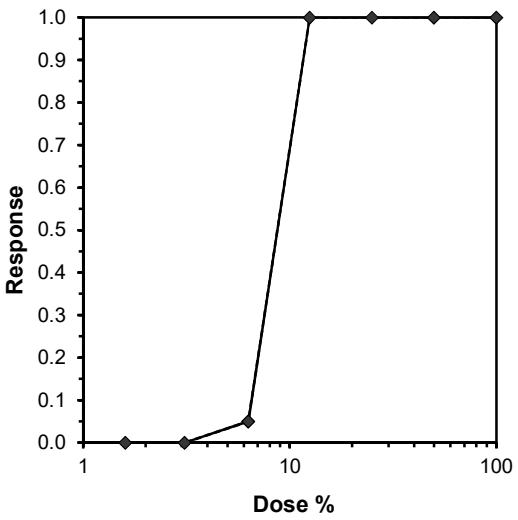
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Number | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Resp | Number |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 0 | 20 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 0 | 20 |
| 6.3 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 1 | 20 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 20 | 20 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.564851 | 0.887 | -2.55551 | 9.368132 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Trimmed Spearman-Karber

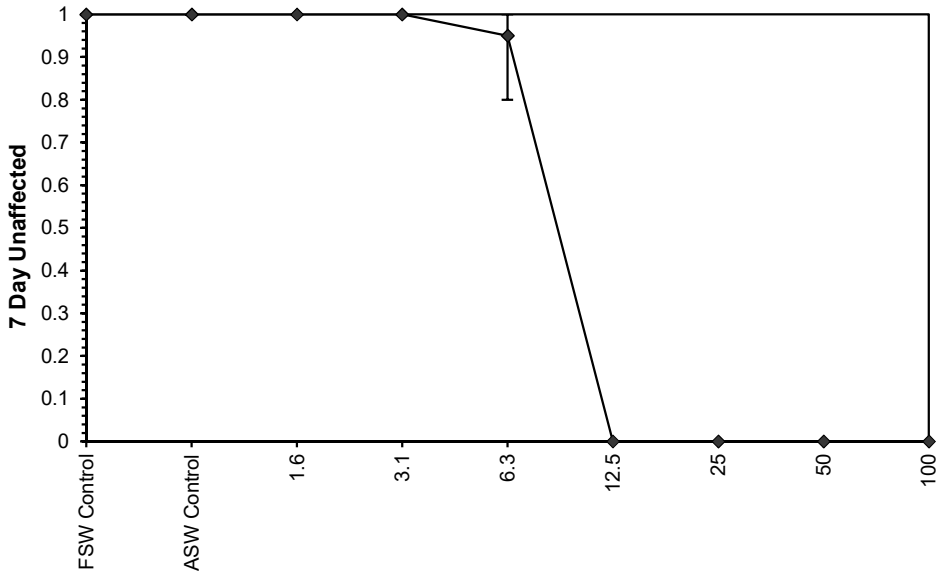
| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 8.5701 | 8.0071 | 9.1727 |
| 5.0% | 8.7155 | 8.3990 | 9.0440 |
| 10.0% | 8.7155 | 8.3990 | 9.0440 |
| 20.0% | 8.7155 | 8.3990 | 9.0440 |
| Auto-0.0% | 8.5701 | 8.0071 | 9.1727 |



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

### Dose-Response Plot



## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

**Auxiliary Data Summary**

| Conc-% | Parameter | Mean | Min | Max | SD | CV% | N |
|---|---|---|---|---|---|---|---|
| FSW Control | % Un-affected | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| ASW Control | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 1.6 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 3.1 | | 100.00 | 100.00 | 100.00 | 0.00 | 0.00 | 4 |
| 6.3 | | 95.00 | 80.00 | 100.00 | 10.00 | 3.33 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | Biomass | 23.06 | 22.16 | 24.14 | 0.82 | 3.92 | 4 |
| ASW Control | | 22.62 | 21.74 | 23.26 | 0.70 | 3.69 | 4 |
| 1.6 | | 23.38 | 21.24 | 26.14 | 2.04 | 6.10 | 4 |
| 3.1 | | 20.64 | 20.12 | 21.56 | 0.63 | 3.85 | 4 |
| 6.3 | | 18.72 | 16.02 | 19.94 | 1.86 | 7.28 | 4 |
| 12.5 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 25 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 50 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| 100 | | 0.00 | 0.00 | 0.00 | 0.00 | | 4 |
| FSW Control | pH | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 8.10 | 8.10 | 8.10 | 0.00 | 0.00 | 1 |
| 1.6 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 3.1 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 12.5 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 25 | | 8.20 | 8.20 | 8.20 | 0.00 | 0.00 | 1 |
| 50 | | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 | 1 |
| 100 | | 7.70 | 7.70 | 7.70 | 0.00 | 0.00 | 1 |
| FSW Control | Salinity | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| ASW Control | | 35.70 | 35.70 | 35.70 | 0.00 | 0.00 | 1 |
| 1.6 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 3.1 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 6.3 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 25 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 50 | | 36.00 | 36.00 | 36.00 | 0.00 | 0.00 | 1 |
| 100 | | 35.80 | 35.80 | 35.80 | 0.00 | 0.00 | 1 |
| FSW Control | % DO | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| ASW Control | | 94.20 | 94.20 | 94.20 | 0.00 | 0.00 | 1 |
| 1.6 | | 99.60 | 99.60 | 99.60 | 0.00 | 0.00 | 1 |
| 3.1 | | 99.20 | 99.20 | 99.20 | 0.00 | 0.00 | 1 |
| 6.3 | | 98.00 | 98.00 | 98.00 | 0.00 | 0.00 | 1 |
| 12.5 | | 99.30 | 99.30 | 99.30 | 0.00 | 0.00 | 1 |
| 25 | | 98.60 | 98.60 | 98.60 | 0.00 | 0.00 | 1 |
| 50 | | 84.10 | 84.10 | 84.10 | 0.00 | 0.00 | 1 |
| 100 | | 79.30 | 79.30 | 79.30 | 0.00 | 0.00 | 1 |

## Fish Growth Test-7 Day Unaffected

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| ASW Control | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.3 | 0.8000 | 1.0000 | 1.0000 | 1.0000 |
| 12.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

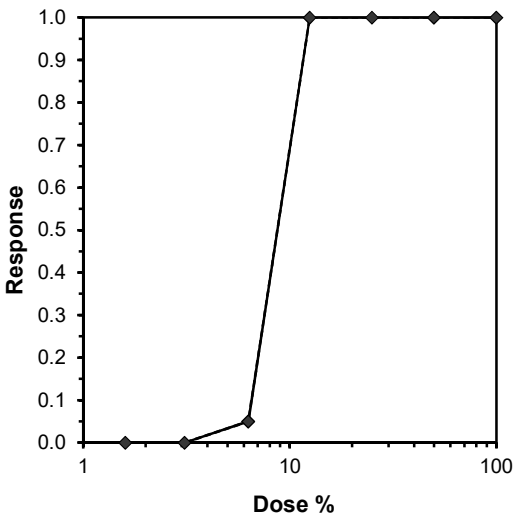
| | | | Transform: Arcsin Square Root | | | | | Rank | 1-Tailed | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | Sum | Critical | Mean | N-Mean |
| FSW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | | | | |
| ASW Control | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | * | | 1.0000 | 1.0000 |
| 1.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 3.1 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 4 | 18.00 | 10.00 | 1.0000 | 1.0000 |
| 6.3 | 0.9500 | 0.9500 | 1.2857 | 1.1071 | 1.3453 | 9.261 | 4 | 16.00 | 10.00 | 0.9500 | 0.9500 |
| 12.5 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 4 | | | 0.0000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05) | 0.564851 | 0.887 | -2.55551 | 9.368132 |
| Equality of variance cannot be confirmed | | | | |
| The control means are not significantly different (p = 1.00) | 0 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Steel's Many-One Rank Test | 6.3 | 12.5 | 8.87412 | 15.87302 |
| Treatments vs ASW Control | | | | |

### Log-Logit Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 6.3000 | 0.9048 | 5.2589 | 9.0169 | 0.6816 |
| IC10 | 6.5812 | 0.8405 | 5.7217 | 9.2117 | 0.7437 |
| IC15 | 6.7607 | 0.8178 | 6.0236 | 9.3337 | 0.7586 |
| IC20 | 6.8986 | 0.8037 | 6.1716 | 9.4262 | 0.7579 |
| IC25 | 7.0144 | 0.7916 | 6.2962 | 9.5031 | 0.7574 |
| IC40 | 7.3004 | 0.7606 | 6.6052 | 9.6898 | 0.7560 |
| IC50 | 7.4724 | 0.7414 | 6.7920 | 9.8001 | 0.7552 |



## Fish Growth Test-7 day Biomass

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 22/10/2019 14:30 | Test ID: | PR1858/15 | Sample ID: | A1-5327 |
| End Date: | 29/10/2019 14:30 | Lab ID: | 9262 | Sample Type: | PFW-Produced Formation Water |
| Sample Date: | | Protocol: | ESA 122 | Test Species: | LT-Lates calcarifer |
| Comments: | | | | | |

| Conc-% | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| FSW Control | 24.140 | 23.000 | 22.940 | 22.160 |
| ASW Control | 23.080 | 23.260 | 21.740 | 22.380 |
| 1.6 | 26.140 | 22.940 | 23.180 | 21.240 |
| 3.1 | 20.120 | 21.560 | 20.460 | 20.420 |
| 6.3 | 16.020 | 18.960 | 19.940 | 19.940 |
| 12.5 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.000 | 0.000 | 0.000 |

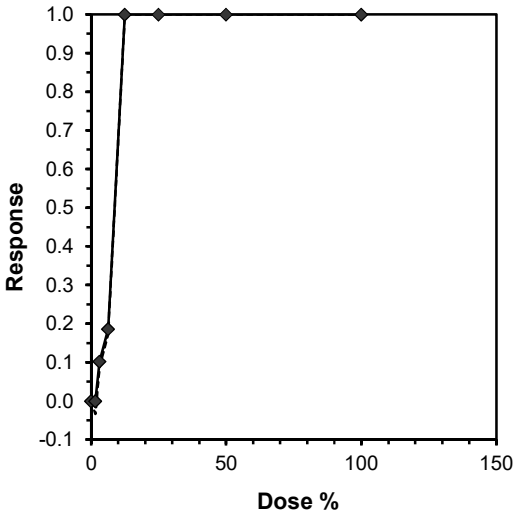
| | | | Transform: Untransformed | | | | | 1-Tailed | | | Isotonic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conc-% | Mean | N-Mean | Mean | Min | Max | CV% | N | t-Stat | Critical | MSD | Mean | N-Mean |
| FSW Control | 23.060 | 1.0197 | 23.060 | 22.160 | 24.140 | 3.536 | 4 | | | | | |
| ASW Control | 22.615 | 1.0000 | 22.615 | 21.740 | 23.260 | 3.077 | 4 | * | | | 22.995 | 1.0000 |
| 1.6 | 23.375 | 1.0336 | 23.375 | 21.240 | 26.140 | 8.708 | 4 | -0.739 | 2.290 | 2.356 | 22.995 | 1.0000 |
| 3.1 | 20.640 | 0.9127 | 20.640 | 20.120 | 21.560 | 3.061 | 4 | 1.920 | 2.290 | 2.356 | 20.640 | 0.8976 |
| *6.3 | 18.715 | 0.8275 | 18.715 | 16.020 | 19.940 | 9.912 | 4 | 3.791 | 2.290 | 2.356 | 18.715 | 0.8139 |
| 12.5 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 25 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 50 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |
| 100 | 0.000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | 4 | | | | 0.000 | 0.0000 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates normal distribution (p > 0.05) | 0.956336 | 0.887 | -0.14716 | 1.088529 |
| Bartlett's Test indicates equal variances (p = 0.16) | 5.23149 | 11.34487 | | |
| The control means are not significantly different (p = 0.44) | 0.83023 | 2.446912 | | |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU | MSDu | MSDp | MSB | MSE | F-Prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| Dunnett's Test<br>Treatments vs ASW Control | 3.1 | 6.3 | 4.419276 | 32.25806 | 2.356109 | 0.104183 | 17.52989 | 2.117142 | 0.002973 | 3, 12 |

### Linear Interpolation (200 Resamples)

| Point | % | SD | 95% CL(Exp) | | Skew |
|---|---|---|---|---|---|
| IC05 | 2.3323 | 0.1792 | 1.8219 | 2.8954 | 0.3291 |
| IC10 | 3.0646 | 0.5357 | 2.4006 | 5.9172 | 1.6593 |
| IC15 | 4.9190 | 0.9476 | 2.4558 | 7.4254 | 0.0603 |
| IC20 | 6.4057 | 0.5624 | 3.8844 | 7.0995 | -1.1757 |
| IC25 | 6.7866 | 0.3070 | 5.6365 | 7.4370 | -1.1526 |
| IC40 | 7.9293 | 0.2191 | 7.1906 | 8.4496 | -0.5149 |
| IC50 | 8.6910 | 0.1826 | 8.0755 | 9.1247 | -0.5149 |



# Appendix C

## RPS 2017 Plume Modelling Report

RPS

# YOLLA PLATFORM – BASS STRAIT
## *Produced Water Dispersion Near-Field Modelling*

*Prepared for* ***Lattice Energy***

**28 NOVEMBER 2017**

Prepared by:

**RPS**

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Report Number: MAQ0573J
Version / Date: Rev 1 | 28/11/2017

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## Document Status

| Version | Purpose of Document | Orig | Review | Review Date |
|---|---|---|---|---|
| Rev A | Draft for internal review | Nathan Benfer | Ryan Dunn | 15/11/2017 |
| Rev 0 | Draft issued to client | | Nathan Benfer | 17/11/2017 |
| Rev 1 | Issued to client | | Nathan Benfer | 28/11/2017 |

## Approval for Issue

| Name | Signature | Date |
|---|---|---|
| Nathan Benfer | | 28/11/2017 |
| Ben Leitinger - BassGas Senior Operations Engineer | | 4/12/2017 |
| Kamran Zaheer - Engineering, Reliability & Maintenance Manager | | 11/12/2017 |

# Contents

**EXECUTIVE SUMMARY** ..... **1**
**Background** ..... **1**
**Key Findings** ..... **1**
Near-field Modelling ..... 1
**1.0 INTRODUCTION** ..... **2**
**1.1 Scope of work** ..... **2**
**2.0 DISCHARGE CHARACTERISTICS** ..... **4**
**2.1 Produced Water Contaminants Assessed** ..... **4**
**3.0 CURRENTS** ..... **6**
**3.1 Tidal Currents** ..... **8**
3.1.1 Grid Setup ..... 8
3.1.2 Tidal Conditions ..... 10
3.1.3 Surface Elevation Validation ..... 10
**3.2 Ocean Currents** ..... **14**
**4.0 MODELLING METHODS** ..... **18**
**4.1 Description of Models** ..... **18**
4.1.1 Near-Field Model ..... 18
**4.2 Near-Field Model Setup** ..... **18**
4.2.1 Ambient Environmental Conditions ..... 18
**5.0 RESULTS** ..... **20**
**5.1 Near-Field Modelling Results** ..... **20**
**6.0 REFERENCES** ..... **4**

# Tables

Table 1 Location of the release site used for the dispersion modelling assessment. ....2
Table 2 Summary of the modelled discharge parameters used to simulate the discharges at Yolla. ....4
Table 3 Summary of produced water contaminants and trigger values ....5
Table 4 Statistical comparison between the observed and HYDROMAP predicted surface elevations. ....11
Table 5 Seasonal temperature and salinity profile adjacent at the release site. ....19
Table 6 Adopted ambient current conditions. ....19
Table 7 Maximum horizontal distance from the discharge point that centreline dilution (X:1) was predicted to travel. ....1

# Figures

Figure 1 Location of the Yolla Platform used in the dispersion modelling study. ....3
Figure 2 HYCOM averaged seasonal surface drift currents during summer and winter. ....7
Figure 3 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh. ....9
Figure 4 Bathymetry defined throughout the tidal model domain. ....9
Figure 5 Location of the tide stations used in the surface elevation validation. ....11
Figure 6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image). ....12
Figure 7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image). ....13
Figure 8 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and sholas. Colourations of individual vectors indicate current speed. ....14
Figure 9 Modelled surface ocean currents presented for the 1st May 2012. Derived from the HYCOM ocean hindcast model. The colours of the vectors indicate current speed in m/s. ....15
Figure 10 Monthly surface current rose plots nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination. ....16
Figure 11 Modelled total surface current rose plot nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination. ....17
Figure 12 Plume depth versus distance for Case 1 Design Operation (100 $m^3$/day flow) for summer and winter under low and high current flow conditions. ....2
Figure 13 Plume depth versus distance for Case 2 Typical Operation (200 $m^3$/day flow) for summer and winter under low and high current flow conditions. ....2
Figure 14 Plume depth versus distance for Case 3 Worst-Case Operation (300 $m^3$/day flow) for summer and winter under low and high current flow conditions. ....3

# Executive Summary

## Background

Lattice Energy Pty Ltd (Lattice) operates the Yolla Platform which is located within the production license T/L1 and is approximately 100 km offshore from mainland Victoria in the Bass Strait.

As part of Lattice's due diligence, they have commissioned RPS to assess the fate of produced water (PW) being operationally discharged from the Yolla Platform. Recent debottlenecking upgrades to the produced water system has increase the maximum discharge rate, therefore Lattice requested RPS to assess a range of operational states; i) Design, ii) Typical and iii) Worst Case.

The rates of discharge for these three cases were 100 $m^3$/day, 200 $m^3$/day and 300 $m^3$/day, which represented the original PW design flow rate, expected operation post-debottlenecking, and worst-case (end of field life, large amounts of PW production) operation scenarios, respectively. All scenarios were modelled as single port discharge through the bottom of the discharge caisson.

## Methodology

The modelling study was carried out by firstly generating a high resolution vertical current profile for the study area, which included the combined influence of ocean and tidal currents. Secondly, the vertical profiles for typical seasonal salinity and temperature profiles were obtained from the World Ocean Atlas. Finally, a near-field discharge model (CORMIX) was used to assess the rate of dilution (defined as the ratio of the initial concentration (at the discharge port) to the concentration at a given location based on the centreline of the plume) of the plume under static low and high current speeds for each of the three model scenarios under summer and winter conditions.

## Key Findings

### Near-field Modelling

- The furthest distance for any plume to reach 1000:1 dilution was 70 m, for Case 3 – Worst Case Operation scenario (300 $m^3$/day) under summer conditions with high current speeds.
- Plumes released during summer conditions required a greater distance before reaching 1,000:1 dilution, in comparison to plumes released during winter.
- Plumes released during low current speed conditions rose higher in the water column and travelled less horizontally than plumes released in high current speed conditions for all three flow rates modelled under summer and winter conditions.

# 1.0 Introduction

Lattice Energy Pty Ltd (Lattice) operates the Yolla Platform which is located within the production license T/L1 and is approximately 100 km offshore from mainland Victoria in the Bass Strait.

As part of Lattice's due diligence, they have commissioned RPS to assess the fate of produced water (PW) being operationally discharged from the Yolla Platform. Recent debottlenecking upgrades to the produced water system has increase the maximum discharge rate, therefore Lattice requested RPS to assess a range of operational states; i) Design, ii) Typical and iii) Worst Case.

The rates of discharge for these three cases were 100 $m^3$/day, 200 $m^3$/day and 300 $m^3$/day, which represented the original PW design flow rate, expected operation post-debottlenecking, and worst-case (end of field life, large amounts of PW production) operation scenarios, respectively. All scenarios were modelled as single port discharge through the bottom of the discharge caisson.

**Table 1 Location of the release site used for the dispersion modelling assessment.**

| Release Site | Latitude | Longitude | Water Depth (m) |
|---|---|---|---|
| Yolla Platform | 39° 50' 39.5" S | 145° 49' 5.9" E | 80 |

## 1.1 Scope of work

The physical mixing of the PW stream can be separated into two distinct zones: (a) near-field; and (b) far-field. The limits of the near-field zone are defined by the area where the levels of mixing and dilution are controlled by the plume's initial jet momentum and the buoyancy flux, resulting from the density difference. When the plume encounters a boundary such as the water surface, or loses its buoyancy, the near-field mixing is complete, and the far-field mixing begins.

Therefore, to accurately determine the dilution of the discharge and the mixing zones, the effect of near-field dynamics need to be considered first.

The scope of work included the following components:

1. Generate a 5-year 3-dimensional current data set (2012-2016) that included the combined influence of ocean and tidal currents;
2. Generate seasonal vertical profiles of salinity and water temperature at the release site; and
3. Simulate the near field-mixing and dilution zone using the three-dimensional near-field model (CORMIX) under static low and high current speeds for each of the three model scenarios under summer and winter conditions.

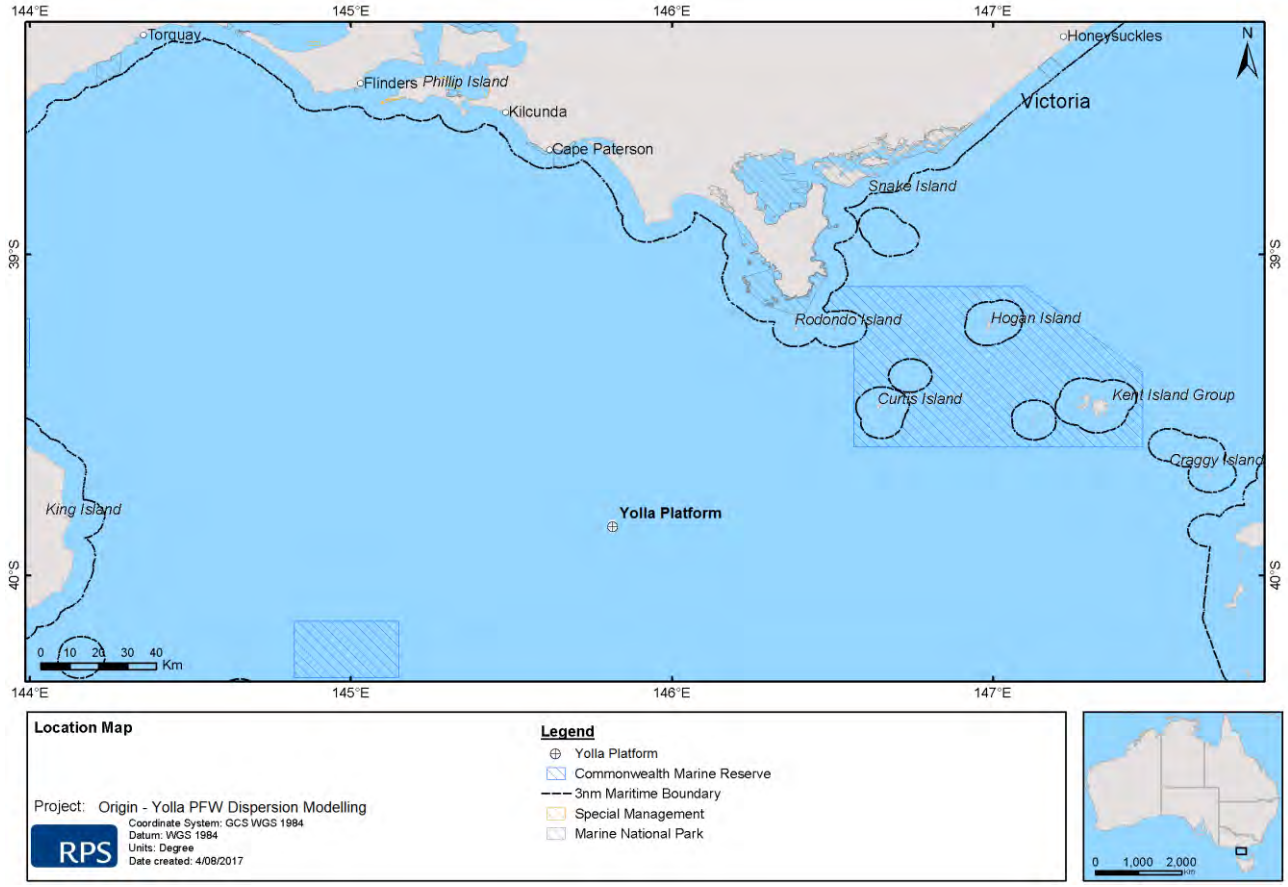


**Figure 1 Location of the Yolla Platform used in the dispersion modelling study.**

# 2.0 Discharge Characteristics

The PW stream, consists of both PW and water of condensation, is discharged vertically downwards through a discharge caisson at a depth of 45 meters below mean sea level (MSL). The depth of the surrounding water is approximately 80 m.

The PW discharge properties, are summarised in Table 2. The PW plume is slightly hotter (1°C above ambient at 45 m below MSL) and less saline than the receiving waters, resulting in a positively buoyant plume.

**Table 2 Summary of the modelled discharge parameters used to simulate the discharges at Yolla.**

| Component | Design Operation | Typical Operation | Worst Case Operation |
|---|---|---|---|
| Flow rate ($m^3/d$) | 100 | 200 | 300 |
| Temperature (°C) | 13.784 – 16.760 | 13.784 – 16.760 | 13.784 – 16.760 |
| Salinity (PSU) | 0.14 | 11.9 | 14.7 |
| Diameter of discharge pipe (m) | 0.73 | | |
| Depth of discharge (m) | 45 | | |
| Pipe orientation | Downward | | |

## 2.1 Produced Water Contaminants Assessed

Lattice has provided a list of measured contaminant levels and trigger values for 99% species protection (Table 3), which were adopted as part of this study.

As shown, the majority of the contaminants require a dilution factor of less than 75.

Contaminants of concern include mercury, phenol, glycol and oil and petroleum hydrocarbons, all of which require dilutions greater than 100 to reach the 99% species protection.

For conservatism the discharge was assessed to a maximum dilution of 1000:1.

**Table 3 Summary of produced water contaminants and trigger values**

| Component | Max recorded produced water concentration (µg/L) | 99% Species protection trigger value (µg/L) | Required dilution factor to achieve 99% trigger value |
|---|---|---|---|
| Aluminium | 3,200 | 27* | 119 |
| Arsenic | BD | 1 | - |
| Boron | 3,400 | 90* | 38 |
| Barium | 13,000 | NL | - |
| Chromium | 1 | 0.14 | 7.1 |
| Iron | 4,300 | ID | - |
| Lead | BD | 1 | - |
| Mercury | 29 | 0.1 | 290 |
| Manganese | 30 | 1200* | NR (<1) |
| Molydenum | 1 | ID | - |
| Nickel | 10 | 7 | 1.4 |
| Selenium | 1 | 5* | NR (<1) |
| Strontium | 810 | NL | - |
| Zinc | 90 | 7 | 12.9 |
| Benzene | 12,000 | 500 | 24 |
| Toluene | 14,000 | 110* | 127 |
| Ethylbenzene | 450 | 50* | 90 |
| o-Xylene | 1,600 | 200* | 8 |
| m&p-Xylene | 5,200 | 50* | 104 |
| Napthalene | 1,000 | 50 | 20 |
| Phenol | 64,000 | 270 | 237 |
| Cresols | 75,000 | NL | - |
| 2,4-Dimethyl Phenol | 8,700 | NL | - |
| Oil & Petroleum Hydrocarbons | <30,000 (current discharge limit) | 70 | 428 |
| Glycol | 2 vol% (20,000,000 µg/L) | 50,000^ | 400 |

^ = Guideline for working limits only, insufficient data to determine level of species protection
* = Taken from data for 99% species protection in fresh water systems ANZECC
BD = Historical testing shows these contaminants are below the limit of detection of 0.001 mg/L
ID = Insufficient data to determine a trigger value for marine or freshwater environment
NL = Component not listed in ANZECC guidelines
NR = Dilution not required, below ANZECC guideline concentration at point of discharge

# 3.0 Currents

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area off the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the straight are driven by tides, winds, incident continental shelf waves and density driven flows. High winds and strong tidal currents are frequent within the area (Jones, 1980).

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 2 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with surface tidal currents developed by RPS. The following sections provide a summary of the hybrid regional data set.

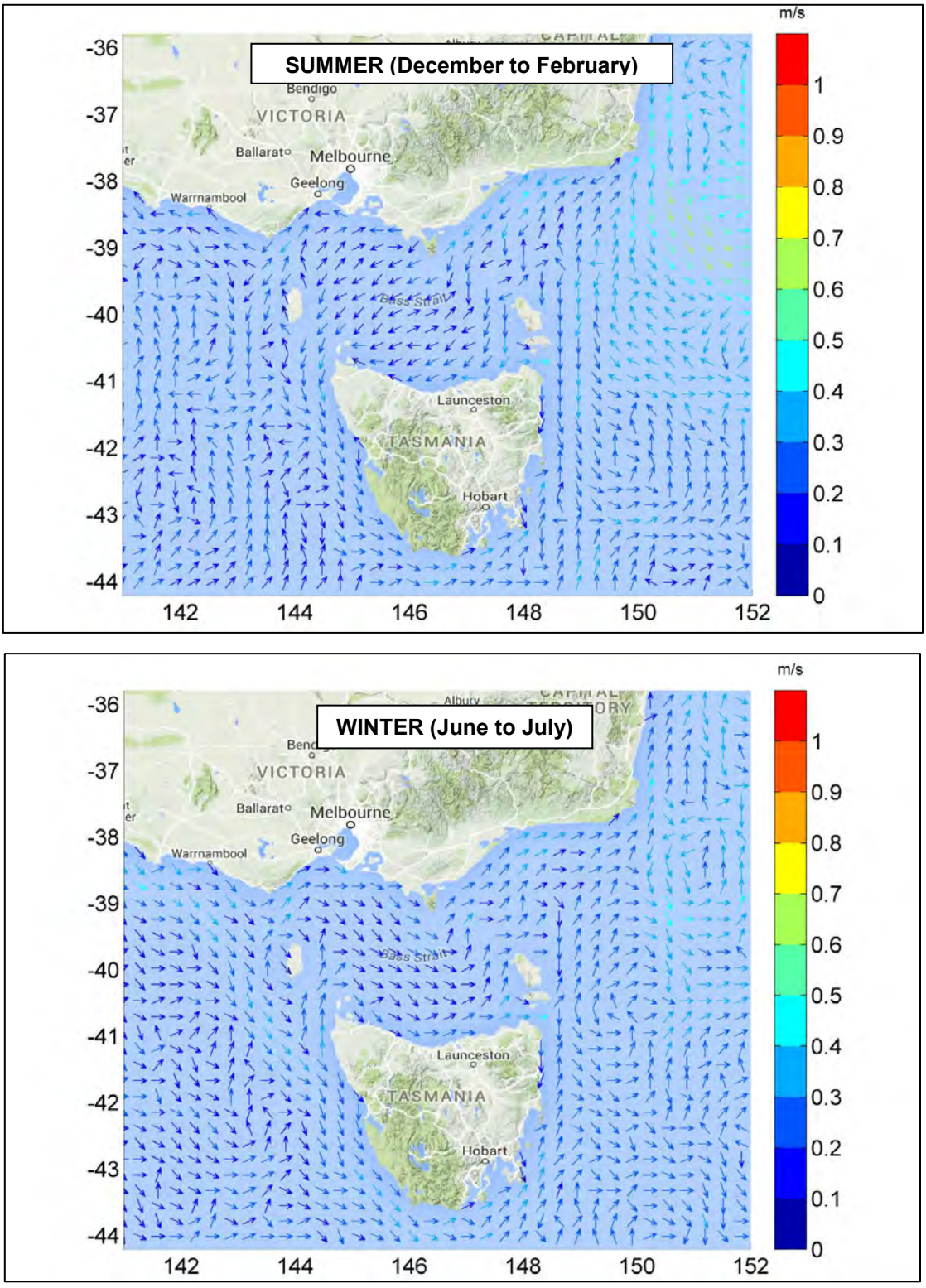


**Figure 2 HYCOM averaged seasonal surface drift currents during summer and winter.**

## 3.1 Tidal Currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified by comparison to field measurements throughout the world over the past 32 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

### 3.1.1 Grid Setup

RPS has a global tidal model with global coverage. The model is sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids are progressively allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3 shows the tidal model grid covering the study domain.

A combination of datasets were used and merged to describe the shape of the seabed within the grid domain (Figure 4). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

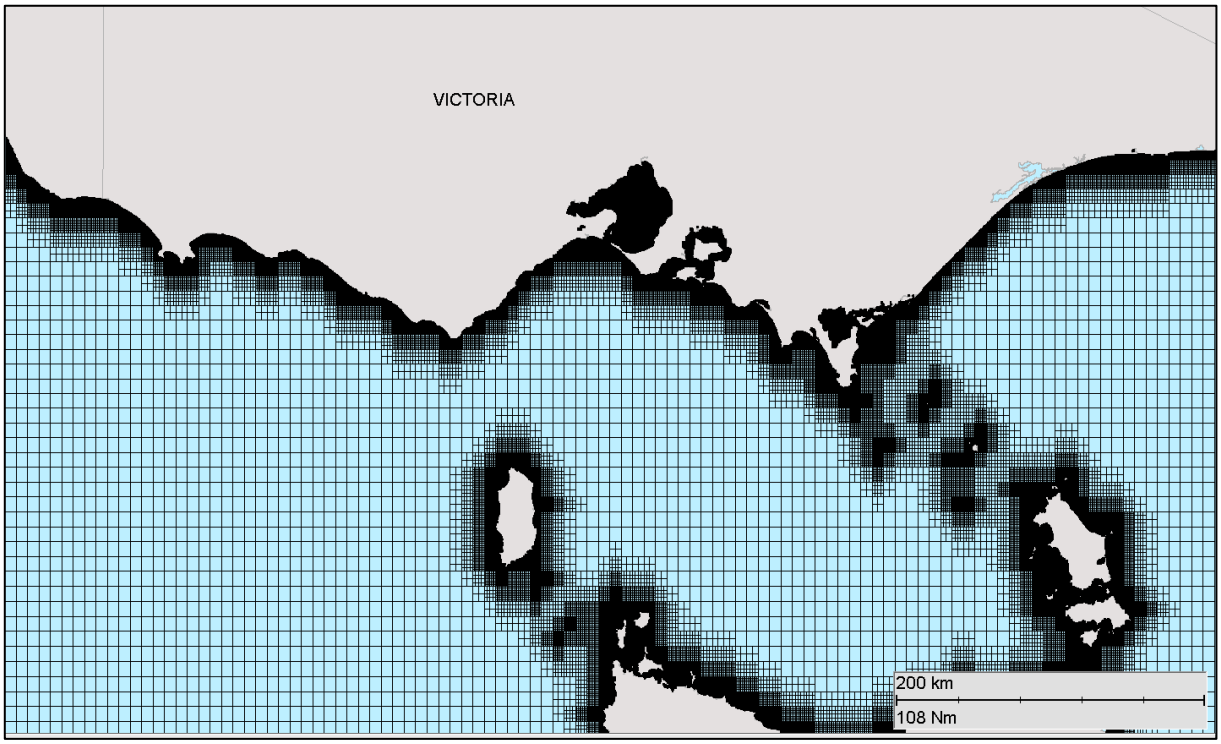


**Figure 3 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.**

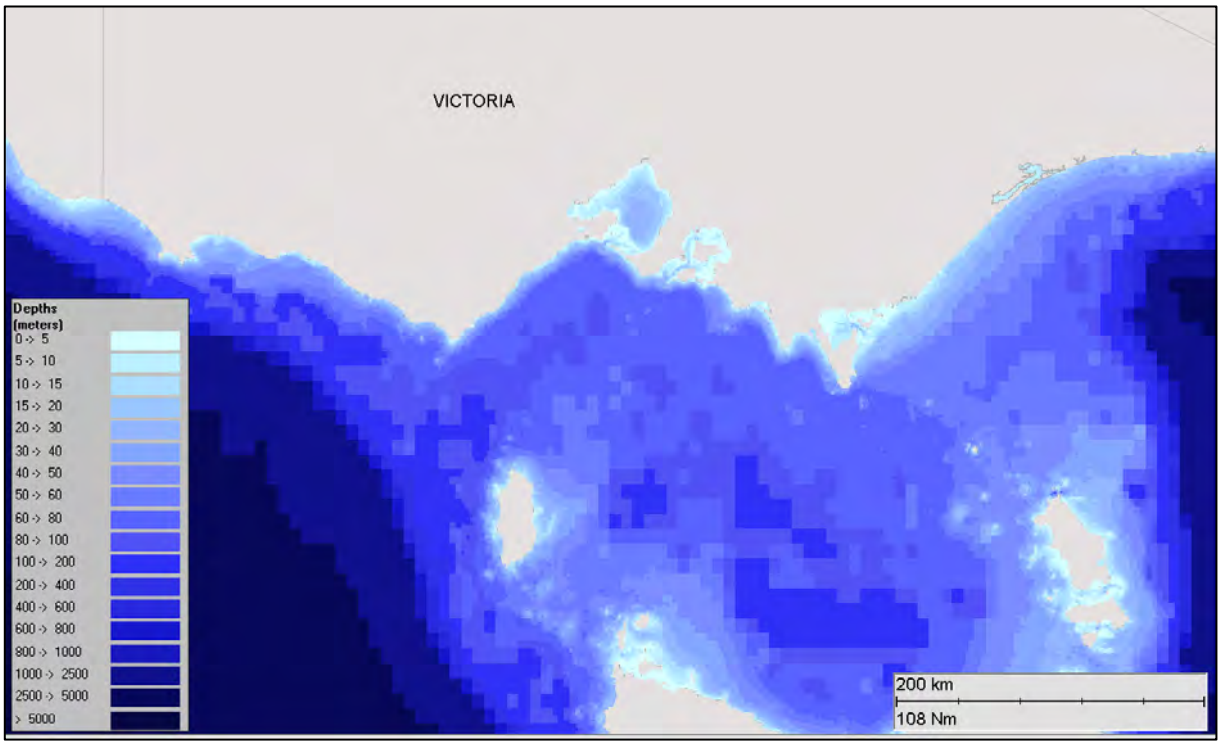


**Figure 4 Bathymetry defined throughout the tidal model domain.**

### 3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 8.0) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were $K_2$, $S_2$, $M_2$, $N_2$, $K_1$, $P_1$, $O_1$ and $Q_1$. Using the tidal data, time series surface heights were calculated along the open boundaries for the simulation period.

