APPENDIX 1

BassGas Offshore Operations Environment Plan 5-year Review

Appendix 1 - Report on Relevant Persons

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.

APPENDIX 2a

BassGas Offshore Operations Environment Plan 5-year Review

Appendix 2a - Report on Consultation from 14 July to 28 November 2025

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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

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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

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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

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

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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

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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
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Business - Local ID: O-00447 Total Marine Gippsland (Corporate Alliance Enterprises) 55
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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
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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

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Community - Recreational groups ID: O-02527 Woolamai Beach Surf Life Saving Club 66
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Indigenous - Aboriginal ID: O-00759 Flinders Island Aboriginal Association Inc..... 69
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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
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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
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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

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

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

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

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

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

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

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

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

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

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

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

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

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

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
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

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

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

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

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

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 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 See ID: C-14165	N/A

								with a review of functions, interests and activities within the area. 2. As the activities within the EP are for existing infrastructure and activities, and there is no additional infrastructure required on the seabed. 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. 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. Key concerns included cultural heritage, ecological impacts, and	N/A outgoing engagement	N/A	N/A 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

						emergency planning. 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. 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. 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. 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

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

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

						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

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

						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

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

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

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

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

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

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

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

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

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										
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

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

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

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

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

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

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

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

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 2b

BassGas Offshore Operations Environment Plan 5-year review

Appendix 2b - Report on Consultation from 28 August to 11 September 2026

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Commercial fishing - Victorian Fisheries ID: O-00061 Abalone Council Victoria 4

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Commercial fishing -Tasmanian Fisheries ID: O-02581 Tasmanian Rock Lobster Council Ltd 5

OPGGS (E) 2023 - Commonwealth - 25(1)(d) a person or organisation whose functions, interest or activities may be affected by the activities to be carried out under the environment plan / Relevant persons, OPGGS(E)R 25(1)(d) and OPGGSR 2021 (Vic) 13F(1)(b)

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

Engagement ID	Date	Engagement type	Direction	Attachments Provided	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-67327	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67332	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67334	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67542	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67546	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67553	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67583	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A
C-67586	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A
C-67593	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A

Commercial fishing - Commonwealth Fisheries ID: O-03426 Small Pelagic Fishery Industry Association Inc.

Engagement ID	Date	Engagement type	Direction	Attachments Provided	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-67331	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67554	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67591	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A

Commercial fishing - Victorian Fisheries ID: O-00061 Abalone Council Victoria

Engagement ID	Date	Engagement type	Direction	Attachments Provided	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-67328	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67329	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67335	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67540	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67543	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67552	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67581	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A
C-67592	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A

Commercial fishing -Tasmanian Fisheries ID: O-00251 Bass Strait Central Zone Scallop Fishery									
Engagement ID	Date	Engagement type	Direction	Attachments Provided	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-67333	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67545	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67580	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A
Commercial fishing -Tasmanian Fisheries ID: O-02581 Tasmanian Rock Lobster Council Ltd									
Engagement ID	Date	Engagement type	Direction	Attachments Provided	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-67330	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67336	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67337	28/08/2026	Email	Outgoing	Link to Engage Beach, Info sheet	Consultation introduction and information for ongoing operational activities.	N/A	N/A	N/A	N/A
C-67541	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67549	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67550	07/09/2026	Email	Outgoing	Link to Engage Beach	Consultation closing date reminder.	N/A	N/A	N/A	N/A
C-67582	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A
C-67585	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A
C-67587	14/09/2026	Email	Outgoing	Link to Engage Beach	Notification consultation has closed.	N/A	N/A	N/A	N/A

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1. Information sheets

1.1 Bass Gas Offshore Operations environment plan 5-year review (2025)

Bass Gas Offshore Operations

Environment plan 5-year review

Consultation information sheet | August 2026

Beach Energy (**Beach**) undertook consultation on the Bass Gas Offshore Operations environment plan (**EP**) 5-year review between 14 July 2025 and 10 October 2025. Following recent modifications to the planning area, which resulted in the identification of additional fishing industry peak bodies and associations, Beach has commenced a further two-week consultation period from 28 August 2026 to 11 September 2026.

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.

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:

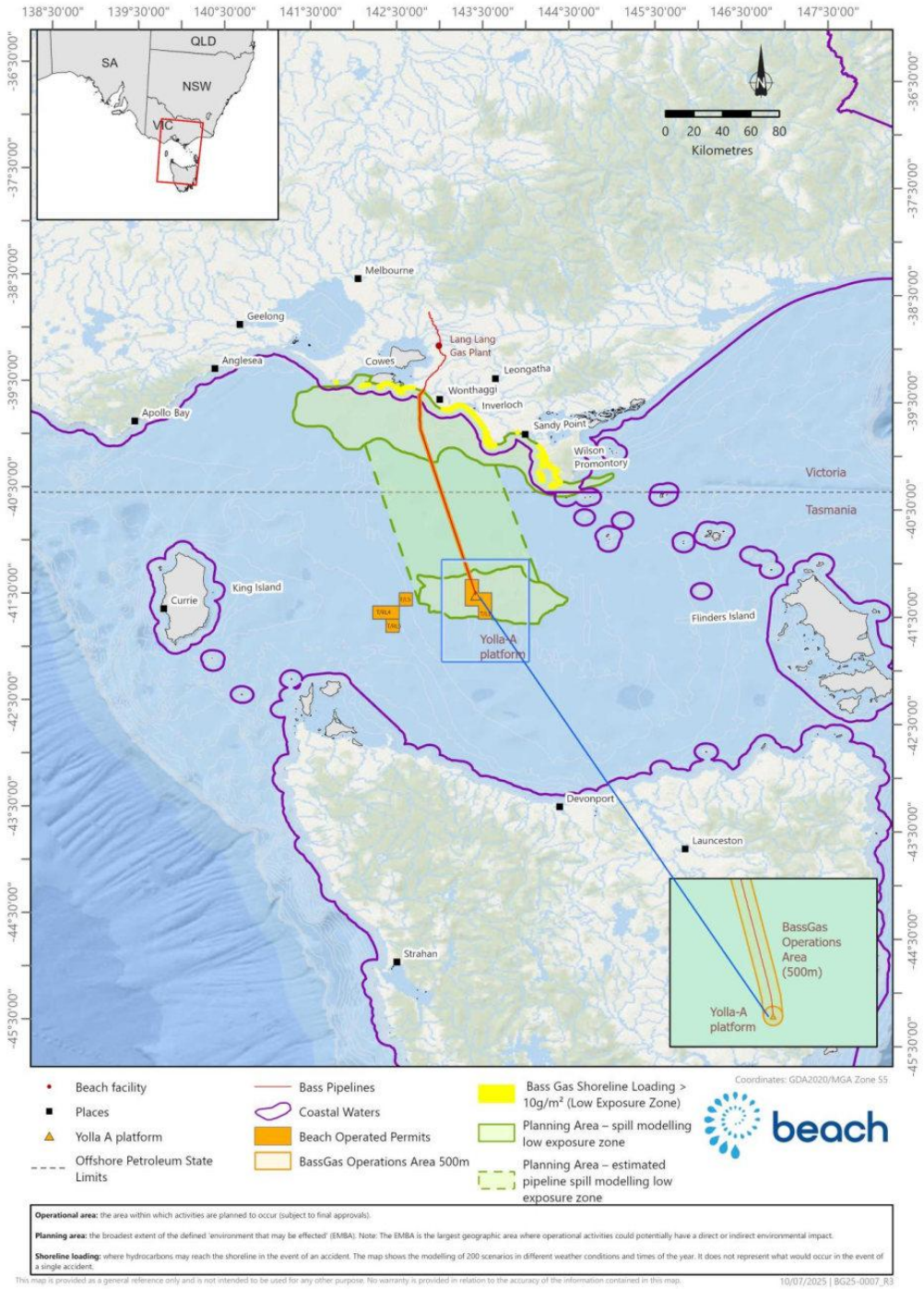
- a description of the existing environment
- a description of the proposed activities
- an evaluation of the impacts and risks, environmental performance outcomes and controls, implementation strategy, and reporting requirements.

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**

1.2 Bass Gas Offshore Operations environment plan 5-year review (2026)

Bass Gas Offshore Operations

Environment plan 5-year review

Consultation information sheet | August 2026

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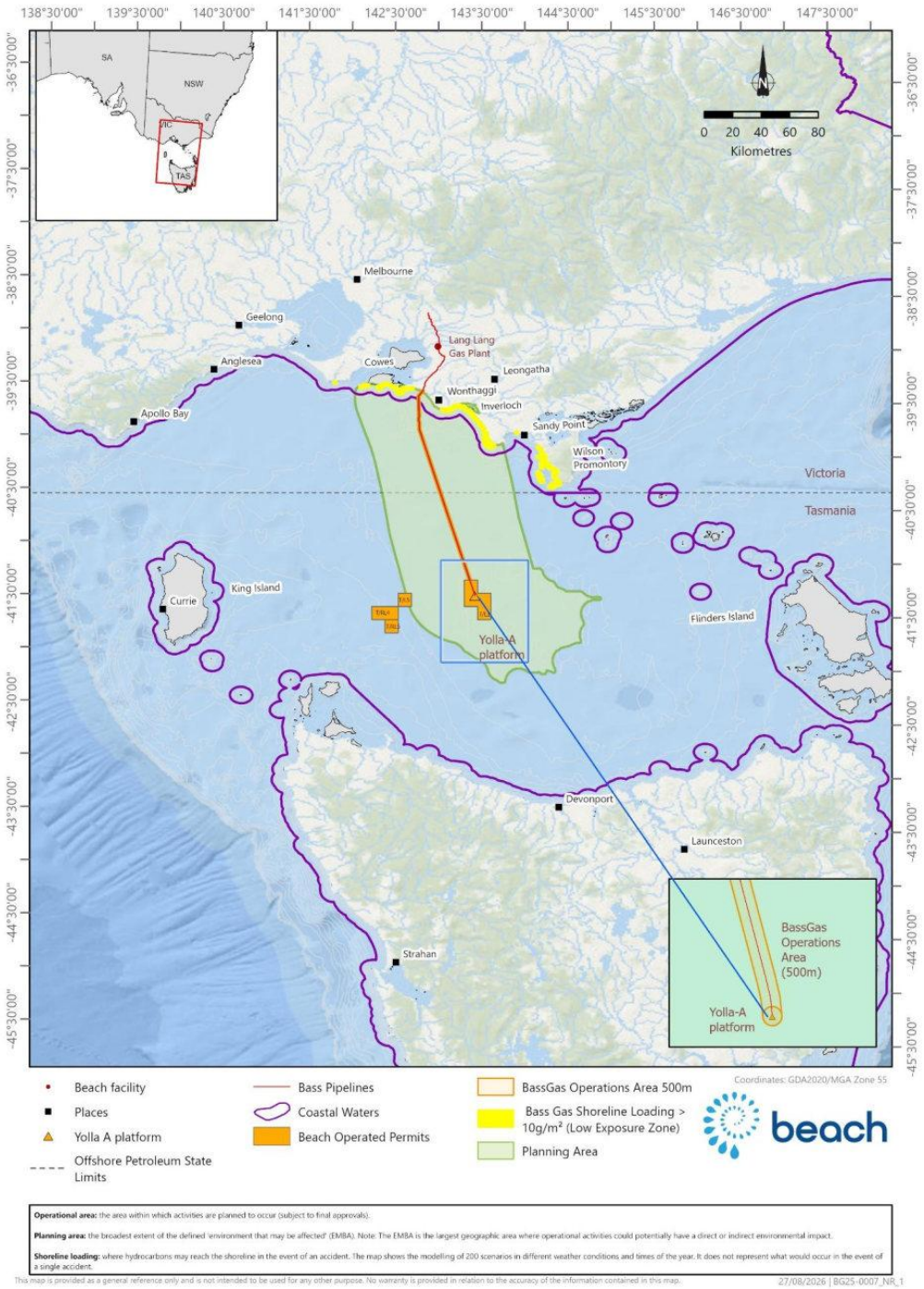
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Location map



Facilities

Yolla Platform

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- Tasmanian-managed Abalone, Scalefish, Lobster, Giant Crab, Scallop, Commercial Dive, and Shellfish Fisheries.
- Victorian-managed Abalone, Giant Crab Fishery, Pipi, Rock Lobster, Scallop, Wrasse, Sea Urchin, and Octopus Fisheries.
- 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
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- Venting and flaring activities at the Yolla Platform is limited to that required for safe operations.
- Continuous monitoring of produced formation water discharges.

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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.

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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:

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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.

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Purpose of consultation

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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.

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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 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. • 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. • Petroleum Safety Zones (PSZs) administered by NOPSEMA for the OPGGS Act are marked on navigational charts. • 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. • Vessels comply with AMSA o Marine Orders Part 30 (Prevention of collisions) o Marine Orders Part 27 (Safety of navigation and radio equipment). • 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 Inspection, Maintenance and Repair (IMR) and surveys	Vessel and the Yolla-A platform lighting is required for navigational and safety purposes. Artificial light may attract light sensitive species such as seabirds, turtles and	• Yolla-A platform navigation lighting complies with maritime standards and regulatory requirements. • 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 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. 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. 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. • Beach Energy has a GHG Management Plan which provides guidance for the management of greenhouse gas emissions from Beach Energy operated facilities. • Vessels comply with AMSA o Marine Orders Part 97 (Marine Pollution Prevention – Air Pollution (appropriate to vessel class) for emissions from combustion of fuel, which includes: ▪ Currency of a valid International Air Pollution Prevention certificate and an International Energy Efficiency certificate. ▪ A Ship Energy Efficiency Management Plan to reduce emissions. ▪ Engine NO_2 emission levels that comply with Regulation 13 of MARPOL 73/78 Annex VI. ▪ Low-sulphur (<0.5% m/m) diesel usage. • Combustion equipment is serviced and maintained in accordance with OEM guidelines via CMMS (Computerised Maintenance Management System).
Routine Emissions - Noise and Vibration	Operations 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. 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. • Where appropriate Adaptive Management Plans for marine-listed threatened species and ecological communities that align with National Recovery Plans (NRPs) will be implemented.

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Aspect – Planned Activity	Relevant Activities	Potential Impact	Summary of Beach Energy Control Measures
		Vessel engines and thrusters. Helicopters Subsea infrastructure maintenance and repair equipment. 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. • 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 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: o Dispersed OIW concentration discharges meet the specification for non-dissolved hydrocarbons. 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. 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. 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 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.

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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. Discharge of treated seawater from the RGP.	• Processes required to contain and recover waste substances for disposal are implemented in a Waste Management Plan. • 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. • Yolla marine studies and modelling. • 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 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. 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. • Waste with the potential to be windblown is stored in covered containers. • 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. • 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). • 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 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

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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. • 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: Changes in the diversity and abundance of native marine species. Alterations to commercial fish stocks, along with associated socio-economic effects. 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). • The Beach Energy's IMS Management Plan is implemented including: o Compliance with Commonwealth and State regulatory requirements regarding marine biosecurity. o Conducting a marine biosecurity risk assessment that involves: ▪ Identifying and evaluating potential IMS risk profiles ▪ Addressing any deficiencies in IMS controls and apply any additional controls to manage IMS risk to as low as reasonably practicable (ALARP). o Taking measures to prevent the translocation and potential establishment of marine pests in unaffected marine environments. 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 Inspection, Maintenance and Repair (IMR) and surveys	Minor spills could occur at the. Yolla-A platform and from vessels due to the following activities: The use, handling, and transfer of hydrocarbons and chemicals. Hydraulic line failures from equipment. 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. • 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.

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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: Behaviour of marine fauna in the surface waters impacted, potentially causing them to avoid the area. Cultural values and sensitives. Functions, interests or activities of marine users.	• If required, bunkering activities follow the rig and vessel contractor bunkering procedures that detail: o Supervision of activities is conducted by trained and experienced operators. o Transfer equipment meets manufacture instructions, industry standards, and compliance inspection checks as outlined in the Beach Energy Planned Maintenance System. o Communications and visibility between the rig and vessel are tested before starting the activity and are maintained for the duration. • Emergency spill response plans implemented include: o Vessels will implement a Shipboard Marine pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (SOPEP) (dependent on vessel class). o Beach Energy Offshore Victoria Oil Pollution Emergency Plan (OPEP). 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). Rupture of the Raw Gas Pipeline (RGP) during production. Rupture of the Raw Gas Pipeline (RGP) while suspended.	Operations COP	A loss of containment resulting in a condensate spill can occur due to: Loss of well control (LoWC) during drilling Unexpected failure leading to a rupture of the RGP during production releasing hydrocarbons to the marine environment. Unexpected failure of the suspended RGP releasing treated seawater to the marine environment. 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. • All producing, suspended and drilling wells have a Well Operations Management Plan (WOMP) accepted by NOPSEMA. A WOMP includes: o Identification of risks to well integrity. o Description of control measures in place. o Assessment and demonstration of well integrity risks reduced to ALARP o Systems established to test and monitor the effectiveness of these control measures. • 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:

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Aspect – Unplanned events	Relevant Activities	Potential Risk	Beach Energy Summary of Control Measures
		impacts on the marine environment include: Reduced water quality. Injury or death of exposed marine fauna and seabirds. Disruption of the food chain where contaminated organisms affect other marine life and seabirds. Damage to sensitive habitats, that may lead to long-term ecological consequences if the spill reaches shorelines. Potential effects on relevant persons, cultural values and sensitives. Changes to the functions, interests or activities of marine users.	○ manage major accident hazards and protect the health and safety of personnel. ○ detail the facility's hazards, risk assessments, safety management systems, and emergency response plans, providing evidence that risks are controlled to ALARP. ○ 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. • Response measures are tested and implemented by the following plans ○ Beach Energy Offshore Victoria Oil Pollution Emergency Plan (OPEP). ○ 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: Mechanical failure. Loss of dynamic positioning, navigational error or floundering due to adverse weather conditions. The known and potential impacts of an MDO spill to the marine environment are: A temporary and localised reduction in water quality. Injury and or death of exposed marine fauna and seabirds.	• Vessel collisions are avoided by: ○ 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. ○ 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. • Vessels comply with AMSA ○ Marine Orders Part 30 (Prevention of collisions): safety navigation and operations of vessels. ○ Marine Orders Part 27 (Safety of navigation and radio equipment): navigation safety measures, radio and communications. ○ Marine Orders Part 21 (Safety and Emergency Arrangements): safety measures for the crew, bridge visibility, pilot transfer arrangements

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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. Sensitive habitat damage that may lead to long term ecological consequences where the spill reaches shorelines. Potential impact to relevant persons, cultural values and sensitives. Changes to the functions, interests or activities of marine users.	and operation of steering gear, and signals and drills and duties of seafarers. • Vessels have enabled an automatic identification system (AIS). • Emergency spill response plans implemented include: ○ Vessels will implement a Shipboard Marine Pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (SOPEP) (dependent on vessel class). ○ Beach Energy Offshore Victoria Oil Pollution Emergency Plan (OPEP). ○ 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 Inspection, Maintenance and Repair (IMR) and surveys	Spill response strategies may be accompanied by a range of environmental and socio-economic impacts.	Preparedness measures • Consultation with relevant persons who may be affected by the Yolla field operations activities is ongoing to maintain communications and awareness. • 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). • 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. • 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). Response measures • Beach Energy's Offshore Victoria Oil Pollution Emergency Plan (OPEP) details: ○ Notification and reporting requirements. ○ Priority Protection Areas.

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Aspect – Unplanned events	Relevant Activities	Potential Risk	Beach Energy Summary of Control Measures
			○ Response strategies including: ▪ access to resources and equipment requirements. ▪ developed Impact Action Plan and environmental assessments (Project specific) for readiness responses and responsibilities. • 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)

18 NEWS
Herald Sun | Monday July 21, 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 Mooroduc 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

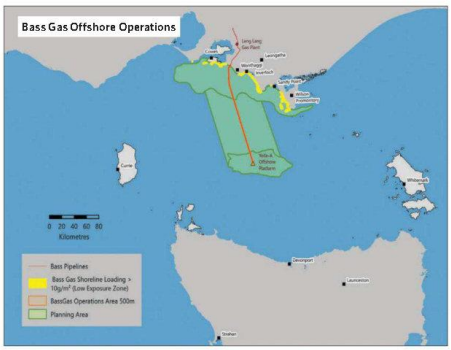
Beach Energy (Beach) supplies natural gas from offshore Victoria to the local market through existing infrastructure. In accordance with regulatory requirements, Beach has commenced planning and consulting for the 5-year review of the Bass Gas Offshore Operations Environment Plan (EP) to cover ongoing 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** 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** Tuesday 19 August, 11am to 3pm (AEST) (Dedicated First Nations session) Tuesday 19 August, 6pm to 8pm (AEST) (Open session) Wednesday 20 August, 11am to 3pm (AEST) (Open session) 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) Tuesday 9 September, 7pm to 7.45pm (AEST) (Dedicated First Nations session) Wednesday 10 September, 2.15pm to 3pm (AEST) (Dedicated First Nations session) 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
MHSE0LZ0LMA - V1

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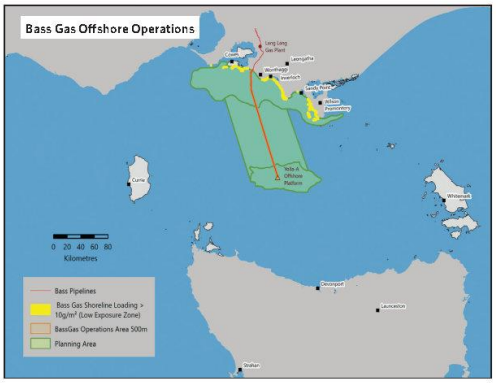
Bass Gas Operations produces natural gas and condensate from the Yolla gas field in the Bass Strait. The gas field is serviced by the Yolla-A Offshore Platform (Yolla Platform), and an approximately 147 km subsea pipeline that transports the gas and liquids from the platform to the Victorian mainland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

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We welcome your questions, please contact:

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READ MORE

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

Consultation for Review of the Bass Gas Offshore Operations EP

beach

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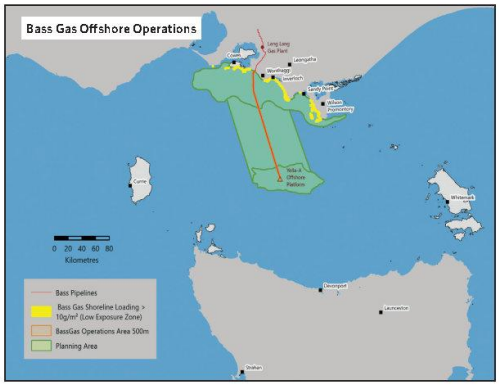
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The revised EP includes the operation of the offshore wells, Yolla Platform and pipeline in the Bass Strait in commonwealth and state waters, and the ongoing maintenance and inspections to ensure safe ongoing field operations.

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

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READ MORE

3.4 National Indigenous Times (29 July 2025)



Public Notice

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beach

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Consultation for this EP commenced on 14 July 2025 and will close at 5pm AEST on 10 October 2025.

Invitation to consult with Beach

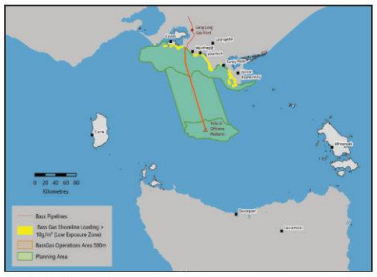
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To register your interest in attending a webinar, please email community@beachenergy.com.au advising the session you would like to attend, and we will send you registration details.

Environment that may be affected (EMBA)

The map in this notice shows the largest geographic area where operational activities under the EP could potentially have a direct or indirect impact under worst-case scenarios.

Within the EMBA, the environment values and sensitivities are defined, potential impacts are assessed, and control measures are developed to mitigate impacts. The EMBA is divided into an operational area for activities defined in the EP, and a planning area where emergency response plans must be ready for activation in the unlikely event of an accident.



Further information

Please see the National Offshore Petroleum Safety and Environmental Management Authority's (NOPSEMA) brochure titled *'Consultation on offshore petroleum environment plans'* at **consultation.nopsema.gov.au** for information regarding consultation.

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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.*





Public Notice

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beach

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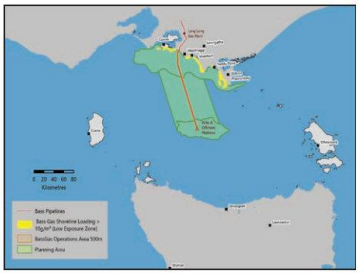
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GD25-0116

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.

Public Notice

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beach

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READ MORE

We welcome your questions, please contact:

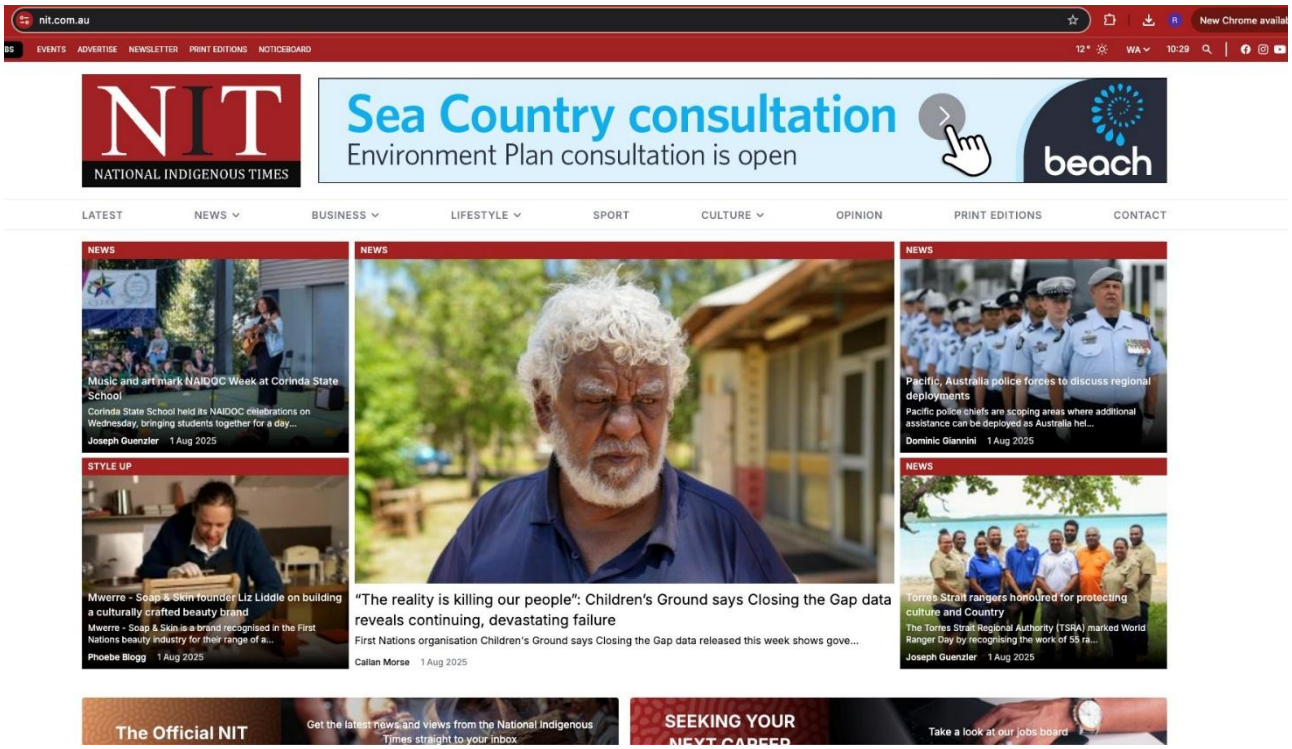
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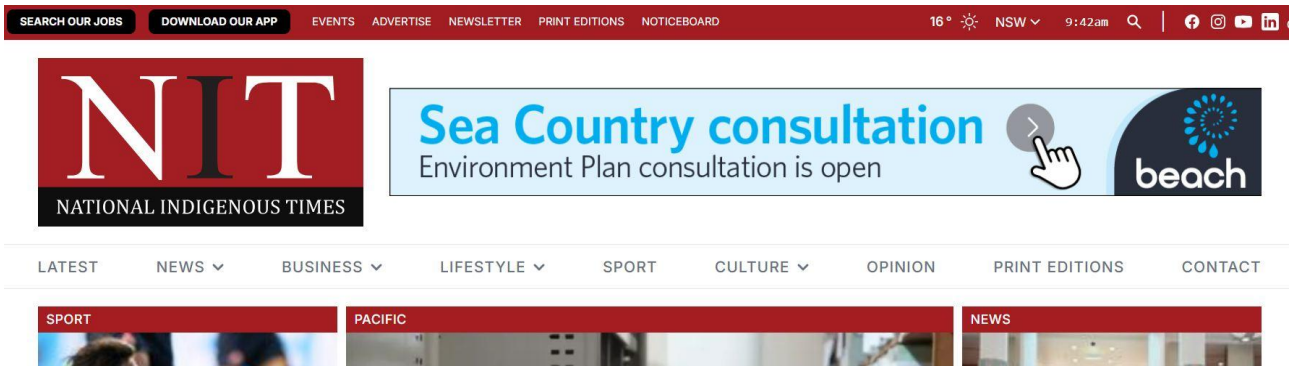
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GD25-0116

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)



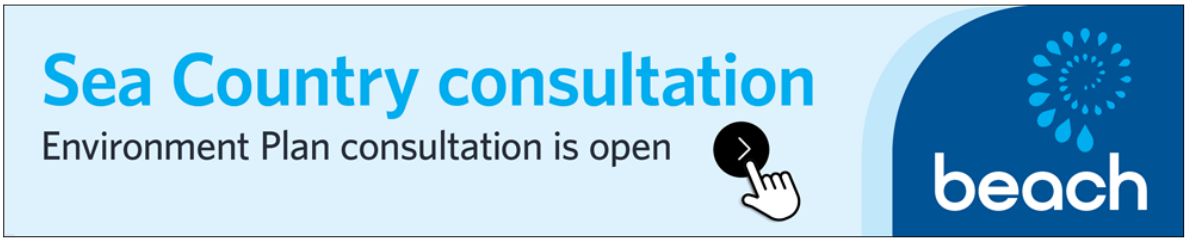
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to drop him to reserve grade as he struggled for form midway through this season.

→ Read more.

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

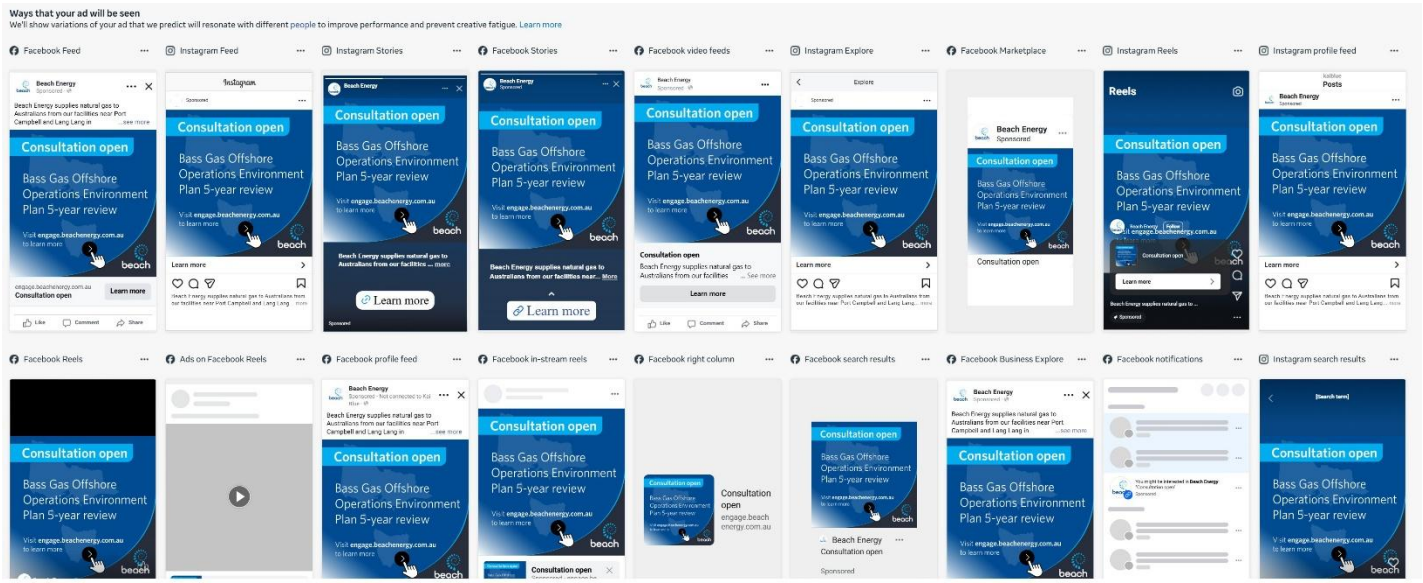
→ Read more.



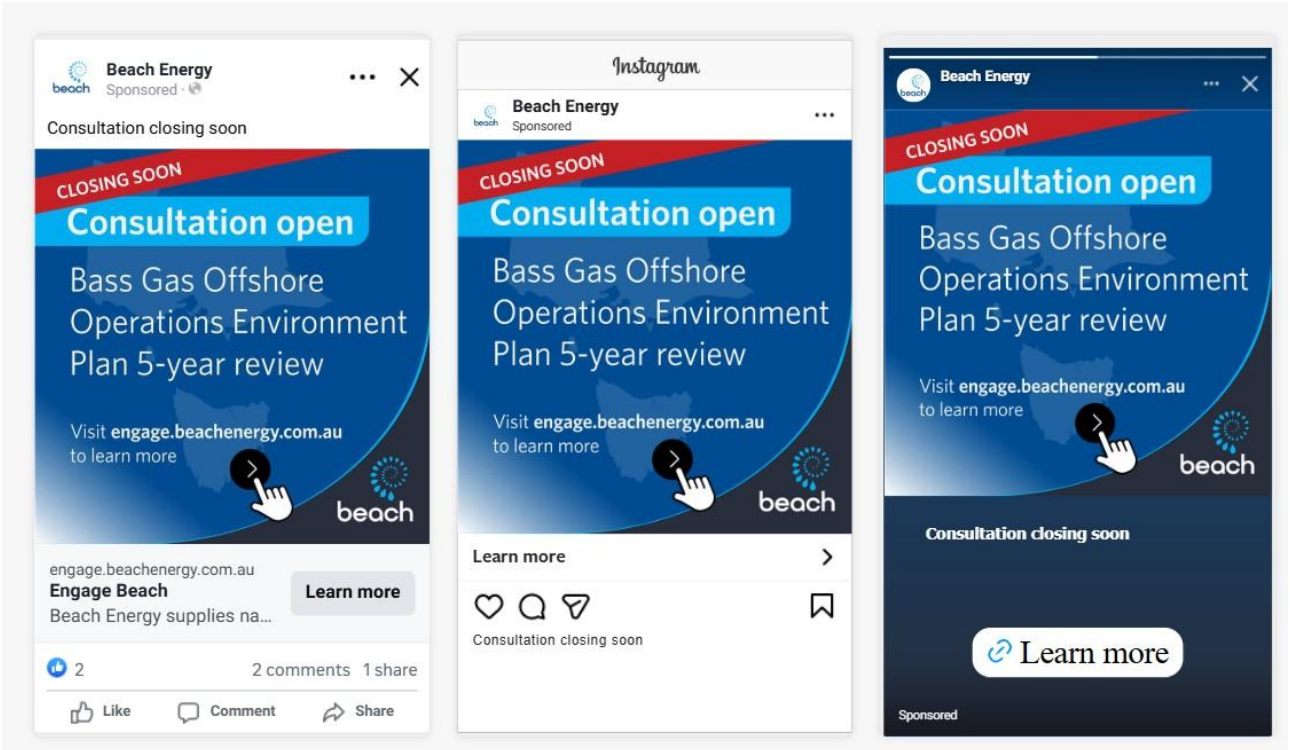
4.3 Koori Mail website (live from 28 July to 10 August and 13 to 28 September 2025)



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)

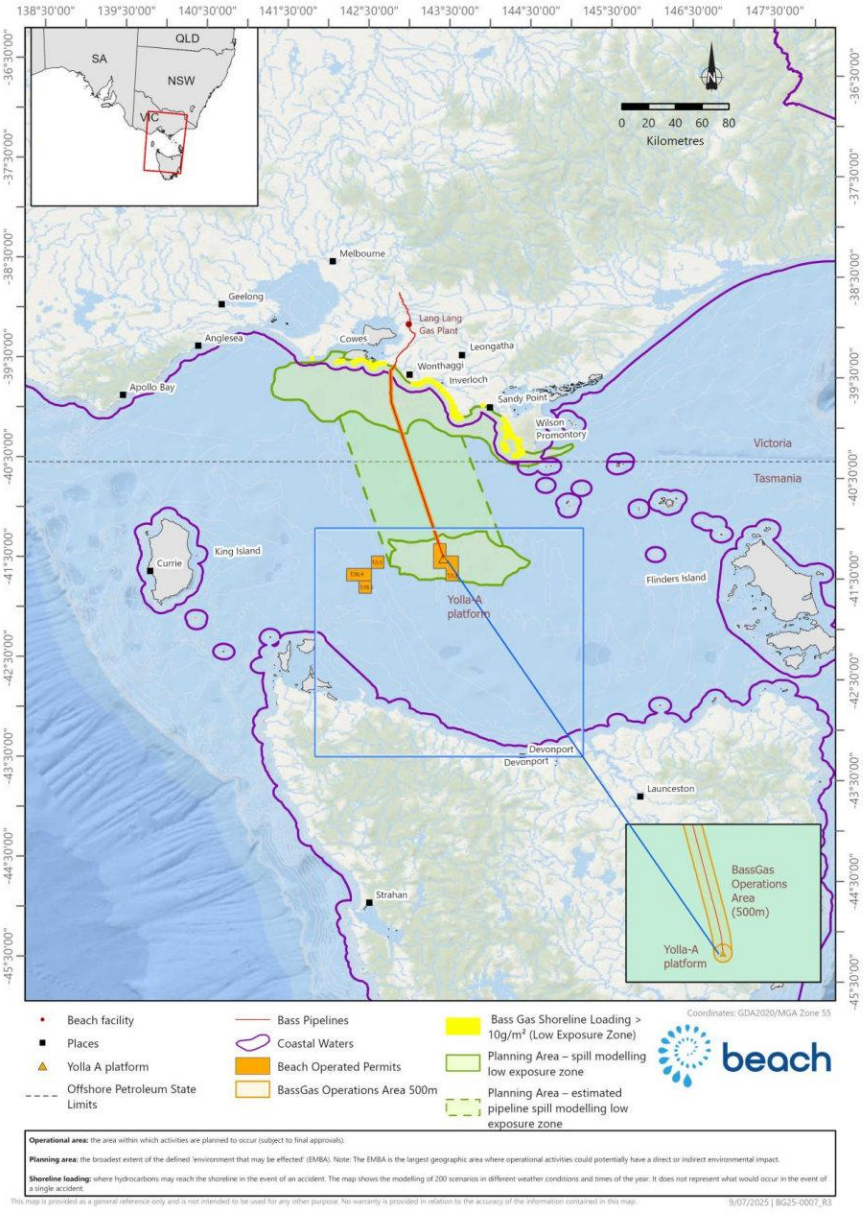
Poster 1

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)



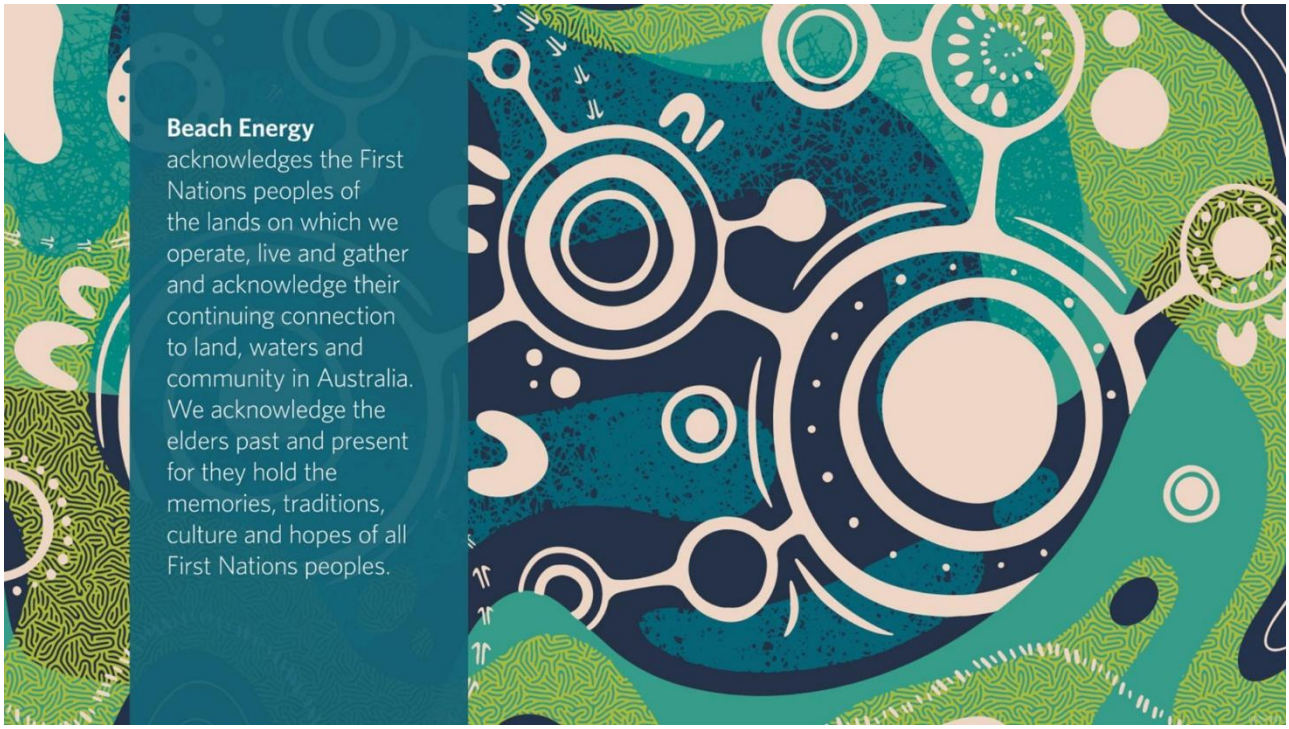
6. Webinar presentations

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

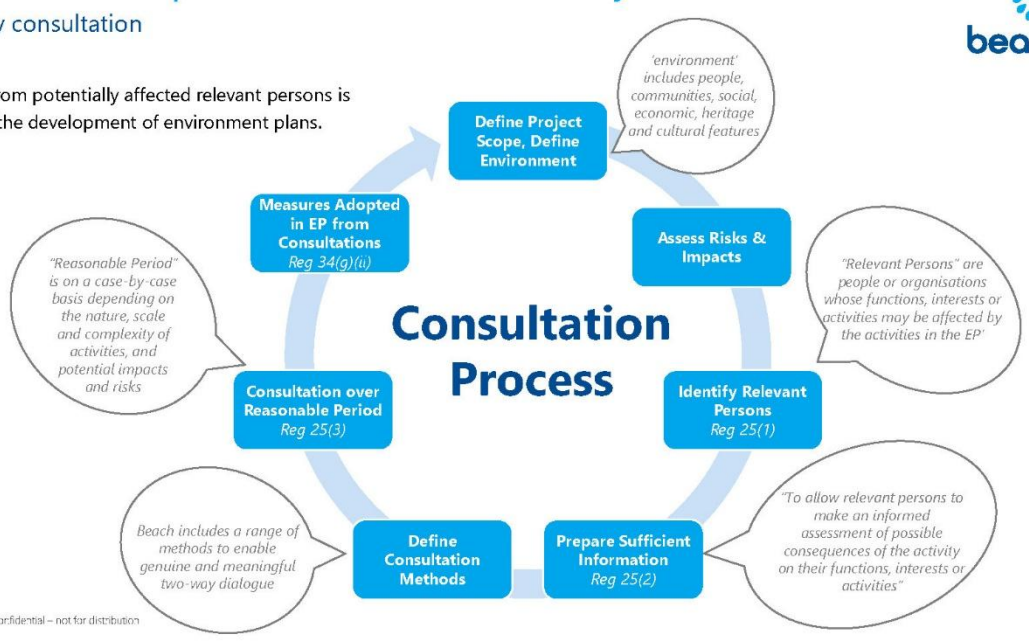
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Slide 4

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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BassGas Offshore Operations Environment Plan 5-year review

Overview

beach



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

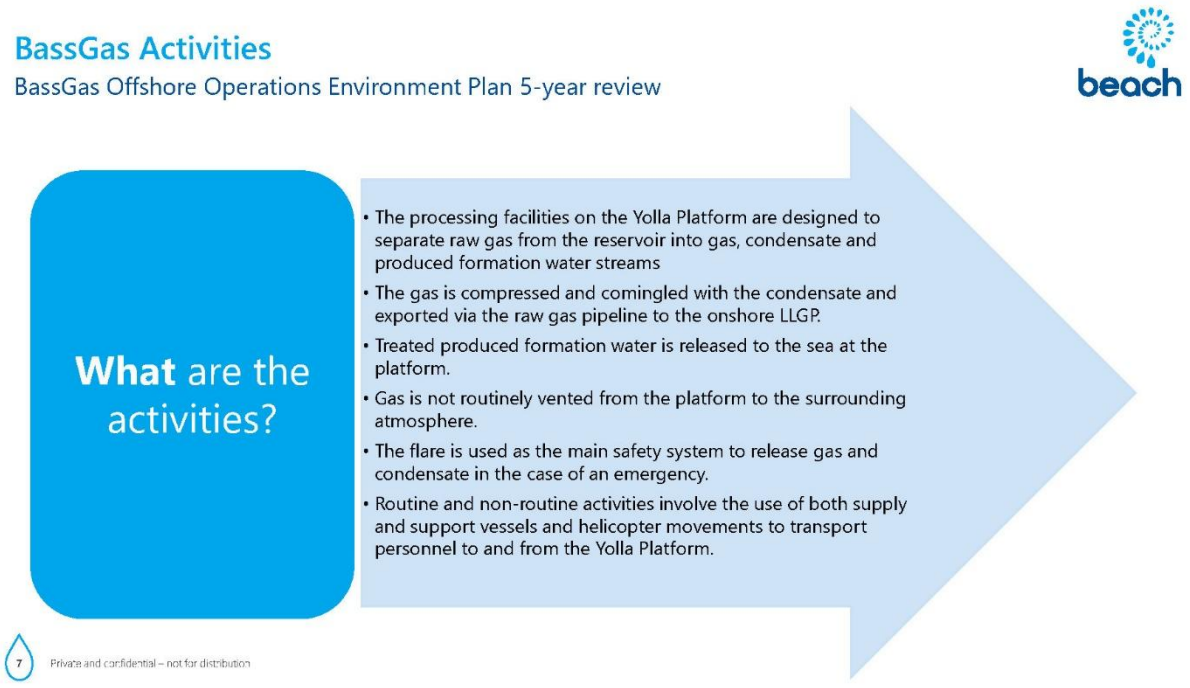
The gas field is serviced by the Yolla-A Offshore Platform, and an approximately 147 km subsea pipeline that transports the gas and liquids from the platform to the Victorian mainland via a coastline crossing near Kilcunda.

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.

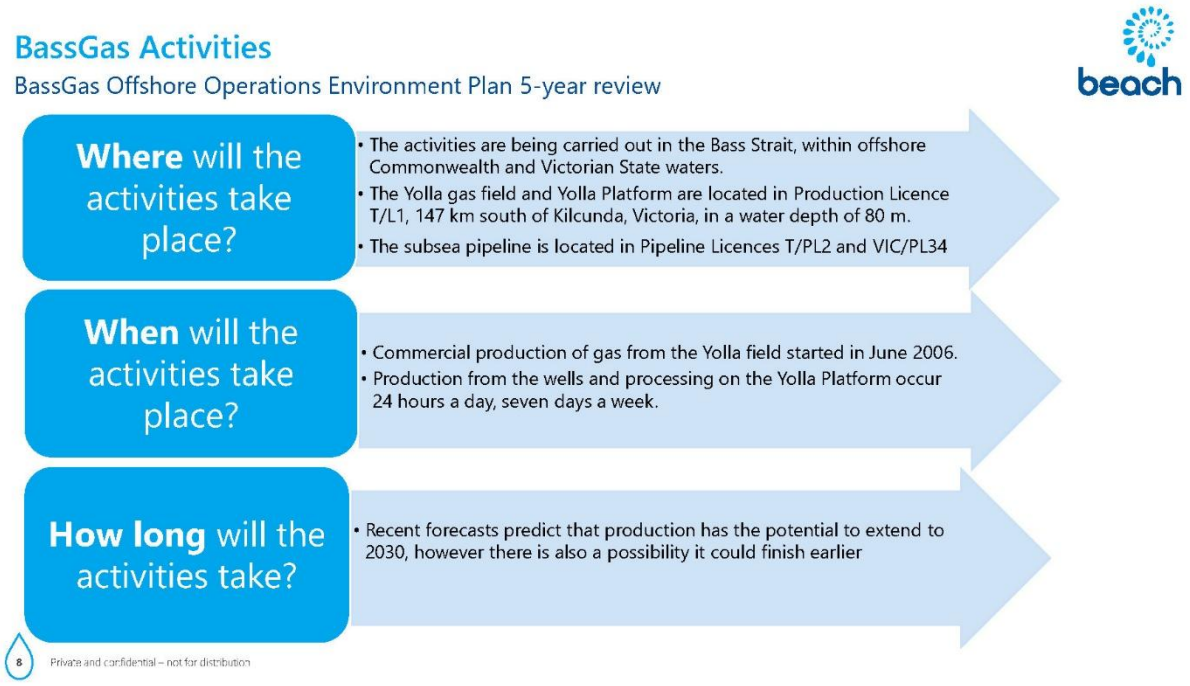


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Slide 8



Slide 9

BASSGAS OFFSHORE OPERATIONS ENVIRONMENT PLAN 5-YR REVIEW

Catriona King
Lead Environmental Adviser

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Slide 10

Activity - Location map

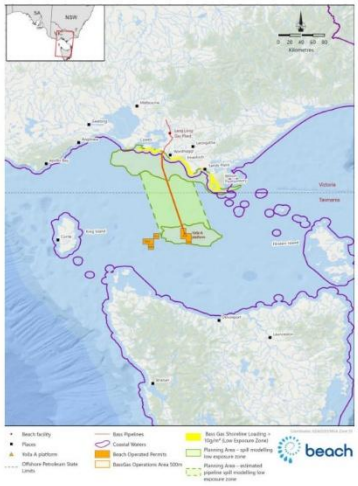
BassGas Offshore Operations Environment Plan 5-year review

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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.

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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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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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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.

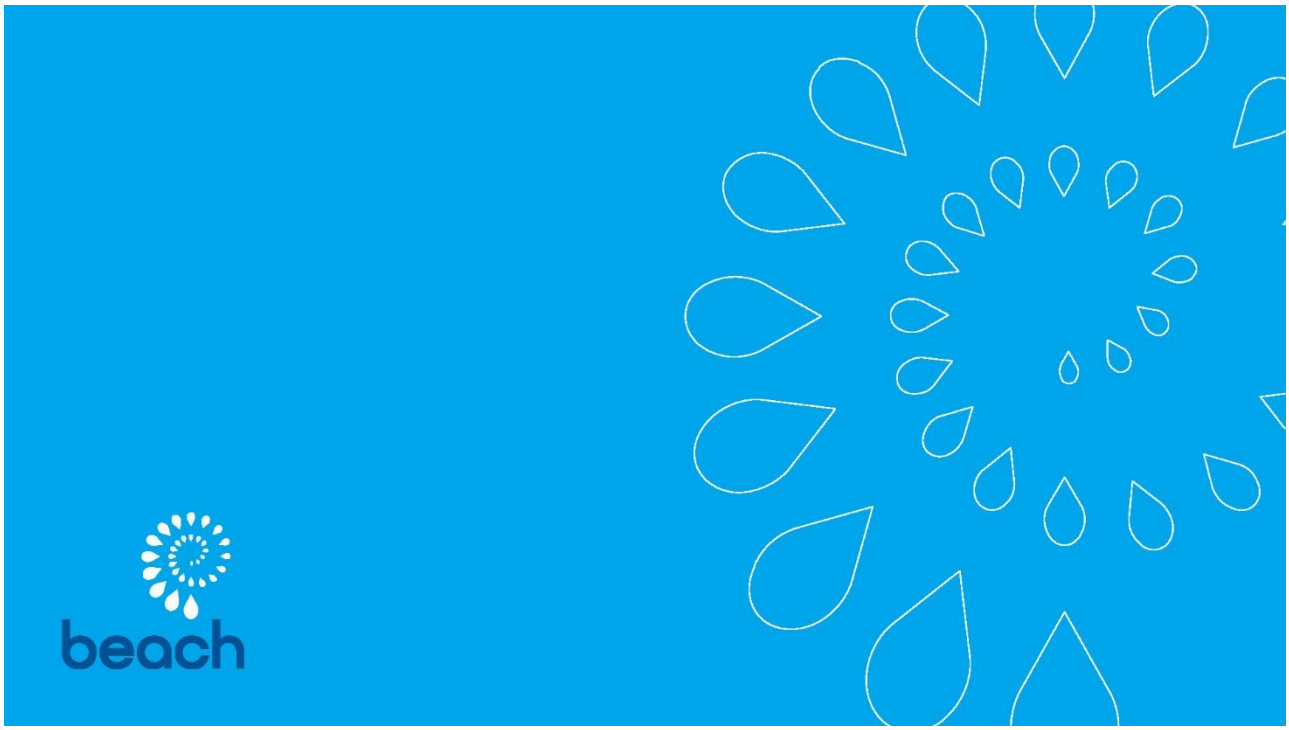
Beach will consider all feedback, including any concerns or objections and will explore measures to reduce any impacts and risks.

ENGAGE WITH US

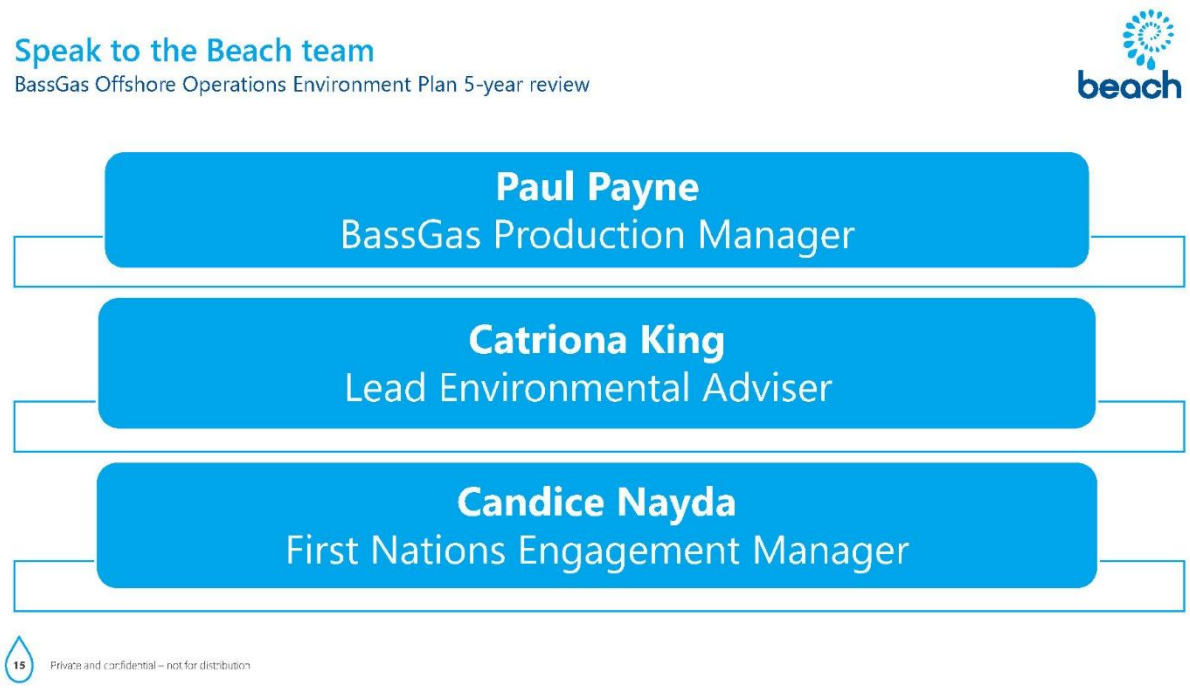
Community Relations Team (Offshore)
Contact: Sharon Donovan, Senior Community Relations Manager
T: 1800 797 011
E: community@beachenergy.com.au
Engage with us: Home | Engage Beach

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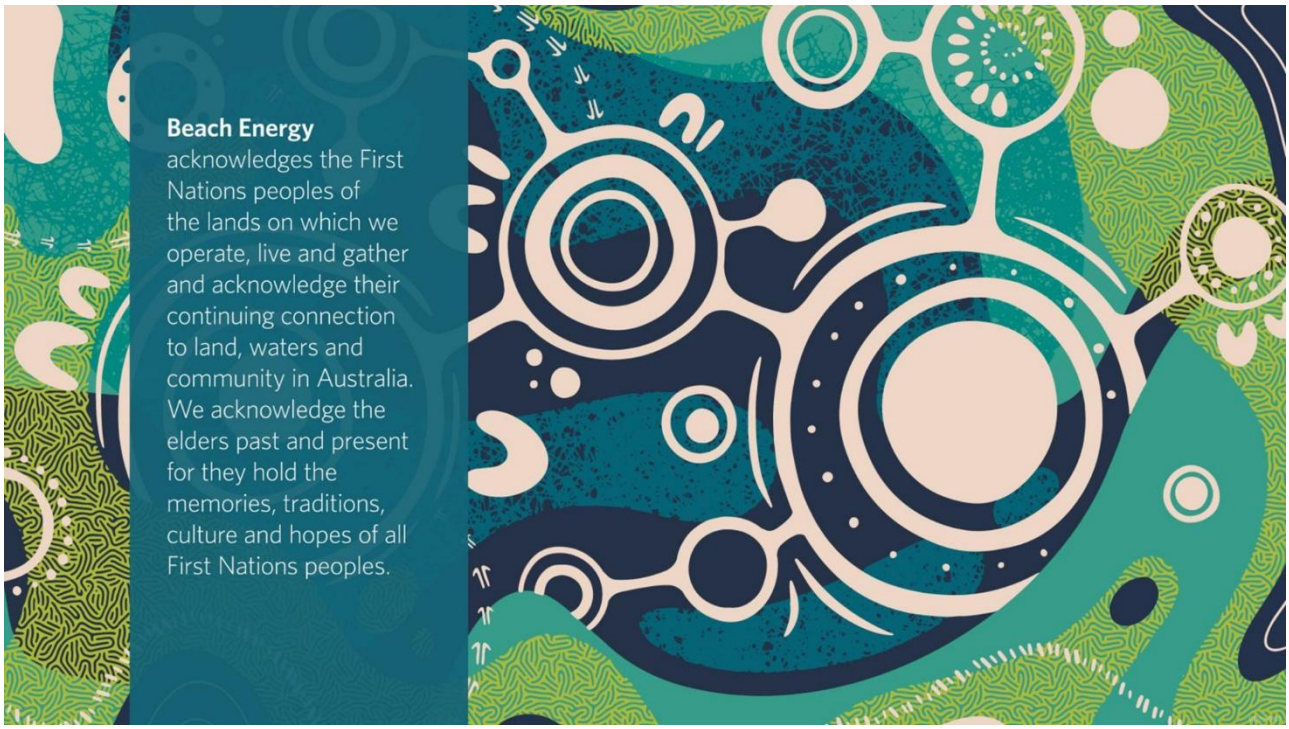


6.2 Dedicated First Nations community information webinar (offered Tuesday 9 and Wednesday 10 September 2025)

Slide 1



Slide 2



Slide 3

BassGas Offshore Operations Environment Plan 5-year review

Open Session Agenda

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

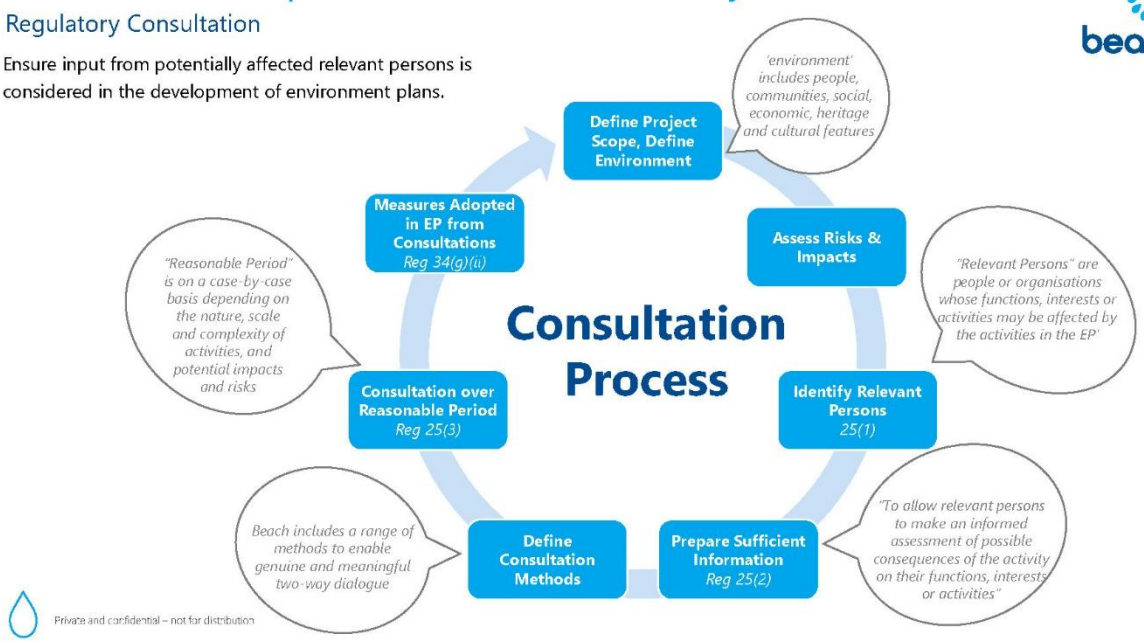
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BassGas Offshore Operations Environment Plan 5-year review

Regulatory Consultation

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



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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



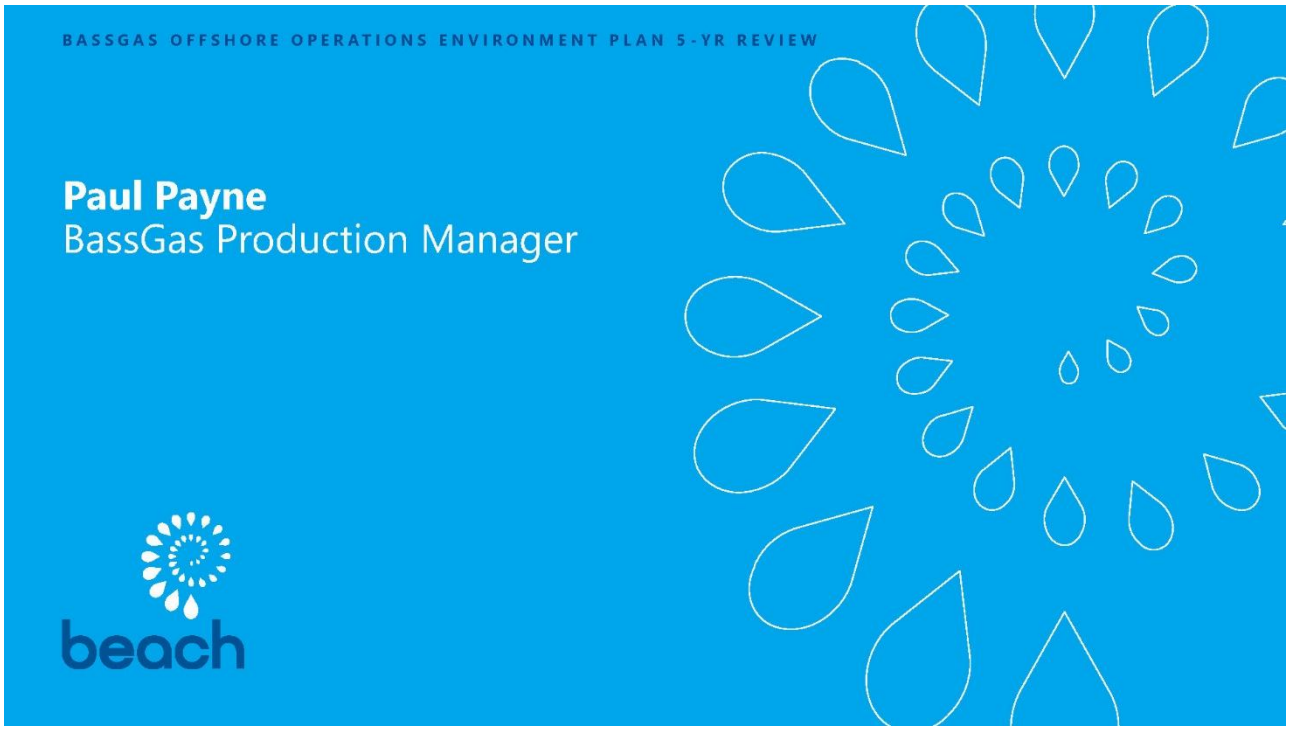
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Consultation with First Nations Groups

- 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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BassGas Activities

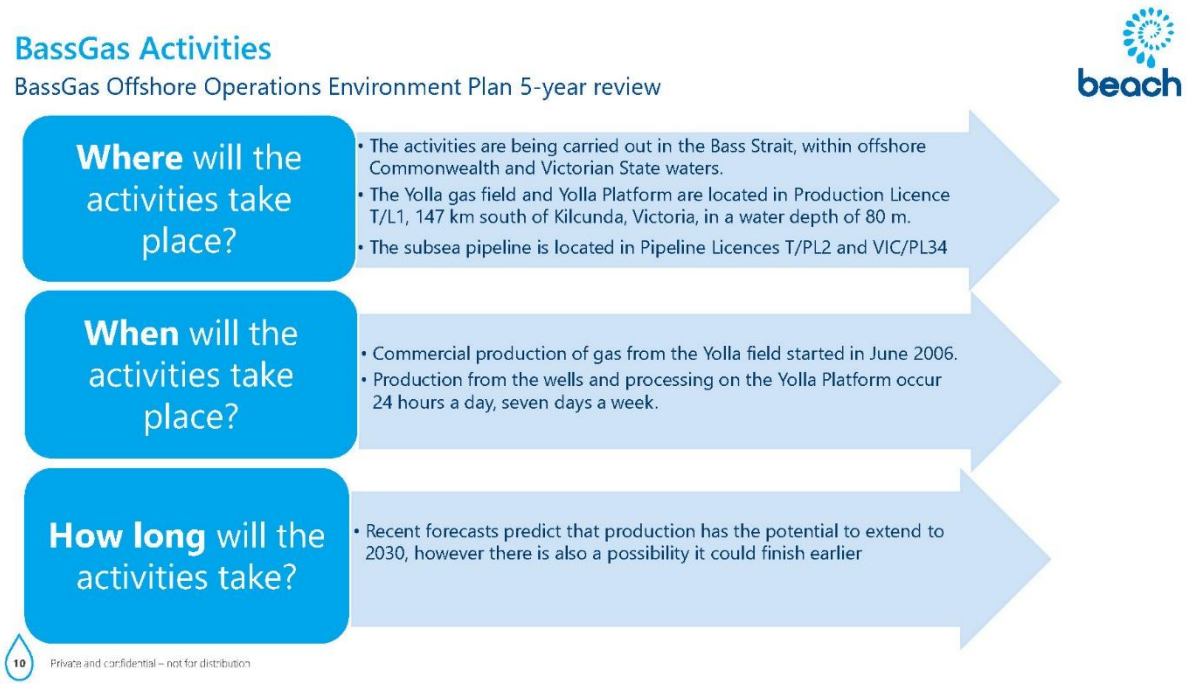
BassGas Offshore Operations Environment Plan 5-year review

What are the activities?