The Topex-Poseidon satellite data has a resolution of 0.25 degrees globally, with higher resolution in coastal regions, and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The data capturing satellites, equipped with two altimeters capable of taking sea level measurements accurate to less than ± 5 cm, measured oceanic surface elevations (and the resultant tides) for the period 1992–2005. In total these satellites carried out 62,000 orbits of the planet. The Topex-Poseidon tidal data has been widely reported amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen 2010). The Topex/Poseidon tidal data is considered suitably accurate for this study.

### 3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data from five locations situated within the study area (Figure 5).

Figure 6 and Figure 7 illustrate comparisons of the predicted and observed surface elevations for each location for January 2014. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

To provide a statistical measure of the model's performance, the Index of Agreement (IOA – Willmott, 1981) and the Mean Absolute Error (MAE – Willmott, 1982; Willmott & Matsuura, 2005) were used.

The MAE is the average of the absolute values of the difference between the model-predicted (P) and observed (O) variables. It is a more natural measure of the average error and more readily understood (Willmott & Matsuura, 2005).

$$MAE = N^{-1}\sum_{i=1}^{N}|P_i - O_i|$$

The Index of Agreement (IOA) is determined by:

$$IOA = 1 - \frac{\sum|X_{model} - X_{obs}|^2}{\sum(|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2}$$

Where: X represents the variable being compared and the time mean of that variable. A perfect agreement exists between the model and field observations if the index gives an agreement value of 1 and complete disagreement will produce an index measure of 0 (Wilmott, 1981). Willmott et al. (1985) also suggests that values meaningfully larger than 0.5 represent good model performance. Clearly, a greater IOA and lower MAE represent a better model performance.

Table 4 Statistical comparison between the observed and HYDROMAP predicted surface elevations. shows the IOA and MAE values for the selected locations.

Figure 8 shows a screenshot of the predicted tidal current vectors within the Otway Basin.

**Table 4 Statistical comparison between the observed and HYDROMAP predicted surface elevations.**

| Tide Station | IOA | MAE (m) |
|---|---|---|
| Gabo Island | 0.98 | 0.08 |
| Port MacDonnell | 0.98 | 0.05 |
| Port Welshpool | 0.92 | 0.30 |
| Portland | 0.97 | 0.07 |
| Stack Island | 0.96 | 0.22 |

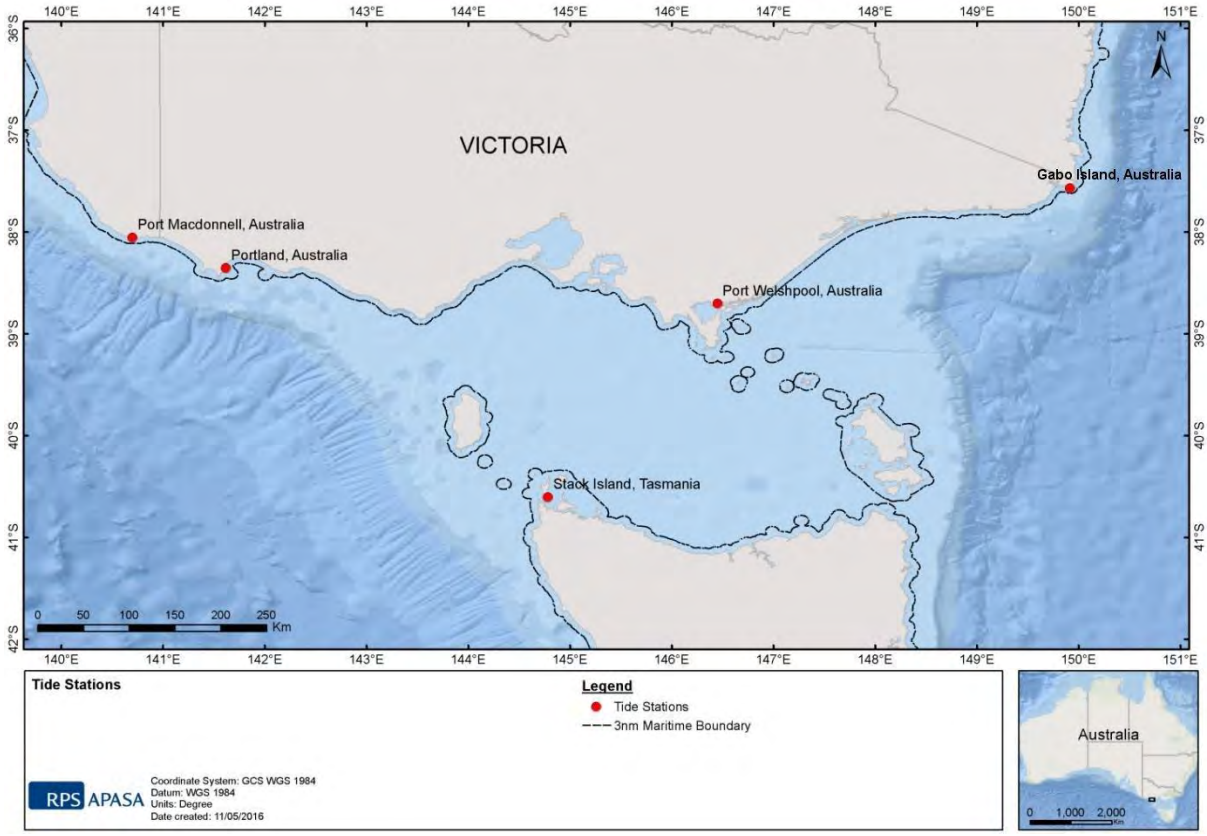


**Figure 5 Location of the tide stations used in the surface elevation validation.**

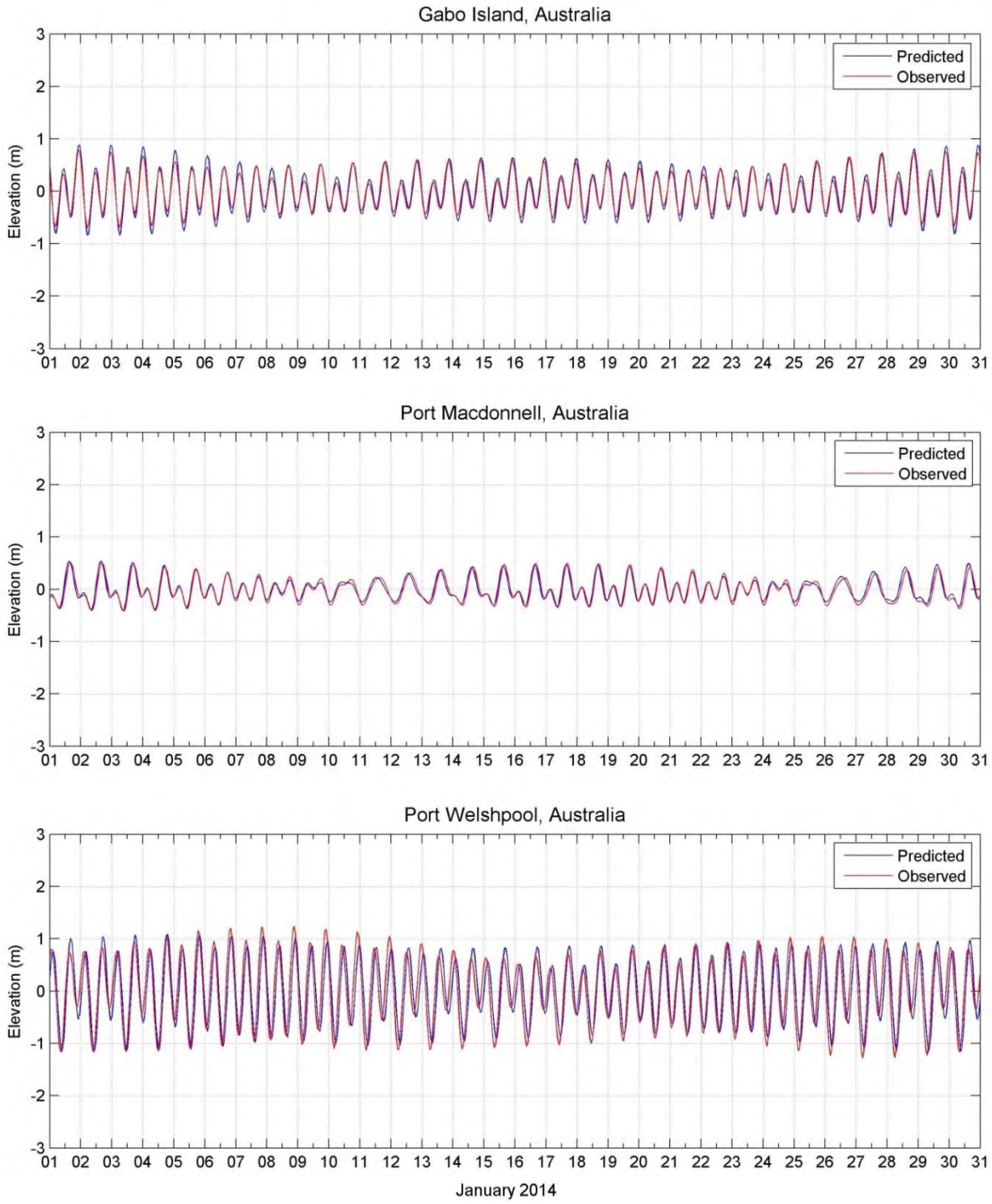


**Figure 6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).**

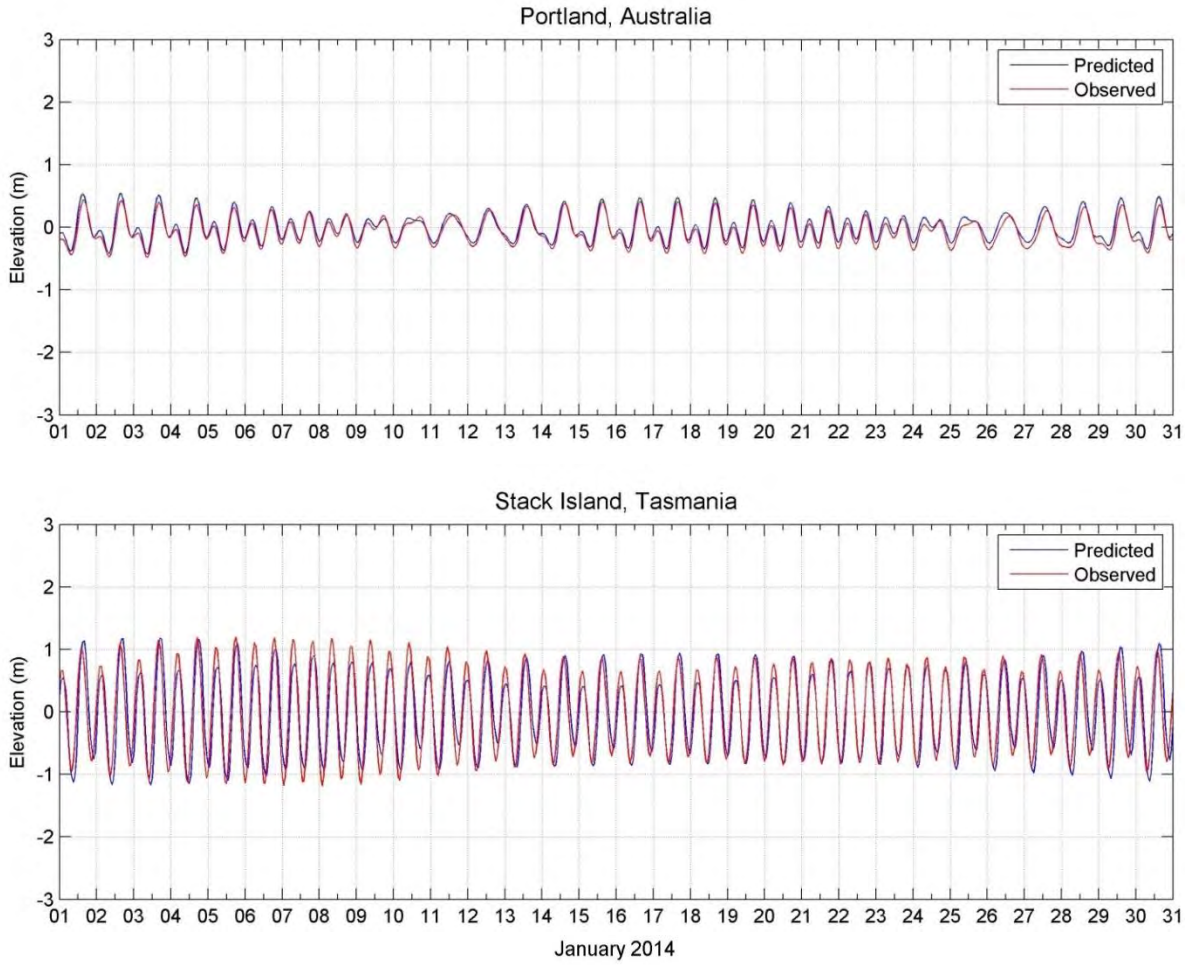


**Figure 7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).**

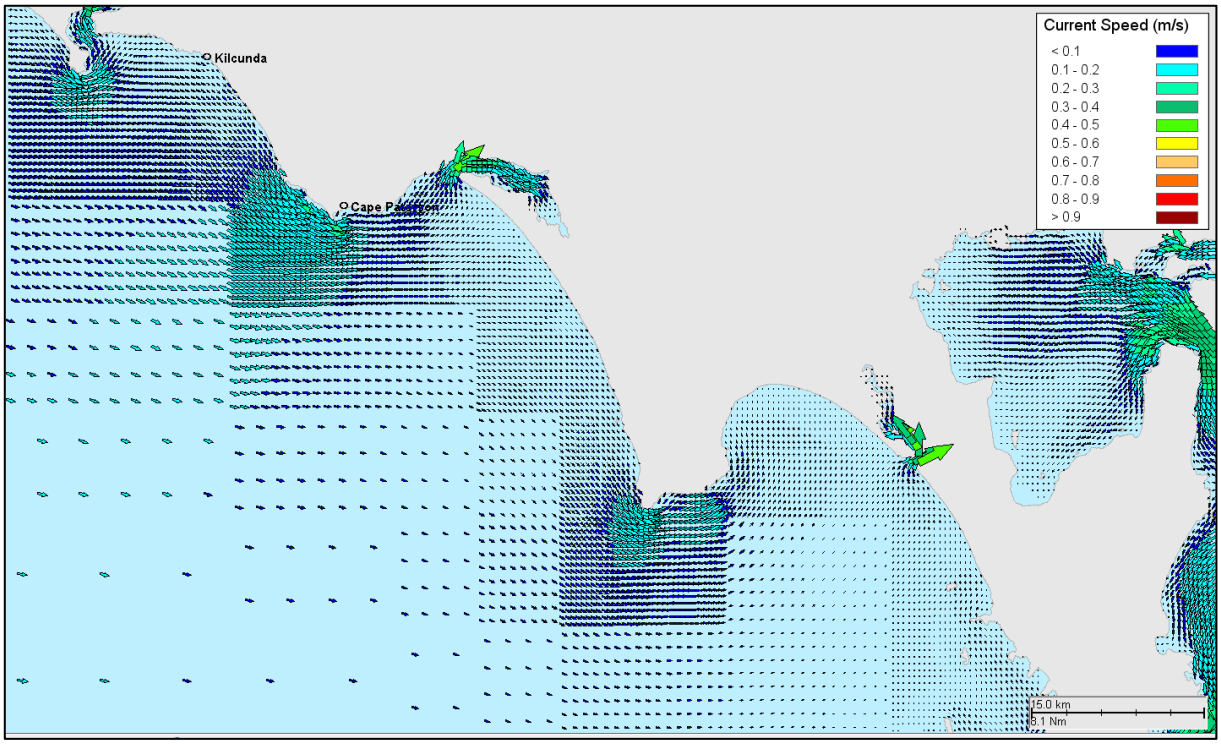


**Figure 8 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and sholas. Colourations of individual vectors indicate current speed.**

## 3.2 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km ($1/12^{th}$ of a degree) over the region, at a frequency of once per day. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain-following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

For this study, the HYCOM hindcast currents were obtained used. Figure 9 shows an example modelled surface ocean currents (HYCOM) during the study period.

Figure 10 and Figure 11 show the monthly and total current rose distributions resulting from the combination of HYCOM ocean current data and HYDROMAP tidal data nearby the Yolla release site.

Note the convention for defining current direction is the direction the current flows towards, which is used to reference current direction throughout this report. Each branch of the rose represents the currents flowing to that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of

0.1 m/s are predominantly used in these current roses. The length of each coloured segment is relative to the proportion of currents flowing within the corresponding speed and direction.

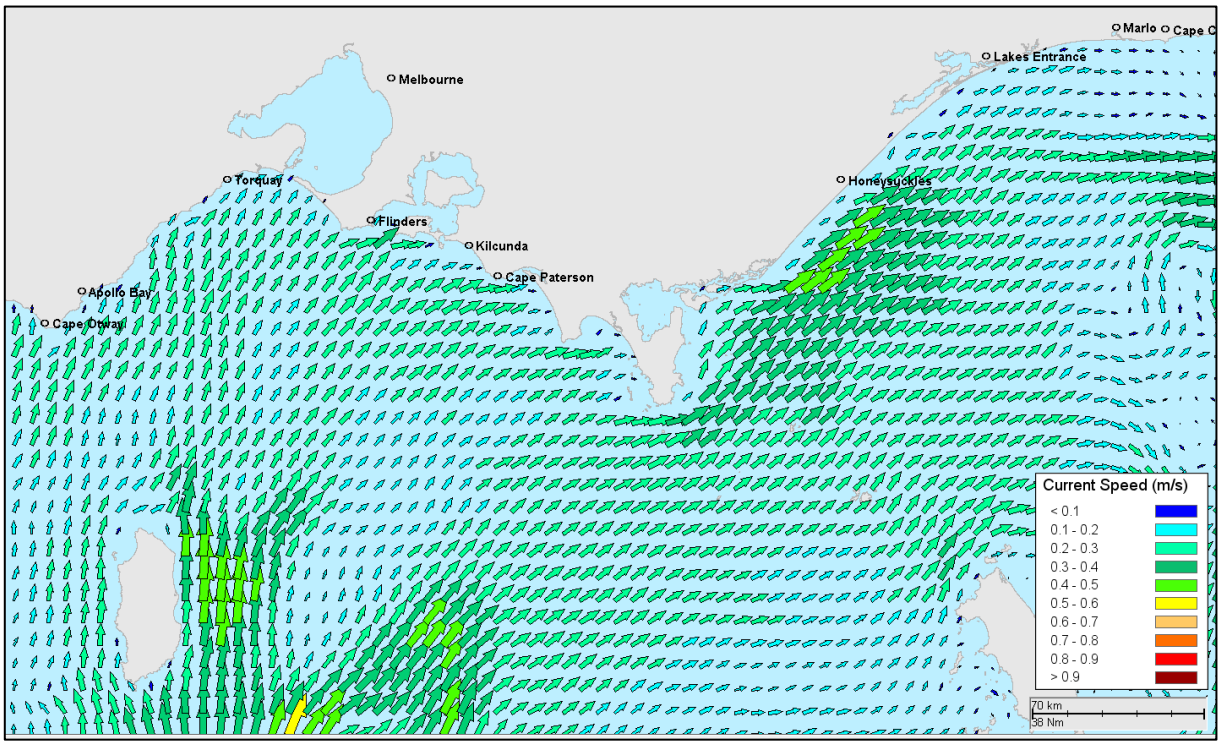


**Figure 9 Modelled surface ocean currents presented for the 1st May 2012. Derived from the HYCOM ocean hindcast model. The colours of the vectors indicate current speed in m/s.**

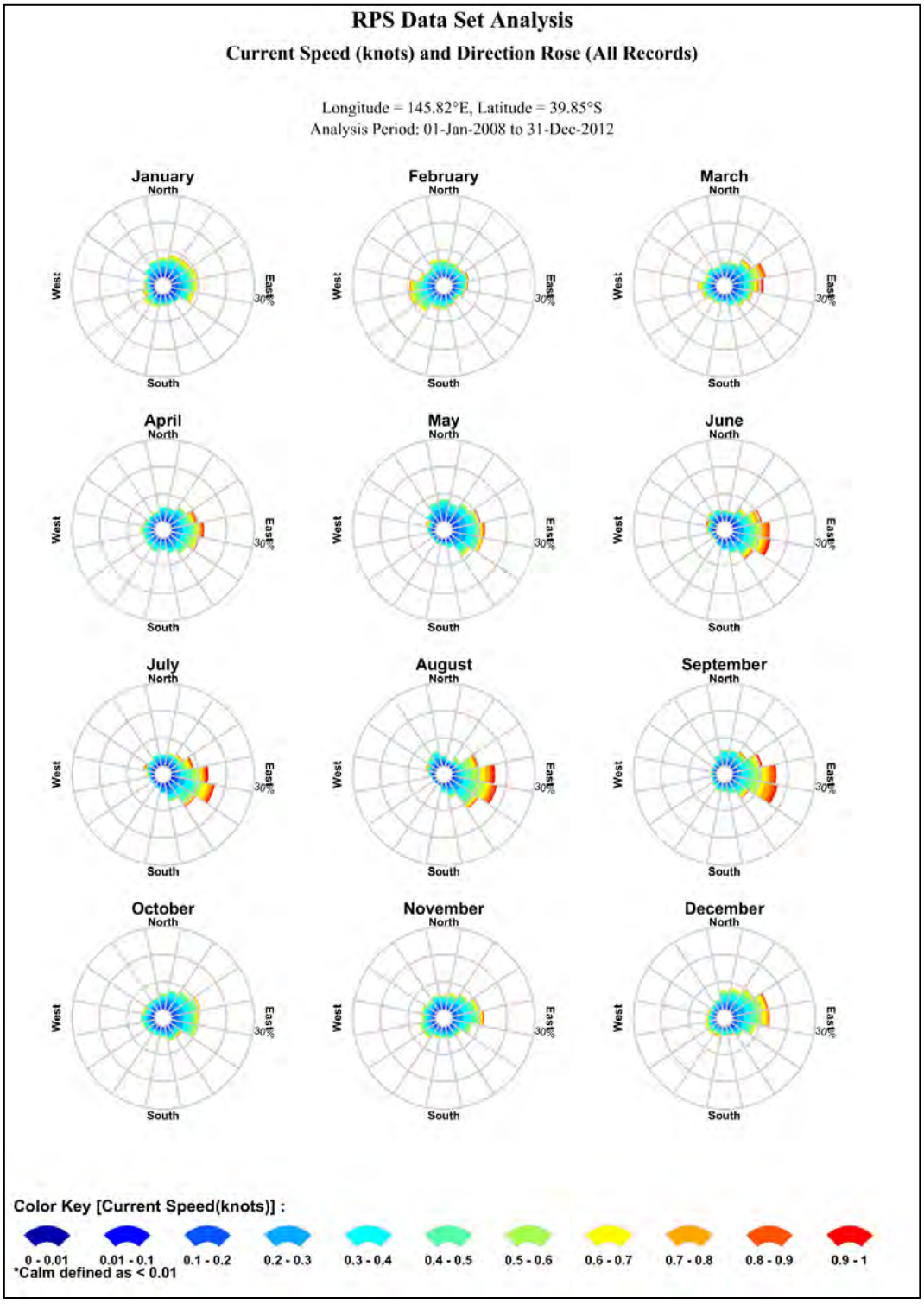


**Figure 10 Monthly surface current rose plots nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination.**

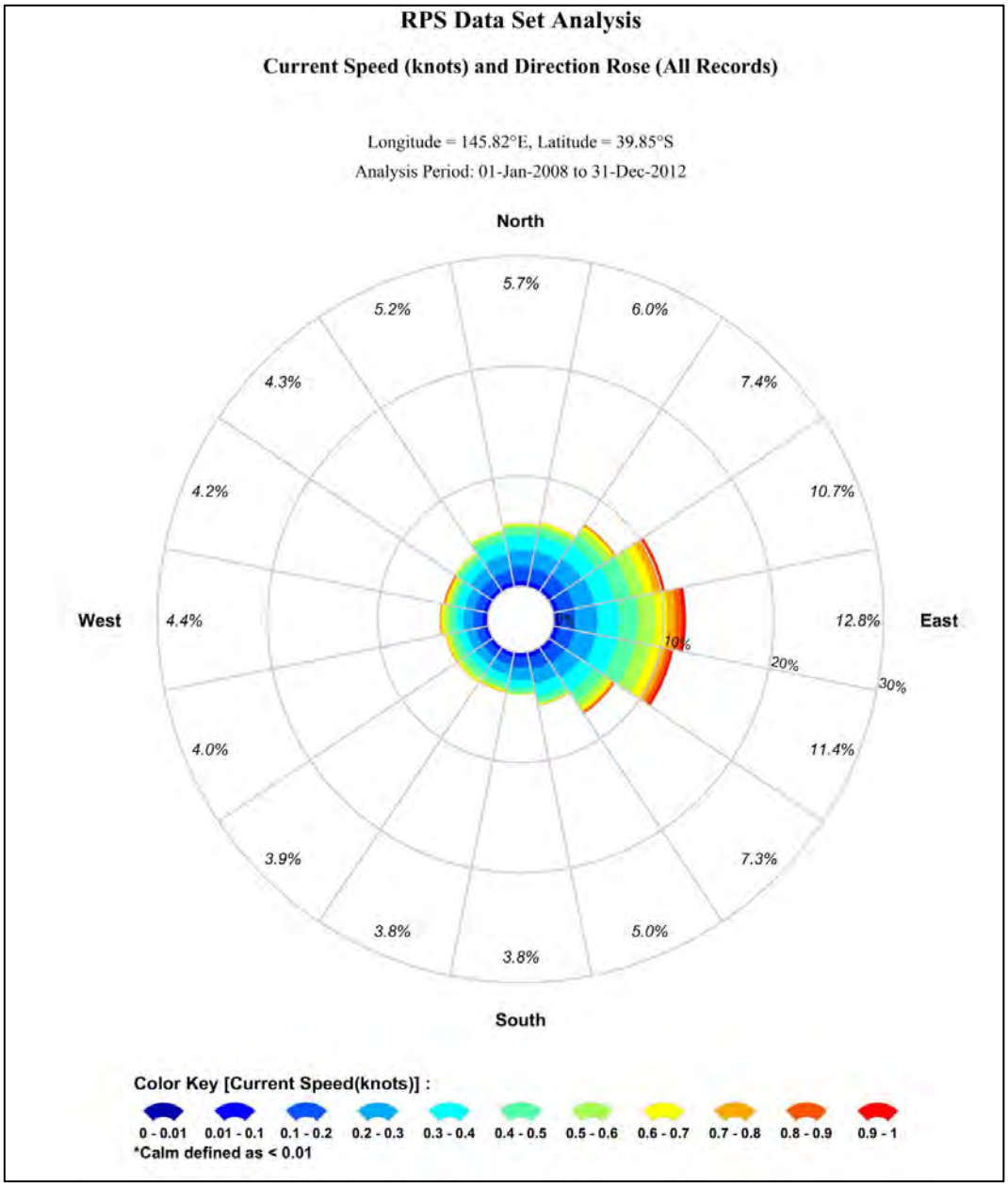


**Figure 11 Modelled total surface current rose plot nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination.**

# 4.0 Modelling Methods

## 4.1 Description of Models

### 4.1.1 Near-Field Model

The near-field mixing and dispersion of the operational discharge was simulated using the fully three-dimensional flow model in CORMIX.

CORMIX is a mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones.

CORMIX contains a series of elements for the analysis and design of conventional or toxic, single or multi-port, submerged or surface, buoyant or nonbuoyant, pollutant discharges into stratified or unstratified watercourses, with emphasis on the geometry and dilution characteristics on the initial mixing zone. (Doneker, 1990; Jirka & Doneker, 1991)

CORMIX has been validated in many independent studies over the years. A list of some of these studies is provided on the CORMIX website (http://www.cormix.info/validations.php).

## 4.2 Near-Field Model Setup

### 4.2.1 Ambient Environmental Conditions

Inputs for the ambient environmental conditions included a vertical profile of salinity and water temperature, along with static current speeds and general direction. The salinity and water temperature and profiles are important to accurately account for buoyancy of the diluting plume, whilst the current speeds influence the intensity of initial mixing and the deflection of the PW plume. These inputs are described below.

#### 4.2.1.1 Ambient Temperature and Salinity

Table 5 shows the seasonal water temperature and salinity levels at varying depths from 0 to 50 m at the release site. The data was sourced from the World Ocean Atlas 2013 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Center for Oceanography (see Levitus et al., 2013).

Seasonal water temperature profiles show a 2–4 $^{o}$C difference between the summer and winter conditions. The temperature ranged from 14.74 to 17.79$^{o}$C during the summer season and 12.78 to 13.11$^{o}$C during the winter season. Alternatively, salinity values demonstrate greater consistency across the seasons and depth range. Salinity values during the summer season ranged from 35.36 to 35.52 PSU and 35.49 to 35.61 PSU during the winter season.

**Table 5 Seasonal temperature and salinity profile adjacent at the release site.**

| Season | Depth (m) | Temperature (°C) | Salinity (PSU) |
|---|---|---|---|
| Summer | 0 | 18.05 | 35.36 |
| | 10 | 17.79 | 35.41 |
| | 20 | 17.55 | 35.44 |
| | 30 | 17.36 | 35.44 |
| | 40 | 16.78 | 35.44 |
| | 50 | 14.74 | 35.52 |
| Winter | 0 | 13.11 | 35.49 |
| | 10 | 13.07 | 35.57 |
| | 20 | 13.02 | 35.58 |
| | 30 | 12.81 | 35.60 |
| | 40 | 12.79 | 35.61 |
| | 50 | 12.78 | 35.61 |

#### 4.2.1.2 Ambient Currents

The 5-year current dataset was analysed to determine the 5$^{th}$ and 95$^{th}$ percentile current speeds as input into the near-field model, representative of low and high current speeds, respectively.

Table 6 presents the 5$^{th}$ and 95$^{th}$ percentiles of current speeds through the water column, which produce contrasting dilution and advection cases:

- 5$^{th}$ percentile current speed: low current speed, low dilution and slow advection;
- 95$^{th}$ percentile current speed: high current speed, high dilution and rapid advection to nearby areas.

The 5$^{th}$ and 95$^{th}$ percentile values are referenced as low and high current speeds throughout the remainder of the report, respectively.

**Table 6 Adopted ambient current conditions.**

| Depth (m) | 5$^{th}$ Percentile or low current speed (m/s) | 95$^{th}$ Percentile or high current speed (m/s) |
|---|---|---|
| 0 | 0.042 | 0.390 |
| 10 | 0.030 | 0.254 |
| 20 | 0.028 | 0.227 |
| 30 | 0.027 | 0.224 |
| 40 | 0.026 | 0.218 |
| 50 | 0.026 | 0.212 |

# 5.0 Results

## 5.1 Near-Field Modelling Results

Table 7 presents a summary of the near-field plume results for each of the three cases for summer and winter conditions under low and high current speed conditions.

Figure 12 to Figure 14 show the trajectory of the plume through the water column as the current transport it away from the discharge point.

The furthest distance for any plume to reach 1000:1 dilution was 70 m, for the Case 3 – Worst Case Operation scenario (300 $m^3$/day) under summer conditions with high current speed.

Plumes released during summer conditions required a greater distance before reaching 1,000:1 dilution, in comparison to plumes released during winter.

Plumes released during low current speed conditions rose higher in the water column and travelled less horizontally than plumes released in high current speed conditions for all three flow rates modelled under summer and winter conditions.