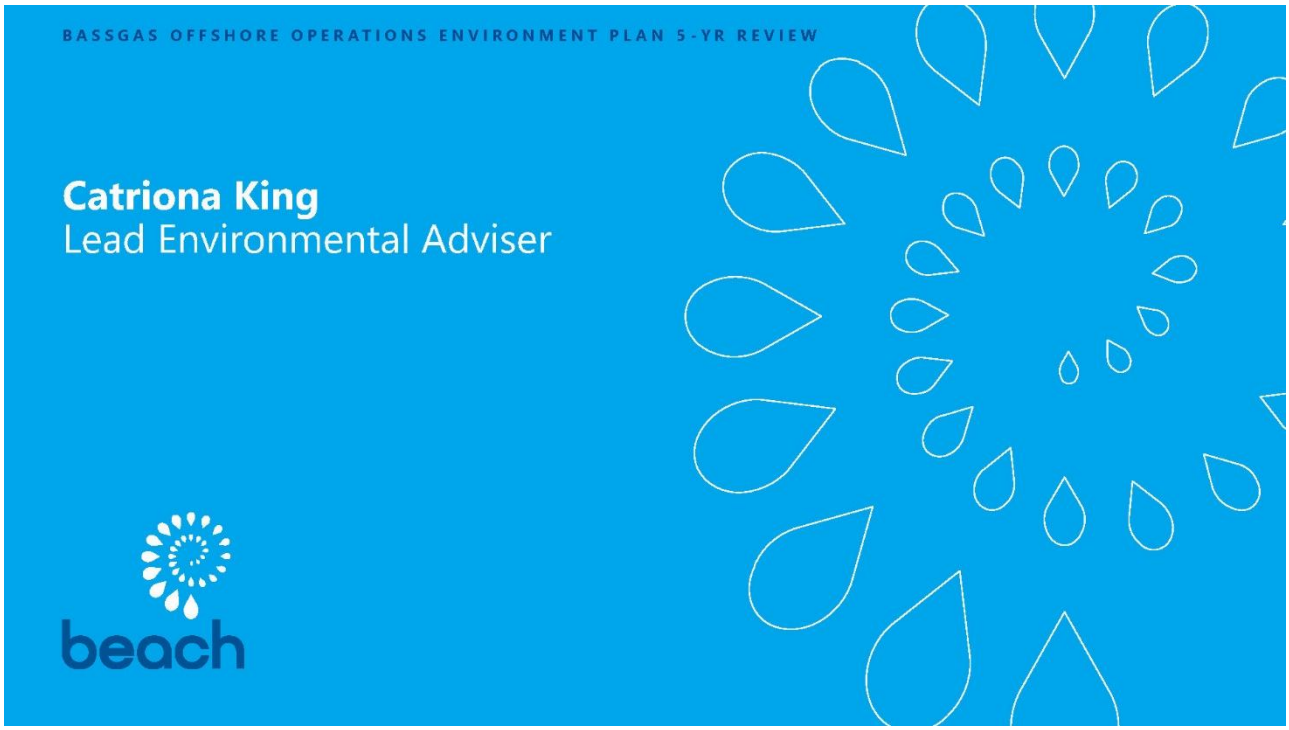
- The processing facilities on the Yolla Platform are designed to separate raw gas from the reservoir into gas, condensate and produced formation water streams
- The gas is compressed and comingled with the condensate and exported via the raw gas pipeline to the onshore LLGP.
- Treated produced formation 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 11



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.

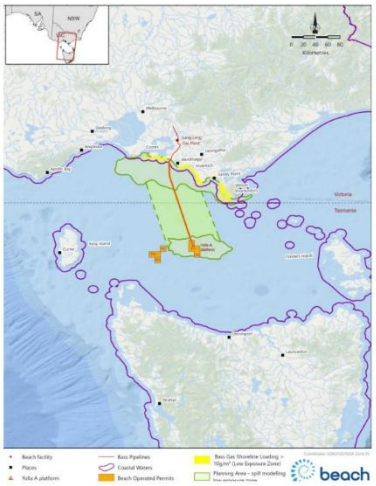
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Indicates where hydrocarbons may reach the shoreline in the event of a hydrocarbon spill event.



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Slide 13

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

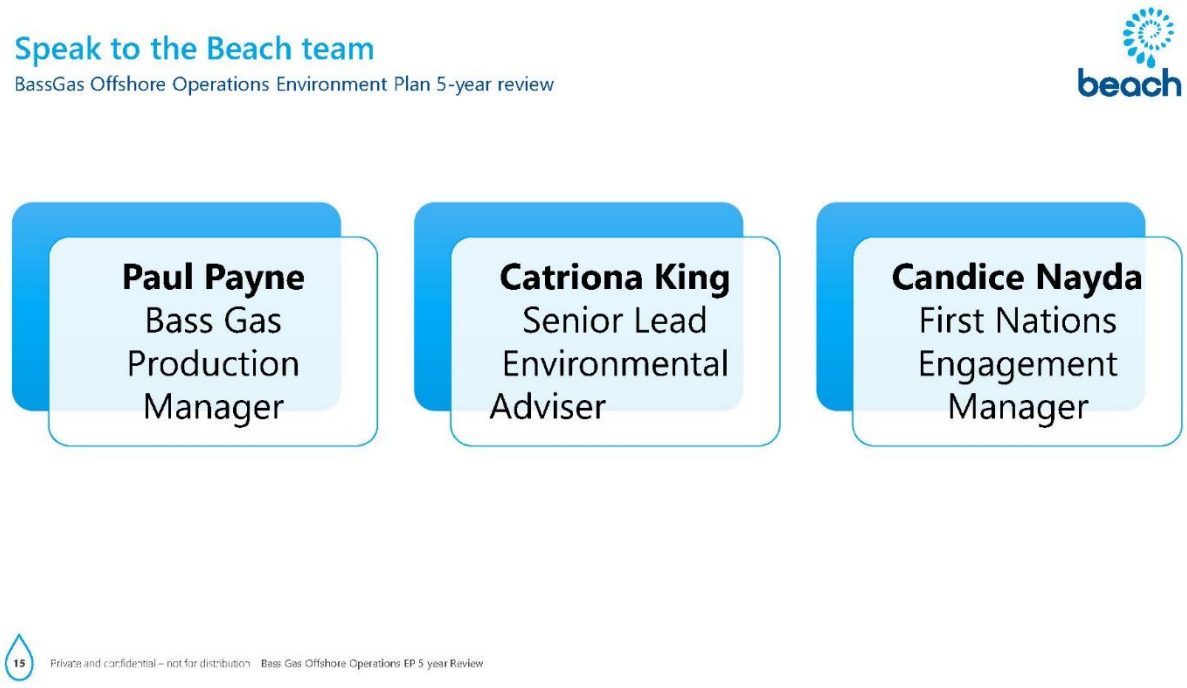
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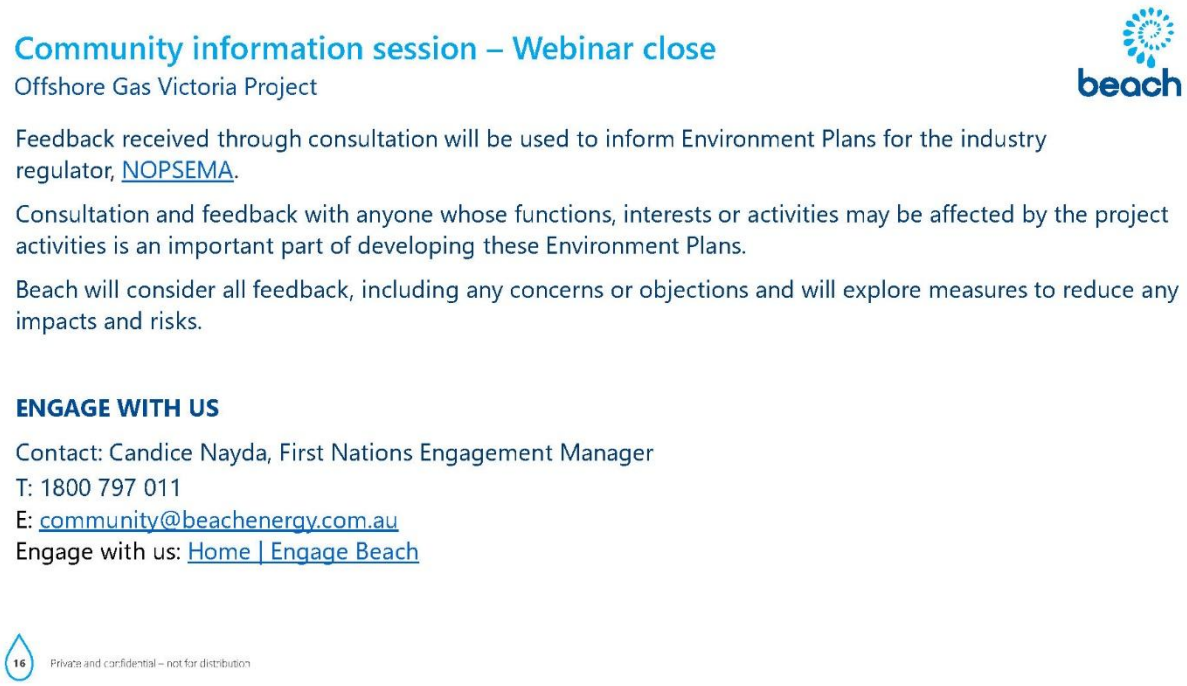


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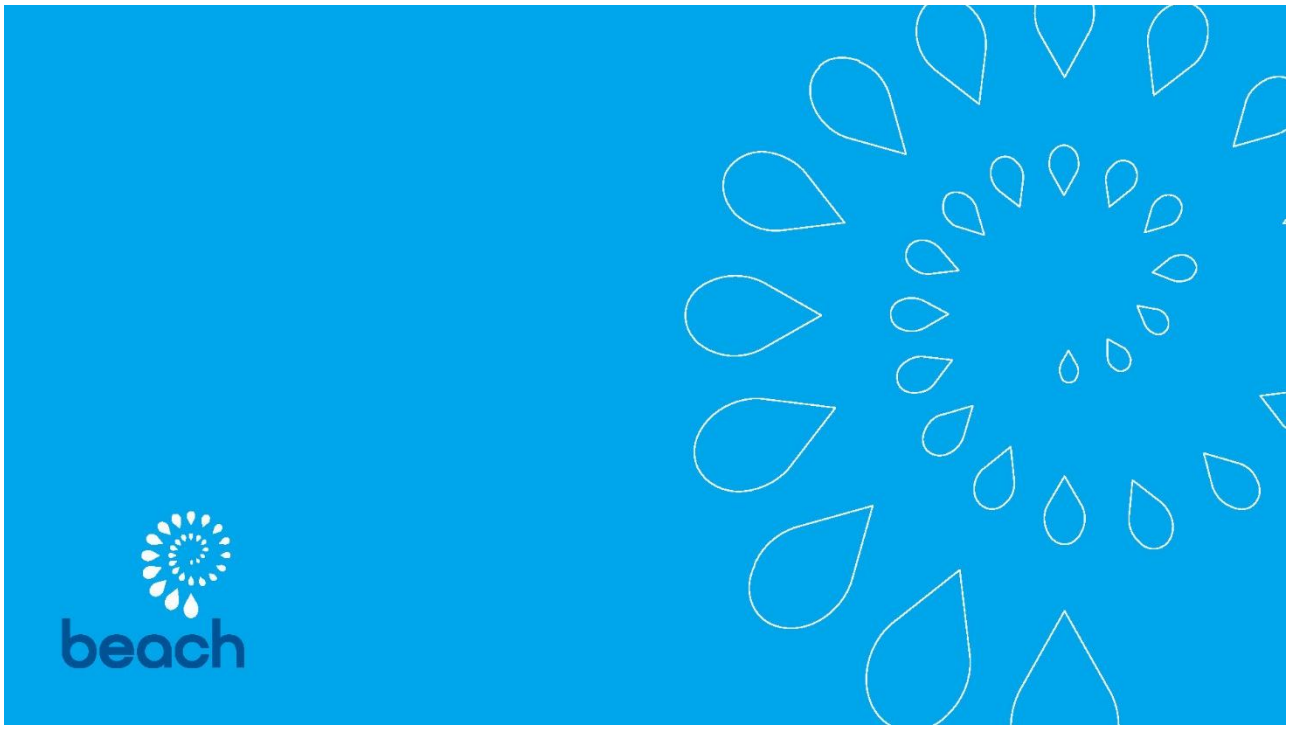
Slide 14



Slide 15



Slide 16



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

Slide 1



Slide 2

Agenda

Time	Item	Presenter
2:00-2:10PM	Welcome Previous actions	Sharon Donovan
2:10-2:30PM	General Plant updates Equinox Plug and Abandonment BassGas 5-year Environment Plan Review	Paul Payne Sharon Donovan 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	

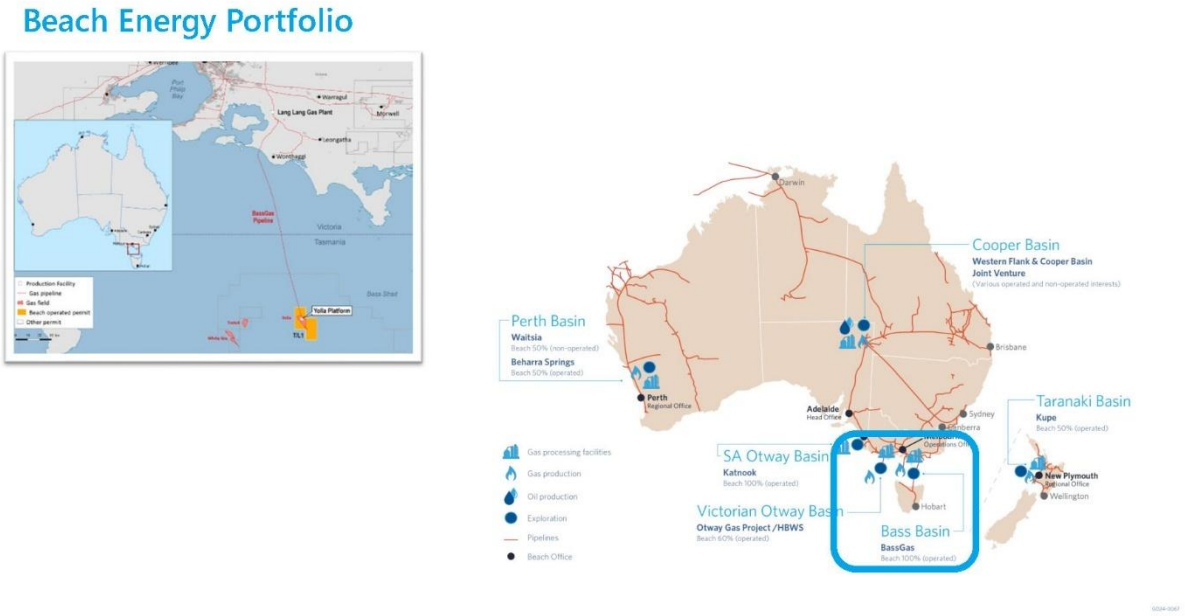
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Previous minutes

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

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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





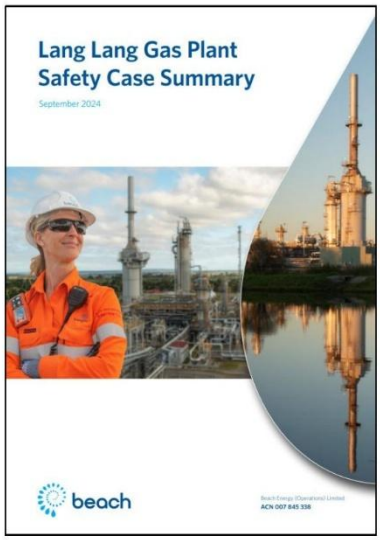
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Lang Lang Gas Plant Major Hazard Facility Licence Renewal Process

- 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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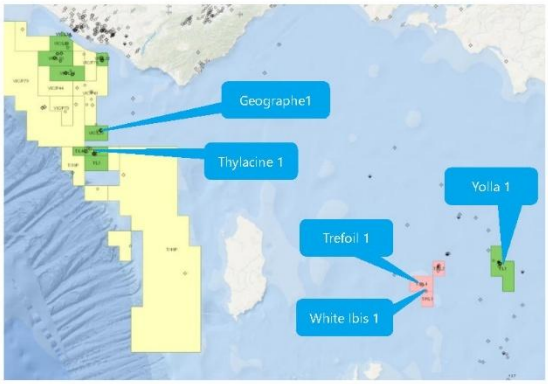
Well Abandonments: Bass

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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BassGas 5-year review - Offshore Operations Environment Plan

Consultation now open

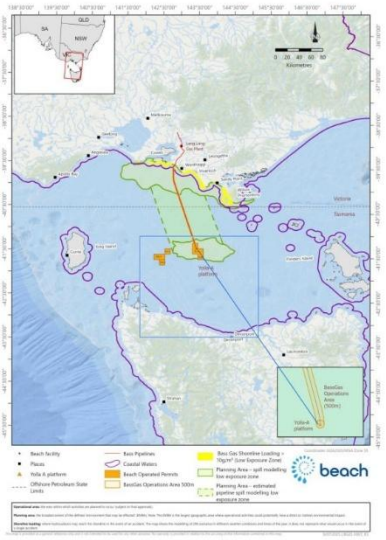
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The associated 32 km onshore pipeline terminates at the Lang Lang Gas Plant where natural gas is processed before being distributed to the domestic east coast market, delivering energy to homes, businesses and industry.

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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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)

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Environmental Update

Ronie Magcamit
Senior Environmental Advisor (VIC)

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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**

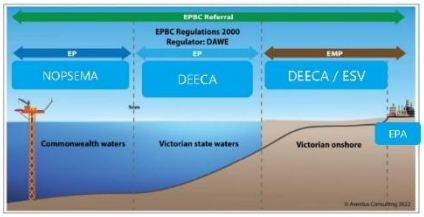






Recent Monitoring

- 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.

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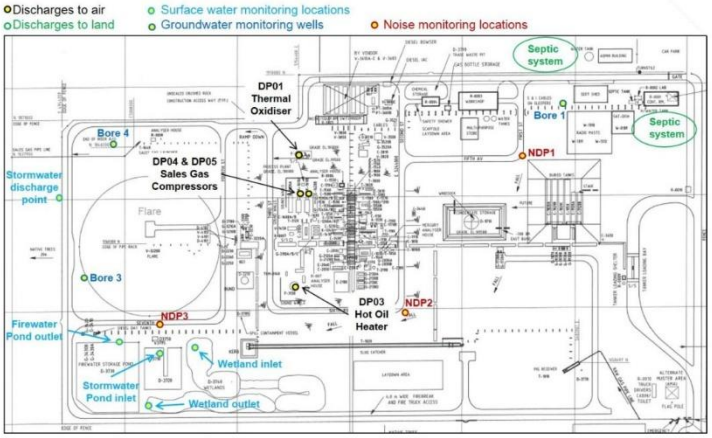
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BassGas Site Plans



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.



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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

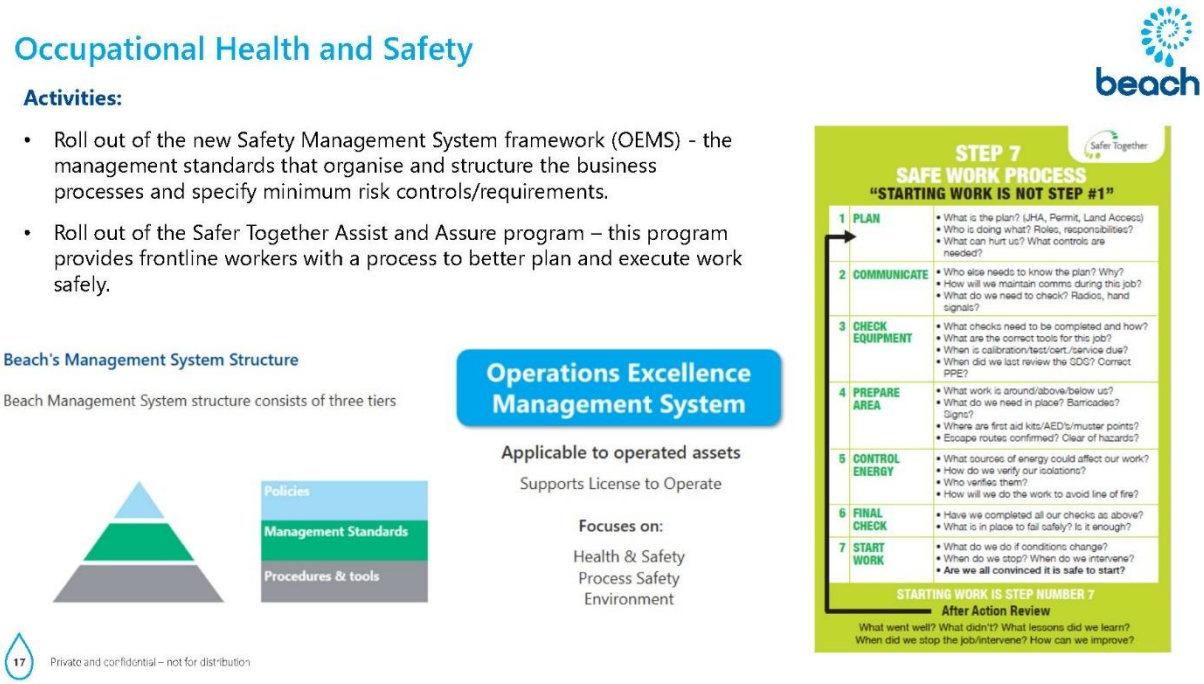

Chemical Storage area


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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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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Community Investment Update



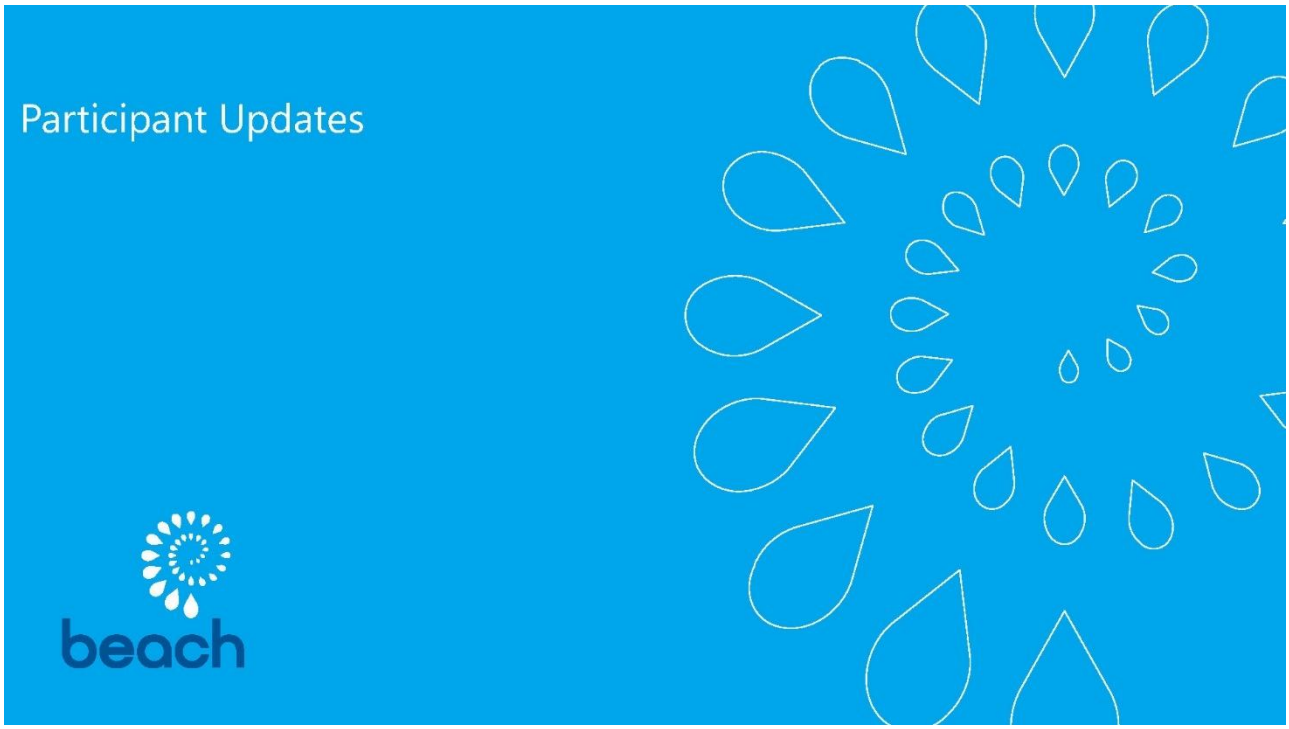






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Community and CRG contacts

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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

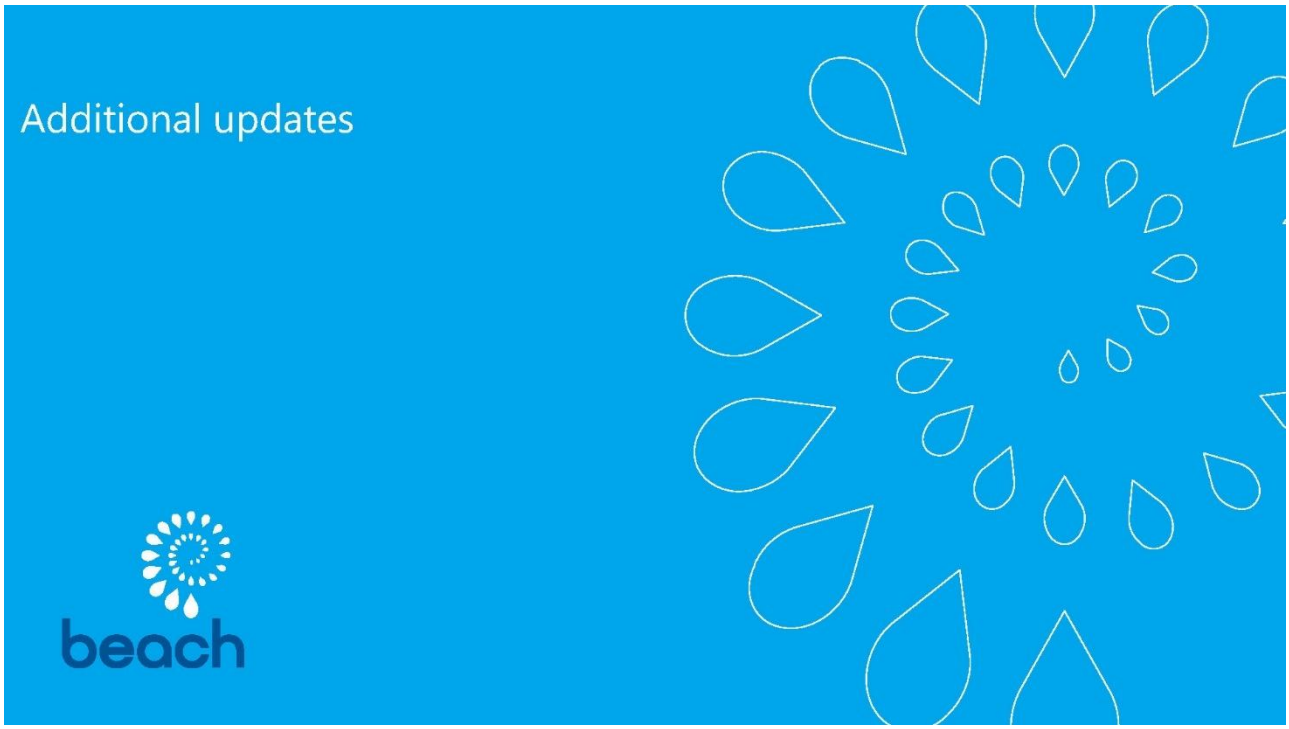
Senior Land & Community Relations Adviser (Vic)
Kieran Keane 0498 617 725 Kieran.keane@beachenergy.com.au

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

Lang Lang Gas Plant:
24-hour operations

23 Private and confidential – not for distribution

Slide 24



APPENDIX 4

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

APPENDIX 5

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: 30-Jul-2026

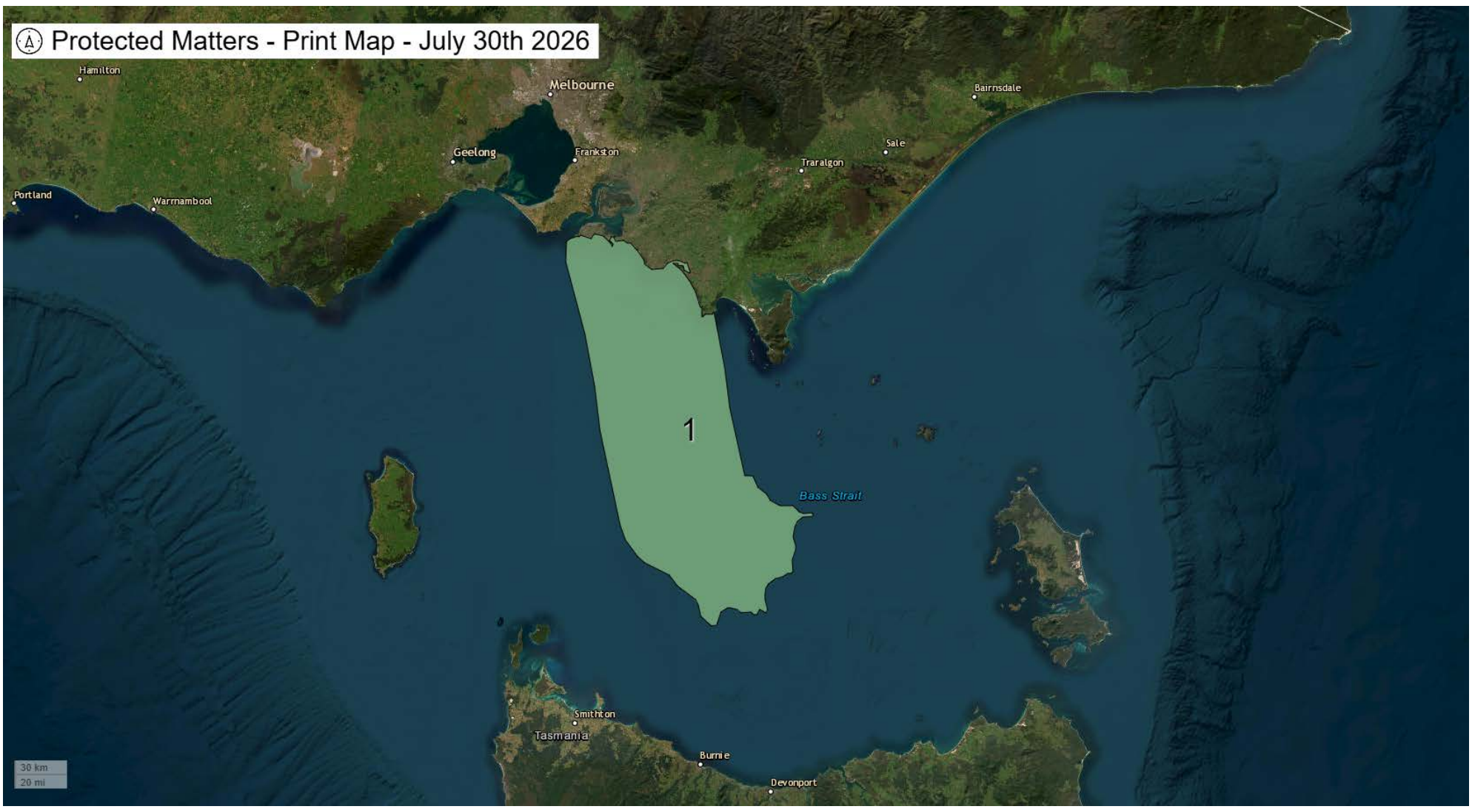
[Summary](#)

[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	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	89
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:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	112
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:	7
Regional Forest Agreements:	1
Nationally Important Wetlands:	None
EPBC Act Referrals:	33
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
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)

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		

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

Scientific Name	Threatened Category	Presence Text
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis 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
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area

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

Scientific Name	Threatened Category	Presence Text
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Pycnoptilus floccosus Pilotbird [525]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area
Sternula albifrons Little Tern [82849]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting likely to occur within area
FISH		
Galaxiella pusilla Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
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 likely to occur within area
FROG		
Ranoidea raniformis listed as Litoria raniformis		
Southern Bell Frog, Growling Grass Frog, Green and Golden Frog [94668]	Vulnerable	Species or species habitat likely to occur within area
MAMMAL		
Antechinus minimus maritimus		
Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat likely 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)		
Spotted-tail Quoll, Spot-tailed Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Breeding likely to occur within area
Isoodon obesulus obesulus		
Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat likely to occur within area
Mastacomys fuscus mordicus		
Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Perameles gunnii Victorian subspecies		
Eastern Barred Bandicoot (Mainland) [88020]	Endangered	Translocated population known to occur within area
Petauroides volans		
Greater Glider (southern and central) [254]	Endangered	Species or species habitat may 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		
Pookila, New Holland Mouse [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
PLANT		
Amphibromus fluitans		
River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat likely to occur within area
Caladenia orientalis		
Eastern Spider Orchid [83410]	Endangered	Species or species habitat likely to occur within area
Caladenia tessellata		
Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus strzeleckii		
Strzelecki Gum [55400]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum spicatum		
Dense Leek-orchid [55146]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
[Pterostylis chlorogramma](#) Green-striped Greenhood [56510]	Vulnerable	Species or species habitat likely to occur within area
[Pterostylis cucullata](#) Leafy Greenhood [15459]	Vulnerable	Species or species habitat likely to occur within area
[Senecio psilocarpus](#) Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat likely to occur within area
[Thelymitra orientalis](#) Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
[Xerochrysum palustre](#) Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
[Lissolepis coventryi](#) Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat likely to occur within area
[Pseudemoia rawlinsoni](#) Glossy Grass Skink, Swampland Cool-skink, Rawlinson's Window-eyed Skink [59160]	Vulnerable	Species or species habitat likely to occur within area
SHARK		
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Galeorhinus galeus Tope, Flake, Oil Shark, School 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 likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	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

Scientific Name	Threatened Category	Presence Text
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
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
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas 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	Breeding likely to occur within area
Eubalaena australis as Balaena glacialis australis		
Southern Right Whale [40]	Endangered	Breeding likely to occur within area
Isurus oxyrinchus		
Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus		
Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus		
Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus		
White-throated Needletail [682]	Vulnerable	Species or species habitat likely 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 likely to occur within area
Arenaria interpres		
Ruddy Turnstone [872]	Vulnerable	Roosting likely to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat likely to occur within area
Calidris falcinellus as Limicola falcinellus Broad-billed Sandpiper [91731]		Roosting likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting likely to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting likely to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat likely to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area

Scientific Name	Threatened Category	Presence Text
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat likely to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting likely to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting likely to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding likely to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Foraging, feeding or related behaviour likely to occur within area
Tringa glareola Wood Sandpiper [829]		Foraging, feeding or related behaviour likely to occur within area
Tringa incana Wandering Tattler [831]		Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour likely to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding likely to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting likely to occur within area

Scientific Name	Threatened Category	Presence Text
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat likely to occur within area overfly marine area
Calidris falcinellus as Limicola falcinellus Broad-billed Sandpiper [91731]		Roosting likely to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting likely to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting likely to occur within area overfly marine area
Charadrius bicinctus Double-banded Plover [895]		Roosting likely to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting likely to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius ruficapillus Red-capped Plover [881]		Roosting likely to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
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 likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat likely to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely 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 likely to occur within area overfly marine area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area overfly marine area
Larus dominicanus Kelp Gull [809]		Breeding likely to occur within area
Larus pacificus Pacific Gull [811]		Breeding likely to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat likely to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting likely to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat likely to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting likely to occur within area

Scientific Name	Threatened Category	Presence Text
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting likely to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting likely to occur within area overfly marine area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Foraging, feeding or related behaviour likely to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding likely to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat likely 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 likely to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Foraging, feeding or related behaviour likely to occur within area
Tringa glareola Wood Sandpiper [829]		Foraging, feeding or related behaviour likely to occur within area overfly marine area
Tringa incana as Heteroscelus incanus Wandering Tattler [831]		Foraging, feeding or related behaviour likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
[Xenus cinereus](#) Terek Sandpiper [59300]	Vulnerable	Roosting likely 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
[Hippocampus minotaur](#) Bullneck Seahorse [66705]		Species or species habitat may occur within area
[Histiogamphelus briggsii](#) Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
[Histiogamphelus cristatus](#) Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
[Hypselognathus rostratus](#) Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
[Kaupus costatus](#) Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
[Kimblaeus bassensis](#) Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
[Leptoichthys fistularius](#) Brushtail Pipefish [66248]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat likely to occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may 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
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding likely to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. 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
Bunurong	Marine National Park	VIC
Cape Liptrap Coastal Park	Conservation Park	VIC
Churchill Island	Marine National Park	VIC
Kilcunda N.C.R.	Natural Features Reserve	VIC
Phillip Island Nature Park	Other	VIC
Screw Creek N.C.R.	Natural Features Reserve	VIC
Yallock-Bulluk Marine and Coastal Park	National Parks Act Schedule 3 Other	VIC

Protected Area Name	Reserve Type	State
	Parks	

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	Victoria

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			
Bald Hills Wind Farm 80 Turbines	2002/730	Controlled Action	Post-Approval
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
Bass Basin - Pee Jay-1 - Drilling Program	2007/3908	Not Controlled Action	Completed
Construct a Recycled Water Pipeline from Somers Treatment Plant to Blue Scope S	2009/4982	Not Controlled Action	Completed
development of retirement resort	2004/1828	Not Controlled Action	Completed
Exploration Drilling Well Trefoil-1	2003/1058	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
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
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

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
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
Labatt 3D Seismic Survey T/47P Bass Strait	2007/3759	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 Short-tailed Shearwater [82652]	Foraging	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Reproduction	Known to occur
Diomedea exulans Wandering Albatross [89223]	Foraging	Known to occur
Eudyptula minor Little Penguin [1085]	Foraging	Likely to occur
Eudyptula minor Little Penguin [1085]	Reproduction	Known to occur

Scientific Name	Behaviour	Presence
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Foraging	Likely to occur
Thalassarche cauta Shy Albatross [89224]	Foraging	Likely to occur
Thalassarche impavida Campbell Albatross [64459]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Eubalaena australis Southern Right Whale [40]	Migration	
Eubalaena australis Southern Right Whale [40]	Reproduction	

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.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-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

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

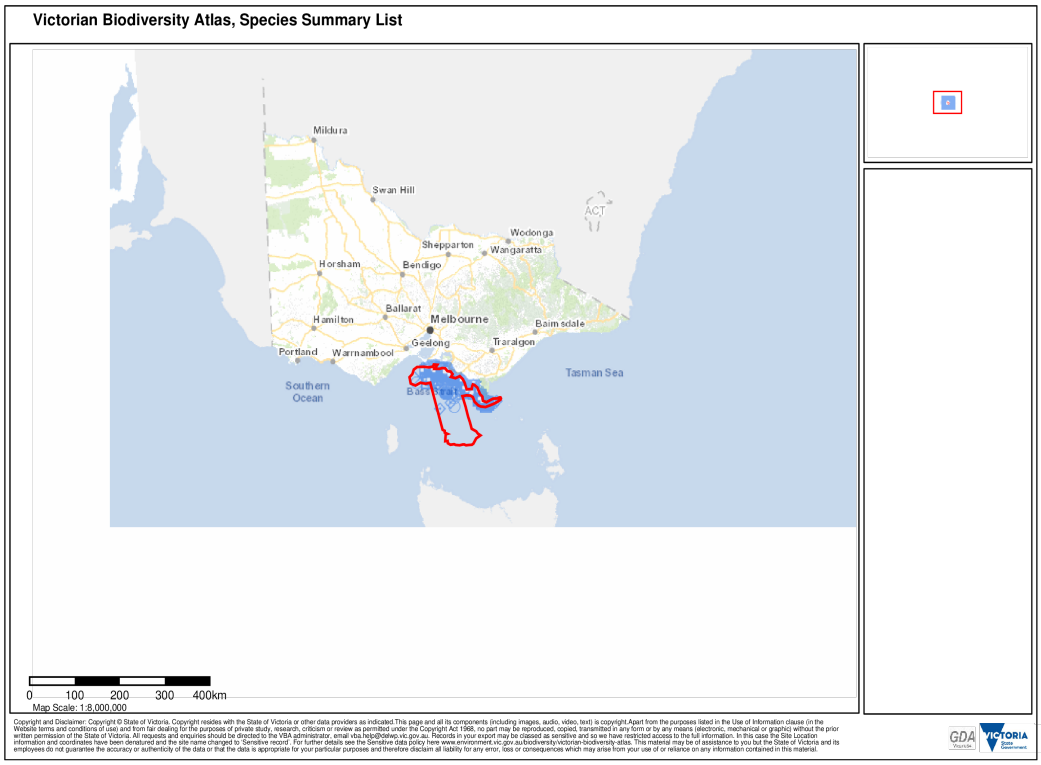
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APPENDIX 6

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

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

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

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

		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

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

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

		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

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

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

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

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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APPENDIX 7

Bass Gas: Yolla Operations Update

Acoustic Modelling for Assessing Marine Fauna Sound Exposures

JASCO Applied Sciences (Australia) Pty Ltd

4 December 2025

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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						

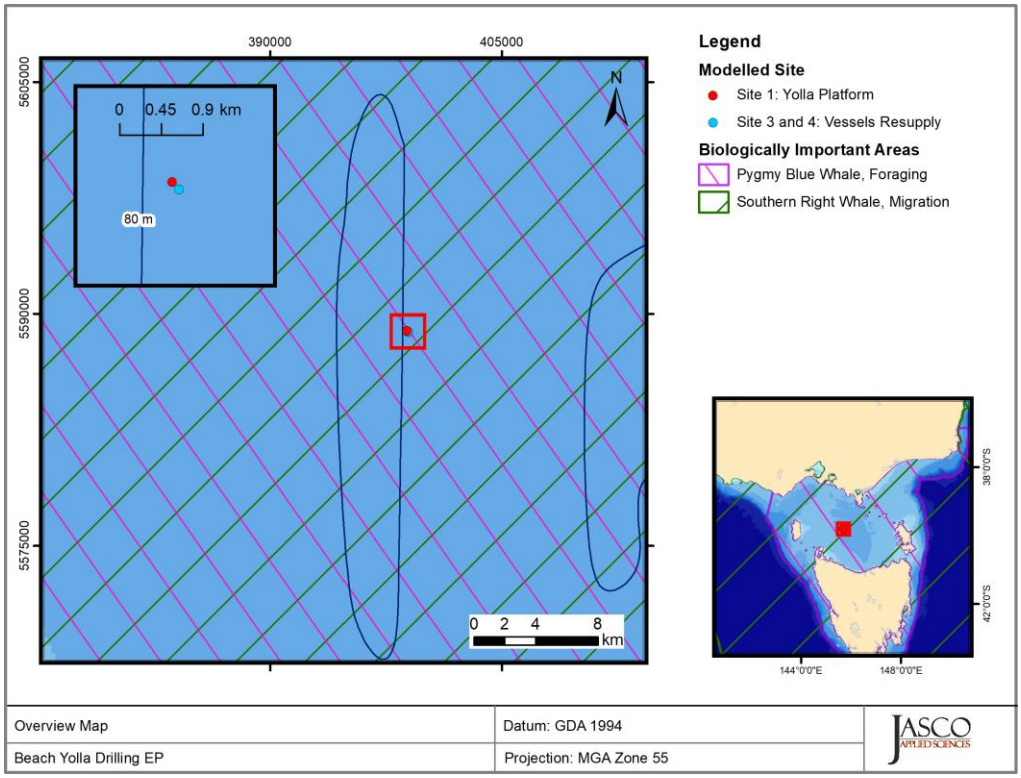


Figure 1. Overview map of the modelling sites and regional context.

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 µPa²·s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·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 µPa²·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: No swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB SPL for 48 h	158 dB SPL for 12 h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea Turtles	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (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 µPa^{2}s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^{2}s)
178	198

L_E denotes cumulative sound exposure over a 24 h period and has a reference value of 1 µPa^{2}s.

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.

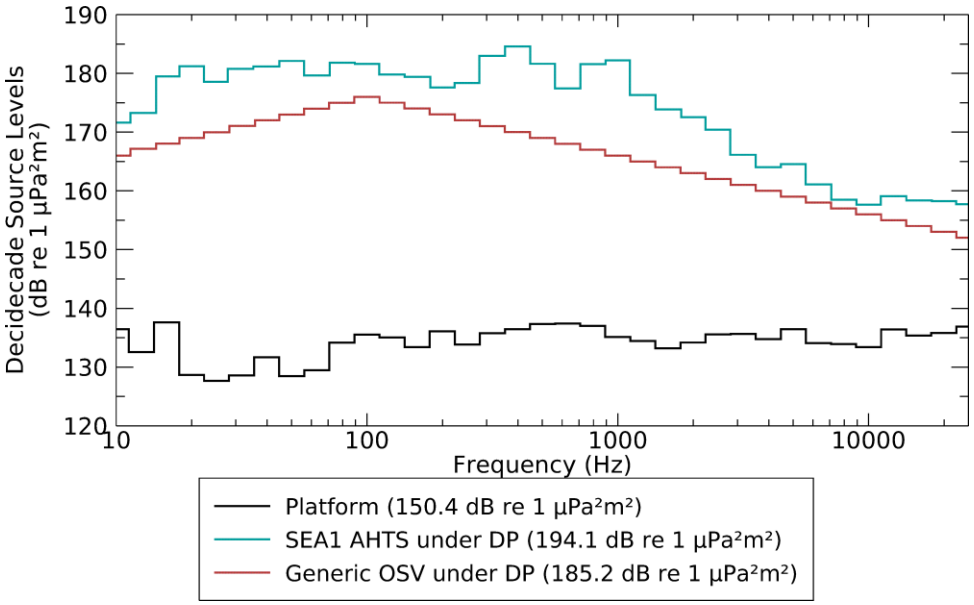


Figure 2. Decidecade monopole source level (MSL) spectra for all three sound sources.

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 µPa^{2}m^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 μPa^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 μPa^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 μPa^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

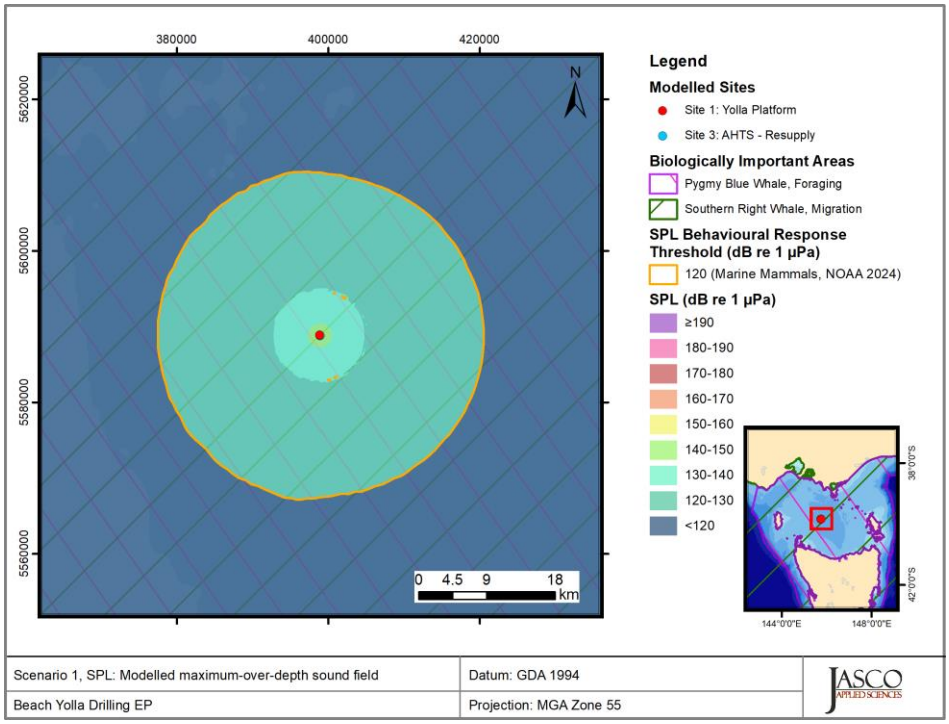


Figure 3. *Scenario 1, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (4 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

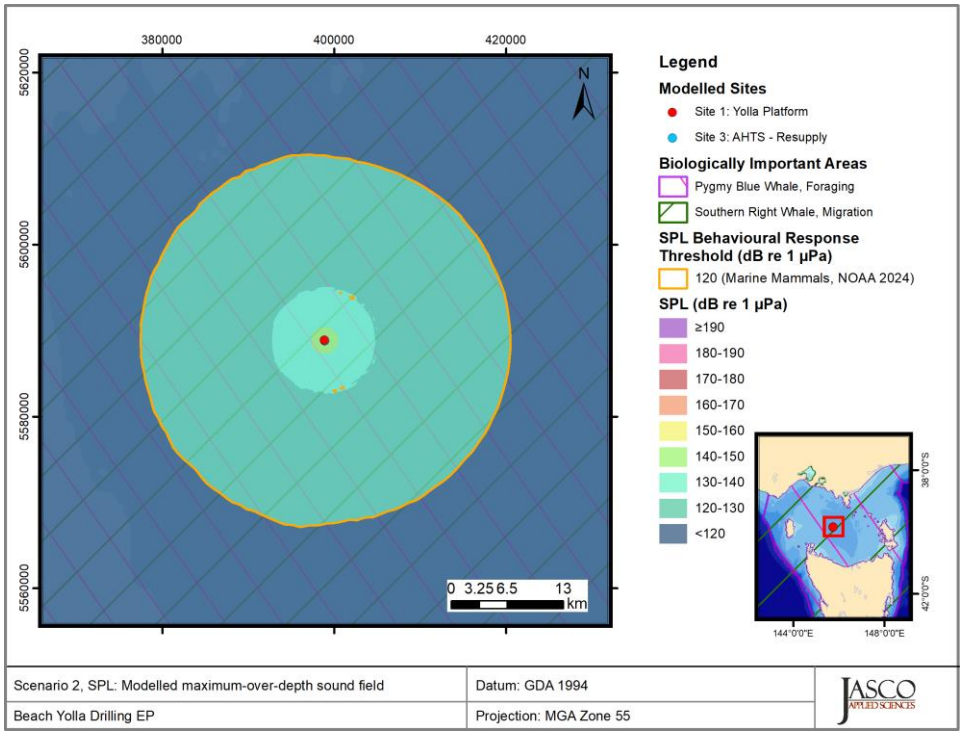


Figure 4. *Scenario 2, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (8 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

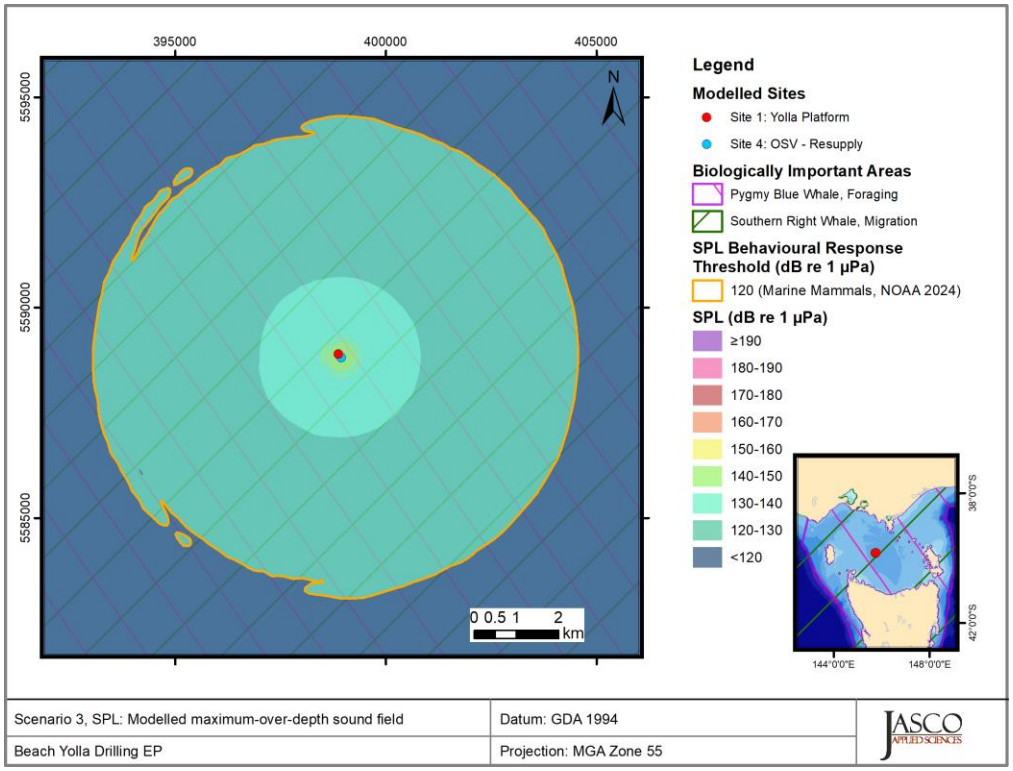


Figure 5. *Scenario 3, Yolla Platform Operations + generic OSV under DP conducting Resupply Ops (4 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

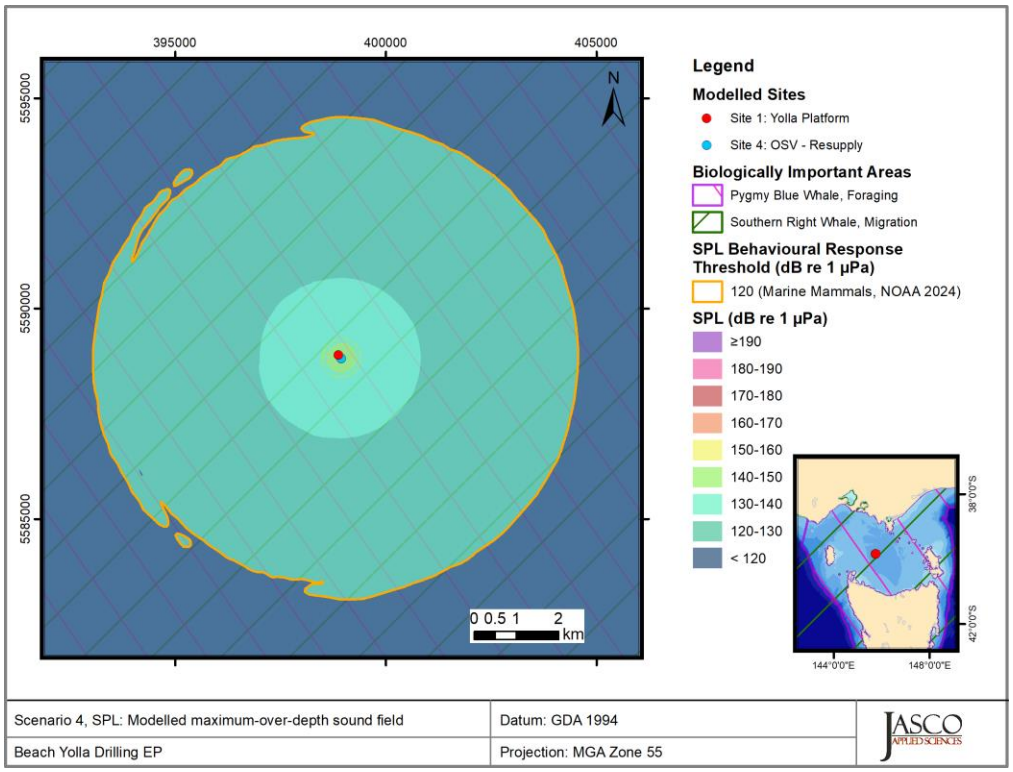


Figure 6. *Scenario 4, Yolla Platform Operations + generic OSV under DP conducting Resupply Ops (8 h), SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

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

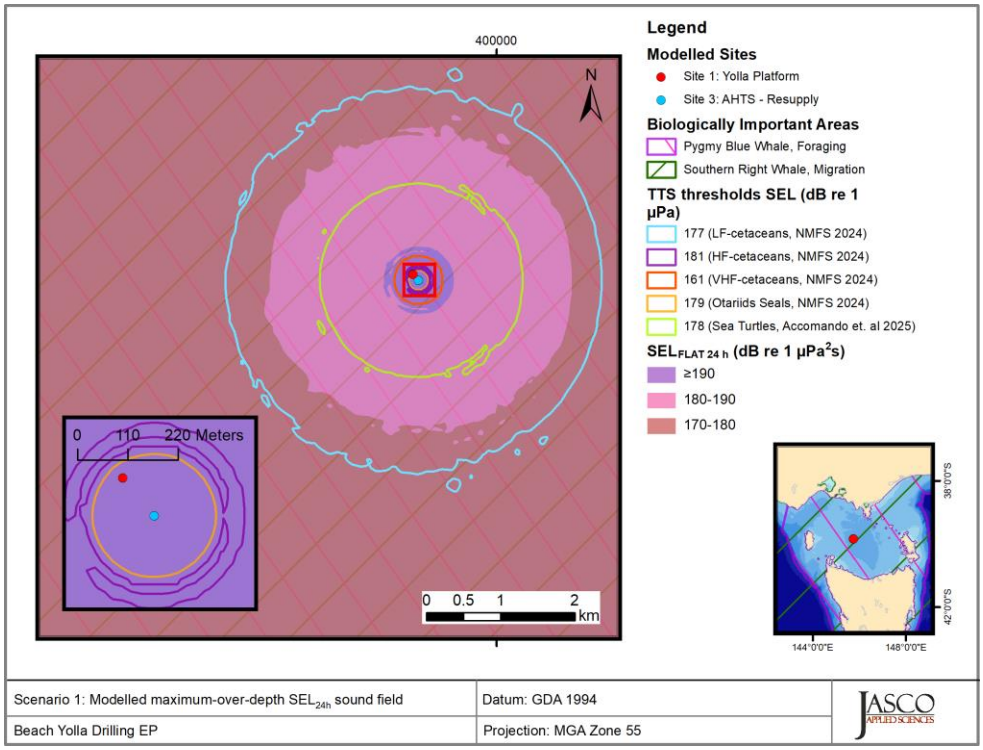


Figure 7. *Scenario 1, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (4 h), accumulated SEL_{24h}*: Sound level contour map showing maximum-over-depth SEL_{24h} results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans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

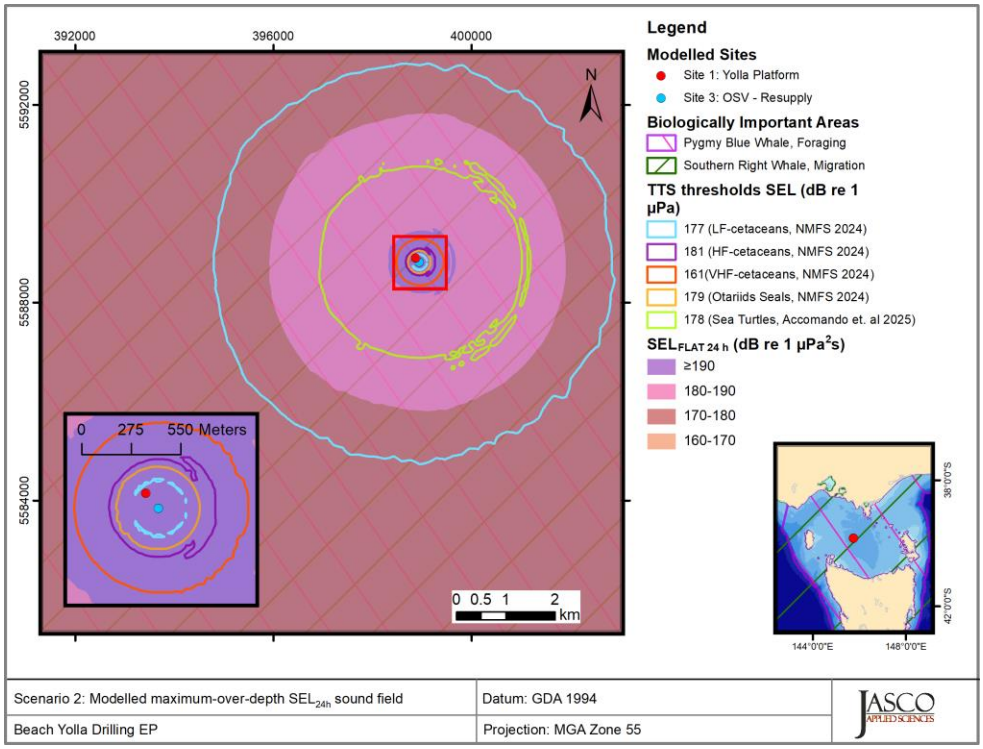


Figure 8. *Scenario 2, Yolla Platform Operations + SEA1 AHTS under DP conducting Resupply Ops (8 h), accumulated SEL_{24h}*: Sound level contour map showing maximum-over-depth SEL_{24h} results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency cetaceans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

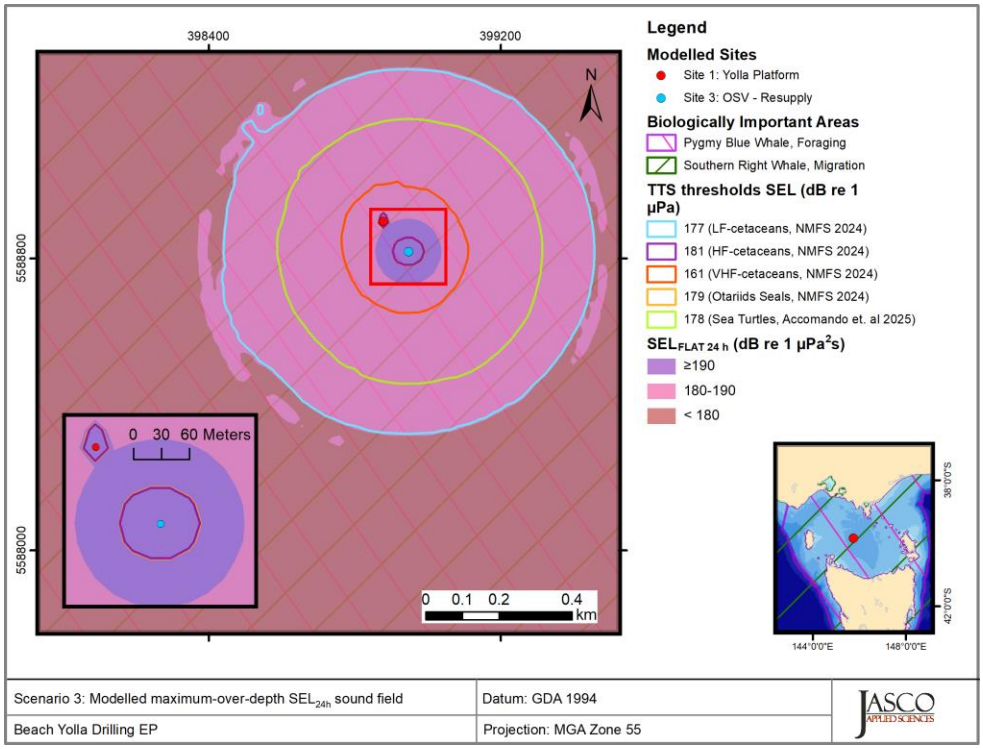


Figure 9. *Scenario 3, Yolla Platform Operations + Generic OSV under DP conducting Resupply Ops (4 h), accumulated SEL_{24h}*: Sound level contour map showing maximum-over-depth SEL_{24h} results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency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

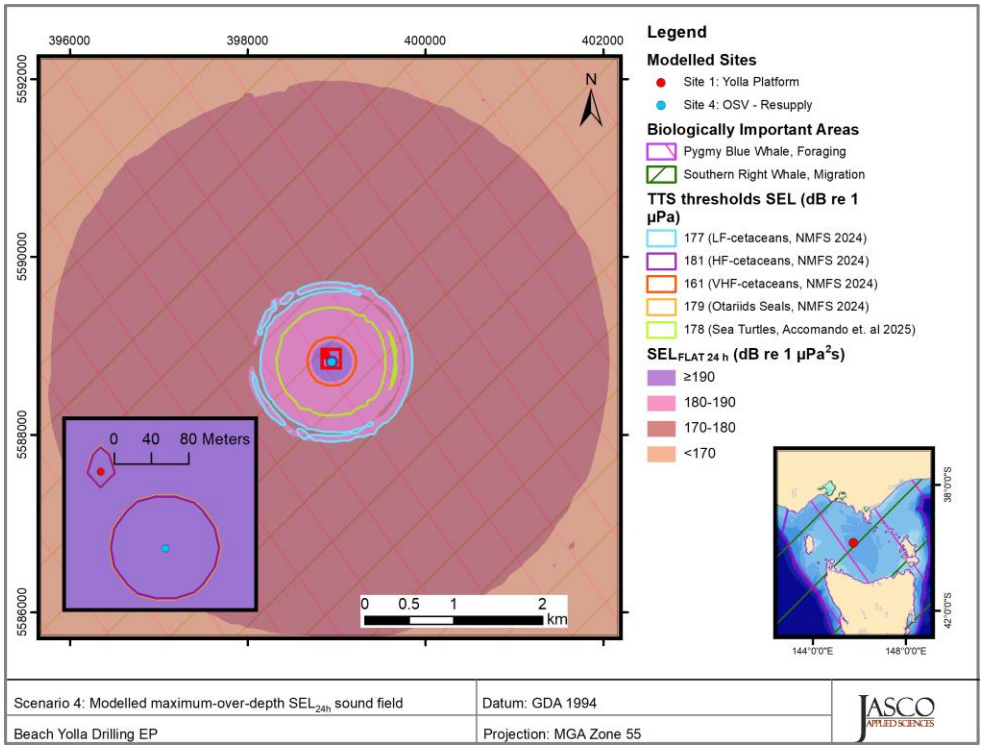


Figure 10. *Scenario 4, Yolla Platform Operations + Generic OSV under DP conducting Resupply Ops (8 h), accumulated SEL_{24h}*: Sound level contour map showing maximum-over-depth SEL_{24h} results (unweighted/flat), along with frequency weighted isopleths for TTS in low, high, and very high-frequency 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 μPa^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 μPa^2 s can be written in the form *x* dB re 1 μPa^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 μPa^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 μPa^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_{rms}). Unit: decibel (dB). Reference value (p_0^2) for sound in water: 1 μPa^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 μPa^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.

Literature Cited

[ANSI] American National Standards Institute and [ASA] Acoustical Society of America. S1.1-2013. *American National Standard: Acoustical Terminology*. New York. https://webstore.ansi.org/Standards/ASA/ANSIASAS12013.

[ANSI] American National Standards Institute and [ASA] Acoustical Society of America. S1.13-2005 (R2010). *American National Standard: Measurement of Sound Pressure Levels in Air*. New York. https://webstore.ansi.org/Standards/ASA/ANSIASAS1132005R2010.

[DoC] Department of Commerce (US) and [NOAA] National Oceanic and Atmospheric Administration (US). 2018. 83 FR 63268: Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Geophysical Surveys in the Atlantic Ocean. *Federal Register* 83(235): 63268–63270. https://www.federalregister.gov/d/2018-26460.

[HESS] High Energy Seismic Survey. 1999. *High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California*. Prepared for the California State Lands Commission and the United States Minerals Management Service Pacific Outer Continental Shelf Region by the High Energy Seismic Survey Team, Camarillo, CA, USA. 98 p. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB2001100103.xhtml.

[ISO] International Organization for Standardization. 2006. *ISO 80000-3:2006. Quantities and units — Part 3: Space and time*. https://www.iso.org/standard/31888.html.

[ISO] International Organization for Standardization. 2016. *ISO 17208-1:2016. Underwater acoustics — Quantities and procedures for description and measurement of underwater sound from ships – Part 1: Requirements for precision measurements in deep water used for comparison purposes*. https://www.iso.org/obp/ui/en/#iso:std:iso:17208:-1:ed-1:v1:en.

[ISO] International Organization for Standardization. 2017. *ISO 18405:2017. Underwater acoustics — Terminology*. Geneva. https://www.iso.org/obp/ui/en/#!iso:std:62406:en.

[NMFS] National Marine Fisheries Service (US). 1998. *Acoustic Criteria Workshop*. Co-Chairs: Dr. Roger Gentry and Dr. Jeanette Thomas. 9-11 Sep 1998.

[NMFS] National Marine Fisheries Service (US). 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 p. http://doi.org/10.7289/V5/TM-NMFS-OPR-55.

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/s3//dam-migration/tech-memo-acoustic-guidance-20-pdf-508.pdf.

[NMFS] National Marine Fisheries Service (US). 2024. *2024 Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts*. Report by the US Department of Commerce and NOAA. NOAA Technical Memorandum NMFS-OPR-71. 182 p. https://www.fisheries.noaa.gov/s3/2024-11/Tech_Memo-Guidance_-3.0-_OCT-2024-508_OPR1.pdf.

[NOAA] National Oceanic and Atmospheric Administration (US). 2013. *Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts*. National Oceanic and Atmospheric Administration, US Department of Commerce, and NMFS Office of Protected Resources, Silver Spring, MD, USA. 76 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2015. *Draft guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic threshold levels for onset of permanent and temporary threshold shifts*. NMFS Office of Protected Resources, Silver Spring, MD, USA. 180 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2016. *Document Containing Proposed Changes to the NOAA Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts*. National Oceanic and Atmospheric Administration and US Department of Commerce. 24 p.

[ONR] Office of Naval Research. 1998. *Workshop on the Effect of Anthropogenic Noise in the Marine Environment*. *ONR Workshop*, 10–12 Feb 1998. https://apps.dtic.mil/sti/tr/pdf/ADA640861.pdf.

Accomando, A.W., J.J. Finneran, E. Henderson, K. Jenkins, S. Kotecki, C. Martin, J. Mulsow, and M. Zapetis. 2025. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase 4). Revision 2025.1*. Report by NIWC Pacific and National Marine Mammal Foundation for the US Navy. https://www.nepa.navy.mil/Portals/20/Documents/Phase%204%20Acoustic%20and%20Explosive%20Criteria%20Final%20APR2025.1.pdf.

Aerts, L.A.M., M. Blees, S.B. Blackwell, C.R. Greene, Jr., K.H. Kim, D.E. Hannay, and M.E. Austin. 2008. *Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort*

Sea, July-August 2008: 90-day report. Document P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc., and JASCO Applied Sciences for BP Exploration Alaska. 199 p. ftp://ftp.library.noaa.gov/noaa_documents.lib/NMFS/Auke%20Bay/AukeBayScans/Removable%20Disk/P1011-1.pdf.

Amoser, S. and F. Ladich. 2003. Diversity in noise-induced temporary hearing loss in otophysine fishes. *Journal of the Acoustical Society of America* 113(4): 2170–2179. https://doi.org/10.1121/1.1557212.

Austin, M.E. and G.A. Warner. 2012. *Sound Source Acoustic Measurements for Apache's 2012 Cook Inlet Seismic Survey*. Version 2.0. Technical report by JASCO Applied Sciences for Fairweather LLC and Apache Corporation.