**Table 7 Maximum horizontal distance from the discharge point that centreline dilution (X:1) was predicted to travel.**

| Case | Season | Current Speed (%ile) | Maximum Distance from Discharge Point to Centreline Dilution X:1 (m) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
| Case 1 Design Operation | Summer | 5th | 0.2 | 0.4 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 2.7 | 3.7 | 4.6 | 5.4 | 6.2 | 7.0 | 7.8 | 8.5 | 9.2 |
| | | 95th | 1.2 | 2.2 | 3.0 | 3.6 | 4.2 | 4.8 | 5.3 | 5.8 | 6.3 | 6.7 | 11.0 | 14.9 | 18.4 | 21.8 | 25.1 | 28.4 | 31.6 | 34.8 | 38.0 |
| | Winter | 5th | 0.2 | 0.4 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.2 | 1.4 | 1.5 | 2.6 | 3.6 | 4.5 | 5.3 | 6.1 | 6.8 | 7.6 | 8.3 | 9.0 |
| | | 95th | 1.2 | 2.2 | 3.0 | 3.6 | 4.2 | 4.7 | 5.2 | 5.7 | 6.2 | 6.7 | 10.9 | 14.6 | 18.0 | 21.2 | 24.3 | 27.3 | 30.1 | 32.9 | 35.6 |
| Case 2 Typical Operation | Summer | 5th | 0.3 | 0.5 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 3.8 | 5.3 | 6.6 | 7.9 | 9.1 | 10.2 | 11.2 | 12.3 | 13.3 |
| | | 95th | 1.4 | 2.6 | 3.6 | 4.5 | 5.4 | 6.2 | 6.9 | 7.7 | 8.4 | 9.1 | 15.4 | 21.1 | 26.5 | 31.8 | 37.1 | 42.5 | 48.1 | 53.9 | 59.9 |
| | Winter | 5th | 0.3 | 0.5 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.1 | 3.7 | 5.2 | 6.5 | 7.7 | 8.9 | 10.0 | 11.1 | 12.2 | 13.2 |
| | | 95th | 1.4 | 2.6 | 3.6 | 4.5 | 5.3 | 6.1 | 6.8 | 7.6 | 8.3 | 9.0 | 15.1 | 20.5 | 25.5 | 30.2 | 34.7 | 39.0 | 43.2 | 47.2 | 51.2 |
| Case 3 Worst Case Operation | Summer | 5th | 0.3 | 0.6 | 0.9 | 1.1 | 1.4 | 1.6 | 1.8 | 2.1 | 2.3 | 2.5 | 4.4 | 6.1 | 7.6 | 9.0 | 10.4 | 11.6 | 12.9 | 14.0 | 15.1 |
| | | 95th | 1.5 | 2.9 | 4.0 | 5.0 | 6.0 | 6.9 | 7.7 | 8.6 | 9.4 | 10.2 | 17.5 | 24.1 | 30.5 | 36.8 | 43.3 | 49.9 | 56.7 | 63.5 | 70.3 |
| | Winter | 5th | 0.3 | 0.6 | 0.9 | 1.1 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 4.3 | 5.9 | 7.4 | 8.9 | 10.2 | 11.5 | 12.8 | 14.1 | 15.4 |
| | | 95th | 1.5 | 2.8 | 3.9 | 4.9 | 5.9 | 6.8 | 7.6 | 8.5 | 9.3 | 10.1 | 17.1 | 23.2 | 28.9 | 34.4 | 39.5 | 44.5 | 49.3 | 54.0 | 58.6 |

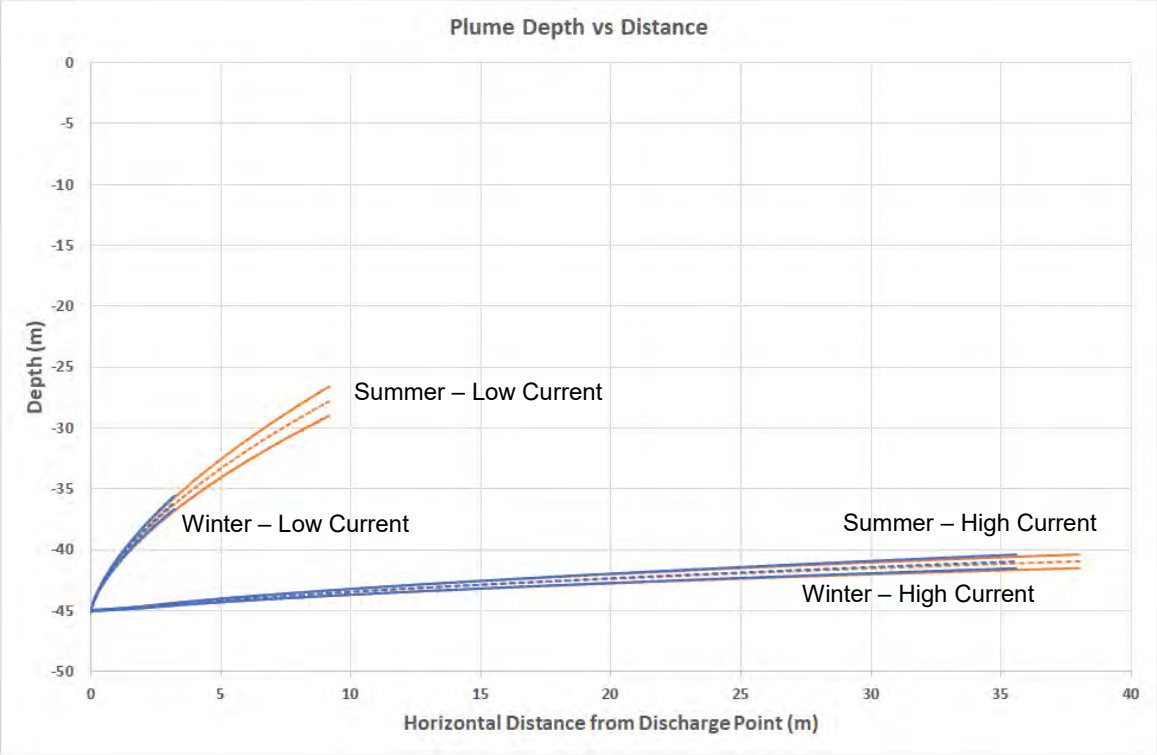


**Figure 12 Plume depth versus distance for Case 1 Design Operation (100 $m^3$/day flow) for summer and winter under low and high current flow conditions.**

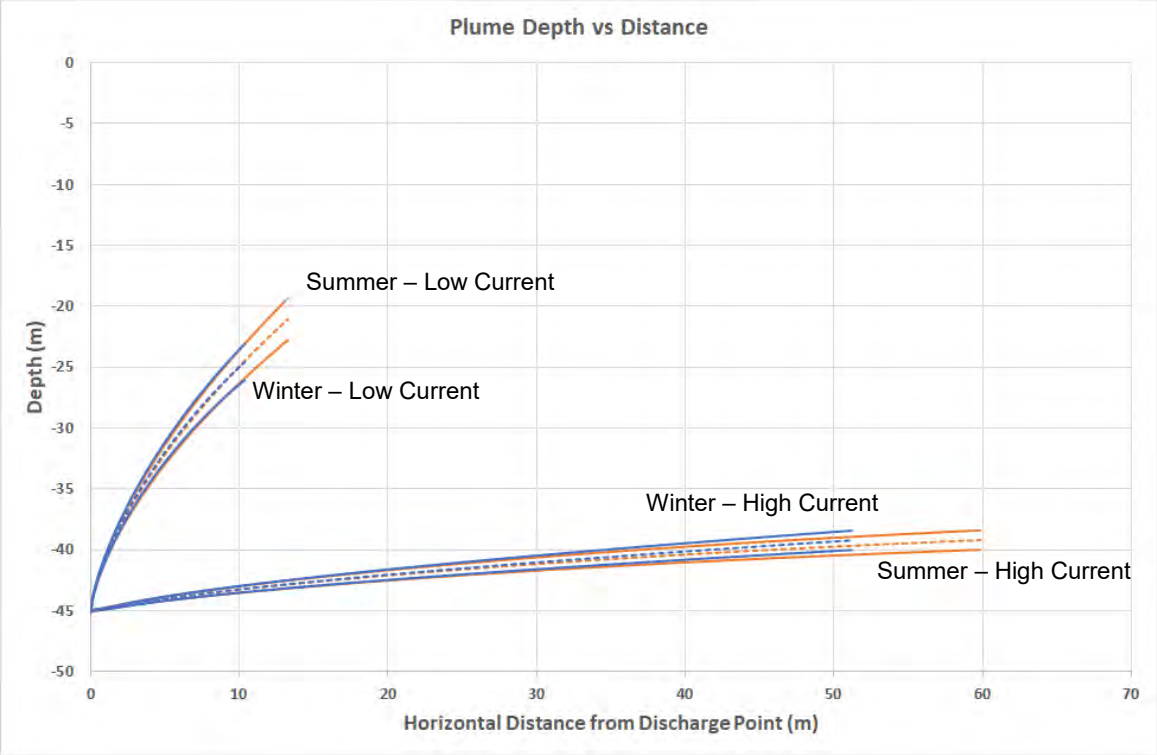


**Figure 13 Plume depth versus distance for Case 2 Typical Operation (200 $m^3$/day flow) for summer and winter under low and high current flow conditions.**

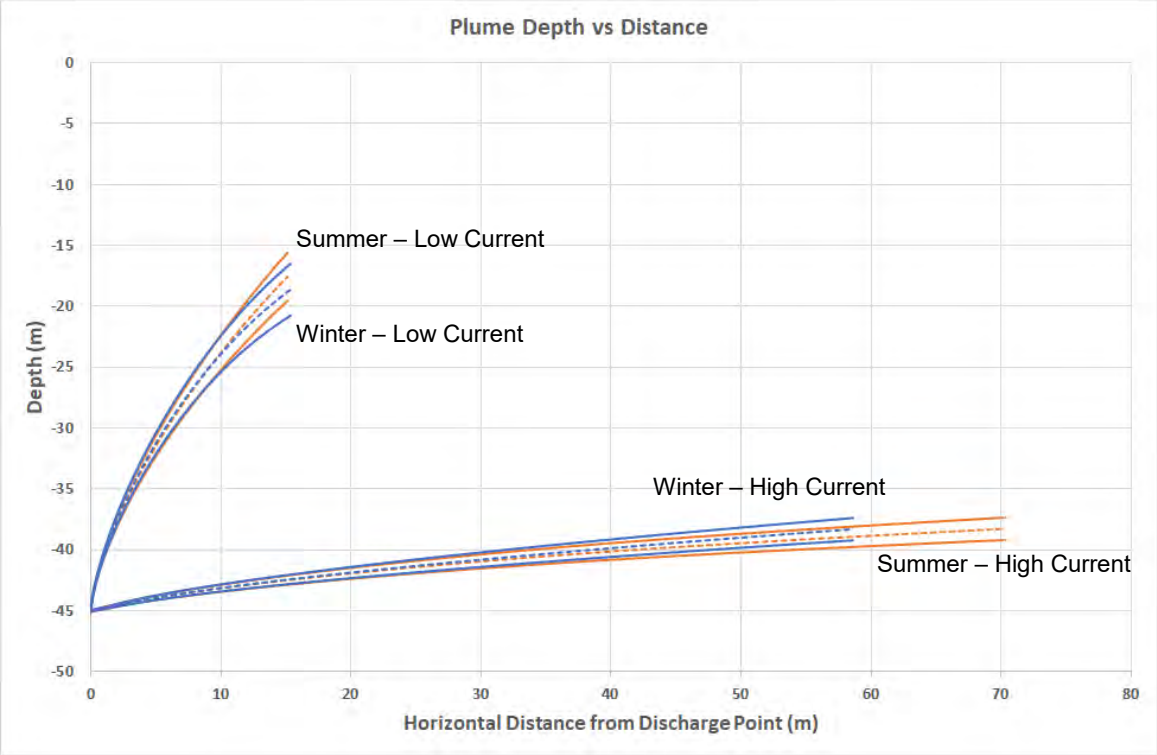


**Figure 14 Plume depth versus distance for Case 3 Worst-Case Operation (300 $m^3$/day flow) for summer and winter under low and high current flow conditions.**

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# Appendix D

## Advisian Report 2019

# Yolla Produced Water Improvements

## TIC estimates

**Beach Energy**

11-December-2019

411010-00050-GE-REP-0001

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Worley Group

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**PROJECT 411010-00050-GE-REP-0001: Yolla Produced Water Improvements - TIC estimates**

| Rev | Description | Author | Review | Advisian approval | Revision date | Client approval | Approval date |
|---|---|---|---|---|---|---|---|
| 0 | Issued for Use | R. George | S. Henzell | C. Adinolfi | 11-Dec-19 | | |
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# Table of contents

**Executive summary** ..... **5**

**1 Introduction** ..... **9**

**2 Macro Porous Polymer Extraction (MPPE)** ..... **10**

**3 Steam Stripping Package** ..... **13**

**4 Gas Stripping Unit** ..... **16**

**5 Layout** ..... **18**

5.1 Main processing equipment ..... 18

5.2 Demineralised water generation equipment ..... 19

**6 Cost Estimates** ..... **21**

**7 References** ..... **24**

# Appendices

**Appendix A Scope of Work**

**Appendix B Vendor (Veolia) MPPE Quote**

**Appendix C Cost Estimates**

# Table list

Table 6-1: Total Installed Cost (TIC) Summary ..... 21

# Figure list

Figure 0-1: Total Installed Cost Comparison of the 3 options ..... 5

Figure 2-1: Sketch for MPPE Option ..... 10

Figure 2-2: MPPE Package ..... 10

Figure 3-1: Sketch for Steam Stripping option ..... 13

Figure 3-2: Steam stripping unit ..... 13

Figure 4-1: Original PW Stripper (with fuel gas) ..... 16

Figure 5-1: Potential Equipment Locations ..... 18
Figure 5-2: Existing PW Filters ..... 19
Figure 5-3: Existing water handling facilities ..... 20
Figure 6-1 CAPEX by option ..... 22

# Executive summary

Due to changes in legislation regarding the allowable oil-in-water content of water discharge overboard, Beach energy are reviewing options to improve the capability of the Produced Water (PW) Treatment system on the Yolla platform.

Beach energy identified 3 options and commissioned Advisian to perform a high level (+/- 50%) Total Installed Cost (TIC) estimated of these options. To generate the costs, assumptions had to be made regarding where equipment would be installed and the adequacy of existing utilities. These assumptions are critical to the cost estimate and given that the platform has limited spare weight, layout and utilities these assumptions have the potential to escalate the costs by +100% or more if invalid. A thorough review and validation of the assumptions should be conducted in the next project phase.

A cost comparison of the 3 options is shown in Figure 0-1 with further details below.

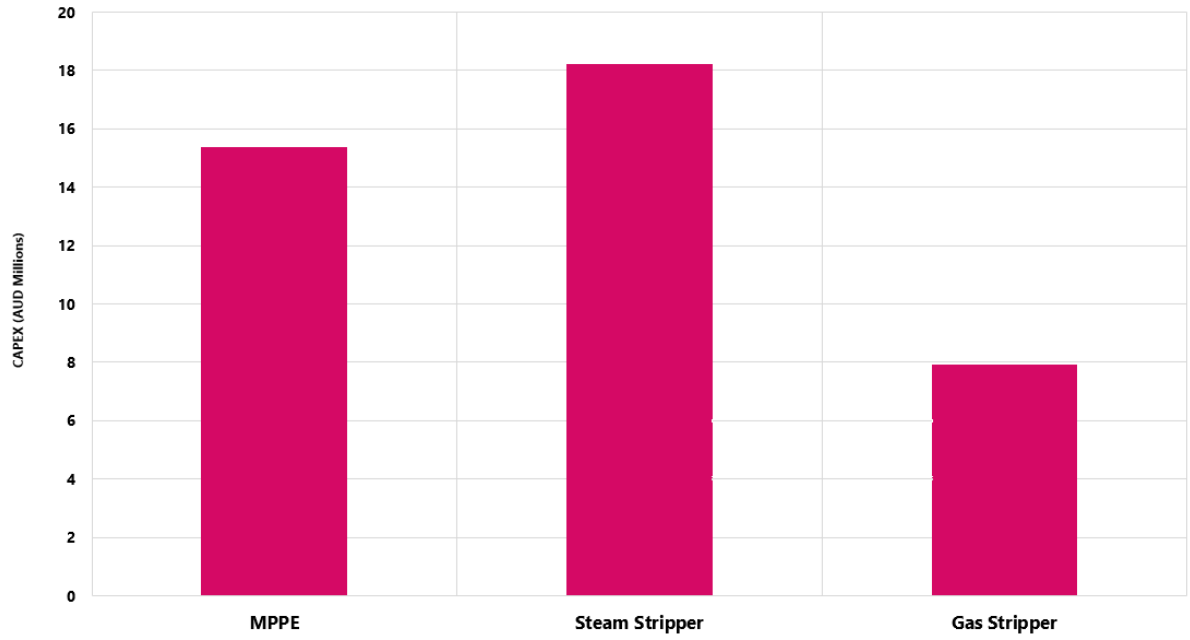



*Figure 0-1: Total Installed Cost Comparison of the 3 options*

**Mono Porous Polymer Extraction (MPPE) Unit**

The MPPE unit removes the hydrocarbons by running the produced water through a media filled extraction column. Two columns are installed in a duty/regeneration arrangement with steam being used to regenerate the offline column. The hydrocarbon laden steam is condensed, and the two liquid phases separated with the water recycled back into the produced water stream and the hydrocarbons sent to the flare drum.

The MPPE unit is provided as a single package containing the columns, condenser, separator, pumps and electric steam boiler. An offtake of Reverse Osmosis (RO) treated water (available on Yolla) will be passed through an Ion Exchange (IX) unit to create demineralised water to feed to the steam boiler.

It is envisaged that the MPPE will be installed where the current Produced Water Filters are located (with the filters demolished) and the IX unit installed near the existing RO units.

The total installed cost is **AUD$15.4M**

### Steam Stripping Unit

The Steam Stripping unit removes the hydrocarbons by contacting the produced water with steam inside a packed column. The hydrocarbon laden steam is condensed with the water recycled in the column and the hydrocarbon/BTEX vapour stream sent to flare.

The steam stripper package consists of a single package containing the column, buffer tank, condenser, BTEX accumulator, pumps and steam boiler. The steam rate required (~420 kg/h) is to too great for the existing RO units, therefore a new demineralised water package needs to be installed to produce the Boiler Feed Water (BFW). The duty of the steam boiler of 400 kW is too great for the existing Yolla power gen sets and hence a fired heater using fuel gas would be installed. The existing seawater lift pumps and fuel gas conditioning units are considered to have adequate capacity to not required modifications.

It is envisaged that the Steam Stripping Unit will be installed where the current Produced Water Filters are located (with the filters demolished) and the demineralised water package to be installed near the existing RO units or if too large to be located close to the steam boiler.

The total installed cost is **AUD $18.2M**

### Gas Stripping Unit

The Gas stripping unit option consists of reinstalling a  gas stripping column similar to what was originally installed on Yolla. In this option hydrocarbons are removed by contacting the produced water with fuel gas. The leaving fuel gas is sent to flare.

It is envisaged that the Gas Stripper will be installed next to the current Produced Water Filters i.e. filters not demolished in this case. This is similar to the original installation; however, the base of the column will need to be installed on the top deck.

The total installed cost is **AUD $7.9M**

## RECOMMENDATION

The gas stripping unit is the cheapest of the options but given the operating experience with the previous column underperforming there is the risk that the technology would not meet the more stringent specification. The MPPE option is cheaper than the steam stripper and has less impact on the water handling (RO units) due to the lower amount of steam required. The MPPE options therefore would be the preferred option at this stage. The issue with this option (and all options) is ensuring the equipment fits within existing constraints of the platform. This study has made the assumption that only minor brownfield work is required to locate and install the necessary package however if major

works such as jacket strengthening is required then the costs provided could escalate by 100% or more.

**FURTHER WORK**

There are several feasibility issues that have not been addressed in this preliminary study that must be investigated.

- Weight limits for Yolla
- Constructability
    - Downtime e.g. while filters are demolished, tie-ins made
    - Manning limits
    - Brownfield works e.g. demolition work required.
- Utility limits / Capacity
    - Power – capacity of existing gen sets
    - Fuel gas requirements (supply to the steam boiler)
    - Water handling (seawater lift, RO units)
- Impact on operations including greater surveillance and operator intervention
- Chemical consumption e.g. MPPE media and chemicals for BFW generation
- Time to implement
    - Site surveys
    - Analysis and design
    - Procurement
    - Installation
    - Hook-up and commissioning

In the next project phase the following activities should occur;

- Confirm with MPPE vendor the impact on size, weight, cost of replacing the plate and frame condenser with an ACHE
- Confirm that based on operating experience and contacting the RO vendor that the existing units could operate without modification for the additional load required for steam generation for the MPPE option.
- Confirm details of the steam stripping package for the full produced water rate (300 $m^3/d$), including confirmation of steam rate and boiler duty required. If boiler duty is below 200 kW, there's the potential to use an electric boiler and stay within the existing capacity of the gen sets.

- Contact vendors to confirm details on the ion exchange for the MPPE option and demineralised water generation package for the Steam Stripper option
- More detailed analysis of layout and where equipment could be installed for all options.
- Develop a detailed project execution schedule for each of the options.

# 1 Introduction

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has recently revised the allowable oil content in water specification for discharge overboard. This change in regulations means that the produced water treatment system on the Yolla platform will require upgrades.

The facility is to handle a maximum of 300 $m^3$/d (12.5 $m^3$/h) of produced water and remove all hydrocarbons (free and dissolved) to no more than 10 mg/L.

Beach Energy has performed an initial assessment and identified three (3) treatment options;

1. Macro Porous Polymer Extraction (MPPE) Unit
2. Stream Stripping Unit
3. Gas Stripping Unit

Beach Energy has commissioned Advisian to perform a high level Total Installed Cost (TIC) estimate of the three options.

The cost estimates have been developed based on the preliminary assessment information provided by Beach Energy for each option (Appendix A). The project is in pre-concept and Advisian has not performed any engineering design/analysis on the identified options other than to assess the necessary works associated with each option to determine the TIC.

As advised in the Beach Energy scope of work document, the following work is excluded;

1. No allowance for Owner's costs
2. No assessment for layout
3. No assessment of existing platform spare weight capacity
4. No estimate for duration of platform outage to install

Although layout is noted as an exclusion, Advisian has performed a brief look at potential locations for where the equipment could be installed at a high level to generate the construction costs associated with each option - Refer to section 5.

The costing has been prepared using in-house cost engineering experience and standard Advisian spreadsheets. The estimating sheets allow for material procurement and construction activities which are added to give the total direct cost. Allowances are added for engineering, project management, design growth and unknowns. These costs have then combined and summarised to build up costs for each option. These cost estimates are for screening purposes only with an estimate range of +/- 50%.

# 2 Macro Porous Polymer Extraction (MPPE)

Beach Energy has provided a quotation for the MPPE unit has from vendor Veolia (Appendix B).

Figure 2-1 shows a sketch of the proposed works associated with installing a MPPE package with further description below.

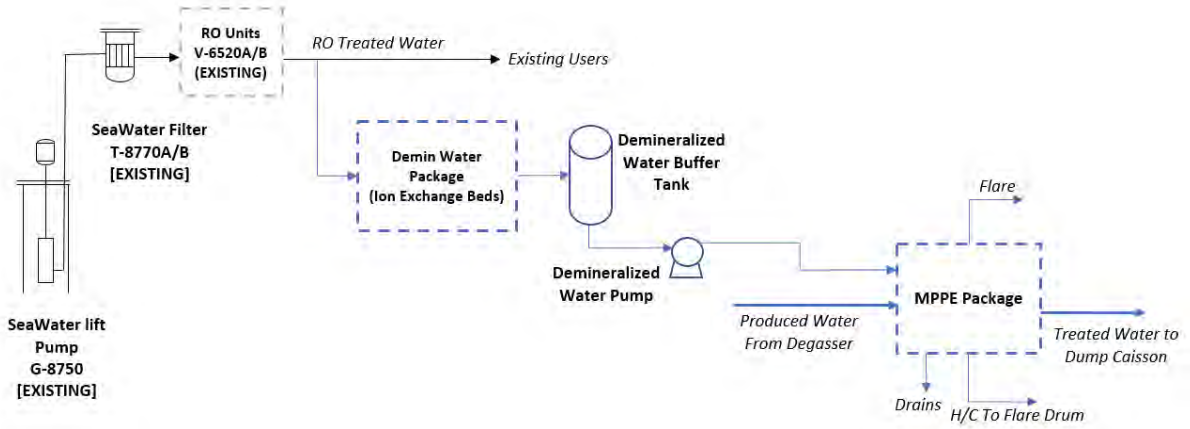



*Figure 2-1: Sketch for MPPE Option*

- MPPE Package
    - Veolia will provide a skid package that contains the processing equipment (cartridge filter, extraction/regeneration columns, stream generator, condenser, separator, water tank, return water pump and hydrocarbons pump).

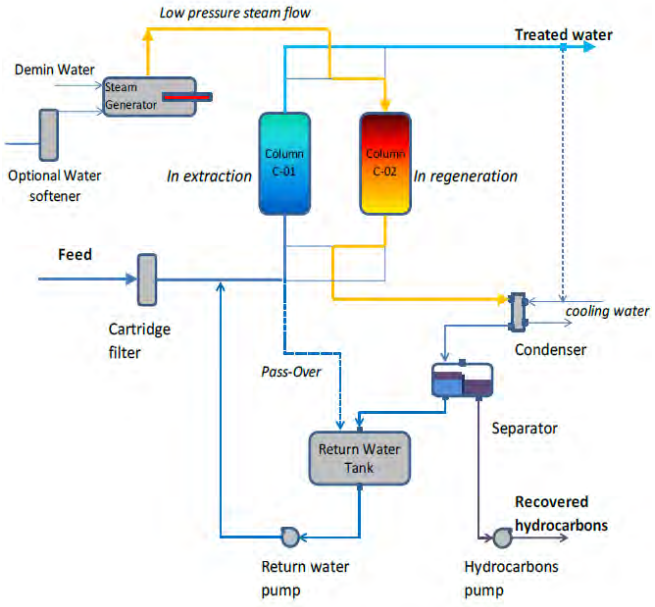



*Figure 2-2: MPPE Package*

- The MPPE package has dimensions and weight of:
  - L x W x H: 6.1m x 2.5m x 3.7m
  - Weight: 12 t
- It is recommended that the cooling medium for the steam condenser change from cooling water to air i.e. installation of an Air Cooled Heat Exchanger (ACHE) in place of the plate and frame exchanger proposed by Veolia. For Yolla the use of air is preferred to water for the following reasons;
  - If raw seawater is used (supply taken from downstream of the existing seawater filters, but upstream of the RO units) there is the high risk of the condenser scaling and fouling due to exchanger operating above 100°C and the water containing salts and minerals.
  - If treated utility water is used additional RO units would be required as the required cooling water rate is 1$m^3$/h whereas the RO units have a combined capacity of 0.76 $m^3$/h (0.38 $m^3$/h each).

  The condenser needs to achieve a temperature of approximately 40°C to condense all hydrocarbons and water which given the ambient temperature at Yolla would be feasible with an ACHE. The inclusion of the ACHE also removes the tie-in to the existing water system and associated new piping, valves, instruments and fittings.

  For the cost estimate no change has been made to the quote provided by Veolia, but NO allowance has been made for modifications necessary to provide cooling water.

- Demineralised water package / Ion exchange (IX) beds
  - Steam is required to regenerate and strip the extracted hydrocarbons from the MPPE columns. The steam generator is part of the MPPE package provided by Veolia but the water to the generator must come from the platform and must be of Boiler Feed Water (BFW) or demineralised water quality. Veolia advise that the steam generator requires 91 L/h [~2 $m^3$/d] of water at a specification of 0.5 German hardness (~9 ppm or mg/L $CaCO_3$).
  - The existing Yolla RO units (duty/standby) have a capacity of 760 L/h (0.38$m^3$/h each) and can produce water with a total hardness of <20mg/L $CaCO_3$. The required 91 L/h is about 12% of the total capacity of the units and hence no upgrade to the RO units is expected, but additional processing of the RO treated water is required. For this option it is assumed that an offtake of the RO treated water will flow through a set of ion exchanger (resin) chambers to generate demineralised water at the necessary hardness specification.
  - It has also been assumed that a small demineralised buffer tank (2$m^3$ i.e. 1 day reserve) and pump (2 $m^3$/d) will be installed (close to the MPPE package boiler) to ensure constant supply to the boiler.

- Hydrocarbon Return Pump
    - The Veolia quote states that the hydrocarbon return pump is an optional equipment item as they assume the oil can gravity flow to the drains. A cost allowance for a <1 kW pump to return hydrocarbon to flare KO drum has been made.
- Demolition
    - It is assumed that the existing Produced Water Filters will be demolished and the MPPE installed in its location. It is assumed that the ion exchange will be installed close to the existing RO units (Refer section 5). The Demin Water buffer tank will be located close to the MPPE.
- Piping Tie-ins include;
        - PW tie-in between PW filters and dump caisson (3") to install MPPE package
        - Tie-in to water system to install demineralised water package (1")
        - Tie-in to flare header (2")
        - Tie-in to Liquids return header to flare knock out drum (2")
        - Tie-ins to closed drains header (2")
- Power generation
    - The installed power for the steam boiler is 66 kW, the other electrical items i.e. pump, lighting, tracing & instruments is estimated at 3 kW, the addition of the ACHE fan motor would be < 5 kW and the hydrocarbon return pump would add <1 kW.
    - The demineralised water package (ion exchange beds) is assumed to have negligible power consumption. The demineralised water pump motor would be < 1kW.
    - Total additional power consumption for MPPE is estimated at ~75 kW. As advised by Beach energy there is approximately a spare 200 kW available to still fit comfortably within the existing rated gen sets.
- Control Systems
    - Works are required to the substations to incorporate and make provisions for the operating and control systems of the MPPE package into the DCS/ESD. Veolia have indicated 32 instruments as part of their package and it is estimated there will be another 8 for the BFW supply.
- Other utilities
    - It is assumed all other utilities e. nitrogen for purging and instrument air have adequate capacity and do not require upgrades other than allowing for the necessary tie-ins.

# 3 Steam Stripping Package

Preliminary information regarding the steam stripping option has been provided by Beach energy (Appendix A).

Figure 2-1 shows a sketch of the proposed works associated with installing a stream stripper unit with further description below.

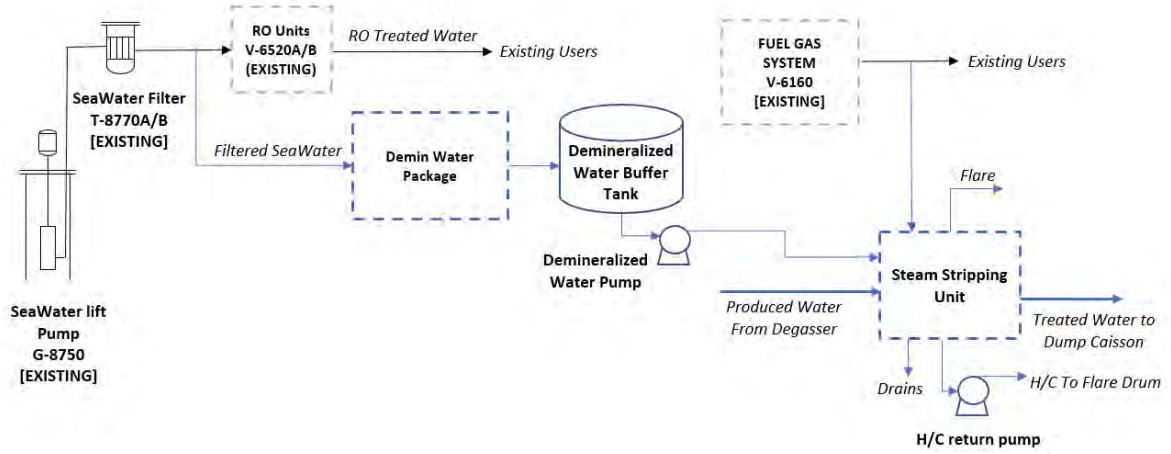



*Figure 3-1: Sketch for Steam Stripping option*

- Steam stripper package
    - The steam stripper package includes; buffer tank, PW booster pump, cross exchanger, stripping column, overheads condenser, BTEX accumulator, reflux pump and steam boiler.

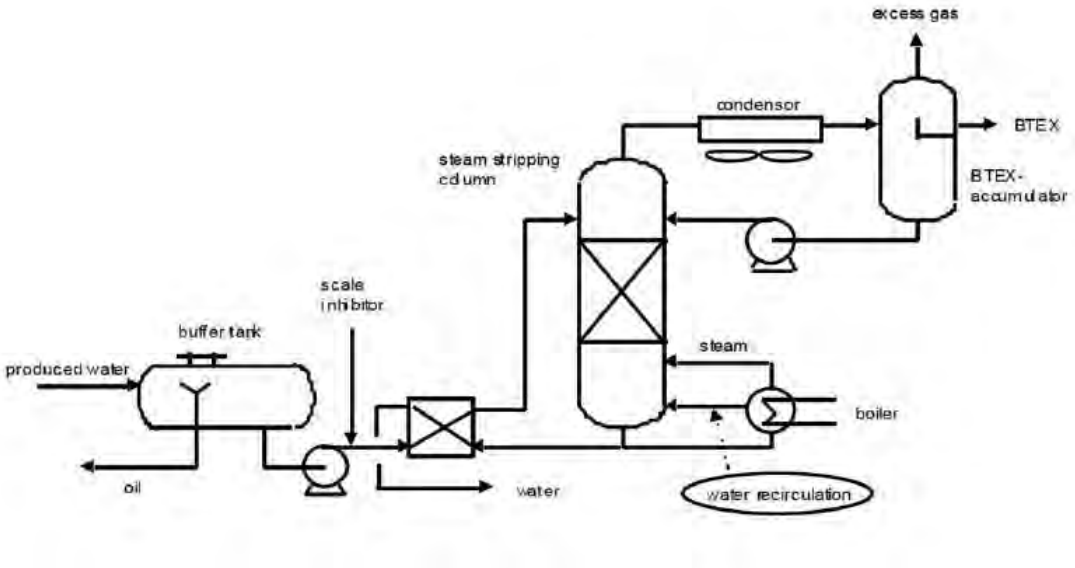



*Figure 3-2: Steam stripping unit*

  - Scaling from the available data provided the estimated dimensions and weight of the steam unit is
    - L x W x H: 7.2m x 3.3m x 5m
    - Weight: 23 t

- BFW / demineralised water package
  - Figure 3-2 indicates that some treated produced water flow is recirculated to the boiler to generate the steam. This study has assumed all the necessary steam is generated from demineralised water.
  - The required BFW rate is estimated on a ratio of 1:30 to produced water feed. At a design rate of 300$m^3$/d (12.5 $m^3$/h) his equates to 10$m^3$/d (0.42$m^3$/h) or ~420 kg/h of steam required.
  - Allowing a margin, a demineralised water package of 0.5$m^3$/h has been allowed. This would equate to about 55% of the existing RO unit's capacity. This has the potential to overload the units and risk the supply of potable water to the accommodation block. Therefore, a new demineralised water package would be installed upstream of the existing RO units / downstream of the Seawater filters.
  - The existing sealift pump has a capacity of 12$m^3$/h with a discharge pressure of 1000 kPag. It is assumed it has spare capacity to supply the additional 0.5$m^3$/h through the demineralised water package to the buffer tank without modification.
  - It has also been assumed that a demineralised buffer tank (~12$m^3$ i.e. 1 day reserve) and pump (0.5 $m^3$/h) will be installed (close to the MPPE package boiler) to ensure constant supply to the boiler.
  - The total installed electrical power required to generate this steam is estimated at 400 kW. This is too large for the existing gen sets to provided (only ~200 kW available) hence a fired (gas fuelled) boiler is required. The fuel gas required is approximately 50 kg/h which is considered within the capacity of the existing fuel gas system [capacity >3,000 kg/h] therefore no upgrade to the fuel gas system has been made.
- Hydrocarbon Return Pump
  - A cost allowance for a 1 kW pump to return hydrocarbon from the buffer tank to the flare KO drum has been made.
- Demolition
  - It is assumed that the existing Produced water filters will be demolished, and the steam stripper package installed in its location. It is assumed that the demineralised water package will be installed close to the existing RO units (Refer section 5), however if there is inadequate space it may need to be located next to the stripper unit. The Demin Water buffer tank will be located close to the Stripper package.