Austin, M.E. and L. Bailey. 2013. *Sound Source Verification: TGS Chukchi Sea Seismic Survey Program 2013*. Document 00706, Version 1.0. Technical report by JASCO Applied Sciences for TGS-NOPEC Geophysical Company.

Austin, M.E., A. McCrodan, C. O'Neill, Z. Li, and A.O. MacGillivray. 2013. *Marine mammal monitoring and mitigation during exploratory drilling by Shell in the Alaskan Chukchi and Beaufort Seas, July–November 2012: 90-Day Report*. *In*: Funk, D.W., C.M. Reiser, and W.R. Koski (eds.). Underwater Sound Measurements. LGL Rep. P1272D–1. Report from LGL Alaska Research Associates Inc. and JASCO Applied Sciences, for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 266 pp plus appendices.

Austin, M.E. 2014. Underwater noise emissions from drillships in the Arctic. *In*: Papadakis, J.S. and L. Bjørnø (eds.). *UA2014*. 22–27 Jun 2014, Rhodes, Greece. pp. 257–263.

Austin, M.E., H. Yurk, and R.A. Mills. 2015. *Acoustic Measurements and Animal Exclusion Zone Distance Verification for Furie's 2015 Kitchen Light Pile Driving Operations in Cook Inlet*. Version 2.0. Technical report by JASCO Applied Sciences for Jacobs LLC and Furie Alaska.

Austin, M.E. and Z. Li. 2016. *Marine Mammal Monitoring and Mitigation During Exploratory Drilling by Shell in the Alaskan Chukchi Sea, July–October 2015: Draft 90-day report*. *In*: Ireland, D.S. and L.N. Bisson (eds.). Underwater Sound Measurements. LGL Rep. P1363D. Report from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. For Shell Gulf of Mexico Inc, National Marine Fisheries Service, and US Fish and Wildlife Service. 188 pp + appendices.

Austin, M.E., D.E. Hannay, and K.C. Bröker. 2018. Acoustic characterization of exploration drilling in the Chukchi and Beaufort seas. *Journal of the Acoustical Society of America* 144: 115–123. https://doi.org/10.1121/1.5044417

Beach Energy Limited. 2020. *Environment Plan: Artisan-1 Exploration Well Drilling*. 544 p. https://docs.nopsema.gov.au/A764159.

Beaman, R.J. 2023. AusBathyTopo (Australia) 250m 2023 - A regional-scale depth model (20230004C). GeoScience Australia. https://doi.org/10.26186/148758.

Buckingham, M.J. 2005. Compressional and shear wave properties of marine sediments: Comparisons between theory and data. *Journal of the Acoustical Society of America* 117: 137–152. https://doi.org/10.1121/1.1810231.

Carnes, M.R. 2009. *Description and Evaluation of GDEM-V 3.0*. US Naval Research Laboratory, Stennis Space Center, MS. NRL Memorandum Report 7330-09-9165. 21 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a494306.pdf.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93(4): 1736–1742. https://doi.org/10.1121/1.406739.

Collins, M.D., R.J. Cederberg, D.B. King, and S. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. *Journal of the Acoustical Society of America* 100(1): 178–182. https://doi.org/10.1121/1.415921.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862–863. https://doi.org/10.1121/1.382038.

Dunlop, R.A., M.J. Noad, R.D. McCauley, L. Scott-Hayward, E. Kniest, R. Slade, D. Paton, and D.H. Cato. 2017. Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity. *Journal of Experimental Biology* 220(16): 2878–2886. https://doi.org/10.1242/jeb.160192.

Dunlop, R.A., M.J. Noad, R.D. McCauley, E. Kniest, R. Slade, D. Paton, and D.H. Cato. 2018. A behavioural dose-response model for migrating humpback whales and seismic air gun noise. *Marine Pollution Bulletin* 133: 506–516. https://doi.org/10.1016/j.marpolbul.2018.06.009.

Ellison, W.T. and P.J. Stein. 1999. *SURTASS LFA High Frequency Marine Mammal Monitoring (HF/M3) Sonar: Sustem Description and Test & Evaluation*. Under US Navy Contract N66604-98-D-5725. http://www.surtass-lfa-eis.com/wp-content/uploads/2018/02/HF-M3-Ellison-Report-2-4a.pdf.

Ellison, W.T. and A.S. Frankel. 2012. A common sense approach to source metrics. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life*. Volume 730. Springer, New York. pp. 433–438. https://doi.org/10.1007/978-1-4419-7311-5_98.

Esso Australia Resources Pty Ltd and ExxonMobil. 2024. *Environment Plan: Jack-Up Rig Plug and Abandonment*. Document AUGO-PO-EMP-069, Revision 3. https://docs.nopsema.gov.au/A1131903.

Finneran, J.J. and C.E. Schlundt. 2010. Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (*Tursiops truncatus*). *Journal of the Acoustical Society of America* 128(2): 567–570. https://doi.org/10.1121/1.3458814.

Finneran, J.J. and A.K. Jenkins. 2012. *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis (Phase 2)*. SPAWAR Systems Center Pacific, San Diego, CA, USA. 64 p.

Finneran, J.J. 2015. *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. Technical report by SSC Pacific, San Diego, CA, USA.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, CA, USA. 49 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

Funk, D.W., D.E. Hannay, D.S. Ireland, R. Rodrigues, and W.R. Koski. 2008. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90-day report*. LGL Report P969-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 218 p. http://www-static.shell.com/static/usa/downloads/alaska/shell2007_90-d_final.pdf.

Hannay, D.E. and R.G. Racca. 2005. *Acoustic Model Validation*. Document 0000-S-90-04-T-7006-00-E, Revision 02. Technical report by JASCO Research Ltd. for Sakhalin Energy Investment Company Ltd. 34 p.

Ireland, D.S., R. Rodrigues, D.W. Funk, W.R. Koski, and D.E. Hannay. 2009. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-Day Report*. Document P1049-1. 277 p.

Jensen, F.B., W.A. Kuperman, M.B. Porter, and H. Schmidt. 2011. *Computational Ocean Acoustics*. 2nd edition. AIP Series in Modern Acoustics and Signal Processing. AIP Press - Springer, New York. 794 p. https://doi.org/10.1007/978-1-4419-8678-8.

Lucke, K., U. Siebert, P.A. Lepper, and M.-A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *Journal of the Acoustical Society of America* 125(6): 4060–4070. https://doi.org/10.1121/1.3117443.

MacGillivray, A.O. 2018. Underwater noise from pile driving of conductor casing at a deep-water oil platform. *Journal of the Acoustical Society of America* 143(1): 450–459. https://doi.org/10.1121/1.5021554.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyak, and J.E. Bird. 1983. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior*. Report 5366. http://www.boem.gov/BOEM-Newsroom/Library/Publications/1983/rpt5366.aspx.

Malme, C.I., P.R. Miles, C.W. Clark, P.L. Tyack, and J.E. Bird. 1984. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Phase II: January 1984 Migration*. Report 5586. Report by Bolt Beranek and Newman Inc. for the US Department of the Interior and Minerals Management Service (Alaska OCS Office), Cambridge, MA, USA. https://www.boem.gov/sites/default/files/boem-newsroom/Library/Publications/1983/rpt5586.pdf.

Malme, C.I., B. Würsig, J.E. Bird, and P.L. Tyack. 1986. *Behavioral responses of gray whales to industrial noise: Feeding observations and predictive modeling*. Document 56. NOAA Outer Continental Shelf Environmental Assessment Program. Final Reports of Principal Investigators. 393–600 p.

Martin, S.B., K.C. Bröker, M.-N.R. Matthews, J.T. MacDonnell, and L. Bailey. 2015. Comparison of measured and modeled air-gun array sound levels in Baffin Bay, West Greenland. *OceanNoise 2015*. 11–15 May 2015, Barcelona, Spain.

Martin, S.B. and A.N. Popper. 2016. Short- and long-term monitoring of underwater sound levels in the Hudson River (New York, USA). *Journal of the Acoustical Society of America* 139(4): 1886–1897. https://doi.org/10.1121/1.4944876.

Martin, S.B., J.T. MacDonnell, and K.C. Bröker. 2017a. Cumulative sound exposure levels—Insights from seismic survey measurements. *Journal of the Acoustical Society of America* 141(5): 3603–3603. https://doi.org/10.1121/1.4987709.

Martin, S.B., M.-N.R. Matthews, J.T. MacDonnell, and K.C. Bröker. 2017b. Characteristics of seismic survey pulses and the ambient soundscape in Baffin Bay and Melville Bay, West Greenland. *Journal of the Acoustical Society of America* 142(6): 3331–3346. https://doi.org/10.1121/1.5014049.

Matthews, M.-N.R. and A.O. MacGillivray. 2013. Comparing modeled and measured sound levels from a seismic survey in the Canadian Beaufort Sea. *Proceedings of Meetings on Acoustics* 19(1): 1–8. https://doi.org/10.1121/1.4800553.

McCrodan, A., C.R. McPherson, and D.E. Hannay. 2011. *Sound Source Characterization (SSC) Measurements for Apache's 2011 Cook Inlet 2D Technology Test*. Version 3.0. Technical report by JASCO Applied Sciences for Fairweather LLC and Apache Corporation. 51 p.

McPherson, C.R. and G.A. Warner. 2012. *Sound Sources Characterization for the 2012 Simpson Lagoon OBC Seismic Survey 90-Day Report*. Document 00443, Version 2.0. Technical report by JASCO Applied Sciences for BP Exploration (Alaska) Inc.

McPherson, C.R., K. Lucke, B.J. Gaudet, S.B. Martin, and C.J. Whitt. 2018. *Pelican 3-D Seismic Survey Sound Source Characterisation*. Document 001583, Version 1.0. Technical report by JASCO Applied Sciences for RPS Energy Services Pty Ltd.

McPherson, C.R. and S.B. Martin. 2018. *Characterisation of Polarcus 2380 in³ Airgun Array*. Document 001599, Version 1.0. Technical report by JASCO Applied Sciences for Polarcus Asia Pacific Pte Ltd.

McPherson, C.R., Z. Li, C.C. Wilson, K.A. Kowarski, and M.W. Koessler. 2021. Appendix 8. Beach Otway Development Acoustic Monitoring. *In* Beach (ed.). *Environment Plan Appendices Geographe Subsea Installation & Commissioning (VIC/L23)*. https://docs.nopsema.gov.au/A802937.

McPherson, C.R., Z. Li, C.C. Wilson, D.E. Hannay, C. Robinson, B. Martin, K.A. Kowarski, and J.J.-Y. Delarue. 2022. *Gippsland Acoustic Monitoring: Characterisation of Vessels, Platform Noise and Marine Mammal Presence.* Document 02470, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Esso Australia Pty Ltd.

Nedwell, J.R. and A.W.H. Turnpenny. 1998. The use of a generic frequency weighting scale in estimating environmental effect. *Workshop on Seismics and Marine Mammals*. 23–25 Jun 1998, London, UK.

Nedwell, J.R., A.W.H. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, J.A.L. Spinks, and D. Howell. 2007. *A validation of the dB_{ht} as a measure of the behavioural and auditory effects of underwater noise*. Document 534R1231 Report by Subacoustech Ltd. for Chevron Ltd, TotalFinaElf Exploration UK PLC, Department of Business, Enterprise and Regulatory Reform, Shell UK Exploration and Production Ltd, The Industry Technology Facilitator, Joint Nature Conservation Committee, and The UK Ministry of Defence. 74 p. https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-et-al-2007.pdf.

NOAA Fisheries. 2019. *ESA Section 7 Consultation Tools for Marine Mammals on the West Coast* (web page), 27 Sep 2019.

NOAA Fisheries. 2024. *ESA Section 7 Consultation Tools for Marine Mammals on the West Coast* (web page), 30 Jan 2024. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west.

O'Neill, C., D. Leary, and A. McCrodan. 2010. Sound Source Verification. (Chapter 3) *In* Blees, M.K., K.G. Hartin, D.S. Ireland, and D.E. Hannay (eds.). *Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report*. LGL Report P1112-1. Technical report by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. pp. 1–34.

Payne, R. and D. Webb. 1971. Orientation by means of long range acoustic signaling in baleen whales. *Annals of the New York Academy of Sciences* 188: 110–141. https://doi.org/10.1111/j.1749-6632.1971.tb13093.x.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2.

Porter, M.B. and Y.C. Liu. 1994. Finite-element ray tracing. *In*: Lee, D. and M.H. Schultz (eds.). *International Conference on Theoretical and Computational Acoustics*. Volume 2. World Scientific Publishing Co. pp. 947–956.

Racca, R., A.N. Rutenko, K.C. Bröker, and M.E. Austin. 2012a. A line in the water - design and enactment of a closed loop, model based sound level boundary estimation strategy for mitigation of behavioural impacts from a seismic survey. *11th European Conference on Underwater Acoustics*. Volume 34(3), Edinburgh, UK.

Racca, R., A.N. Rutenko, K.C. Bröker, and G.A. Gailey. 2012b. Model based sound level estimation and in-field adjustment for real-time mitigation of behavioural impacts from a seismic survey and post-event evaluation of sound exposure for individual whales. *In*: McMinn, T. (ed.). *Acoustics*. Fremantle, Australia. http://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p92.pdf.

Racca, R., M.E. Austin, A.N. Rutenko, and K.C. Bröker. 2015. Monitoring the gray whale sound exposure mitigation zone and estimating acoustic transmission during a 4-D seismic survey, Sakhalin Island, Russia. *Endangered Species Research* 29(2): 131–146. https://doi.org/10.3354/esr00703.

Scholik, A.R. and H.Y. Yan. 2002. Effects of Boat Engine Noise on the Auditory Sensitivity of the Fathead Minnow, *Pimephales promelas*. *Environmental Biology of Fishes* 63(2): 203–209. https://doi.org/10.1023/A:1014266531390.

Smith, M.E., A.B. Coffin, D.L. Miller, and A.N. Popper. 2006. Anatomical and functional recovery of the goldfish (*Carassius auratus*) ear following noise exposure. *Journal of Experimental Biology* 209(21): 4193–4202. https://doi.org/10.1242/jeb.02490.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411–521. https://doi.org/10.1578/AM.33.4.2007.411.

Southall, B.L., D.P. Nowacek, P.J.O. Miller, and P.L. Tyack. 2016. Experimental field studies to measure behavioral responses of cetaceans to sonar. *Endangered Species Research* 31: 293–315. https://doi.org/10.3354/esr00764.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2): 125–232. https://doi.org/10.1578/AM.45.2.2019.125.

Spence, J.H., R. Fischer, M.A. Bahtiarian, L. Boroditsky, N. Jones, and R. Dempsey. 2007. *Review of Existing and Future Potential Treatments for Reducing Underwater Sound from Oil and Gas Industry Activities*. Report NCE 07-001. Report by Noise Control Engineering, Inc. for the Joint Industry Programme on E&P Sound and Marine Life. 185 p.

Stroot, D.H., M.W. Koessler, and C.R. McPherson. 2022. *Beach Energy Yolla Drilling Campaign: Acoustic Modelling for Assessing Marine Fauna Sound Exposures*. Document 02741, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Beach Energy.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. *Journal of Geophysical Research* 95(C5): 7167–7183. https://doi.org/10.1029/JC095iC05p07167.

Warner, G.A., C. Erbe, and D.E. Hannay. 2010. Underwater Sound Measurements. (Chapter 3) *In* Reiser, C.M., D.W. Funk, R. Rodrigues, and D.E. Hannay (eds.). *Marine Mammal Monitoring and Mitigation during Open Water Shallow Hazards and Site Clearance Surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-Day Report*. LGL Report P1112-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (US), and Fish and Wildlife Service (US). pp. 1–54.

Warner, G.A., M.E. Austin, and A.O. MacGillivray. 2017. Hydroacoustic measurements and modeling of pile driving operations in Ketchikan, Alaska [Meeting abstract]. *Journal of the Acoustical Society of America* 141(5): 3992. https://doi.org/10.1121/1.4989141.

Wood, J.D., B.L. Southall, and D.J. Tollit. 2012. *PG&E offshore 3-D Seismic Survey Project Environmental Impact Report–Marine Mammal Technical Draft Report*. Report by SMRU Ltd. 121 p. https://www.coastal.ca.gov/energy/seismic/mm-technical-report-EIR.pdf.

Zhang, Z.Y. and C.T. Tindle. 1995. Improved equivalent fluid approximations for a low shear speed ocean bottom. *Journal of the Acoustical Society of America* 98(6): 3391–3396. https://doi.org/10.1121/1.413789.

Zykov, M.M. and J.T. MacDonnell. 2013. *Sound Source Characterizations for the Collaborative Baseline Survey Offshore Massachusetts Final Report: Side Scan Sonar, Sub-Bottom Profiler, and the R/V Small Research Vessel experimental*. Document 00413, Version 2.0. Technical report by JASCO Applied Sciences for Fugro GeoServices, Inc. and US Bureau of Ocean Energy Management.

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 ith 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 ith 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).

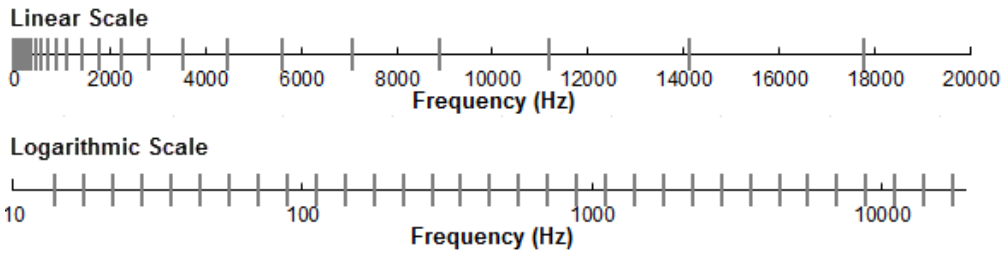


Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith 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.

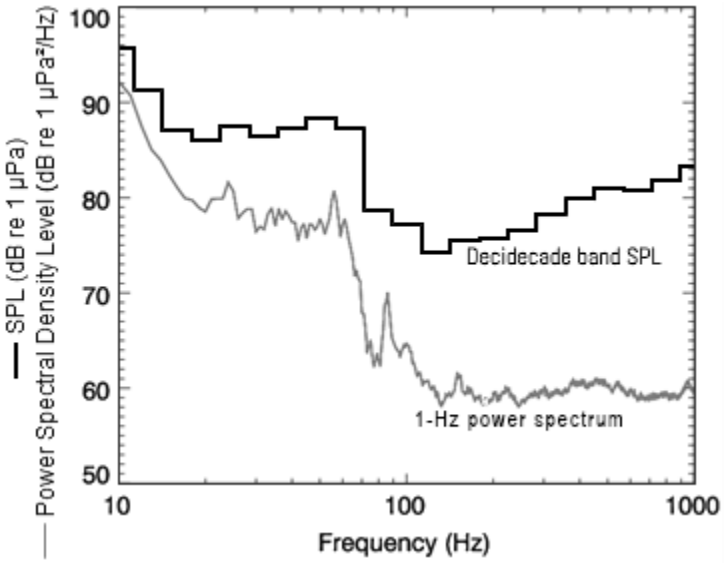


Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the power spectrum.

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).

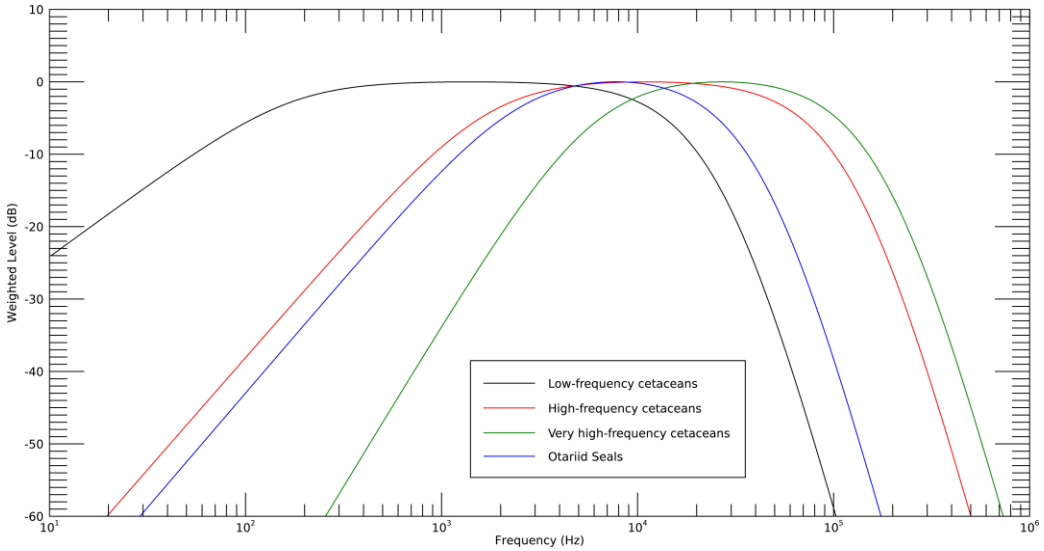


Figure A-3. Auditory weighting functions for functional marine mammal hearing groups used in this project as recommended by NMFS (2024).

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).

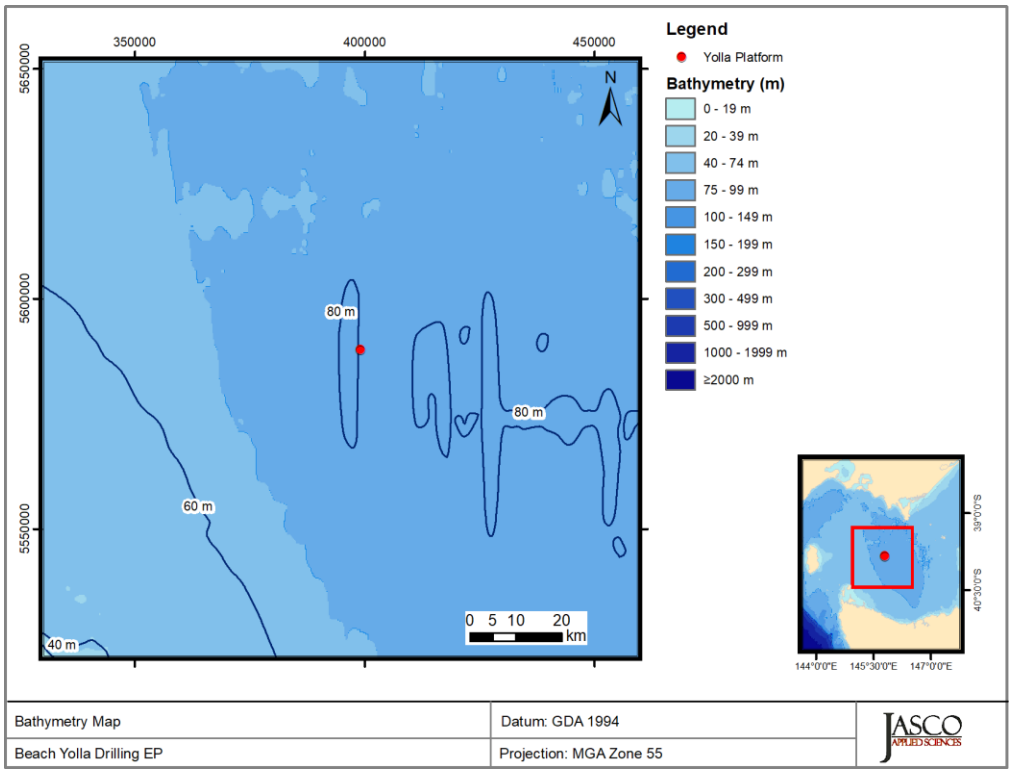


Figure B-1. Bathymetry in the modelled area.

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.

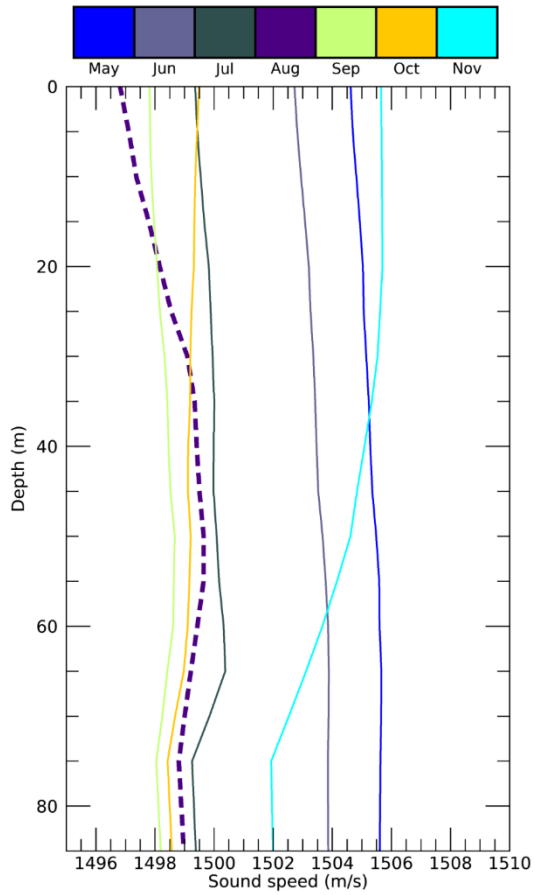


Figure B-2. The sound speed profile considered for acoustic modelling corresponding to August (dashed curve) and other considered monthly profiles Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

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).

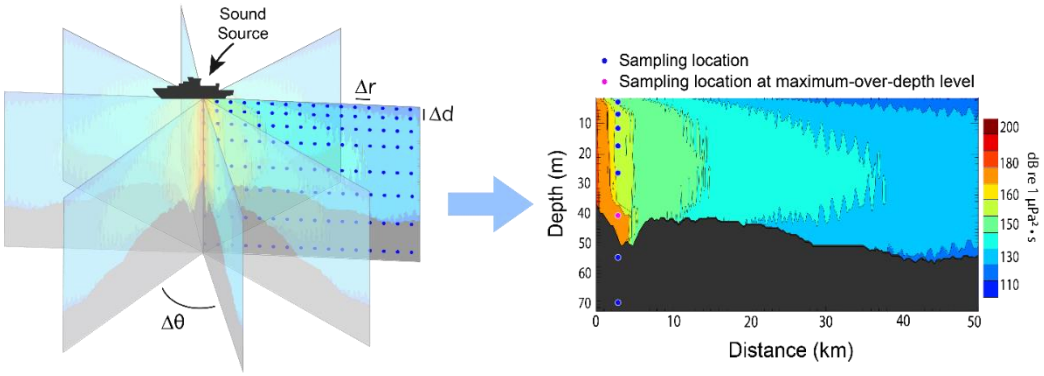


Figure B-3. The N×2-D and maximum-over-depth modelling approach used by MONM.

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.

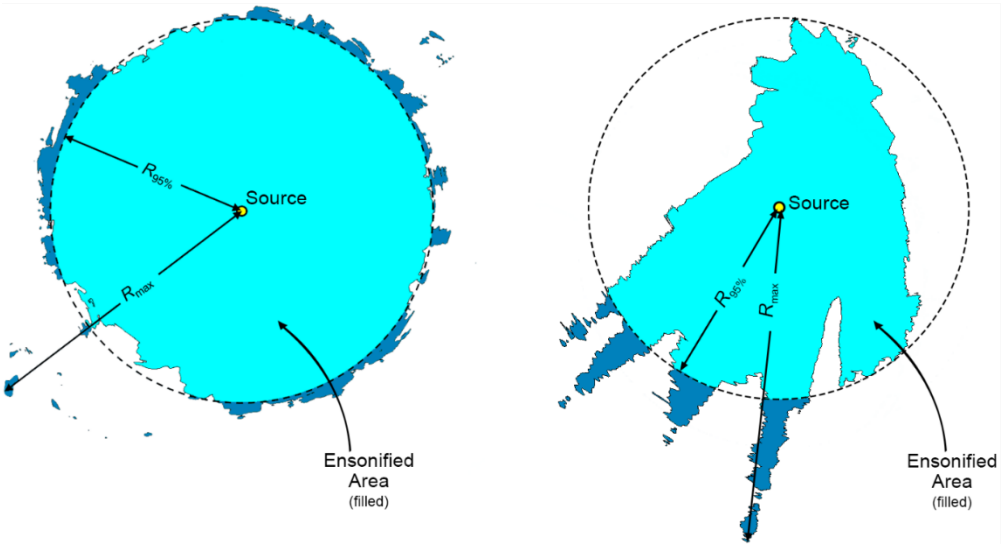


Figure B-4. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified 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)

APPENDIX 8

Procedure

T-5100-AP-0461

CDN/ID 19063285

Whale Management Procedure

Bass Offshore Operations

Operation & Production

Review record (record the last 3 revisions here or the revisions required to achieve current approval version)

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
A	07/05/2026	Draft	RM, ZP, CK, PP	Xodus	-
B	01/06/2026	Issued for Review	RM, ZP, CK, PP,	Xodus	-
C	02/06/2026	Issued for Review	RM, ZP, CK, PP,	Xodus	
0	03/06/2026	Issued for Use			PP

Review due	Review frequency
03/06/2031	5 years

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THE THREE WHATS

What can go wrong?

What could cause it to go wrong?

What can I do to prevent it?

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Definitions / Acronyms

Terms/acronym	Definition/expansion
AHTS	Anchor Handler Tug Supply
BIA	Biologically Important Area
BoM	Bureau of Meteorology
CM	Control Measure
DCCEEW	Department of Climate Change, Energy, Environment and Water
Darkness	Sunset plus 15 minutes using times provided by the Bureau of Meteorology (BoM)
Daylight	Sunrise minus 15 minutes through to darkness (sunset plus 15 minutes) using times provided by the BoM
EP	Environment Plan
EPBC	Environment Protection and Biodiversity Conservation [Act (1999)] and [Regulations (2000)]
EPO	Environmental Performance Outcomes
EPS	Environmental Performance Standards
IMR	Inspection, Maintenance and Repair
JNCC	Joint Nature Conservation Committee
MFO	Marine Fauna Observer
OA	Operational Areas, being: • 500m radius around the Yolla A platform, and/or • 500m either side of the raw gas pipeline (RGP). • 500m radius around each of the Trefoil-1 and Yolla-1 wellheads.
OOW	Officer of the Watch – A member of the vessel crew that is responsible for the safe navigation and operation of the vessel during their watch.
OSV	Offshore Supply Vessel
PIC	Person in Charge
PSZ	Petroleum Safety Zone
PTS	Permanent Threshold Shift
RGP	Raw Gas Pipeline
SoC	Species of concern [as identified in the EP]
SSS	Senior Subsea Supervisor
TTS	Temporary Threshold Shift
VSP	Vertical Seismic Profiling
WMP	Whale Management Procedure

1 Introduction

1.1 Purpose and Scope

The purpose of this Whale Management Procedure (WMP) is to detail the control measures (CMs) that Beach Energy (Operations) Limited (Beach) will implement to minimise anthropogenic noise and collision threats to cetaceans during Beach Energy operations in the Bass Basin.

This WMP applies to operation, inspection, maintenance and repair (IMR) activities related to the production and flow of gas and condensate through the Yolla A platform, associated wells (in Production Licence T/L1), suspended wells Trefoil-1 and Yolla-1 (in permits T/L5 and T/L1, respectively), the subsea pipelines in Commonwealth waters (pipeline licences VIC/PL34 and T/PL2), and associated pipeline in state waters (licence VIC/PL34(V)).

Measures to mitigate threats from anthropogenic noise are detailed in Section 2 for sub-activities, as follows:

- Resupply and Inspection, Maintenance and Repair (IMR) activities, and
- Geophysical, geotechnical and environmental studies, including Vertical Seismic Profiling (VSP).

These measures apply only to cetacean Species of Concern (SoCs) as identified in the EP, being:

- Endangered pygmy blue whales that are known to be or likely to be present within foraging Biologically Important Areas (BIAs), and
- Endangered southern right whales that may be within Reproduction and Migration BIAs.

Measures to mitigate the risk of vessel and helicopter interactions with cetaceans are detailed in Section 3 and apply to all whales and dolphins at any time during offshore activities.

The implementation of measures described within this WMP will ensure that relevant BassGas Offshore Operations EP and Bass Non-production Well Operations (Trefoil-1 and Yolla-1) Environmental Performance Outcomes (EPOs) are achieved, specifically:

- No death or injury to listed threatened or migratory species from the activity.
- Biologically important behaviours can continue while the activity is being undertaken.
- Anthropogenic noise in biologically important areas and habitat critical to the survival of a species will be managed such that:
    - Any blue whale continues to utilise biologically important areas without injury and is not displaced from a foraging area.
    - It does not prevent any southern right whale from utilising biologically important areas or habitat critical to the survival of a species or cause auditory impairment (Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS)).
    - Fauna use the waters around the Bass operational area without displacement or injury due to noise and vibration from offshore operations.

1.2 Assumptions

Key assumptions have been listed in Table 1-1 to assist in the interpretation and implementation of this procedure. Where an aspect is unclear, users are to consider these assumptions in determining what action, if any, to take. If there is uncertainty about the instructions in this procedure, users are required to take actions that (i) minimise threats to whales; (ii) are precautionary and, (iii) achieve EPOs, so that impacts remain within the acceptable levels defined in the EP.

Table 1-1: Key WMP assumptions

Aspect	Assumption
Observations	For Activity Zones >6 km, the horizon represents the maximum observation boundary. Observations undertaken on AHTS and that are <11 km from the activity location will count towards pre-activity surveys.
Activity Zones	Conservatism has been built into the Activity Zone distances, accounting for distance estimation accuracy, weather conditions, uncertainty in impact assessment and whale behaviour. Distances to sound criteria, used to inform the Activity Zones, have been developed using acoustic modelling as described in the EP.
Vessels	Bass offshore activities are typically conducted by Offshore Supply Vessels (OSV) of opportunity, or less likely, Anchor Handler Tug Supply (AHTS) vessels. Activity Zones for OSVs are considered appropriate for typical alternative vessels of opportunity, i.e. survey and fishing vessels.
Whales	All blue whales are considered to be foraging regardless of whether the activity of foraging is observed to ensure greater protection for blue whales in the area. Once an activity is underway, any whale considered undertaking foraging activities that enters pre-activity survey zones, will not be considered to be displaced or disrupted. As blue and southern right whales can be hard to distinguish from other baleen whales, a blue whale or southern right whale is either: • Confirmed to be a blue whale or southern right whale; or • If uncertainty exists, is 'like a blue whale or ''like a southern right whale'.

1.3 Roles and Responsibilities

Key roles and responsibilities for implementation of the WMP are listed in Table 1-2 below.

Table 1-2: Roles and responsibilities for implementation of the WMP

Position	Roles and Responsibilities
General Manager Offshore	• Ensure the WMP is implemented, records obtained, and reporting undertaken (see Section 1.5).
BassGas Production Manager	• Ensure systems and resources are in place to implement the WMP. • Inform the General Manager Offshore of any changes to equipment, systems, and documentation where there may be a new or change to an environmental impact or risk related to the WMP.
Activity Manager	• Ensure the WMP is communicated and personnel with responsibilities for implementation know their responsibilities and are competent to fulfil their designated role. • Ensure assurance processes are undertaken to confirm effectiveness of the WMP. • Maintain open communication with Person in Charge (PIC), Senior Subsea Supervisor (SSS) and Vessel Masters. • Report reasons for not following procedure to the BassGas Production Manager and Beach Senior Environmental Advisor.
Beach Senior Environmental Advisor	• Coordinate the training and implementation of the WMP offshore. • Ensure that the WMP is in accordance with the current BassGas Offshore EP and Bass Non-production Well Operations (Trefoil-1 and Yolla-1) EP • Ensure requirements for WMP implementation are in place prior to the commencement. • Review MFO/vessel daily reports to ensure detection and actions meet the requirements of the WMP. • Ensure MFOs and Officers of the Watch (OOW) are trained and competent to fulfil their role. • Review and update the WMP and communicate changes to relevant personnel. • Coordinate and document reviews of effectiveness and audit compliance against this procedure. • Report non-compliances to the regulator.
Bass Person in Charge (PIC) for resupply or Senior Subsea Supervisor (SSS) for studies/IMR	• Maintain open communication with Vessel Master and MFO/OOW and regularly (daily or more often as operational changes dictate) communicate activity status. • Liaise with Vessel Master and MFO/OOW and decide whether WMP actions can safely be implemented and take action accordingly. • Document reasons for not following procedure in the daily report and report to the Activity Manager and Beach Senior Environmental Advisor why actions could not be safely implemented. • Provide input into reviews of effectiveness and compliance with the WMP.
Vessel Master (or delegate)	• Maintain open communication with PIC/SSS and MFO/OOW and regularly (daily or more often as operational changes dictate) communicate activity status (i.e. commencing, underway, at Safe Point). • Liaise with PIC/SSS and MFO/OOW and decide whether WMP actions can safely be implemented and take action accordingly. • Document reasons for not following procedure in the daily report and report to the PIC/SSS and Activity Manager why actions could not be safely implemented. • Report incidents of vessel strike with a cetacean to the Beach Senior Environmental Advisor and the Department of Climate Change, Energy, Environment and Water (DCCEEW) (see Section 1.4). • Vessel Master's responsibility for the safety of life, environment and the vessel overrides this procedure.

Position	Roles and Responsibilities
Marine Fauna Observers (MFOs) and Officers of the Watch (OOW)	• Be trained and experienced in observations and be familiar with WMP Activity Zones and actions (see Section 1.4). • Undertake observations and reporting in accordance with this WMP. • Undertake to verify sightings made by crew and advise actions where verified. • Communicate sightings and advice on WMP requirements to the PIC/SSS and Vessel Master/Officer of the Watch (OOW). • Communicate with Beach Senior Environmental Advisor when procedural clarification is required. • Provide input into reviews of effectiveness and compliance with the WMP.
Vessel Crew	• Report sightings of marine mammals to MFO/OOW
Helicopter Pilot	• Maintain separation distances to marine fauna as detailed in Section 3.3.

1.4 Competency requirements

1.4.1 Marine Fauna Observers

Observations during geophysical, geotechnical and environmental studies, including VSP, will be undertaken by suitably trained and experienced MFOs, as follows:

- One MFO will be stationed onboard from April to August, with a trained OOW providing support during breaks.
- Two MFOs will be stationed onboard when survey duration is >5 days and daylight hours (between sunrise and sunset) are >12 hours (i.e., from September to March).

Minimum MFO competencies are detailed in Table 1-3.

1.4.2 Officers of the Watch

Observations during resupply and IMR activities will be conducted by suitably trained OOWs, with minimum competencies detailed in Table 1-3.

Table 1-3: MFO and OOW Competencies

Position	Competencies
MFO	• Completion of industry recognised MMO/MFO training course (Joint Nature Conservation Committee (JNCC) or equivalent • Previous MFO experience in whale observation • Familiarity with Australian regulations and EP requirements • Experience in distance estimation and reporting • Familiarity with key species – blue, southern right, t and humpback whales • Experience in setting up operational procedures with direction from Beach Environmental Advisor • Experience in the preparation and delivery of induction material and operational procedures to other MFOs and OOWs
OOW	• Trained by Beach Environmental Advisor or MFO in: ○ Offshore EP Induction ○ Requirements of this procedure ○ Whale observation and identification, and ○ Distance measurement and reporting.

1.5 Reporting

1.5.1 Fauna-related Incidents

Vessel Masters are to report all fauna incidents to the Beach Senior Environmental Advisor as soon as possible. The Beach Senior Environmental Advisor will provide advice regarding notifications to relevant government agencies. Notification requirements are detailed in EP Table 7.97: Regulatory incident reporting.

1.5.2 MFO/Daily Vessel Reporting Requirements

Sightings and actions implemented in accordance with the WMP will be documented in MFO Daily Reports or Daily Vessel Reports. Key activity stages will also be recorded such as commencement of pre-activity survey, time All Clear or delay to start-up is given, time when vessels enter and exit relevant OAs, etc.

2 Whale Management Procedure – Anthropogenic Noise

Table 2-1 below describes the specific actions to be taken prior to and during operational activities to minimise the impact of underwater noise on SoCs. It also includes daytime 'all clear' start criteria and start-up delay requirements, night-time and low visibility 'all clear' start criteria, and safe points for operational activities. Figure 2-1 depicts this information as a decision tree to support implementation.

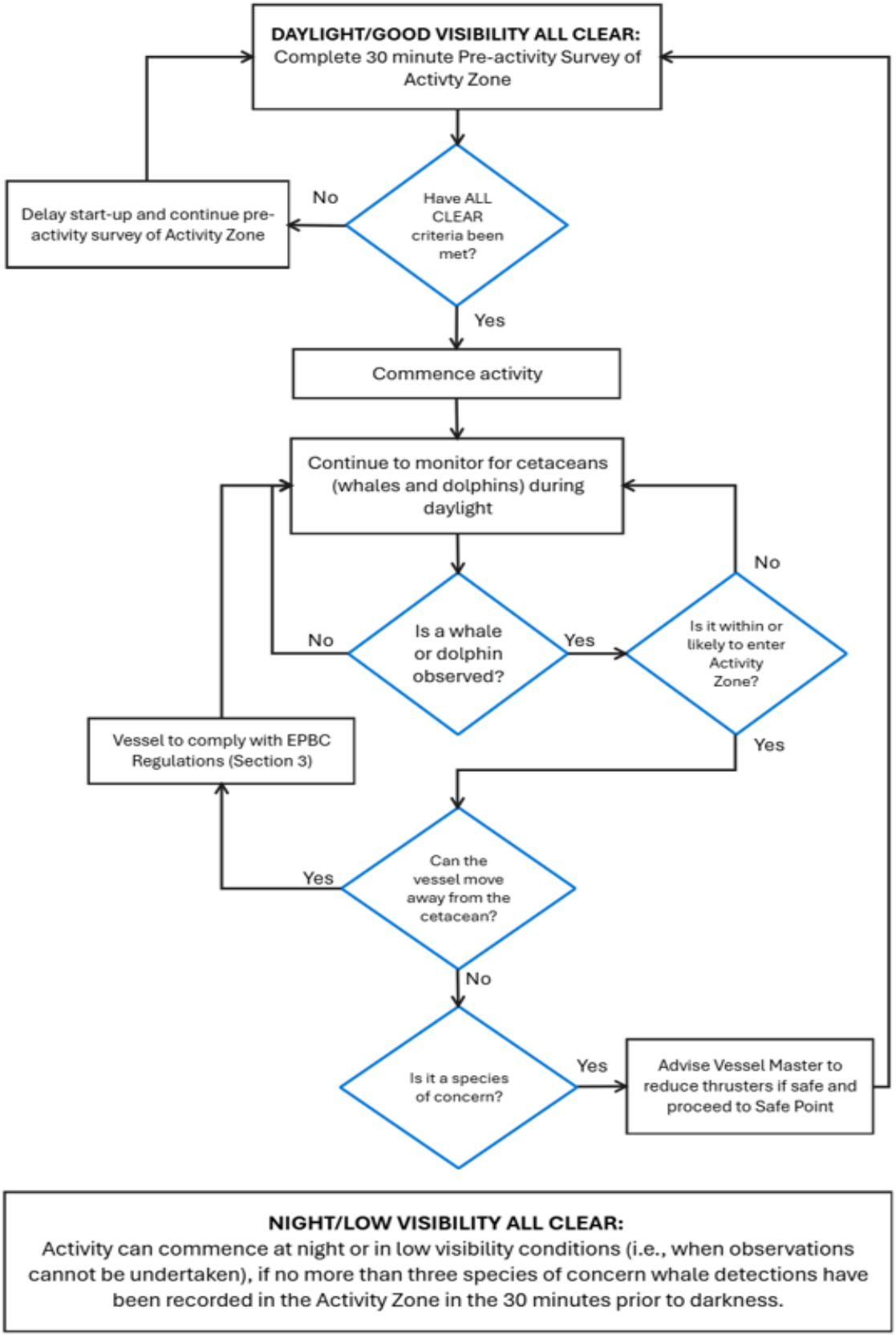


Figure 2-1: WMP flowchart for Bass offshore operations

Table 2-1: Distance to Modelled Sound Criteria and Link to Activity Zones

Activity	Prestart actions and key criteria	Activity Zone1		Start Point	Safe Point2	Actions to minimise noise and maintain safe operations after activity has commenced
		OSV	AHTS			
Resupply and IMR within 500 m PSZ around Yolla A platform or within the pipeline OA (500m either side of RGP) or within the Suspended Wells OA (500m radius around each of the Trefoil-1 and Yolla-1 wellheads).	Prior to entering the PSZ or OA, OOW is to complete a 30-minute pre-activity survey of Activity Zone. • During pre-activity survey, the Vessel will maneuver to view the blind spot behind the platform to confirm the absence of whales[4]. **DAYLIGHT/GOOD VISIBILITY ALL CLEAR**: Activity can commence and proceed to Safe Point when absence of whales[4] in Activity Zone is confirmed. **START-UP DELAY**: If a whale[3] is sighted within the Activity Zone during the pre-activity survey, commencement will be delayed until absence of whales[4] in the Activity Zone is confirmed. **NIGHT/LOW VISIBILITY ALL CLEAR**: Activity can commence at night or in low visibility conditions (i.e., when observations cannot be undertaken), if: • no more than three whale[3] detections have been recorded in the Activity Zone in the 30 minutes prior to darkness.	6 km	22 km (horizon)	Entry to PSZ	Exit of PSZ	OOW to continue observations. If activity has commenced and whales[3] are observed within the Activity Zone: • Vessel to reduce thrusters if safe to do so; and • Activity to proceed to Safe Point as soon as it is safe, and not recommence until absence of whales[3,4] in the Activity Zone is confirmed.
Geophysical, Geotechnical and Environmental Studies (including VSP) within 500 m PSZ around Yolla A platform or within the pipeline OA (500m either side of RGP)	Prior to entering PSZ or OA, MFO to complete 30-minute pre-activity survey of Activity Zone. • If pre-activity survey occurs near the platform, Vessel to manoeuvre to view blind spot behind platform to confirm absence of whales[4]. **DAYLIGHT/GOOD VISIBILITY ALL CLEAR**: Activity can commence and proceed to Safe Point when absence of whales[4] in Activity Zone is confirmed. **START-UP DELAY**: If a whale[3] is sighted within the Activity Zone during the pre-activity survey, commencement will be delayed until absence of whales[4] in Activity Zone is confirmed. **NIGHT/LOW VISIBILITY ALL CLEAR**: Activity can commence at night or in low visibility conditions (i.e., when observations cannot be undertaken), if: • no more than three whale[3] detections have been recorded in the Activity Zone in the 30 minutes prior to darkness.	6 km	22 km (horizon)	Entry to OA	Exit of OA	MFO to continue observations. If activity has commenced and whales[3] are observed within the Activity Zone: • Vessel to reduce thrusters if safe to do so; and • Activity to proceed to Safe Point as soon as it is safe, and not recommence until absence of whales[3,4] in the Activity Zone is confirmed.

Notes:

1. Activity Zones for each sub-activity, are based on the furthest distance to an effect criterion (auditory injury, TTS or behavioural disturbance), as detailed in the EP, and have been rounded up to take into account accuracy of estimation of distance at sea. The distance provided is a radius around either the platform or the start location along the RGP.
2. Proceeding to the Safe Point involves completing activities as soon as safe to do so and exiting the PSZ or OA where thrusters are more likely to be able to be reduced, depending on sea state.
3. Whale species of concern (SoC) include blue and southern right whales.
4. Absence of whales means:
   - No whales[3] are observed for 30 minutes within the Activity Zone; or
   - Whales[3] are observed leaving the Activity Zone.

3 EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with Cetaceans

Sections 3.1 and 3.2 provide guidance on separation distances for vessels and helicopters to whales and dolphins, as per EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with Cetaceans.

3.1 Vessels and Whales

Vessel operators shall adhere to the distances and vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with whales, specifically:

- Do not approach a whale.
- Maintain a minimum distance of 300 m from a whale.
- If a whale approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal.

3.2 Vessels and Dolphins

Vessel operators shall adhere to the distances and vessel management practices of EPBC Regulations (Part 8) and EP CM02 Operational Procedures, and report vessel interactions with dolphins, specifically:

- Do not approach a dolphin.
- Maintain a minimum distance of 150 m from a dolphin (with the exception of bow riding).
- If a dolphin approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal.

3.3 Helicopters and Whales and Dolphins

Helicopters will not fly lower than 1650 ft when within 500 m horizontal distance of a cetacean except when landing or taking off and will not approach a cetacean from head on (EPBC Regulations Part 8, Division 8.1).

4 References and Associated Documents

4.1 Beach Energy Documents

1. BassGas Offshore Operations Environment Plan, CDN/ID 3972814
2. Field Support Vessel Operations (CP), CDN/ID 3974221
3. Marine Mammal Observer Requirements Offshore Victoria Memorandum, 28 April 2023
4. Bass Non-production Well Operations Environment Plan (Trefoil-1 and Yolla-1)

4.2 External Documents

1. Environment Protection and Biodiversity Conservation Regulations 2000, Part 8 – Interacting with Cetaceans and Whale Watching

5 Document Information and History

Document custodian group

Title	Name/s

Document history

Rev	Date	Changes made in document	Reviewer/s	Consolidator	Approver
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APPENDIX 9

Prepared for
Beach Energy Limited
ABN: 30007617969

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

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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).

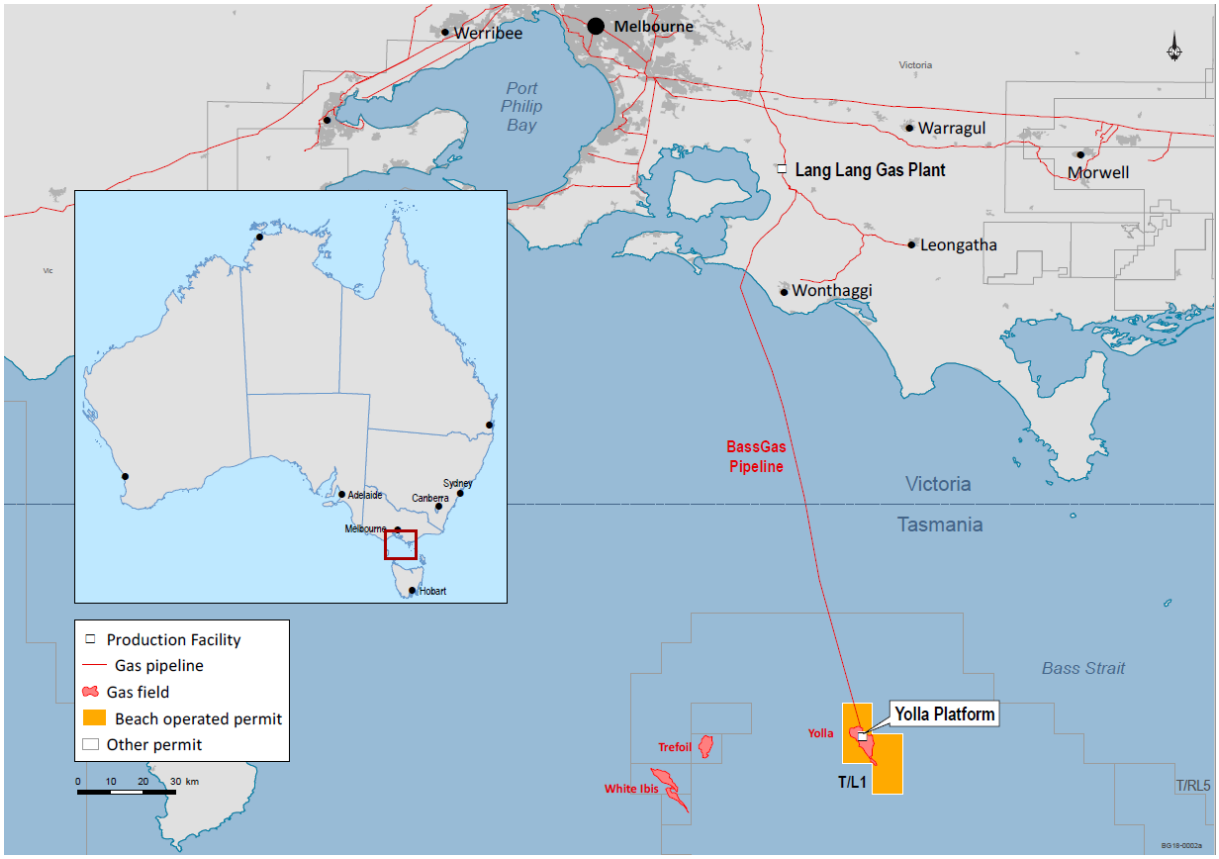


Figure 1 Yolla Platform location

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 (5th percentile) and high current (95th 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 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 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 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.

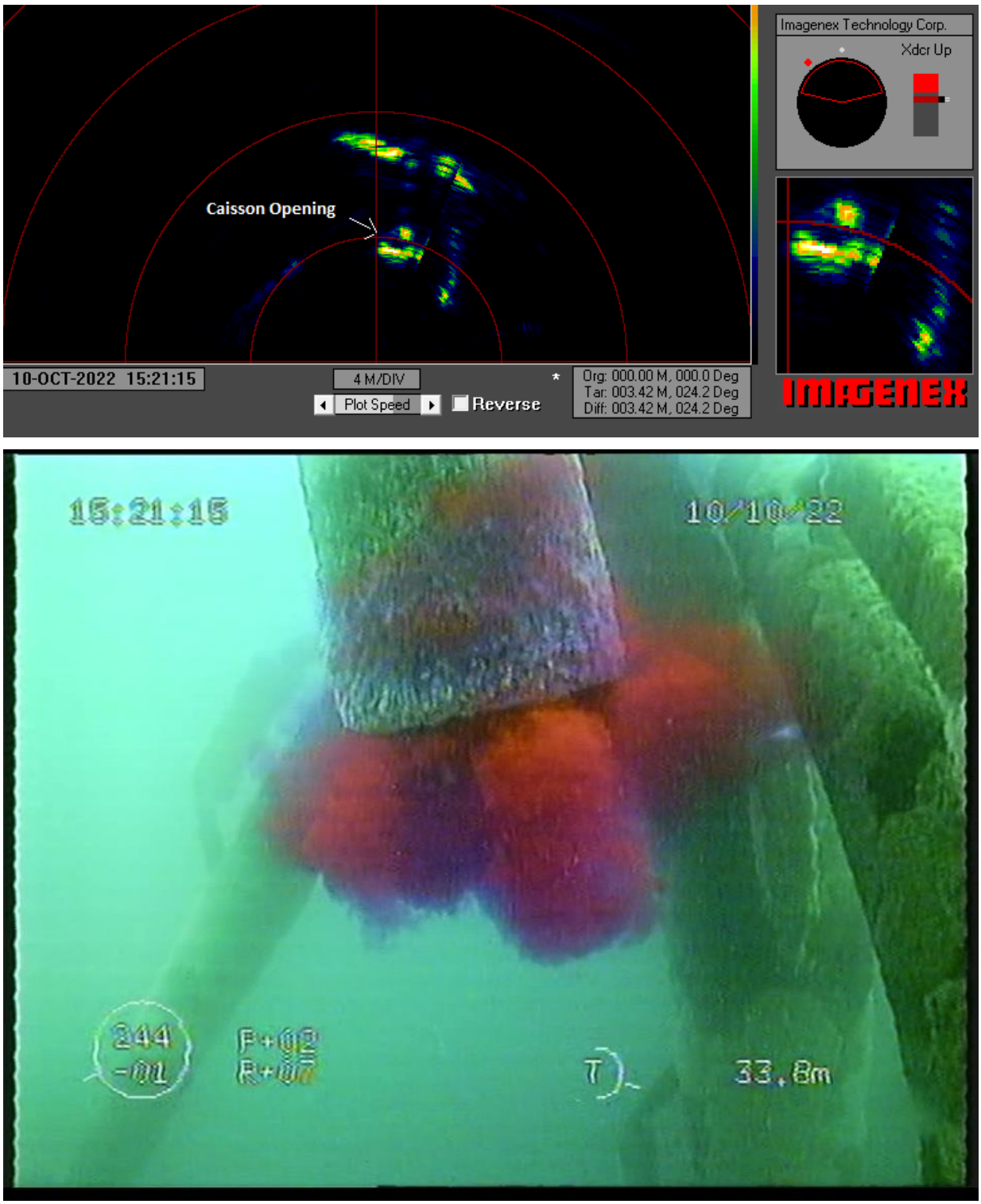


Figure 4 Screenshot of the sonar data alongside the ROV video feed used to determine distance from the caisson

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.

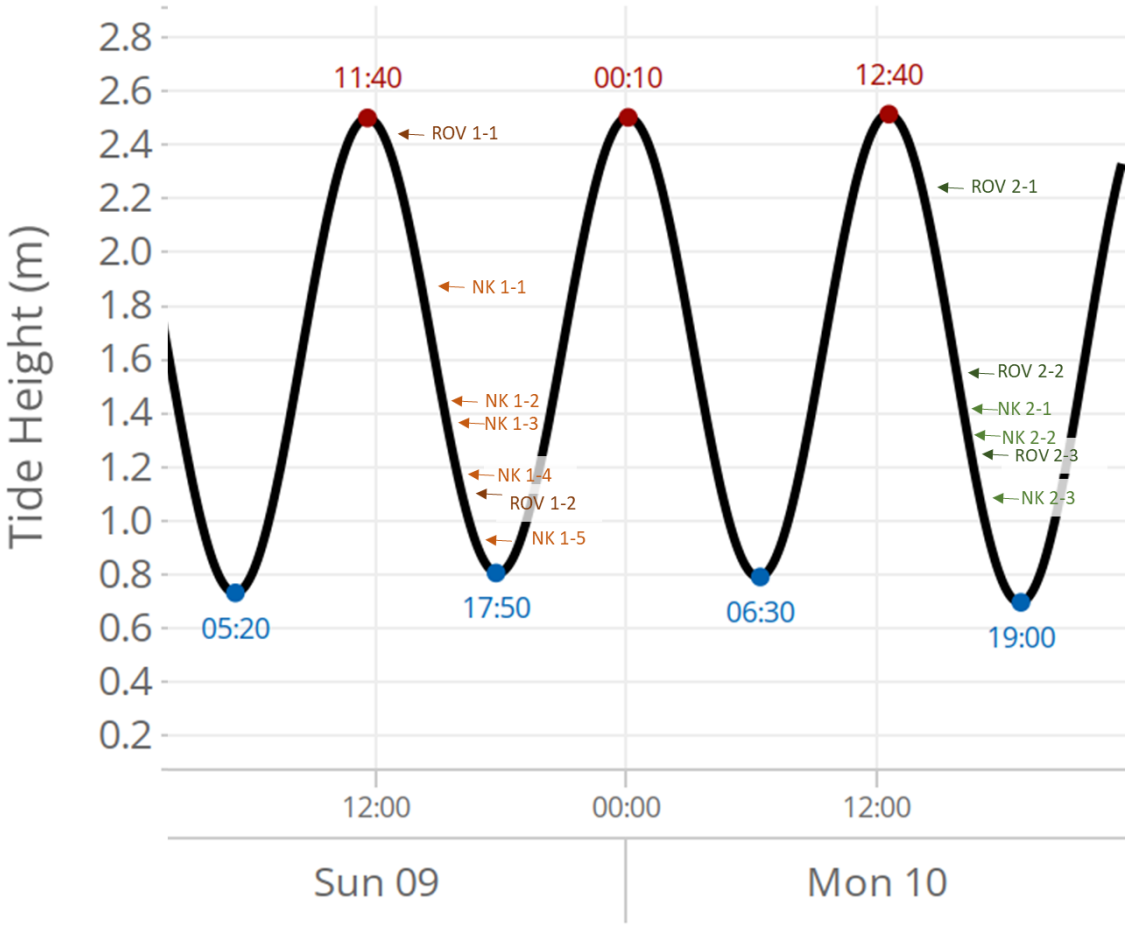


Figure 5 Timings for high and low water during the sample dates with the time points of when insitu samples were collected

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 (5th percentile) and high (95th percentile) current speed scenarios as presented in the 2017 near field modelling (Figure 2).

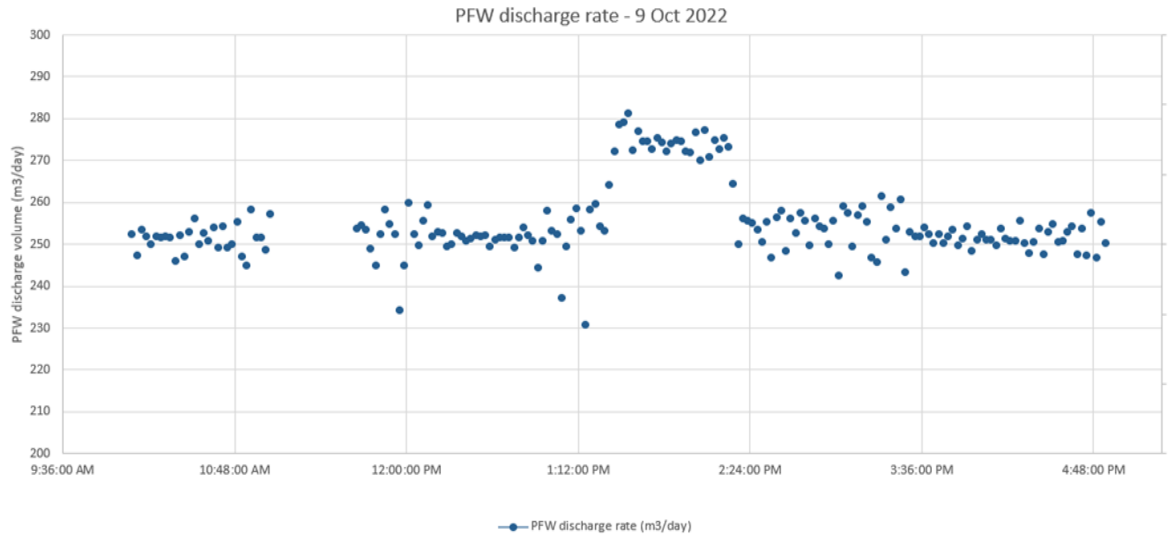


Figure 6 PFW discharge rate during Day 1 (9 October 2022)

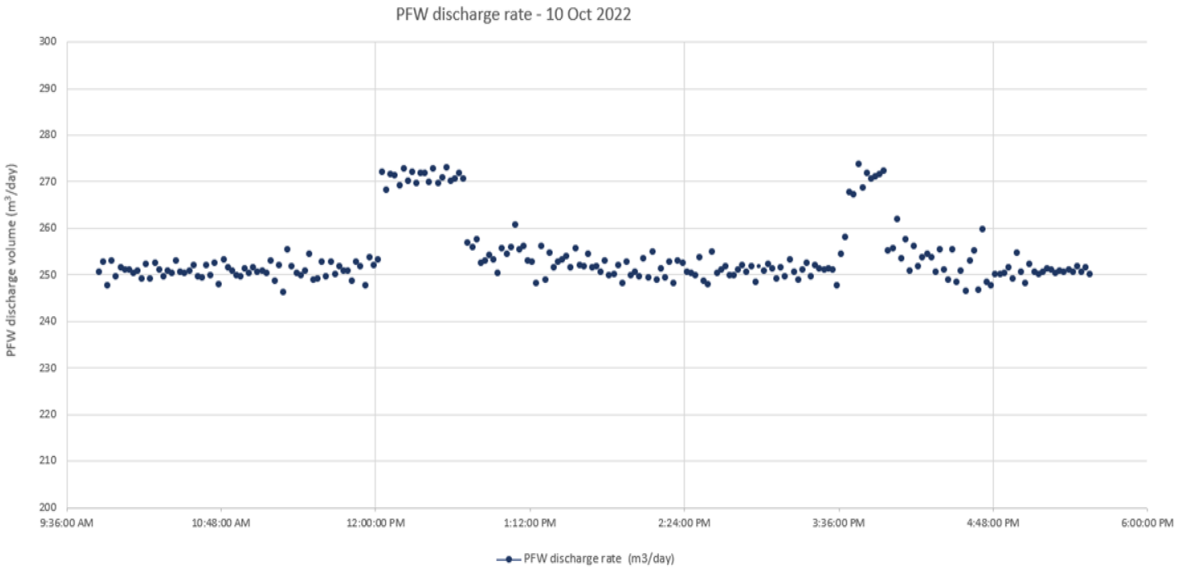


Figure 7 PFW discharge rate during Day 2 (10 October 2022)

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 (5th 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 (95th 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

		Distance from Caisson (m)	Depth (m)		Barium	
					ALS Results	MAFRL Results
				Units	µg/L	µg/L
Sample date	Sample ID			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						
		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 (F1)	>C10 - C16 Fraction	>C16 - C34 Fraction	>C34 - C40 Fraction	>C10 - C40 Fraction (sum)	>C10 - C16 Fraction minus Naphthalene (F2)
				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
Sample date	Sample ID			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
			Sample Time	<0.1 / <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
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
NK 1-3	9/10/2022	15	3:25 PM	1.2
NK 1-4	9/10/2022	20	4:10 PM	1.6
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
ROV 1-2	9/10/2022	15	4:20 PM	0.2

Number of dilutions#
-
2107
9658
7244
-
-
38633
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.

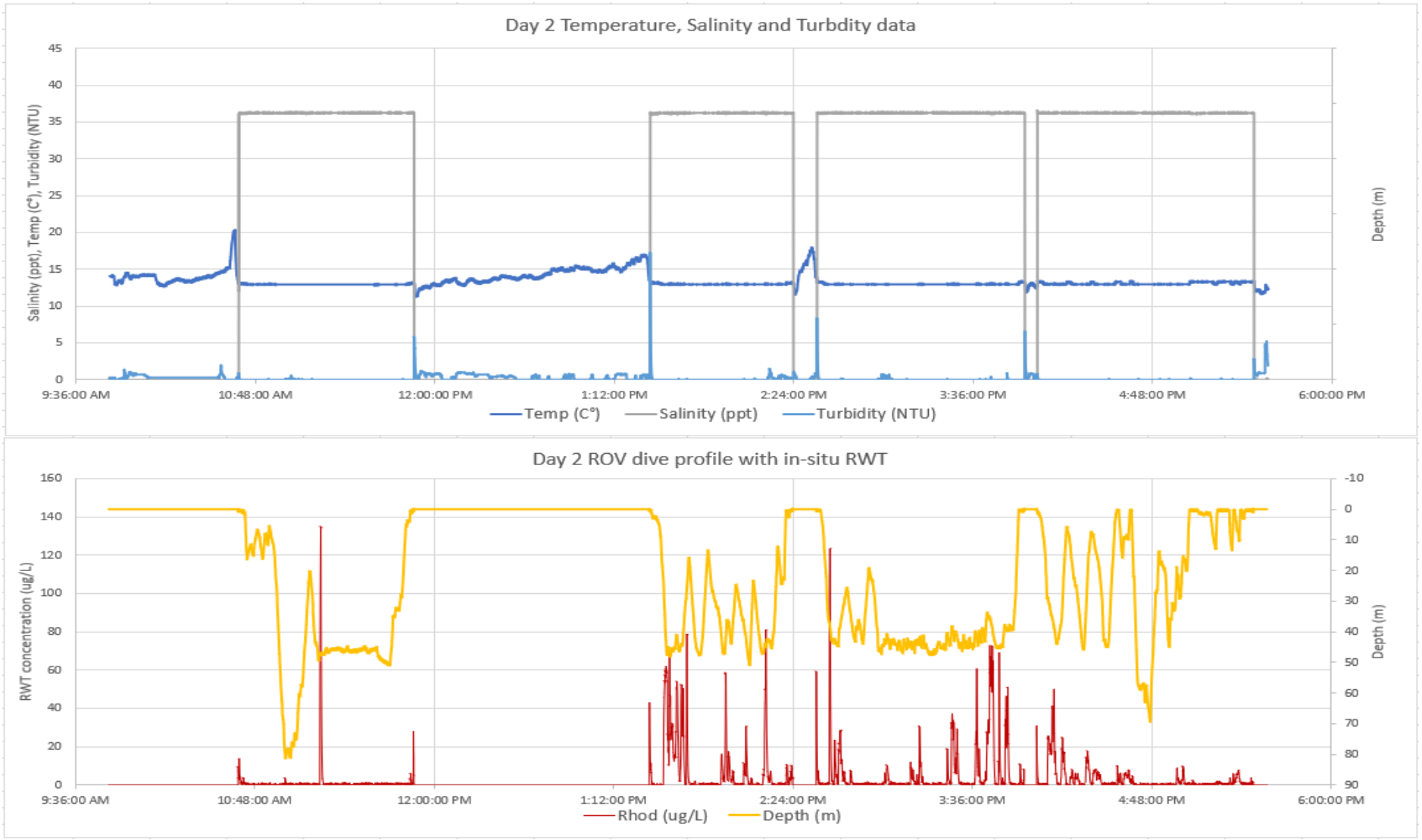


Figure 8 Day 2 Temperature, salinity and turbidity data (top) along with Day 2 ROV dive profile with measured insitu RWT concentrations (bottom)

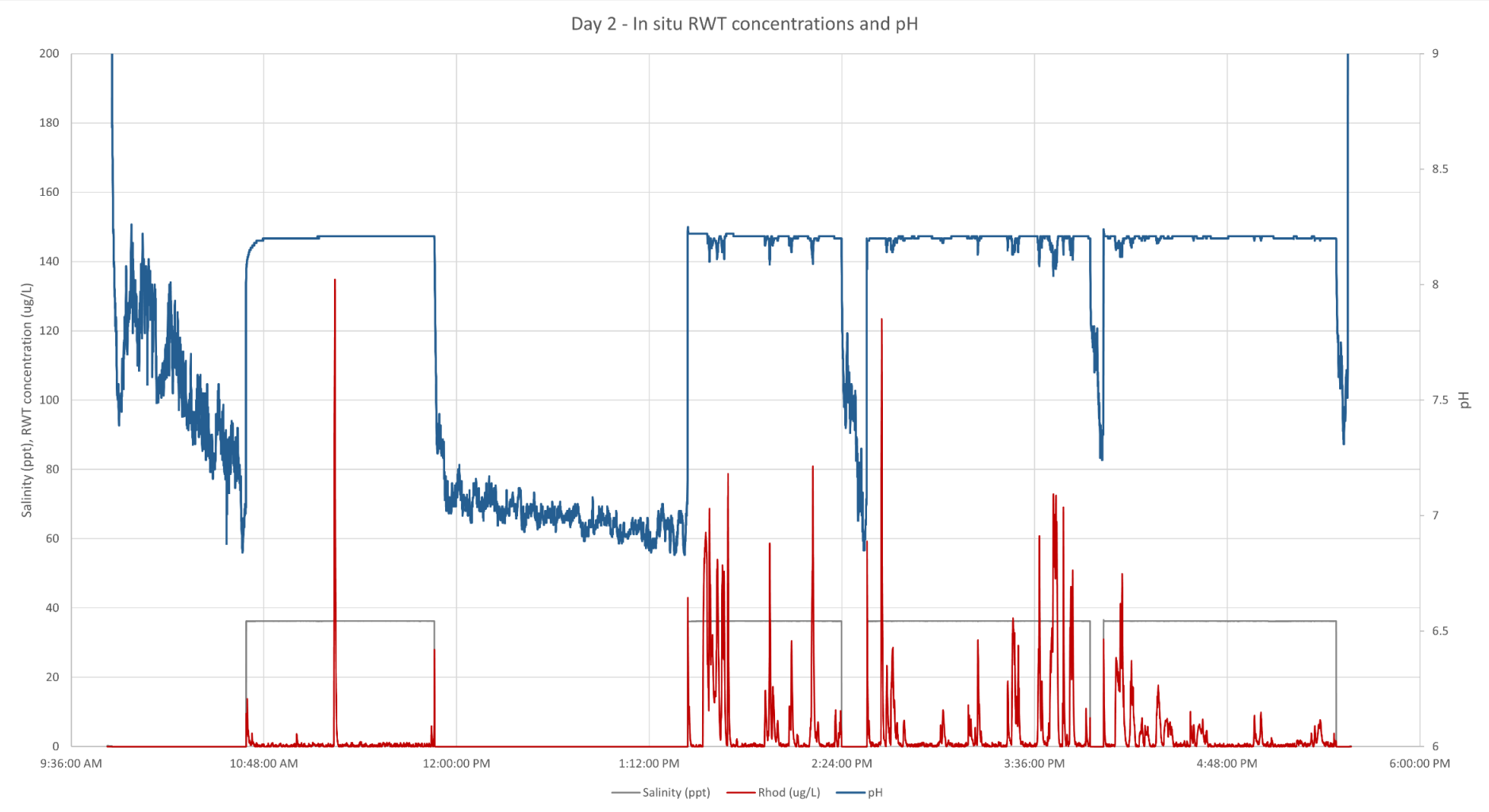


Figure 9 Day 2 insitu RWT concentrations and pH measurements

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 (5th percentile) and high current (95th percentile) results are shown along with a calculated 'average' curve based on the average of the 5th and 95th 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 (95th 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 5th 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 5th 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.