- Piping Tie-ins include;
    - PW tie-in between PW filters and dump caisson (3") to install steam stripper package
    - Tie-in to water system to install Demineralised water package (1")
    - Tie-in to Liquids return header to flare knock out drum (2")
    - Tie-in to the fuel gas supply system (2")
    - Tie-in to flare header (3")
    - Tie-ins to closed drains header (2")
- Power generation
    - As stated above the assumption is the steam boiler with be fired and not electric. The other power users i.e. water supply pump, condenser fan, reflux pump along with lighting, instruments etc is expected to be <10 kW.
    - The demineralised water package will have negligible power consumption. Associated chemical injection Pulsation pumps will likely be air driven. The demineralised water pump motor will be <1 kW.
    - Total additional power consumption for steam stripper is estimated at ~10 kW. As advised by Beach energy there is approximately a spare 200 kW available to still fit comfortably within the existing rated gen sets.
- Control Systems

  Works are required to the substations to incorporate and make provisions for the operating and control systems of the steam stripper package into the DCS/ESD. It is estimated that there will be about 25 instruments in total.
- Other utilities
    - It is assumed all other utilities e.g. nitrogen for purging and instrument air have adequate capacity and do not require upgrades other than allowing for the necessary tie-ins.

# 4 Gas Stripping Unit

For the gas stripping unit it is assumed that the previous gas stripping column arrangement will be re-instated. Works involved are:

- Installation of the gas stripping column
    - 0.4m ID x 10.6 F/F
    - Weight 1.6t [Column = 1.4t, internals 0.2t]

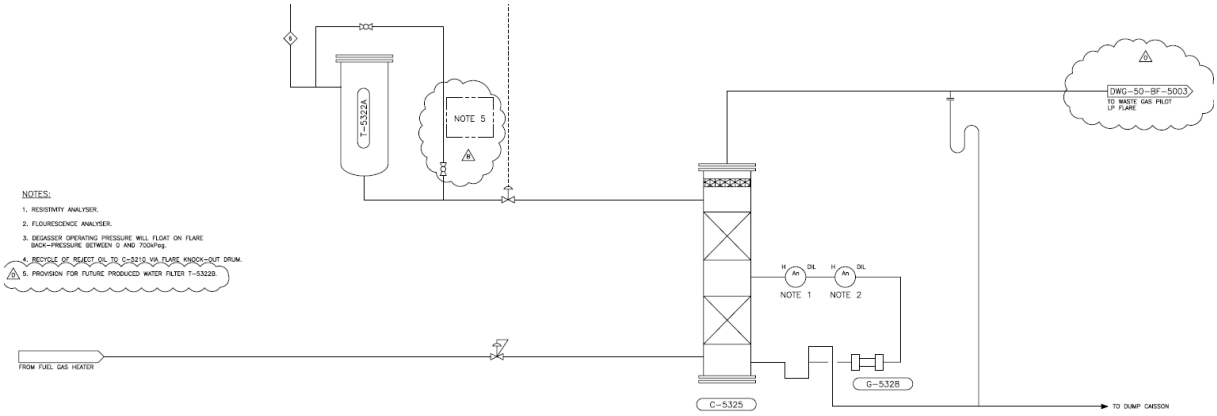



*Figure 4-1: Original PW Stripper (with fuel gas)*

- Fuel Gas System
    - As this is a re-instatement of the original design and an additional fuel gas conditioning unit has been installed to support the booster compressor, it is assumed there is adequate fuel gas supply capacity and no upgrade required.
- Tie-ins
    - Tie-in between PW filters and dump caisson (3")
        - PW sample show in Figure 4-1 is to remain in current position close to dump caisson and to not be reconnected to the column.
    - Tie-in to the fuel gas system (2")
    - Tie-in to the flare header (3")
    - Tie-in the drains header (2")
- Demolition
    - For this option is assumed that the existing Produced water filters will NOT be demolished and that the stripper column be installed next to the filters on the upper deck.

- Power generation
    - No additional power uses to be added as part of this option.
- Control Systems
    - Works are required to the substations to incorporate and make provisions for the operating and control systems of the steam stripper package into the DCS/ESD. It is estimated there'll be 8 instruments to connect.
- Other utilities
    - It is assumed all other utilities e.g. nitrogen for purging and instrument air have adequate capacity and do not require upgrades other than allowing for the necessary tie-ins.

# 5 Layout

Layout was listed as an exclusion in the Scope of Work and has not been investigated in any detail, however the location of the equipment does have a significant bearing on the cost of construction. Therefore, a brief review of the Yolla layout drawings and 3D model has been performed to make assumptions of where the equipment could be located. The locations proposed have been shown in Figure 5-1 and has formed the basis for the cost of construction. The feasibility of using these locations requires a more thorough investigation.

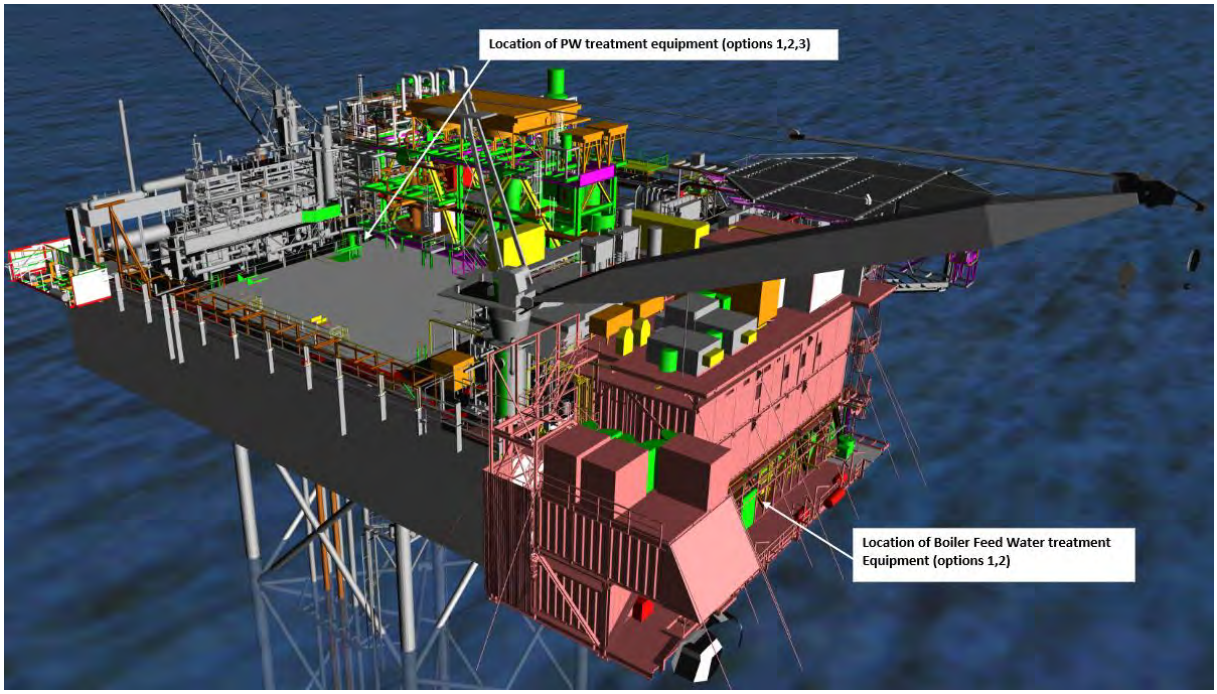



*Figure 5-1: Potential Equipment Locations*

## 5.1 Main processing equipment

For this assessment it has been assumed that for either of the 3 options the main equipment items i.e. MPPE package, the Steam stripper package or the gas stripper column would be installed on the main deck area where the current produced water filter and chemical injection skid are installed. These items would need to be removed/relocated as required.

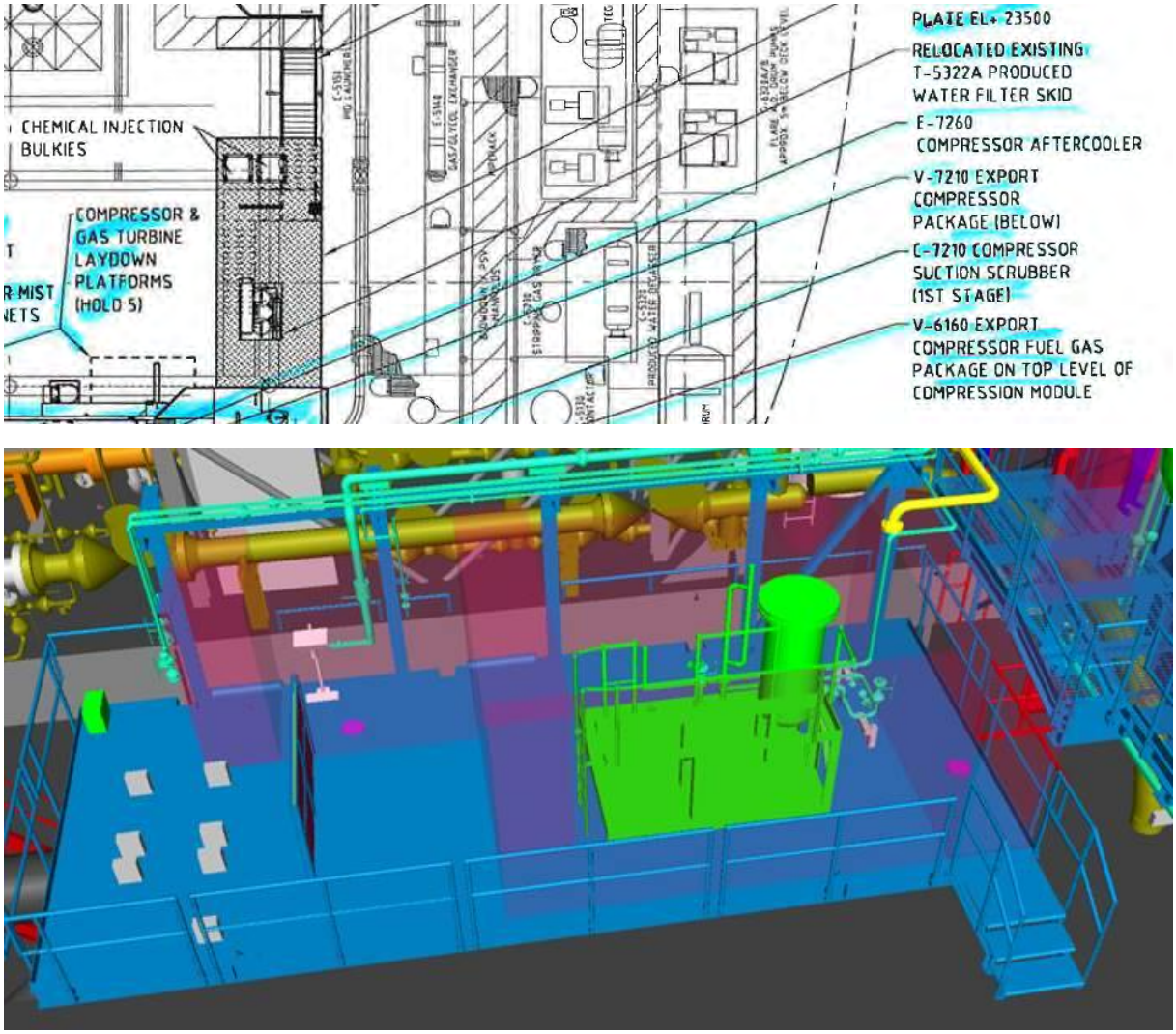



*Figure 5-2: Existing PW Filters*

## 5.2 Demineralised water generation equipment

For the options that require steam i.e. the MPPE and steam stripper option, the equipment required for pre-treating the boiler feed water is assumed to be installed on the accommodation utilities level where the existing water utilities (RO units, freshwater tanks, sea water filters etc.) are installed. It is assumed that relocation of some of these items may be required in order to fit the new equipment items in. For the steam stripping option, the demineralised water package may not fit into this location and alternatively it too would need on the upper deck close to the steam stripping package.

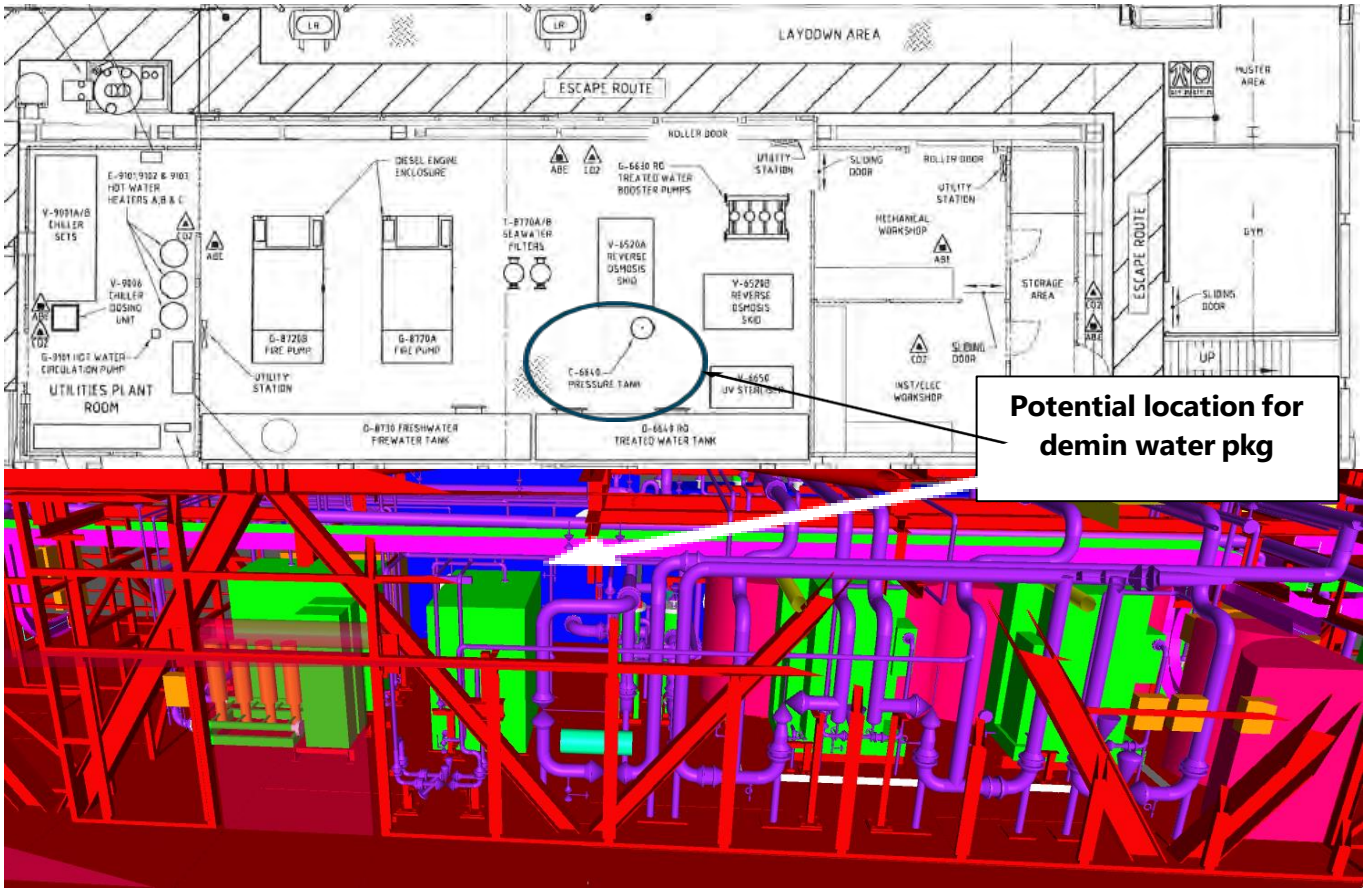



*Figure 5-3: Existing water handling facilities*

# 6 Cost Estimates

A summary of the cost estimates is provided in Table 6-1 with full costing spreadsheets provided in Appendix C. Estimates have been prepared for three cases:

- MPPE
- Steam Stripper
- Gas Stripper

The estimated CAPEX ranges from $18.2 million for the Steam stripper option to $7.9 million for the gas stripper option. These estimates are P50 estimates including a 30% to 40% contingency, the P50 cost is the most likely cost that has an equal probability of being underrun or overrun.

The estimate has been prepared using budget quotes from previous work for the MPPE and steam stripper equipment, other equipment is estimated using historical metrics escalated to todays costs. Bulks have been generated using bulk weight factors. All installation costs have been estimated by task allowing a crew size, duration and productivity factor for each activity. The procurement, fabrication and installation give the total direct costs.

Allowances have been added for design growth, engineering, project management and insurance as a percentage of direct costs. A 30% contingency is added to the bottom line to allow for unknowns.

*Table 6-1: Total Installed Cost (TIC) Summary*

| AUD ($Millions) | MPPE | STEAM STRIPPER | GAS STRIPPER |
|---|---|---|---|
| Equipment Costs | 1.92 | 2.42 | 0.19 |
| Bulks | 0.14 | 0.23 | 0.03 |
| Mobilisation / Demobilisation | 0.54 | 0.54 | 0.54 |
| Construction | 4.80 | 5.71 | 2.88 |
| Engineering / Project Management | 2.60 | 2.99 | 1.52 |
| Allowances | 0.52 | 0.64 | 0.16 |
| Contingency | 4.84 | 5.69 | 2.57 |
| TOTAL INSTALLED COST | **15.4** | **18.2** | **7.9** |

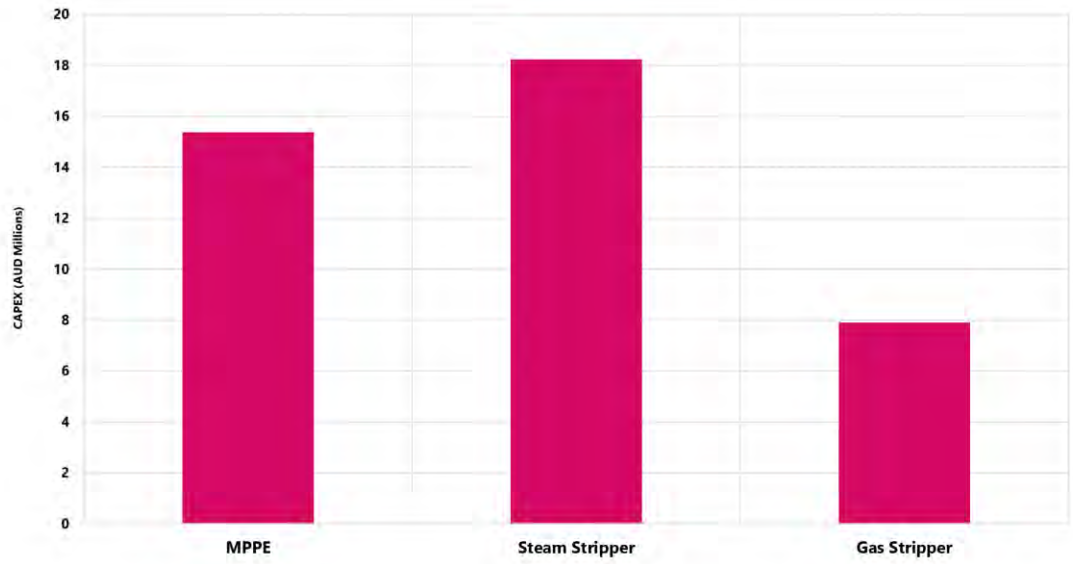



*Figure 6-1 CAPEX by option*

The Gas Stripper is the least expensive as it requires the least amount of equipment to install. However, as the original gas stripper was removed from Yolla, additional investigation is required to confirm that the new column would be able to meet the necessary specification.

The Steam Stripper is the most expensive due to the size and quantity of the processing equipment to install and requires the most steam. This option would have the most difficulty in finding the necessary layout, especially trying to fit the new demineralised water package close to the existing water handling facilities.

The MPPE option is less than the steam stripper however does make the assumption that condenser could be replaced with an air cooler. If cooling water is required, then modifications to the water handling system would be required i.e. installation of a demineralised water package which would make the costs fairly similar to the steam stripper option.

The following basis has been used for this study;

- All costs in 2019 AUD
- Exchange rate of 1 Euro = 1.62 AUD [spot rate at 6-December-2019]
- An all-inclusive Labour rate of $280 / hr consisting of overheads, transport, accommodation, food, tools and consumables.
- A productivity factor of 50% or 60% has been applied to offshore works.
- No owners' costs have been allowed
- Assumes the utilities are adequate except where specifically specified for each option.

- Assumes demolition work is minimal i.e. removal of filters and existing water handling equipment.
- Allowances have been added as a % of costs
    - Freight at 8% of equipment and bulks procurement
    - Spares at 5% of equipment procurement
    - Insurance and certification at 3% of total direct costs
    - Design growth at 3% of total direct costs
    - Engineering at 8% of fabrication costs and 20% of offshore costs
    - Project Management at 10% of fabrication costs and 25% of offshore costs
    - Contingency at 30% of fabrication costs and 40% of offshore costs

# 7 References


1. Origin, Yolla PFD, Produced Water Degasser, DWG-50-BF-5005 Rev 0
2. Origin, Yolla UFD, Water Handling System, DWG-50-BF-6601-2P, Rev P1
3. Origin, Yolla P&ID, Produced Water Stripper, DWG-50-BP-5305 Rev 1
4. FEGL/Origin, FD101-4 RO Watermakers, UV Sterilizer Package, Manufacturing Record Book (MRB), T-5150-40-RP-B002-906, Rev 0
5. GLP Plant, Produced Water Degasser Stripper C-5325, Manufacturing Data Record (MDR), 35101304-BG000502-007, Rev A

# Appendix A
# Scope of Work

Beach Energy Limited | ABN 20 007 617 969
Level 15, 150 Latrobe Street Melbourne, Victoira 3000
**beachenergy.com.au**

21 November 2019

**Project to Determine TIC of a Produced Water Treatment Facility on Yolla Platform**

## SCOPE OF WORK

Beach Energy require an indicative estimate to perform works associated with generating a total installed cost to modify Yolla platform with a facility to remediate the produced water system. The project is at pre-concept stage only and only requires indicative estimates against each option.

Use in-house cost engineering experience and/or industry cost estimating software for an offshore facility. Allowances to include engineering design, procurement, construction, construction management and commissioning.

**Design Basis**

Facility will handle up to design maximum of 300m3/day of produced water.

Target to reduce total hydrocarbons (free and dissolved) to no more than 10 mg/litre. Currently typically about 80 mg/litre comprising mostly dissolved BTEX.

Three treatment options have been identified:

(1) MPPE Unit
(2) Steam Stripping Unit
(3) Gas Stripping Unit

**Schedule**

Target by close of business Friday, 13th December 2019

**Deliverable**

Cover note and a spreadsheet outlining indicative costs for each option.

**OPTIONS:**

### (1) MPPE Unit

A quotation and sizing/weight for a Macro Porous Polymer Extraction (MPPE) unit has been requested from a vendor Veolia. Quote expected by start of week of 25-Nov which will include steam generation capacity. This estimate will be forwarded as soon as it is available.

Allowance for utility/process connections include power supply, treated water supply, cooling, flare/drains:

- Allow for some substation works, expect to have adequate capacity from existing gensets.
- Allow for cooling water mods from downstream of filters and return line to dump caisson. Assume existing seawater pump has adequate spare capacity.

- Allow for some upgrade to water supply ex RO units, and chemical injection eg BFW treatment Assume produced water can gravity flow from existing Degassing Vessel.
- Allow for pump to deliver recovered hydrocarbons to Flare KO Drum
- Allowance for integration into DCS/ESD systems.
- Scale up estimated weight from package estimate from vendor. Factor weight for piping and connections.

### (2) Steam Stripping Unit

Attached document provides 2012 estimates for a steam stripping unit. Consider a factored cost based on capacity, year and location, and for duplex vs carbon steel.

Allowance for utility/process connections include power supply, treated water supply, cooling, flare/drains:

- Allow for some substation works, expect to have adequate capacity from existing gensets.
- Assume doubling the size of the existing seawater pump.
- Allow for some upgrade to water supply ex RO units, and chemical injection eg BFW treatment Note: Indicative water/steam ratio of approx. 30-40:1. Assume 30:1, therefore steam rate from 10m3/hr of feed water. Allow for 8MW gas fired steam boiler. Allow for upgrade of fuel gas facility.
- Assume produced water can gravity flow from existing Degassing Vessel.
- Allow for pump to deliver recovered hydrocarbons to Flare KO Drum.
- Allowance for integration into DCS/ESD systems.
- Scale up estimated weight from package estimate from vendor. Factor weight for piping and connections.

Clarified in email with Richard Walls (03-Dec-19) that this should have been per day not hour making boiler duty ~400kW [Email attached at end of SoW]

### (3) Gas Stripping Unit

Assume a Gas Stripping Column similar to what was removed from Yolla a few years ago. Refer attached historical P&ID.

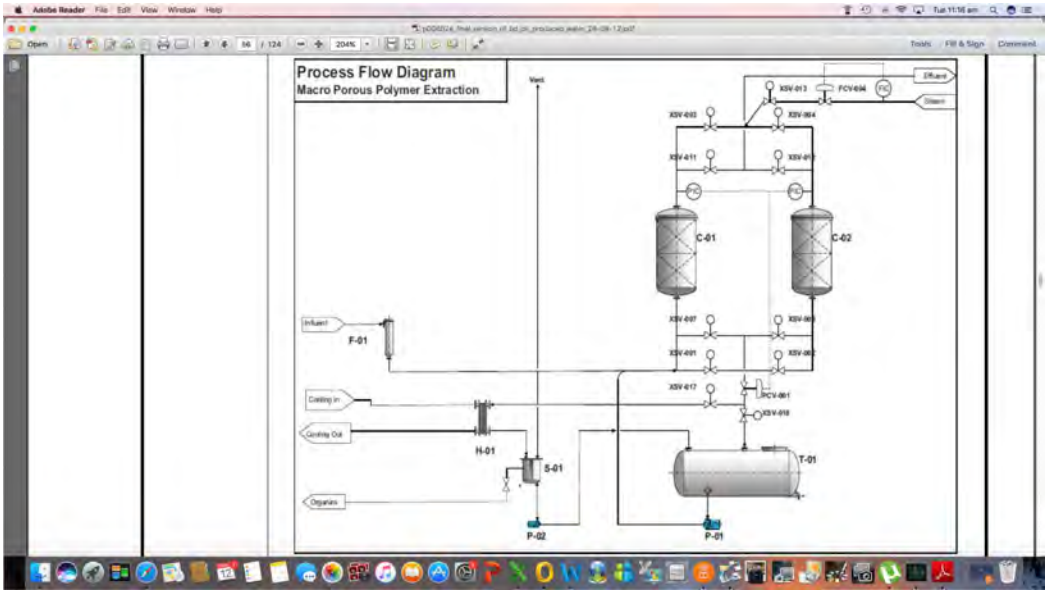
Allowance for utility/process connections include flare/drains:

- Allowance to have validation of the design and process guarantee.
- Allowance for integration into DCS/ESD systems.
- Use estimated package weight from previous design. Factor weight for piping and connections.

Exclusions:

1. No allowance for Owner's costs.
2. No assessment for layout
3. No assessment of existing platform spare weight capacity.
4. No estimate for duration of platform outage to install.

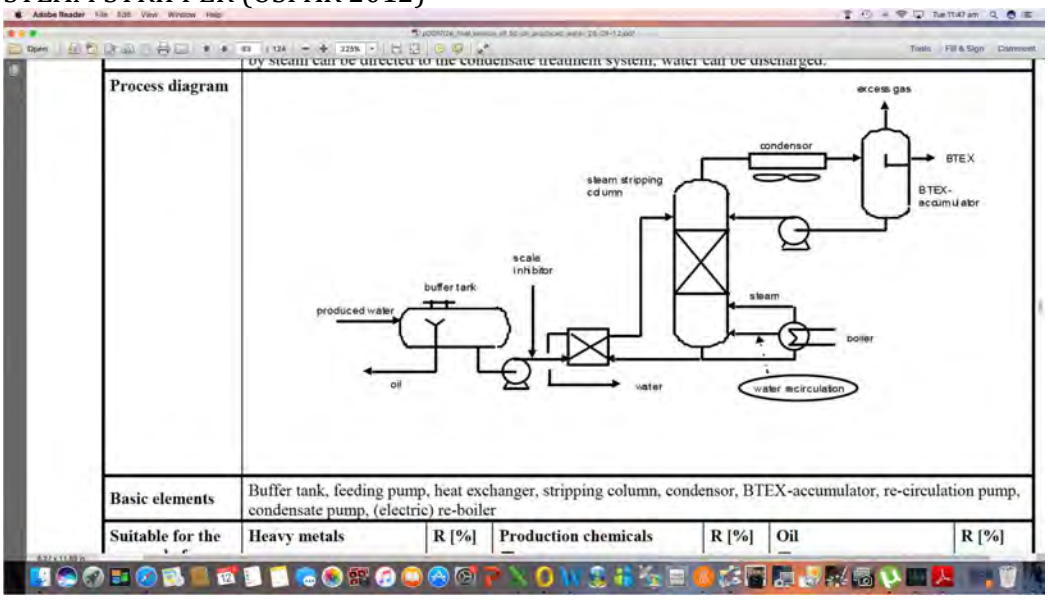
# MPPE Information (OSPAR 2012)




| | Per Unit | Minimum | Maximum |
|---|---|---|---|
| **Technical details** | Treatment capacity (m3 produced water per hour) | 0,3-15 | 150 |
| | Gross Package volume (LxWxH) | 6,2 x 4 x 3 m | 10 x 6 x 12 |
| | Operating weight | 10 ton | 250 ton |
| | CAPEX (€) | 1 000 000 (2012) | 10 000 000 |
| | OPEX (€/year) | 50 000 (2012) | 250 000 |
| | Cost per m3 produced water(€/m3) | 0,60 (2012) | 0,24 |

| | |
|---|---|
| **Critical operational parameters** | The main critical parameter is the measured outlet concentration vs. discharge limit. If this comes close to the discharge limit the MPPE material needs to be replaced. This is a very slow process (Years) and can be done say on a weekly basis. The reduction performance is very stable and does not change overnight. |
| **Operational reliability incl. information on downtime** | -The MPPE unit is fully automatic and remote controlled and has been in operation on an unmanned platform |

# STEAM STRIPPER (OSPAR 2012)




| | | | | |
|---|---|---|---|---|
| **Technical details** | Platform | Gas 1 (small) | Gas 2 (large) | Oil 1 |
| | Produced water volume (design) | 1 m3/h | 6 m3/h | n.a. |
| | Required area (LxWxH) | 3 x 2 x 5 m | 6 x 3 x 5 m | |
| | Mass (filled) | 12 tonnes | 20 tonnes | |

**Critical operational parameters**

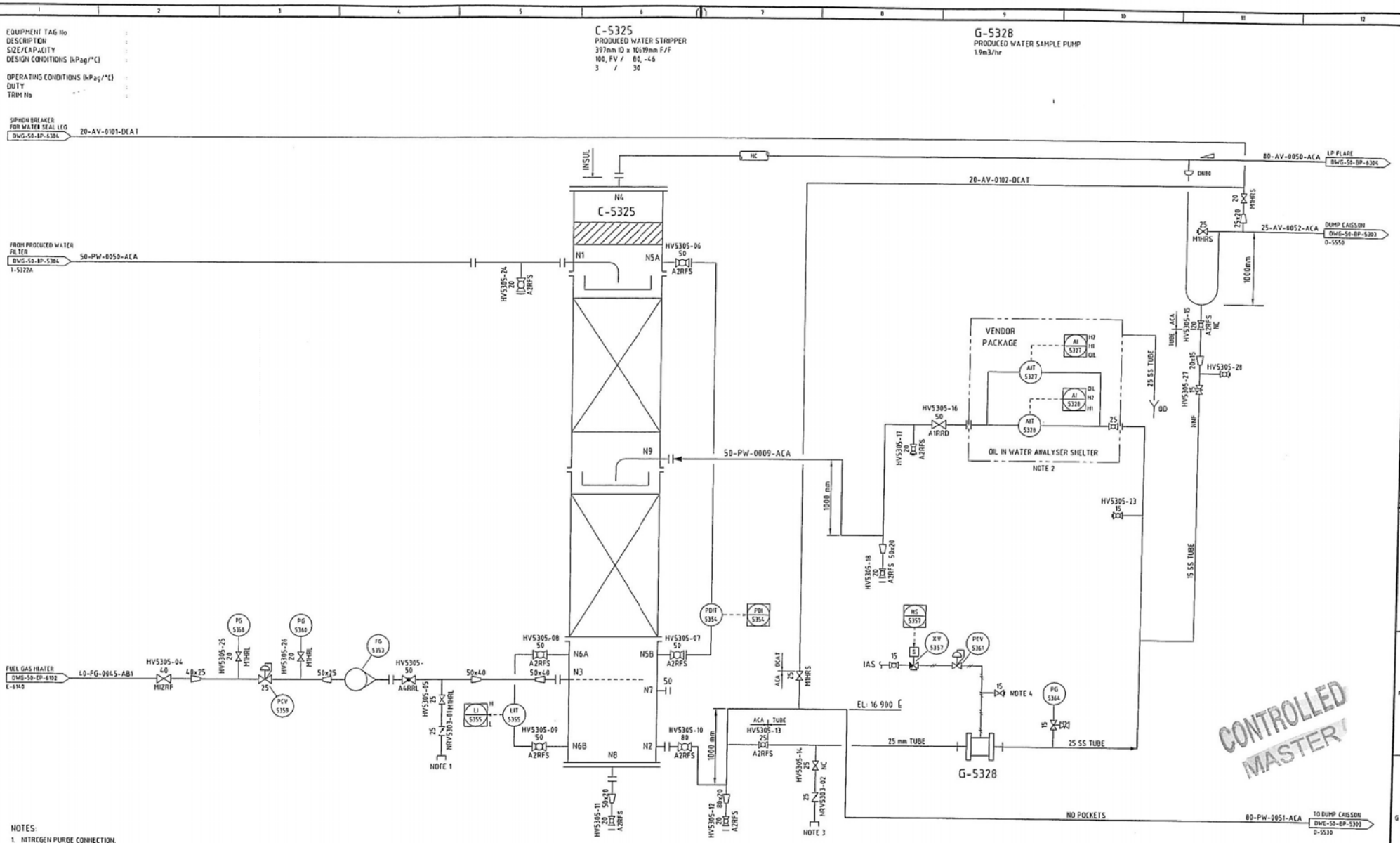
Since produced water usually contains salts and solid particles, problems with depositions (scale) may occur in the boiler and the heat exchanger. In order to prevent concentration of salts in the boiler, it is recommended to create a slight throughput by means of a re-circulation line from the boiler to the column. The steam line must be large enough in order to allow for equal levels in boiler and column (and above the bundle of the boiler). In order to guarantee a constant throughput, a buffer tank is required. This also provides the possibility to skim off oil, avoiding disruption of the process in the column.

**Operational reliability**

When the produced water contains large amounts of salts, the installation will need to be shut down regularly to enable removal of salt depositions.