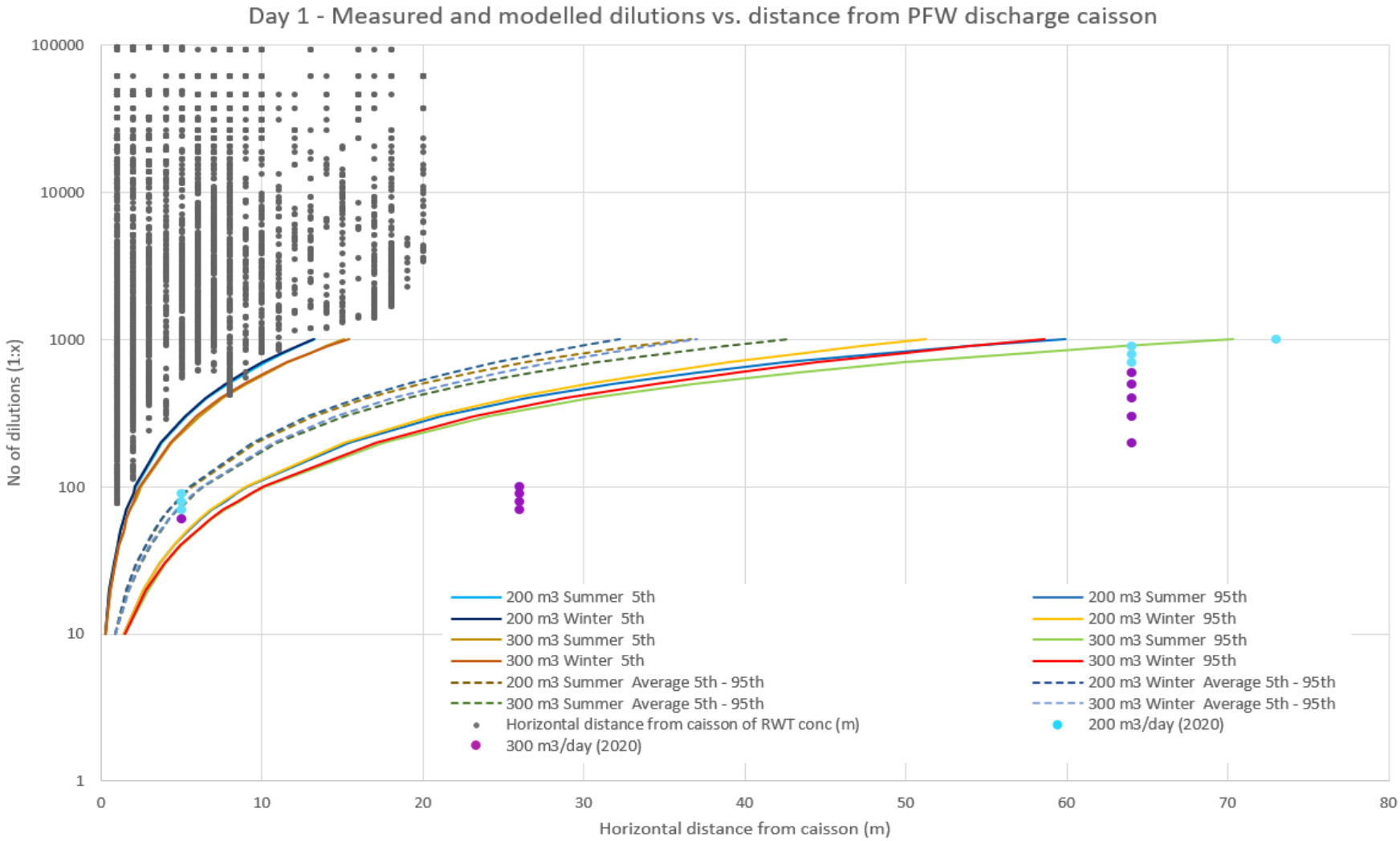


Figure 10 Day 1 Insitu RWT dilutions and 2017 and 2020 modelled dilutions, across horizontal distance from caisson

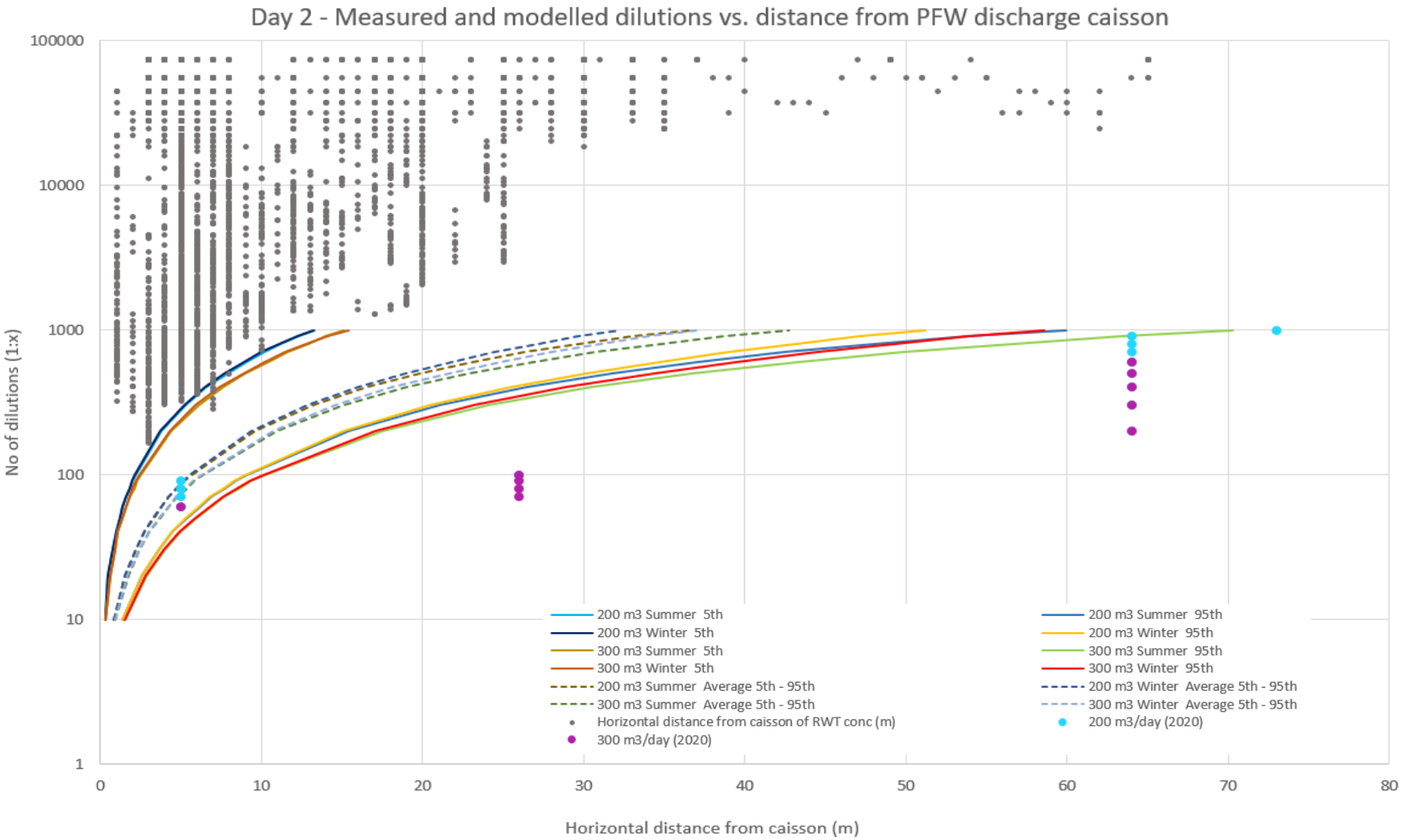


Figure 11 Day 2 Insitu RWT dilutions and 2017 and 2020 modelled dilutions, across horizontal distance from caisson

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 (5th percentile) current speed
- 200 m^3/day discharge rate during winter with high (95th percentile) current speed
- 200 m^3/day discharge rate during summer with low (5th percentile) current speed
- 200 m^3/day discharge rate during summer with high (95th percentile) current speed
- 300 m^3/day discharge rate during winter with low (5th percentile) current speed
- 300 m^3/day discharge rate during winter with high (95th percentile) current speed
- 300 m^3/day discharge rate during summer with low (5th percentile) current speed
- 300 m^3/day discharge rate during summer with high (95th 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 SAMPLE CODE	Sampling Date	Sampling Time	Low Range/Marine Water Rhodamine µg/L	High Range/Wastewater Rhodamine 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.

This document may not be reproduced except in full.

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 SAMPLE CODE	Sampling Date	Sampling Time	Low Range/Marine Water Rhodamine µg/L	High Range/Wastewater Rhodamine 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.
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

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 SAMPLE CODE	Sampling Date	MS001 Unfiltered Ba 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)

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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	108-38-3 106-42-3	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	205-99-2 205-82-3	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	205-99-2 205-82-3	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: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Days overdue	Analysis: Date analysed	Analysis: Due for analysis	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: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
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 →**

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8161 7133 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

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TOWNSVILLE 14-15 Desma Court Garbutt QLD 4814 Ph: 07 4796 0600 E: townsville@alsglobal.com

WAGGA WAGGA 1/19-21 Rylah Place NSW Australia 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):**		
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COC SEQUENCE NUMBER (Circle)

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

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DATE/TIME:	DATE/TIME: 11/10/22 17:38	DATE/TIME:	DATE/TIME:

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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
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	ROV 1-2	4:20:00 PM	9/10/2022			5	X	X	X	X	X				Samples may also contain traces of Rhodamine WT
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	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;

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EM2219948



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CLIENT: AECOM	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	X Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: WA		☐ 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	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7
PROJECT MANAGER: Marthin Slabber	**CONTACT PH:** 0430 111 569		OF: 1 2 3 4 5 6 7
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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
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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
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APPENDIX 10

MAKING COMPLEX EASY

A TETRA TECH COMPANY

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 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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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.

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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

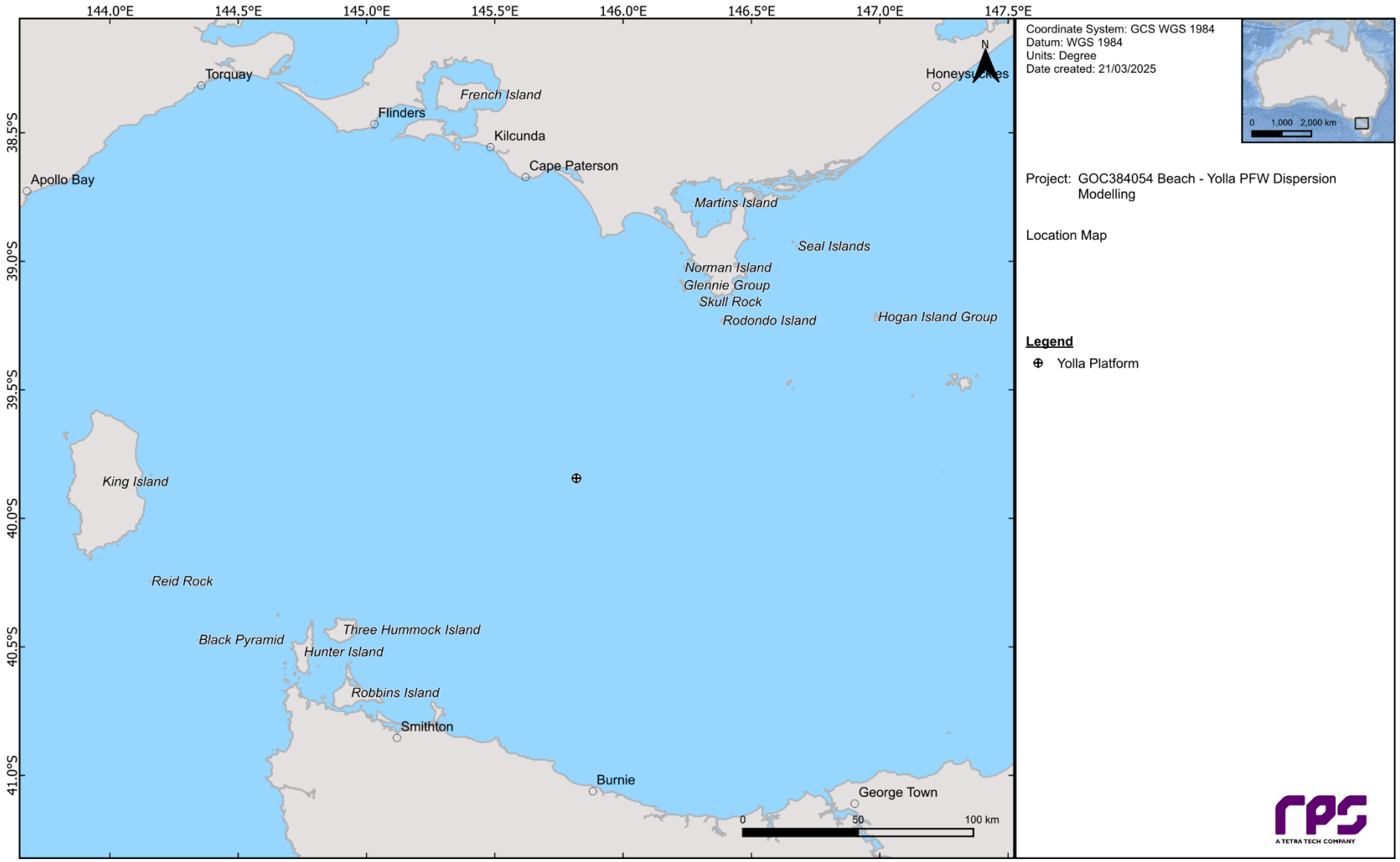


Figure 1-1 Location of the Yolla Platform.

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.

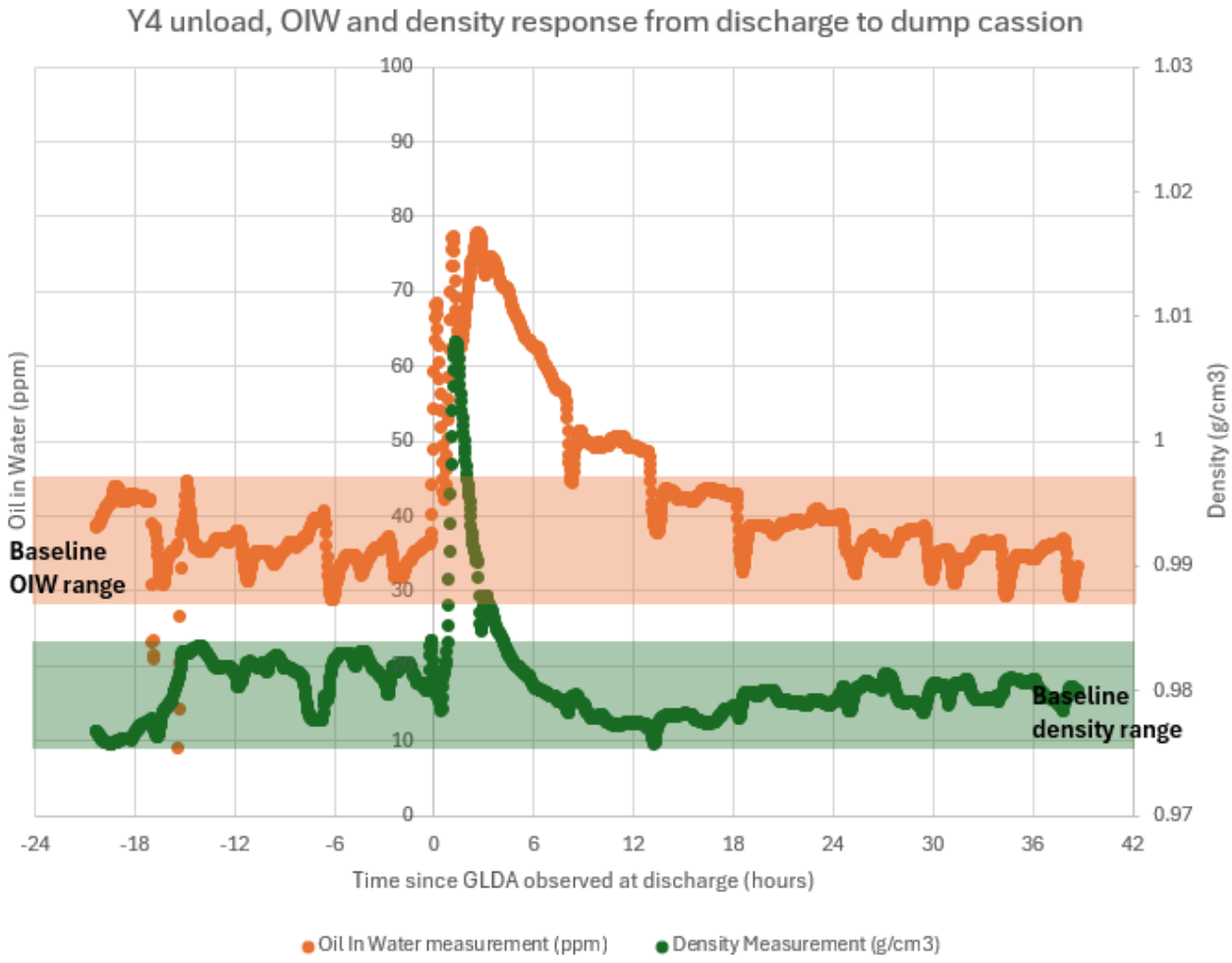


Figure 3-1 Time-series of density and oil in water measurements taken in the PFW outlet during normal and descaling activities. Image provided by Beach.

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.

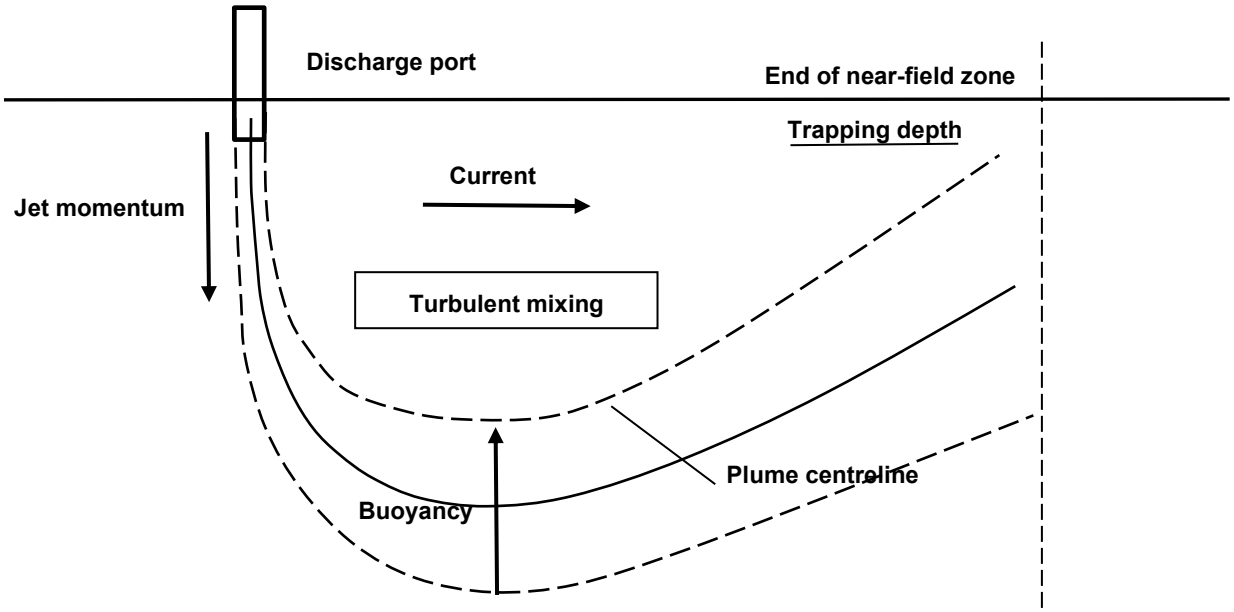


Figure 4-1 Conceptual diagram showing the general behaviour of a positively buoyant discharge discharged vertically into receiving water moving due to current.

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

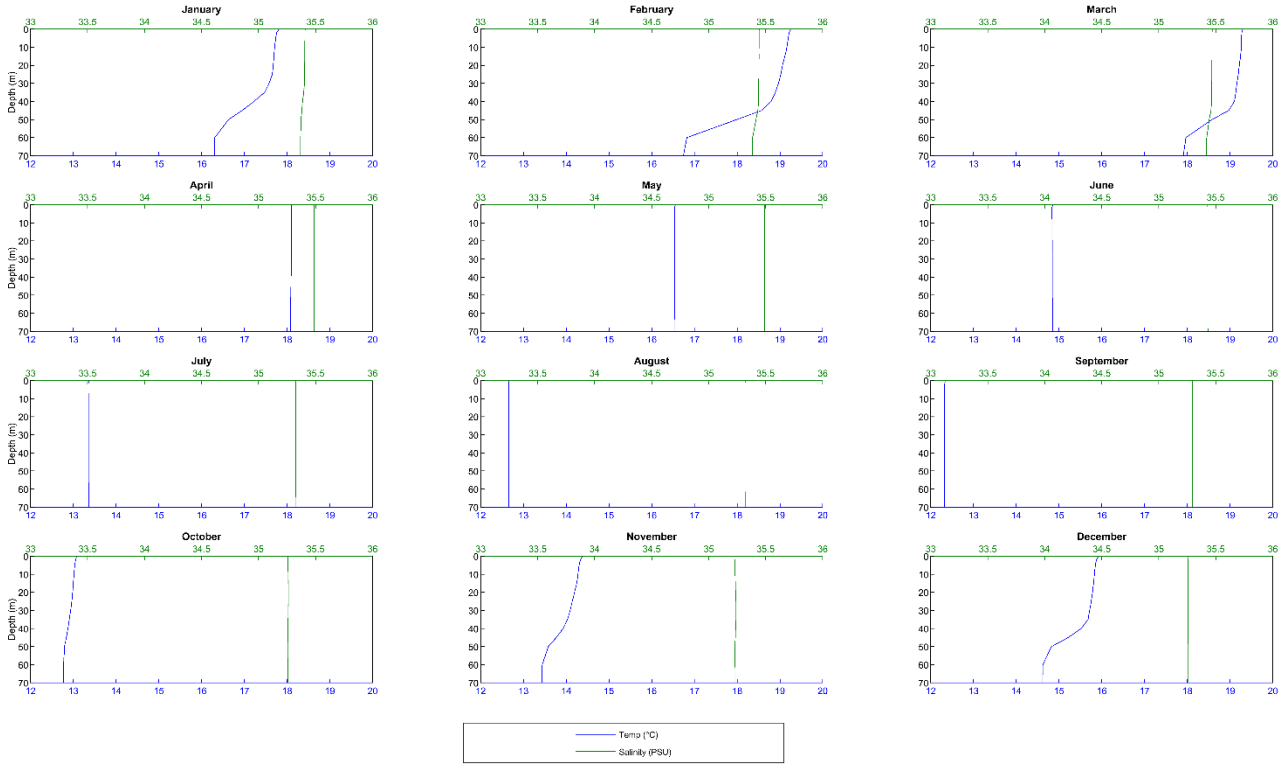


Figure 4-2 Monthly salinity and temperature profiles at the Yolla Platform

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 5th, 50th and 95th 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:

- 5th percentile current speed: weak currents, low dilution and slow advection.
- 50th percentile (median) current speed: average currents, moderate dilution and advection.
- 95th percentile current speed: strong currents, high dilution and rapid advection to nearby areas.

The 5th, 50th and 95th 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	5th Percentile (Weak) Current Speed (m/s)	50th Percentile (Medium) Current Speed (m/s)	95th 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 95th percentile dilution over time.

The 95th 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 95th 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.

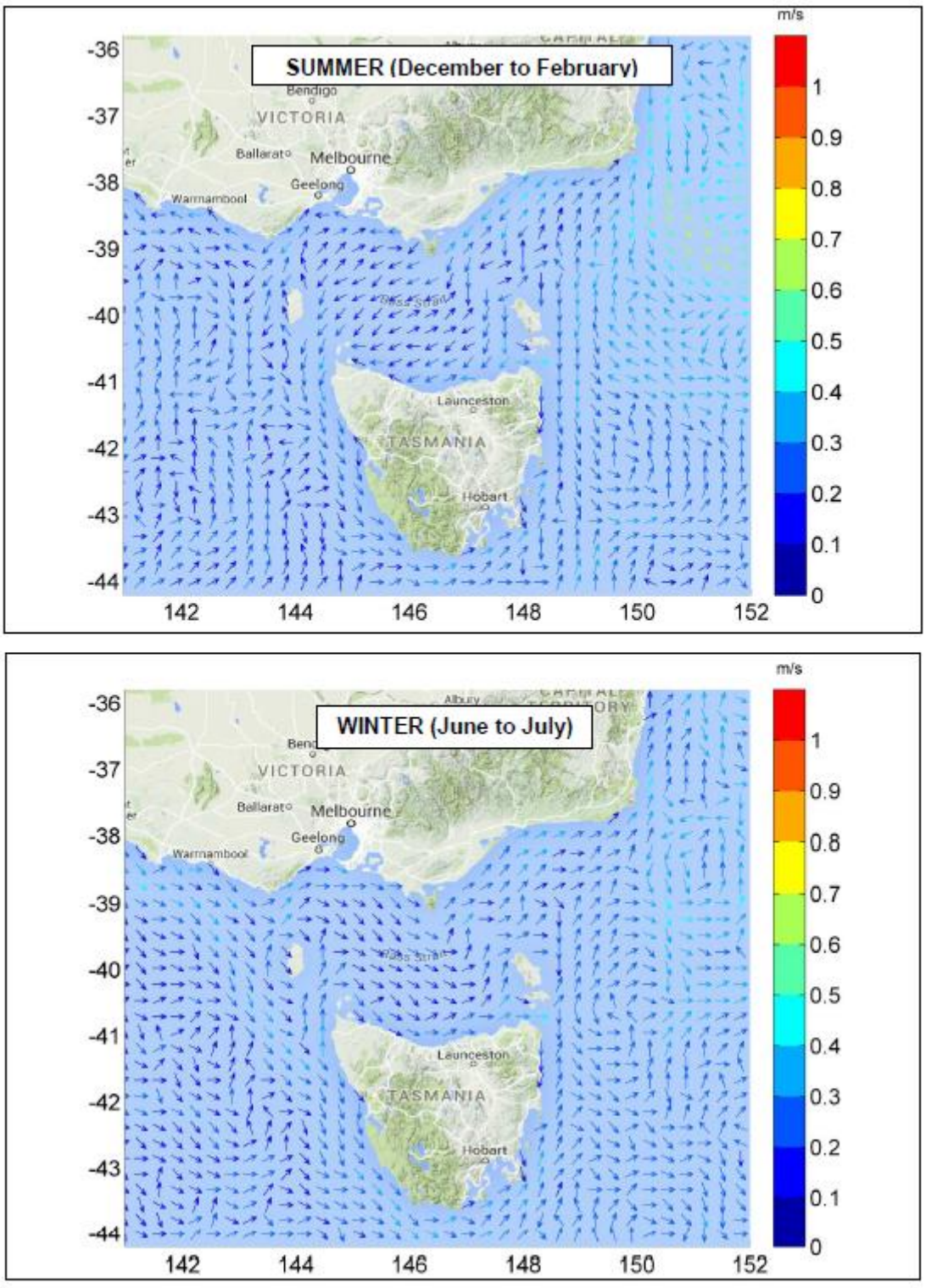


Figure 4-3 Example HYCOM averaged seasonal surface drift currents during summer (top) and winter (bottom).

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).

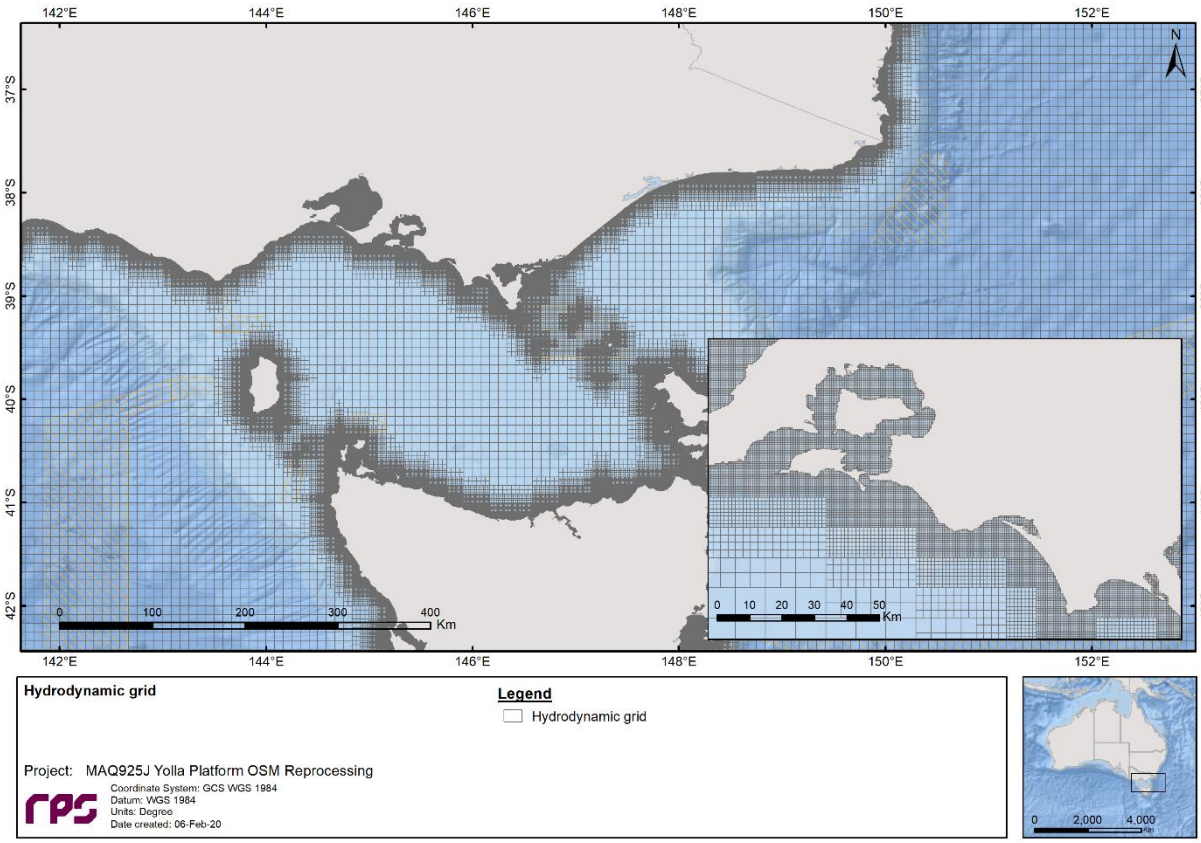


Figure 4-4 Zoomed in view of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

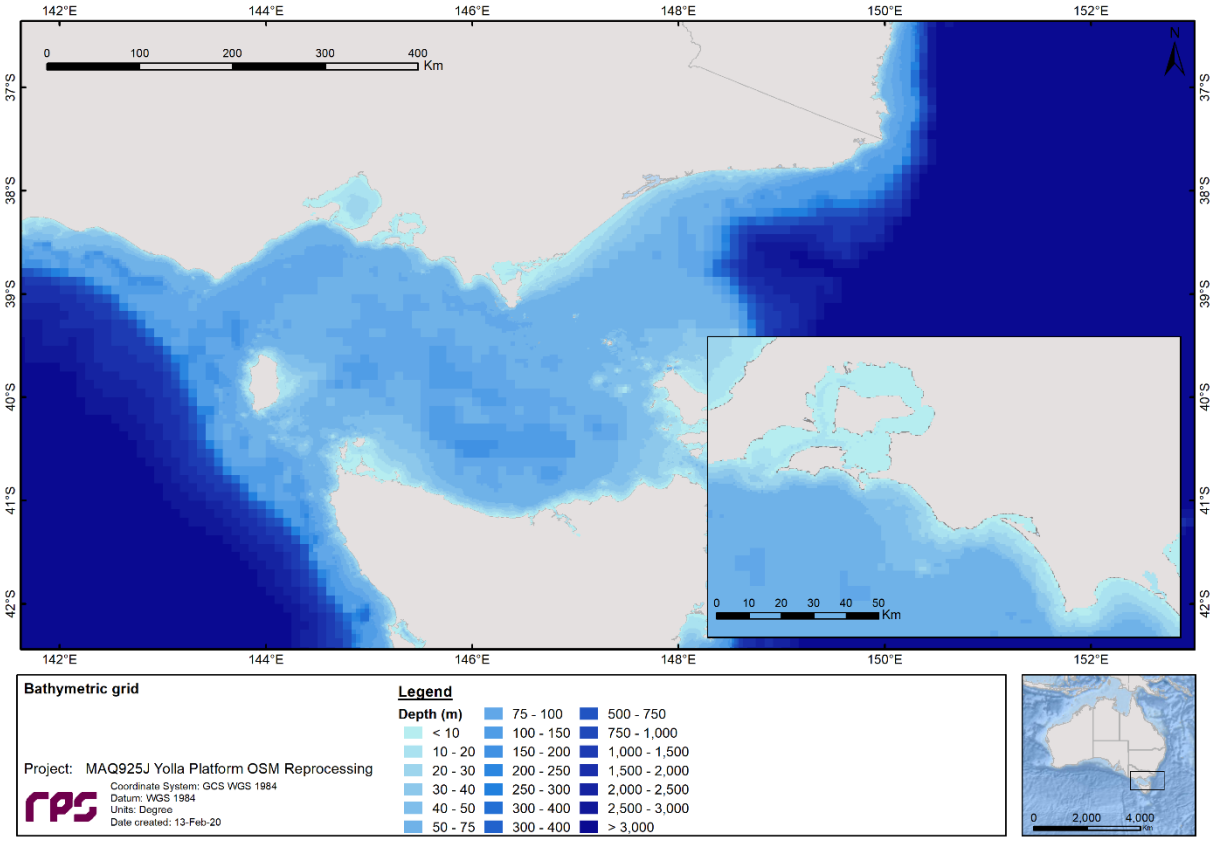


Figure 4-5 Bathymetry defined throughout the tidal model domain.

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 (1/12th 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**	-

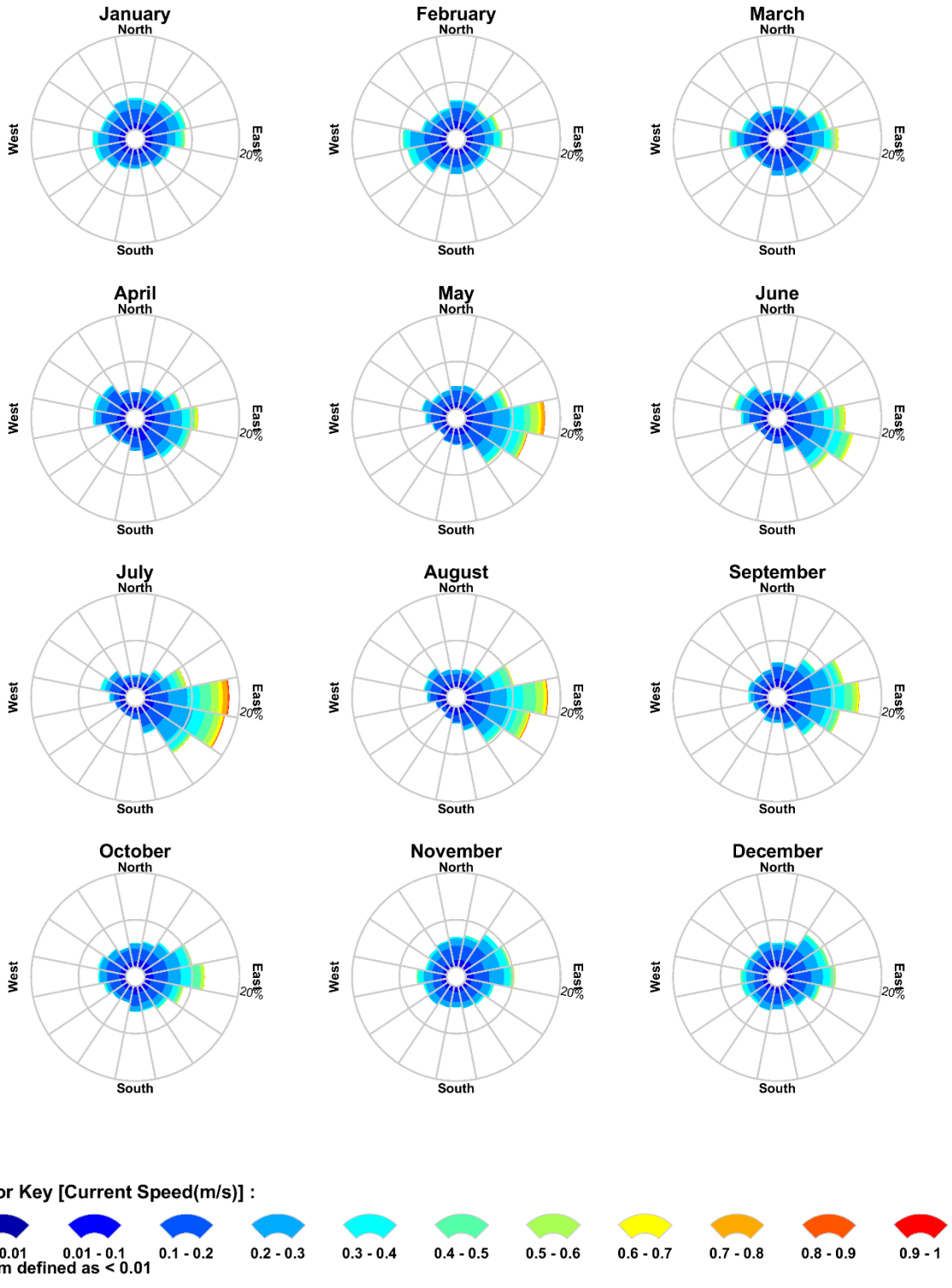


Figure 4-6 Monthly surface current rose distributions at the release location derived from the 2010 to 2019 modelled dataset.

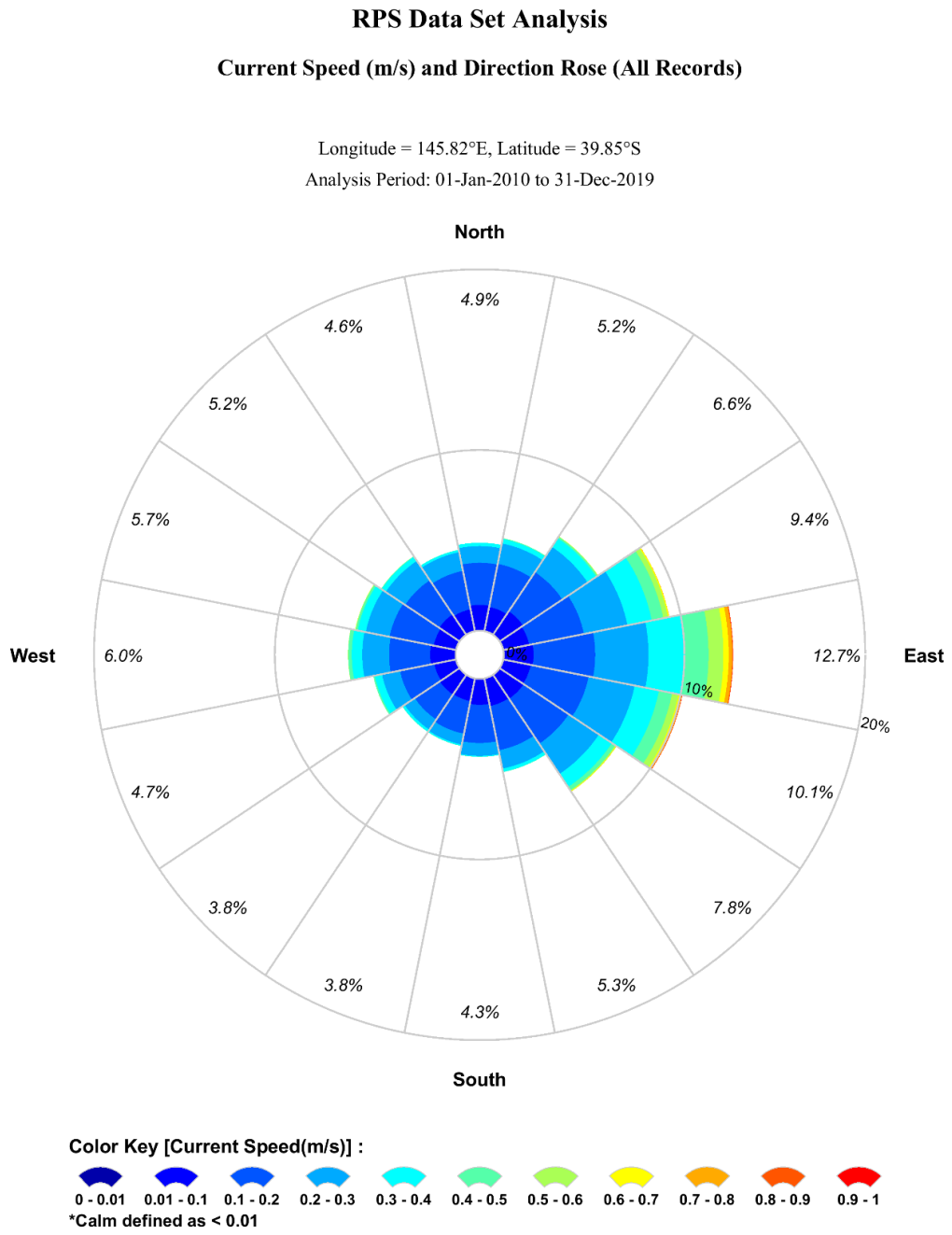


Figure 4-7 Total surface current rose plot at the release location derived from the 2010 to 2019 modelled dataset.

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

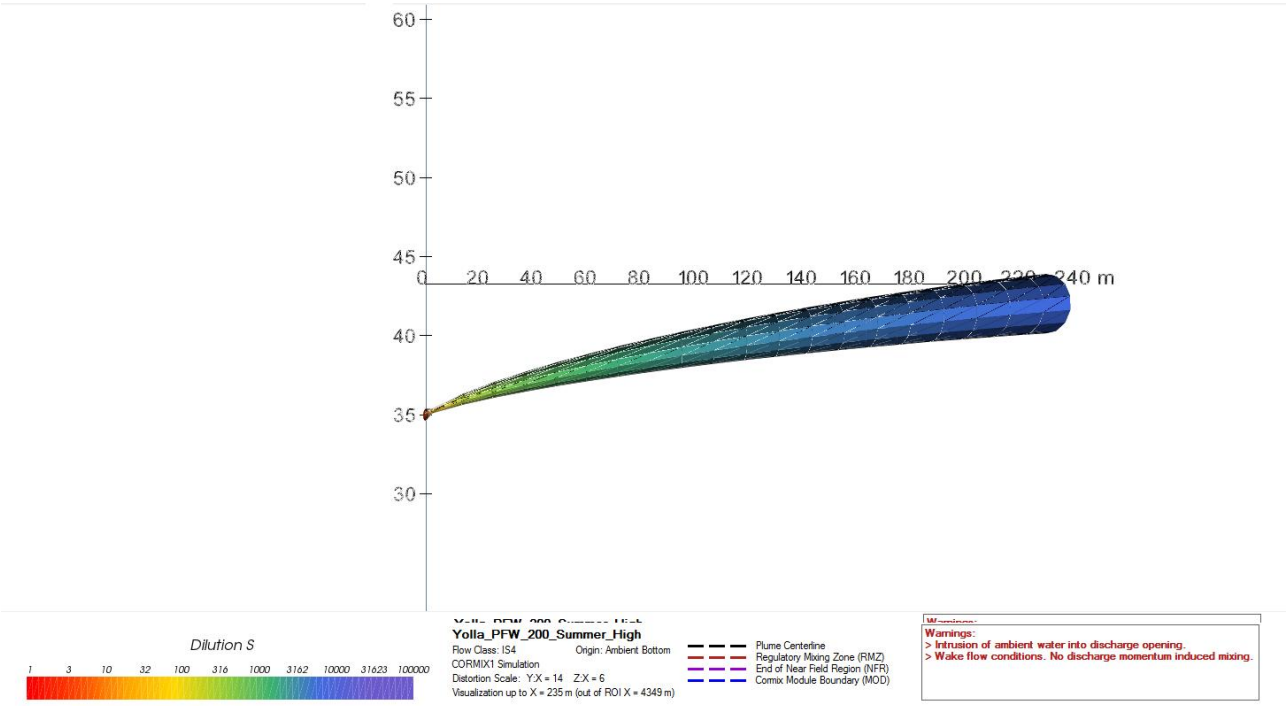


Figure 5-1 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

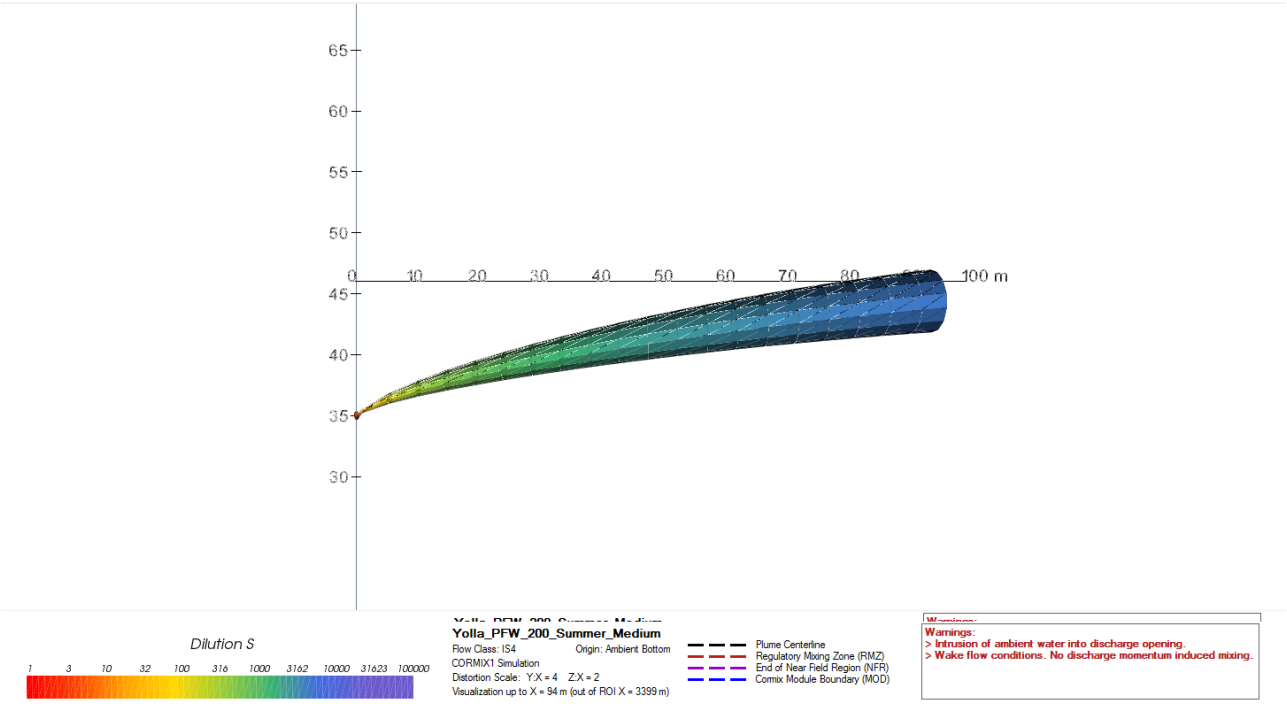


Figure 5-2 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

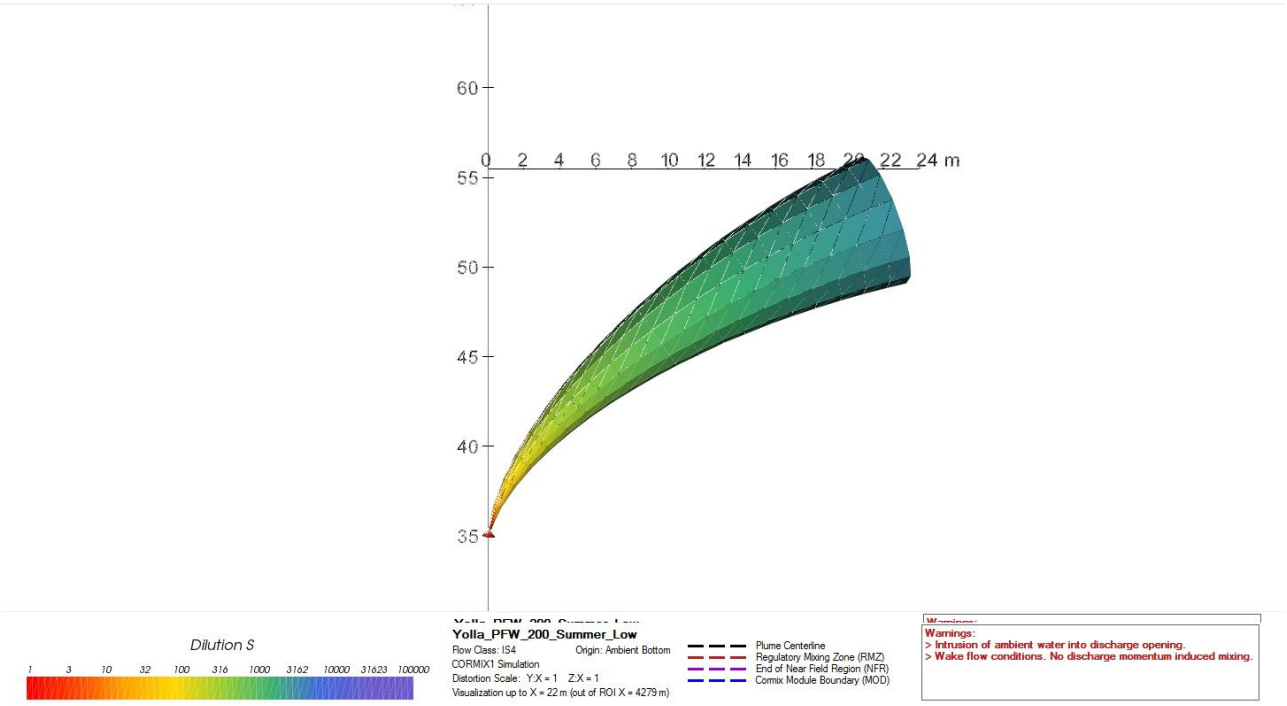


Figure 5-3 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 200 m³/d at discharge height of 45 m below the sea surface.

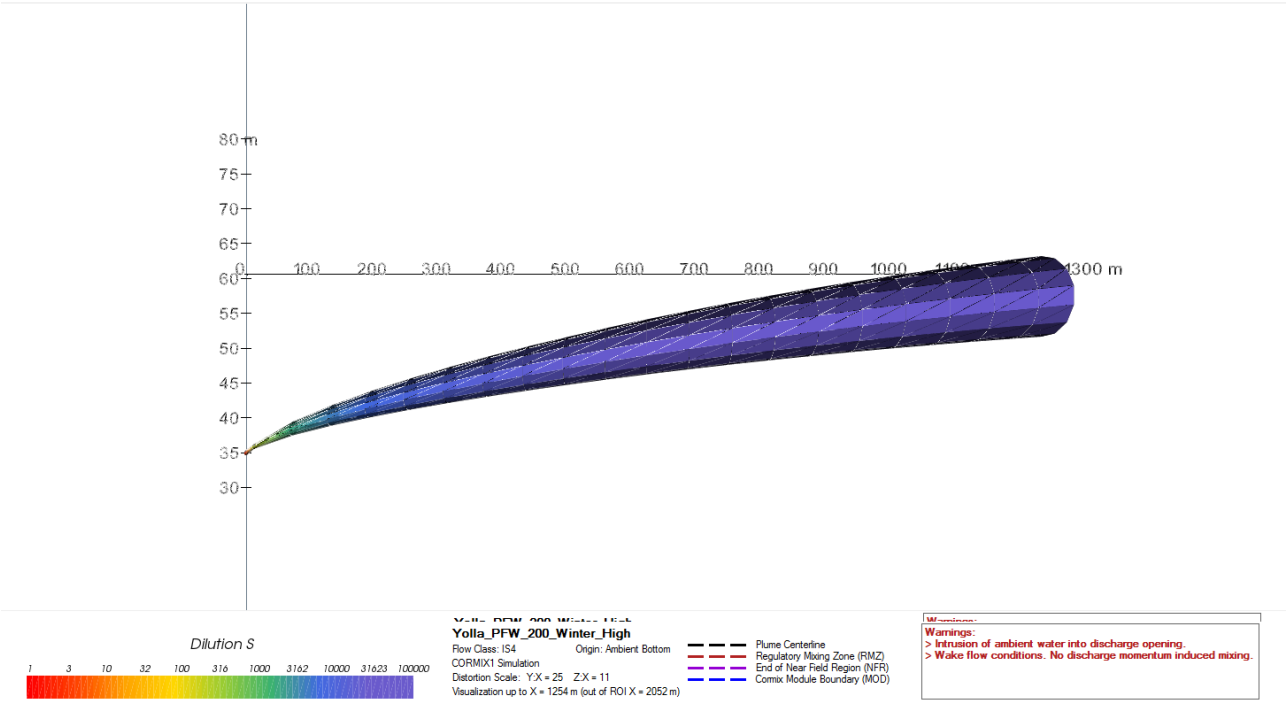


Figure 5-4 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 200 m³/d at discharge height of 45 m below the sea surface.

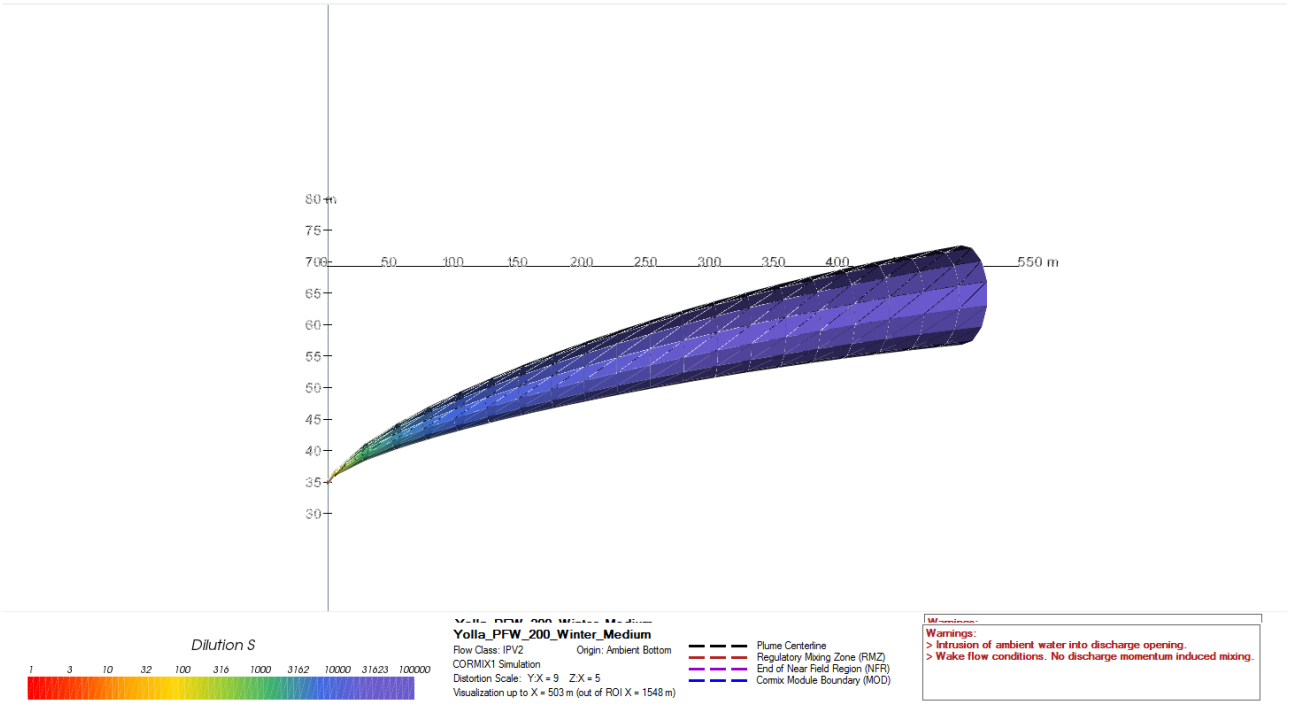


Figure 5-5 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

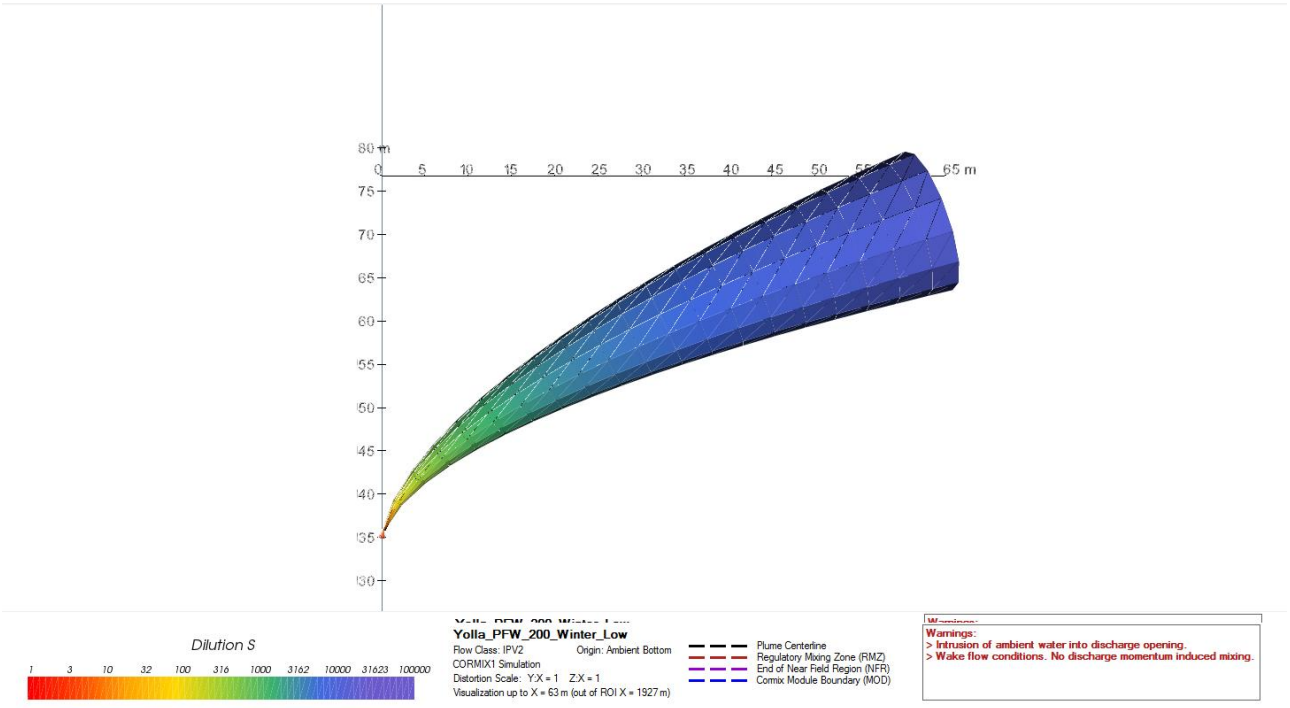


Figure 5-6 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

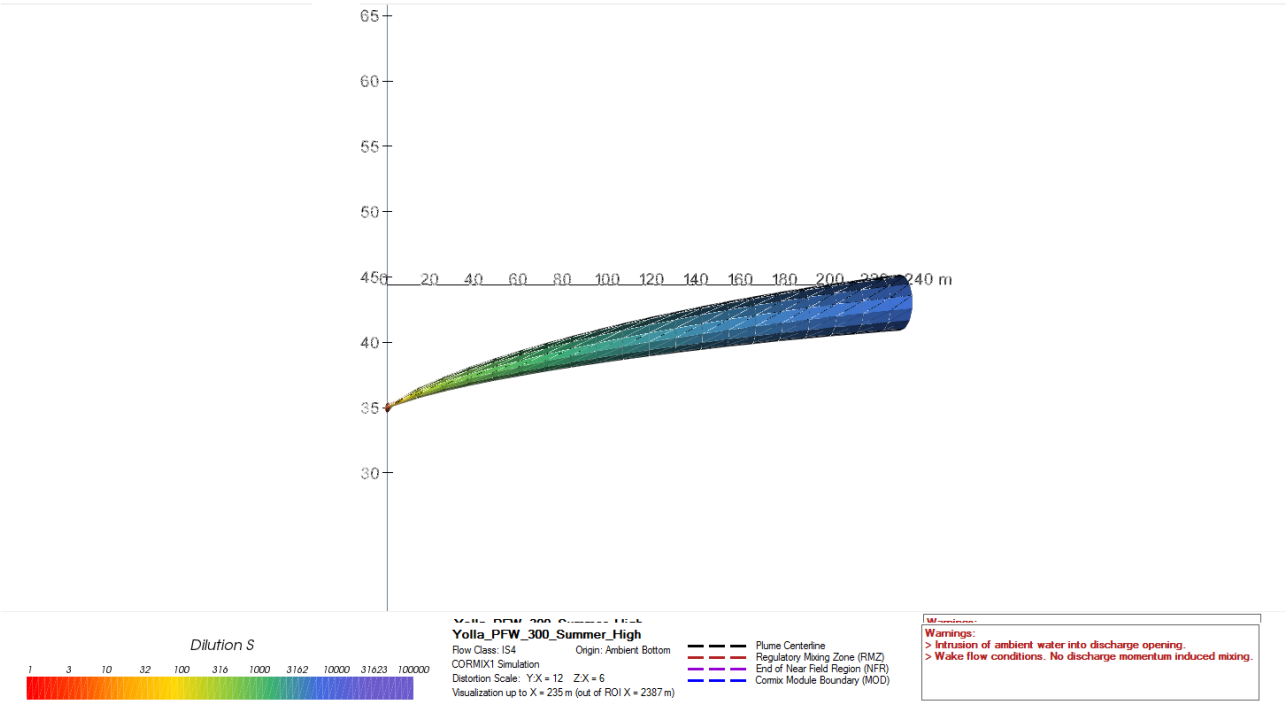


Figure 5-7 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 300 m^3/d at discharge height of 45 m below the sea surface.

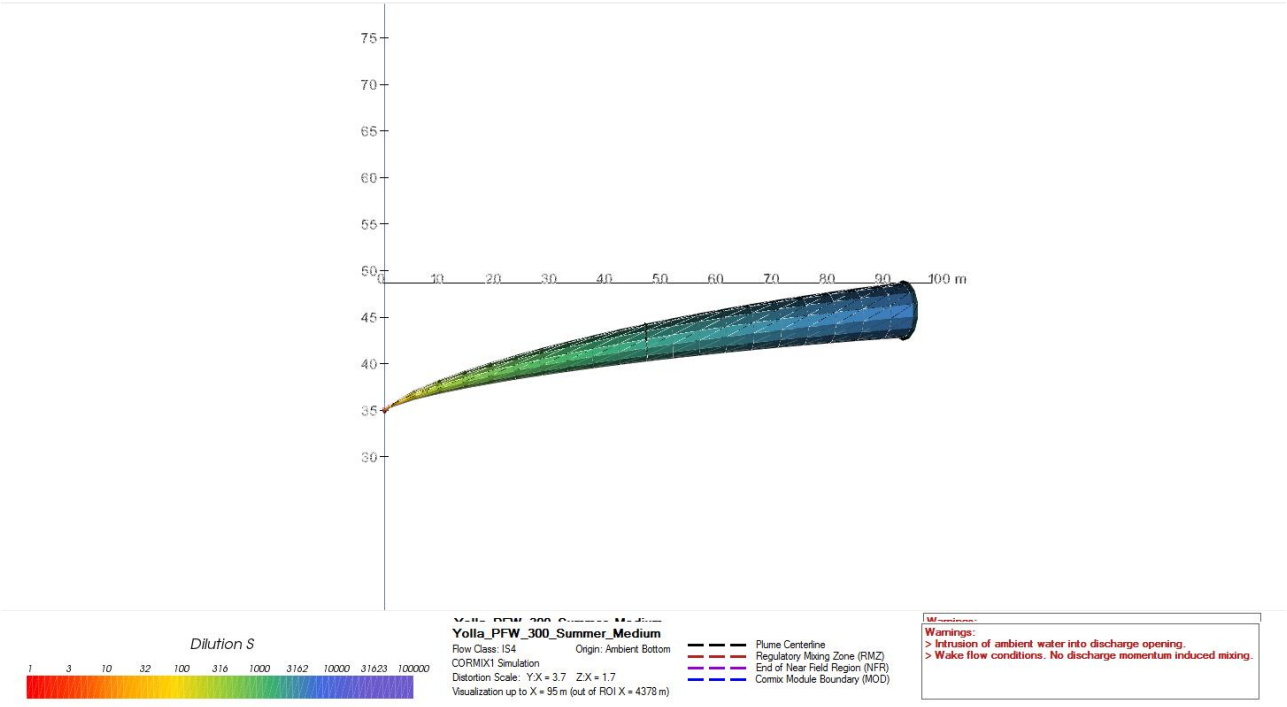


Figure 5-8 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 300 m^3/d at discharge height of 45 m below the sea surface.

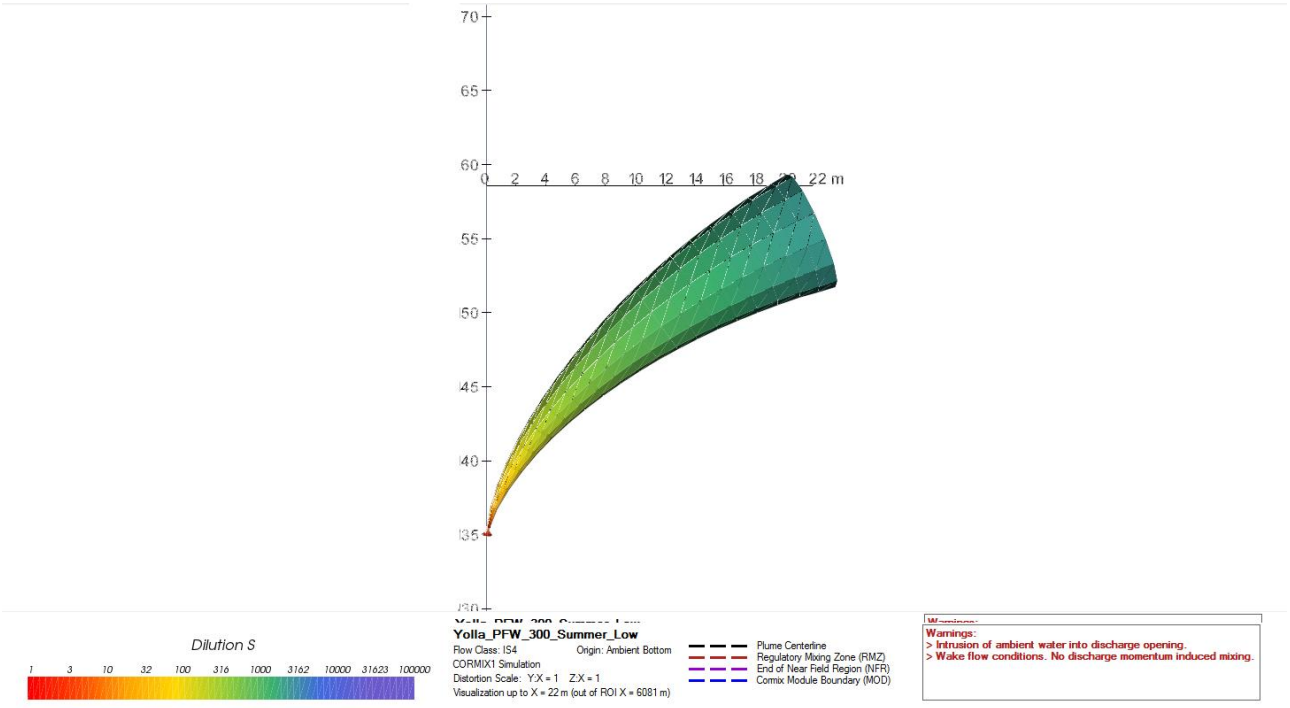


Figure 5-9 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

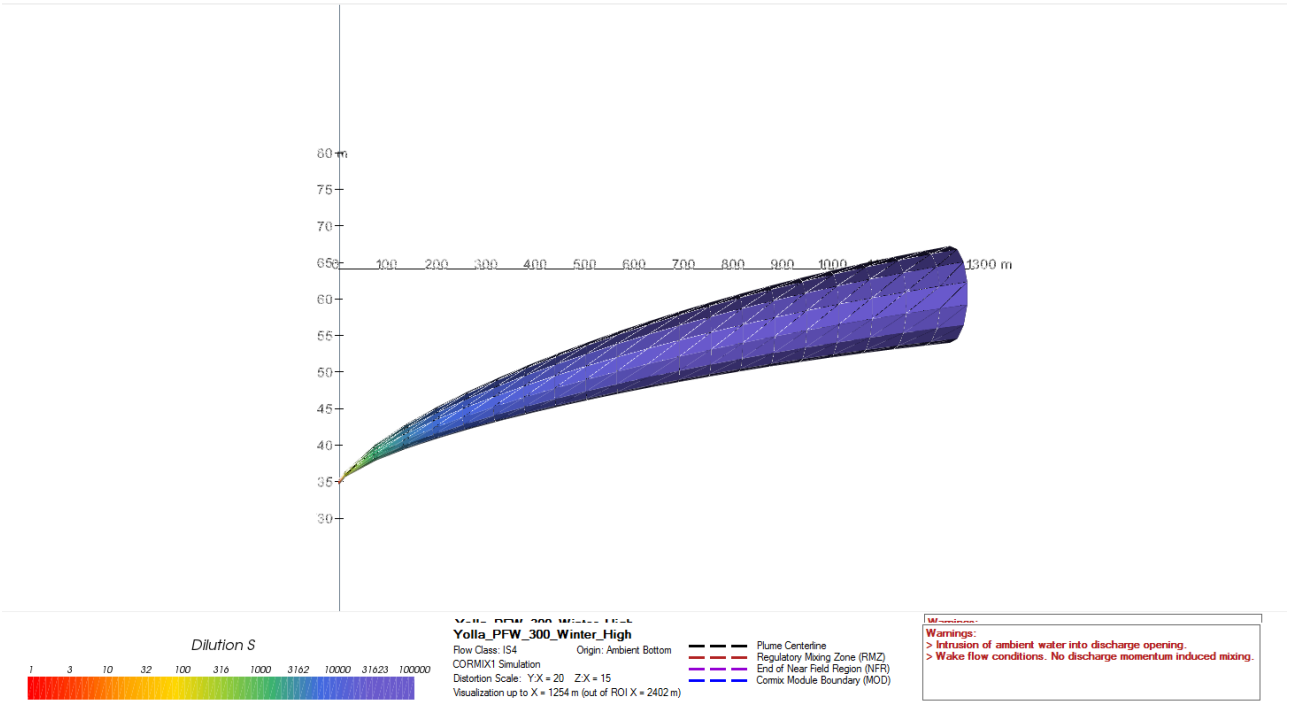


Figure 5-10 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

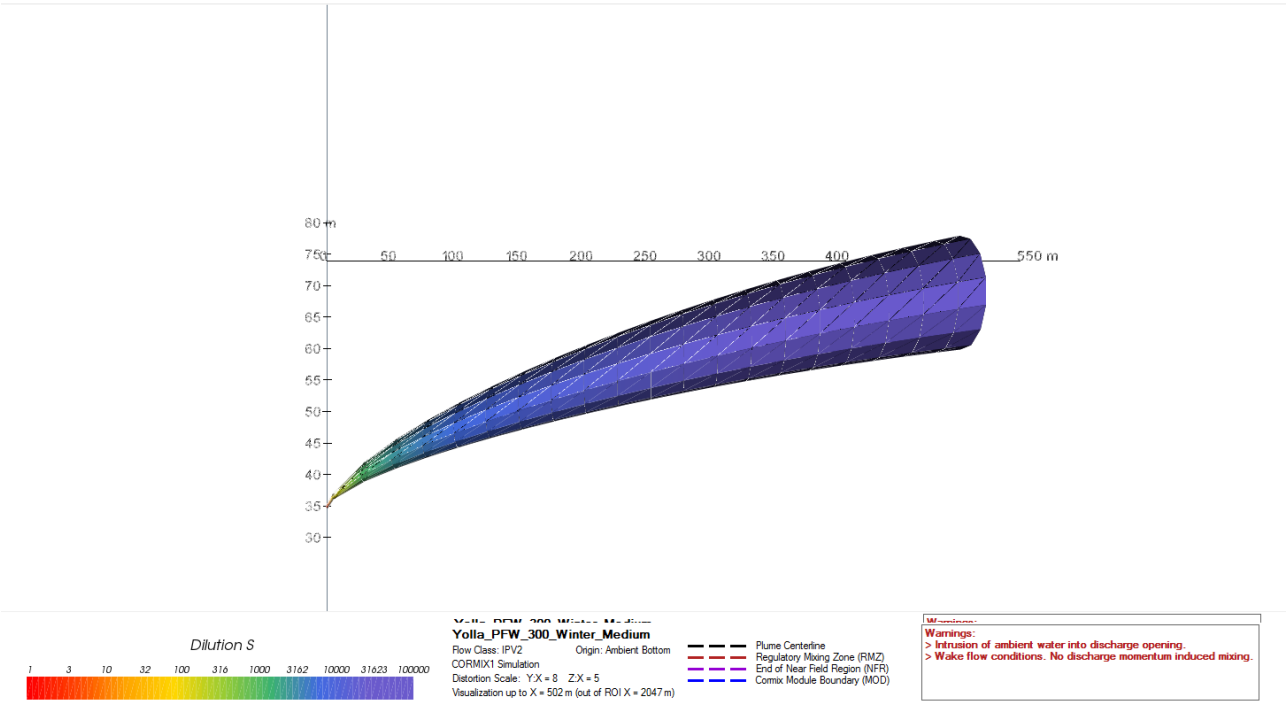


Figure 5-11 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 300 m^3/d at discharge height of 45 m below the sea surface.

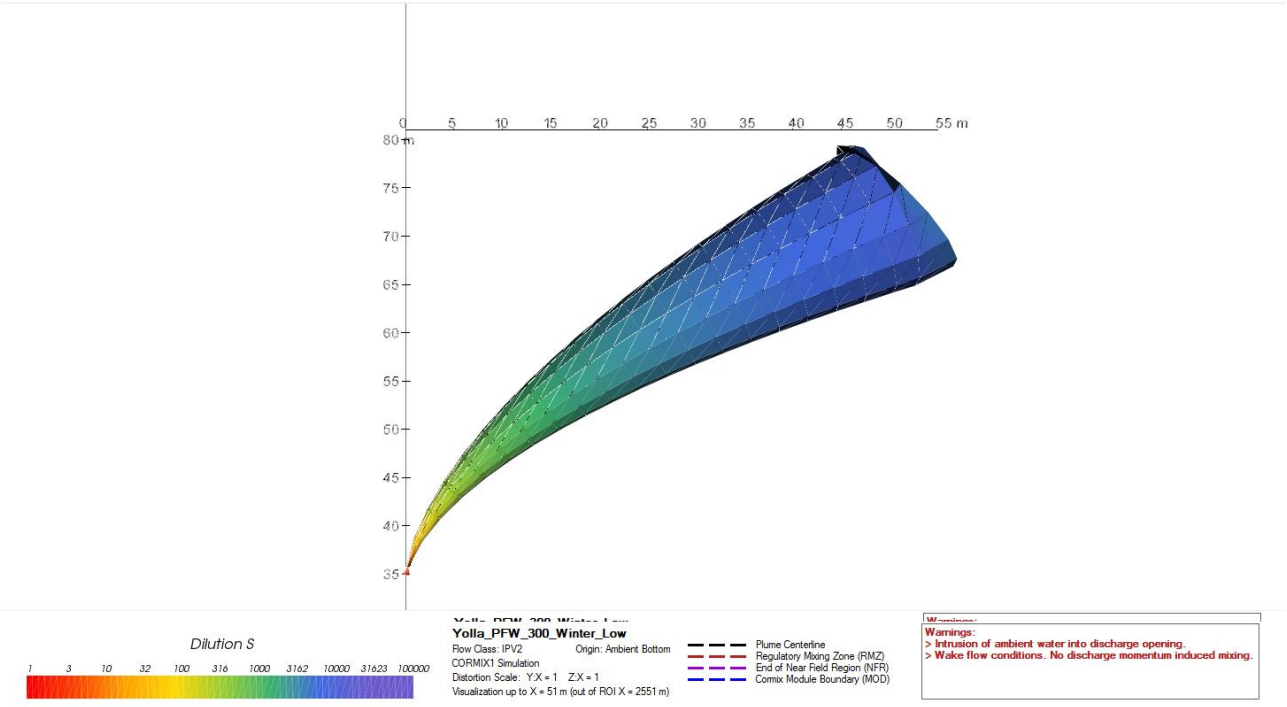


Figure 5-12 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 300 m^3/d at discharge height of 45 m below the sea surface.

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 95th 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 95th 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)
95th 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

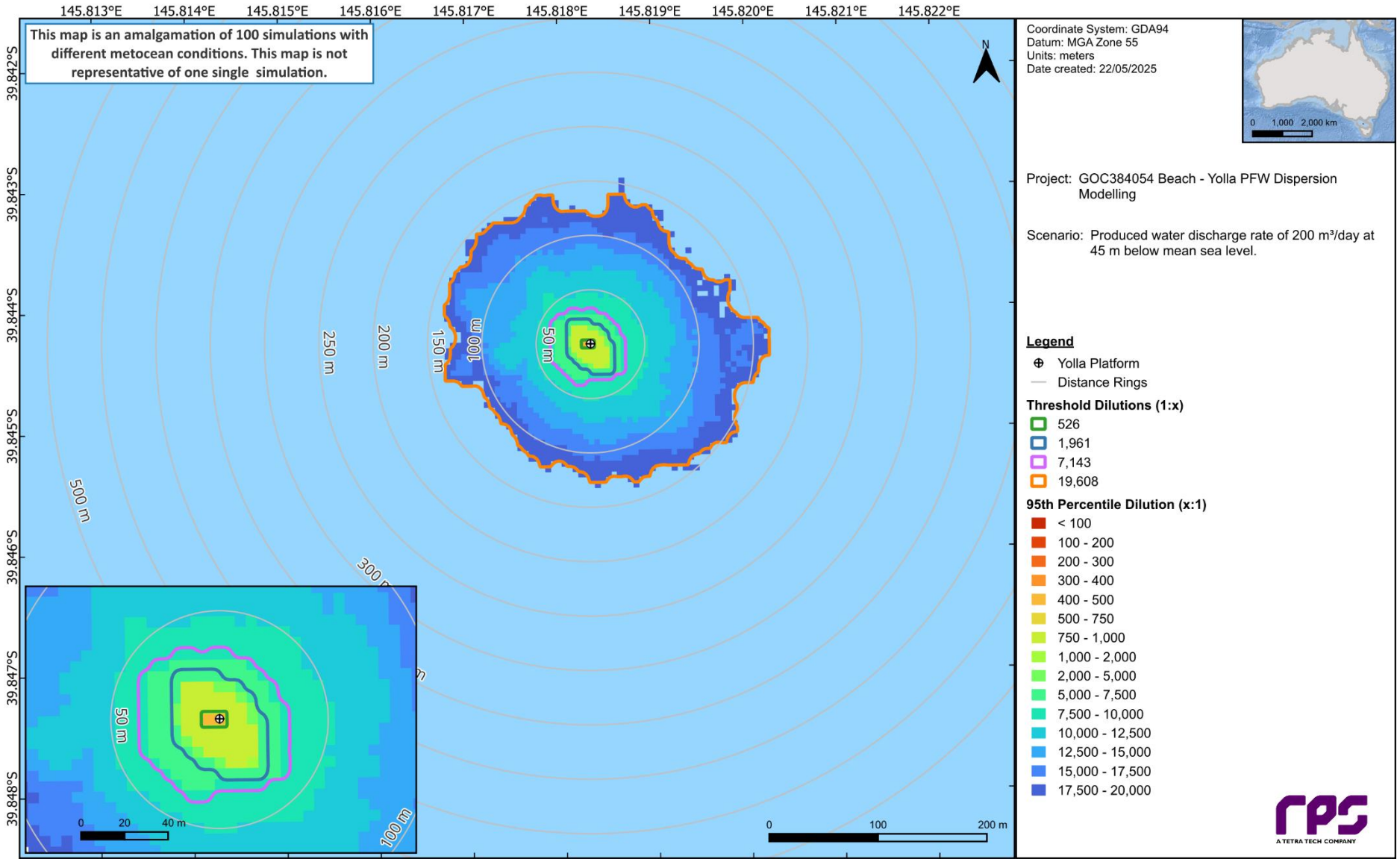


Figure 5-13 95th percentile dilution for a PFW discharge at 200 m³/d. Results refer to annual conditions.

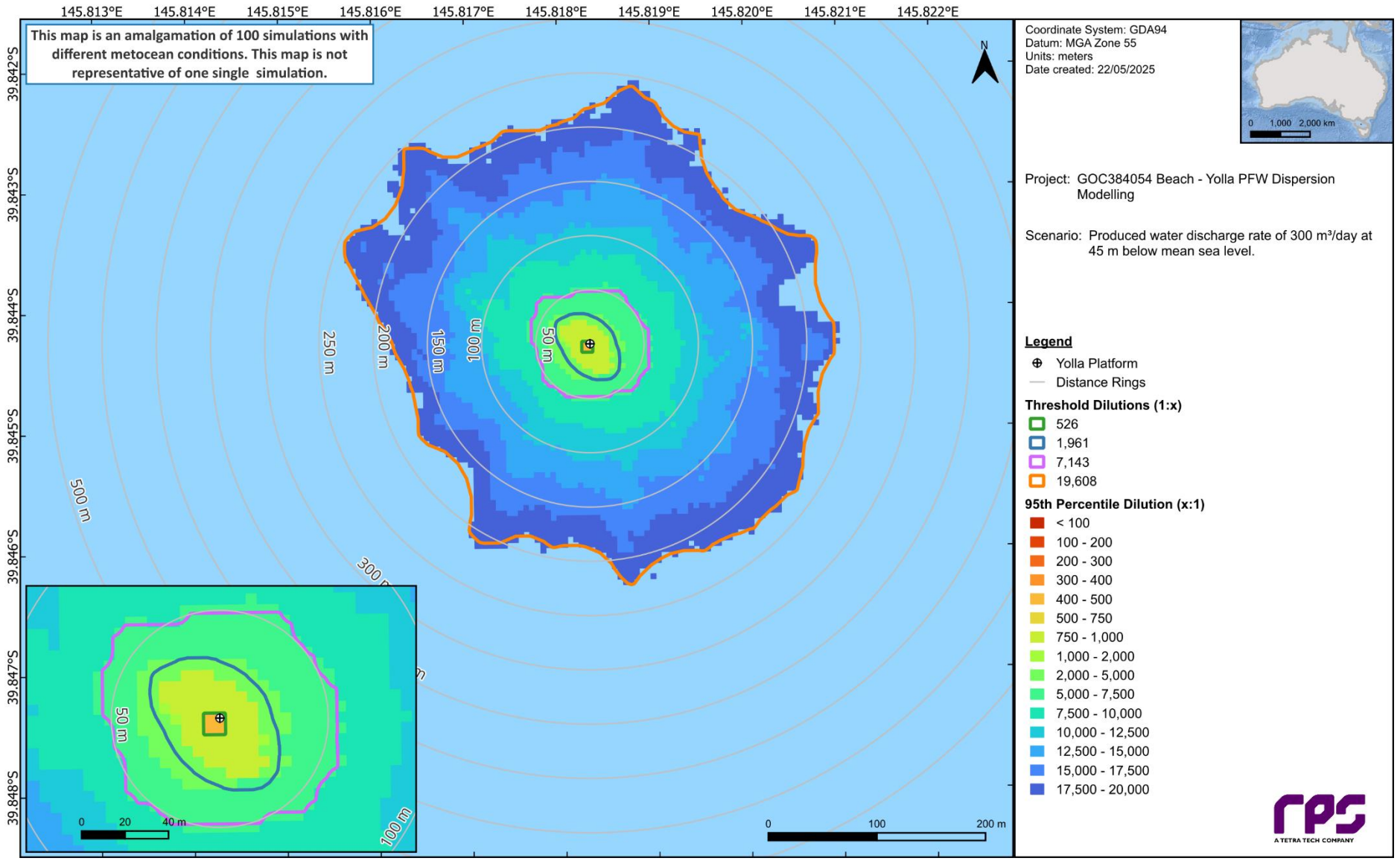


Figure 5-14 95th percentile dilution for a PFW discharge at 300 m³/d. Results refer to annual conditions.

6 REFERENCES

Andersen, OB 1995, 'Global ocean tides from ERS 1 and TOPEX/POSEIDON altimetry', Journal of Geophysical Research: Oceans, vol. 100, no. C12, pp. 25249-25259.

Burns, K, Codi, S, Furnas, M, Heggie, D, Holdway, D, King, B & McAllister, F 1999, 'Dispersion and fate of produced formation water constituents in an Australian Northwest Shelf shallow water ecosystem', Marine Pollution Bulletin, vol. 38, pp. 593-603.

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R & Bleck, R 2007, 'The HYCOM (HYbrid Coordinate Ocean Model) data assimilative system', Journal of Marine Systems, vol. 65, no. 1, pp. 60-83.

Chassignet, EP, Hurlburt, HE, Metzger, E, Smedstad, OM, Cummings, J & Halliwell, GR 2009, 'U.S. GODAE: Global ocean prediction with the HYbrid Coordinate Ocean Model (HYCOM)', Oceanography, vol. 22, no. 2, pp. 64-75.

Condie, SA., & Andrewartha, JR 2008, 'Circulation and connectivity on the Australian Northwest Shelf', Continental Shelf Research, 28, 1724–1739.

Davies, AM 1977a, 'The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile', in Bottom Turbulence: Proceedings of the 8th Liege Colloquium on Ocean Hydrodynamics, ed. Nihoul, JCJ, Elsevier.

Davies, AM 1977b, 'Three-dimensional model with depth-varying eddy viscosity', in Bottom Turbulence: Proceedings of the 8th Liege Colloquium on Ocean Hydrodynamics, ed. Nihoul, JCJ, Elsevier.

Doneker, R & Jirka, G 1990, 'Expert System for Hydrodynamic Mixing Zone Analysis of Conventional and Toxic Submerged Single Port Discharges (CORMIX1)', EPA/600/3-90/012, U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Gordon, R 1982, Wind driven circulation in Narragansett Bay, PhD thesis, University of Rhode Island, Kingston, RI, USA.

Isaji, T & Spaulding, ML 1984, 'A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank', Journal of Physical Oceanography, vol. 14, no. 6, pp. 1119-1126.

Isaji, T, Howlett, E, Dalton, C & Anderson, E 2001, 'Stepwise-continuous-variable-rectangular grid hydrodynamics model', in Proceedings of the 24th Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Edmonton, AB, Canada, pp. 597-610.

Jirka, GH, Doneker, RL, & Barnwell, TO, 1991, 'CORMIX: an expert system for mixing zone analysis', Water Science and Technology, vol. 24, no. 6, pp. 267–274.

Khondaker, AN 2000, 'Modeling the fate of drilling waste in marine environment – an overview', Journal of Computers and Geosciences, vol. 26, pp. 531-540.

King, B & McAllister, FA 1997, 'The application of MUDMAP to investigate the dilution and mixing of the above water discharge at the Harriet A petroleum platform on the Northwest Shelf', in Modelling the Dispersion of Produced Water Discharge in Australia, Australian Institute of Marine Science, Canberra, ACT, Australia.

King, B & McAllister, FA 1998, 'Modelling the dispersion of produced water discharges', APPEA Journal, pp. 681-691.

Koh, RCY & Chang, YC 1973, Mathematical model for barged ocean disposal of waste, Environmental Protection Technology Series, EPA 660/2-73-029, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, USA.

Kostianoy, AG, Ginzburg, AI, Lebedev, SA, Frankignoulle, M & Delille, B 2003, 'Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data', Oceanology, vol. 43, no. 5, pp. 632-642.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, 'The world ocean database', Data Science Journal, vol. 12, pp. WDS229-WDS234.

Ludicone, D, Santoleri, R, Marullo, S & Gerosa, P 1998, 'Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data', Journal of Geophysical Research I, vol. 103, no. C2, pp. 2995-3011.

Matsumoto, K, Takanezawa, T & Ooe, M 2000, 'Ocean tide models developed by assimilating TOPEX/POSEIDON altimeter data into hydrodynamical model: A global model and a regional model around Japan', Journal of Oceanography, vol. 56, no. 5, pp. 567-581.

Owen, A 1980, 'A three-dimensional model of the Bristol Channel', Journal of Physical Oceanography, vol. 10, no. 8, pp. 1290-1302.

Qiu, B & Chen, S 2010, 'Eddy-mean flow interaction in the decadally modulating Kuroshio Extension system', Deep-Sea Research II, vol. 57, no. 13, pp. 1098-1110.

RPS APASA 2016, Wandoo Operations, North West Shelf: Produced Formation Water - Oil in Water and Ammonia Discharge Modelling. Report Q0397. Prepared for Vermilion Oil and Gas Australia. RPS APASA Pty Ltd

Yaremchuk, M & Tangdong, Q 2004, 'Seasonal variability of the large-scale currents near the coast of the Philippines', Journal of Physical Oceanography, vol. 34, no. 4, pp. 844-855.

Zigic, S, Zapata, M, Isaji, T, King, B & Lemckert, C 2003, 'Modelling of Moreton Bay using an ocean/coastal circulation model', in Proceedings of the Coasts & Ports 2003 Australasian Conference, Auckland, New Zealand, paper no. 170.

APPENDIX 11

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
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Delivering a better world

Site Specific Dilution Factor and Revised Mixing Zone Report

BassGas Operations, Yolla-A Platform

Client: Beach Energy Limited

ABN: 20 007 617 969

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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.

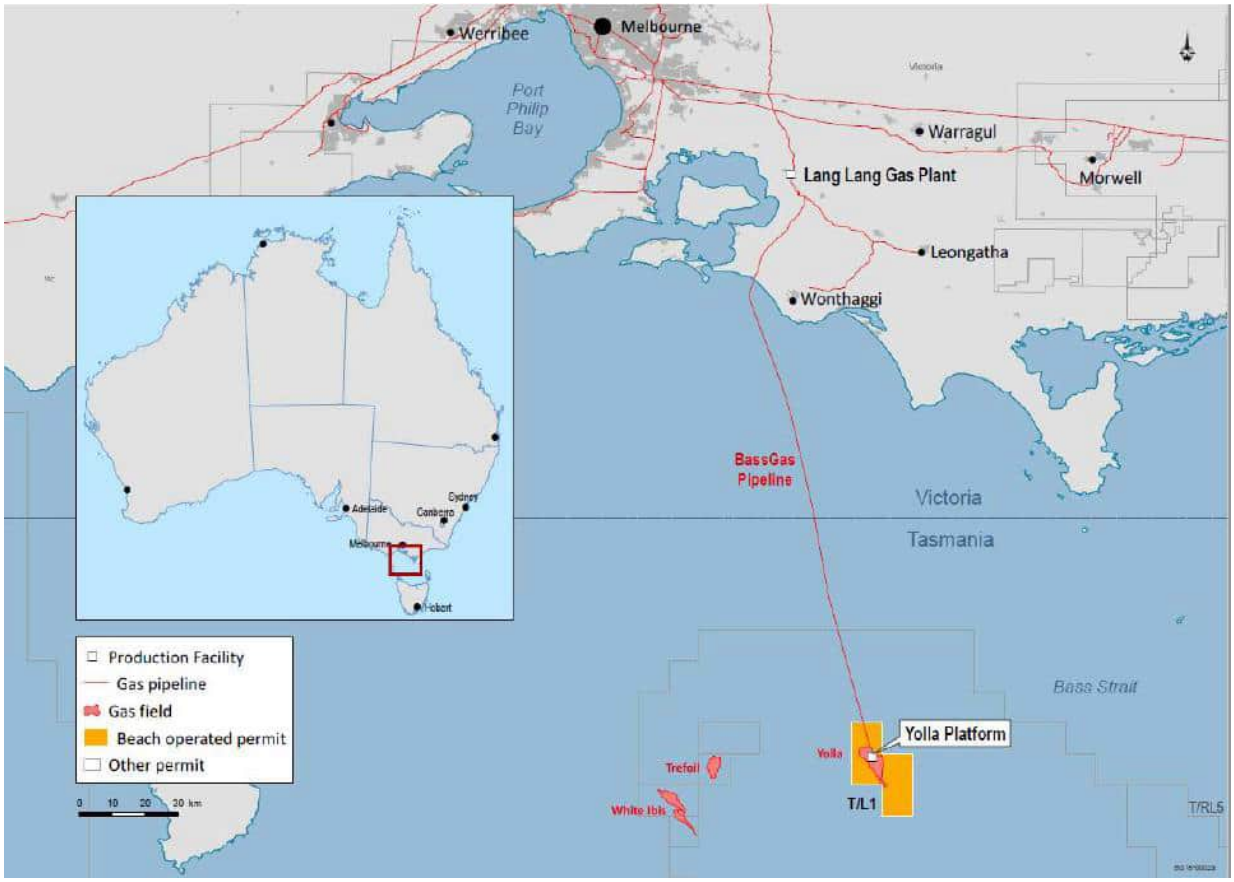


Figure 1 Yolla-A Platform location at the BassGas Development facility.

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).

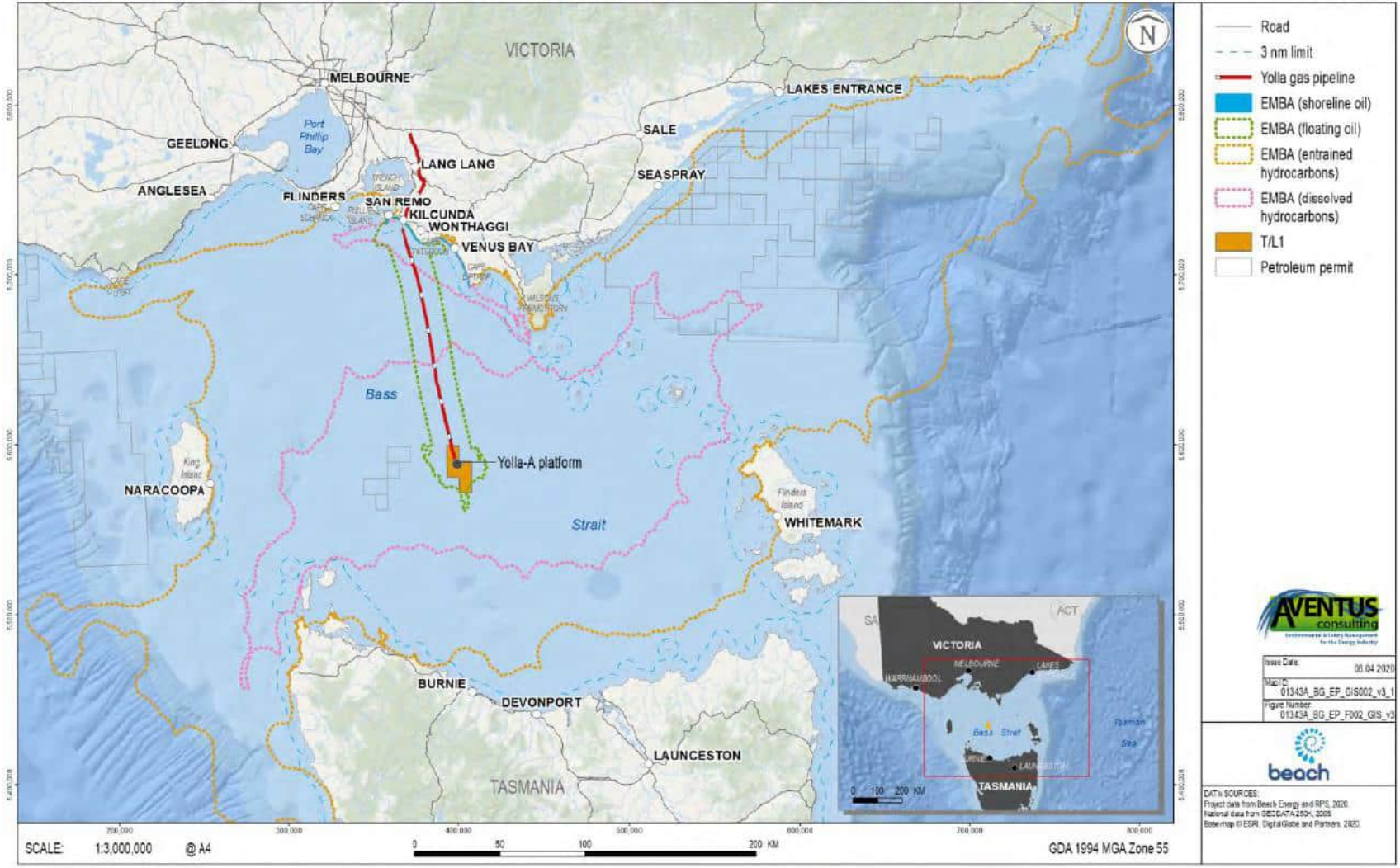


Figure 2 The BassGas Development 'Spill EMBA' (sourced from Aventus, 2020)

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**. 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%. 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**. 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**. 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.** 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)? 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)? 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.

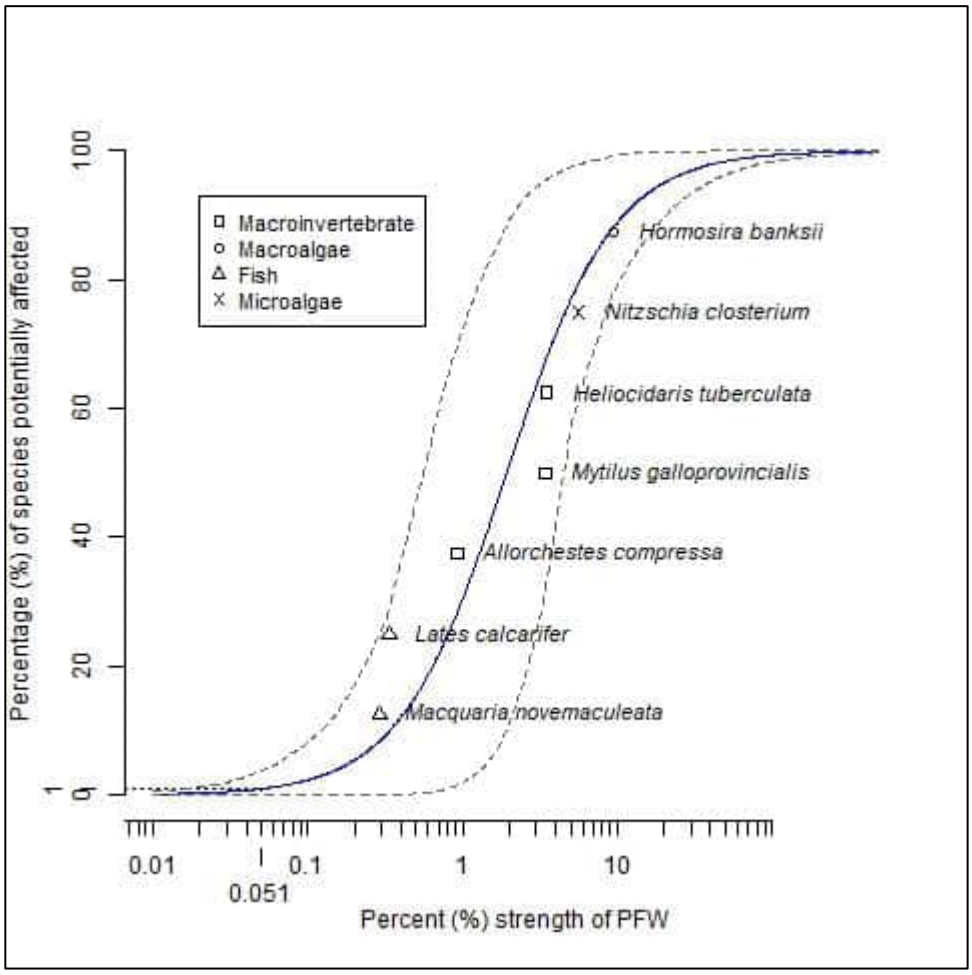


Figure 3 SSD plot generated by Burrlioz 2.0 for PFW (based on WET-testing of 12 samples collected between September 2019 to September 2024)

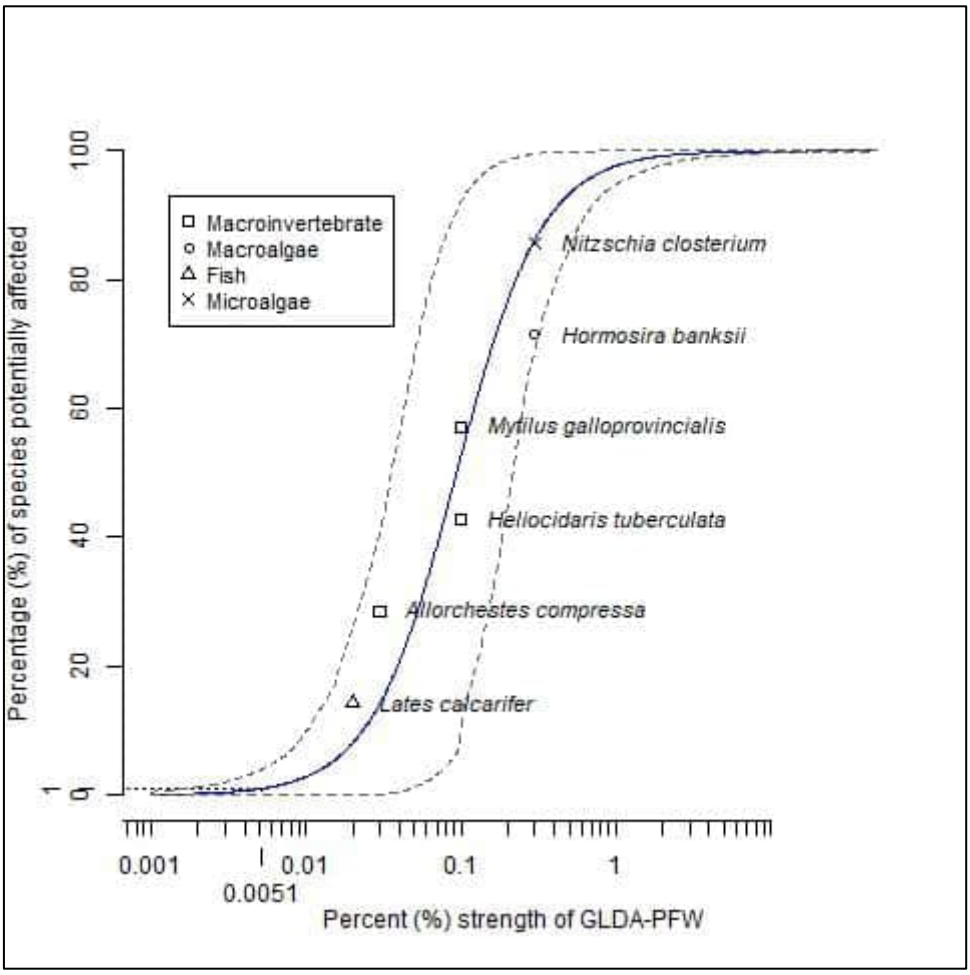


Figure 4 SSD plot generated by Burrlioz 2.0 for GLDA-PFW (based on WET-testing of one sample collected in November 2024)

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.** 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**). 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.** 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**). 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.** 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.** 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.** 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.** 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.** 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.

8.0 References

AECOM, 2020. Yolla-A Platform ALARP Assessment, AECOM Australia Pty Ltd, 23 July 2020.

AECOM, 2023a. Site Specific Dilution Factor and Revised Mixing Zone Report, BassGas Operations, Yolla-A Platform, Rev 0, AECOM Australia Pty Ltd, 22 May 2023.

AECOM, 2023b. Yolla Produced Formation Water Plume Model Verification Study Results Report. AECOM Australia Pty Ltd, 23 May 2023.

AECOM, 2024a. Site Specific Dilution Factor and Revised Mixing Zone Report, BassGas Operations, Yolla-A Platform, Rev 1, AECOM Australia Pty Ltd, 15 May 2024.

AECOM, 2024b. Descaling Agent Ecotoxicology Review MC MX 2-5895 Report, BassGas Operations, Yolla-A Platform, Rev 0, AECOM Australia Pty Ltd, 29 November 2024

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

Aventus, 2020. Environment Plan, BassGas Offshore Operations, Revision 3, Aventus Consulting (Doc No. CDN/ID 3972814), 30 November 2020.

Barry S and Henderson B, 2014. Burrlioz 2.0 software, The Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia, in cooperation with the Australian Government Department of Environment, accessed at https://research.csiro.au/software/burrlioz/ in February 2022.

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.

EPA Victoria, 2010. Guidance for the determination and assessment of mixing zones. Publication number 1344. Environment Protection Authority Victoria accessed at https://www.epa.vic.gov.au/about-epa/publications/1344

NOPSEMA, 2021. NOPSEMA Inspection of BassGas Operations (Draft for discussion with duty holders), NOPSEMA Inspection Report, Inspection No. 2448, 13 September 2021.

OPGGS(E), 2009. Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Commonwealth).

OPGGS, 2011. Offshore Petroleum and Greenhouse Gas Storage Regulations 2011 (Victoria).

Peters, A., Merrington, G., Leverett, D., Wilson, I., Schlekat, C. and Garman, E., 2019. Comparison of the chronic toxicity of nickel to temperate and tropical freshwater species. Environmental toxicology and chemistry, 38(6), pp.1211-1220.

Rico, A., Waichman, A.V., Geber-Corrêa, R. and van den Brink, P.J., 2011. Effects of malathion and carbendazim on Amazonian freshwater organisms: comparison of tropical and temperate species sensitivity distributions. Ecotoxicology, 20, pp.625-634.

RPS, 2020. Beach Yolla Platform – Produced Water Dispersion Far-Field Modelling Study, RPS Group, 23 September 2020.

RPS, 2025. Yolla Platform – Produced Water Dispersion Modelling, Report no. GOC384054, Rev 2. RPS Group, 23 May 2025.

Victoria Government, 2021. Environment Reference Standard. Victoria Government Gazette No. S245, 26 May 2021. Melbourne. Victoria. Australia. http://www.gazette.vic.gov.au/gazette/Gazettes2021/GG2021S245.pdf

Warne MStJ, Batley GE, van Dam RA, Chapman JC, Fox DR, Hickey CW and Stauber JL, 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 Governments and Australian state and territory governments, Canberra, 48 pp, October 2018.

Appendix A

Chemical Characterisation Data

Appendix A - Produced Formation Water (PFW) Characterisation Data

Project: Site-Specific Dilution Factor, Yolla-A Platform
Client: Beach Energy
Project number: 60731020

	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	Yes	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	<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	<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	<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	<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

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: TR1858/1

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Ltd GPO Box 175 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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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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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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)% **72-hr EC50 =3.4 (3.28-3.50)%** **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: TR1858/3

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

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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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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 **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.

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Toxicity Test Report: TR1858/5

Performed in compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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* **Concentration (%)**	**Cell Yield (Mean number of cells/mL x10^4 ± 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)% **72-hr IC50 = 6.0 (5.43-6.93)%** **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: 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.
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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 GPO Box 175 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. 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.
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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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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

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

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)

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 • 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
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

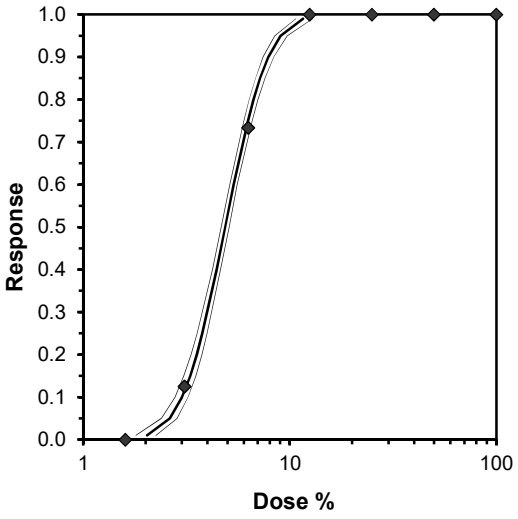
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.975273	0.887	-0.42954	0.482187
Bartlett's Test indicates equal variances (p = 0.41)	2.877388	11.34487		
The control means are not significantly different (p = 0.64)	0.498347	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

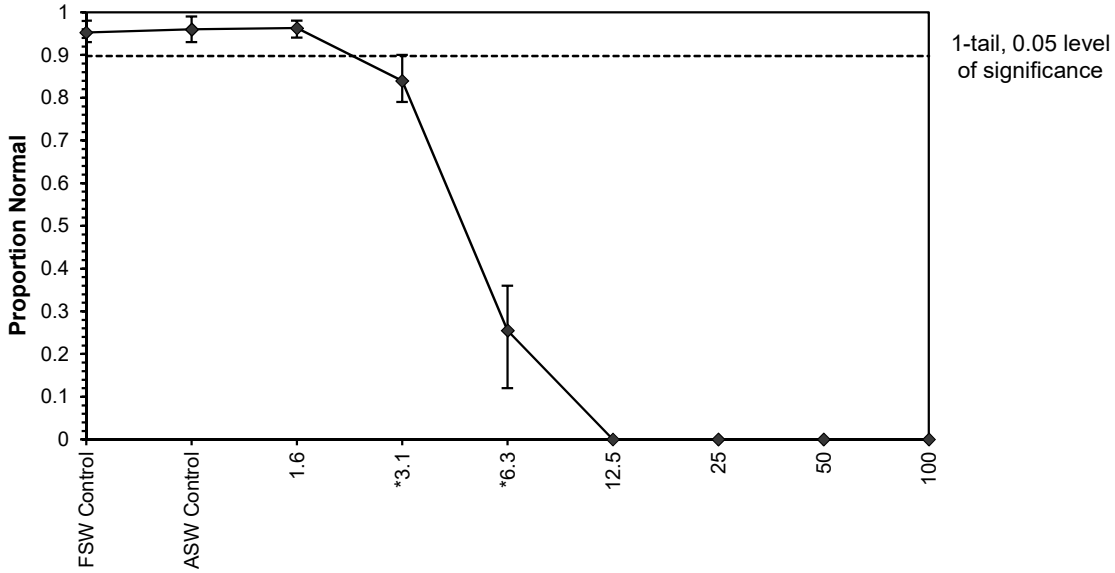
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	2.03712	1.801262	2.253447
EC05	3.355	2.629277	2.390429	2.845354
EC10	3.718	3.012408	2.777552	3.224509
EC15	3.964	3.301971	3.07203	3.51023
EC20	4.158	3.55183	3.326811	3.756811
EC25	4.326	3.781202	3.560788	3.983656
EC40	4.747	4.427037	4.216199	4.628583
EC50	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

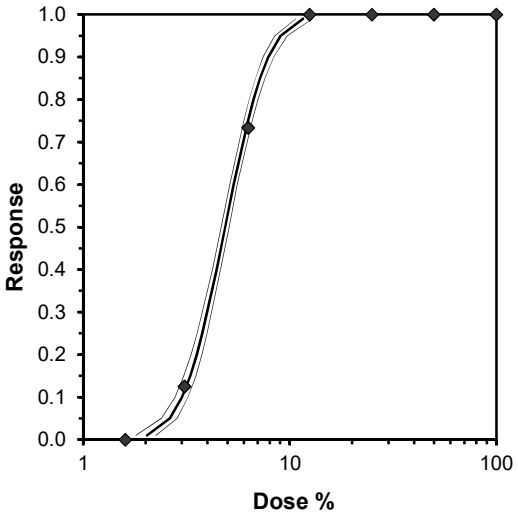
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.975273	0.887	-0.42954	0.482187
Bartlett's Test indicates equal variances (p = 0.41)	2.877388	11.34487		
The control means are not significantly different (p = 0.64)	0.498347	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

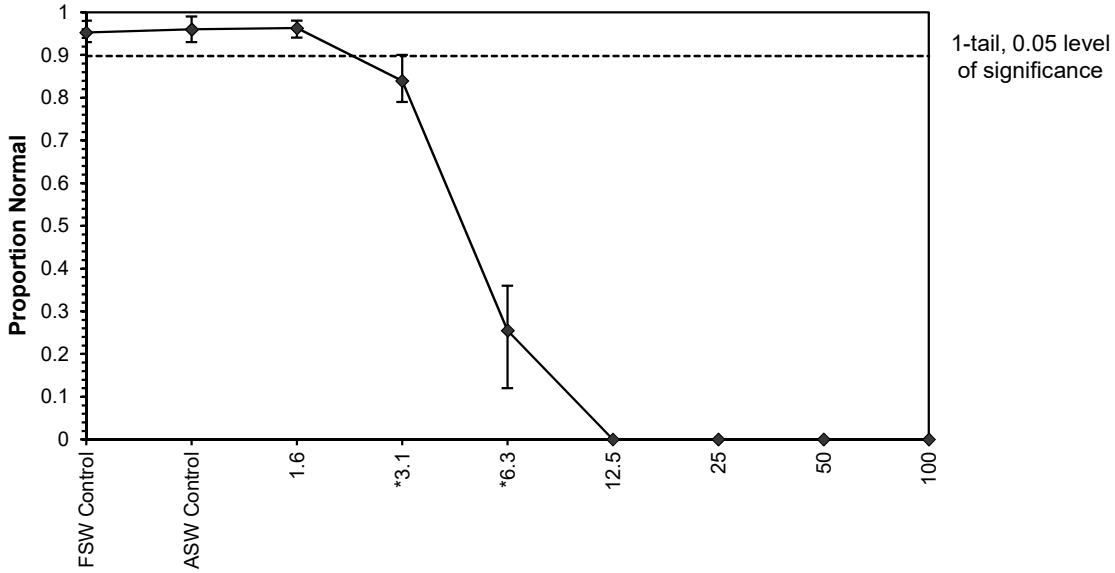
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	2.03712	1.801262	2.253447
EC05	3.355	2.629277	2.390429	2.845354
EC10	3.718	3.012408	2.777552	3.224509
EC15	3.964	3.301971	3.07203	3.51023
EC20	4.158	3.55183	3.326811	3.756811
EC25	4.326	3.781202	3.560788	3.983656
EC40	4.747	4.427037	4.216199	4.628583
EC50	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

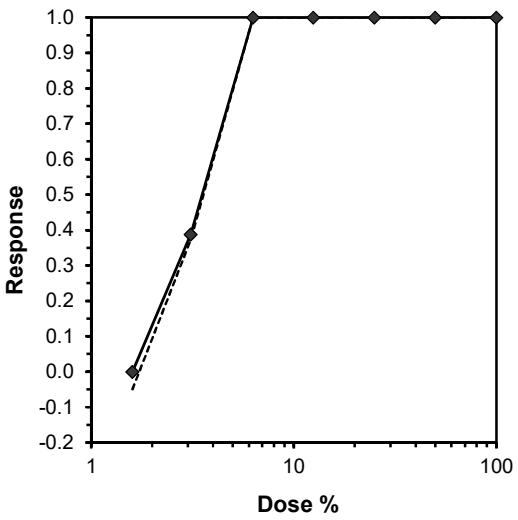
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7825	1.0229	1.0869	1.0357	1.1458	4.535	4					
ASW Control	0.7650	1.0000	1.0655	1.0244	1.1198	3.830	4	*			94	400
1.6	0.8025	1.0490	1.1119	1.0357	1.1593	4.799	4	-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 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

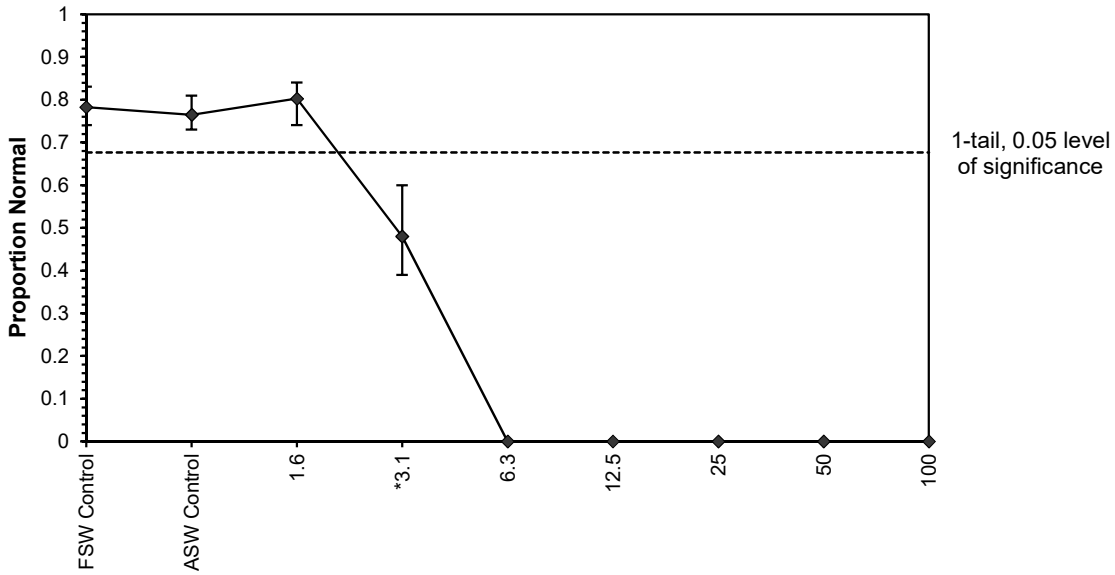
Trim Level	EC50	95% CL	
0.0%	3.3885	3.2773	3.5036
5.0%	3.4105	3.2858	3.5400
10.0%	3.4323	3.2895	3.5813
20.0%	3.4747	3.2733	3.6886
Auto-0.0%	3.3885	3.2773	3.5036



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

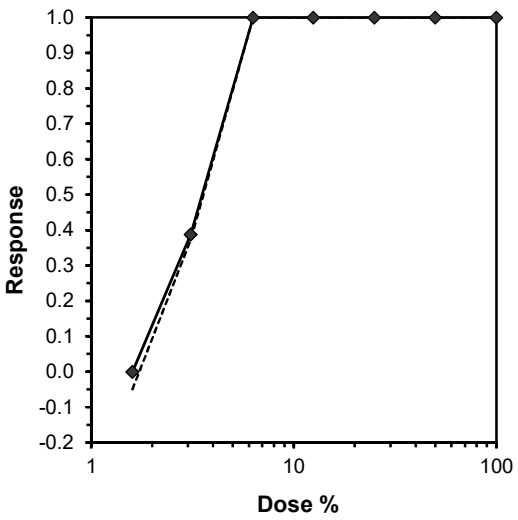
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7825	1.0229	1.0869	1.0357	1.1458	4.535	4					
ASW Control	0.7650	1.0000	1.0655	1.0244	1.1198	3.830	4	*			0.7838	1.0000
1.6	0.8025	1.0490	1.1119	1.0357	1.1593	4.799	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 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

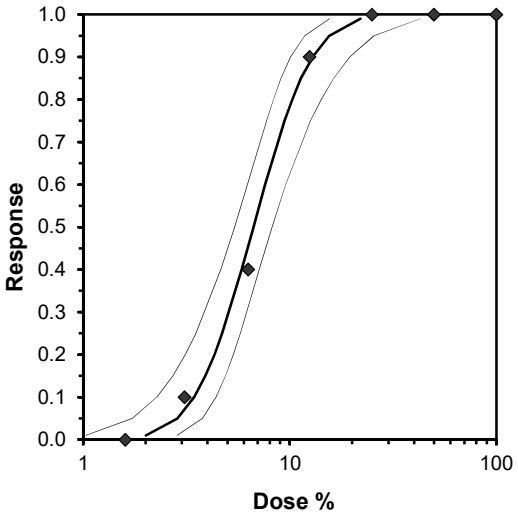
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.874764	0.905	-1.01023	1.925233
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

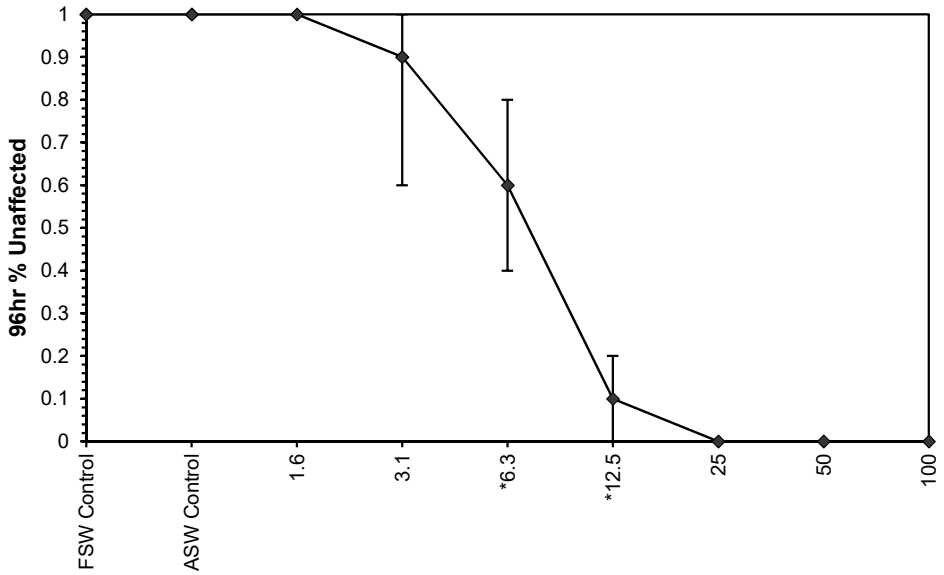
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	2.012376	1.034186	2.85415
EC05	3.355	2.857278	1.733282	3.765561
EC10	3.718	3.444395	2.271134	4.387061
EC15	3.964	3.907252	2.716143	4.87997
EC20	4.158	4.319085	3.122326	5.326055
EC25	4.326	4.706828	3.509488	5.756475
EC40	4.747	5.845344	4.639124	7.111008
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				

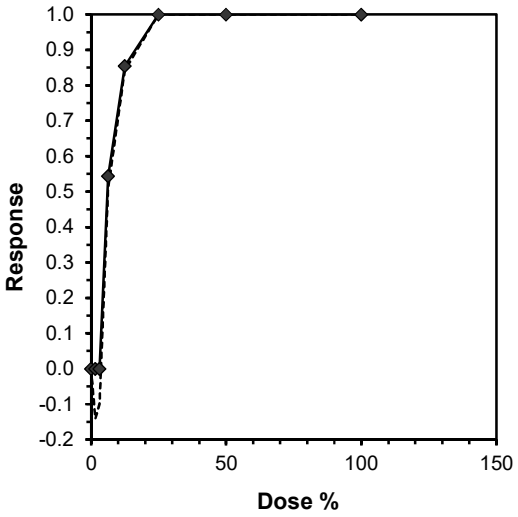
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	18.064	1.0840	18.064	16.614	19.514	5.472	8					
ASW Control	16.664	1.0000	16.664	15.914	17.314	3.482	4	*			17.997	1.0000
1.6	19.014	1.1410	19.014	17.714	20.714	6.611	4	-2.327	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 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)

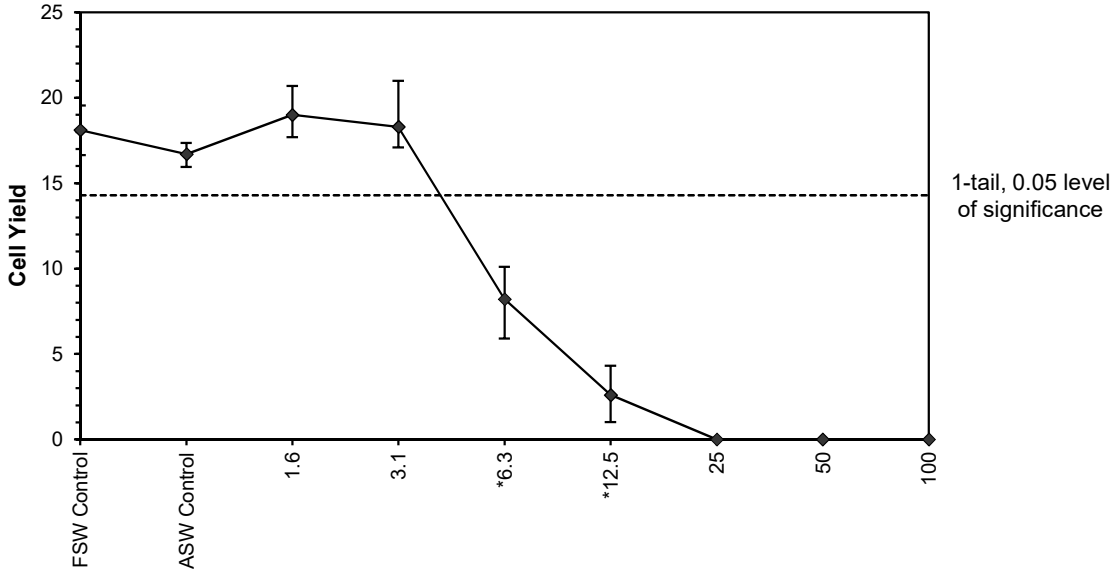
Point	%	SD	95% CL(Exp)		Skew
IC05	3.3943	0.0843	2.9935	3.4479	-1.8951
IC10	3.6887	0.0779	3.3296	3.8001	-1.1331
IC15	3.9830	0.0832	3.6401	4.1536	-0.6121
IC20	4.2773	0.0953	3.9400	4.5055	-0.2673
IC25	4.5717	0.1121	4.2001	4.8608	-0.0793
IC40	5.4547	0.1757	4.9306	5.9203	0.1581
IC50	6.0433	0.2582	5.4339	6.9275	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		

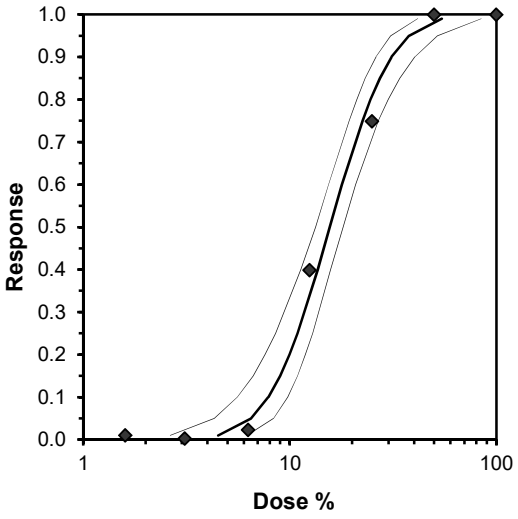
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test Treatments vs ASW Control	6.3	12.5	8.87412	15.87302	0.078607	0.081794	0.526421	0.007882	5.5E-11	5, 18

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

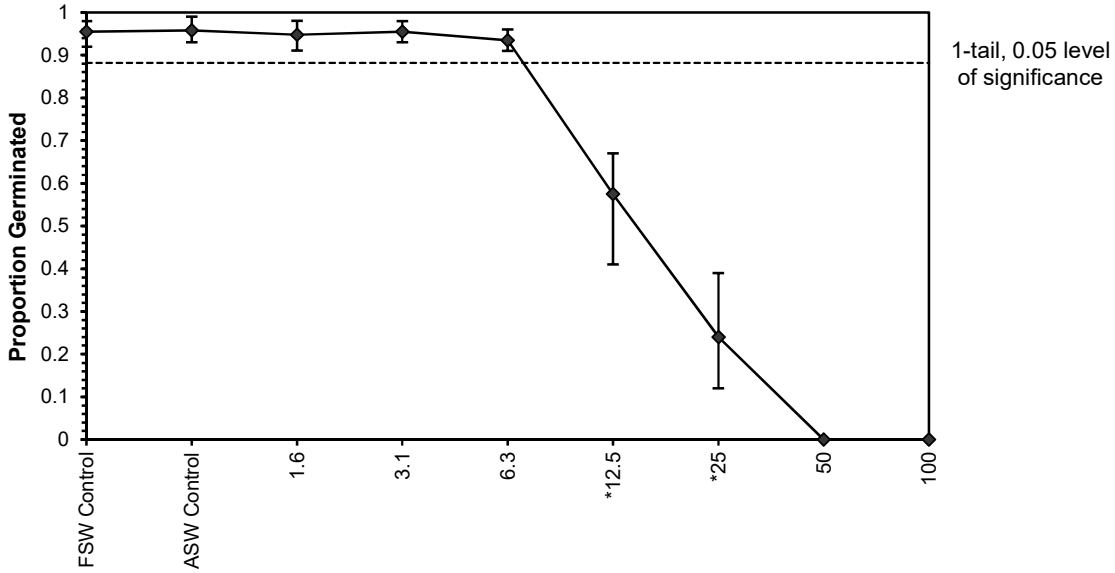
Significant heterogeneity detected (p = 2.40E-04)



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

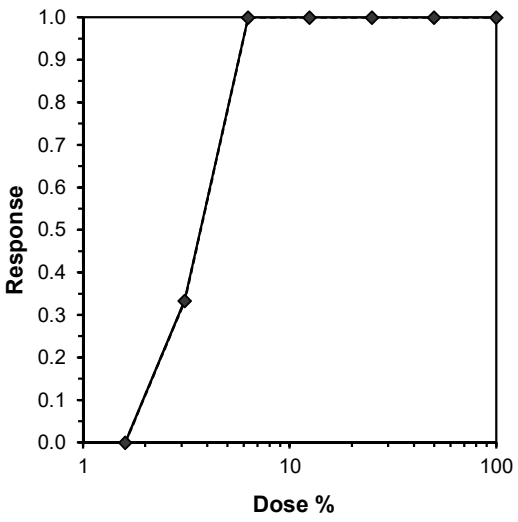
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4					
ASW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4	*			2	20
1.6	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4	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 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

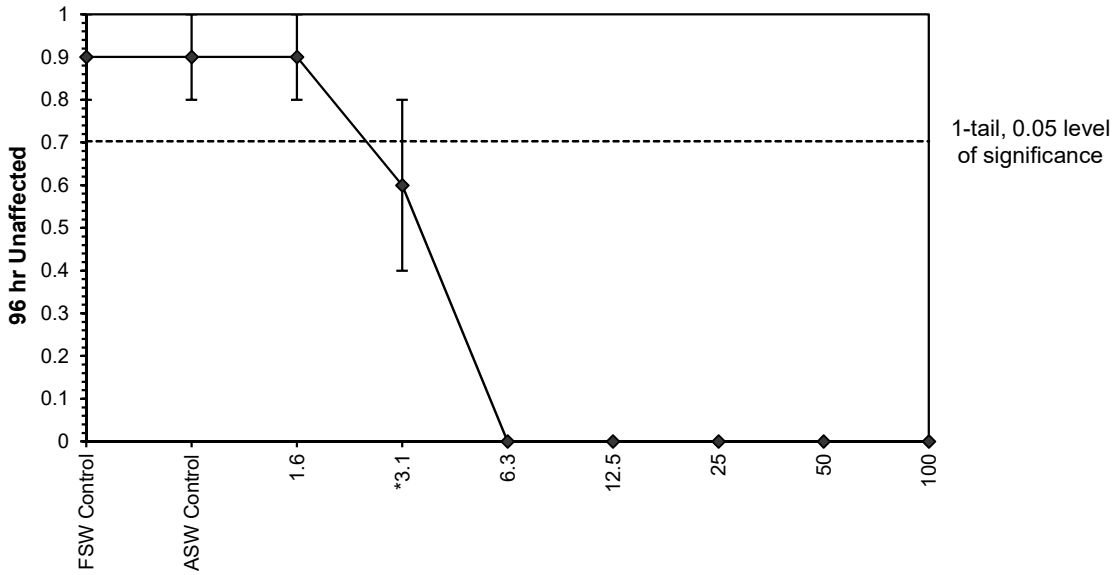
Trim Level	EC50	95% CL	
0.0%	3.5168	3.0437	4.0634
5.0%	3.5524	3.0218	4.1763
10.0%	3.5872	2.9774	4.3219
20.0%	3.6512	2.7833	4.7896
Auto-0.0%	3.5168	3.0437	4.0634



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

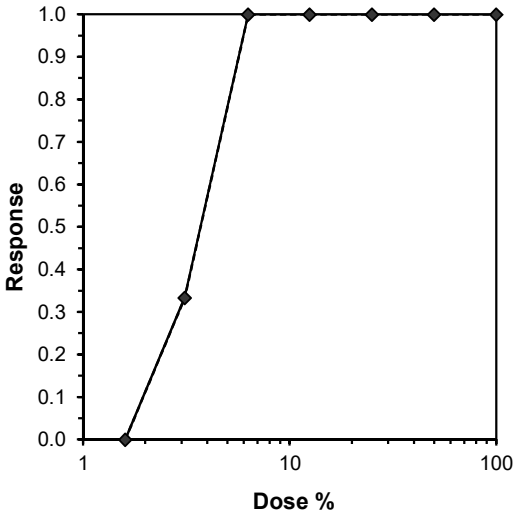
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4					
ASW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4	*			0.9000	1.0000
1.6	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	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 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

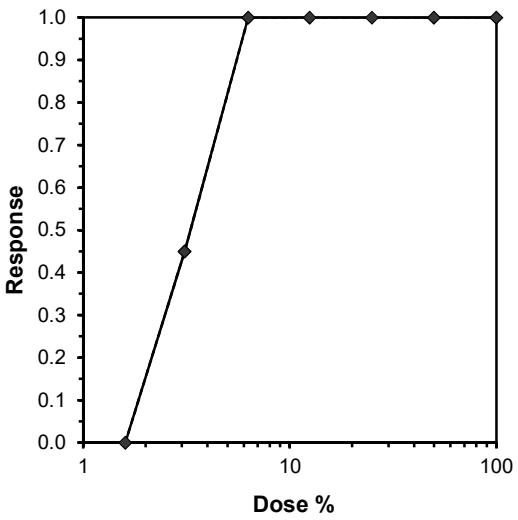
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	11.00	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

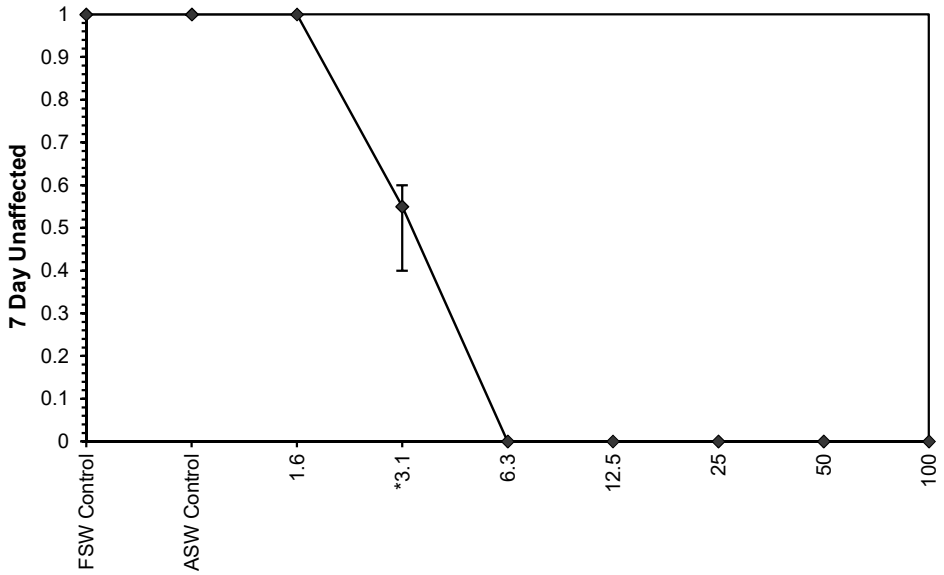
Trim Level	EC50	95% CL	
0.0%	3.2466	2.7875	3.7813
5.0%	3.2538	2.7460	3.8556
10.0%	3.2611	2.6918	3.9508
20.0%	3.2755	2.5232	4.2521
Auto-0.0%	3.2466	2.7875	3.7813



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

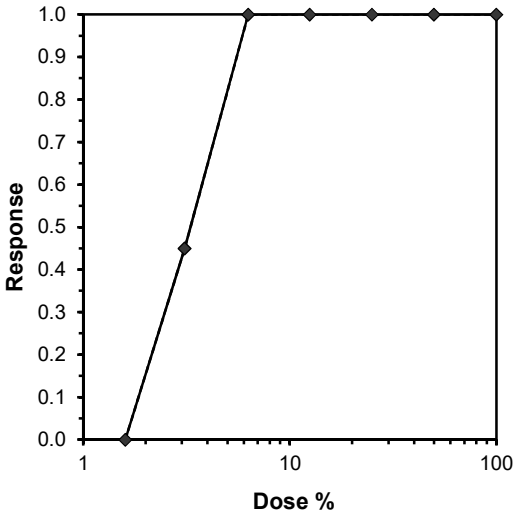
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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

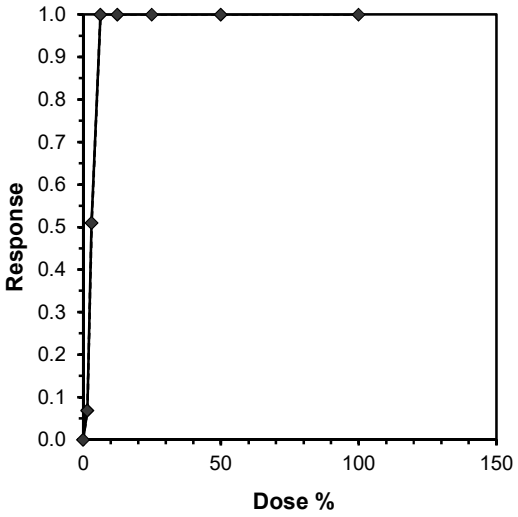
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.882251	0.859	-0.34393	-1.65716
Bartlett's Test indicates equal variances (p = 0.76)	0.551451	9.21034		
The control means are not significantly different (p = 0.85)	0.196645	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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 (Page 1 of 2)

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Ltd GPO Box 175 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.