The expected removal efficiency for BTEX is high: reduction from 50 mg/l to < 6 mg/l, aliphatic hydrocarbons from 30 mg/l to < 3 mg/l . Removal efficiencies of >90% for Dissolved oil, BETX, benzene and PAHs.

| **Costs** | Investment costs (CAPEX) [€] 2012 | | Exploitation costs (OPEX) [€ / year] | |
|---|---|---|---|---|
| | present | new | present | new |
| gas platform, small | 670 000 | 560 000 | 238 000 | 169 200 |
| gas platform, large | 990 000 | 840 000 | 401 400 | 276 900 |
| oil platform | n.a. | n.a. | n.a. | n.a. |




NOTES:

1. NITROGEN PURGE CONNECTION.
2. ANALYSER MOVED FROM P&ID 5302.
3. CONNECTION FOR FRESH WATER.
4. PRESSURE TAP CONNECTION.

| DRAWING NO. | REFERENCE DRAWING TITLE | REV | DATE | REVISION DESCRIPTION | DRAWN | DWG CHECK | DESIGN |
|---|---|---|---|---|---|---|---|
| | | 0 | 7/06 | AS BUILT | KW | KLM | BFK / CS |

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| DESIGN | | |
| DESIGN CHECK | | |
| DRAFT, SUPER. | BFK | 7/06 |
| PROJECT APPROVAL | CS | 7/06 |

TITLE: BASSGAS YOLLA A PLATFORM
PRODUCED WATER STRIPPER
PIPING & INSTRUMENTATION DIAGRAM

PROJECT NO. 35111734
DRAWING NO. DWG-50-BP-5305
REVISION 0
SCALE NTS
CADFILE DWG-50-BP-5305-00.dwg
A1

Fri, 03 Nov 2006 - 2:08pm

## George, Richard (Melbourne)

**From:** Richard Walls <Richard.Walls@beachenergy.com.au>
**Sent:** Tuesday, 3 December 2019 8:38 AM
**To:** George, Richard (Melbourne)
**Cc:** Bruzzaniti, Arlette (Melbourne); Adinolfi, Carolina (Melbourne); Henzell, Steve (Melbourne); Perri, Antony (Melbourne)
**Subject:** RE: Request for quote to provide indicative cost estimate for works on Yolla[External Sender]

** [EXTERNAL SENDER] Do not click links or open attachments unless you recognize the sender. **

Nice pick up Richard.
Agree that it should have been 10m3/day.

R

Richard Walls | Service Provider to Production Optimisation Team LEad VIC/NZ | Beach Energy Lim

Level 15, 150 Lonsdale St, Melbourne, VIC 3000

E: Richard.Walls@beachenergy.com.au
Reception: +61 8 8338 2833 W: www.beachenergy.com.au

This message is intended only for the use of the addressee. This email and any attachments are confidential and may contain legally privileged information return email and delete the original message without making a copy. It is important to check for viruses and defects before opening or using attachments. B

---

**From:** George, Richard (Melbourne) <Richard.George@advisian.com>
**Sent:** Friday, 29 November 2019 4:32 PM
**To:** Richard Walls <Richard.Walls@beachenergy.com.au>
**Cc:** Bruzzaniti, Arlette (Melbourne) <arlette.bruzzaniti@advisian.com>; Adinolfi, Carolina (Melbourne) <Carolina.Adinolfi@advisian.com>; Henzell, Steve (Melbourne) <steve.henzell@advisian.com>; Perri, Antony (Melbourne) <antony.perri@advisian.com>
**Subject:** RE: Request for quote to provide indicative cost estimate for works on Yolla

Hi Richard

Just a question regarding the basis for the steam stripping option;

In the SoW it's noted that an indicative water/steam ratio of 30:1 is to be assumed, giving steam rate generated from 10m3/h of BFW. Should this be 10m3/**d?** i.e. total produce water to column is 300 m3/d. At 10m3/d (0.42 m3/h) the steam to the column is closer to 420 kg/h and the boiler duty comes down to ~300 kW as opposed to the 8 MW given in the SoW.

This would still result in the boiler needing to be fired not electric, but probably within the existing margins of the fuel gas system and the seawater lift pump.

Regards

**Richard George**
*Senior Process Engineer*

Level 13, 333 Collins Street | Melbourne, Vic 3000
**P** +613 8676 3587 | **M** +61 408 994 739
**E** richard.george@advisian.com
www.advisian.com

Advisian

**From:** Adinolfi, Carolina (Melbourne)
**Sent:** Thursday, 28 November 2019 3:56 PM
**To:** George, Richard (Melbourne) <Richard.George@advisian.com>; Henzell, Steve (Melbourne) <steve.henzell@advisian.com>; Perri, Antony (Melbourne) <antony.perri@advisian.com>
**Cc:** Bruzzaniti, Arlette (Melbourne) <arlette.bruzzaniti@advisian.com>
**Subject:** FW: Request for quote to provide indicative cost estimate for works on Yolla[External Sender]

FYI – See details from Richard below on Yolla power availability. I've filed email in the proposal folder.

Thanks,
Carolina

**From:** Richard Walls <Richard.Walls@beachenergy.com.au>
**Sent:** Thursday, 28 November 2019 3:04 PM
**To:** Adinolfi, Carolina (Melbourne) <Carolina.Adinolfi@advisian.com>
**Cc:** Bruzzaniti, Arlette (Melbourne) <arlette.bruzzaniti@advisian.com>; Adrian Cukovski <Adrian.Cukovski@beachenergy.com.au>
**Subject:** RE: Request for quote to provide indicative cost estimate for works on Yolla[External Sender]

**** [EXTERNAL SENDER] Do not click links or open attachments unless you recognize the sender. ****

Carolina/Arlette,
Follow-up item from the meeting:
Current power draw of Yolla is typically 900-1000 kW, spiking to 1050 kW. Several months ago, it was slightly higher, with spikes to nearly 1100 kW.
The rated power of the gensets is 1400 kW (P&ID BP-7101) each.
Guess we could allow additional power draw of up to 200 kW and stay comfortably within the genset capacity.

Richard

beach

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# Appendix B
# Vendor (Veolia) MPPE Quote

VEOLIA

# Proposal for Offshore Produced Water Treatment

**For:** Beach Energy
**End-user:** Beach Energy
Melbourne Australia

**MPP project:** M-199B
**Revision:** A
**Date:** 21-11-2019

WATER TECHNOLOGIES

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| Revision | Date | Status | Issued by | Checked by |
|---|---|---|---|---|
| A | 21-11-2019 | Budget | JBK | JBO |
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## Contents


1. EXECUTIVE SUMMARY 4
   - 1.1 Veolia's Solution to the Key Projects Requirements ..... 4
   - 1.2 Conclusion & Next Steps ..... 5
   - 1.3 Point of contact: ..... 6
2. COMMERCIAL 7
   - 2.1 Budget Estimate (CAPEX) ..... 7
   - 2.2 Operational expenditures ..... 7
     - 2.2.1 OPEX ..... 7
     - 2.2.2 Performance Guarantee & related Service Contract (PGS) ..... 7
   - 2.3 Value recovered Hydrocarbons (profits) ..... 7
   - 2.4 Price ..... 8
   - 2.5 Delivery conditions ..... 8
     - 2.5.1 Delivery type ..... 8
     - 2.5.2 Time of Delivery ..... 8
3. PROCESS DESIGN 9
   - 3.1 Design conditions and Separation performance ..... 9
4. GENERAL PROCESS DESCRIPTION 11
   - 4.1 Description including a Return Tank ..... 11
5. DESIGN ASSUMPTIONS AND CONSIDERATIONS 13
6. UNIT PROPERTIES AND UTILITIES 15
   - 6.1 Estimated Sizing & Weight ..... 15
   - 6.2 Estimated Utilities Consumption ..... 15
7. SCOPE OF SUPPLY 16
   - 7.1 Engineering services ..... 16
   - 7.2 Functional duration test with water prior to shipment ..... 16
   - 7.3 Spare parts for commissioning and Start up ..... 16
   - 7.4 Referenced Documents and Standards ..... 16
   - 7.5 Equipment supply ..... 16
   - 7.6 Preferred suppliers ..... 18
8. MPPE PROCESS : CHARACTERSTICS & PROVEN EXPERIENCE 19
   - 8.1 MPPE Flexibility and Robustness ..... 19
   - 8.2 MPPE Experience, Reliability and Performance ..... 19
   - 8.3 References ..... 20

ATTACHMENT 1: TYPICAL CONTAINER LAY-OUT 21

ATTACHMENT 2: TYPICAL PFD FOR REDUNDANT COLUMNS MPPE UNIT 22

ATTACHMENT 3: CASE SHEETS 23

# 1. Executive Summary

***A proven safe, robust and one-step solution to efficiently remove dispersed & dissolved Hydrocarbons and Mercury from Produced Water.***

Beach Energy has requested Veolia Water Technologies Techno Center Netherlands B.V. to provide preliminary budget proposal including design, sizing and weight information for a MPPE unit treating Gas Produced Water from an existing Offshore Platform.
We have based our Technical proposal on the received website inquiry data and communication by phone.

The present Technical proposal accounts for general O&G specifications in terms of engineering, quality, inspection and documentation, but some deviations on HFE requirements with regards to spacing and accessibility might be applicable mainly due to the fact that the unit has been contained in a 20' Sea container.

We are investigating the option for long term rental of the unit through our local Australian office.

Veolia has been supplying on- and offshore MPPE units for Gas Produced Water since 1994. MPPE Technology treats the Gas Produced Water on for instance for Shell Prelude, Inpex Ichthys, Equinor Kollsnes, Shell Ormen Lange and Woodside Pluto.

## 1.1 Veolia's Solution to the Key Projects Requirements

| Key Project Requirement | Veolia's MPPE System Solution |
|---|---|
| Achieve the required Effluent quality | Yes |
| Treat a maximum inlet flow rate of 12.5 m3/h | Yes |
| Ability to maintain removal efficiency independent of Feed concentration | Yes |
| Ability to handle emulsions that maybe present | Yes |
| Ability to remove Mercury if present | Yes, removal rate 90% - 98% |
| Most compact solution possible | Yes, the Sea container version is the most compact and easy to install solution. However an open skid mounted unit may also be offered. |
| Value added benefits of Veolia's solution | • *Full recovery of hydrocarbons for sale*<br>• *Fully regenerable system providing certainty of OPEX costs & performance irrespective of influent hydrocarbon levels*<br>• *Proven performance to handle slugs of oil or increased BTEX levels as seen in LNG related wastewater as high as 2500 mg/l* |
| Performance impact due to motion | No impact |

**MPPE Features & Benefits**

| MPPE Features | Benefits to the Project |
|---|---|
| 1. Very High Separation Performance | • MPPE technology removes dissolved and dispersed hydrocarbons with high reduction factor (any removal rate from 80% to 99.99%).<br>• Reduction factor independent of inlet concentration. I.e. the design is made for a certain reduction rate. So when designed for 99% removal 100 ppm will be reduced to 1 ppm and 500 ppm to 5 ppm. |
| 2. Robust, No Fouling | • No interference from dissolved iron, heavy metals, surfactants, salt and polar compounds, and no scaling<br>• No biological fouling because of periodic in situ regeneration by steam |
| 3. Reliable and Easy Operation | • Fully automated operation. NO operator intervention required for adjusting of settings or on-site controls.<br>• No special equipment requiring dedicated maintenance. |
| 4. Flexible Operation | • Turndown ratio up to 10%.<br>• Higher Feed concentrations can be treated at lower flow rates. For example, if the feed concentration is 50% higher, effluent requirements can still be maintained with only a 10% lower flow.<br>At lower feed concentrations, higher flows can be treated while still meeting the effluent demand.<br>• Immediate performance at start up<br>• Batch wise operation possible |
| 5. Compact Equipment | • MPPE offers a Single unit treatment. Compared to existing technologies, the unit is compact with a small footprint. |
| 6. No Chemicals uses No Sludge produced | • NO Chemicals required, thus NO HSE issues, NO logistics, NO dosing tweaking required and NO Chemical sludge produced requiring storage and dewatering.<br>• Removed hydrocarbons are recovered almost 100% pure and may be reused (blended). Thus no waste. |
| 7. Performance Guarantee during Operational Life | • The MPPE media performance is guaranteed through the Performance Guarantee Service Contract |
| 8. Environmental Benefits | • Long lifetime of media. Normally 2-4 years.<br>Spent media are collected by Veolia, cleaned and refilled with extraction fluid to be reused.<br>• Low energy consumption<br>• Low noise<br>• No off-gas produced |

## 1.2 Conclusion & Next Steps

We trust that we have supplied you with sufficient information and look forward to discuss further possibilities with you in detail.

Veolia is available to answer any questions you may have regarding this proposal and are excited at the prospect of working with Beach Energy on this project.
If this budget proposal is of further commercial interest, we would welcome the opportunity to present this proposal through tele- or videoconferencing and discuss the next steps along with their timing.

We would like to inform you that Veolia Water is the Number 1 water treatment company in the world. Veolia Water Technologies as part of Veolia Water is able to deliver you the whole portfolio of

water treatment technologies to treat your wastewater, produced water, process water and groundwater.

## 1.3 Point of contact:

Sales Manager: Jan Bart Kok
Phone: Office +31 318 664010
Direct +31 318 664006
Mobile +31 6 51335419
Email: janbart.kok@veolia.com

# 2. Commercial

## 2.1 Budget Estimate (CAPEX)

The CAPEX price is given for the engineering, manufacturing, equipment delivery, tests and inspection, optional functional duration test and services for a MPPE unit as described in following paragraphs. The MPPE material is supplied through the PGS contract (see 2.3.1).

For the Base Case, i.e. **including** Return Tank and Return Pump:

**€ 1,000,000.- (One Million Euro)**

## 2.2 Operational expenditures

### 2.2.1 OPEX

The annual operating expenditures consist of:

- A fixed annual fee for a Performance Guarantee & related Service (PGS) Contract
- Utility costs
- Operation and maintenance costs

Note that the recovered Hydrocarbons have a market value (equivalent to condensates) and can be considered as a revenue.

### 2.2.2 Performance Guarantee & related Service Contract (PGS)

An MPPE unit is delivered with an operational lifetime Performance Guarantee with related services, meaning that VWT Techno Center Netherlands B.V guarantees the Intermediate and Hydrocarbons removal efficiency over the lifetime of the MPPE unit.
This removal efficiency guarantee is covered in the Performance Guarantee and related Services (PGS) Contract. The PGS contract includes supply, replacement and return of the MPPE material, operations support, service and periodic control, access to new developments (process, automation etc.).

The fixed annual PGS fee, is independent of the number of MPPE exchanges per year and the performance guarantee is valid for the total operational lifetime of the MPPE unit.
At lower influent concentrations it is possible to run the unit at higher capacity (higher flow) while still meeting effluent requirements.
At higher influent concentrations than design it is possible to meet the effluent criteria at lower flows.
These conditions are all within the performance guarantee at no higher operational costs.

The PGS contract will be closed with the End user (owner and operator) and includes the following:

- MPPE material supply / exchange / return
- Columns internals inspection
- Performance guarantee during lifetime operation
- Performance control and optimization (based on remote control facility)
- Operations support by remote control and local support
- Access to new developments / improvements

Annual Fee: **€ 45,000 (Forty Five Thousand Euro)**

## 2.3 Value recovered Hydrocarbons (profits)

The recovered Hydrocarbons have a market value (assumed 65 $/barrel). Based on design Feed conditions and design removal rates the annual recovery is approximately **150 barrels per year i.e. $10,000 per year.**

## 2.4 Price

The price is based on the complete and undivided delivery.
Value Added Tax or similar fiscal imposition, any taxes such as withholding taxes which are in force or which may be introduced by the government, is not included in any price indicated in this proposal.

## 2.5 Delivery conditions

### 2.5.1 Delivery type

The delivery is FCA Workshop according to Incoterms 2017. Workshop location may be The Netherlands, Middle East or Asia. Location can only be fixed in during EPC, after contract award.

### 2.5.2 Time of Delivery

Under normal conditions the expected delivery time FCA Workshop is 12 months from PO acceptance.

# 3. Process Design

The design has been based on Feed flow rate and concentrations of Dispersed & Dissolved HC's and BTEX as specified.

## 3.1 Design conditions and Separation performance

| FEED CONDITIONS | | | |
|---|---|---|---|
| **Parameter** | **Unit** | **Value** | **Remark** |
| Design Flow rate ~~max~~ for ~~separation~~ performance guarantee. | m3/h | 12,5 | Note 1 |
| Feed pressure at flow | barg | 1 - 5 | |
| Temperature | C | <40 | Note 2 |
| | | | |
| **Inlet composition** | | | |
| Dispersed Hydrocarbons | mg/l | <40 | Assumed to be present as C11-C16 |
| Dissolved Hydrocarbons (aliphatic) | mg/l | <100 | Assumed to be present as C6-C10 |
| BTEX | mg/l | <60 | |
| **Total** | mg/l | **<200** | |
| Hg | mg/l | N/A | Note 4 |
| PAHs | mg/l | N/A | No information provided, note 5 |
| NPDs | mg/l | N/A | |
| Corrosion & Scale Inhibitors | mg/l | N/A | |

| DISCHARGE DATA | | | |
|---|---|---|---|
| **Parameter** | **Unit** | **Value** | **Remark** |
| Dispersed Hydrocarbons | mg/l | <5 | |
| BTEX | mg/l | <5 | |
| **Total HC** | **mg/l** | **<10** | |
| PAHs removal rate | Removal | >99% | Expected removal |
| NPDs removal rate | Removal | >99% | Expected removal |
| Temperature increase | C | 2-3 | Estimate |
| Flow rate outlet | $m^3/h$ | 0- 112% | Every hour: 7 min zero flow<br>Remaining time at 112% inlet flow. |
| Pressure at flow (approx..) | mwc | 12 | |

Notes:

**1) Maximum flowrate**

Hydraulic flow rate limitations are set by the pipe sizes used. Veolia allows for a maximum velocity in the pipe of 2.5 m/s. In this offer a pipe size of 2" is used allowing a maximum Feed Flow rate of approximately 15 m3/h (but at reduced removal efficiency).

**2) Temperature**

For the technology to be efficient the Feed temperature needs to be below 50 degC and preferably below 40degC.

**3) Inlet concentration of hydrocarbons**

It should be noted that the values for BTEX are low compared to what we see in other references. We have assumed that the C11-C16 is predominantly present as dispersed phase. The C6-C10 will be partly dispersed and partly dissolved.

**4) Mercury removal**

No information has been provided on the Hg level in the produced water, nor information on maximum discharge level is given.

In benchmark studies of current MPPE units a structural removal of total Mercury content of 80-99% has been observed. This phenomenon has been studied and Hg removal can be guaranteed at 90% for dissolved Hg, either metallic or ionic. Particulate Hg or Hg chemically bound to organic molecules are excluded from this guarantee.

**5) Removal of other constituents**

This MPPE process design is based on the dissolved & dispersed aliphatics and BTEX. Other extractable compounds like PAHs, NPDs (and partly field chemicals like corrosion/scale inhibitors) will also be removed. In principle a Zero Harmful Discharge to the Environment will be achieved.

## 4. General Process Description

The extraction process itself is a batch process but by using two columns, one in extractioj mode and one in regeneration mode, the process can be made continuous. This however requires a process sequence that will create an internal recycle which can be dealt with in two ways: (i) include a Return Tank, or (ii) make use of a projected feed tank or off-spec tank. The latter reduces the number of equipment and decreases the size and the weight of the MPPE unit, but does require the MPPE unit to be above and close to the projected tank. The two options are described below:

### 4.1 Description including a Return Tank

A Macro Porous Polymer Extraction (MPPE) unit consists of two columns, containing a packed bed of MPPE material. One Column is in extraction mode, the other in regeneration (figure 1). The MPPE media contain an immobilized extraction fluid that enables the extraction of hydrocarbons from the Feed water.

A cartridge filter protects the media from incidental off-spec solids. The MPPE-column C-01 is in operation and fed in up flow direction (blue line) . Column C-02 is in regeneration (yellow) and is heated up with Low-pressure steam. The temperature of around 102 C in the Bed is maintained for approximately 30 minutes. The extracted hydrocarbons contained in the media are forced out into the steam vapor. The vapor condenses in two phases – a water and a hydrocarbon phase - in a water cooled condenser. Density differences between the condensed phases allow a final separation of hydrocarbons and water in the Separator.

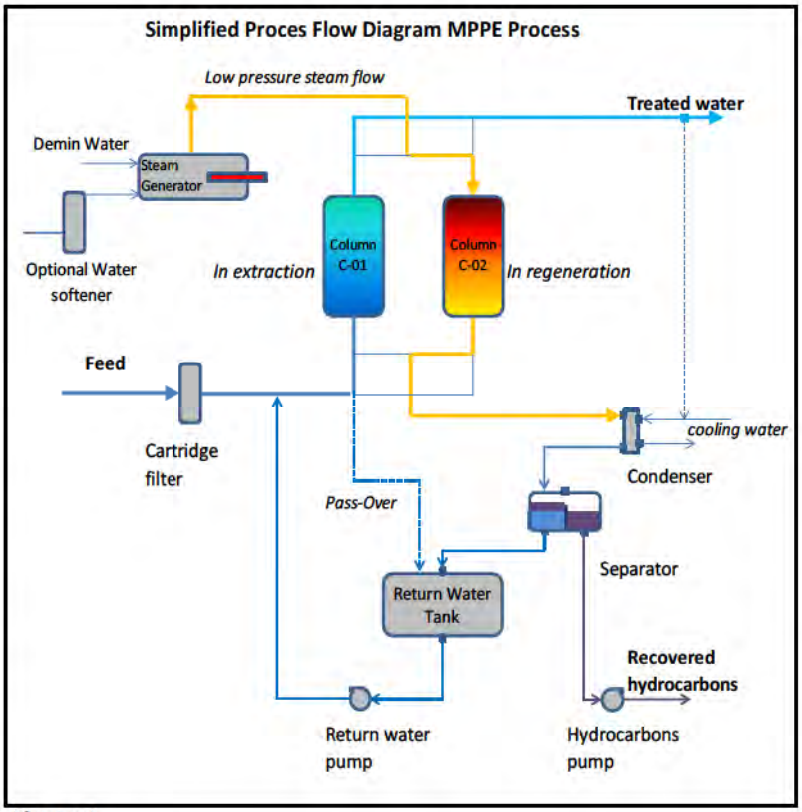



*Figure 1*

When the regeneration has completed (normally 1 hour) the operation of the Columns is switched. The hot regenerated Column C-02 is fed with Feed Water which is led to the Column C-01 to be regenerated. This so-called Pass-over enables cooling down of the regenerated Column and pre-heating of the Column to be regenerated. As the Pass-over Water coming from the Column is hot and containing elevated levels of hydrocarbons it cannot be discharged. The pass-over Water is led to the Water Return Tank and gradually fed back with the Feed Water over the next operational phase. The switching of Columns does not interrupt the Feed. The discharge of treated water is interrupted for several minutes during the Pass-over step.

The process is fully automated, flow rate adjusted and requires no Operator intervention. The process has a Turn-down ratio up to 10% of the design flow rate. The process operates at very low noise levels.

## Description of the No Return Tank option

The so-called Return water is required to buffer the drain (so-called Pass-over step) from the MPPE Columns during the Regeneration step. The buffered water is contaminated with HC from the Columns and is pumped by the Return Water Pump back to the Feed line of the MPPE Unit within one Regeneration cycle. The Return Water Tank (with related pumps and piping) can be deleted in case there is an external Buffer Tank available positioned below the MPPE unit (to allow gravity flow) and that has the option of pumping to the Feed of the MPPE unit. The Buffer Tank may either be an existing upstream Buffer Tank from which the Feed is pumped to the MPPE Unit or for instance Off-Spec Tank that has the option of pumping to the Feed line of the MPPE Unit (see figure 2).
The major advantage is the deletion of one floor (that holds the Return Tank and pumps) in the Base case unit resulting in a major weight, height and cost reduction.

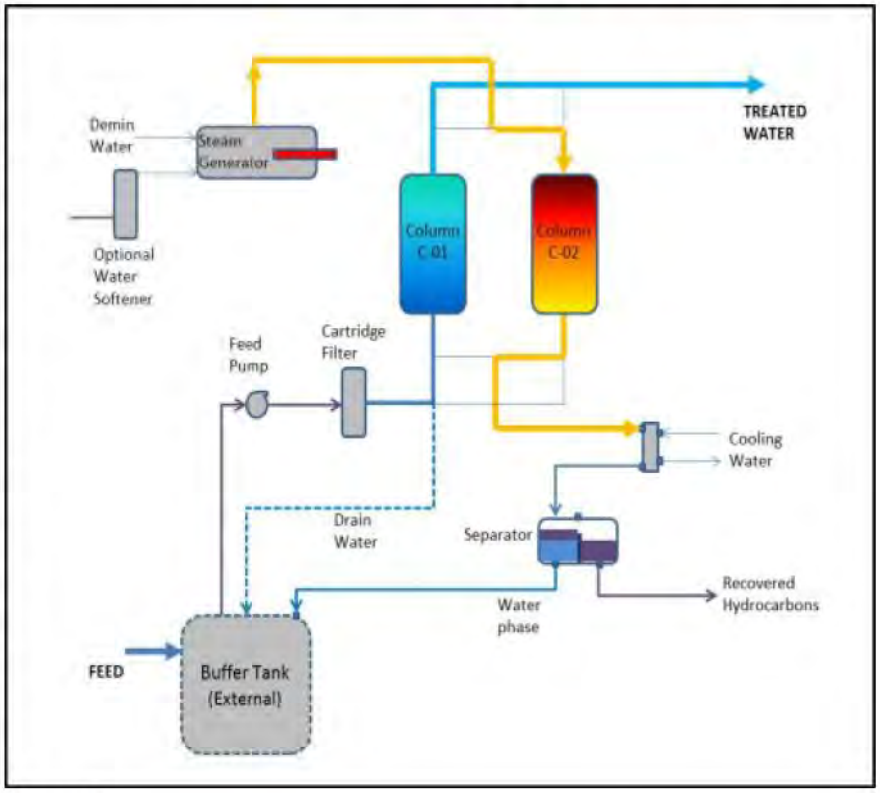



*Figure 2*

The following requirements apply for this option:

- Buffer Tank (upstream) Tank should be below and near to MPPE Unit to allow for gravity drain from MPPE Columns.
- Buffer Tank Feed pumps allow for approximately 4 m3/h additional flow rate on top of the design Feed Flow rate. Preferably VSD controlled to limit the Flow Control Valve pressure drop.

The following process consequences should be noted:

- The drain from the columns will be during approximately 3-15 minutes and has a temperature that is equivalent to the Feed temperature. However the last approximately 0.2 m3 will have a temperature of 95 C.
- The drain from the Columns may hold dispersed HC that may float in the Buffer tank. It is advised to have a skimming option in the Tank (something that is normally considered for this type of Tanks)

## 5. Design Assumptions and Considerations

The following assumptions and considerations have been used in the design:

1. **Build type**
   We have proposed a **containerized MPPE Unit**. The Unit will be supplied with all piping, electrical and I/O connections at battery limits. The on-site works for deck connection, connection of (external) piping, electrical and I/O cabling is by Client or third party local Contractor. Veolia will provide Supervisor for on-site support.

2. **Pre-treatment**
   A standard Cartridge type pre-filter is included for preventive reasons. As a default we assume that TSS content is low and particles are small in the Feed and that no continuous TSS removal is required. In existing MPPE units treating offshore Gas/Condensate produced water TSS is no issue and typical lifetime of the cartridges is 6-12 months.

3. **Material of construction**
   The material of construction for piping and vessels Duplex SS due to salt and sea environment and high design temperature of certain parts.

4. **Redundancy <u>OPTIONS</u>**
   - Cartridge Filters
     Cartridge Filters are supplied as 1 duty + 1 standby preventing a unit shutdown when filters are exchanged.

   - Condenser
     Condenser plates may foul depending on Feed and Cooling water composition. Generally the cleaning/inspection frequency is every 1-4 years. Redundant Condensers will allow for uninterrupted operations.

   - BTEX/Recovered Hydrocarbon pumps
     The BTEX/RHC pump discharges the Recovered Hydrocarbons from the Separator tank. The Separator Tank has a typical buffer capacity for Hydrocarbons of several days, allowing for repair/maintenance of the BTEX/RHC pump.

   - Water Return Pumps
     The Water Return Pump recycles the condensed steam and back-flow water into the Feed of the Unit. Discontinuation of operation can only be allowed for several minutes and does not allow for repair or maintenance works.

   - Redundant Extraction capacity
     Generally the efficiency loss of the MPPE media is very gradual. A required exchange of the media can be predicted months ahead. A media exchange requires a total stop of the operations. An additional set of 2 columns can be included as a warehouse (onshore/offshore) spare option for quick exchange (less than one working day). This however requires sufficient lay down area and access by crane with around 2 tons lifting capacity.

5. **Nitrogen/Fuel gas Blanketing option**
   Small volumes of "breathing" off-gas due to level variations in the Return Water Tank and the Separator are vented at a high point of the unit as default.
   Some environmental regulation may not allow breathing to the air. Connection to a venting, blanketing and/or flare system may be required and can be offered as an option.

6. **Specifications**
   We have accounted for typical O&G specifications in terms of required design & engineering, quality & inspection and documentation standards. However some specific Company requirements may lead to major design, lay-out or equipment changes that will impact price and supply time.

7. **Zoning**
   We have assumed that the Unit is placed in a Zone 2 area

8. **Control**
   The default supply consists of instrument cabling to Junction boxes on unit edge. Power cabling to be installed by client (separate cable trays are included in scope).
   Functional description as basis for programming of Client (central) control is included.

# 6. Unit properties and Utilities

## 6.1 Estimated Sizing & Weight

For typical GA please refer to Attachment 1, dimensions and weights are listed below

Base Case:
Estimated MPPE Unit sizing: 6.1 x 2.5 x 3.7 m (L x W x H) excluding external stairs and ladders
Estimated Weight: Empty 12 tons
Wet (max.) 15 tons

## 6.2 Estimated Utilities Consumption

Estimated Utilities Consumption below are based on Design conditions as listed in previous paragraph

| | | |
|---|---|---|
| Cooling water consumption Condenser (design conditions) | m3/y | 5.762 |
| *Assuming Cooling water temp. 25 C; max. temp. increase 15 C* | m3/h | 1 |
| Feed water Steam Boiler (design conditions) | m3/y | 494 |
| *Feed water quality should be better than 0.5 German hardness* | l/h | 91 |
| Annual steam consumption (LP: 110C; 1.5 bar abs.) | ton/y | 449 |
| Peak Steam flow rate | kg/h | 82 |
| Electrical consumption: eg. pumps, lighting, tracing, instruments | kWh/y | 25.448 |
| Electrical consumption Steam Generator | kWh/y | 203 |
| Installed Power Steam Boiler | kW | 66 |

# 7. Scope of Supply

## 7.1 Engineering services

Following major Engineering services are included:

| Item | Remark |
|---|---|
| Project Management and Detailed Engineering incl:<br>• Project Management<br>• Structural analysis and design,<br>• MPPE Process design<br>• Pipe stress analysis<br>• Thermal & Mechanical design of exchanger(s),<br>• Mechanical design of equipment<br>• Assembly of equipment, piping and MPPE skid (at Veolia Workshop)<br>• Inspections Equipment and at works Veolia workshop<br>• Packing | |
| Participation and technical support at<br>- Kick-Off meeting (1 meetings of 2 days)<br>- Progress meetings (max 2 meetings of 2 days),<br>- HAZOP (1 meeting of max 2 days),<br>- 30% 3D, 60% 3D and 90% 3D meetings (each meeting of max 2 days)<br>- Bi-weekly engineering conference (video or telephone) | |
| DCC and Documentation/certification as per Veolia standard | |
| MPPE Polymer first fill | Not included but part of the Performance Guarantee & Services Contract with End-user |
| Functional Test MPPE unit, incl software validation | Optional |
| Vendor assistance onshore and/or offshore, e.g. Pre-Commissioning, Commissioning, SAT and Ready For Start Up (RFSU) | Optional |
| Training for Company operations and maintenance personnel at Company Site or other nominated venue | Optional |

## 7.2 Functional duration test with water prior to shipment

Once completed, the MPPE unit will be fully functional tested including automatic extraction regeneration cycles. Apart from testing all equipment, this functional testing makes it also possible to "debug" the automation program (possibly made by client based on narratives supplied by MPP Systems). The functional test can be executed in the presence of End user/Contractor after which the MPPE unit is then "Plug and Play" ready for delivery.

## 7.3 Spare parts for commissioning and Start up

Commissioning and start up spare parts based on a standard list and included.

## 7.4 Referenced Documents and Standards

No Technical specifications and requirements have been forwarded by the Client at this stage.
We have assumed "general" Oil & Gas specifications for budget estimate purposes.

## 7.5 Equipment supply

All Equipment will be mounted in and on a 20' Sea container. The attached typical PFD (Attachment 2) shows the main Equipment, Valves and Instrumentation. Attachment 1 shows a typical layout.

| Item | MOC | # | Remark |
|---|---|---|---|
| **EQUIPMENT** | | | |
| Inlet Filter | Duplex | 1 | Atmospheric with lid |
| MPPE Columns | Duplex | 2 | FV-9 barg |
| Separator | Duplex | 1 | FV-9 barg |
| HC Pump | Duplex | - | Optional; assumed gravity flow from separator |
| Steam Generator | Duplex | 1 | electrical |
| Condenser | Duplex plates, | 1 | FV-9 barg, CS frame |
| Return Water Tank | Duplex | 1 | FV-9 barg<br>*(not in No Return Tank option)* |
| Return Water Pump | Duplex | 1 | Magnetic Type<br>*(not in No Return Tank option)* |
| **PIPING** | | | |
| Piping | Duplex | 1 | ASME |
| Insulation; certain part of piping + vessels | Mineral wool + alu cladding | 1 | CINI Guidelines |
| Overpressure safety on steam gen | Duplex | 1 | |
| Drains and vents | | 1 | Connected to main header prior TP |
| Positive isolation by MV only | | 1 | |
| Sample connections | Duplex | 2 | Feed Water, Effluent Water |
| **STRUCTURAL** | | | |
| Structural Steel | SS | 1 | steel base, support structures, platforms, stairs, ladders, walkways, handrails, pinned construction/ positioning |
| Grating | Galvanised CS | 1 | 20mm ball proof (by Hilti assembly) |
| **INSTRUMENTS** | | | |
| Temperature transmitters | | 4 | |
| Pressure transmitters | | 8 | |
| Level transmitters | | 3 | |
| Flow transmitters | | 2 | |
| Control Valves | | 2 | |
| Automated ON/OFF Valves | | 13 | |
| Instrumentation tubing | SS316 | incl. | |
| Manual Valves | | 34 | |
| E&I cabling | | incl. | Power & instrument cables segregated |
| Cable trays | | incl. | |
| Cables supports | | incl. | |
| Cables wired to junction boxes at package edge | | incl. | |
| Earthing system | Cu-cable | incl. | |
| **PROCESS CONTROL** | | | |
| Software Control MPPE process | | - | Base offer: control by Client control system. Optional PLC + HMI, incl software license |
| **MARKING** | | | |
| ATEX | | incl. | |
| CE Marking | | incl. | |
| Fluid tagging | | incl. | As per Client spec |
| Name plates for E&I | | incl. | As per Client spec |
| Name plates for equipment | | incl. | As per Client spec |
| Name plates for Vessels | | incl. | As per Client spec |

## 7.6 Preferred suppliers

| Item | Vendor |
|---|---|
| **Mechanical** | |
| Steel structure, vessels, piping, assembly | Yard in China, South East Asia, Middle East or Europe may be selected |
| | |
| **Valves** | |
| Automated Ball Valves | Pentair |
| Check valves | Pentair |
| Control Valves | Samson |
| Manual Valves | Eriks |
| | |
| **Pumps** | |
| Return Water Pump | Flowserve, Sulzer, Dickow |
| Hydrocarbon Transfer Pump | Axflow; SPX Flow, Dickow |
| | |
| **Condensor** | Alfa Laval, Tranter, Kelvion, ITM |
| | |
| **Safety relief Valves** | Tyco, Pentair |
| | |
| **Instruments** | Endress+Hauser or equivalent |

# 8. MPPE Process : Characterstics & Proven Experience

## 8.1 MPPE Flexibility and Robustness

- High reduction factor.
- Reduction factor independent of inlet concentration.
- Robust against water environment (salt, methanol, glycols, corrosion inhibitors, scale inhibitors, H2S scavengers, demulsifiers, defoamers and dissolved (heavy) metals).
- Predictable performance.
- Flow/inlet concentration flexibility:
  - 10% lower flow than design: 50% higher inlet concentration possible.
  - lower inlet concentration: higher flow possible.
- Capacity flexibility: turn up / down ratio e.g. 0 to 150% of design capacity (depending on hydraulic constraints).
- Batch wise operation possible, immediate performance after start up.
- Separated hydrocarbons are practically 100% pure ready for (re)use.
- No waste stream, no air emission, low noise.
- 100% water and hydrocarbon recovery.

## 8.2 MPPE Experience, Reliability and Performance
## (OIL & GAS, LNG, Chemical, Pharmaceutical, Coatings, Electronics Industry)

**Introduction**

The MPPE Technology is a relatively new Innovative Technology and therefore generally not described in text books and being taught at Schools and Universities. For potential new users, not familiar and experienced with this technology, it is often difficult to evaluate and predict the reliability, robustness, separation and operation performance. Therefore this summary has been prepared to get a quick impression. Further information/analyses can be received on request.

**General Performance predictability and experience**

MPPE is basically a liquid – liquid Extraction Technology where the extraction liquid is immobilized in an Macro Porous Polymer.
The MPPE separation performance for dissolved and dispersed hydrocarbons is independent of the influent concentration (law of physics) and therefore separation effectiveness is maintained at influent levels from ppb levels to thousands of ppm and higher.
The MPPE process is mathematically described, computer modeled and tested, so the performance predictability of any design is practically 100%.
All installed MPPE units (> 30) have reached their predicted performance.
Various business concepts (Design & Build, Operation and Maintenance or Design, Build, Finance and Maintenance) have been applied.

**Gas / Condensate / LNG Produced water (BTEX, PAHs, Aliphatics)**

- In Offshore Produced Water treatment of Gas/Condensate/LNG production a more than 50 years of accumulated experience (TOTAL, NAM (SHELL/EXXON), STATOIL) has been built up with good separation performance and operational experience.
- On 3 offshore platforms, MPPE units have been installed without prior testing and are operating successfully now since 2002 (99% removal of 600-900 ppm of dispersed and dissolved hydrocarbons, BTEX, PAHs, Aliphatics).
- The oldest MPPE unit (ELF/TOTAL/VERMILION in Harlingen) is operating successfully since 1994 on offshore produced water (gas/condensate) with a > 99.9% removal of 2,000 to 3,000 ppm dissolved and dispersed hydrocarbons.
- Environmental Impact Factor reductions of 95 to 99% (removal of toxic contents of produced water) were reported (HYDRO / STATOIL) for gas/condensate produced water.
- HYDRO/SHELL ORMEN LANGE Norway (NORSOK specifications) offshore gas/condensate field, aiming at zero harmful discharge (startup 2008).
- WOODSIDE PLUTO LNG Australia, (startup 2011).
- SHELL PRELUDE Australia, first Floating LNG (startup 2018).
- INPEX ICHTHYS LNG Australia, MPPE on FPSO (startup 2018)

**Waste water (CHCs, BTEX, PAHs, Aliphatics, THT)**

For waste water treatment a more than 45 years of accumulated experience has been built up in Europe and the USA (PHILIPS, DUPONT, TOTAL, ALBEMARLE, GAZ DE FRANCE, AKZO NOBEL) with removal at 99% levels or higher.

In five projects the MPPE units were installed without prior testing and have shown performances as predicted/designed.

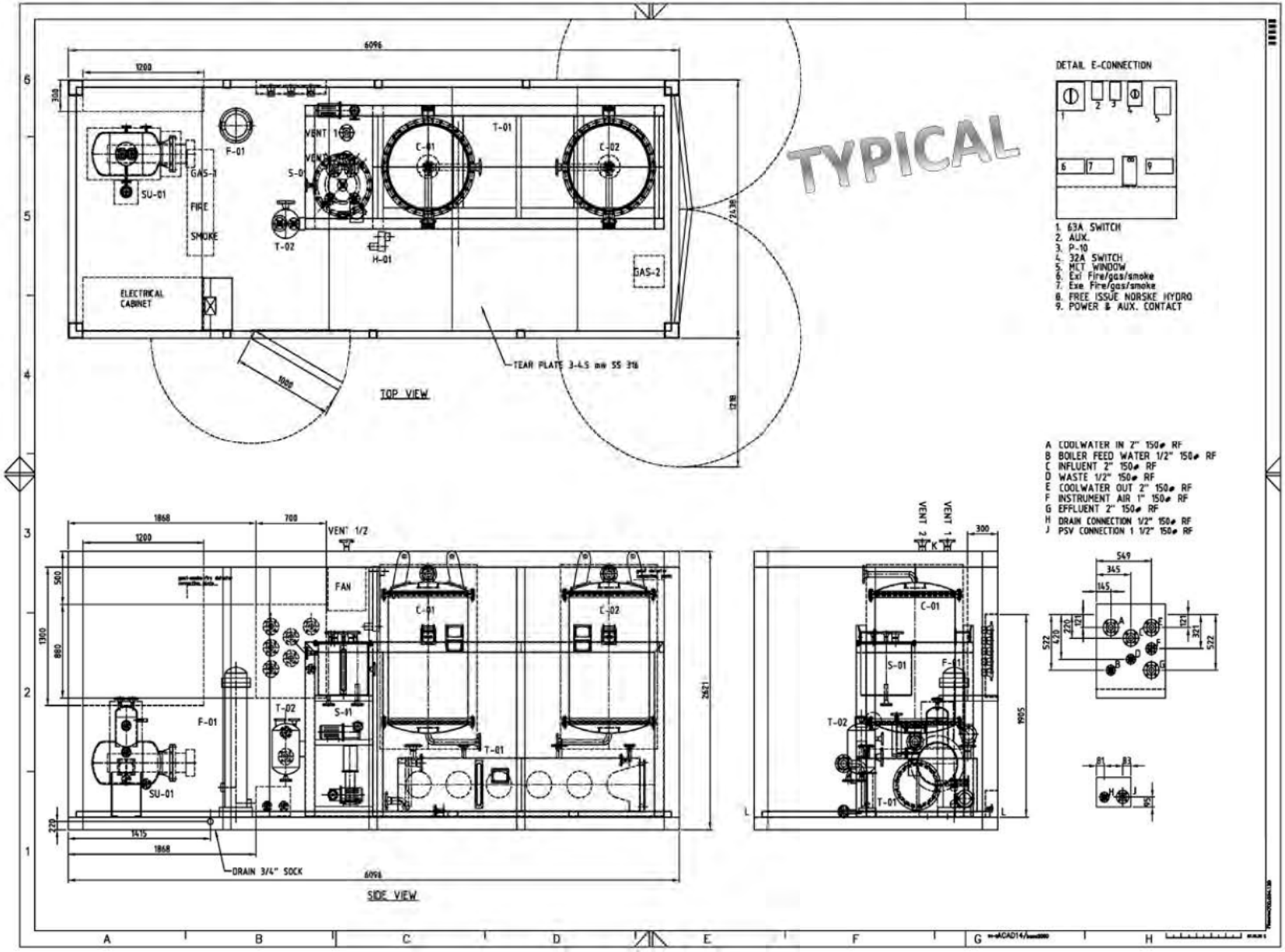
## 8.3 References

| Unit | Flow rate m3/hr (6) | Composition (1) | Inlet mg/l (ppm) | Outlet mg/l (ppm) |
|---|---|---|---|---|
| **The Netherlands** | | | | |
| Vermilion (Total) (Harlingen) Offshore Gas (3) | 4-6 | Al, Ar | 2000-3000 | < 0.5 |
| Allied Signal, Weert | 0.2 | CFHC, CHC | 5 | < 0.010 |
| Akzo Nobel Industrial Fibers, Arnhem | 25 | Solvesso | 400 | < 0.050 |
| LBC Rotterdam bv; Groupe Fimalac | 15/0.1 | CHC, Ar | 5/2000 | ≤ 0.1 |
| Shell/Exxon (NAM B.V.), Offshore Gas Produced water, k15A | 3-5 | Al, Ar, PAH | Hundreds | > 90% removal |
| Shell/Exxon (NAM B.V.), Offshore Gas Produced water k15B | 3-5 | Al, Ar, PAH | Hundreds | > 90% removal |
| Total F15A Offshore Gas Produced water | 3 | Al, Ar, PAH | 700-950 | > 90% removal |
| **Germany** | | | | |
| Philips Bildröhrenfabrik, Aachen | 5 | Ar | 500 | < 0.05 |
| **France** | | | | |
| Gaz de France | 3 | THT | 75 | < 0.5 |
| Synthexim Calais (3) | 6 | Ar, CHC, COD | 1400 – 11000 | > 99.9% removal |
| **Norway** | | | | |
| Statoil/Shell, Ormen Lange Offshore Gas Produced water (5) | 68 | Al, Ar, PAH | 600-1300 | >99% removal |
| Statoil Kollsnes Offshore Gas PW (5) | 20 | Al, Ar, PAH | 240 | >99% removal |
| Offshore Atlantic StatoilHydro Åsgard Å(2) | 3 | Ar, PAH | 70-80 | > 98% removal |
| Offshore Atlantic StatoilHydro Troll B (2) | 9 | Al, Ar, PAH | 15-25 | 95-99% removal |
| **United States of America** | | | | |
| Akzo Nobel Resins, Louisville | 3 | Ar | 150 | < 0.05 |
| Akzo Nobel Resins, East St. Louis | 3 | Ar | 150 | < 0.05 |
| Northeast Chemical Manufacturer | 16 | CHC | 225 | < 0.2 |
| Total Fina Elf, Houston | 3 | Ar | 150 | < 0.05 |
| Total Fina Elf, Milwaukee | 3 | Ar | 150 | < 0.05 |
| Midwestern Chemical Manufacturer | 10 | Ar, CHC | 300 | < 0.03 |
| Albemarle Tyrone | 6 | Ar, CHC | 800 | < 1 |
| Western Refining | 114 | Al, Ar | 200-260 | <0.5 |
| **Rest of World** | | | | |
| Offshore South China Sea (2) | 3 | Al, Ar | 200-500 | > 99% removal |
| Woodside Pluto LNG Australia (5) | 40 | Al, Ar, PAH | Hundreds | > 99% removal |
| Shell Floating LNG Prelude, Australia (5) | 140 | Al,Ar, PAH | Hundreds | > 99% removal |
| Inpex Ichthys FPSO offshore, Australia (5) | 180 | Al,Ar,PAH | 1150 | > 99% removal |

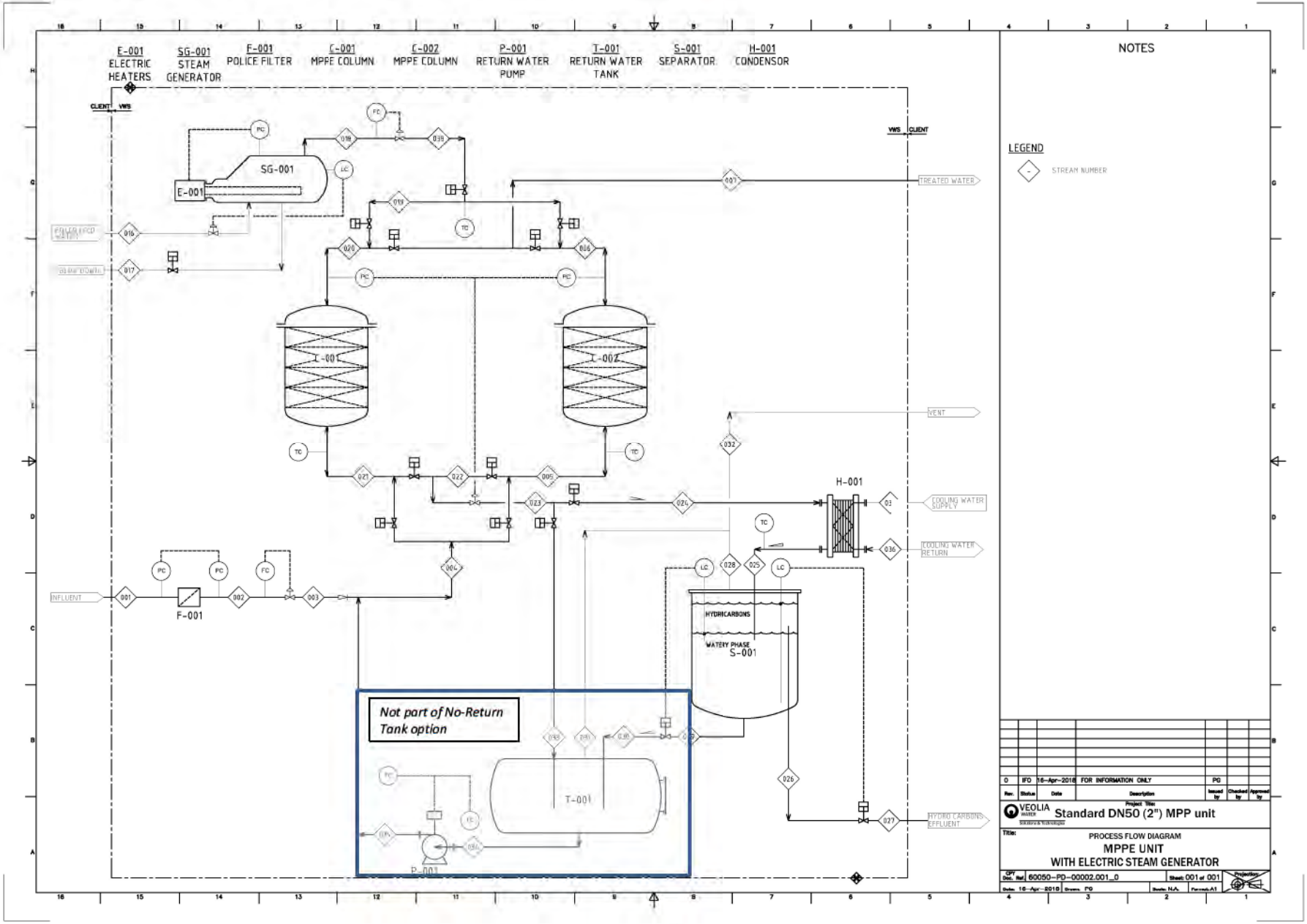
(1) AL: Aliphatics – Ar: Aromatics – PAH: PolyAromatic Hydrocarbons – CHC: Chlorinated Hydrocarbons
(2) Long duration test
(3) Combined groundwater and process water
(4) Combined with biotreatment
(5) MEG-Regen upstream
(6) 1m3/hr = 4.4 gpm

## Attachment 1: Typical Container Lay-out

***NOTES:*** *Model shown below is a typical 20"Sea container unit. Our current offering have higher columns that protrude through the container roof and are covered by a roof extension approx. 1 m height.*



## Attachment 2: Typical PFD for Redundant Columns MPPE unit



**Attachment 3: Case sheets**

VEOLIA

Veolia MPPE Technology — TOTAL F 15A Offshore - NL

## Offshore Gas Produced Water treatment- Unmanned Operation

**Operational since 2002**
- Robust against salt, surfactants, Corrosion inhibitors
- Fulfilling TOTAL's environmental goal beyond present legal requirements

## Challenge
- Unmanned operation
- Remote control
- Practically no space on existing platform
- Dissolved/dispersed toxic content removal for Zero Harmful Discharge

## Performance

**MPPE removes:**
- Dispersed oil (aliphatics) > 99%
- Dissolved and dispersed aromatics (BTEX) >99%
- Poly Aromatics (PAHs) >99.5%

**MPPE Unit capacity 5 m3/h**
- Built in container
- Hanging 50% outside platform
- Fully integrated including
  - steamboiler
  - water maker
- No waste stream

### The MPPE process

*MPPE stands for Macro Porous Polymer Extraction. Polymer beads contain a specific immobilized extraction liquid. Hydrocarbon contaminated water is passed through a column packed with MPPE particles. The hydrocarbons are extracted from the water at any designed efficiency up to 99.999%. The MPPE particles can simply be regenerated by heating with steam. The removed hydrocarbons are recovered as an almost 100% pure product. No other waste stream is created. No chemicals requires, no off gasses produced.*

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VEOLIA

Veolia MPPE Technology — NAM K15A Offshore - NL

## Offshore Gas Produced Water treatment-

**Operational since 2002**
- Robust against salt, surfactants, Corrosion inhibitors
- Fulfilling NAM's environmental goal beyond present legal requirements

## Challenge
- Remote control
- Practically no space on existing platform
- Dissolved/dispersed toxic content removal for Zero Harmful Discharge

## Performance

**MPPE removes:**
- Dispersed oil (aliphatics) <30 ppm
- Dissolved and dispersed aromatics (BTEX) >90%
- Poly Aromatics (PAHs) >99%

**MPPE Unit capacity 4.2 m3/h**
- Built in container
- Placed on Top deck
- Including steam boiler
- No waste stream

### The MPPE process

*MPPE stands for Macro Porous Polymer Extraction. Polymer beads contain a specific immobilized extraction liquid. Hydrocarbon contaminated water is passed through a column packed with MPPE particles. The hydrocarbons are extracted from the water at any designed efficiency up to 99.999%. The MPPE particles can simply be regenerated by heating with steam. The removed hydrocarbons are recovered as an almost 100% pure product. No other waste stream is created. No chemicals requires, no off gasses produced.*

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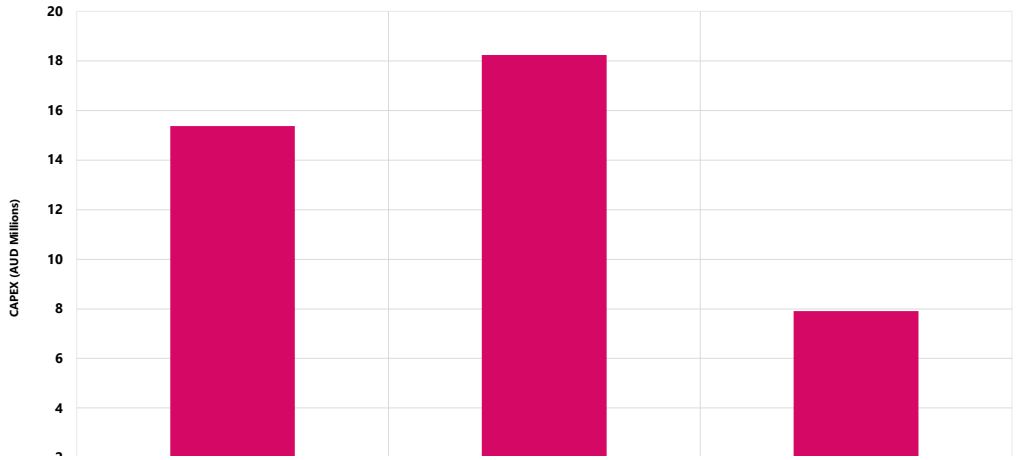
# Appendix C
# Cost Estimates

| | | | |
|---|---|---|---|
| Client | Beach Energy | | |
| Calc. No. | 411010-00050 | | |
| Prepared | Antony Perri | Rev. | 0 |
| Checked | Richard George | Date: | 11/12/19 |

**Yolla Water Handling Upgrade**
**Cost Estimates Summary**
**Cost Summary**

| COST COMPONENT | DEVELOPMENT OPTIONS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (All in AUD Millions unless indicated | MPPE | Steam Stripper | Gas Stripper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Offshore Facility | | | | | | | | | | | | | | | | |
| Offshore Mobilisation | 15.4 | 18.2 | 7.9 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| **TOTAL DEVELOPMENT COST (P50)** | **15** | **18** | **8** | | | | | | | | | | | | | |
| P10 -30% | 11 | 13 | 6 | | | | | | | | | | | | | |
| P90 +40% | 22 | 26 | 11 | | | | | | | | | | | | | |



| | | | |
|---|---|---|---|
| **Client** | Beach Energy | | |
| **Calc. No.** | 411010-00050 | | |
| **Prepared** | Antony Perri | **Rev.** | 0 |
| **Checked** | Richard George | **Date:** | 11/12/19 |

**Yolla Water Handling Upgrade**
**Cost Estimates Summary**
**Building Blocks Summary**

| COST COMPONENT (All in AUD Millions unless indicated otherwise) | METRIC | | | | MOB. / DEMOB. | PROCUREMENT | | CONSTRUCTION | | | | ALLOWANCES | | | | | CONT. | TOTAL | MPPE | Steam Stripper | Gas Stripper | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Equip. | Bulks | Fab. | Load-Out & Trans. | Install. | Hook-Up & Comm. | Eng. | PM | Freight | Spares | Ins. & Cert. | | | | | | |
| **Offshore Mobilisation** | **Inst. Dur. (days)** | **Len (km)** | **Dia. (in)** | **$k/in/km** | | | | | | | | | | | | | | | | | | |
| MPPE Macro Porous Polymer Extraction | | | | | 0.54 | 1.92 | 0.14 | 0.47 | 0.11 | 4.10 | 0.13 | 1.16 | 1.45 | 0.16 | 0.09 | 0.27 | 4.84 | 15.36 | 15.4 | | | |
| Steam Stripper | | | | | 0.54 | 2.43 | 0.23 | 0.82 | 0.12 | 4.53 | 0.24 | 1.33 | 1.66 | 0.21 | 0.12 | 0.32 | 5.69 | 18.23 | | 18.2 | | |
| Gas Stripper | | | | | 0.54 | 0.19 | 0.03 | 0.14 | 0.10 | 2.61 | 0.03 | 0.68 | 0.85 | 0.01 | 0.01 | 0.14 | 2.57 | 7.91 | | | 7.9 | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | **Subtotal** | **15.4** | **18.2** | **7.9** | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | **Subtotal** | | | | |
| **TOTAL DEVELOPMENT COST (P50)** | | | | | | | | | | | | | | | | | | | **15** | **18** | **8** | |
| P10 - 30% | | | | | | | | | | | | | | | | | | | 11 | 13 | 6 | |
| P90 + 40% | | | | | | | | | | | | | | | | | | | 22 | 26 | 11 | |

| | | | |
|---|---|---|---|
| **Client** | Beach Energy | | |
| **Calc. No.** | 411010-00050 | | |
| **Prepared** | Antony Perri | **Rev.** | 0 |
| **Checked** | Richard George | **Date:** | 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**MPPE Macro Porous Polymer Extraction**

**Offshore Facility Parameters**

| | | | | | |
|---|---|---|---|---|---|
| Type | Water Handling | Pre-Fabrication Location | VIC | Installation by | Heavy Lift Vessel |
| Capacity | | Site Location | VIC | Method | Lift Installed |

**Topsides - Equipment / Bulks and Installation**

| Equipment Description | Structure Type | Piping Material | Number | Sizing Parameter | Unit | $/Unit | $/Item | t/Item | $ | t | Equip. Type | Electrical | | Instrument | | Piping | | Structural | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Factor | Weight | Factor | Weight | Factor | Weight | Factor | Weight |
| **Water Treatment System** | | | | | | | | | | | | | | | | | | | |
| New MPPE Package | Modules, topsides | CS | 1 | 1,000,000 | Euro | 1.62 | 1,620,000 | 12.0 | 1,620,000 | 12.0 | Skids | 0.03 | 0.4 | 0.06 | 0.7 | 0.15 | 1.8 | 0.00 | 0.0 |
| Hydrocarbon Return Pump | Modules, topsides | CS | 1 | 2 | m3/d | | 25,000 | 1.0 | 25,000 | 0.2 | Pumps | 0.14 | 0.0 | 0.44 | 0.1 | 1.50 | 0.3 | 0.00 | 0.0 |
| Demin water tank | Modules, topsides | CS | 1 | 2 | m3 | | 30,000 | 1.0 | 30,000 | 1.0 | Tanks/Storage | 0.05 | 0.1 | 0.05 | 0.1 | 0.70 | 0.7 | 1.15 | 2.1 |
| Demin water package / Ion Exchange | Modules, topsides | CS | 1 | 2 | m3/d | | 150,000 | 1.5 | 150,000 | 1.5 | Skids | 0.03 | 0.0 | 0.06 | 0.1 | 0.15 | 0.2 | 1.15 | 2.1 |
| Demin water pump | Modules, topsides | CS | 1 | 2 | m3/d | | 25,000 | 1.0 | 25,000 | 1.0 | Pumps | 0.14 | 0.1 | 0.44 | 0.4 | 1.50 | 1.5 | 1.15 | 3.5 |
| **Bulks Procurement & Fabrication** | | | | | | | | | | | | | | | | | | | |
| Structure | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| Installation aids | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| Rigging | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| CS pipe | Modules, topsides | CS | | | t | | | | | | | | | | | | 0.0 | | |
| CRA Pipe | Modules, topsides | SS | | | t | | | | | | | | | | | | 0.0 | | |
| | | | | | t | | | | | | | | | | | | | | |
| Building | Modules, topsides | CS | 1 | | | | | | | | | | | | | | | | |
| **Subtotals** | | | | | | | | | **1,850,000** | **16** | | | **1** | | **1** | | **5** | | **8** |

| **Summary** | | | | | | | | | **Bulks** | **equip + bulks** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **Unit** | **Equipment** | **Elec.** | **Inst.** | **Piping** | | | **Structure** | **Subtotals** | |
| | | | | | **CS** | **CRA** | **CS/CRA** | | | |
| Unit cost | $/t | 117,834 | 25,000 | 40,000 | 12,000 | 18,000 | 25,000 | 1,500 | | |
| Productivity | hrs/t | 25 | 600 | 600 | 300 | 400 | 450 | 120 | | |
| % spent in Fabyard | Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Productivity Factor | Factor | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | |
| Labour rate | $/hr | 120 | 120 | 120 | 120 | 120 | 120 | 120 | | |
| **Hours to install** | **hrs** | **393** | **374** | **833** | **1,358** | **0** | **0** | **930** | **3,494** | **3,887** |
| **Weight** | **t** | **16** | **1** | **1** | **5** | **0** | **0** | **8** | **14** | **30** |
| **Procurement** | **$** | **1,850,000** | **15,575** | **55,520** | **54,300** | **0** | **0** | **11,627** | **137,022** | **1,987,022** |
| **Installation** | **$** | **47,100** | **44,856** | **99,936** | **162,900** | **0** | **0** | **111,614** | **419,306** | **466,406** |

| **Miscellaneous** | **Weight (t)** | **Length (m)** | **Breadth (m)** | **Area.** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|---|---|---|
| | | | | | m2 | 10,000 | |
| | | | | | m2 | 10,000 | |
| **Subtotal Miscellaneous** | **0** | | | | | | **0** |

| **Seafastening & Load-Out** | **Factor** | **Unit** | **Weight** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|---|---|
| Total Topside Weight | | | 30 | t | | |
| Seafastening Materials (as % of Total Topside Weight) | 5.0% | - | 1 | t | 1,800 | 2,699 |
| Seafastening Fabrication | 120 | hrs/t | 1 | t | 35 | 6,297 |
| Load-Out on vessel | | | 1 | each | 25,000 | 25,000 |
| **Subtotal Seafastening & Load-Out** | | | | | | **33,996** |

| **Transportation** | **Distance (nm** | **peed (knots** | **Duration** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|---|---|
| Standby at wharf | | | 0.25 | days | 35,000 | 8,750 |
| Transport to site | 200 | 10 | 0.8 | days | 35,000 | 29,167 |
| standby at site | | | 0.25 | days | 35,000 | 8,750 |
| Return to fab yard | 200 | 10 | 0.8 | days | 35,000 | 29,167 |
| Fuel | | | 35 | days | 0 | |
| **Subtotal Transportation** | | | | | | **75,833** |

| **Installation** | **Duration** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|
| Set up at site | | days | 300,000 | |
| Lift skid 1 | | days | 300,000 | |
| Lift skid 2 | | days | 300,000 | |
| **Total Duration** | 0.0 | days | | |
| **Equipment & weather downtime** | 0.0 | days | 300,000 | |
| **Subtotal Installation** | | | | **0** |

| **Hook-Up and Commissioning** | **Qty.** | **Unit** | **Factor** | **Unit** | **Duration** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|---|---|---|---|
| Total Topside Weight | 30 | t | | | | | | |
| Hook up | | | | hrs/t | 0 | hours | 280 | |
| Pre-Commissioning | | | 10 | hrs/t | 300 | hours | 420 | 125,945 |
| Hook up Barge | 8 | crew | 12 | hrs/day | | days | 150,000 | |
| **Total Duration** | | | | | 0.0 | days | | |
| **Equipment & weather downtime** | | | | 25% | 0.0 | days | 150,000 | |
| **Subtotal Hook-Up and Commissioning** | | | | | | | | **125,945** |

| | |
|---|---|
| **Client** | Beach Energy |
| **Calc. No.** | 411010-00050 |
| **Prepared** | Antony Perri **Rev.** 0 |
| **Checked** | Richard George **Date:** 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**MPPE Macro Porous Polymer Extraction**

| **Standard Rates for Offshore Work** | | | | |
|---|---|---|---|---|
| **Labours** | | | | |
| | Offshore Labour | 280 | $/hr | inclusive of tools, consumables, accommodation, food and helicopter transfers |
| | Hours per day | 12 | hrs | |
| **Productivity Factors** | | | | |
| | Works in protected location | 80.0% | effective % of time | |
| | Field work on platform | 60.0% | effective % of time | |
| | Field work in exposed location, shutdown work | 50.0% | effective % of time | |

| **Mobilisation Crew and Equipment** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Mobilise/demob crew to platform, training, induction etc. | 16 | crew | 3 | 100.0% | 576 | 280 | 161,280 | |
| Clear deck/work area | 8 | crew | 3 | 60.0% | 480 | 280 | 134,400 | |
| Install workshop/stores/office | 8 | crew | 4 | 60.0% | 640 | 280 | 179,200 | |
| Tie in power/comms to temporary buildings | 3 | crew | 4 | 60.0% | 240 | 280 | 67,200 | |
| **Subtotal Mobilisation Crew and Equipment** | | | | | **1,936** | | **542,080** | |

| **Hire Equipment** | **Qty.** | **Unit** | **Duration** | **Unit** | **$/week** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|
| Office/stores containers | 1 | each | 26 | weeks | 200 | 5,200 | |
| Mobile workshop | 1 | each | 26 | weeks | 1,000 | 26,000 | |
| Scrap/transport Containers | 4 | each | 26 | weeks | 100 | 10,400 | |
| Scaffolding | 200 | m2 | 26 | weeks | 5 | 26,000 | |
| Accommodation vessel | | | 0 | days | 150,000 | | Flotel if required for additional POB |
| Additional escape craft | | | | | | | If required for additional POB |
| **Subtotal Hire Equipment** | | | | | | **67,600** | |

| **Scaffold, Rigging and Construction Aids** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Scaffold deck area | 5 | crew | 10 | 60.0% | 1,000 | 280 | 280,000 | |
| Demolish scaffolding | 5 | crew | 5 | 60.0% | 500 | 280 | 140,000 | |
| | | crew | 2 | 60.0% | | 280 | | |
| | | crew | 1 | 60.0% | | 280 | | |
| | | crew | 3 | 60.0% | | 280 | | |
| **Subtotal Scaffold, Rigging and Construction Aids** | | | | | **1,500** | | **420,000** | |

| **Crane Upgrade** | | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|---|
| **Service existing crane** | | 3 | people | 2 | 60.0% | 120 | 280 | **33,600** | Service existing crane |
| **Spares** | | 1 | lot | | | | 10,000 | **10,000** | |
| **Temporary Crane** | Install temporary crane | | people | | 60.0% | | 280 | | |
| | hire temporary crane | | weeks | | | | 10,000 | | |
| | remove temporary crane | | people | | 60.0% | | 280 | | |
| | **Subtotal** | | | | | | | **0** | |
| **Upgrade existing crane** | Purchase crane upgrade equipment | | each | | | | 10,000 | | |
| | Crane upgrade construction | 10 | people | | 60.0% | | 280 | | |
| | **Subtotal** | | | | | | | **0** | |
| **Subtotal Crane Upgrade** | | | | | | **120** | | **43,600** | |

| **Demolition** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Isolate existing water equipment | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| Remove existing water handling equipment | 8 | crew | 3 | 60.0% | 480 | 280 | 134,400 | |
| Remove redundant piping | 8 | crew | 5 | 60.0% | 800 | 280 | 224,000 | |
| Remove filters | 8 | crew | 2 | 60.0% | 320 | 280 | 89,600 | |
| Clear structure | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| Paint touch up | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| **Subtotal Demolition** | | | | | **2,040** | | **571,200** | |

| **Building and HVAC** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| **Subtotal Building and HVAC** | | | | | **0** | | **0** | |

| **Equipment Installation** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Lift in MPPE Container | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| Rig in Demin water unit | 5 | crew | 4 | 60.0% | 400 | 280 | 112,000 | |
| Lift in demin water tank | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| **Subtotal Equipment Installation** | | | | | **720** | | **201,600** | |

| **Structure** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Secure MPPE skid | 5 | crew | 3 | 60.0% | 300 | 280 | 84,000 | |
| Secure demin water tank | 5 | crew | 2 | 60.0% | 200 | 280 | 56,000 | |
| Secure and install supports for demin water maker | 5 | crew | 2 | 60.0% | 200 | 280 | 56,000 | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| Paint touch up | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| NDT for structural work | 2 | crew | 1 | 80.0% | 30 | 280 | 8,400 | |
| **Subtotal Structure** | | | | | **850** | | **238,000** | |

| **Piping** | **dia** | **length** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|---|---|
| Piping tie in #1 Produced water inlet | 3 | 5 | 5 | crew | 1 | 50.0% | 120 | 280 | 33,600 | Shut down required |
| Piping tie in #2 to Produced water to dump caisson | 3 | 5 | 5 | crew | 1 | 50.0% | 120 | 280 | 33,600 | Shut down required |
| Piping tie in #3 to flare header | 2 | 20 | 5 | crew | 3 | 50.0% | 360 | 280 | 100,800 | Shut down required |
| Piping tie in #4 to liquids to flare drum | 2 | 20 | 5 | crew | 3 | 50.0% | 360 | 280 | 100,800 | |
| Piping tie in #5 to drains | 2 | 20 | 5 | crew | 3 | 50.0% | 360 | 280 | 100,800 | |
| Piping tie in # 6 RO unit to demin water maker | 1 | 80 | 5 | crew | 7 | 50.0% | 840 | 280 | 235,200 | |
| Piping Run from demin maker to tank | 1 | 5 | 3 | crew | 1 | 50.0% | 72 | 280 | 20,160 | |
| Piping run from demin tank to demin pump | 1 | 2 | 1 | crew | 1 | 50.0% | 24 | 280 | 6,720 | |
| Piping tie in # 7 Demin water tank to MPPE | 1 | 5 | 3 | crew | 1 | 50.0% | 72 | 280 | 20,160 | |
| Leak test piping systems | | | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| Paint touch up | | | 3 | crew | 3 | 60.0% | 180 | 280 | 50,400 | |
| **Subtotal Piping** | | | | | | | **2,628** | | **735,840** | |

| **Electrical** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Power supply to demin water skid | 3 | crew | 7 | 50.0% | 504 | 280 | 141,120 | Local shut down required |
| Power supply to MPPE | 3 | crew | 7 | 80.0% | 315 | 280 | 88,200 | |
| MCC mods in SG room | 3 | crew | 4 | 60.0% | 240 | 280 | 67,200 | |
| Testing and precommissioning | 3 | crew | 3 | 60.0% | 180 | 280 | 50,400 | |
| **Subtotal Electrical** | | | | | **1,239** | | **346,920** | |

| | | | |
|---|---|---|---|
| **Client** | Beach Energy | | |
| **Calc. No.** | 411010-00050 | | |
| **Prepared** | Antony Perri | **Rev.** | 0 |
| **Checked** | Richard George | **Date:** | 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**MPPE Macro Porous Polymer Extraction**

| Instrumentation | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Run cables from Ins room to local panel | 150 | m | 0.10 | 60.0% | 300 | 280 | 84,000 | allow approx. 1 hr per m |
| Install field instruments & cable | 40 | instruments | 1.00 | 60.0% | 800 | 280 | 224,000 | allow 12 hrs per instrument |
| Install tubing, chem injection | 0 | m | 0.16 | 60.0% | | 280 | | allow 2 hrs per m |
| Instrument hook up to skid | 40 | instruments | 0.25 | 60.0% | 200 | 280 | 56,000 | allow 3 hrs per instrument |
| Testing and precomm 100 loop checks | 80 | loops | 0.10 | 60.0% | 160 | 280 | 44,800 | Allow 1 hour per loop |
| Testing and precomm new to existing system | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| Install Fire and Gas detectors | 1 | instruments | 1 | 60.0% | 20 | 280 | 5,600 | allow 1 day per instrument |
| **Subtotal Instrumentation** | | | | | **1,600** | | **448,000** | |

| Safety and Risk | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| New manual alarm | | no | | 60.0% | | 280 | | |
| Fire fighting, portable extinguishers | 3 | no | 0 | 60.0% | 6 | 280 | 1,680 | |
| Fire fighting, fixed hose reel | | no | | 60.0% | | 280 | | |
| safety shower | | no | | 60.0% | | 280 | | |
| Comms PA station | | no | | 60.0% | | 280 | | |
| **Subtotal Safety and Risk** | | | | | **6** | | **1,680** | |

| Support Vessels / Helicopters | #Trip/Week | Time/Trip | Unit | Weeks | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Helicopter additional flights, urgent freight etc. | 1 | 2 | hrs | 21 | 42 | 3,500 | 147,455 | |
| Supply boat for equipment | 1 | 1 | days | 21 | 21 | 45,000 | 947,925 | |
| **Subtotal Support Vessels / Helicopters** | | | | | | | **1,095,380** | |