*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. 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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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 GPO Box 175 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.

*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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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* **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)% **72-hr EC50 =3.9 (3.75-3.96)%** **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: TR1858/11

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.

Toxicity Test Report: TR1858/12

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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.
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: TR1858/13

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	17.7x10^4 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.
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: TR1858/14

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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: 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 Whole water 96 h BA52 FIT	72 h Nitrate toxicity 72 h Ammonia toxicity	48 h Microtox 15 min Solid phase test	72 h Seed germination & root elongation	7 d FIT of Groundwater	Sediment - Sampling for Freezing	**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** 18558
X 2/10/19	X 06:00	X YO021019-1	Grab	4 x 2 L	✓	✓	✓	✓	✓	✓	
"	06:00	YO021019-2	"	"	✓	✓	✓	✓	✓	✓	
"	06:00	YO021019-3	"	"	✓	✓	✓	✓	✓	✓	
"	06:00	YO021019-4	"	"	✓	✓	✓	✓	✓	✓	

X 1) Released By:	Date:	2) Received By:	Date:	3) Released By:	Date:	4) Received By:	Date:
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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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

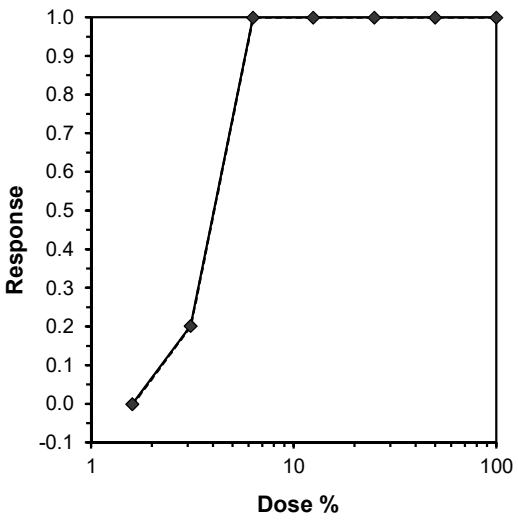
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9525	1.0079	1.3536	1.3030	1.3967	2.935	4				
ASW Control	0.9450	1.0000	1.3353	1.3030	1.3694	2.140	4	*		22	400
1.6	0.9475	1.0026	1.3413	1.3030	1.3694	2.499	4	19.00	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 Treatments vs ASW Control	1.6	3.1	2.227106	62.5

Trimmed Spearman-Karber

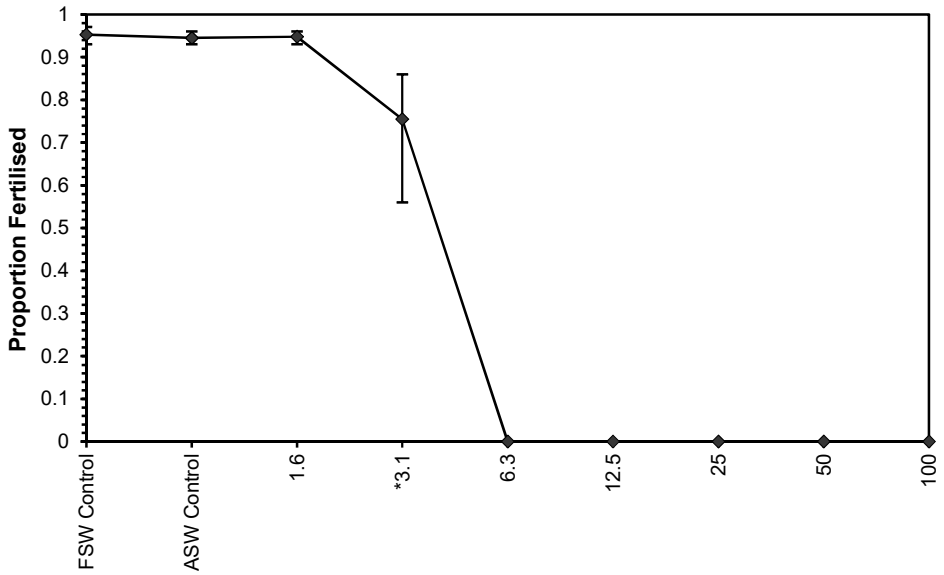
Trim Level	EC50	95% CL	
0.0%	3.8477	3.7432	3.9550
5.0%	3.9177	3.7966	4.0428
10.0%	3.9774	3.8284	4.1322
20.0%	4.0396	3.7814	4.3154
Auto-0.0%	3.8477	3.7432	3.9550



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

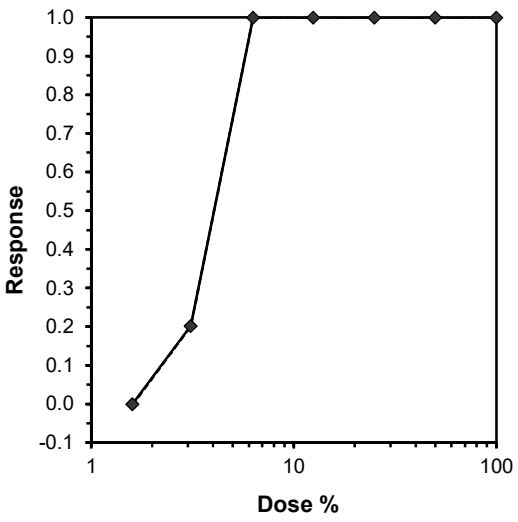
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9525	1.0079	1.3536	1.3030	1.3967	2.935	4				
ASW Control	0.9450	1.0000	1.3353	1.3030	1.3694	2.140	4	*		0.9463	1.0000
1.6	0.9475	1.0026	1.3413	1.3030	1.3694	2.499	4	19.00	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 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

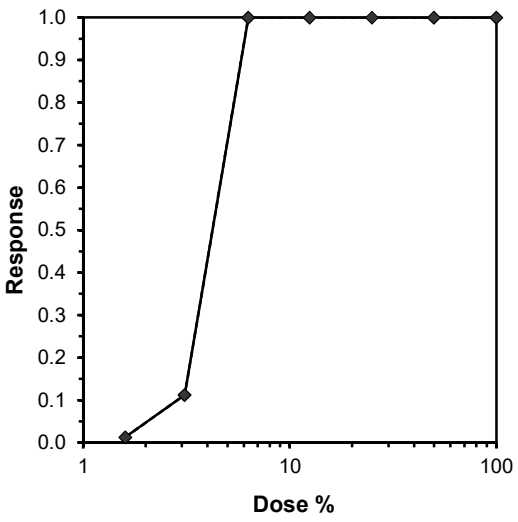
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9400	0.9766	1.3316	1.2490	1.4289	5.701	4					
ASW Control	0.9625	1.0000	1.3770	1.3453	1.3967	1.799	4	*			15	400
1.6	0.9500	0.9870	1.3481	1.3030	1.3967	3.165	4	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 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

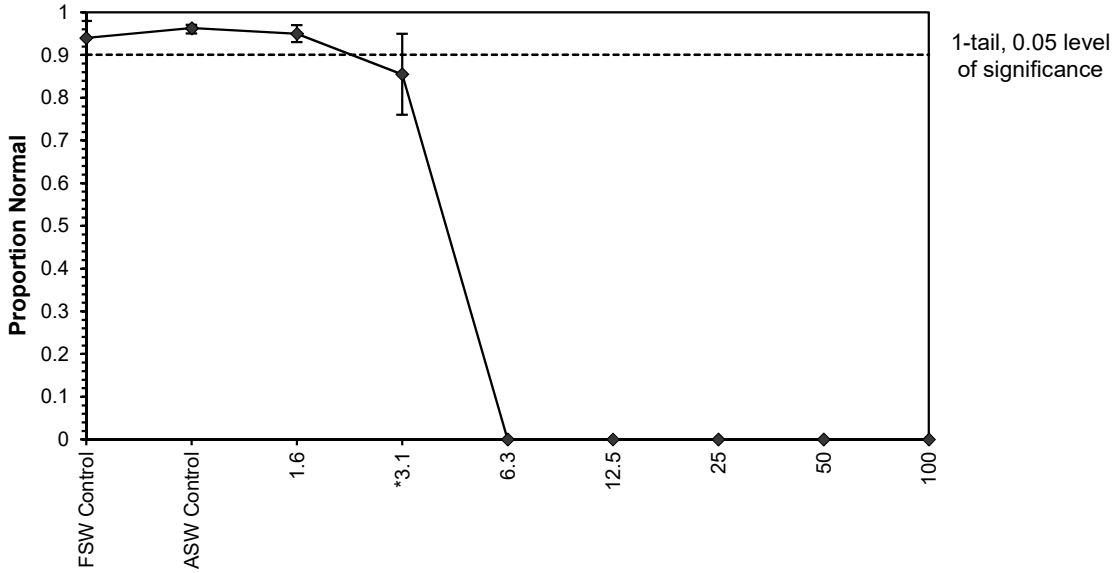
Trim Level	EC50	95% CL	
0.0%			
5.0%	4.1742	4.0686	4.2825
10.0%	4.2245	4.0713	4.3834
20.0%	4.2266	4.1672	4.2868
Auto-1.3%	4.1036	4.0124	4.1970



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

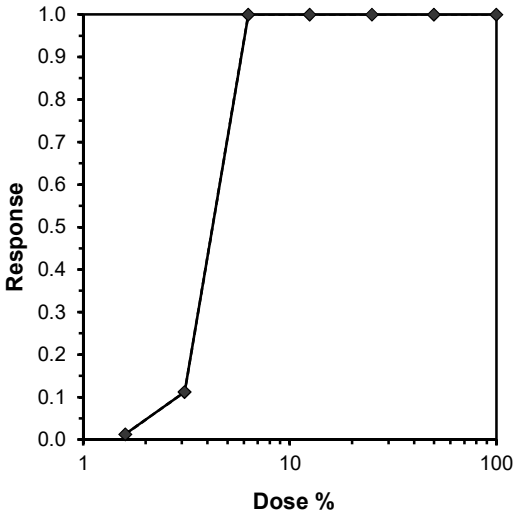
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9400	0.9766	1.3316	1.2490	1.4289	5.701	4					
ASW Control	0.9625	1.0000	1.3770	1.3453	1.3967	1.799	4	*			0.9625	1.0000
1.6	0.9500	0.9870	1.3481	1.3030	1.3967	3.165	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 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

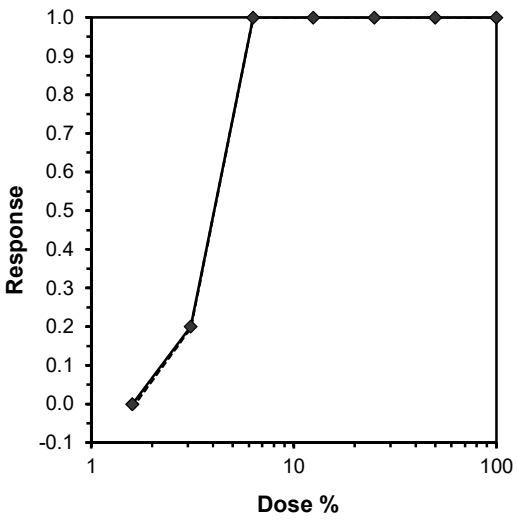
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7875	0.9813	1.0919	1.0706	1.1198	1.924	4					
ASW Control	0.8025	1.0000	1.1113	1.0588	1.1593	3.727	4	*			79	400
1.6	0.8100	1.0093	1.1209	1.0588	1.1593	3.972	4	-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 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

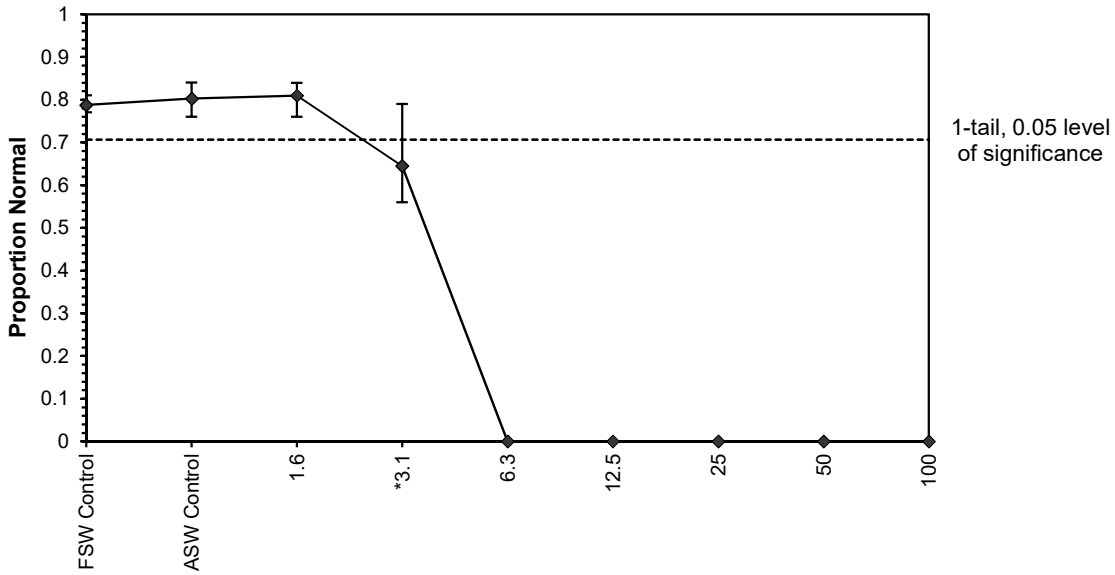
Trim Level	EC50	95% CL	
0.0%	3.8533	3.7491	3.9603
5.0%	3.9239	3.8029	4.0487
10.0%	3.9837	3.8347	4.1385
20.0%	4.0444	3.9558	4.1350
Auto-0.0%	3.8533	3.7491	3.9603



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

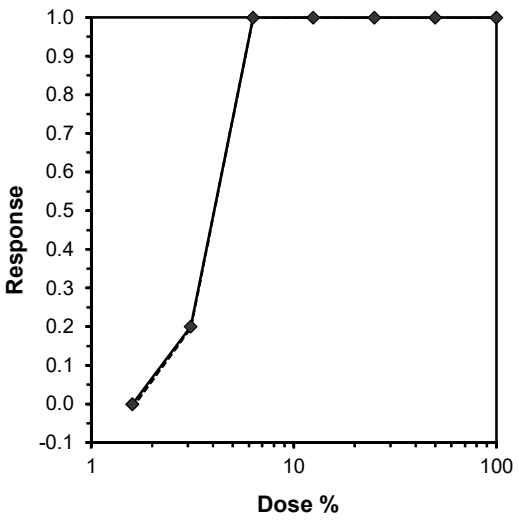
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7875	0.9813	1.0919	1.0706	1.1198	1.924	4					
ASW Control	0.8025	1.0000	1.1113	1.0588	1.1593	3.727	4	*			0.8063	1.0000
1.6	0.8100	1.0093	1.1209	1.0588	1.1593	3.972	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 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

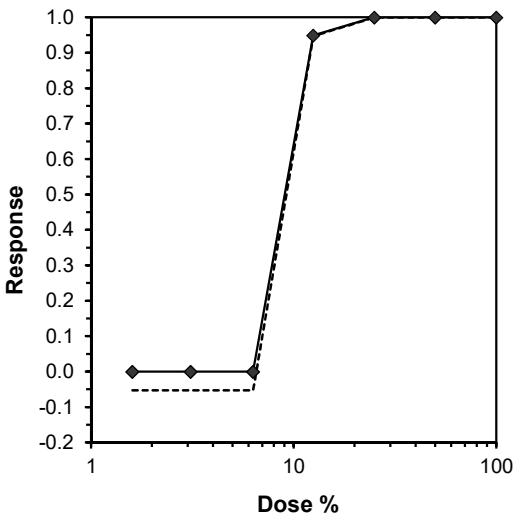
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4				
ASW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	*		1	20
1.6	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4	20.00	10.00	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

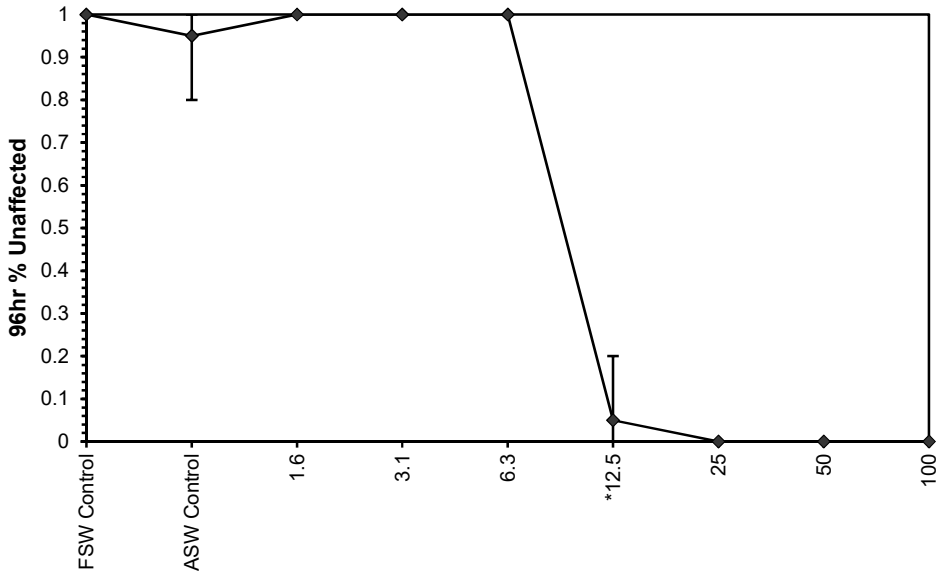
Trim Level	EC50	95% CL	
0.0%	9.1892	8.5888	9.8316
5.0%	9.0378	8.6976	9.3912
10.0%	9.0378	8.7071	9.3809
20.0%	9.0378	8.7071	9.3809
Auto-0.0%	9.1892	8.5888	9.8316



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

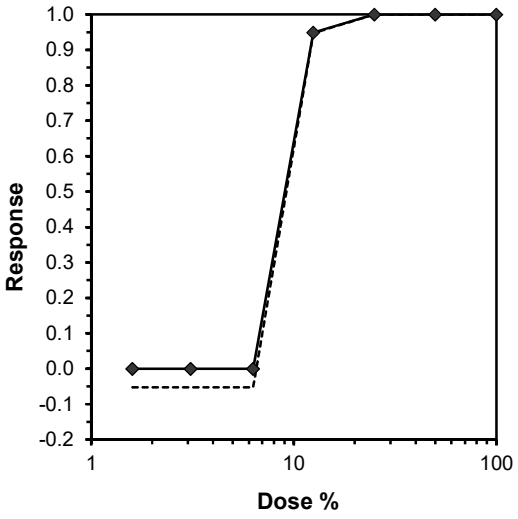
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4				
ASW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	*		0.9875	1.0000
1.6	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4	20.00	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)

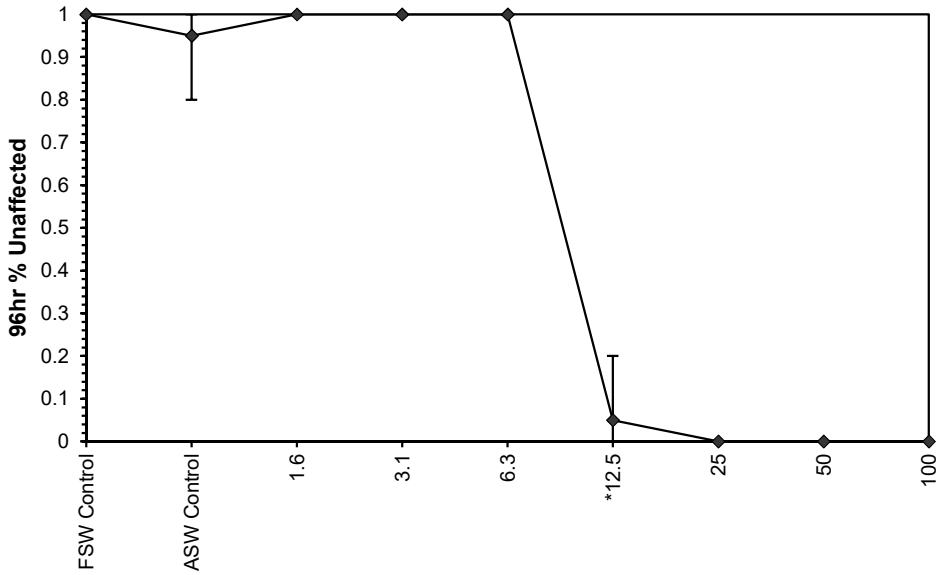
Point	%	SD	95% CL(Exp)		Skew
IC05	7.3866	0.8671	6.2975	10.3402	0.7131
IC10	7.8507	0.8948	6.3541	10.7345	0.5631
IC15	8.1722	0.9114	6.4007	10.9719	0.4202
IC20	8.4291	0.9264	6.4397	11.1489	0.2870
IC25	8.6502	0.9415	6.4736	11.2945	0.1633
IC40	9.2135	0.9922	6.5588	11.6449	-0.1592
IC50	9.5622	1.0336	6.6092	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				

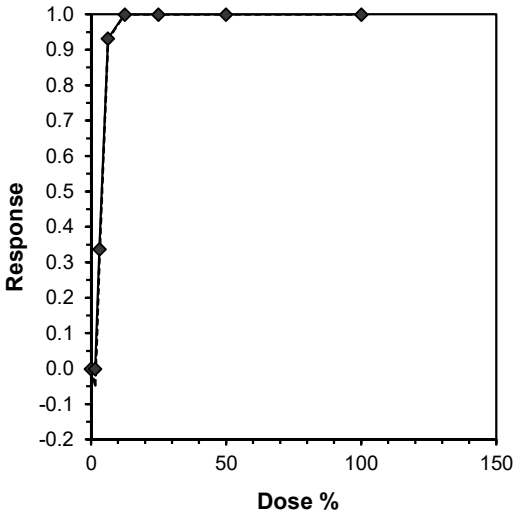
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	16.642	1.0568	16.642	15.260	17.969	5.320	8					
ASW Control	15.748	1.0000	15.748	14.935	16.777	5.040	4	*			16.154	1.0000
1.6	16.560	1.0516	16.560	15.585	17.860	5.728	4	-0.855	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 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)

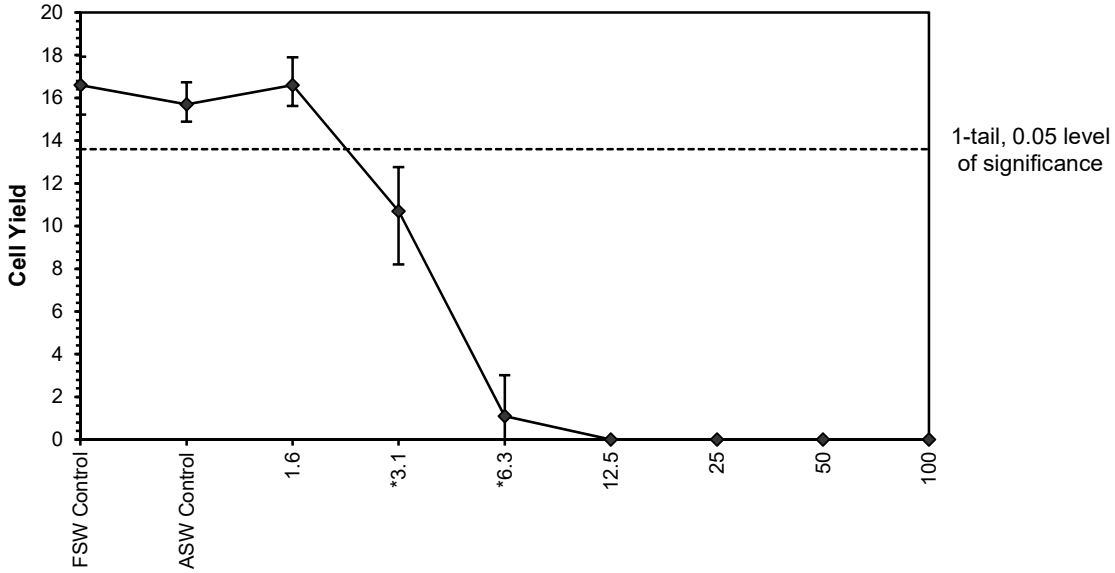
Point	%	SD	95% CL(Exp)		Skew
IC05	1.8226	0.0445	1.7147	1.9580	-1.5970
IC10	2.0451	0.0709	1.8906	2.3161	0.5371
IC15	2.2677	0.1038	2.0359	2.6741	0.6902
IC20	2.4902	0.1382	2.1812	3.0321	0.7386
IC25	2.7128	0.1700	2.3266	3.3674	0.6835
IC40	3.4390	0.2288	2.7656	4.0806	-0.0785
IC50	3.9771	0.2087	3.3138	4.5373	-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

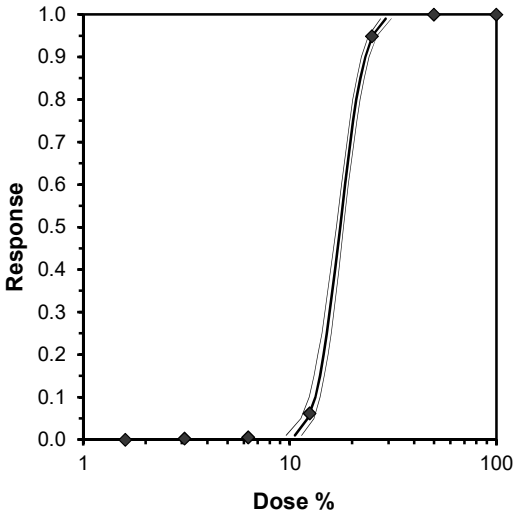
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.990604	0.916	0.038641	-0.27548
Bartlett's Test indicates equal variances (p = 0.57)	3.828166	15.08627		
The control means are not significantly different (p = 0.68)	0.431366	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

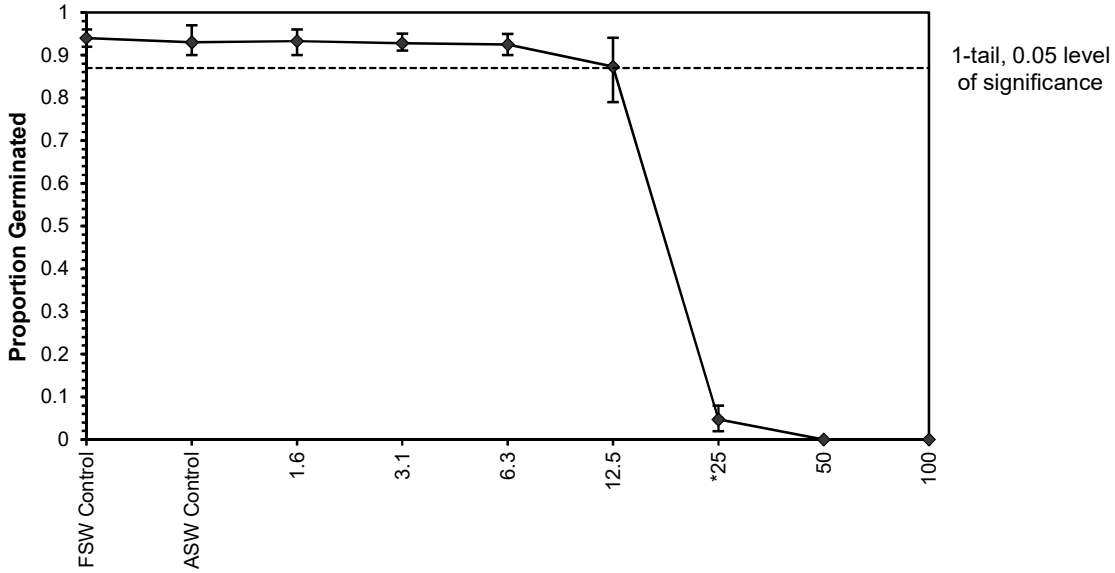
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	10.55641	9.597342	11.40222
EC05	3.355	12.24471	11.32893	13.0509
EC10	3.718	13.25248	12.37001	14.03231
EC15	3.964	13.97887	13.12206	14.74019
EC20	4.158	14.58448	13.7492	15.33156
EC25	4.326	15.1249	14.30833	15.86081
EC40	4.747	16.57714	15.80406	17.29447
EC50	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

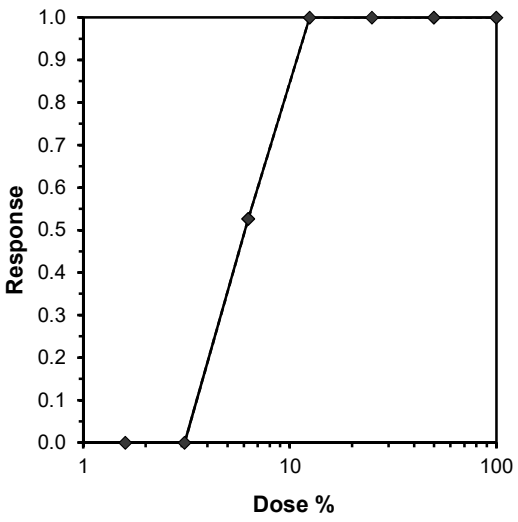
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9000	0.9474	1.2262	1.1071	1.3453	11.212	4				
ASW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	*		1	20
1.6	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	18.00	10.00	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Trimmed Spearman-Karber

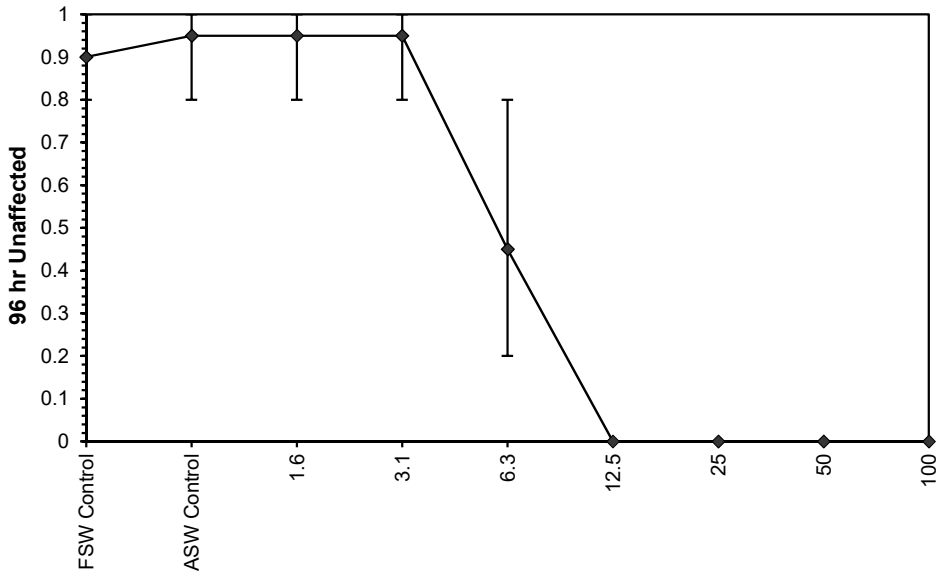
Trim Level	EC50	95% CL	
0.0%	6.1485	5.2621	7.1842
5.0%	6.1409	5.1663	7.2994
10.0%	6.1334	5.0523	7.4458
20.0%	6.1183	4.7374	7.9016
Auto-0.0%	6.1485	5.2621	7.1842



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

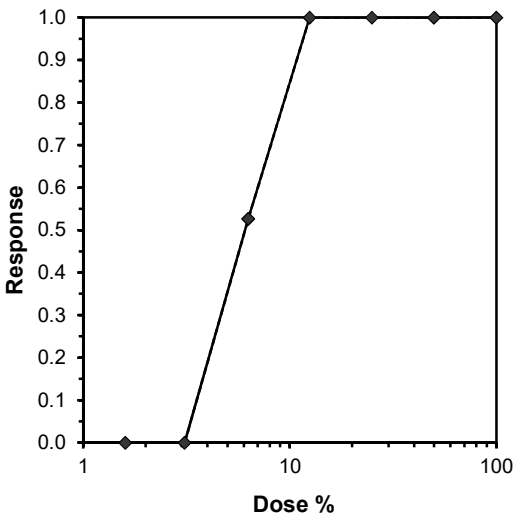
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9000	0.9474	1.2262	1.1071	1.3453	11.212	4				
ASW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	*		0.9500	1.0000
1.6	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	18.00	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

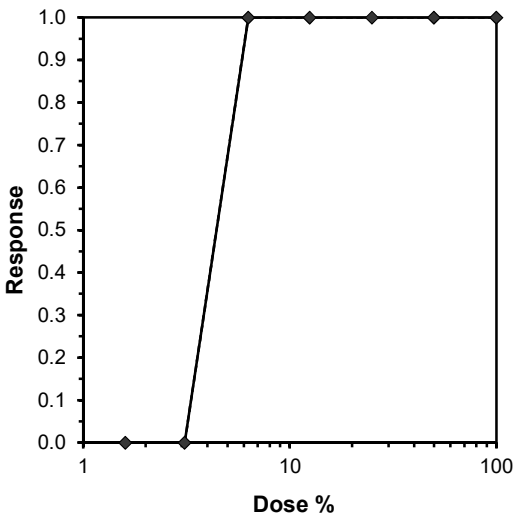
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

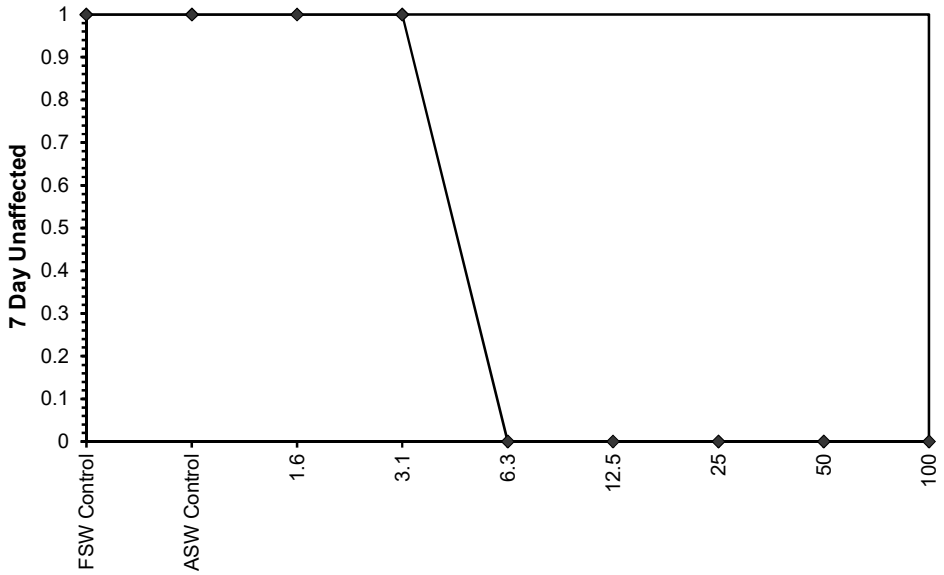
Point	%	SD	95% CL(Exp)		Skew
IC05	3.9889	0.0000	3.9889	3.9889	1.0076
IC10	4.1070	0.0000	4.1070	4.1070	-1.0076
IC15	4.1816	0.0000	4.1816	4.1816	-1.0076
IC20	4.2384	0.0000	4.2384	4.2384	1.0076
IC25	4.2858	0.0000	4.2858	4.2858	#DIV/0!
IC40	4.4018	0.0000	4.4018	4.4018	1.0076
IC50	4.4708	0.0000	4.4708	4.4708	-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

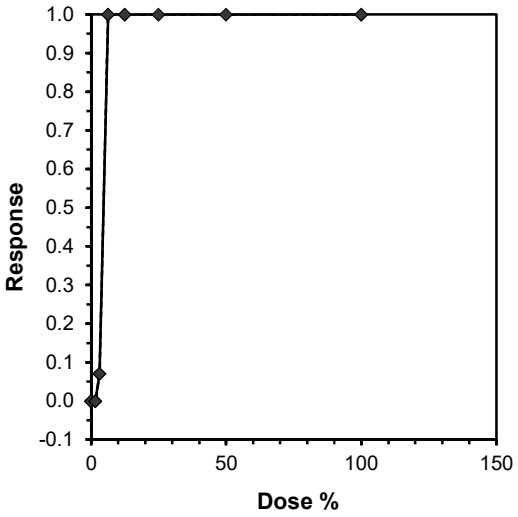
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	16.810	0.9529	16.810	15.760	18.200	6.170	4					
ASW Control	17.640	1.0000	17.640	15.980	19.980	9.971	4	*			17.693	1.0000
1.6	17.745	1.0060	17.745	16.540	18.740	5.583	4	-0.116	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 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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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 GPO Box 175 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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* **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)% **72-hr EC50 = 13.9 (13.41-14.34)%** **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)

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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.

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 GPO Box 175 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. 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)% **72-hr EC50 =12.3 (11.93-12.78)%** **NOEC = 6.3%** **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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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 GPO Box 175 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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	16.9x10^4 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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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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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

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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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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

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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 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 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 Marine Alga	48-h Acute Toxicity Test 1-h Sperm Cell Test	72-h Sperm Cell Test	7-d FIT & Growth	Sediment - Sampling for Porewater	**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** 15558
9-10-19	0600	Yolla-A, A1-5327	Grab	4 x 2 5L	/	/	/	/	/	/	

14 ov
A262

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

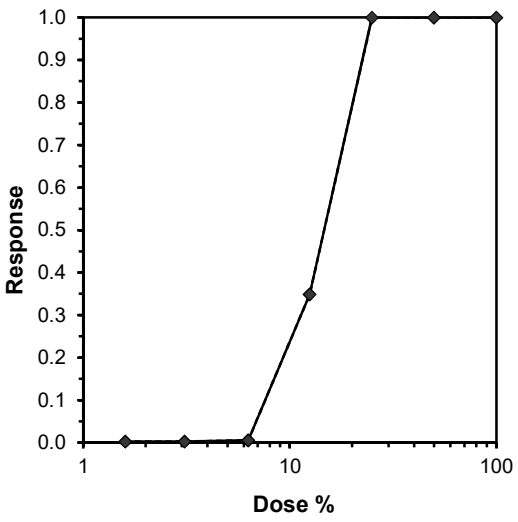
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9525	0.9922	1.3562	1.3030	1.4289	4.120	4				
ASW Control	0.9600	1.0000	1.3736	1.3233	1.4289	3.497	4	*		16	400
1.6	0.9575	0.9974	1.3667	1.3233	1.4289	3.330	4	17.50	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Trimmed Spearman-Karber

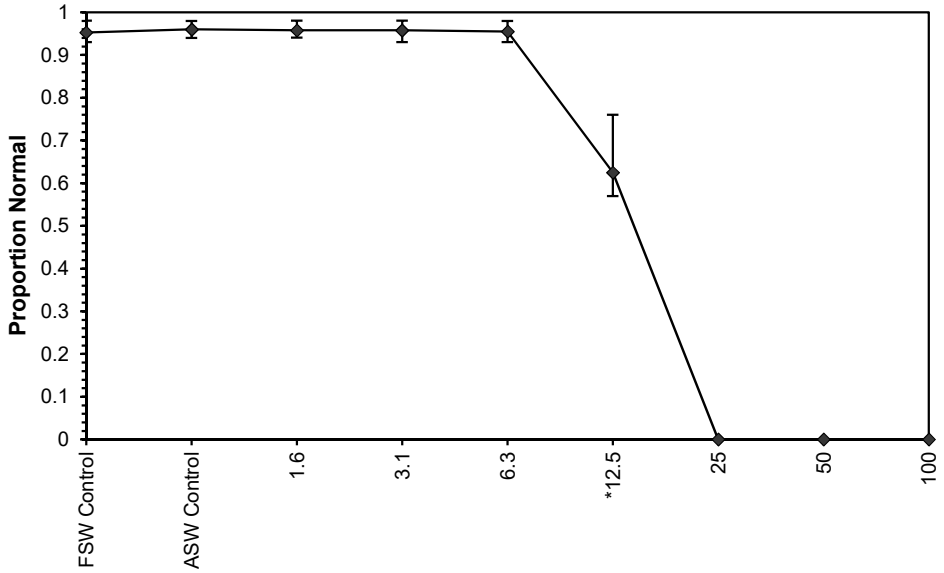
Trim Level	EC50	95% CL	
0.0%			
5.0%	14.019	13.513	14.544
10.0%	14.162	13.577	14.772
20.0%	14.431	13.578	15.337
Auto-0.3%	13.869	13.412	14.340



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

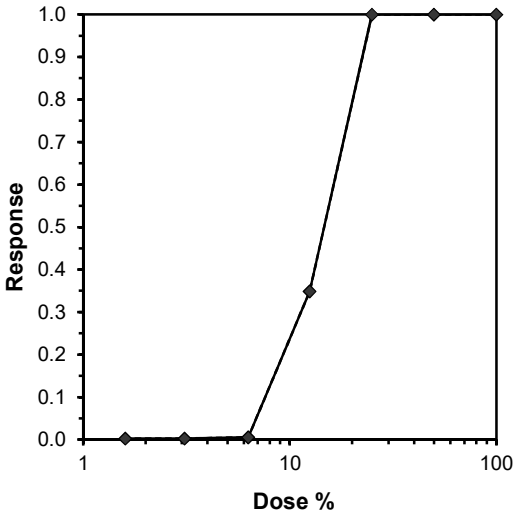
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9525	0.9922	1.3562	1.3030	1.4289	4.120	4				
ASW Control	0.9600	1.0000	1.3736	1.3233	1.4289	3.497	4	*		0.9600	1.0000
1.6	0.9575	0.9974	1.3667	1.3233	1.4289	3.330	4	17.50	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

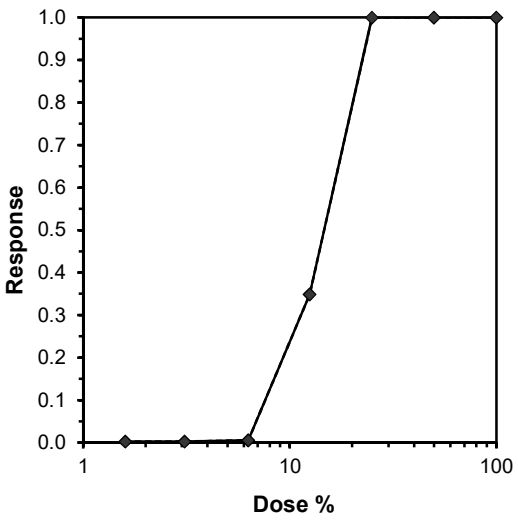
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9525	0.9922	1.3562	1.3030	1.4289	4.120	4				
ASW Control	0.9600	1.0000	1.3736	1.3233	1.4289	3.497	4	*		16	400
1.6	0.9575	0.9974	1.3667	1.3233	1.4289	3.330	4	17.50	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Trimmed Spearman-Karber

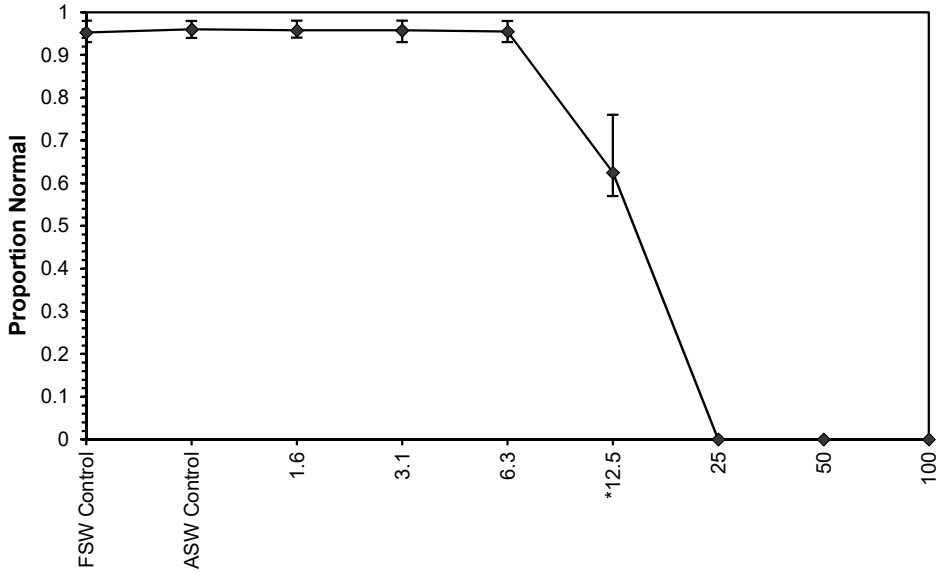
Trim Level	EC50	95% CL	
0.0%			
5.0%	14.019	13.513	14.544
10.0%	14.162	13.577	14.772
20.0%	14.431	13.578	15.337
Auto-0.3%	13.869	13.412	14.340



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

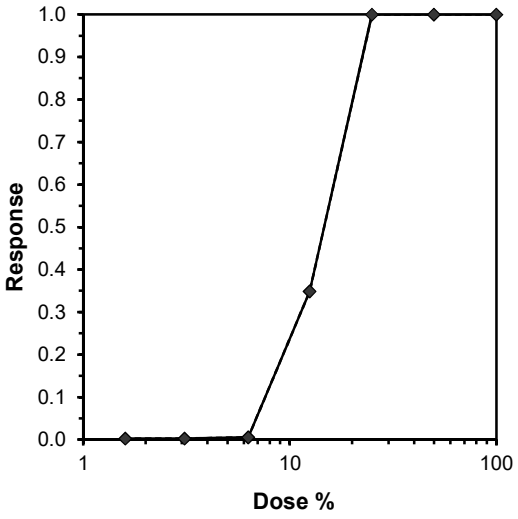
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9525	0.9922	1.3562	1.3030	1.4289	4.120	4				
ASW Control	0.9600	1.0000	1.3736	1.3233	1.4289	3.497	4	*		0.9600	1.0000
1.6	0.9575	0.9974	1.3667	1.3233	1.4289	3.330	4	17.50	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 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

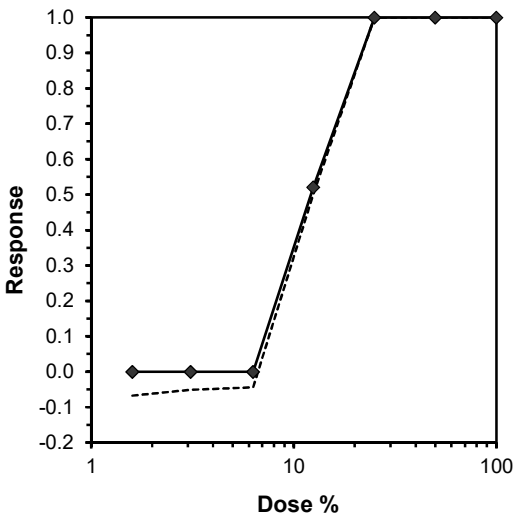
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7675	1.0337	1.0684	1.0244	1.1198	3.694	4					
ASW Control	0.7425	1.0000	1.0391	1.0021	1.0826	3.306	4	*			103	400
1.6	0.7925	1.0673	1.0989	1.0588	1.1593	3.909	4	-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 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

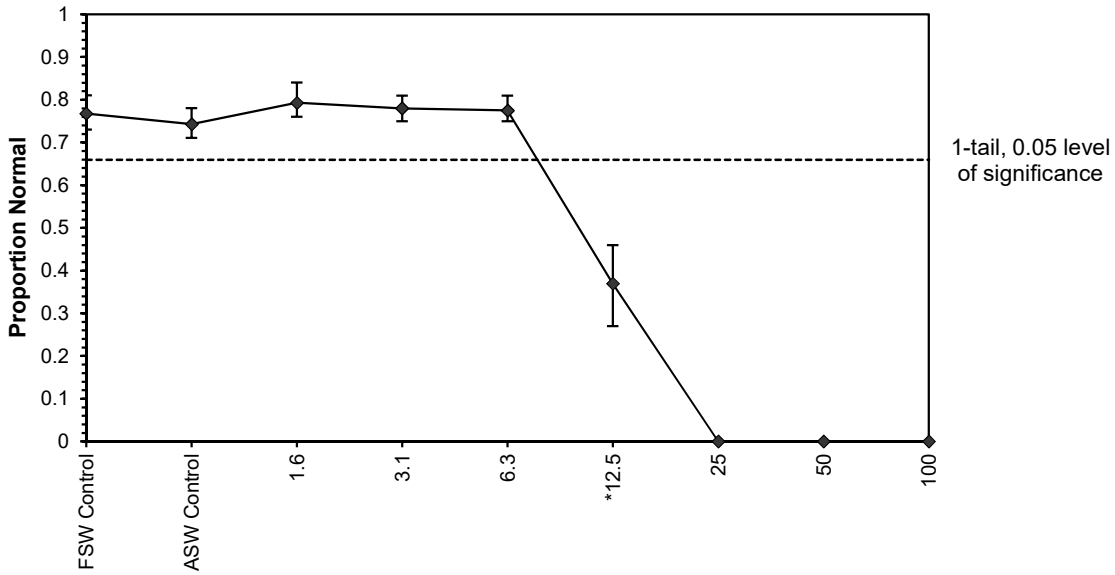
Trim Level	EC50	95% CL	
0.0%	12.345	11.927	12.777
5.0%	12.324	11.862	12.804
10.0%	12.304	11.788	12.843
20.0%	12.264	11.589	12.977
Auto-0.0%	12.345	11.927	12.777



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

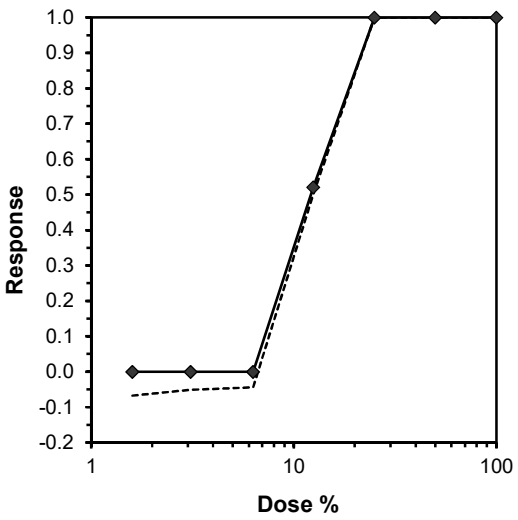
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7675	1.0337	1.0684	1.0244	1.1198	3.694	4					
ASW Control	0.7425	1.0000	1.0391	1.0021	1.0826	3.306	4	*			0.7725	1.0000
1.6	0.7925	1.0673	1.0989	1.0588	1.1593	3.909	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 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

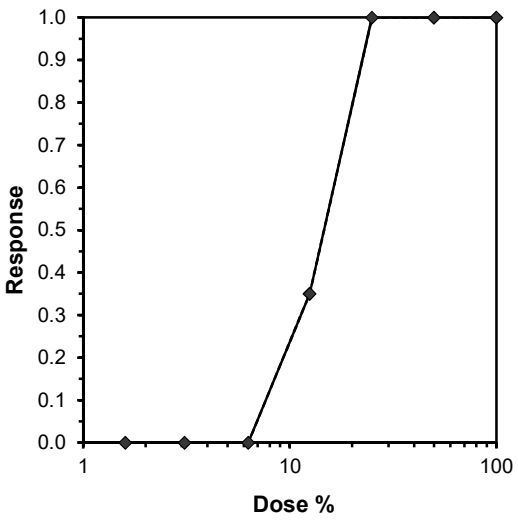
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

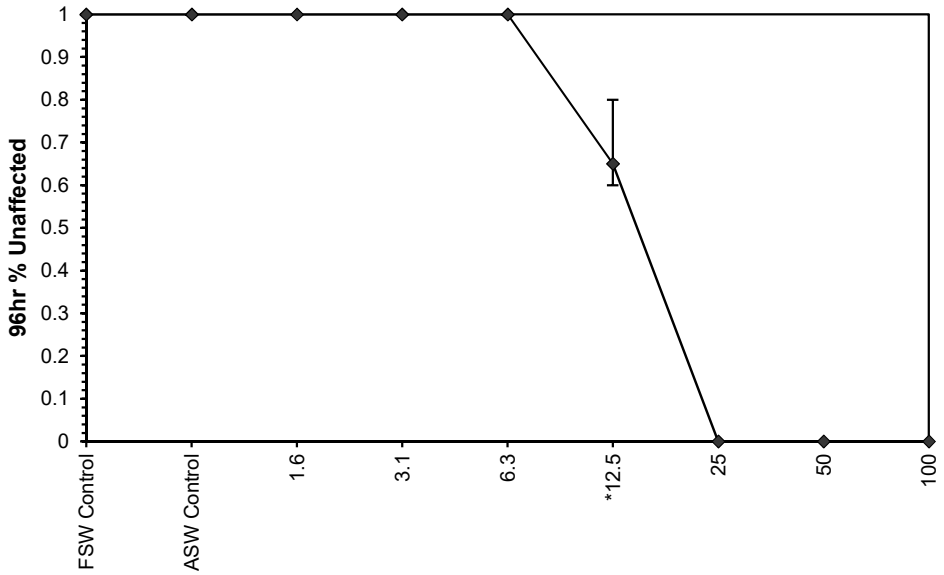
Trim Level	EC50	95% CL	
0.0%	13.889	11.990	16.088
5.0%	14.029	11.901	16.537
10.0%	14.166	11.726	17.114
20.0%	14.425	10.978	18.955
Auto-0.0%	13.889	11.990	16.088



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

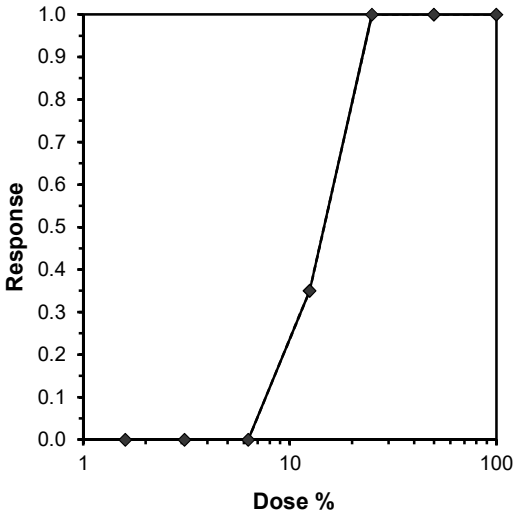
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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				

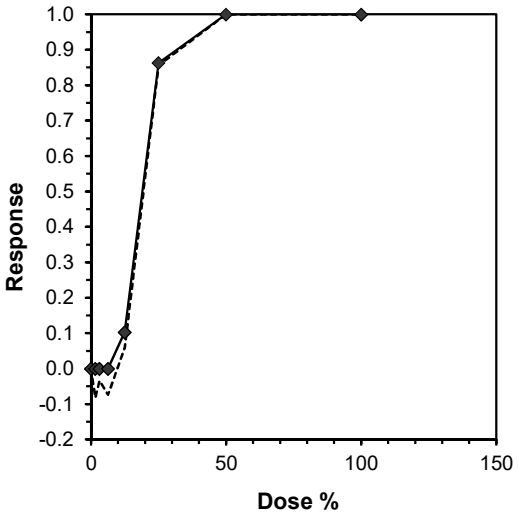
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	15.888	1.0618	15.888	14.463	16.863	5.464	8					
ASW Control	14.963	1.0000	14.963	13.563	15.763	6.988	4	*			15.669	1.0000
1.6	16.188	1.0819	16.188	15.363	16.863	4.109	4	-1.247	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 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)

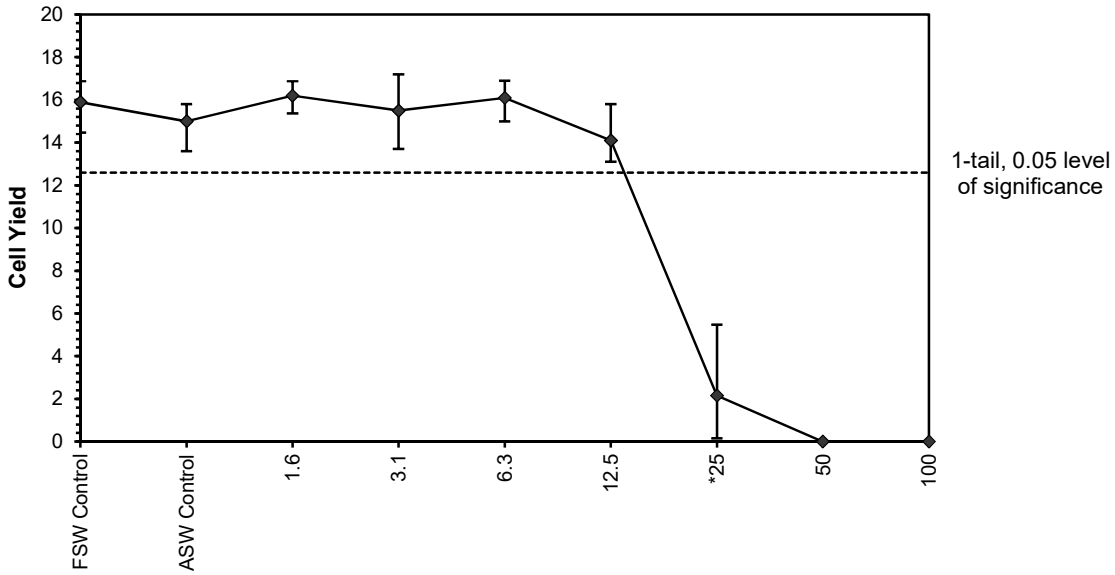
Point	%	SD	95% CL(Exp)		Skew
IC05	9.324	1.595	4.966	14.219	-0.7465
IC10	12.348	1.105	8.325	13.878	-0.2383
IC15	13.281	0.566	11.506	14.673	-0.0083
IC20	14.103	0.510	12.737	15.539	0.5533
IC25	14.924	0.505	13.615	16.409	0.6795
IC40	17.390	0.565	15.933	18.952	0.7747
IC50	19.034	0.654	17.457	21.013	0.7583



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

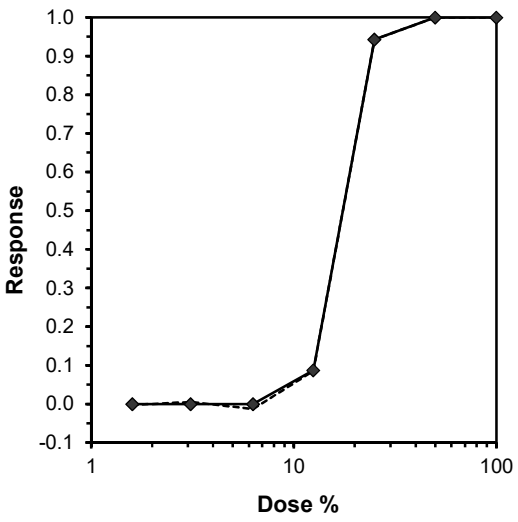
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9725	1.0026	1.4060	1.3694	1.4289	2.042	4					
ASW Control	0.9700	1.0000	1.4085	1.3233	1.4706	5.265	4	*			12	400
1.6	0.9725	1.0026	1.4060	1.3694	1.4289	2.042	4	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 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

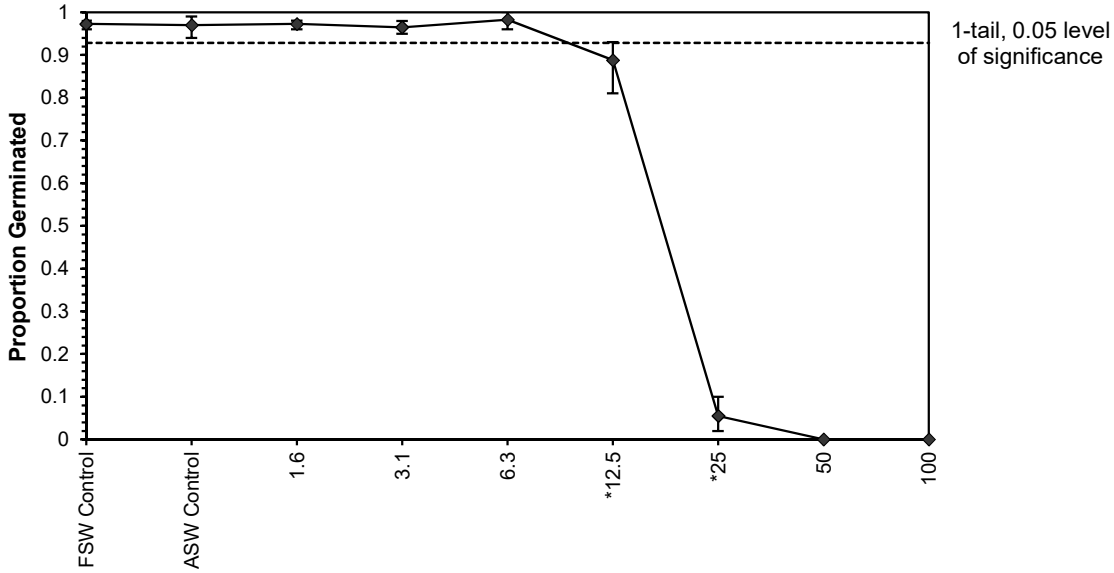
Trim Level	EC50	95% CL	
0.0%	17.310	16.879	17.752
5.0%	17.368	17.005	17.738
10.0%	17.458	17.200	17.720
20.0%	17.458	17.200	17.720
Auto-0.0%	17.310	16.879	17.752



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

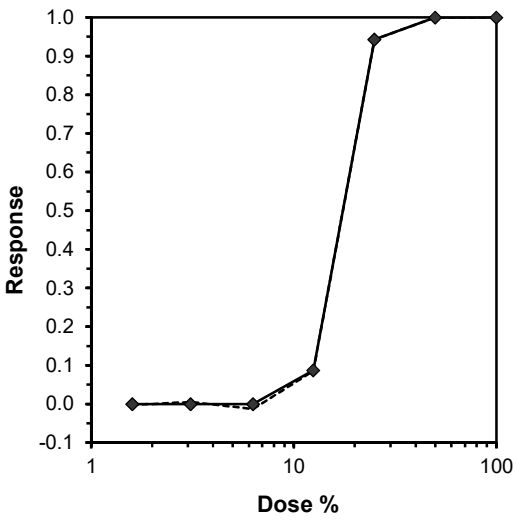
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9725	1.0026	1.4060	1.3694	1.4289	2.042	4					
ASW Control	0.9700	1.0000	1.4085	1.3233	1.4706	5.265	4	*			0.9725	1.0000
1.6	0.9725	1.0026	1.4060	1.3694	1.4289	2.042	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 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

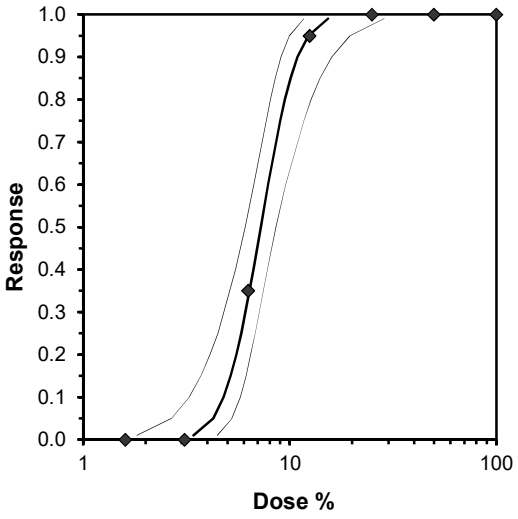
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.772021	0.905	-0.337	3.142347
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

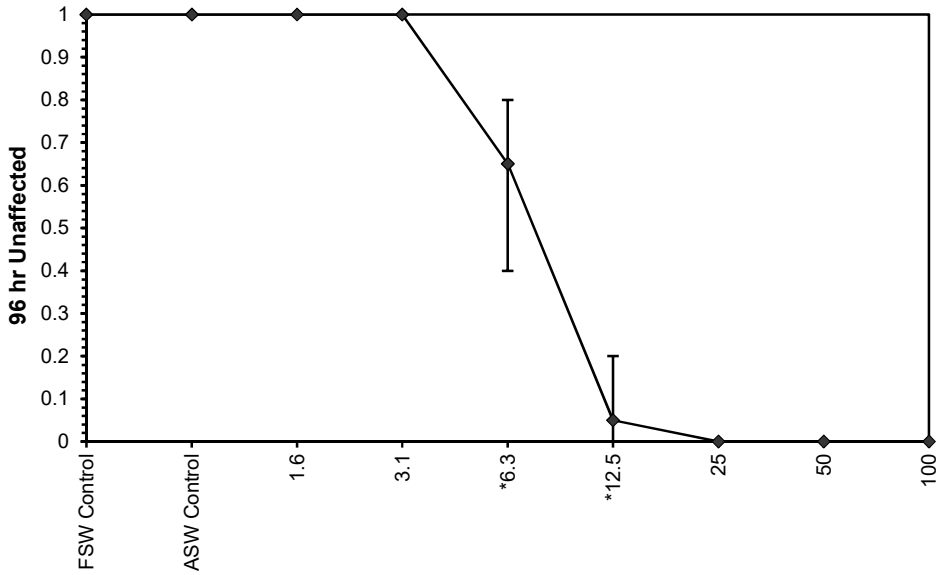
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	3.424425	1.823373	4.459235
EC05	3.355	4.262061	2.668168	5.253962
EC10	3.718	4.789397	3.255165	5.757561
EC15	3.964	5.181574	3.711936	6.141831
EC20	4.158	5.516042	4.110225	6.481224
EC25	4.326	5.820141	4.475316	6.80322
EC40	4.747	6.662855	5.467963	7.796544
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

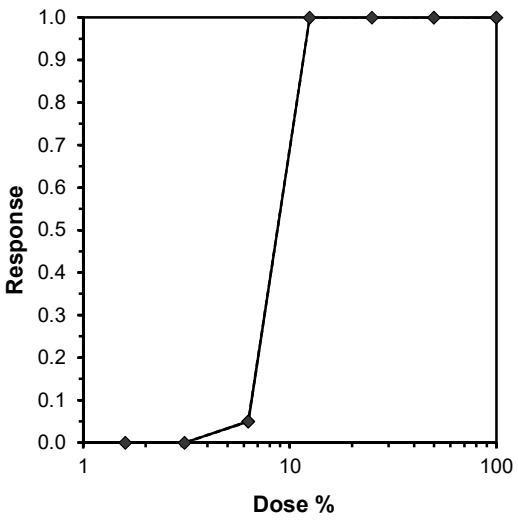
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

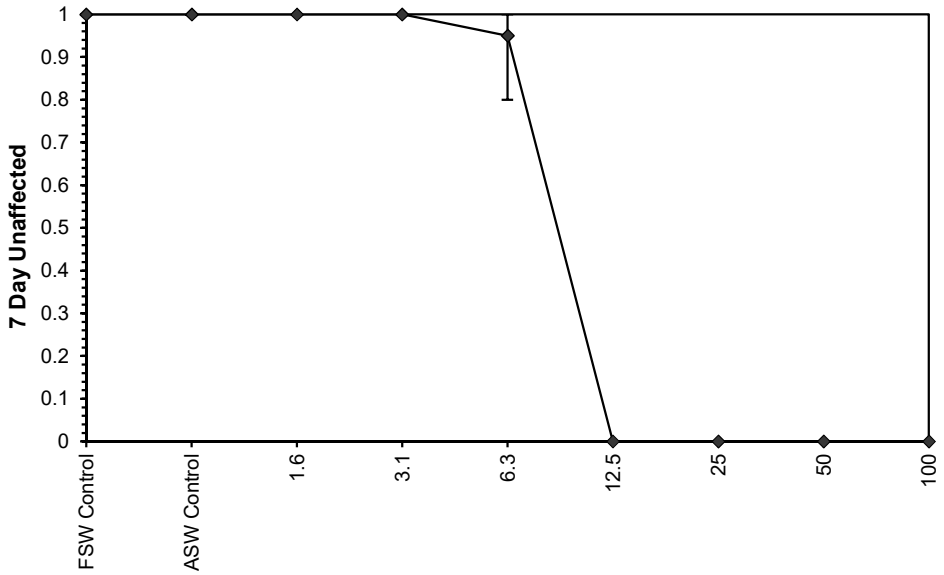
Trim Level	EC50	95% CL	
0.0%	8.5701	8.0071	9.1727
5.0%	8.7155	8.3990	9.0440
10.0%	8.7155	8.3990	9.0440
20.0%	8.7155	8.3990	9.0440
Auto-0.0%	8.5701	8.0071	9.1727



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

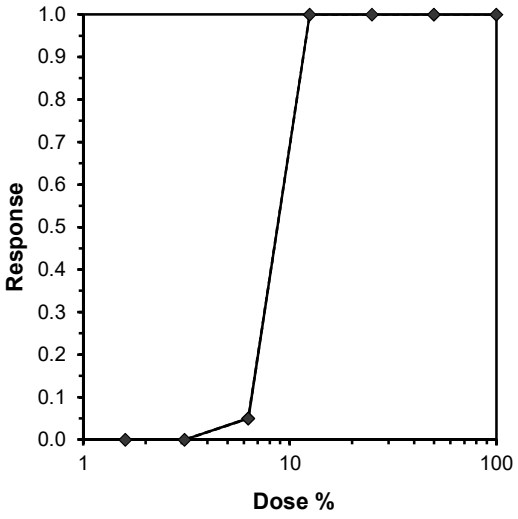
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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

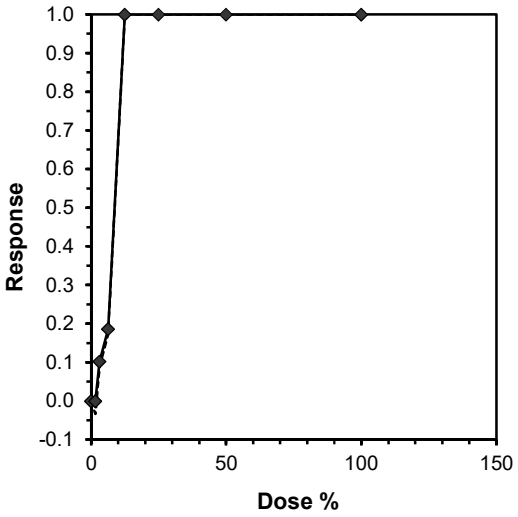
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	23.060	1.0197	23.060	22.160	24.140	3.536	4					
ASW Control	22.615	1.0000	22.615	21.740	23.260	3.077	4	*			22.995	1.0000
1.6	23.375	1.0336	23.375	21.240	26.140	8.708	4	-0.739	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 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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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: TR1978/1

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 16 February 2021 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. 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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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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 16 February 2021 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. 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)% **72-hr EC50 = 9.4 (9.21-9.57)%** **NOEC = 6.3%** **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.