**Summaries**

| Fabrication Costs Summary | | |
|---|---|---|
| **Direct Procurement & Fabrication Costs** | | |
| Equipment Procurement | | 1,850,000 |
| Bulks Procurement | | 137,022 |
| Equipment Installation | | 47,100 |
| Bulks Fabrication | | 419,306 |
| Miscellaneous | | 0 |
| **Subtotal Direct Costs** | | **2,453,428** |
| **Installation Costs Summary** | | |
| **Direct Transport & Installation Costs** | | |
| Seafastening & Load-Out | | 33,996 |
| Transportation | | 75,833 |
| Installation | | 0 |
| Hook-Up and Commissioning | | 125,945 |
| **Subtotal Direct Costs** | | **235,775** |
| **Allowances** | | ***Applied to:*** |
| Freight | 8.0% | 158,962 *Equipment & Bulks Procurement* |
| Spares | 5.0% | 92,500 *Equipment Procurement* |
| Insurance | 2.5% | 67,230 *Subtotal Direct Costs* |
| Certification | 0.5% | 12,897 *Subtotal Direct Costs* |
| Engineering | 8.0% | 215,136 *Subtotal Direct Costs* |
| Contractors Project Management | 10.0% | 268,920 *Subtotal Direct Costs* |
| Design Growth | 10.0% | 245,343 *Subtotal Procurement & Fabrication Costs* |
| **Subtotal Allowances** | | **1,060,988** |
| **Fabrication Cost** | | **3,750,191** |
| **Contingency** | 30.0% | **1,125,057** |
| **Total Fabrication Cost** | | **4,875,248** |

| Tie-In Costs Summary | | | hours | $ |
|---|---|---|---|---|
| **Direct Costs** | | | | |
| Mobilisation Crew and Equipment | | | 1,936 | 542,080 |
| Hire Equipment | | | 0 | 67,600 |
| Scaffold, Rigging and Construction Aids | | | 1,500 | 420,000 |
| Crane Upgrade | | | 120 | 43,600 |
| Demolition | | | 2,040 | 571,200 |
| Building and HVAC | | | 0 | 0 |
| Equipment Installation | | | 720 | 201,600 |
| Structure | | | 850 | 238,000 |
| Piping | | | 2,628 | 735,840 |
| Electrical | | | 1,239 | 346,920 |
| Instrumentation | | | 1,600 | 448,000 |
| Safety and Risk | | | 6 | 1,680 |
| Support Vessels / Helicopters | | | 0 | 1,095,380 |
| ***Notes:*** | | | | |
| - *Crew Size* | *10* | | | |
| - *uration (no contingency)* | *105* | *days* | | |
| - *Duration (with contingency)* | *21* | *weeks* | | |
| **Subtotal Direct Costs** | | | **12,639** | **4,711,900** |
| **Allowances** | | | | |
| Insurance | | | 3.0% | 141,357 |
| Certification | | | 1.0% | 47,119 |
| Engineering | | | 20.0% | 942,380 |
| Project Management | | | 25.0% | 1,177,975 |
| Design Growth | | | 10.0% | 471,190 |
| **Subtotal Allowances** | | | | **2,780,021** |
| **Contingency** | | | 40.0% | **2,996,768** |
| **Total Tie-In Cost** | | | | **10,488,689** |

| Overall Summary | | |
|---|---|---|
| **Direct Costs** | | |
| Mobilisation / Demobilisation | | 542,080 |
| Equipment Procurement | | 1,917,600 |
| Bulks Procurement | | 137,022 |
| Fabrication | | 466,406 |
| Load-Out & Transport | | 109,829 |
| Installation | | 4,102,220 |
| Hook-Up & Commissioning | | 125,945 |
| **Subtotal Direct Costs** | | **7,401,103** |
| **Allowances** | | |
| Engineering | | 1,157,516 |
| Project Management | | 1,446,895 |
| Freight | | 158,962 |
| Spares | | 92,500 |
| Insurace & Certification | | 268,603 |
| **Subtotal Allowances** | | **3,124,476** |
| **Contingency** | | **4,838,358** |
| **Total Cost** | | **15,363,937** |
| Lower Bound P10- | 30.0% | 10,754,756 |
| Upper Bound P90+ | 40.0% | 21,509,512 |
| **Owners Cost** | 0.0% | **0** |

| Weights Summary | equip | I&E | Pipe | Struct | uildings/mis | Total |
|---|---|---|---|---|---|---|
| Raw weight | 16 | 2 | 5 | 8 | 0 | 30 |
| Factored | 19 | 2 | 5 | 9 | 0 | 36 |
| % | 52% | 7% | 15% | 26% | 0% | 100% |
| Weight growth factor | 20.0% | | | | | |

| Hours Summary Fabrication | equip | I&E | Pipe | Struct | | Total | Crew size | Hours/week | Duration |
|---|---|---|---|---|---|---|---|---|---|
| Hours | 393 | 1,207 | 1,358 | 930 | | 3,887 | | | |
| Factored | 393 | 1,207 | 1,358 | 930 | | 3,887 | 60 | 60 | 1 |
| % | 10% | 31% | 35% | 24% | 0% | 100% | | | |
| Growth factor | 25.0% | | | | | | | | |

| Hours Summary Offshore | Prelims | Demolition | Buildings | equip | I&E | Pipe | Struct | HUC | Total | Crew size | Hours/week | Duration |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hours | 3,556 | 2,040 | 0 | 720 | 2,839 | 2,628 | 850 | 300 | 7,337 | | | |
| Factored | 4,445 | 2,550 | 0 | 900 | 3,549 | 3,285 | 1,063 | 375 | 9,171 | 30 | 84 | 4 |
| % | 48% | 28% | 0% | 10% | 39% | 36% | 12% | 4% | 100% | | | |
| Growth factor | 25.0% | | | | | | | | | | | |

Advisian

| | | | |
|---|---|---|---|
| **Client** | Beach Energy | | |
| **Calc. No.** | 411010-00050 | | |
| **Prepared** | Antony Perri | **Rev.** | 0 |
| **Checked** | Richard George | **Date:** | 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**Steam Stripper**

**Offshore Facility Parameters**

| | | | | | |
|---|---|---|---|---|---|
| Type | Water Handling | Pre-Fabrication Location | VIC | Installation by | Heavy Lift Vessel |
| Capacity | | Site Location | VIC | Method | Lift Installed |

**Topsides - Equipment / Bulks and Installation**

| Equipment Description | Structure Type | Piping Material | Number | Sizing Parameter | Unit | $/Unit | $/Item | t/Item | $ | t | Equip. Type | Electrical | | Instrument | | Piping | | Structural | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Factor | Weight | Factor | Weight | Factor | Weight | Factor | Weight |
| **Water Treatment System** | | | | | | | | | | | | | | | | | | | |
| Steam Stripper Package | Modules, topsides | CS | 1 | 1,200,000 | Euro | 1.62 | 1,944,000 | 23.0 | 1,944,000 | 23.0 | Skids | 0.03 | 0.7 | 0.06 | 1.4 | 0.15 | 3.5 | 0.00 | 0.0 |
| Hydrocarbon Return Pump | Modules, topsides | CS | 1 | 2 | m3/d | | 25,000 | 0.5 | 25,000 | 0.2 | Pumps | 0.14 | 0.0 | 0.44 | 0.1 | 1.50 | 0.3 | 0.00 | 0.0 |
| Demin water tank | Modules, topsides | CS | 1 | 12 | m3 | | 60,000 | 2.0 | 60,000 | 2.0 | Tanks/Storage | 0.05 | 0.1 | 0.05 | 0.1 | 0.70 | 1.4 | 1.15 | 4.1 |
| New Demin water skid | Modules, topsides | CS | 1 | 12 | m3/d | | 300,000 | 5.0 | 300,000 | 5.0 | Skids | 0.03 | 0.2 | 0.06 | 0.3 | 0.15 | 0.8 | 1.15 | 7.1 |
| Demin water pump | Modules, topsides | CS | 1 | 12 | m3/d | | 30,000 | 1.0 | 30,000 | 1.0 | Pumps | 0.14 | 0.1 | 0.44 | 0.4 | 1.50 | 1.5 | 1.15 | 3.5 |
| **Bulks Procurement & Fabrication** | | | | | | | | | | | | | | | | | | | |
| Structure | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| Installation aids | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| Rigging | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| CS pipe | Modules, topsides | CS | | | t | | | | | | | | | | | | 0.0 | | |
| CRA Pipe | Modules, topsides | SS | | | t | | | | | | | | | | | | 0.0 | | |
| | | | | | t | | | | | | | | | | | | | | |
| Building | Modules, topsides | CS | 1 | | | | | | | | | | | | | | | | |
| **Subtotals** | | | | | | | | | **2,359,000** | **31** | | | **1** | | **2** | | **7** | | **15** |

| Summary | | | | | | | | | Bulks | equip + bulks |
|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **Unit** | **Equipment** | **Elec.** | **Inst.** | **Piping** | | | **Structure** | **Subtotals** | |
| | | | | | **CS** | **CRA** | **CS/CRA** | | | |
| Unit cost | $/t | 75,609 | 25,000 | 40,000 | 12,000 | 18,000 | 25,000 | 1,500 | | |
| Productivity | hrs/t | 25 | 600 | 600 | 300 | 400 | 450 | 120 | | |
| % spent in Fabyard | Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Productivity Factor | Factor | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | |
| Labour rate | $/hr | 120 | 120 | 120 | 120 | 120 | 120 | 120 | | |
| **Hours to install** | **hrs** | **780** | **665** | **1,385** | **2,220** | **0** | **0** | **1,777** | **6,047** | **6,827** |
| **Weight** | **t** | **31** | **1** | **2** | **7** | **0** | **0** | **15** | **26** | **57** |
| **Procurement** | **$** | **2,359,000** | **27,700** | **92,320** | **88,800** | **0** | **0** | **22,218** | **231,038** | **2,590,038** |
| **Installation** | **$** | **93,600** | **79,776** | **166,176** | **266,400** | **0** | **0** | **213,293** | **725,645** | **819,245** |

| Miscellaneous | Weight (t) | Length (m) | Breadth (m) | Area. | Unit | $/Unit | $ |
|---|---|---|---|---|---|---|---|
| | | | | | m2 | 10,000 | |
| | | | | | m2 | 10,000 | |
| **Subtotal Miscellaneous** | **0** | | | | | | **0** |

| Seafastening & Load-Out | Factor | Unit | Weight | Unit | $/Unit | $ |
|---|---|---|---|---|---|---|
| Total Topside Weight | | | 57 | t | | |
| Seafastening Materials (as % of Total Topside Weight) | 5.0% | - | 3 | t | 1,800 | 5,115 |
| Seafastening Fabrication | 120 | hrs/t | 3 | t | 35 | 11,934 |
| Load-Out on vessel | | | 1 | each | 25,000 | 25,000 |
| **Subtotal Seafastening & Load-Out** | | | | | | **42,048** |

| Transportation | Distance (nm | peed (knots | Duration | Unit | $/Unit | $ |
|---|---|---|---|---|---|---|
| Standby at wharf | | | 0.25 | days | 35,000 | 8,750 |
| Transport to site | 200 | 10 | 0.8 | days | 35,000 | 29,167 |
| standby at site | | | 0.25 | days | 35,000 | 8,750 |
| Return to fab yard | 200 | 10 | 0.8 | days | 35,000 | 29,167 |
| Fuel | | | 35 | days | 0 | |
| **Subtotal Transportation** | | | | | | **75,833** |

| Installation | Duration | Unit | $/Unit | $ |
|---|---|---|---|---|
| Set up at site | | days | 300,000 | |
| Lift skid 1 | | days | 300,000 | |
| Lift skid 2 | | days | 300,000 | |
| **Total Duration** | 0.0 | days | | |
| **Equipment & weather downtime** | 0.0 | days | 300,000 | |
| **Subtotal Installation** | | | | **0** |

| Hook-Up and Commissioning | Qty. | Unit | Factor | Unit | Duration | Unit | $/Unit | $ |
|---|---|---|---|---|---|---|---|---|
| Total Topside Weight | 57 | t | | | | | | |
| Hook up | | | | hrs/t | 0 | hours | 280 | |
| Pre-Commissioning | | | 10 | hrs/t | 568 | hours | 420 | 238,678 |
| Hook up Barge | 8 | crew | 12 | hrs/day | | days | 150,000 | |
| **Total Duration** | | | | | 0.0 | days | | |
| **Equipment & weather downtime** | | | | 25% | 0.0 | days | 150,000 | |
| **Subtotal Hook-Up and Commissioning** | | | | | | | | **238,678** |

| | | | |
|---|---|---|---|
| **Client** | Beach Energy | | |
| **Calc. No.** | 411010-00050 | | |
| **Prepared** | Antony Perri | **Rev.** | 0 |
| **Checked** | Richard George | **Date:** | 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**Steam Stripper**

| **Standard Rates for Offshore Work** | | | | |
|---|---|---|---|---|
| **Labours** | | | | |
| | Offshore Labour | 280 | $/hr | inclusive of tools, consumables, accommodation, food and helicopter transfers |
| | Hours per day | 12 | hrs | |
| **Productivity Factors** | | | | |
| | Works in protected location | 80.0% | effective % of time | |
| | Field work on platform | 60.0% | effective % of time | |
| | Field work in exposed location, shutdown work | 50.0% | effective % of time | |

| **Mobilisation Crew and Equipment** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Mobilise/demob crew to platform, training, induction etc. | 16 | crew | 3 | 100.0% | 576 | 280 | 161,280 | |
| Clear deck/work area | 8 | crew | 3 | 60.0% | 480 | 280 | 134,400 | |
| Install workshop/stores/office | 8 | crew | 4 | 60.0% | 640 | 280 | 179,200 | |
| Tie in power/comms to temporary buildings | 3 | crew | 4 | 60.0% | 240 | 280 | 67,200 | |
| **Subtotal Mobilisation Crew and Equipment** | | | | | **1,936** | | **542,080** | |

| **Hire Equipment** | **Qty.** | **Unit** | **Duration** | **Unit** | **$/week** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|
| Office/stores containers | 1 | each | 26 | weeks | 200 | 5,200 | |
| Mobile workshop | 1 | each | 26 | weeks | 1,000 | 26,000 | |
| Scrap/transport Containers | 4 | each | 26 | weeks | 100 | 10,400 | |
| Scaffolding | 200 | m2 | 26 | weeks | 5 | 26,000 | |
| Accommodation vessel | | | 0 | days | 150,000 | | Flotel if required for additional POB |
| Additional escape craft | | | | | | | If required for additional POB |
| **Subtotal Hire Equipment** | | | | | | **67,600** | |

| **Scaffold, Rigging and Construction Aids** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Scaffold deck area | 5 | crew | 10 | 60.0% | 1,000 | 280 | 280,000 | |
| Demolish scaffolding | 5 | crew | 5 | 60.0% | 500 | 280 | 140,000 | |
| | | crew | 2 | 60.0% | | 280 | | |
| | | crew | 1 | 60.0% | | 280 | | |
| | | crew | 3 | 60.0% | | 280 | | |
| **Subtotal Scaffold, Rigging and Construction Aids** | | | | | **1,500** | | **420,000** | |

| **Crane Upgrade** | | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|---|
| **Service existing crane** | | 3 | people | 2 | 60.0% | 120 | 280 | **33,600** | Service existing crane |
| **Spares** | | 1 | lot | | | | 10,000 | **10,000** | |
| **Temporary Crane** | Install temporary crane | | people | | 60.0% | | 280 | | |
| | hire temporary crane | | weeks | | | | 10,000 | | |
| | remove temporary crane | | people | | 60.0% | | 280 | | |
| | **Subtotal** | | | | | | | **0** | |
| **Upgrade existing crane** | Purchase crane upgrade equipment | | each | | | | 10,000 | | |
| | Crane upgrade construction | 10 | people | | 60.0% | | 280 | | |
| | **Subtotal** | | | | | | | **0** | |
| **Subtotal Crane Upgrade** | | | | | | **120** | | **43,600** | |

| **Demolition** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Isolate existing water equipment | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| Remove existing water handling equipment | 8 | crew | 3 | 60.0% | 480 | 280 | 134,400 | |
| Remove redundant piping | 8 | crew | 5 | 60.0% | 800 | 280 | 224,000 | |
| Remove filters | 8 | crew | 2 | 60.0% | 320 | 280 | 89,600 | |
| Clear structure | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| Paint touch up | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| **Subtotal Demolition** | | | | | **2,040** | | **571,200** | |

| **Building and HVAC** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| **Subtotal Building and HVAC** | | | | | **0** | | **0** | |

| **Equipment Installation** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Lift in Steam stripper | 8 | crew | 2 | 60.0% | 320 | 280 | 89,600 | |
| Rig in Demin water unit | 5 | crew | 6 | 60.0% | 600 | 280 | 168,000 | |
| Lift in demin water tank | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| Install pump | 5 | crew | 3 | 60.0% | 300 | 280 | 84,000 | |
| | | crew | | 60.0% | | 280 | | |
| **Subtotal Equipment Installation** | | | | | **1,380** | | **386,400** | |

| **Structure** | **Qty.** | **Unit** | **days** | **Productivity** | **hrs** | **$/hr** | **$** | **Comment(s) / Remark(s)** |
|---|---|---|---|---|---|---|---|---|
| Secure steam stripper skid | 5 | crew | 3 | 60.0% | 300 | 280 | 84,000 | |
| Secure demin water tank | 5 | crew | 2 | 60.0% | 200 | 280 | 56,000 | |
| Secure and install supports for demin water maker | 5 | crew | 3 | 60.0% | 300 | 280 | 84,000 | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| Paint touch up | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| NDT for structural work | 2 | crew | 1 | 80.0% | 30 | 280 | 8,400 | |
| **Subtotal Structure** | | | | | **950** | | **266,000** | |

| | | | |
|---|---|---|---|
| Client | Beach Energy | | |
| Calc. No. | 411010-00050 | | |
| Prepared | Antony Perri | Rev. | 0 |
| Checked | Richard George | Date: | 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**Steam Stripper**

| Piping | dia | length | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|---|---|
| Piping tie in #1 Produced water inlet | 3 | 5 | 5 | crew | 1 | 50.0% | 120 | 280 | 33,600 | Shut down required |
| Piping tie in #2 to Produced water to dump caisson | 3 | 5 | 5 | crew | 1 | 50.0% | 120 | 280 | 33,600 | Shut down required |
| Piping tie in #3 to flare header | 3 | 20 | 5 | crew | 3 | 50.0% | 360 | 280 | 100,800 | Shut down required |
| Piping tie in #4 to liquids to flare drum | 2 | 20 | 5 | crew | 3 | 50.0% | 360 | 280 | 100,800 | |
| Piping tie in #5 to drains | 2 | 20 | 5 | crew | 3 | 50.0% | 360 | 280 | 100,800 | |
| Piping tie in # 6 to demin water maker | 1 | 80 | 5 | crew | 7 | 50.0% | 840 | 280 | 235,200 | |
| Piping Run from demin maker to tank | 1 | 5 | 3 | crew | 1 | 50.0% | 72 | 280 | 20,160 | |
| Piping tie in # 7 Demin water tank to steam stripper | 1 | 5 | 3 | crew | 1 | 50.0% | 72 | 280 | 20,160 | |
| Piping tie in # 8 Fuel gas supply | 2 | 30 | 5 | crew | 4 | 50.0% | 480 | 280 | 134,400 | |
| Piping to pump | 1 | 20 | 3 | crew | 2 | 50.0% | 144 | 280 | 40,320 | |
| Leak test piping systems | | | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| Paint touch up | | | 3 | crew | 3 | 60.0% | 180 | 280 | 50,400 | |
| **Subtotal Piping** | | | | | | | **3,228** | | **903,840** | |

| Electrical | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Power supply to demin water skid | 3 | crew | 7 | 50.0% | 504 | 280 | 141,120 | Local shut down required |
| Power supply to steam stripper | 3 | crew | 7 | 80.0% | 315 | 280 | 88,200 | |
| Power supply to pump | 3 | crew | 4 | 80.0% | 180 | 280 | 50,400 | |
| MCC mods in SG room | 3 | crew | 5 | 60.0% | 300 | 280 | 84,000 | |
| Testing and precommissioning | 3 | crew | 3 | 60.0% | 180 | 280 | 50,400 | |
| **Subtotal Electrical** | | | | | **1,479** | | **414,120** | |

| Instrumentation | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Run cables from Ins room to local panel | 150 | m | 0.10 | 60.0% | 300 | 280 | 84,000 | allow approx. 1 hr per m |
| Install field instruments & cable | 25 | instruments | 1 | 60.0% | 500 | 280 | 140,000 | allow 12 hrs per instrument |
| Install tubing, chem injection | 0 | m | 0.16 | 60.0% | | 280 | | allow 2 hrs per m |
| Instrument hook up to skid | 25 | instruments | 0.25 | 60.0% | 125 | 280 | 35,000 | allow 3 hrs per instrument |
| Testing and precomm 100 loop checks | 50 | loops | 0.10 | 60.0% | 100 | 280 | 28,000 | Allow 1 hour per loop |
| Testing and precomm new to existing system | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| Install Fire and Gas detectors | 1 | instruments | 1 | 60.0% | 20 | 280 | 5,600 | allow 1 day per instrument |
| **Subtotal Instrumentation** | | | | | **1,165** | | **326,200** | |

| Safety and Risk | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| New manual alarm | | no | | 60.0% | | 280 | | |
| Fire fighting, portable extinguishers | 3 | no | 0 | 60.0% | 6 | 280 | 1,680 | |
| Fire fighting, fixed hose reel | | no | | 60.0% | | 280 | | |
| safety shower | | no | | 60.0% | | 280 | | |
| Comms PA station | | no | | 60.0% | | 280 | | |
| **Subtotal Safety and Risk** | | | | | **6** | | **1,680** | |

| Support Vessels / Helicopters | #Trip/Week | Time/Trip | Unit | Weeks | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Helicopter additional flights, urgent freight etc. | 1 | 2 | hrs | 23 | 46 | 3,500 | 161,047 | |
| Supply boat for equipment | 1 | 1 | days | 23 | 23 | 45,000 | 1,035,300 | |
| **Subtotal Support Vessels / Helicopters** | | | | | | | **1,196,347** | |

**Summaries**

| Fabrication Costs Summary | | | |
|---|---|---|---|
| **Direct Procurement & Fabrication Costs** | | | |
| Equipment Procurement | | 2,359,000 | |
| Bulks Procurement | | 231,038 | |
| Equipment Installation | | 93,600 | |
| Bulks Fabrication | | 725,645 | |
| Miscellaneous | | 0 | |
| **Subtotal Direct Costs** | | **3,409,283** | |
| **Installation Costs Summary** | | | |
| **Direct Transport & Installation Costs** | | | |
| Seafastening & Load-Out | | 42,048 | |
| Transportation | | 75,833 | |
| Installation | | 0 | |
| Hook-Up and Commissioning | | 238,678 | |
| **Subtotal Direct Costs** | | **356,559** | |
| **Allowances** | | ***Applied to:*** | |
| Freight | 8.0% | 207,203 | *Equipment & Bulks Procurement* |
| Spares | 5.0% | 117,950 | *Equipment Procurement* |
| Insurance | 2.5% | 94,146 | *Subtotal Direct Costs* |
| Certification | 0.5% | 18,240 | *Subtotal Direct Costs* |
| Engineering | 8.0% | 301,267 | *Subtotal Direct Costs* |
| Contractors Project Management | 10.0% | 376,584 | *Subtotal Direct Costs* |
| Design Growth | 10.0% | 340,928 | *Subtotal Procurement & Fabrication Costs* |
| **Subtotal Allowances** | | **1,456,319** | |
| **Fabrication Cost** | | **5,222,161** | |
| **Contingency** | 30.0% | **1,566,648** | |
| **Total Fabrication Cost** | | **6,788,809** | |

| Tie-In Costs Summary | | | hours | $ |
|---|---|---|---|---|
| **Direct Costs** | | | | |
| Mobilisation Crew and Equipment | | | 1,936 | 542,080 |
| Hire Equipment | | | 0 | 67,600 |
| Scaffold, Rigging and Construction Aids | | | 1,500 | 420,000 |
| Crane Upgrade | | | 120 | 43,600 |
| Demolition | | | 2,040 | 571,200 |
| Building and HVAC | | | 0 | 0 |
| Equipment Installation | | | 1,380 | 386,400 |
| Structure | | | 950 | 266,000 |
| Piping | | | 3,228 | 903,840 |
| Electrical | | | 1,479 | 414,120 |
| Instrumentation | | | 1,165 | 326,200 |
| Safety and Risk | | | 6 | 1,680 |
| Support Vessels / Helicopters | | | 0 | 1,196,347 |
| ***Notes:*** | | | | |
| - *Crew Size* | *10* | | | |
| - *uration (no contingency)* | *115* | *days* | | |
| - *Duration (with contingency)* | *23* | *weeks* | | |
| **Subtotal Direct Costs** | | | **13,804** | **5,139,067** |
| **Allowances** | | | | |
| Insurance | | | 3.0% | 154,172 |
| Certification | | | 1.0% | 51,391 |
| Engineering | | | 20.0% | 1,027,813 |
| Project Management | | | 25.0% | 1,284,767 |
| Design Growth | | | 10.0% | 513,907 |
| **Subtotal Allowances** | | | | **3,032,049** |
| **Contingency** | | | 40.0% | **3,268,446** |
| **Total Tie-In Cost** | | | | **11,439,562** |

| Overall Summary | | |
|---|---|---|
| **Direct Costs** | | |
| Mobilisation / Demobilisation | | 542,080 |
| Equipment Procurement | | 2,426,600 |
| Bulks Procurement | | 231,038 |
| Fabrication | | 819,245 |
| Load-Out & Transport | | 117,882 |
| Installation | | 4,529,387 |
| Hook-Up & Commissioning | | 238,678 |
| **Subtotal Direct Costs** | | **8,904,909** |
| **Allowances** | | |
| Engineering | | 1,329,081 |
| Project Management | | 1,661,351 |
| Freight | | 207,203 |
| Spares | | 117,950 |
| Insurace & Certification | | 317,949 |
| **Subtotal Allowances** | | **3,633,533** |
| **Contingency** | | **5,689,930** |
| **Total Cost** | | **18,228,372** |
| Lower Bound P10- | 30.0% | 12,759,860 |
| Upper Bound P90+ | 40.0% | 25,519,720 |
| **Owners Cost** | 0.0% | **0** |

| Weights Summary | equip | I&E | Pipe | Struct | uildings/mis | Total |
|---|---|---|---|---|---|---|
| Raw weight | 31 | 3 | 7 | 15 | 0 | 57 |
| Factored | 37 | 4 | 9 | 18 | 0 | 68 |
| % | 55% | 6% | 13% | 26% | 0% | 100% |
| Weight growth factor | 20.0% | | | | | |

| Hours Summary Fabrication | equip | I&E | Pipe | Struct | | Total | Crew size | Hours/week | Duration |
|---|---|---|---|---|---|---|---|---|---|
| Hours | 780 | 2,050 | 2,220 | 1,777 | | 6,827 | | | |
| Factored | 780 | 2,050 | 2,220 | 1,777 | | 6,827 | 60 | 60 | 2 |
| % | 11% | 30% | 33% | 26% | 0% | 100% | | | |
| Growth factor | 25.0% | | | | | | | | |

| Hours Summary Offshore | Prelims | Demolition | Buildings | equip | I&E | Pipe | Struct | HUC | Total | Crew size | Hours/week | Duration |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hours | 3,556 | 2,040 | 0 | 1,380 | 2,644 | 3,228 | 950 | 568 | 8,770 | | | |
| Factored | 4,445 | 2,550 | 0 | 1,725 | 3,305 | 4,035 | 1,188 | 710 | 10,963 | 30 | 84 | 4 |
| % | 41% | 23% | 0% | 16% | 30% | 37% | 11% | 6% | 100% | | | |
| Growth factor | 25.0% | | | | | | | | | | | |

| | | | |
|---|---|---|---|
| **Client** | Beach Energy | | |
| **Calc. No.** | 411010-00050 | | |
| **Prepared** | Antony Perri | **Rev.** | 0 |
| **Checked** | Richard George | **Date:** | 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**Gas Stripper**

**Offshore Facility Parameters**

| | | | | | |
|---|---|---|---|---|---|
| Type | Water Handling | Pre-Fabrication Location | VIC | Installation by | Heavy Lift Vessel |
| Capacity | | Site Location | VIC | Method | Lift Installed |

**Topsides - Equipment / Bulks and Installation**

| Equipment Description | Structure Type | Piping Material | Number | Sizing Parameter | Unit | $/Unit | $/Item | t/Item | $ | t | Equip. Type | Electrical | | Instrument | | Piping | | Structural | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Factor | Weight | Factor | Weight | Factor | Weight | Factor | Weight |
| **Water Treatment System** | | | | | | | | | | | | | | | | | | | |
| Gas Stripper column | Modules, topsides | CS | 1 | 1.4 | t | 30,000 | 42,000 | 1.4 | 42,000 | 1.4 | Columns | 0.05 | 0.1 | 0.12 | 0.2 | 0.70 | 1.0 | 1.15 | 3.0 |
| Column internals | Modules, topsides | CS | 1 | | | | 100,000 | 0.5 | 100,000 | 0.5 | Columns | 0.05 | 0.0 | 0.12 | 0.1 | 0.70 | 0.4 | 1.15 | 1.1 |
| **Bulks Procurement & Fabrication** | | | | | | | | | | | | | | | | | | | |
| Structure | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| Installation aids | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| Rigging | Modules, topsides | | | | t | | | | | | | | | | | | | | 0.0 |
| CS pipe | Modules, topsides | CS | | | t | | | | | | | | | | | | 0.0 | | |
| CRA Pipe | Modules, topsides | SS | | | t | | | | | | | | | | | | 0.0 | | |
| | | | | | t | | | | | | | | | | | | | | |
| Building | Modules, topsides | CS | 1 | | | | | | | | | | | | | | | | |
| **Subtotals** | | | | | | | | | **142,000** | **2** | | | **0** | | **0** | | **1** | | **4** |

| **Summary** | | | | | | | | | **Bulks** | **equip + bulks** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **Unit** | **Equipment** | **Elec.** | **Inst.** | **Piping** | | | **Structure** | **Subtotals** | |
| | | | | | **CS** | **CRA** | **CS/CRA** | | | |
| Unit cost | $/t | 74,737 | 25,000 | 40,000 | 12,000 | 18,000 | 25,000 | 1,500 | | |
| Productivity | hrs/t | 25 | 600 | 600 | 300 | 400 | 450 | 120 | | |
| % spent in Fabyard | Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Productivity Factor | Factor | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | |
| Labour rate | $/hr | 120 | 120 | 120 | 120 | 120 | 120 | 120 | | |
| **Hours to install** | **hrs** | **48** | **57** | **137** | **399** | **0** | **0** | **490** | **1,083** | **1,131** |
| **Weight** | **t** | **2** | **0** | **0** | **1** | **0** | **0** | **4** | **6** | **8** |
| **Procurement** | **$** | **142,000** | **2,375** | **9,120** | **15,960** | **0** | **0** | **6,129** | **33,584** | **175,584** |
| **Installation** | **$** | **5,700** | **6,840** | **16,416** | **47,880** | **0** | **0** | **58,838** | **129,974** | **135,674** |

| **Miscellaneous** | **Weight (t)** | **Length (m)** | **Breadth (m)** | **Area.** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|---|---|---|
| | | | | | m2 | 10,000 | |
| | | | | | m2 | 10,000 | |
| **Subtotal Miscellaneous** | **0** | | | | | | **0** |

| **Seafastening & Load-Out** | **Factor** | **Unit** | **Weight** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|---|---|
| Total Topside Weight | | | 8 | t | | |
| Seafastening Materials (as % of Total Topside Weight) | 5.0% | - | 0 | t | 1,800 | 688 |
| Seafastening Fabrication | 120 | hrs/t | 0 | t | 35 | 1,604 |
| Load-Out on vessel | | | 1 | each | 25,000 | 25,000 |
| **Subtotal Seafastening & Load-Out** | | | | | | **27,292** |

| **Transportation** | **Distance (nm** | **peed (knots** | **Duration** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|---|---|
| Standby at wharf | | | 0.25 | days | 35,000 | 8,750 |
| Transport to site | 200 | 10 | 0.8 | days | 35,000 | 29,167 |
| standby at site | | | 0.25 | days | 35,000 | 8,750 |
| Return to fab yard | 200 | 10 | 0.8 | days | 35,000 | 29,167 |
| Fuel | | | 35 | days | 0 | |
| **Subtotal Transportation** | | | | | | **75,833** |

| **Installation** | **Duration** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|
| Set up at site | | days | 300,000 | |
| Lift skid 1 | | days | 300,000 | |
| Lift skid 2 | | days | 300,000 | |
| **Total Duration** | 0.0 | days | | |
| **Equipment & weather downtime** 25% | 0.0 | days | 300,000 | |
| **Subtotal Installation** | | | | **0** |

| **Hook-Up and Commissioning** | **Qty.** | **Unit** | **Factor** | **Unit** | **Duration** | **Unit** | **$/Unit** | **$** |
|---|---|---|---|---|---|---|---|---|
| Total Topside Weight | 8 | t | | | | | | |
| Hook up | | | | hrs/t | 0 | hours | 280 | |
| Pre-Commissioning | | | 10 | hrs/t | 76 | hours | 420 | 32,084 |
| Hook up Barge | 8 | crew | 12 | hrs/day | | days | 150,000 | |
| **Total Duration** | | | | | 0.0 | days | | |
| **Equipment & weather downtime** 25% | | | | | 0.0 | days | 150,000 | |
| **Subtotal Hook-Up and Commissioning** | | | | | | | | **32,084** |

| | |
|---|---|
| Client | Beach Energy |
| Calc. No. | 411010-00050 |
| Prepared | Antony Perri |
| Rev. | 0 |
| Checked | Richard George |
| Date: | 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**Gas Stripper**

| Standard Rates for Offshore Work | | | | |
|---|---|---|---|---|
| **Labours** | | | | |
| | Offshore Labour | 280 | $/hr | inclusive of tools, consumables, accommodation, food and helicopter transfers |
| | Hours per day | 12 | hrs | |
| **Productivity Factors** | | | | |
| | Works in protected location | 80.0% | effective % of time | |
| | Field work on platform | 60.0% | effective % of time | |
| | Field work in exposed location, shutdown work | 50.0% | effective % of time | |

| Mobilisation Crew and Equipment | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Mobilise/demob crew to platform, training, induction etc. | 16 | crew | 3 | 100.0% | 576 | 280 | 161,280 | |
| Clear deck/work area | 8 | crew | 3 | 60.0% | 480 | 280 | 134,400 | |
| Install workshop/stores/office | 8 | crew | 4 | 60.0% | 640 | 280 | 179,200 | |
| Tie in power/comms to temporary buildings | 3 | crew | 4 | 60.0% | 240 | 280 | 67,200 | |
| **Subtotal Mobilisation Crew and Equipment** | | | | | **1,936** | | **542,080** | |

| Hire Equipment | Qty. | Unit | Duration | Unit | $/week | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|
| Office/stores containers | 1 | each | 20 | weeks | 200 | 4,000 | |
| Mobile workshop | 1 | each | 20 | weeks | 1,000 | 20,000 | |
| Scrap/transport Containers | 4 | each | 20 | weeks | 100 | 8,000 | |
| Scaffolding | 200 | m2 | 20 | weeks | 5 | 20,000 | |
| Accommodation vessel | | | 0 | days | 150,000 | | Flotel if required for additional POB |
| Additional escape craft | | | | | | | If required for additional POB |
| **Subtotal Hire Equipment** | | | | | | **52,000** | |

| Scaffold, Rigging and Construction Aids | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Scaffold deck area | 5 | crew | 10 | 60.0% | 1,000 | 280 | 280,000 | |
| Demolish scaffolding | 5 | crew | 5 | 60.0% | 500 | 280 | 140,000 | |
| | | crew | 2 | 60.0% | | 280 | | |
| | | crew | 1 | 60.0% | | 280 | | |
| | | crew | 3 | 60.0% | | 280 | | |
| **Subtotal Scaffold, Rigging and Construction Aids** | | | | | **1,500** | | **420,000** | |

| Crane Upgrade | | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|---|
| **Service existing crane** | | 3 | people | 2 | 60.0% | 120 | 280 | **33,600** | Service existing crane |
| **Spares** | | 1 | lot | | | | 10,000 | **10,000** | |
| **Temporary Crane** | Install temporary crane | | people | | 60.0% | | 280 | | |
| | hire temporary crane | | weeks | | | | 10,000 | | |
| | remove temporary crane | | people | | 60.0% | | 280 | | |
| | **Subtotal** | | | | | | | **0** | |
| **Upgrade existing crane** | Purchase crane upgrade equipment | | each | | | | 10,000 | | |
| | Crane upgrade construction | 10 | people | | 60.0% | | 280 | | |
| | **Subtotal** | | | | | | | **0** | |
| **Subtotal Crane Upgrade** | | | | | | **120** | | **43,600** | |

| Demolition | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Isolate existing water equipment | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| Remove existing water handling equipment | 8 | crew | 3 | 60.0% | 480 | 280 | 134,400 | |
| Remove redundant piping | 8 | crew | 5 | 60.0% | 800 | 280 | 224,000 | |
| Clear structure | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| Paint touch up | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| **Subtotal Demolition** | | | | | **1,720** | | **481,600** | |

| Building and HVAC | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| **Subtotal Building and HVAC** | | | | | **0** | | **0** | |

| Equipment Installation | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Lift in Gas Stripper Column | 8 | crew | 1 | 60.0% | 160 | 280 | 44,800 | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| **Subtotal Equipment Installation** | | | | | **160** | | **44,800** | |

| Structure | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Secure Gas stripper column | 5 | crew | 7 | 60.0% | 700 | 280 | 196,000 | |
| | | crew | | 60.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| Paint touch up | 3 | crew | 1 | 60.0% | 60 | 280 | 16,800 | |
| NDT for structural work | 2 | crew | 1 | 80.0% | 30 | 280 | 8,400 | |
| **Subtotal Structure** | | | | | **790** | | **221,200** | |

| | | | |
|---|---|---|---|
| Client | Beach Energy | | |
| Calc. No. | 411010-00050 | | |
| Prepared | Antony Perri | Rev. | 0 |
| Checked | Richard George | Date: | 11/12/19 |

**Yolla Water Handling Upgrade**
**Offshore Facility**
**Gas Stripper**

| Piping | dia | length | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|---|---|
| Piping tie in #1 Produced water inlet | 3 | 5 | 5 | crew | 1 | 50.0% | 120 | 280 | 33,600 | Shut down required |
| Piping tie in #2 to Produced water to dump caisson | 3 | 5 | 5 | crew | 1 | 50.0% | 120 | 280 | 33,600 | Shut down required |
| Piping tie in #3 to flare header | 2 | 20 | 5 | crew | 3 | 50.0% | 360 | 280 | 100,800 | Shut down required |
| Piping tie in #5 to drains | 2 | 20 | 5 | crew | 3 | 50.0% | 360 | 280 | 100,800 | |
| Piping tie in # 6 Fuel gas to column | 2 | 30 | 5 | crew | 4 | 50.0% | 480 | 280 | 134,400 | |
| Leak test piping systems | | | 3 | crew | 2 | 60.0% | 120 | 280 | 33,600 | |
| Paint touch up | | | 3 | crew | 3 | 60.0% | 180 | 280 | 50,400 | |
| **Subtotal Piping** | | | | | | | **1,740** | | **487,200** | |

| Electrical | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| | | crew | | 50.0% | | 280 | | Local shut down required |
| | | crew | | 80.0% | | 280 | | |
| | | crew | | 60.0% | | 280 | | |
| Testing and precommissioning | 3 | crew | 3 | 60.0% | 180 | 280 | 50,400 | |
| **Subtotal Electrical** | | | | | **180** | | **50,400** | |

| Instrumentation | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Run cables from Ins room to local panel | 100 | m | 0.10 | 60.0% | 200 | 280 | 56,000 | allow approx. 1 hr per m |
| Install field instruments & cable | 5 | instruments | 1 | 60.0% | 100 | 280 | 28,000 | allow 12 hrs per instrument |
| Install tubing, chem injection | 0 | m | 0.16 | 60.0% | | 280 | | allow 2 hrs per m |
| Instrument hook up to skid | 5 | instruments | 0.25 | 60.0% | 25 | 280 | 7,000 | allow 3 hrs per instrument |
| Testing and precomm 100 loop checks | 10 | loops | 0.10 | 60.0% | 20 | 280 | 5,600 | Allow 1 hour per loop |
| Testing and precomm new to existing system | 3 | crew | 1 | 60.0% | 60 | 280 | 16,800 | |
| Install Fire and Gas detectors | 1 | instruments | 1 | 60.0% | 20 | 280 | 5,600 | allow 1 day per instrument |
| **Subtotal Instrumentation** | | | | | **425** | | **119,000** | |

| Safety and Risk | Qty. | Unit | days | Productivity | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| New manual alarm | | no | | 60.0% | | 280 | | |
| Fire fighting, portable extinguishers | 3 | no | 0 | 60.0% | 6 | 280 | 1,680 | |
| Fire fighting, fixed hose reel | | no | | 60.0% | | 280 | | |
| safety shower | | no | | 60.0% | | 280 | | |
| Comms PA station | | no | | 60.0% | | 280 | | |
| **Subtotal Safety and Risk** | | | | | **6** | | **1,680** | |

| Support Vessels / Helicopters | #Trip/Week | Time/Trip | Unit | Weeks | hrs | $/hr | $ | Comment(s) / Remark(s) |
|---|---|---|---|---|---|---|---|---|
| Helicopter additional flights, urgent freight etc. | 1 | 2 | hrs | 14 | 29 | 3,500 | 100,065 | |
| Supply boat for equipment | 1 | 1 | days | 14 | 14 | 45,000 | 643,275 | |
| **Subtotal Support Vessels / Helicopters** | | | | | | | **743,340** | |

**Summaries**

| Fabrication Costs Summary | | | |
|---|---|---|---|
| **Direct Procurement & Fabrication Costs** | | | |
| Equipment Procurement | | 142,000 | |
| Bulks Procurement | | 33,584 | |
| Equipment Installation | | 5,700 | |
| Bulks Fabrication | | 129,974 | |
| Miscellaneous | | 0 | |
| **Subtotal Direct Costs** | | **311,258** | |
| **Installation Costs Summary** | | | |
| **Direct Transport & Installation Costs** | | | |
| Seafastening & Load-Out | | 27,292 | |
| Transportation | | 75,833 | |
| Installation | | 0 | |
| Hook-Up and Commissioning | | 32,084 | |
| **Subtotal Direct Costs** | | **135,209** | |
| **Allowances** | | ***Applied to:*** | |
| Freight | 8.0% | 14,047 | *Equipment & Bulks Procurement* |
| Spares | 5.0% | 7,100 | *Equipment Procurement* |
| Insurance | 2.5% | 11,162 | *Subtotal Direct Costs* |
| Certification | 0.5% | 1,717 | *Subtotal Direct Costs* |
| Engineering | 8.0% | 35,717 | *Subtotal Direct Costs* |
| Contractors Project Management | 10.0% | 44,647 | *Subtotal Direct Costs* |
| Design Growth | 10.0% | 31,126 | *Subtotal Procurement & Fabrication Costs* |
| **Subtotal Allowances** | | **145,515** | |
| **Fabrication Cost** | | **591,981** | |
| **Contingency** | 30.0% | **177,594** | |
| **Total Fabrication Cost** | | **769,575** | |

| Tie-In Costs Summary | | | | hours | $ |
|---|---|---|---|---|---|
| **Direct Costs** | | | | | |
| Mobilisation Crew and Equipment | | | | 1,936 | 542,080 |
| Hire Equipment | | | | 0 | 52,000 |
| Scaffold, Rigging and Construction Aids | | | | 1,500 | 420,000 |
| Crane Upgrade | | | | 120 | 43,600 |
| Demolition | | | | 1,720 | 481,600 |
| Building and HVAC | | | | 0 | 0 |
| Equipment Installation | | | | 160 | 44,800 |
| Structure | | | | 790 | 221,200 |
| Piping | | | | 1,740 | 487,200 |
| Electrical | | | | 180 | 50,400 |
| Instrumentation | | | | 425 | 119,000 |
| Safety and Risk | | | | 6 | 1,680 |
| Support Vessels / Helicopters | | | | 0 | 743,340 |
| ***Notes:*** | | | | | |
| *- Crew Size* | | *10* | | | |
| *- uration (no contingency)* | | *71* | *days* | | |
| *- Duration (with contingency)* | | *14* | *weeks* | | |
| **Subtotal Direct Costs** | | | | **8,577** | **3,206,900** |
| **Allowances** | | | | | |
| Insurance | | | 3.0% | | 96,207 |
| Certification | | | 1.0% | | 32,069 |
| Engineering | | | 20.0% | | 641,380 |
| Project Management | | | 25.0% | | 801,725 |
| Design Growth | | | 10.0% | | 320,690 |
| **Subtotal Allowances** | | | | | **1,892,071** |
| **Contingency** | | | 40.0% | | **2,039,588** |
| **Total Tie-In Cost** | | | | | **7,138,559** |

| Overall Summary | | |
|---|---|---|
| **Direct Costs** | | |
| Mobilisation / Demobilisation | | 542,080 |
| Equipment Procurement | | 194,000 |
| Bulks Procurement | | 33,584 |
| Fabrication | | 135,674 |
| Load-Out & Transport | | 103,125 |
| Installation | | 2,612,820 |
| Hook-Up & Commissioning | | 32,084 |
| **Subtotal Direct Costs** | | **3,653,366** |
| **Allowances** | | |
| Engineering | | 677,097 |
| Project Management | | 846,372 |
| Freight | | 14,047 |
| Spares | | 7,100 |
| Insurace & Certification | | 141,154 |
| **Subtotal Allowances** | | **1,685,770** |
| **Contingency** | | **2,568,998** |
| **Total Cost** | | **7,908,135** |
| Lower Bound P10- | 30.0% | 5,535,694 |
| Upper Bound P90+ | 40.0% | 11,071,389 |
| **Owners Cost** | 0.0% | **0** |

| Weights Summary | | | | | | |
|---|---|---|---|---|---|---|
| | equip | I&E | Pipe | Struct | uildings/mis | Total |
| Raw weight | 2 | 0 | 1 | 4 | 0 | 8 |
| Factored | 2 | 0 | 2 | 5 | 0 | 9 |
| % | 25% | 4% | 17% | 53% | 0% | 100% |
| Weight growth factor | 20.0% | | | | | |

| Hours Summary Fabrication | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | equip | I&E | Pipe | Struct | | Total | Crew size | Hours/week | Duration |
| Hours | 48 | 194 | 399 | 490 | | 1,131 | | | |
| Factored | 48 | 194 | 399 | 490 | | 1,131 | 60 | 60 | 0 |
| % | 4% | 17% | 35% | 43% | 0% | 100% | | | |
| Growth factor | 25.0% | | | | | | | | |

| Hours Summary Offshore | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prelims | Demolition | Buildings | equip | I&E | Pipe | Struct | HUC | Total | Crew size | Hours/week | Duration |
| Hours | 3,556 | 1,720 | 0 | 160 | 605 | 1,740 | 790 | 76 | 3,371 | | | |
| Factored | 4,445 | 2,150 | 0 | 200 | 756 | 2,175 | 988 | 95 | 4,214 | 30 | 84 | 2 |
| % | 105% | 51% | 0% | 5% | 18% | 52% | 23% | 2% | 100% | | | |
| Growth factor | 25.0% | | | | | | | | | | | |

# Appendix E

## Beach Risk Assessment Guidance

# Risk Rating Toolkit

## Risk Matrix Instruction

**Step A**
Identify and describe the risk as follows: "(something happens) leading to outcomes expressed in terms of impact on objectives).

**Step B**
Assess the potential exposure (maximum credible impact on Lattice Energy arising from a risk without regards for controls).

**Step C**
Identify existing controls, and assess their effectiveness.

**Step D**
Identify the consequence rating (1-6) corresponding to the maximum credible impact across the Consequence Categories (may be more than one), given the existing controls and their effectiveness.

**Step E**
Identify the Likelihood of occurrence ("remote" through to "almost certain") of those consequences at that level, taking into account the current controls and their effectiveness.

**Step F**
Determine the Level of Risk (Low, medium, High, Severe, Extreme) based on the intersection of the Consequence rating and Likelihood.

**Step G**
Determine and action (e.g. Risk treatment) and escalation required based on the Level of Risk.

## Control Effectiveness

| Rating | Explanation |
|---|---|
| **Fully Effective** (100%) | Controls are well designed for the risk, largely prevent the risk from eventuating, and address the root causes. The controls are operating effectively and are reliable at all times. Nothing more to be done except review and monitor the existing controls. |
| **Substantially Effective** (75%) | Most controls are designed correctly and are in place and effective. Some more work needs to be done to improve operating effectiveness of the controls, or there are doubts about operational effectiveness and reliability. |
| **Partially Effective** (50%) | While the design of controls may be largely correct in that they treat most of the root causes of the risk, they are not currently very effective. There may be an over reliance on reactive controls. |
| **Largely ineffective** (25%) | Significant control gaps. Either controls do not treat root cause or they do not operate effectively at all. Controls, if they exist, are just reactive. |
| **None** (0%) | Virtually no credible control. There is little to no confidence that any degree of control is being achieved due to poor control design and/or very limited operational effectiveness of controls. |

## Risk Management Action

| Level of risk | Action required | Escalation and Approval of Treatment Plans | Acceptance authority |
|---|---|---|---|
| EXTREME | Risk treatment Plan must be in place immediately<br>Risk reviewed monthly by Risk owner | Exco for review and approval of the treatment plan | Exco |
| SEVERE | Risk treatment must be considered<br>Risk reviewed monthly by Risk owner | Exco for review and approval of associated treatment plan (if applicable) | Exco |
| HIGH | Risk treatment must be considered<br>Risk reviewed twice per year by Risk owner | Project / Operations Manager for review and approval of associated treatment plan (if applicable) | Exco direct report (Exco -1) |
| MEDIUM | Risk treatment may be considered<br>Risk reviewed annually by Risk owner | Project / Operations Manager | Exco direct report (Exco -1) |
| LOW | No risk treatment required<br>Risk reviewed annually by Risk owner | Facilities Manager / Operations Superintendent | Exco Direct report – reports (Exco -2) |



Based on the Origin Risk Matrix 2010

# Risk Matrix

| CONSEQUENCE CATEGORIES | Impact to Lattice or contracting personnel | Natural environment | Community damage/ impact/ social/ cultural heritage | Financial impact (e.g. due to loss of revenue, business | Damage to reputation, services interruption, customer interruption | Breach of law or criminal prosecution or civil action (e.g. OHS, environment, industrial relations, trade practices, industry acts) |
|---|---|---|---|---|---|---|
| 6 CATASTROPHIC | Multiple fatalities >4 or severe irreversible disability to large group of people (>10). | Long term destruction of highly significant ecosystem or very significant effects on endangered species or habitats. | Multiple community fatalities, complete breakdown of social order, irreparable damage of highly valued items or structures of great cultural significance. | EBIT: impact, loss or deterioration from expectation greater than $100m. CASH FLOW: severe cash flow crisis, unable to source funds. | Negative international or prolonged national media (e.g. 2 weeks). continued severe degradation of services to customers > 1 month or > 10,000 customer days. | Potential jail terms for executives and or very high fines for the company. Prolonged multiple litigations. |
| 5 CRITICAL | 1-3 fatalities or serious irreversible disability (>30%) to multiple persons (<10). | Major offsite release or spill, significant impact on highly valued species or habitats to the point of eradication or impairment of the ecosystem. Widespread long-term impact. | Community fatality. Significant breakdown of social order. Ongoing serious social issue. Major irreparable damage to highly valuable structures/ items of cultural significance. | EBIT: impact, loss or deterioration from expectation greater than $30m but less than $100m. CASH FLOW: severe cash flow crisis, difficulty to source funds. Probable credit rating downgrade. | Negative media national for 2 days or more. Significant public outcry. severe degradation of services to customers up to 1 month or >5,000 customer days | Very significant fines and prosecutions. Multiple prosecution and fines. |
| 4 MAJOR | Serious permanent injury/ illness or moderate irreversible disability (<30%) to one or more persons. | Offsite release contained or immediately reportable event with very serious Environmental effects, such as displacement of species and partial impairment of ecosystem. Widespread medium and some long-term impact. | Serious injury to member of the community, Widespread social impacts. Significant damage to items of cultural significance. | EBIT: impact, loss or deterioration from expectation greater than $3m but less than $30m. CASH FLOW: Loss of flexibility and/or increase in cost to source funds. Market explanation required. | Negative national media for 1 day. Individual customers or segments disadvantaged up to 1 week. Customer interruption >500 customer days. NGO adverse attention. | Major breach of regulation and significant prosecution including class actions. |
| 3 SERIOUS | Serious reversible/ temporary injury/illness (e.g. lost time >5 days or hospitalisation or alternate/Restricted Duties > 1 month). | Moderate effects on biological or physical environment and serious short term effect to ecosystem functions. | Media attention and heightened concerns by local community and criticism by NGOs. Ongoing social issues. Permanent damage to items of cultural significance. | EBIT: impact, loss or deterioration from expectation greater than $0.3m but less than $3m. CASH FLOW: Material impact to cash flow. | Negative state media. Heightened concern from local community. Service interruption up to 1 day or > 10 customer days. Criticism by NGOs. | Serious breach of law/regulation with investigation or report to authority with possible prosecution. Performance infringement notice (Pin). |
| 2 MODERATE | Reversible temporary injury/illness requiring Medical treatment (e.g. lost time <5 days or alternate/Restricted Duties for < 1 month). | Event contained within site. Minor short term damage to area of limited significance. Short term effects but not affecting ecosystem functions. | Medical treatment injury to a member of the community, Minor adverse local public or media attention and complaints. Minor medium term social impact on local population, mostly repairable. | EBIT: impact or loss greater than $30k but less than $0.3m. CASH FLOW: impact to project or business unit cash flow. | Public concern restricted to local complaints Negative local media. Internal escalation to senior management. Few hours service interruption. Adverse local public attention. | Breach of law/regulation or non-compliance. Minor legal issues, minor litigation possible. |
| 1 MINOR | Injury/illness requiring Medical treatment (no lost time, no alternate/ Restricted Duties), First aid, Report only. | Minor consequence, local response. No lasting effects. Low level impacts on biological and physical environment to an area of low significance. | Public concern restricted to local complaints, low level repairable damage to common place structures. | EBIT: impact or loss greater than $3k but less than $30k. CASH FLOW: no significant impact. | Public concern restricted to local complaints. | Local investigation, minor breach of regulation, on the spot fine or technical non-compliance. Prosecution unlikely. |

| LIKELIHOOD | 1 REMOTE | 2 HIGHLY UNLIKELY | 3 UNLIKELY | 4 POSSIBLE | 5 LIKELY | 6 ALMOST CERTAIN |
|---|---|---|---|---|---|---|
| | <1% chance of occurring within the next year. Occurrence requires exceptional circumstances exceptionally unlikely event in the long-term future only occur as a 100-year event. | >1% chance of occurring within the next year May occur but not anticipated could occur years to decades. | >5% chance of occurring within the next year May occur but not for a while could occur within a few years. | >10% chance of occurring within the next year May occur shortly but a distinct probability it wont could occur within months to years. | >50% chance of occurring within the next year Balance of probability will occur could occur within weeks to months. | 99% chance of occurring within the next year impact is occurring now could occur within days to weeks. |
| 6 CATASTROPHIC | HIGH | HIGH | SEVERE | SEVERE | EXTREME | EXTREME |
| 5 CRITICAL | MEDIUM | MEDIUM | HIGH | SEVERE | SEVERE | EXTREME |
| 4 MAJOR | MEDIUM | MEDIUM | MEDIUM | HIGH | SEVERE | SEVERE |
| 3 SERIOUS | LOW | MEDIUM | MEDIUM | MEDIUM | HIGH | SEVERE |
| 2 MODERATE | LOW | LOW | MEDIUM | MEDIUM | MEDIUM | HIGH |
| 1 MINOR | LOW | LOW | LOW | MEDIUM | MEDIUM | MEDIUM |

# Appendix F

## Memo: Potential Impact of Yolla Platform PFW Discharge on Marine Life

AECOM Imagine it. Delivered.

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# Memorandum

| | | | |
|---|---|---|---|
| To | Harry Grynberg | Page | 1 |
| CC | Ian Baxter, Peter Young | | |
| Subject | Potential Impact of Yolla Platform PFW Discharge on Marine Life | | |
| From | Abigail Ross | | |
| File/Ref No. | 60612990 | Date | 19-Dec-2019 |

This memo presents a high-level overview of the potential impacts of the Yolla PFW discharge on the marine environment to satisfy the following comment from Beach Energy (in response to their discussion with NOPSEMA):

- We need to ensure we have risk assessed and considered the potential effect on surrounding marine life. Please refer to our Existing Environment (Section 5) in particular Section 5.5 of the EP to get an understanding of what marine life we have that may frequent around the platform and what this means in connection to our WET results.

## PFW toxicants effects in the Marine Environment

A brief overview of the potential effects on the marine environment associated with each of the toxicants which exceed detection limits in the Yolla Platform PFW discharge (see Table 4.0 in Yolla Platform ALARP Assessment) for which the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) provide default guideline values (DGVs, which are included in Table 4 of the ALARP assessment) is as follows:

- Naphthalene – The acute toxicity of naphthalene to marine organisms is considered by Bates, Young & Sutton (1997, in Nazir et al 2008) to be 'high to moderate'. Other toxicity effects include bioaccumulation, reproduction defects, and limited growth (Nazir et al 2008). It has been shown to biodegrade in water, with half-lives ranging from about 0.8 to 43 days (Toxnet 2017a).
- Benzene – The potential for benzene to bioconcentrate[1] in aquatic organisms is considered to be low (Toxnet 2017b). It also has a low tendency to bioaccumulate; hence it is not considered likely to biomagnify though food chains (ATSDR 2007). It has high volatility and relatively low water solubility and is rapidly lost to the atmosphere from water bodies (ANZG 2018). Biodegradation has been found to vary with season (e.g. Wakeham et al 1983), but is considered by ANZG (2018) to also be rapid.
- PAHs (phenanthrene, anthracene, fluoranthene and benzo(a)pyrene) - Concentrations of PAHs in marine ecosystems are generally highest in sediments, intermediate in biota and lowest in the water column (Neff 1979). Marine biota can take up PAHs via a number of routes, including dermal absorption, inhalation and consumption of contaminated prey or sediment (Meador et al. 1995). However, the persistence of these compounds in tissues and body fluids of exposed marine organisms varies depending upon the rates of uptake, metabolism and elimination (Krahn and Stein 1998, Rust et al 2004). Vertebrates, such as fish and marine mammals, quickly metabolise PAHs into more polar forms that are then excreted into urine or secreted into bile for rapid elimination via faeces (Roubal, Collier & Malins 1977, Krahn et al. 1984, Varanasi Stein & Nishimoto 1989). However, some of the PAH intermediates formed during metabolism can be more toxic, and may pose a greater health risk than the parent PAHs (Varanasi Stein & Nishimoto

[1] Bioconcentration is the intake and retention of a substance in an organism entirely by respiration from water in aquatic ecosystems. Bioaccumulation is the intake of a chemical and its concentration in an organism by all possible means, including contact, respiration and ingestion (Alexander 1999).

1989). Fish exposed to PAHs may exhibit an array of toxic effects including genetic damage, morphological deformities, altered growth and development, decreased body size, inhibited swimming abilities and mortality (e.g. White, Robitaille & Rasmussen 1999, Incardona et al 2005). Benzo(a)pyrene has a higher molecular weight than the other three PAHs, has a greater potential to bioaccumulate and has been found to cause tumours in fish (Hawkins et al. 1990).

- Toluene – Algae seem to be more resistant to the acute effects of toluene than fish and crustaceans (Jones and Zabel 1986). Bioaccumulation in marine organisms has been found to be low, and depuration rates high (Jones and Zabel 1986). Bioconcentration in aquatic organisms is considered to be low to moderate (Toxnet 2017c). Toluene has high volatility and relatively low water solubility and is rapidly lost to the atmosphere from water bodies (ANZG 2018). Complete degradation has been observed over periods of four days (summer) and 22 days (spring) in a marine mesocosm (Wakeham et al 1983).
- Ethylbenzene – The acute toxicity of ethylbenzene to marine algae, invertebrates and fish is rated by Toxnet (2017d) as 'moderate'; there are no data reported for chronic toxicity. The potential for bioconcentration in aquatic organisms is considered low and ethylbenzene is considered to be volatile and inherently biodegradable in water under aerobic conditions (OECD 2002).
- Xylenes - Meta-, para- and ortho-xylenes are chemical isomers, with similar physicochemical properties and moderate to low toxicity (OECD 2003, Toxnet 2017e). They are inherently biodegradable under aerobic conditions and their bioaccumulation and bioconcentration potentials are considered to be relatively low (OECD 2003, Ogata et al 1984).
- Copper – adsorbed strongly by suspended material (Florence & Batley 1980 in ANZG 2018). Copper is readily accumulated by plants and animals and bioconcentration has been recorded for various species of phytoplankton, zooplankton, macrophytes, macro-invertebrates and fish (Spear & Pierce 1979 in ANZG 2018). Toxic effects occur when the rate of uptake exceeds the rates of physiological or biochemical detoxification and excretion (Rainbow 1996). Some marine invertebrates, particularly crustaceans, corals, sea anemones and bivalve molluscs, are sensitive to copper (ANZG 2018), while gastropod molluscs are more tolerant and can accumulate quite high concentrations without toxic effects (Taylor & Anstiss 1999). Marine fish appear to be relatively tolerant of copper (e.g. Denton & Burdon-Jones 1986 in ANZG 2018). Copper toxicity in algae, invertebrates and fish generally increases as salinity decreases (e.g. Stauber 1995). Precipitation of copper hydroxide reaches a maximum around pH8 (Ayres, Davis & Gietka 1994) but there is no clear relationship between pH and toxicity (ANZG 2018).
- Silver - one of the most toxic metals to aquatic life in laboratory experiments, in particular silver nitrate and silver iodide (CCREM 1987). However, in the natural environment silver is often found in less bioavailable complexes with chloride, dissolved organic carbon and sulfur-containing ligands and hence laboratory data may overestimate the toxicity of silver (Gorsuch & Purcell 1999 in ANZG 2018). The acute toxicity of silver to marine fish is considerably lower than for freshwater fish, though toxicity to most marine species increases with decreasing salinity and with elevated ammonia concentrations (Hogstrand & Wood 1998).
- Zinc – commonly forms complexes with organic matter in marine waters (Florence & Batley 1977 in ANZG 2018, Bruland 1989). Zinc is adsorbed by certain metal hydroxides (Dzombak & Morel 1990) and by suspended material; bioavailability after adsorption is variable (e.g. Vercauteren & Blust 1996). Zinc toxicity generally decreases with decreasing pH, at least up to pH 8, above which trends are variable (e.g. Everall, Macfarlane & Sedgwick 1989, Roy & Campbell 1995). Zinc uptake and toxicity generally decreases as salinity increases (e.g. Hamilton & Buhl 1990).
- Ammonia – lost from water by volatilisation (Johnson et al 2007) and rapidly oxidised by bacteria (under aerobic conditions) into nitrite (Ward 1996). Ammonia is directly toxic to biota and can cause convulsions, coma and/or death in marine vertebrates such as fish (Randall & Tsui 2002). The toxicity of ammonia in water increases with increasing temperature and pH, but decreases with increasing salinity (ATSDR 2004). Exposure to sub-lethal ammonia stress can lead to adverse reproductive effects in fish (e.g. Armstrong et al 2015) and invertebrates (e.g. Lee et al 2013), changes in invertebrate behaviour (e.g. Montresor et al 2013, Alonso & Camargo 2014) and reduced growth in a wide range of aquatic organisms (Cheng et al 2015). Some fish species

have been found to adapt to long-term sublethal ammonia concentrations by increased excretion from the body and detoxification in the brain (e.g. Kolarevic et al 2012).

- Phenol - Readily soluble in, and not expected to volatilise from, water (ANZG 2018). Phenol is expected to adsorb to suspended solids (Toxnet 2017e) but there has been no indication that it accumulates in sediment (IHCP 2006). Depuration is rapid (half-life ≤12 hours, ANZG 2018) and it is considered unlikely to bioaccumulate (e.g. Crookes & Howe 1996 in ANZG 2018, Toxnet 2017e). Toxicity to fish is considered high (Toxnet 2017e) and has been shown to increase with decreasing pH (e.g. Dalela et al. 1980 and Verma et al. 1980 in ANZG 2018).

**Potential impacts of PFW discharge on marine life**

Indirect impacts of the PFW discharge on marine life may include potential bioaccumulation, bioconcentration and/or biomagnification (i.e. increasing concentrations with increasing trophic levels) of toxicants through trophic levels. These may potentially arise from the ingestion/foraging of prey species that have established on, or are associated with, the legs and subsea infrastructure of the Yolla platform, particularly those established habitats/species that have been present within the PFW mixing zone for an extended period of time (i.e. they are less likely to arise in those species whose presence is of a transitory nature and not related to foraging). The level of any indirect impact would likely be localised to:

- the predator-prey relationships of those species that have interacted with, or been directly associated with, the habitat present within the PFW mixing zone; or
- the species that have inhabited the area within the zone of influence, that are more likely to have long-term exposure to those toxicants (see Table 4.0 of the Yolla Platform ALARP assessment).

Arnould et al (2015) investigated the use of habitat created by offshore infrastructure in Bass Strait by marine mammals and the potential benefits this infrastructure may have to certain marine ecosystems. The Australian fur seal (*Arctocephalus puillus doriferus*), is a benthic forager that feeds exclusively on demersal fish and cephalopod species over the continental shelf, with all but one of the known breeding colonies occurring within Bass Strait (Arnould et al 2015). This region is considered to be of low primary productivity (Gibbs 1992), therefore the presence of subsea infrastructure can potentially provide valuable foraging habitat. The study conducted by Arnould et al (2015) concluded that offshore infrastructure in the Bass Strait was potentially important foraging habitat for Australian fur seals, due to creation of fish habitat etc, however the study indicated that pipelines and cable routes appeared to be the most influential structures (over wells and shipwrecks), potentially providing habitat connectivity for prey species. Fur seals are often observed below the Yolla platform, which indicates that the associated subsea infrastructure may support suitable foraging habitat.

There is a potential for pinnipeds (seals and sea lions), specifically the Australian fur seal, to forage on species that have had a direct association with habitat within the PFW mixing zone, e.g. seals eat fish that may have eaten algae/crustaceans/molluscs that inhabit the zone of influence of the PFW mixing zone. Therefore, there is a potential that bioaccumulation or bioconcentration of toxicants within fur seals may occur.

The principal diet of most seals and sea lions consist of cephalopod molluscs and fish; unlike bivalves and suspension feeders these prey are not likely to accumulate petroleum hydrocarbons. All seals and sea lion species are assumed to have the necessary enzymes available within their systems to metabolise some petroleum fractions, while others may be deposited into fat stores. To date, no evidence of deleterious effects related to bioaccumulation of petroleum hydrocarbons has been documented (NOAA 1992).

**Conclusion**

Due to the small zone of impact associated with the PFW mixing zone, it is concluded that there is a negligible risk of the PFW having a significant impact upon the marine ecosystem within the receiving environment. It is reasonable to conclude that any impacts that may occur would be localised to those biological communities present in those habitats with long-term exposure to the PFW plume, which represent only a very small proportion of the total available similar habitat (i.e. other platform legs or subsea infrastructure). Any indirect impacts would be localised to those species that forage on the biota within the habitats that experience long-term exposure to the PFW plume.

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