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: TR1978/3

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 16 February 2021 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. 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)% **48-hr EC50 = 8.8 (8.68-8.89)%** **NOEC = 6.3%** **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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 16 February 2021 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. 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.

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Toxicity Test Report: TR1978/5

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 16 February 2021 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. 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.

Toxicity Test Report: TR1978/6

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 16 February 2021 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. 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 x10^4 ± 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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 16 February 2021 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. 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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 16 February 2021 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. 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

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: TR1978/9

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 23 February 2021 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. 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* **Concentration (%)**	**% Fertilised Eggs (Mean ± SD)**	*Vacant*	*Vacant*
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)% **EC50 = 5.2 (4.52-5.52)%** **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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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

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 23 February 2021 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. 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)% **72-hr EC50 = 8.8 (8.74-8.89)%** **NOEC = 6.3%** **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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 23 February 2021 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. 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)% **48-hr EC50 = 8.4 (8.27-8.60)%** **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: 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.

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: TR1978/12

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 23 February 2021 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. 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	**ESA Job #:**	PR1978
	Level 15, 150 Lonsdale Street	**Date Sampled:**	23 February 2021
	Melbourne VIC 3000	**Date Received:**	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. 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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 23 February 2021 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. 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 x10^4 ± 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)% **72-hr IC50 = 11.9 (11.05-12.70)%** **NOEC = 6.3%** **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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 23 February 2021 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. 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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 23 February 2021 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. 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

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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: TR1978/17

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 02 March 2021 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. 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

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Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 02 March 2021 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. 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.

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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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 02 March 2021 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. 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)% **48-hr EC50 = 3.6 (3.47-3.70)%** **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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ABN 95 619 426 201

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

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: TR1978/20

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 02 March 2021 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. 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)%		
72-hr EC50 = 15.5 (14.02-15.89)%		
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: TR1978/20

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 Level 15, 150 Lonsdale Street 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. 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.
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.

Toxicity Test Report: TR1978/22

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1978 02 March 2021 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. 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 x10^4 ± 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 Level 15, 150 Lonsdale Street 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. 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.
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: TR1978/24

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street 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. 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

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ABN 95619426201
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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 Algal Growth	Acute Inhibition to Seed Germination	Chronic Fish Test	Sub-Sampling Instructions	Comments / Instructions
16/2/2021	18:00	YO160221-1	Grab	4 x 250ml	✓	✓	✓	✓	✓	✓	Beach Energy Work Order # 3600489
"	"	YO160221-2	"	"	✓	✓	✓	✓	✓	✓	"
"	"	YO160221-3	"	"	✓	✓	✓	✓	✓	✓	"
"	"	YO160221-4	"	"	✓	✓	✓	✓	✓	✓	"

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 478

ESA Project Number: PR 1858

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

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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 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)

9°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
					As per PER178-401						**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** 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							

9966

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

9983

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 QUOTE PL1978	**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* 1978 **ESA Project Number: PR** ~~1858~~
2/3/21	18:00	YO 020321 - 1	GRAB	1 x 2.5L		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		" "

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: 1905	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

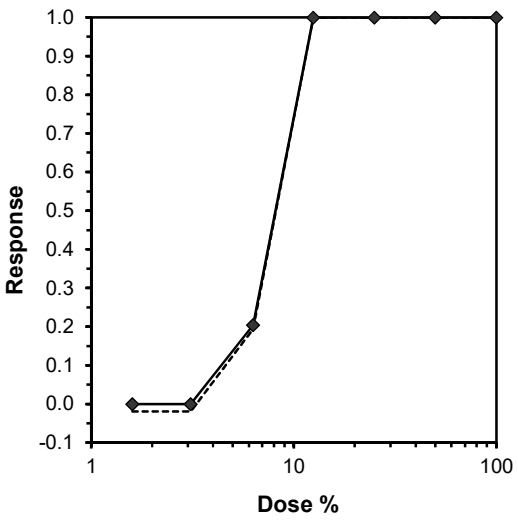
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9400	1.0273	1.3260	1.2661	1.3694	3.331	4					
ASW Control	0.9150	1.0000	1.2756	1.2490	1.3030	1.821	4	*			34	400
1.6	0.9325	1.0191	1.3094	1.2661	1.3453	2.570	4	-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

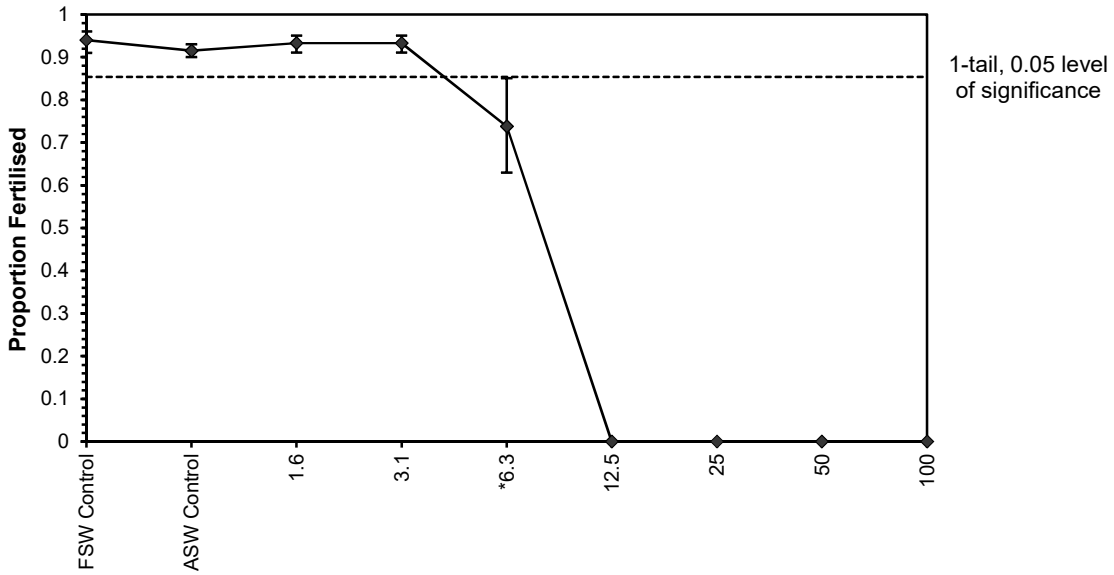
Trim Level	EC50	95% CL	
0.0%	7.6969	7.4837	7.9163
5.0%	7.8521	7.6039	8.1083
10.0%	7.9849	7.6784	8.3037
20.0%	8.1273	7.5912	8.7013
Auto-0.0%	7.6969	7.4837	7.9163



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

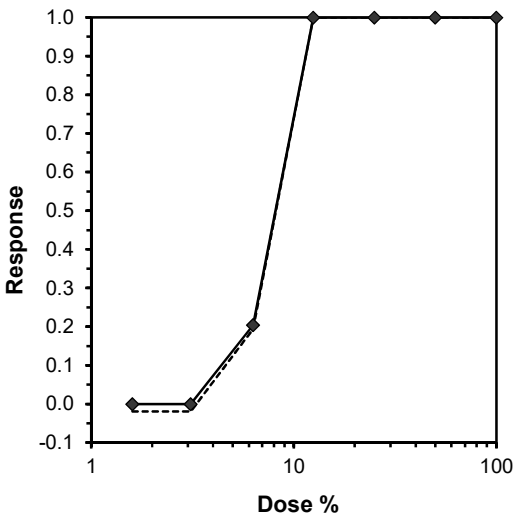
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9400	1.0273	1.3260	1.2661	1.3694	3.331	4					
ASW Control	0.9150	1.0000	1.2756	1.2490	1.3030	1.821	4	*			0.9267	1.0000
1.6	0.9325	1.0191	1.3094	1.2661	1.3453	2.570	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 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)

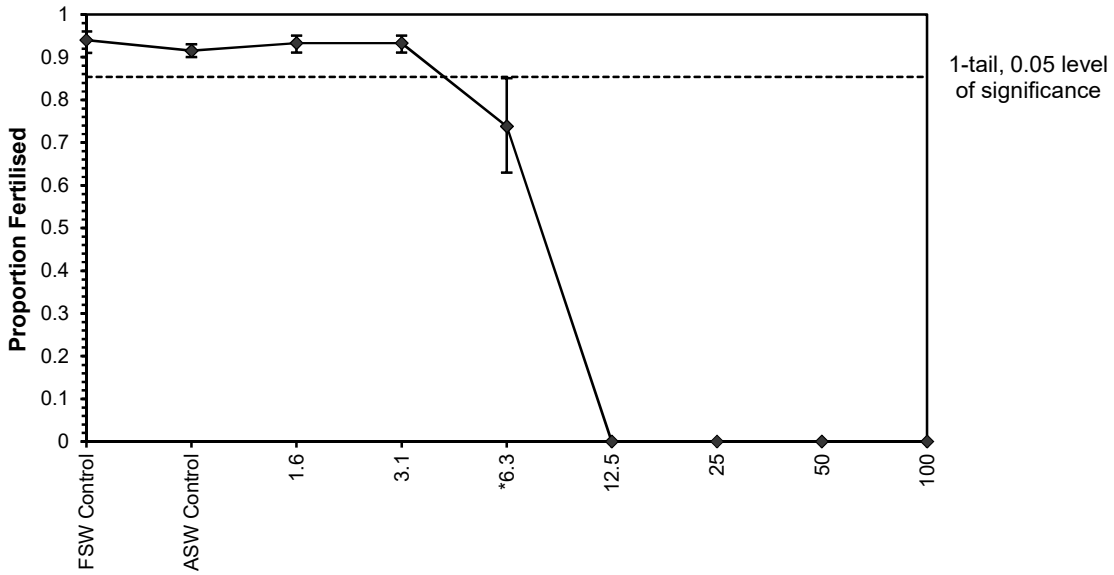
Point	%	SD	95% CL(Exp)		Skew
IC05	4.0458	0.1811	3.6809	4.7902	1.0804
IC10	4.8408	0.3512	4.2192	6.3482	1.2349
IC15	5.5617	0.4211	4.6527	6.8570	0.4524
IC20	6.2445	0.3004	5.0348	6.6241	-0.5946
IC25	6.3923	0.1449	5.7034	6.6947	-1.3406
IC40	6.6628	0.0909	6.4104	6.9580	0.2661
IC50	6.8357	0.0893	6.5881	7.1258	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	

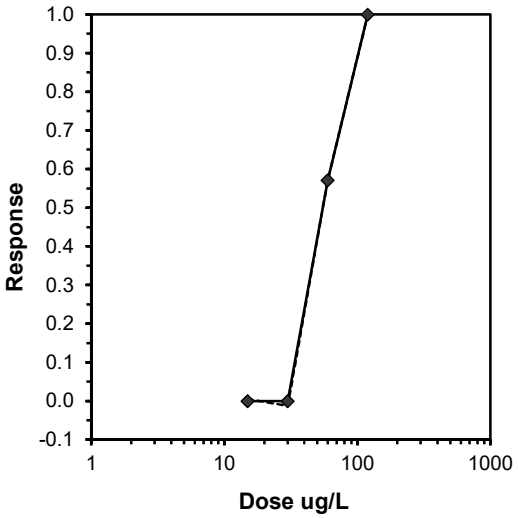
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-ug/L	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9150	1.0000	1.2756	1.2490	1.3030	1.821	4	*			34	400
ASW Control	0.9150	1.0000	1.2756	1.2490	1.3030	1.821	4					
15	0.9100	0.9945	1.2670	1.2490	1.3030	2.460	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

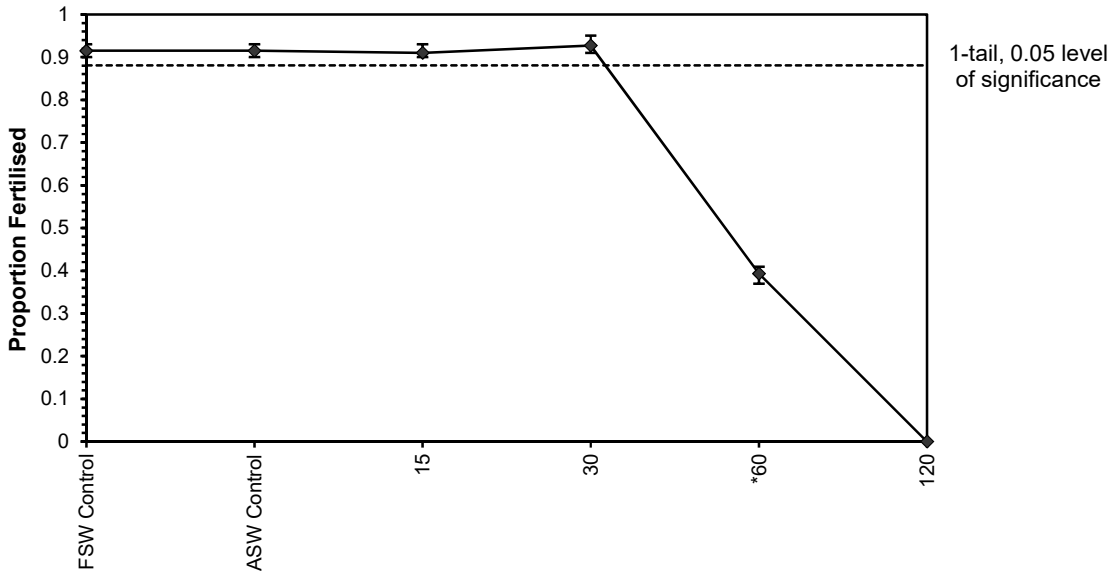
Trim Level	EC50	95% CL	
0.0%	57.112	54.894	59.420
5.0%	56.832	54.392	59.381
10.0%	56.554	53.854	59.390
20.0%	56.011	52.597	59.647
Auto-0.0%	57.112	54.894	59.420



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

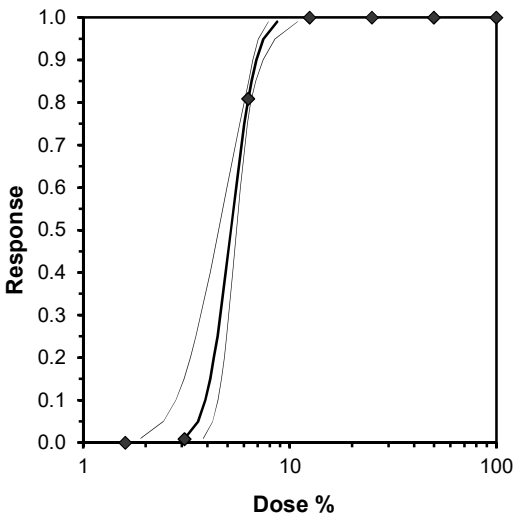
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.889811	0.887	1.50593	3.794957
Bartlett's Test indicates equal variances (p = 0.05)	7.665179	11.34487		
The control means are not significantly different (p = 1.00)	0	2.446912		

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							

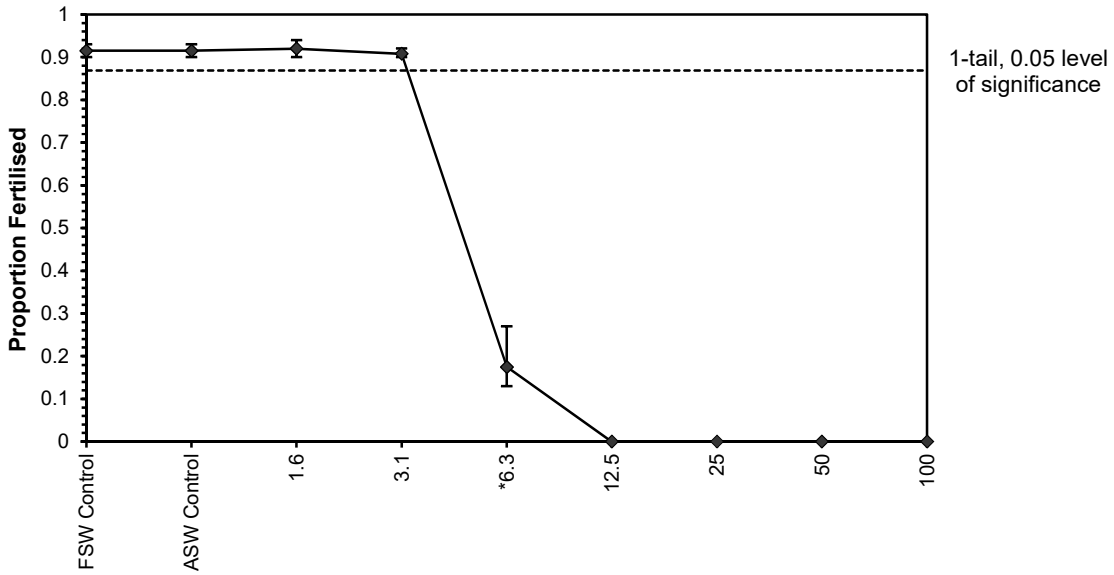
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	3.095439	1.900467	3.80577
EC05	3.355	3.600858	2.451586	4.239765
EC10	3.718	3.903209	2.807651	4.491598
EC15	3.964	4.12142	3.076399	4.670309
EC20	4.158	4.303514	3.307983	4.817748
EC25	4.326	4.466134	3.520258	4.948289
EC40	4.747	4.903682	4.11558	5.295659
EC50	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

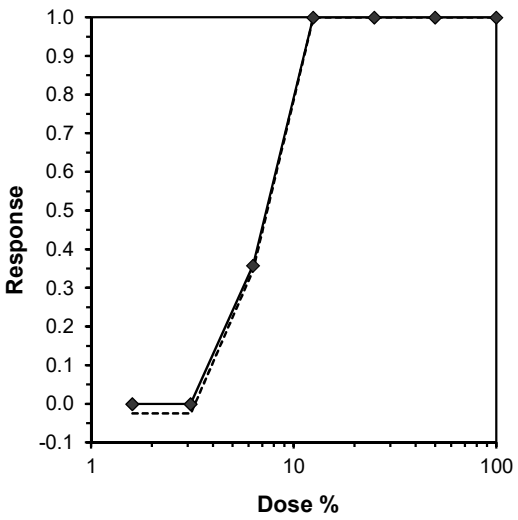
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9350	1.0219	1.3155	1.2661	1.3694	3.274	4					
ASW Control	0.9150	1.0000	1.2778	1.2327	1.3453	3.900	4	*			34	400
1.6	0.9375	1.0246	1.3223	1.2661	1.3967	4.158	4	-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 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

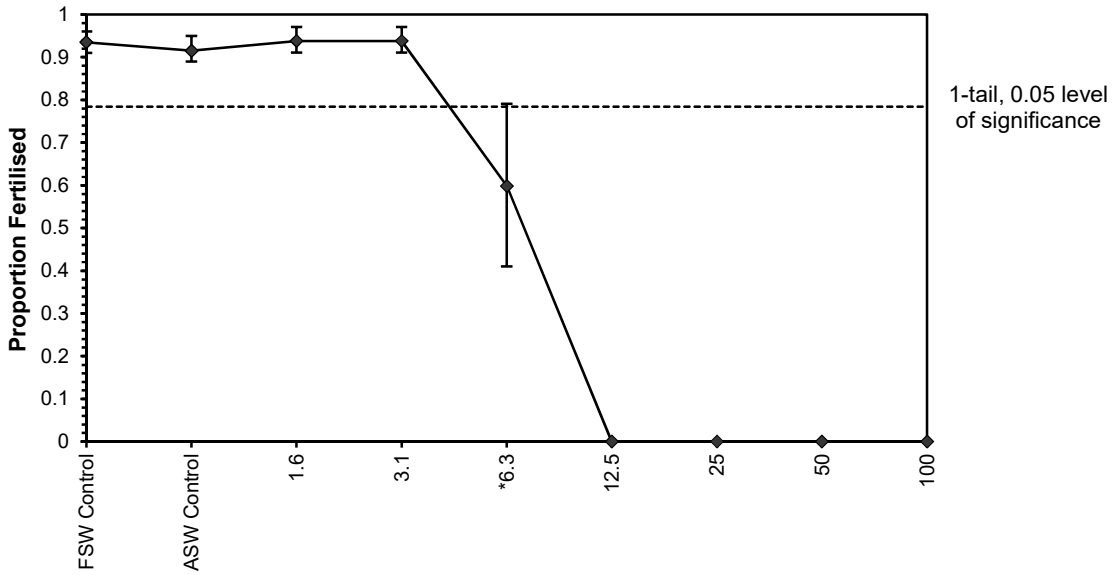
Trim Level	EC50	95% CL	
0.0%	6.9163	6.6890	7.1513
5.0%	6.9888	6.7324	7.2550
10.0%	7.0603	6.7636	7.3700
20.0%	7.1960	6.7641	7.6555
Auto-0.0%	6.9163	6.6890	7.1513



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

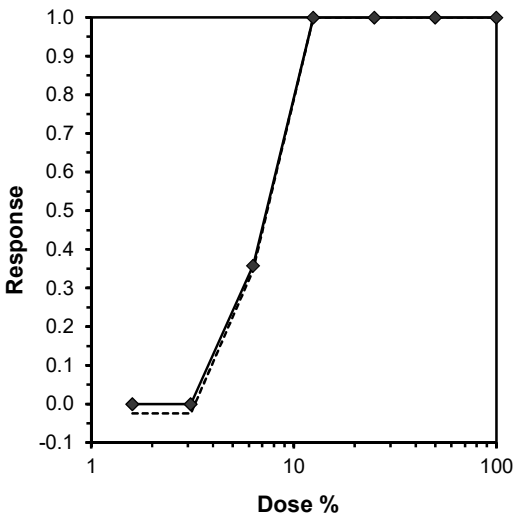
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9350	1.0219	1.3155	1.2661	1.3694	3.274	4					
ASW Control	0.9150	1.0000	1.2778	1.2327	1.3453	3.900	4	*			0.9300	1.0000
1.6	0.9375	1.0246	1.3223	1.2661	1.3967	4.158	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 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)

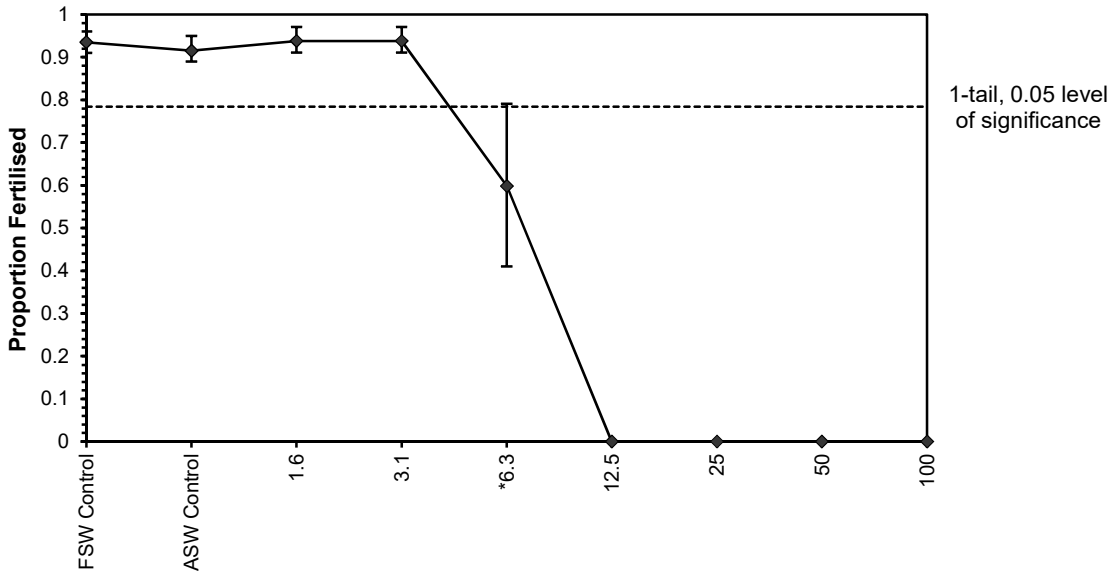
Point	%	SD	95% CL(Exp)		Skew
IC05	3.7520	0.1667	3.3240	4.4882	1.0177
IC10	4.2657	0.2930	3.7315	5.7040	1.4363
IC15	4.7106	0.4211	3.9832	6.8414	1.5300
IC20	5.1168	0.4628	4.1873	7.1323	0.9305
IC25	5.5010	0.4882	4.3683	7.0650	0.4184
IC40	6.3761	0.2962	5.0338	6.9719	-0.7369
IC50	6.5545	0.1901	5.7452	7.1391	-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

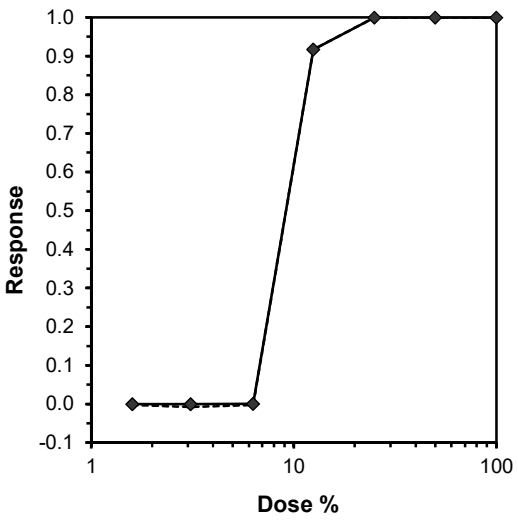
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9675	1.0026	1.3931	1.3453	1.4289	3.048	4					
ASW Control	0.9650	1.0000	1.3851	1.3453	1.4289	2.598	4	*			14	400
1.6	0.9675	1.0026	1.3931	1.3453	1.4289	3.048	4	-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 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

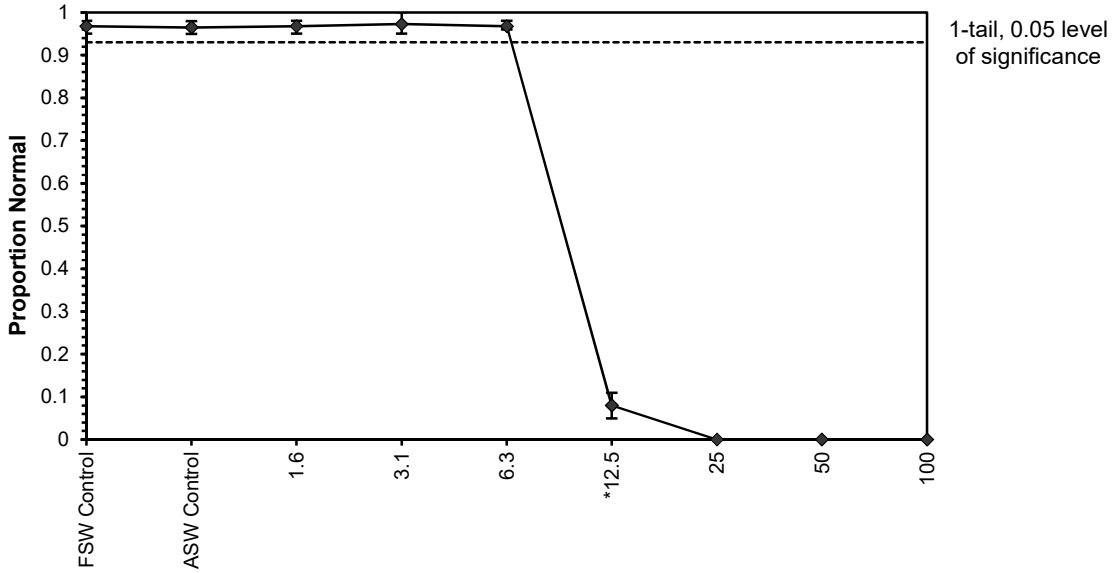
Trim Level	EC50	95% CL	
0.0%	9.3884	9.2109	9.5693
5.0%	9.1909	9.0337	9.3509
10.0%	9.1495	9.0471	9.2530
20.0%	9.1495	9.0471	9.2530
Auto-0.0%	9.3884	9.2109	9.5693



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

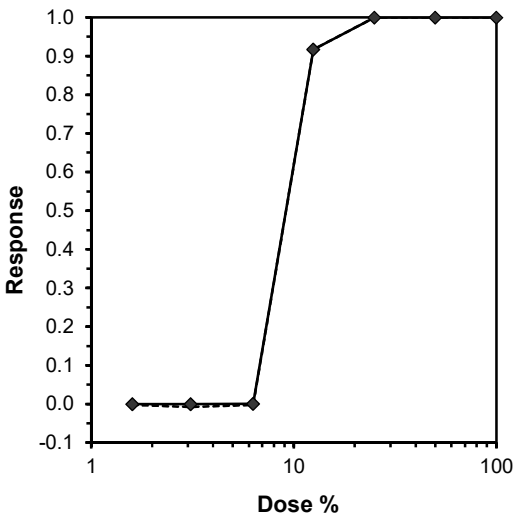
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9675	1.0026	1.3931	1.3453	1.4289	3.048	4					
ASW Control	0.9650	1.0000	1.3851	1.3453	1.4289	2.598	4	*			0.9683	1.0000
1.6	0.9675	1.0026	1.3931	1.3453	1.4289	3.048	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 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)

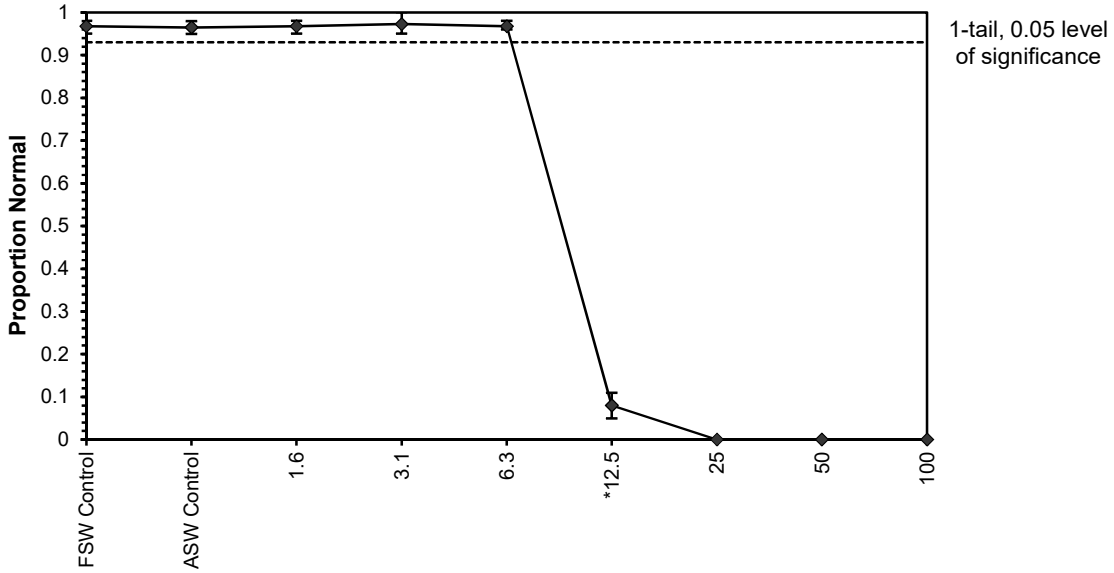
Point	%	SD	95% CL(Exp)		Skew
IC05	7.0703	0.0734	6.7578	7.1815	-0.2633
IC10	7.5310	0.0737	7.2544	7.6688	0.0902
IC15	7.8766	0.0775	7.5889	8.0437	0.1675
IC20	8.1641	0.0821	7.8635	8.3395	0.1658
IC25	8.4177	0.0870	8.1004	8.6024	0.1417
IC40	9.0840	0.1028	8.6997	9.2862	0.0579
IC50	9.5072	0.1148	9.0795	9.7491	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

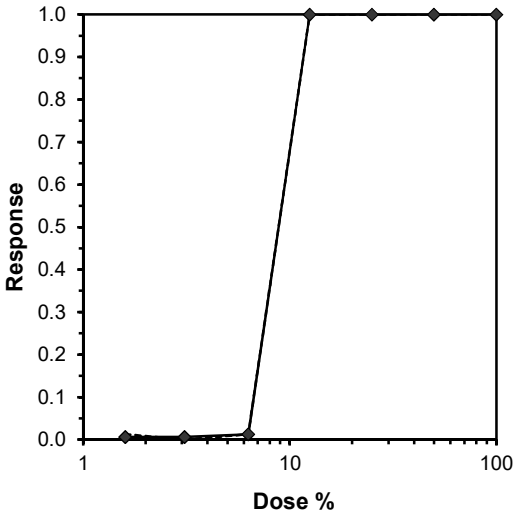
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9700	0.9974	1.4081	1.3453	1.5208	5.542	4					
ASW Control	0.9725	1.0000	1.4060	1.3694	1.4289	2.042	4	*			0.9725	1.0000
1.6	0.9600	0.9871	1.3745	1.3030	1.4289	3.892	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 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)

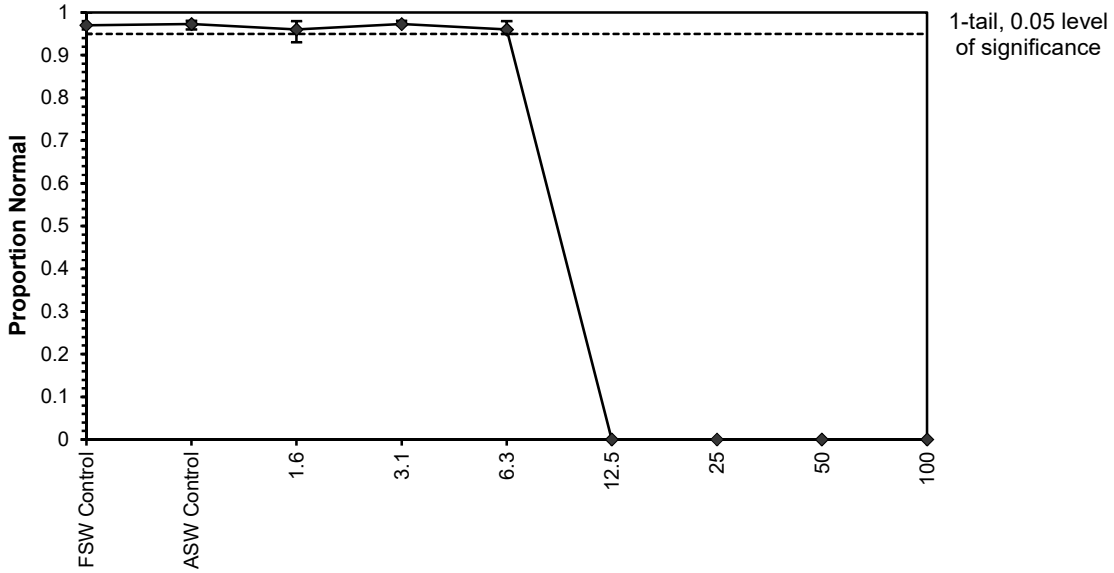
Point	%	SD	95% CL(Exp)		Skew
IC05	6.5513	0.0520	6.3964	6.7112	0.3206
IC10	6.7594	0.0491	6.6195	6.9072	0.3429
IC15	6.9096	0.0478	6.7803	7.0549	0.3441
IC20	7.0314	0.0470	6.9038	7.1746	0.3419
IC25	7.1368	0.0464	7.0107	7.2782	0.3394
IC40	7.4053	0.0448	7.2834	7.5419	0.3332
IC50	7.5705	0.0438	7.4513	7.7040	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

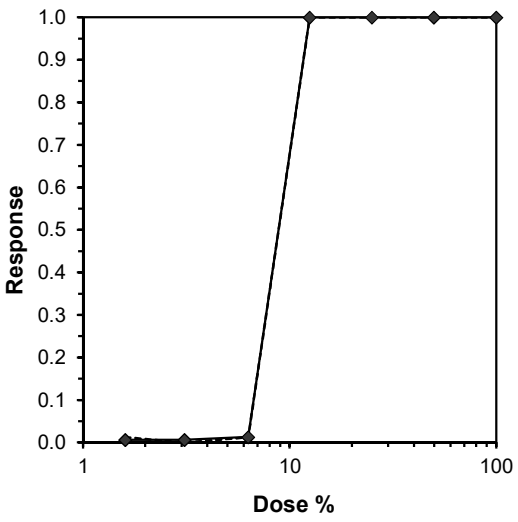
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9700	0.9974	1.4081	1.3453	1.5208	5.542	4					
ASW Control	0.9725	1.0000	1.4060	1.3694	1.4289	2.042	4	*			11	400
1.6	0.9600	0.9871	1.3745	1.3030	1.4289	3.892	4	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 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

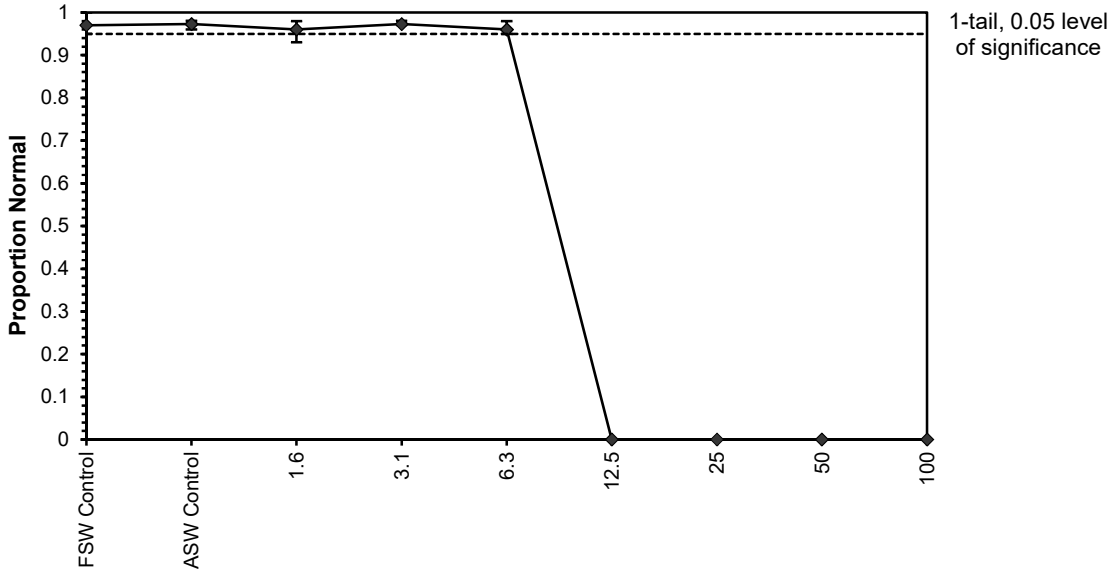
Trim Level	EC50	95% CL	
0.0%			
5.0%	8.8346	8.7997	8.8697
10.0%	8.8346	8.7997	8.8697
20.0%	8.8346	8.7997	8.8697
Auto-0.6%	8.8144	8.7402	8.8892



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

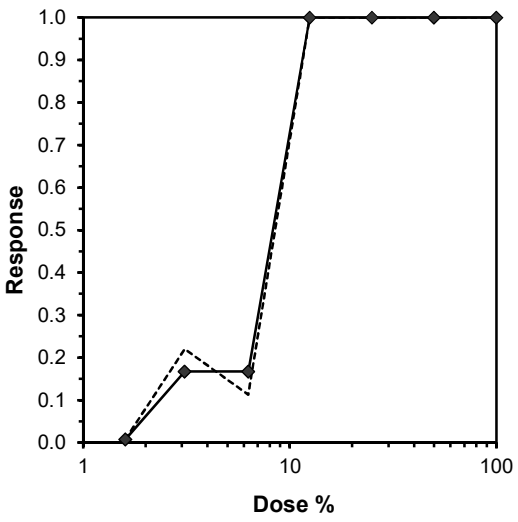
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9550	1.0026	1.3617	1.3030	1.4289	3.860	4					
ASW Control	0.9525	1.0000	1.3536	1.3030	1.3967	2.935	4	*			19	400
1.6	0.9450	0.9921	1.3353	1.3030	1.3694	2.140	4	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 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

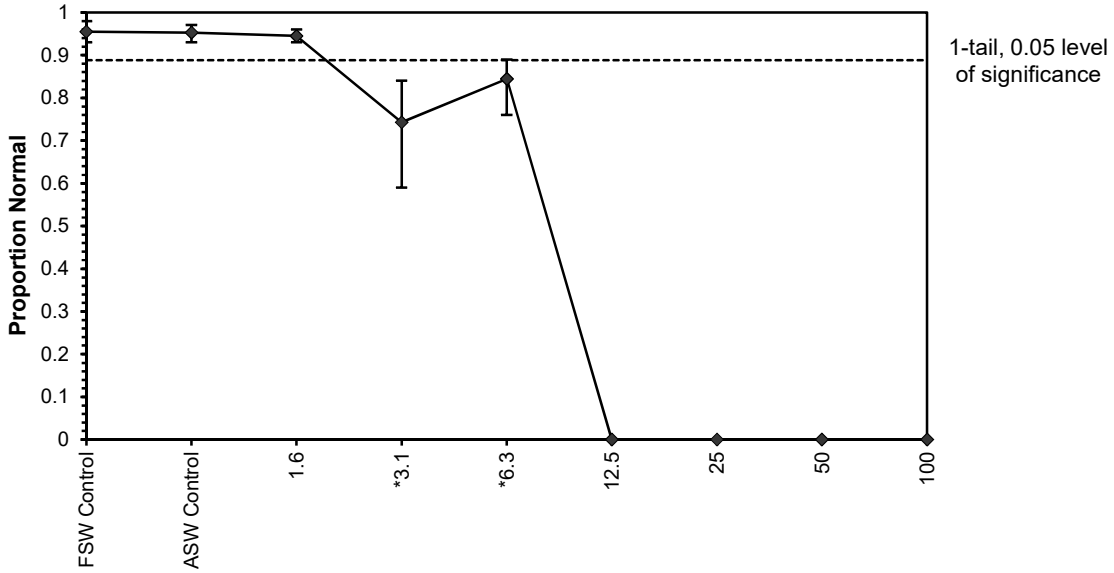
Trim Level	EC50	95% CL	
0.0%			
5.0%	7.3700	7.0823	7.6693
10.0%	7.7387	7.4212	8.0699
20.0%	8.2864	8.1355	8.4402
Auto-0.8%	7.0808	6.8227	7.3487



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

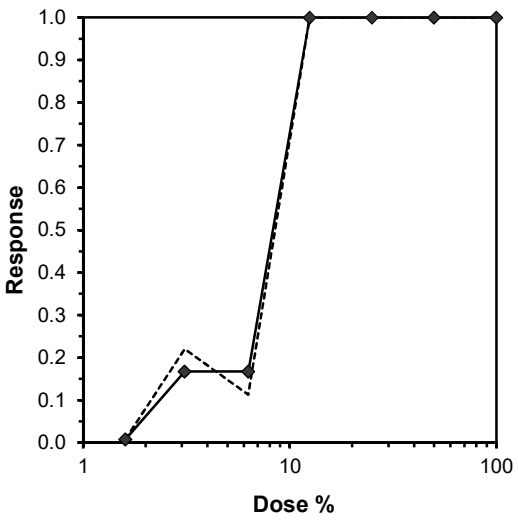
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9550	1.0026	1.3617	1.3030	1.4289	3.860	4					
ASW Control	0.9525	1.0000	1.3536	1.3030	1.3967	2.935	4	*			0.9525	1.0000
1.6	0.9450	0.9921	1.3353	1.3030	1.3694	2.140	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 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)

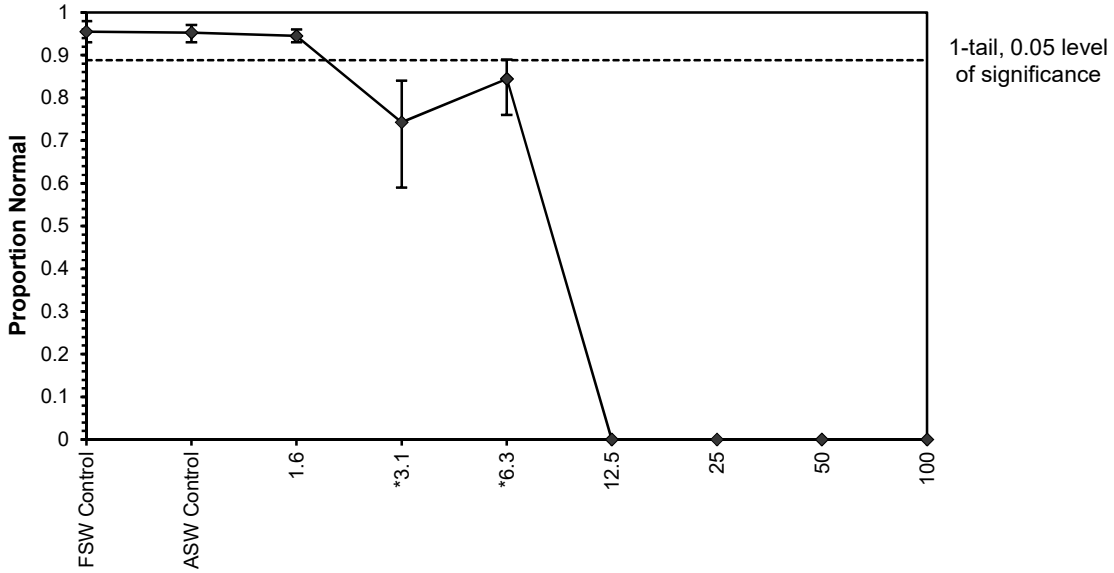
Point	%	SD	95% CL(Exp)		Skew
IC05	2.1127	0.1082	1.7900	2.4165	0.1195
IC10	2.5806	0.3007	2.2352	3.1146	9.4537
IC15	2.9772	1.5775	2.5158	8.4430	0.8945
IC20	6.3786	1.0993	0.9704	6.5936	-2.3462
IC25	6.4855	0.0678	6.3000	6.7005	0.1202
IC40	6.7647	0.0652	6.5860	6.9729	0.1268
IC50	6.9398	0.0638	6.7645	7.1435	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

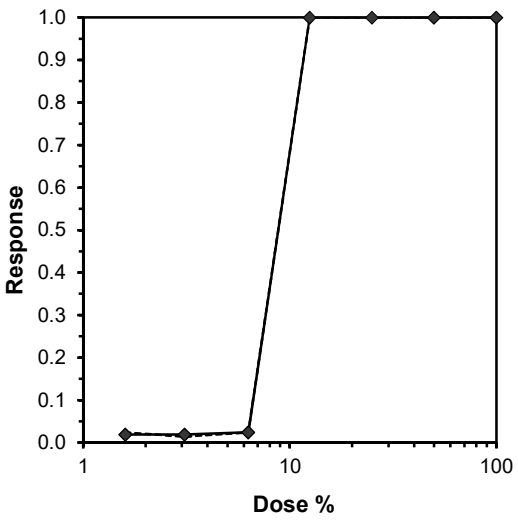
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7075	0.9826	0.9996	0.9803	1.0357	2.619	4					
ASW Control	0.7200	1.0000	1.0144	0.9695	1.0948	5.587	4	*			112	400
1.6	0.7025	0.9757	0.9941	0.9695	1.0244	2.448	4	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 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

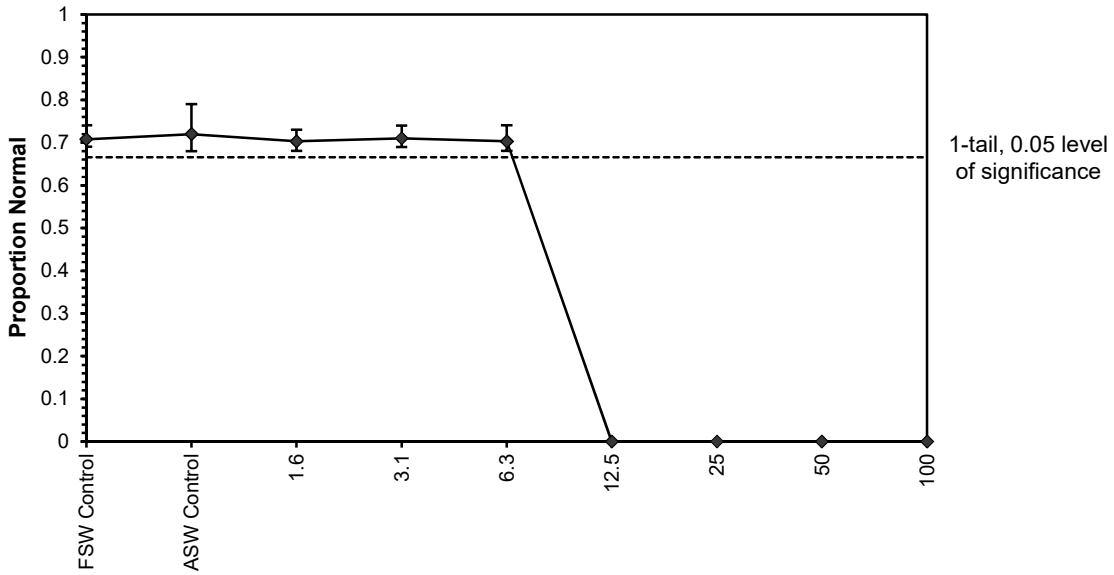
Trim Level	EC50	95% CL	
0.0%			
5.0%	8.7987	8.7501	8.8476
10.0%	8.7987	8.7501	8.8476
20.0%	8.7987	8.7501	8.8476
Auto-1.9%	8.7819	8.6750	8.8901



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

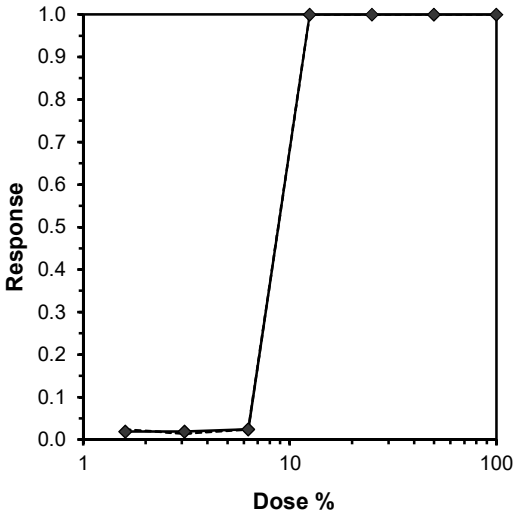
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7075	0.9826	0.9996	0.9803	1.0357	2.619	4					
ASW Control	0.7200	1.0000	1.0144	0.9695	1.0948	5.587	4	*			0.7200	1.0000
1.6	0.7025	0.9757	0.9941	0.9695	1.0244	2.448	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 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)

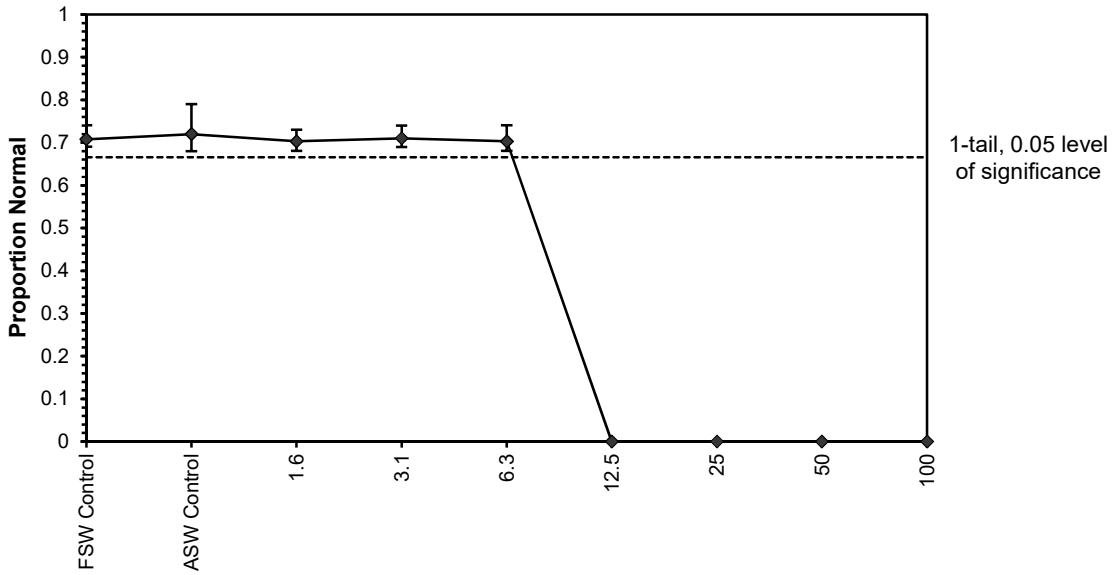
Point	%	SD	95% CL(Exp)		Skew
IC05	6.3389	1.9079	0.0000	6.3946	-1.5964
IC10	6.4118	0.1277	6.2621	6.4636	-12.4284
IC15	6.4821	0.0335	6.3421	6.5306	-0.6303
IC20	6.5506	0.0315	6.4219	6.5964	-0.6105
IC25	6.6182	0.0298	6.4974	6.6620	-0.5930
IC40	6.8228	0.0262	6.7177	6.8629	-0.5505
IC50	6.9683	0.0245	6.8675	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

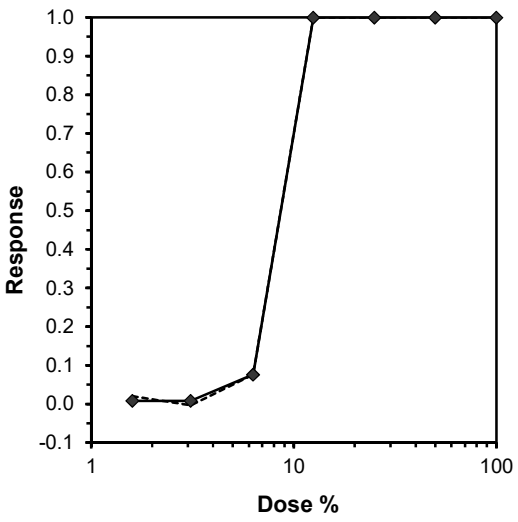
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7550	1.0272	1.0534	1.0244	1.0948	2.948	4	*			98	400
ASW Control	0.7350	1.0000	1.0304	0.9912	1.0588	2.893	4					
1.6	0.7400	1.0068	1.0367	0.9803	1.0948	4.597	4	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 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

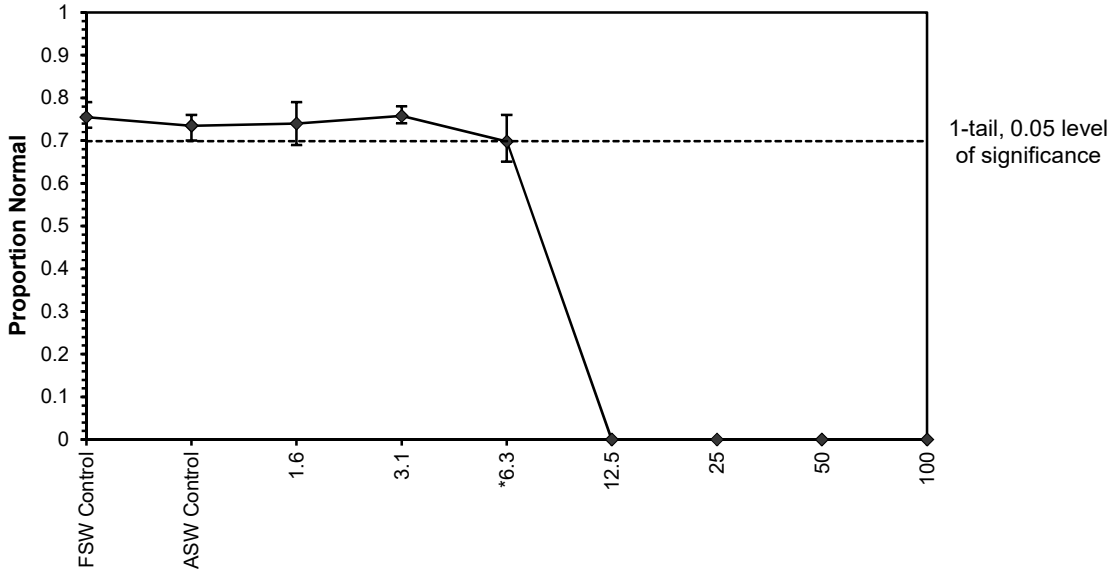
Trim Level	EC50	95% CL	
0.0%			
5.0%	8.5952	8.3874	8.8082
10.0%	8.6270	8.5356	8.7193
20.0%	8.6270	8.5356	8.7193
Auto-0.8%	8.4331	8.2737	8.5956



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

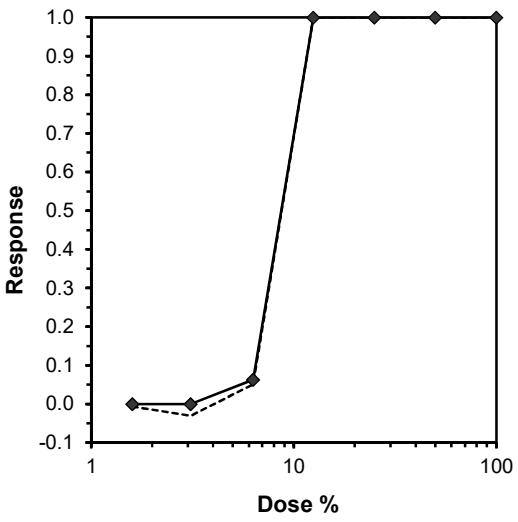
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7550	1.0272	1.0534	1.0244	1.0948	2.948	4					
ASW Control	0.7350	1.0000	1.0304	0.9912	1.0588	2.893	4	*			0.7442	1.0000
1.6	0.7400	1.0068	1.0367	0.9803	1.0948	4.597	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 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)

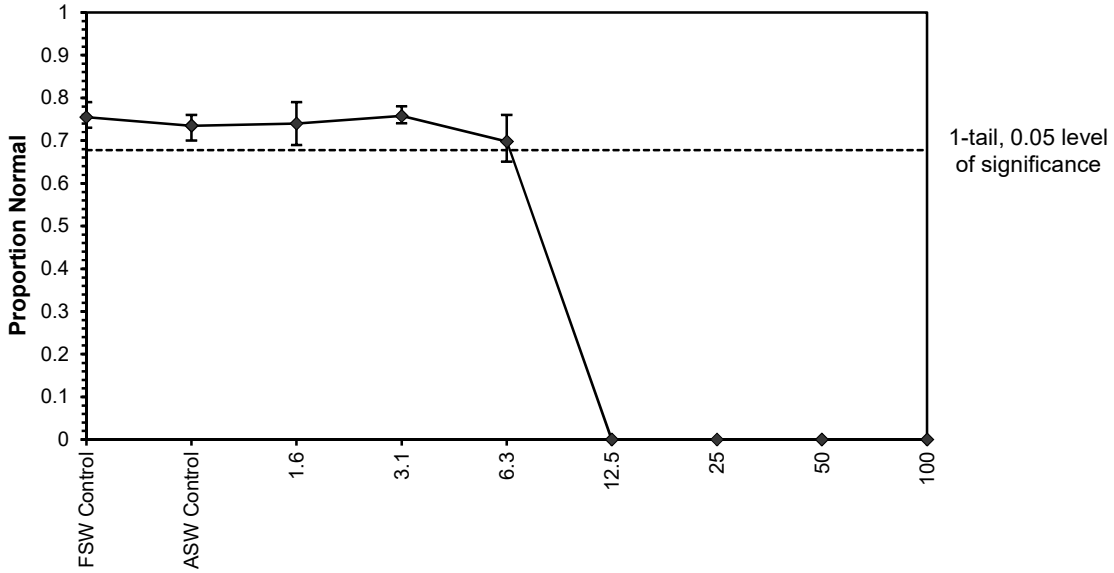
Point	%	SD	95% CL(Exp)		Skew
IC05	5.5244	0.7400	3.4417	6.8775	-0.0480
IC10	6.3576	0.1705	5.3561	6.5022	-3.0444
IC15	6.4318	0.0430	6.2996	6.5764	0.1431
IC20	6.5036	0.0424	6.3730	6.6476	0.1509
IC25	6.5739	0.0419	6.4448	6.7147	0.1570
IC40	6.7846	0.0406	6.6594	6.9175	0.1694
IC50	6.9330	0.0398	6.8102	7.0615	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

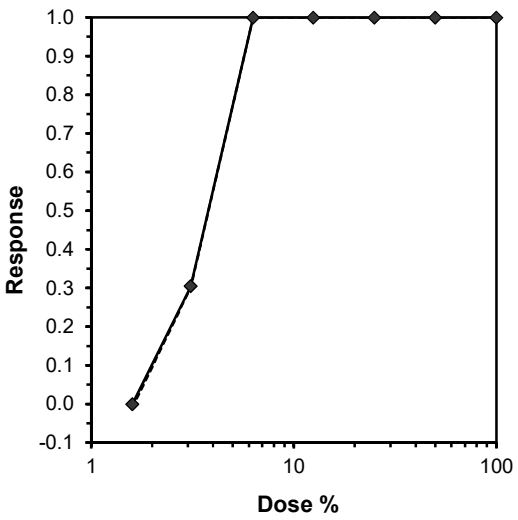
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7675	0.9746	1.0689	1.0021	1.1198	4.776	4					
ASW Control	0.7875	1.0000	1.0921	1.0588	1.1198	2.474	4	*			85	400
1.6	0.7950	1.0095	1.1015	1.0588	1.1326	2.951	4	-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 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

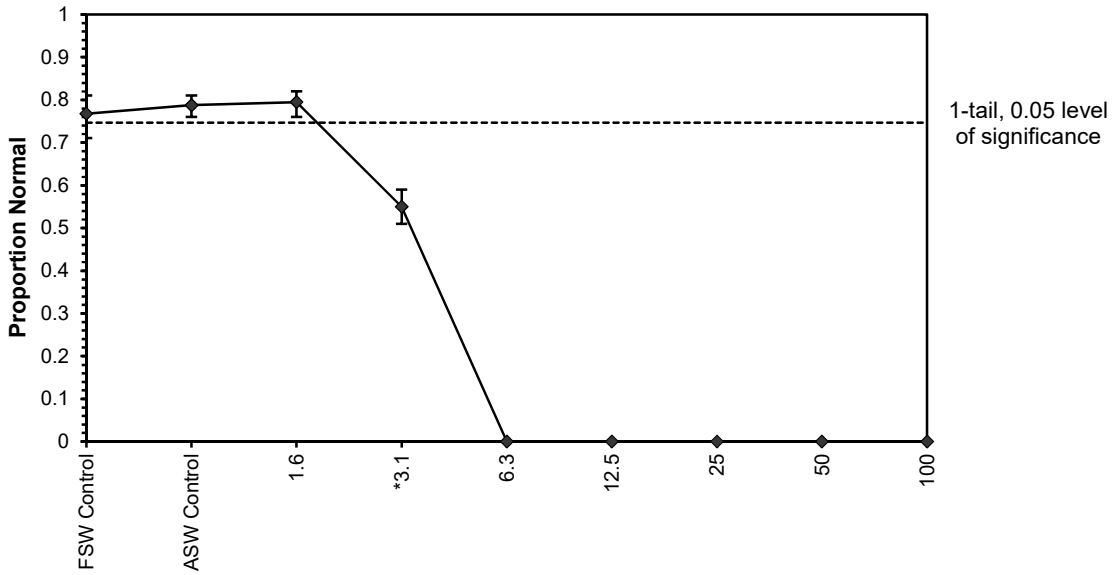
Trim Level	EC50	95% CL	
0.0%	3.5860	3.4746	3.7009
5.0%	3.6291	3.5028	3.7599
10.0%	3.6704	3.5227	3.8242
20.0%	3.7431	3.5207	3.9795
Auto-0.0%	3.5860	3.4746	3.7009



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

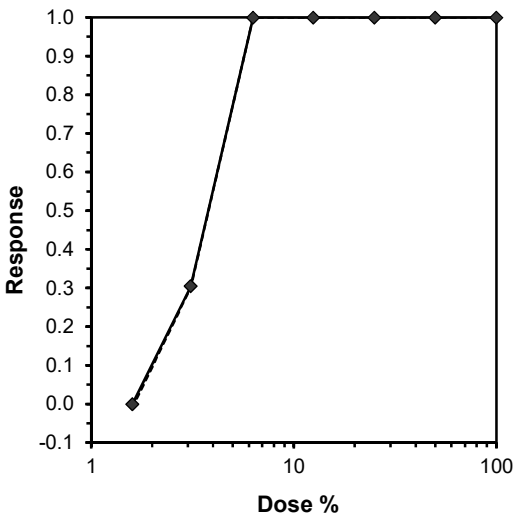
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7675	0.9746	1.0689	1.0021	1.1198	4.776	4					
ASW Control	0.7875	1.0000	1.0921	1.0588	1.1198	2.474	4	*			0.7913	1.0000
1.6	0.7950	1.0095	1.1015	1.0588	1.1326	2.951	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 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)

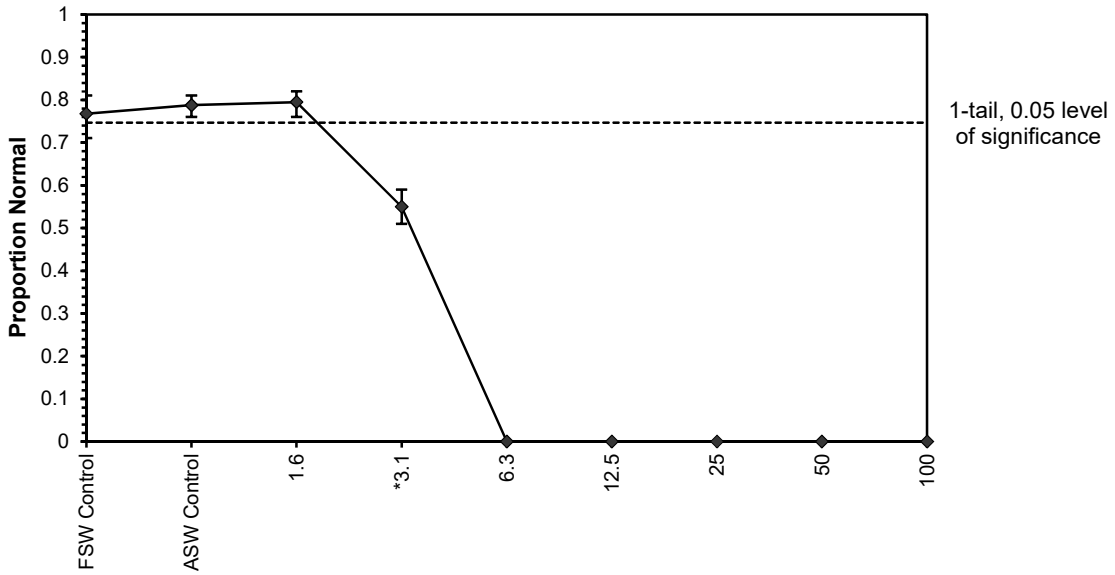
Point	%	SD	95% CL(Exp)		Skew
IC05	1.8462	0.0443	1.6141	1.8957	-2.6331
IC10	2.0872	0.0468	1.8892	2.1914	-1.3638
IC15	2.3270	0.0556	2.1421	2.4914	-0.3001
IC20	2.5693	0.0695	2.3547	2.8143	0.1567
IC25	2.8173	0.0875	2.5487	3.1413	0.2987
IC40	3.1765	0.0159	3.1251	3.2279	-0.0982
IC50	3.2600	0.0155	3.2105	3.3098	-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

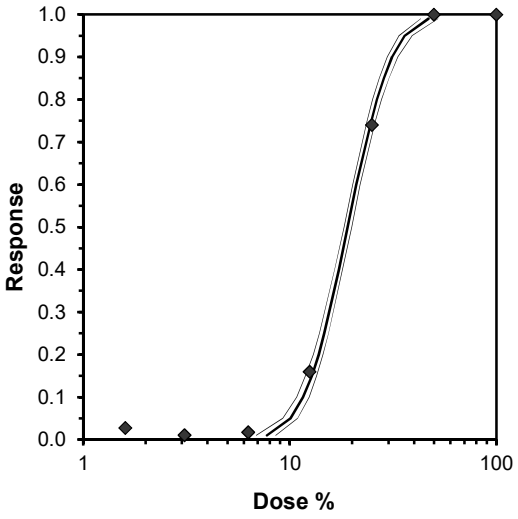
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.964728	0.916	-0.33293	-0.44461
Bartlett's Test indicates equal variances (p = 0.76)	2.599519	15.08627		
The control means are not significantly different (p = 0.16)	1.606623	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

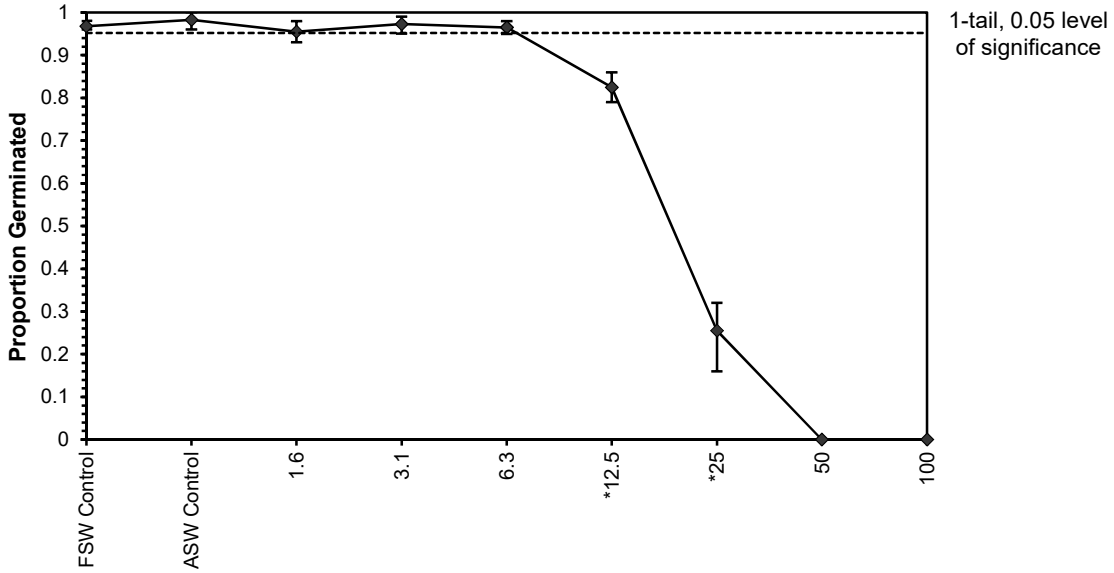
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	7.754731	6.893198	8.548282
EC05	3.355	10.09365	9.220699	10.88723
EC10	3.718	11.61656	10.75879	12.39557
EC15	3.964	12.77185	11.9325	13.53696
EC20	4.158	13.77145	12.95013	14.52517
EC25	4.326	14.69113	13.88613	15.43685
EC40	4.747	17.29025	16.51354	18.04208
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
End Date:	28/02/2021 14:30	Lab ID:	9966
Sample Date:		Protocol:	ESA 116
Comments:			

Sample ID:	Y0230221		
Sample Type:	PFW-Produced Formation Water		
Test Species:	HB-Hormosira banksii		

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		

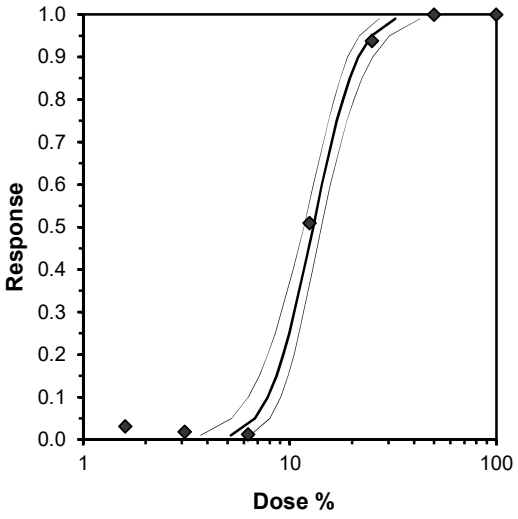
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test Treatments vs ASW Control	6.3	12.5	8.87412	15.87302	0.038167	0.039514	0.87473	0.002574	3.7E-17	5, 18

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

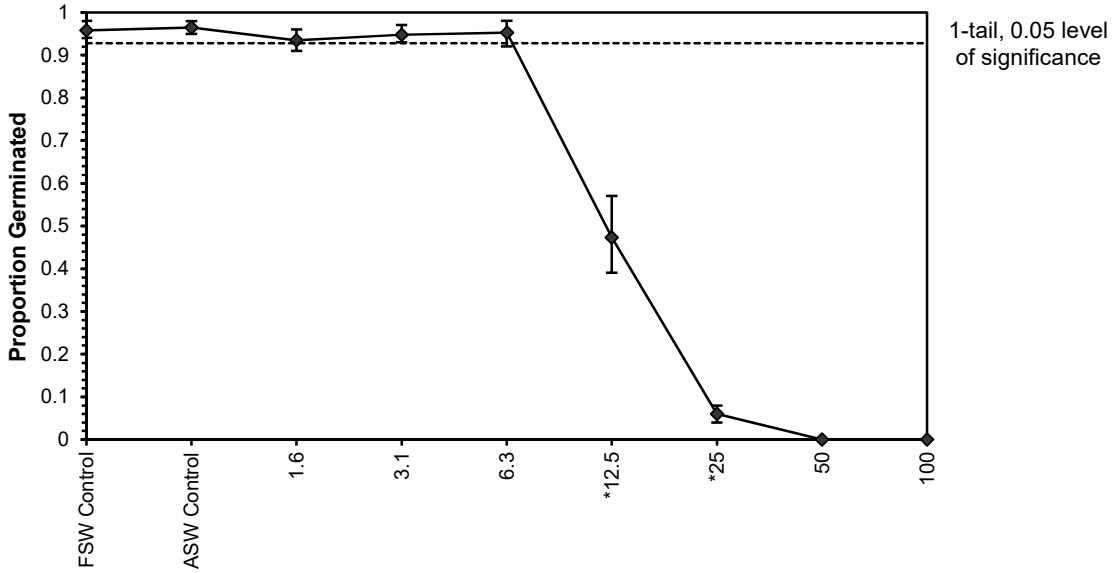
Significant heterogeneity detected (p = 2.00E-02)



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

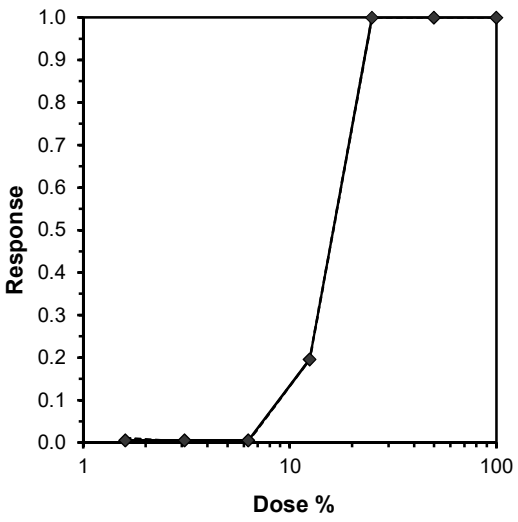
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9550	0.9974	1.3617	1.3030	1.4289	3.860	4					
ASW Control	0.9575	1.0000	1.3667	1.3233	1.4289	3.330	4	*			17	400
1.6	0.9475	0.9896	1.3451	1.3030	1.4289	4.411	4	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 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

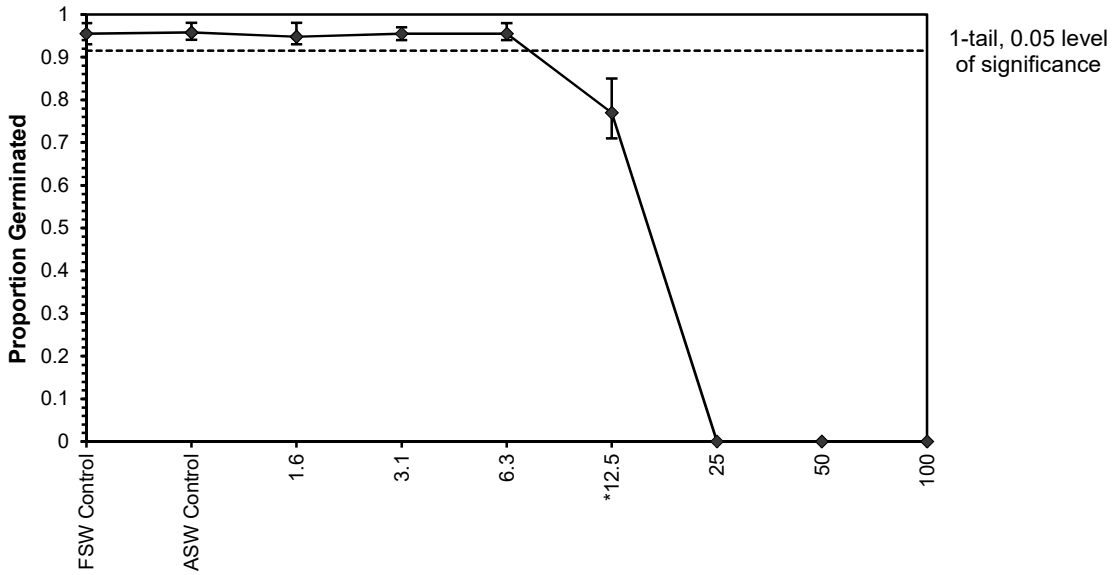
Trim Level	EC50	95% CL	
0.0%			
5.0%	15.731	15.248	16.229
10.0%	15.994	15.396	16.616
20.0%	16.247	15.905	16.596
Auto-0.5%	15.452	15.029	15.887



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

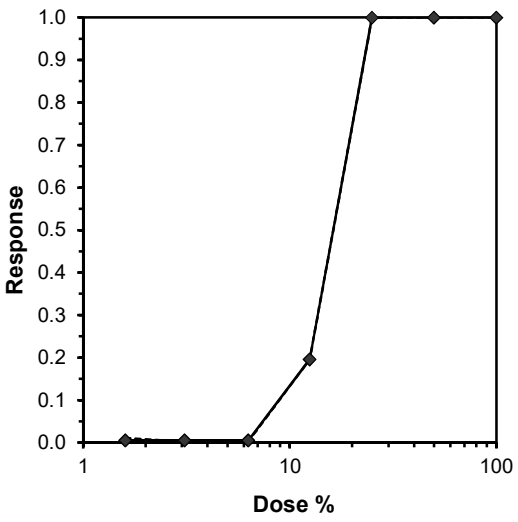
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9550	0.9974	1.3617	1.3030	1.4289	3.860	4					
ASW Control	0.9575	1.0000	1.3667	1.3233	1.4289	3.330	4	*			0.9575	1.0000
1.6	0.9475	0.9896	1.3451	1.3030	1.4289	4.411	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 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)

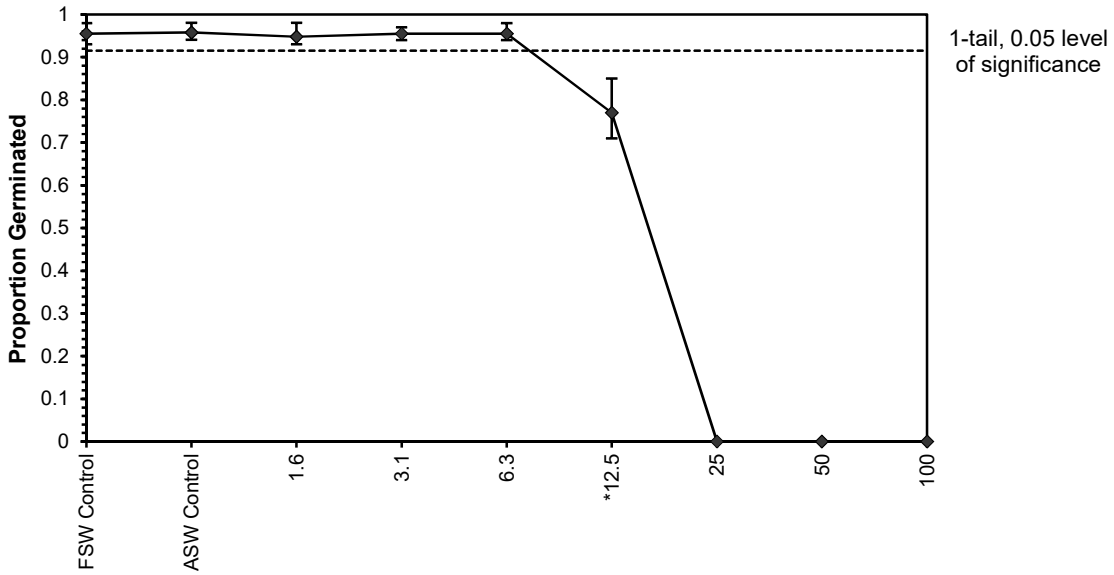
Point	%	SD	95% CL(Exp)		Skew
IC05	8.250	0.373	6.953	9.367	-0.0198
IC10	9.905	0.513	8.669	11.806	1.0912
IC15	11.317	0.596	9.892	13.348	0.4246
IC20	12.519	0.365	10.924	13.022	-1.0313
IC25	12.734	0.142	12.368	13.239	0.3233
IC40	13.294	0.135	12.947	13.797	0.4328
IC50	13.644	0.133	13.301	14.142	0.4323



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

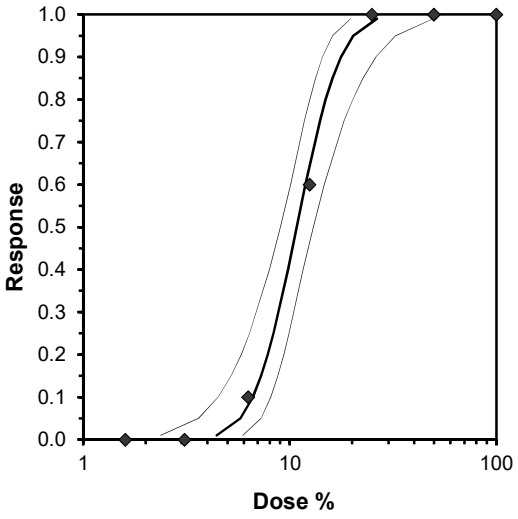
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.788756	0.905	-0.11449	2.327683
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

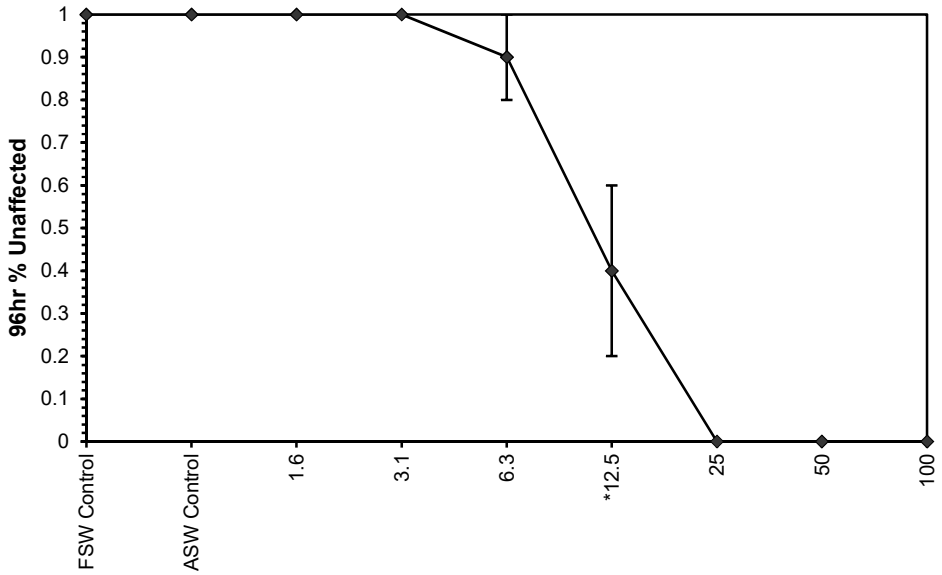
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	4.433288	2.371942	5.930733
EC05	3.355	5.7566	3.610349	7.248063
EC10	3.718	6.616686	4.4964	8.102277
EC15	3.964	7.26846	5.198007	8.76172
EC20	4.158	7.831959	5.817777	9.348142
EC25	4.326	8.350083	6.392285	9.906804
EC40	4.747	9.812809	7.987689	11.6345
EC50	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

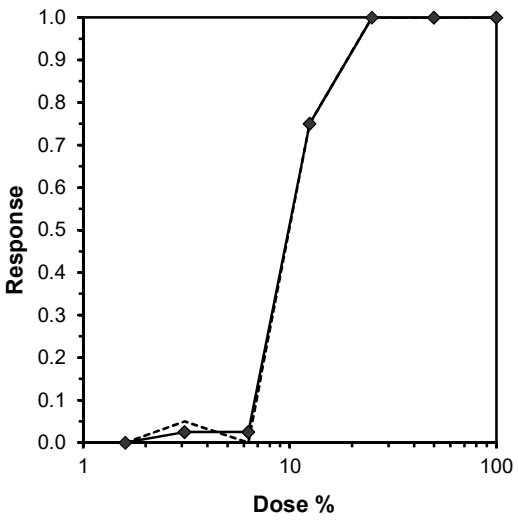
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

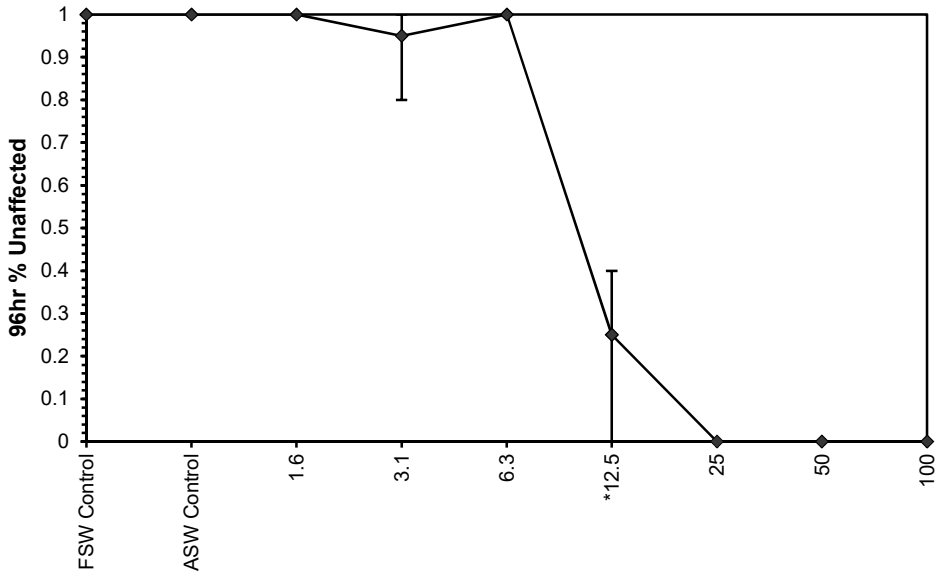
Trim Level	EC50	95% CL	
0.0%	10.185	8.767	11.832
5.0%	10.279	8.869	11.912
10.0%	10.127	8.663	11.838
20.0%	9.907	8.451	11.614
Auto-0.0%	10.185	8.767	11.832



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

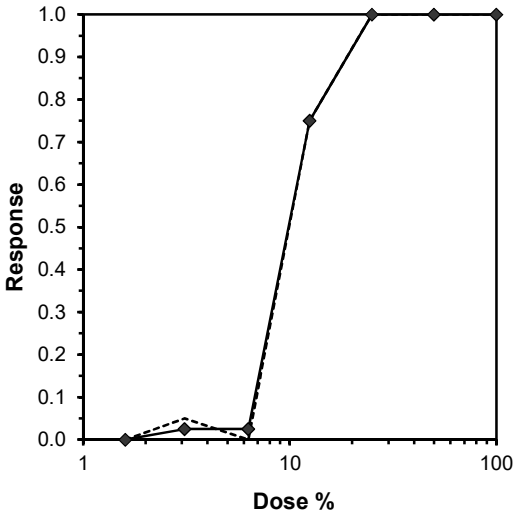
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

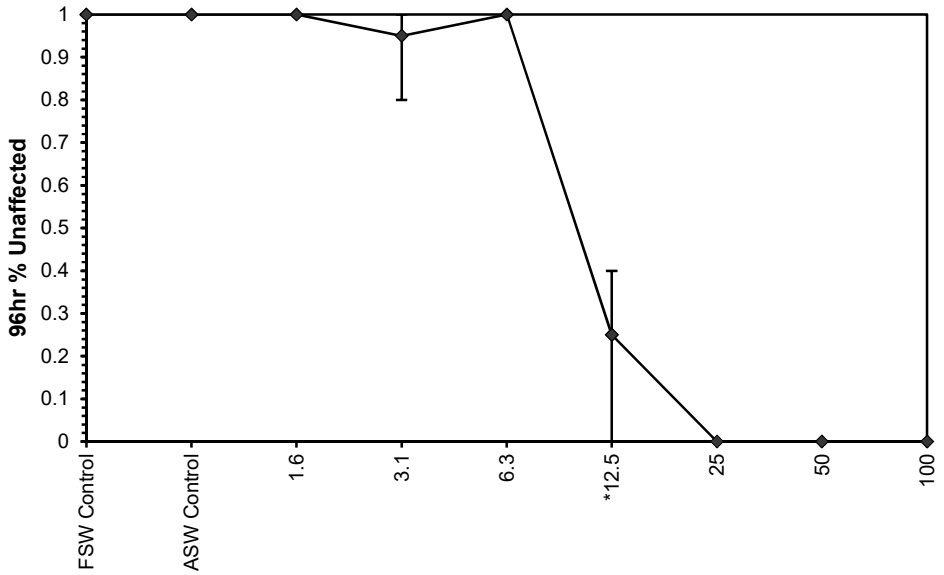
Point	%	SD	95% CL(Exp)		Skew
IC05	7.010	1.606	0.564	11.478	-0.2676
IC10	7.821	1.210	6.079	11.818	0.6554
IC15	8.364	1.102	6.713	12.024	0.6104
IC20	8.795	1.016	7.192	12.177	0.5477
IC25	9.166	0.944	7.498	12.300	0.4643
IC40	10.117	0.778	8.613	12.589	0.0622
IC50	10.715	0.703	9.125	12.751	-0.3157



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

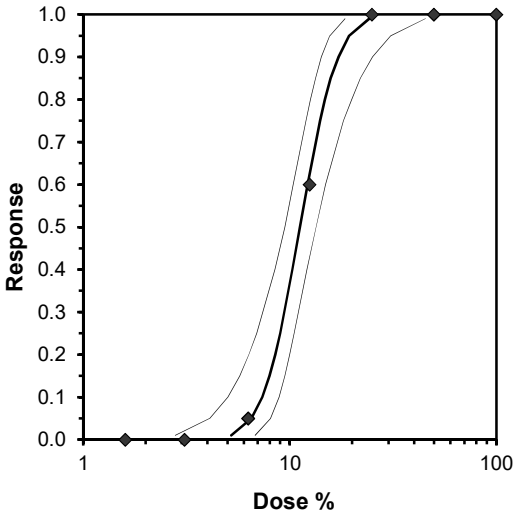
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.637021	0.905	-0.26968	7.213282
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

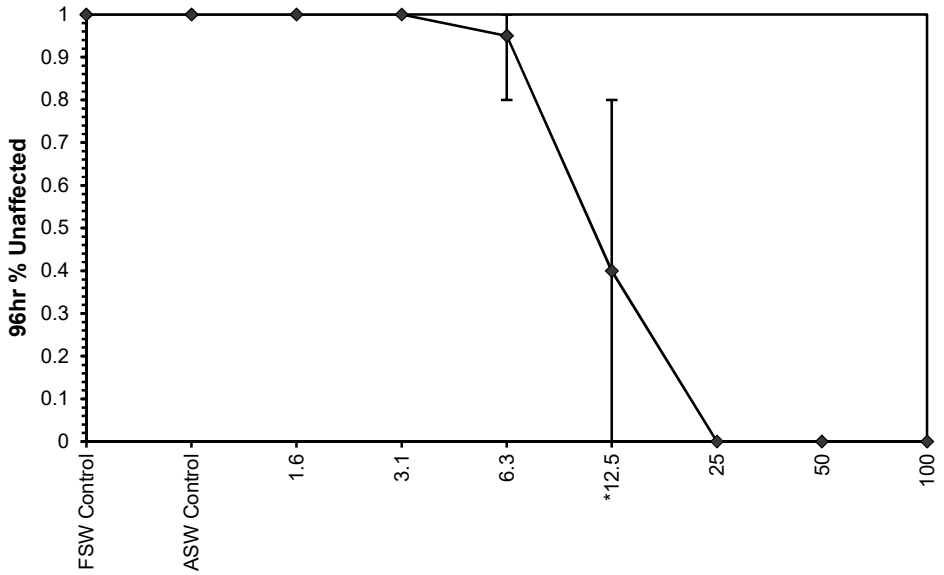
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	5.206068	2.785406	6.803598
EC05	3.355	6.521401	4.096381	8.061657
EC10	3.718	7.353503	5.010585	8.861713
EC15	3.964	7.974105	5.723459	9.473291
EC20	4.158	8.504484	6.34601	10.014
EC25	4.326	8.98753	6.917417	10.52728
EC40	4.747	10.32992	8.475073	12.1107
EC50	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				

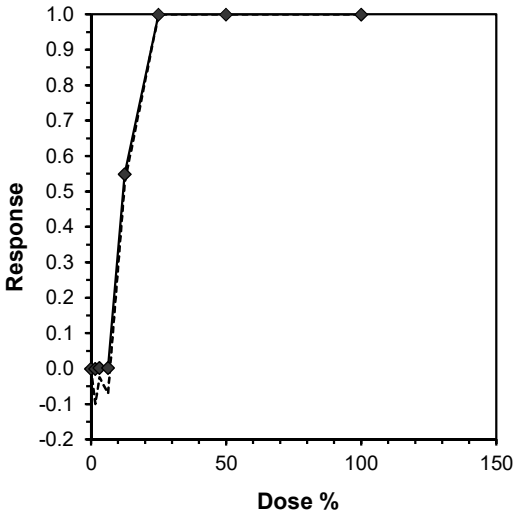
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	14.895	1.0365	14.895	13.445	16.045	6.617	8					
ASW Control	14.370	1.0000	14.370	13.845	15.345	4.933	4	*			15.083	1.0000
1.6	15.795	1.0992	15.795	14.845	17.045	5.995	4	-2.090	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 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)

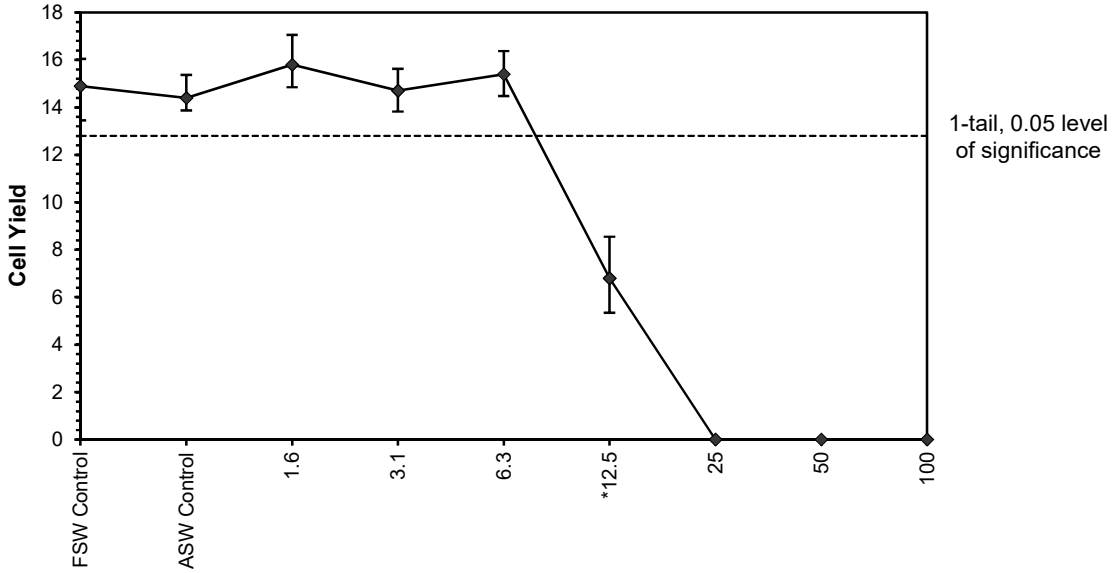
Point	%	SD	95% CL(Exp)		Skew
IC05	6.839	0.492	6.159	7.015	-6.9344
IC10	7.405	0.174	6.787	7.716	-0.6019
IC15	7.972	0.197	7.346	8.417	-0.1704
IC20	8.539	0.228	7.906	9.118	0.1012
IC25	9.106	0.266	8.422	9.858	0.2475
IC40	10.806	0.396	9.927	12.083	0.3840
IC50	11.939	0.570	10.927	14.225	0.8150



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				

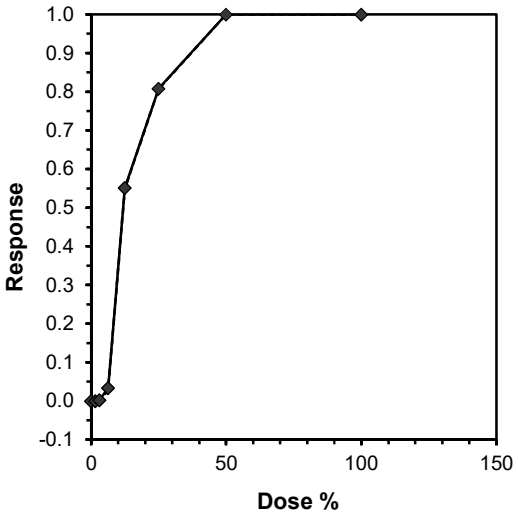
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	19.212	1.0145	19.212	18.387	20.587	4.415	8					
ASW Control	18.937	1.0000	18.937	18.187	19.587	3.298	4	*			19.024	1.0000
1.6	19.112	1.0092	19.112	18.387	19.687	2.846	4	-0.279	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 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)

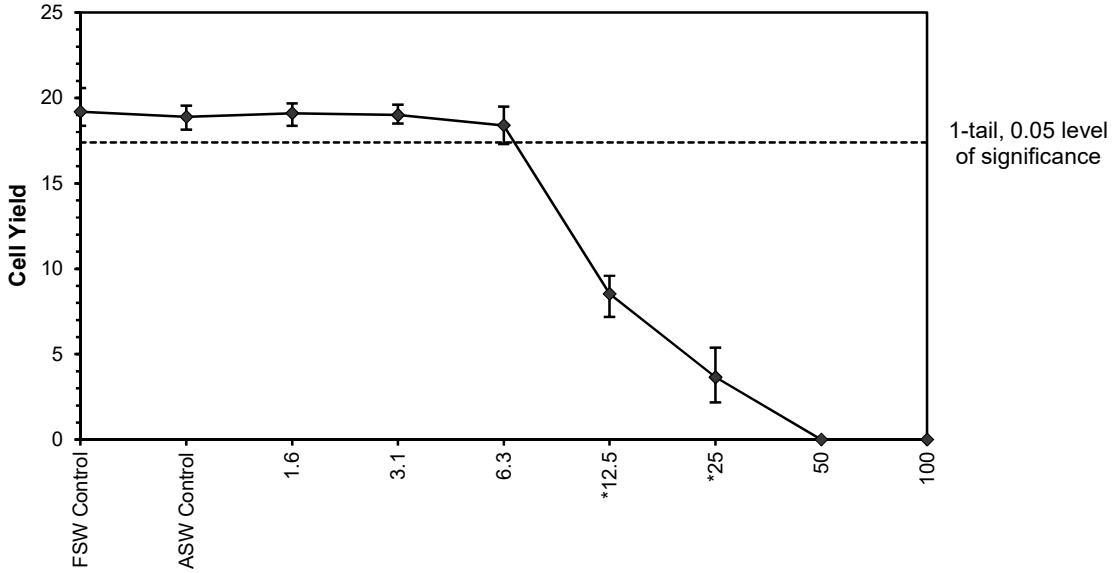
Point	%	SD	95% CL(Exp)		Skew
IC05	6.497	0.621	3.866	7.037	-1.5256
IC10	7.096	0.242	6.362	7.619	-0.2038
IC15	7.695	0.226	6.977	8.242	-0.1287
IC20	8.294	0.216	7.588	8.825	-0.0412
IC25	8.892	0.212	8.204	9.416	0.0400
IC40	10.689	0.237	9.987	11.408	0.1130
IC50	11.886	0.289	11.052	12.697	0.2998



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
End Date:	9/03/2021 14:00	Lab ID:	9983
Sample Date:		Protocol:	ESA 110
Comments:			
Sample ID:		Y020321	
Sample Type:		PFW-Produced Formation Water	
Test Species:		NC-Nitzschia closterium	

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				

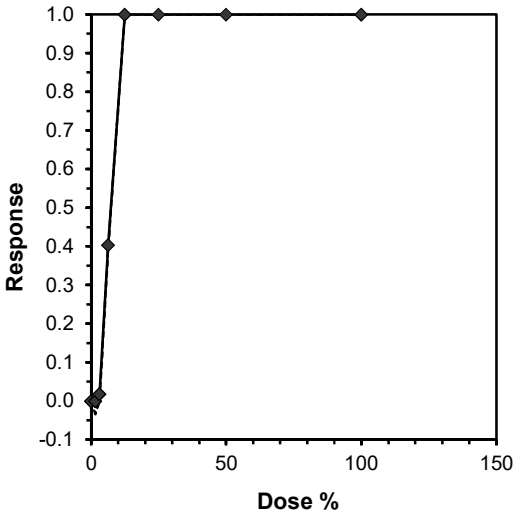
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	17.475	1.0295	17.475	16.300	18.800	4.565	8					
ASW Control	16.975	1.0000	16.975	16.100	17.500	3.579	4	*			17.262	1.0000
1.6	17.550	1.0339	17.550	16.300	18.800	6.039	4	-0.698	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 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)

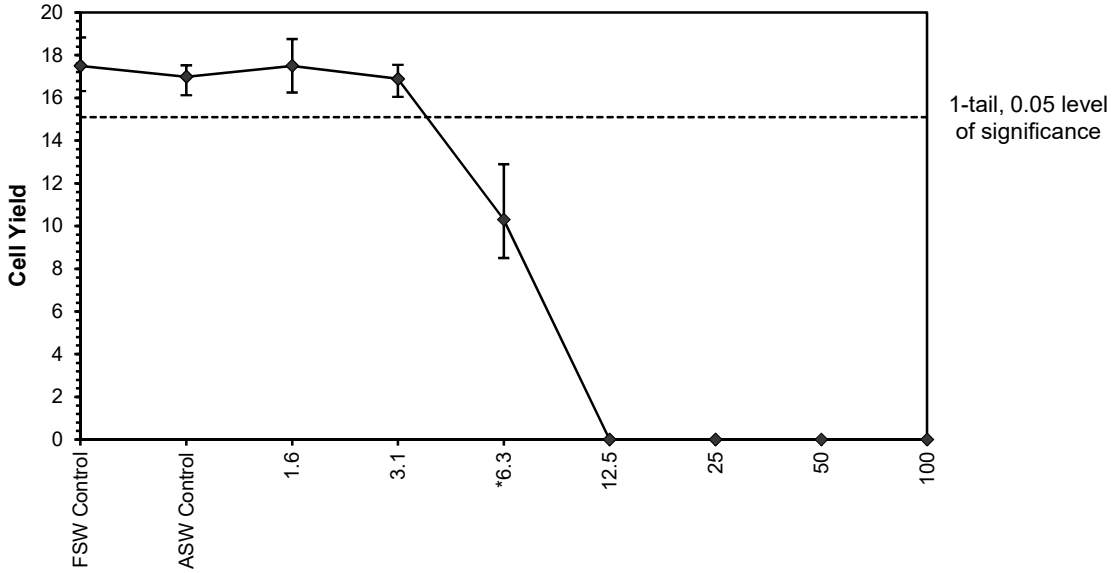
Point	%	SD	95% CL(Exp)		Skew
IC05	3.3650	0.1733	2.6357	3.6800	-1.4384
IC10	3.7803	0.1568	3.3047	4.1998	-0.1935
IC15	4.1956	0.1780	3.7133	4.7312	0.2264
IC20	4.6109	0.2113	4.0998	5.2685	0.4339
IC25	5.0263	0.2518	4.4452	5.8877	0.5232
IC40	6.2722	0.3737	5.4426	7.4693	0.3492
IC50	7.3044	0.3994	6.0539	8.3106	-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

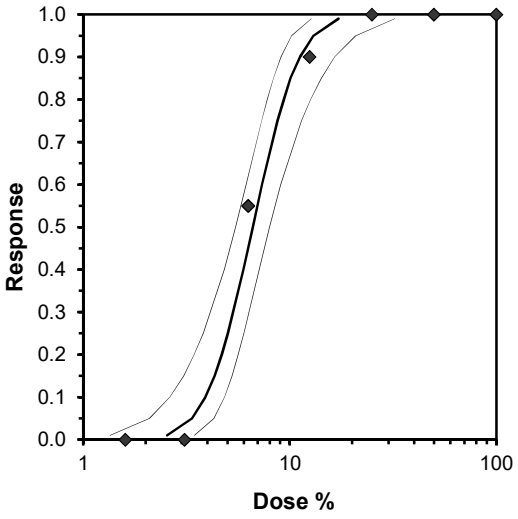
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.679268	0.905	2.328965	7.557935
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

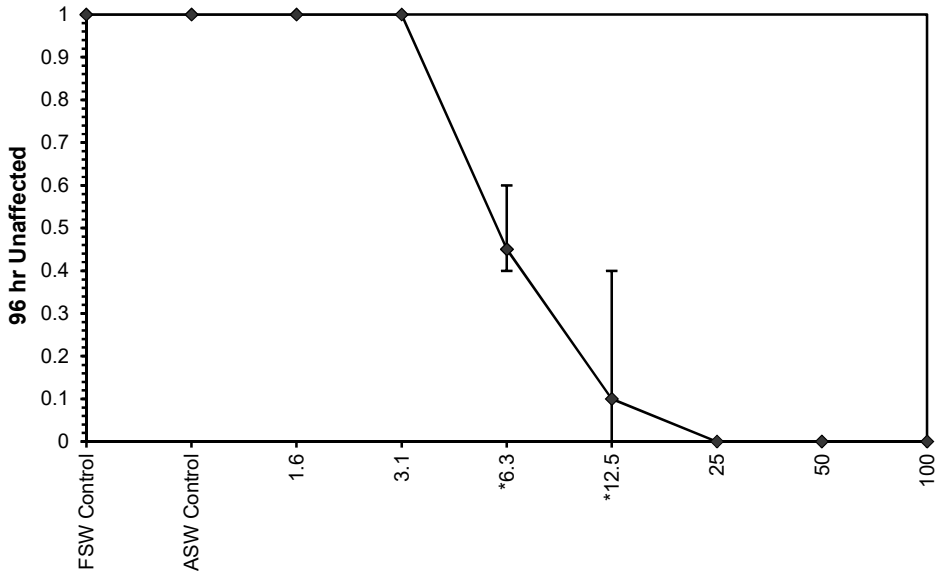
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	2.549867	1.350206	3.461013
EC05	3.355	3.37195	2.094039	4.295932
EC10	3.718	3.913629	2.634102	4.842201
EC15	3.964	4.327444	3.065732	5.265595
EC20	4.158	4.687319	3.449813	5.642816
EC25	4.326	5.019818	3.808201	6.002442
EC40	4.747	5.966052	4.816224	7.114029
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

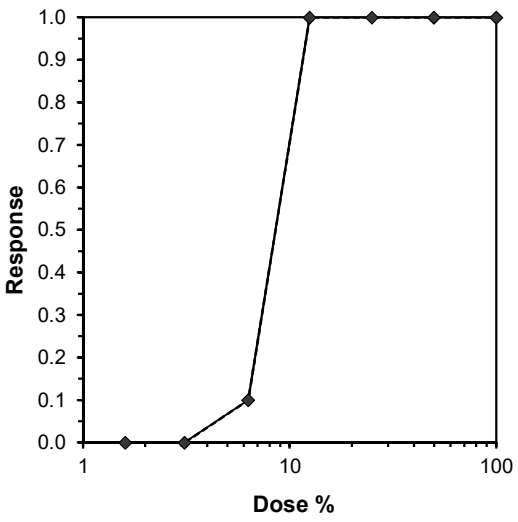
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

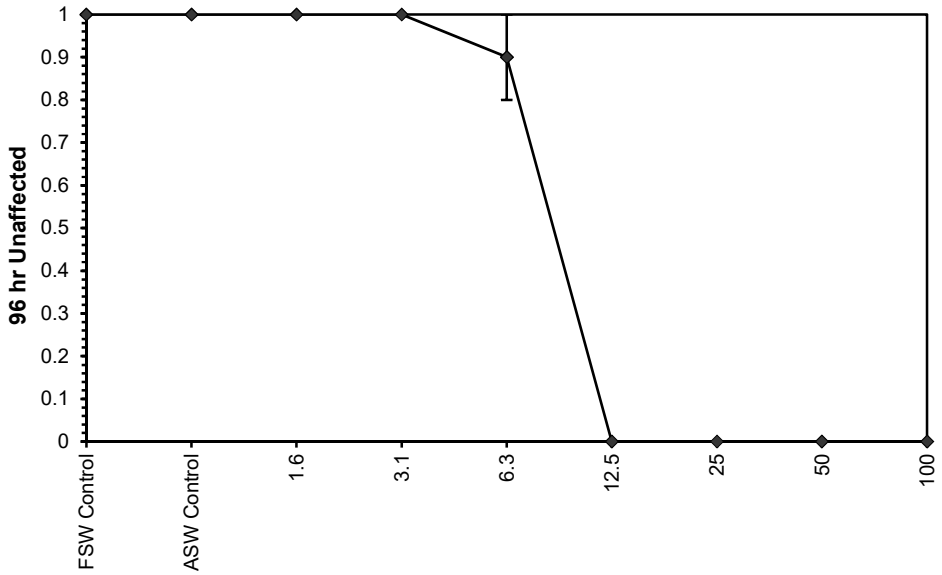
Trim Level	EC50	95% CL	
0.0%	8.2765	7.5375	9.0880
5.0%	8.4679	7.5330	9.5188
10.0%	8.5427	8.0714	9.0414
20.0%	8.5427	8.0714	9.0414
Auto-0.0%	8.2765	7.5375	9.0880



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

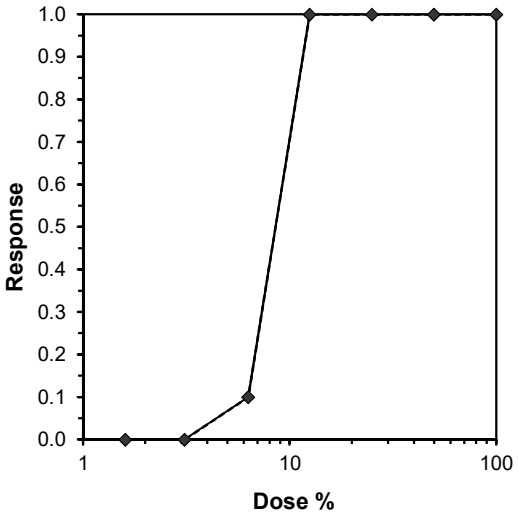
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

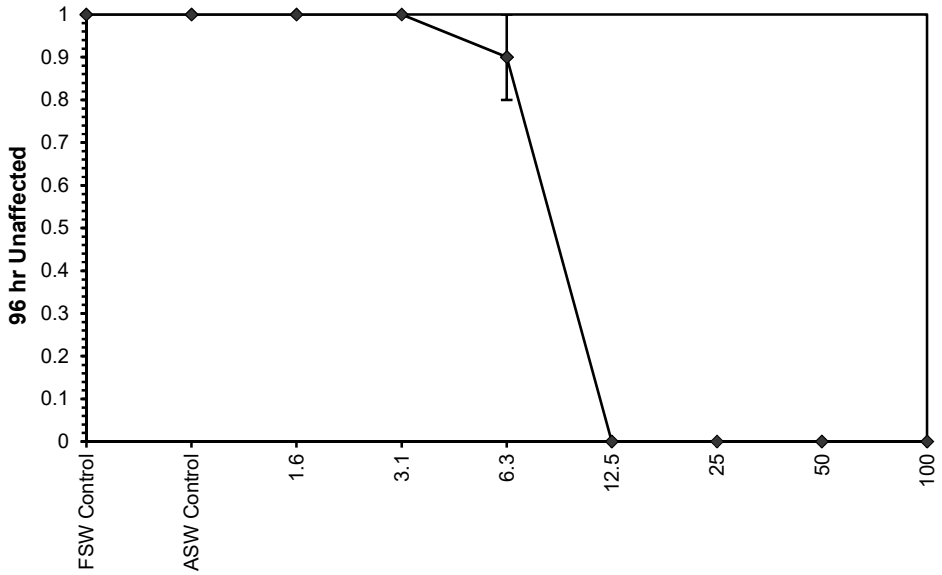
Point	%	SD	95% CL(Exp)		Skew
IC05	5.8648	0.6043	5.2934	9.2780	2.3198
IC10	6.3000	0.5509	5.6221	9.3804	2.4259
IC15	6.4843	0.5279	5.8933	9.4995	2.5474
IC20	6.6261	0.5167	6.1043	9.5897	2.5782
IC25	6.7453	0.5091	6.2294	9.6645	2.5748
IC40	7.0401	0.4898	6.5399	9.8460	2.5664
IC50	7.2177	0.4777	6.7276	9.9529	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

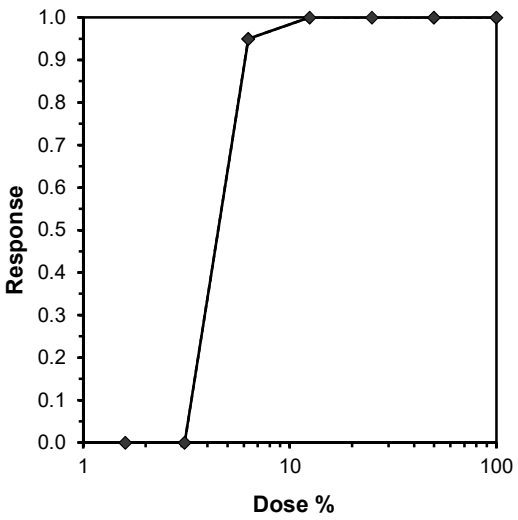
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

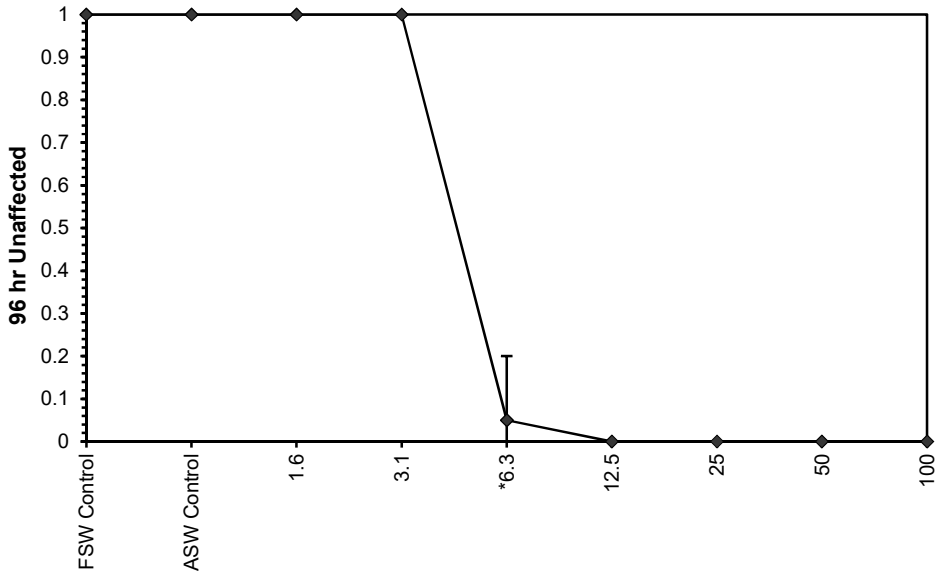
Trim Level	EC50	95% CL	
0.0%	4.5760	4.2754	4.8978
5.0%	4.5025	4.3334	4.6783
10.0%	4.5025	4.3334	4.6783
20.0%	4.5025	4.3334	4.6783
Auto-0.0%	4.5760	4.2754	4.8978



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

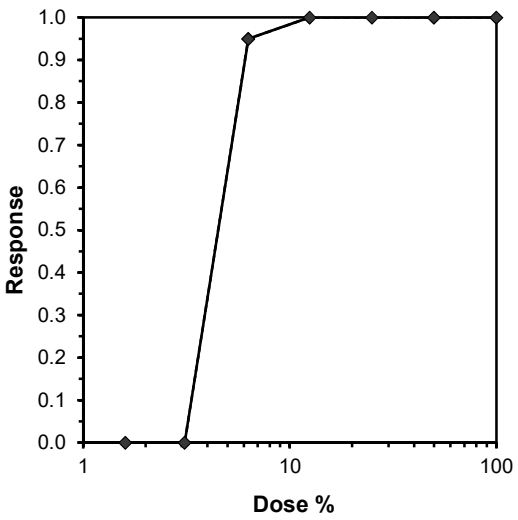
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

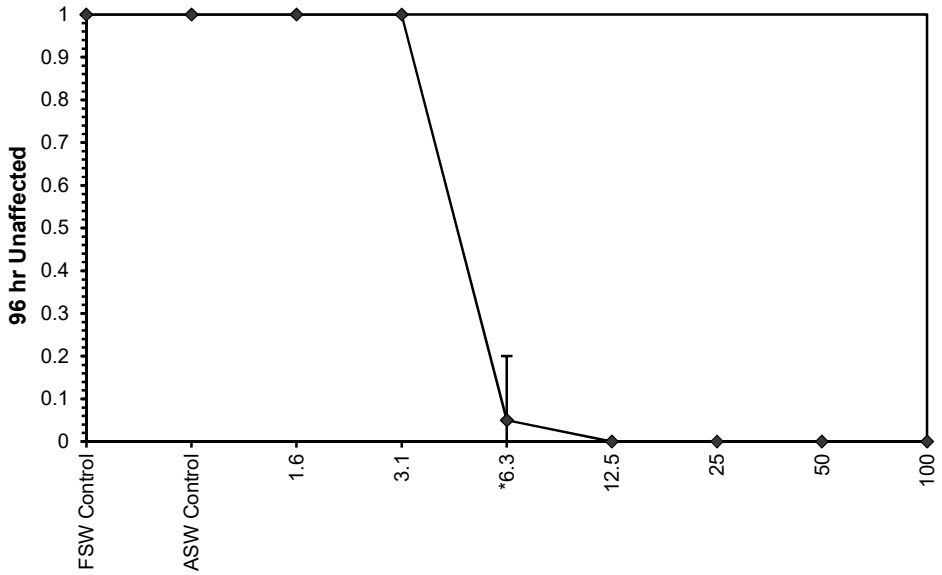
Point	%	SD	95% CL(Exp)		Skew
IC05	4.5200	0.2740	3.6703	4.8151	-0.6877
IC10	4.7193	0.3161	3.7397	5.0622	-0.6862
IC15	4.8462	0.3434	3.7828	5.2204	-0.6852
IC20	4.9437	0.3645	3.8152	5.3422	-0.6845
IC25	5.0254	0.3824	3.8421	5.4445	-0.6839
IC40	5.2269	0.4269	3.9067	5.6979	-0.6824
IC50	5.3479	0.4540	3.9446	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		

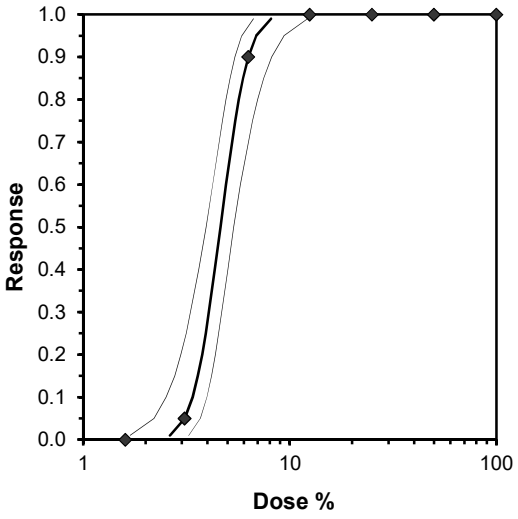
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	3.1	6.3	4.419276	32.25806
Treatments vs ASW Control				

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

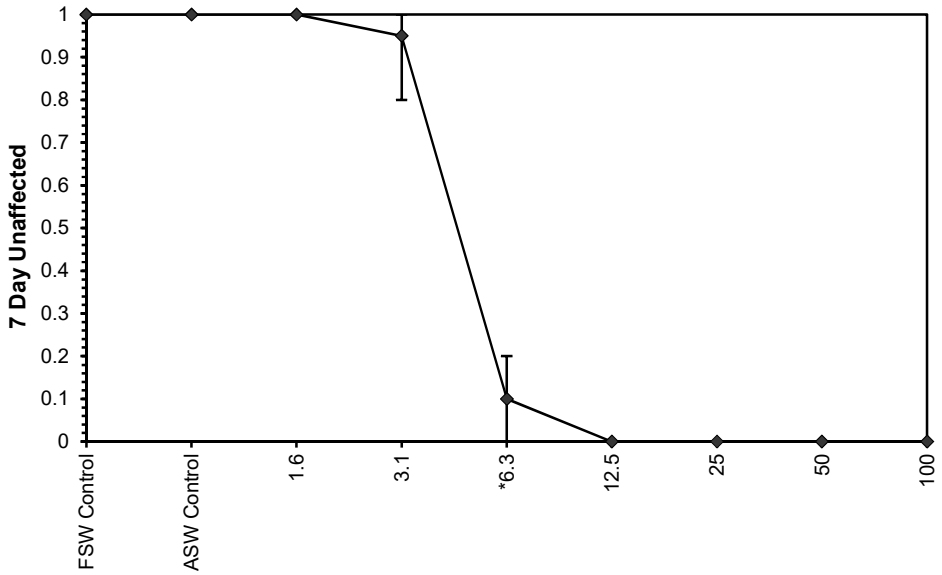
Significant heterogeneity detected (p < 0.01)



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

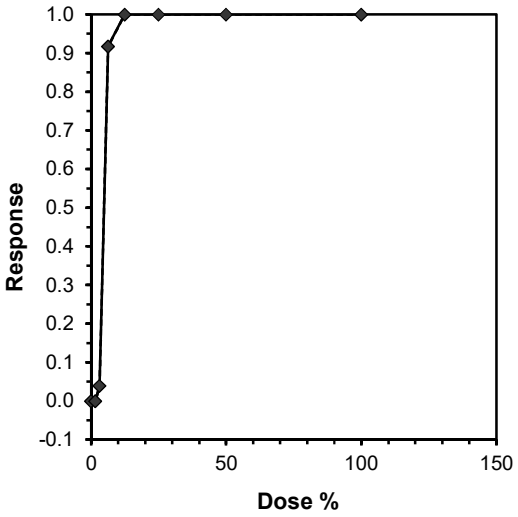
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	15.650	0.9940	15.650	14.980	16.820	5.318	4					
ASW Control	15.745	1.0000	15.745	15.180	16.180	2.780	4	*			15.753	1.0000
1.6	15.760	1.0010	15.760	14.380	16.880	8.067	4	-0.019	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 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)

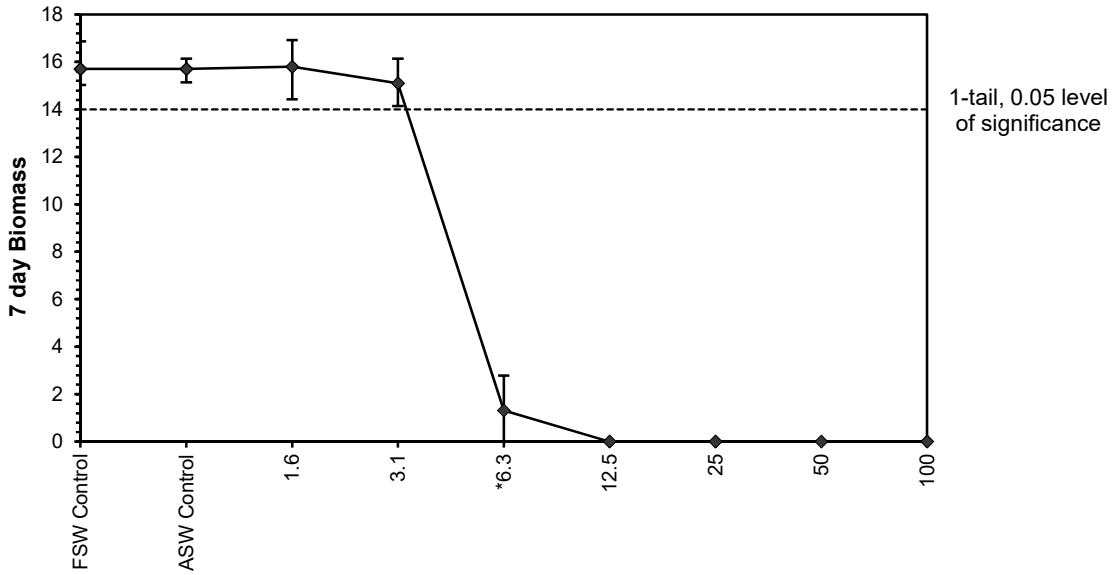
Point	%	SD	95% CL(Exp)		Skew
IC05	3.1405	0.4568	0.3510	3.3435	-2.1042
IC10	3.3228	0.0836	3.0216	3.5092	-0.2901
IC15	3.5050	0.0796	3.2081	3.7081	0.0277
IC20	3.6872	0.0790	3.4056	3.9107	0.1245
IC25	3.8695	0.0796	3.6015	4.1043	0.2071
IC40	4.4162	0.0886	4.1231	4.7040	0.3311
IC50	4.7807	0.0994	4.4584	5.1140	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

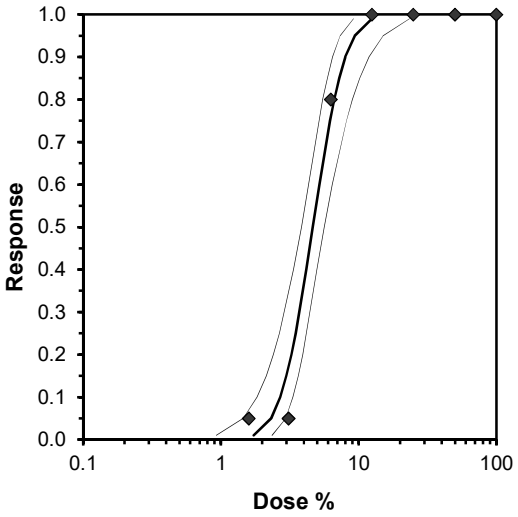
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.874636	0.887	-0.27847	-0.32298
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

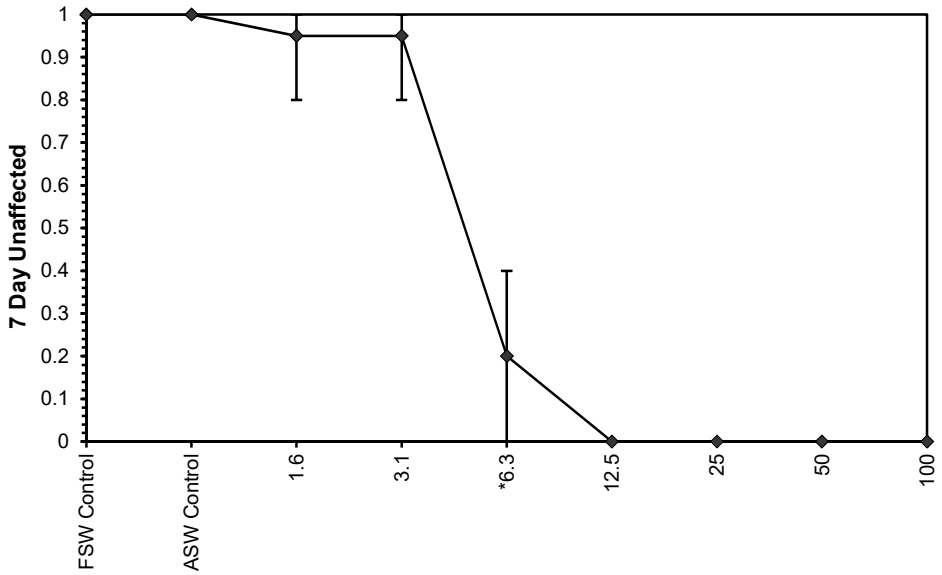
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	1.729231	0.925835	2.353387
EC05	3.355	2.310228	1.447006	2.949606
EC10	3.718	2.695996	1.827298	3.342664
EC15	3.964	2.99204	2.132017	3.648715
EC20	4.158	3.250342	2.403607	3.922298
EC25	4.326	3.489643	2.657334	4.183797
EC40	4.747	4.173714	3.372507	4.994769
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

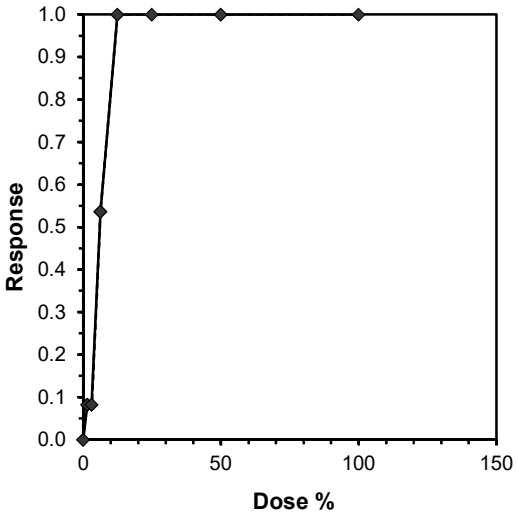
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.750951	0.887	1.454235	6.90931
Bartlett's Test indicates unequal variances (p = 4.07E-04)	18.16347	11.34487		
The control means are not significantly different (p = 0.41)	0.876707	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test 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

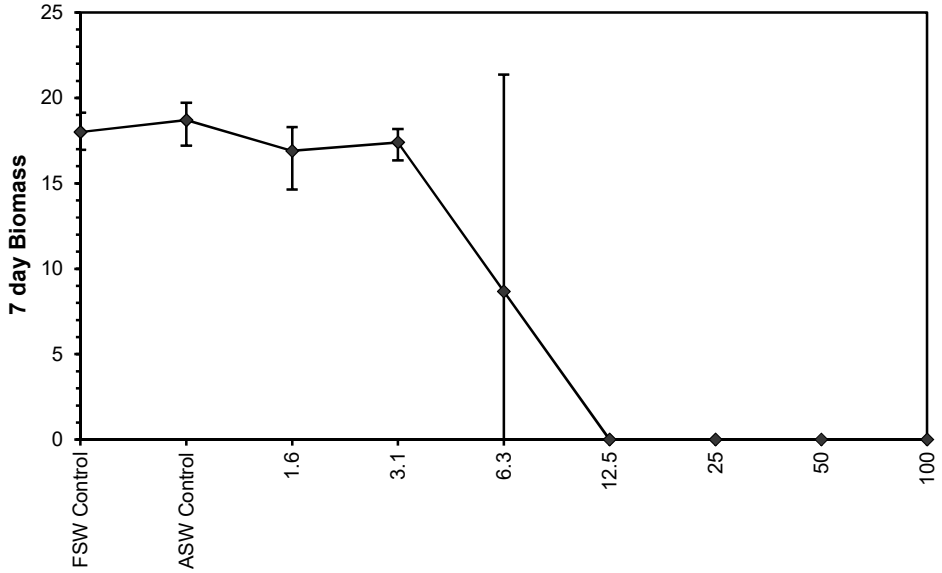
* indicates IC estimate less than the lowest concentration



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

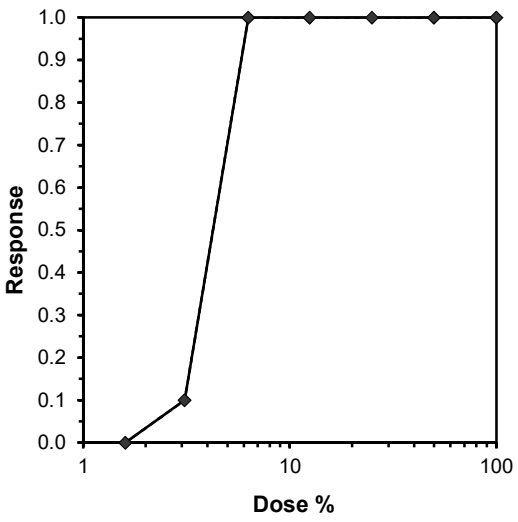
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	11.00	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

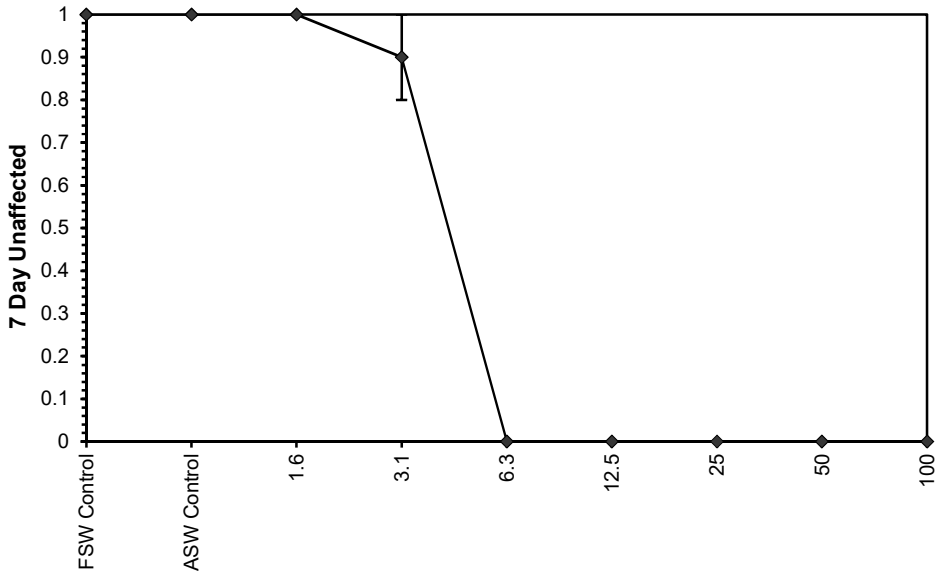
Trim Level	EC50	95% CL	
0.0%	4.1266	3.7641	4.5240
5.0%	4.2143	3.7591	4.7247
10.0%	4.2486	4.0062	4.5055
20.0%	4.2486	4.0062	4.5055
Auto-0.0%	4.1266	3.7641	4.5240



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

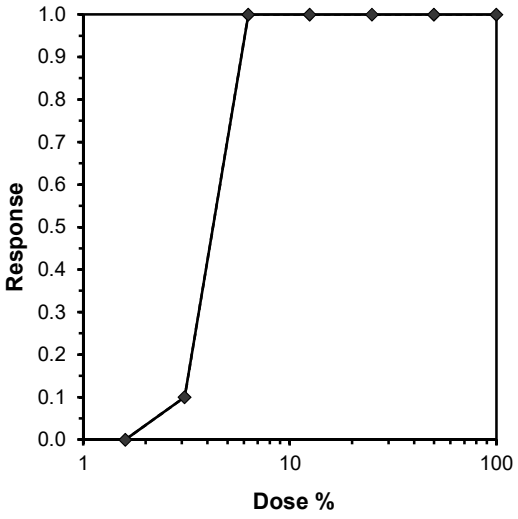
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

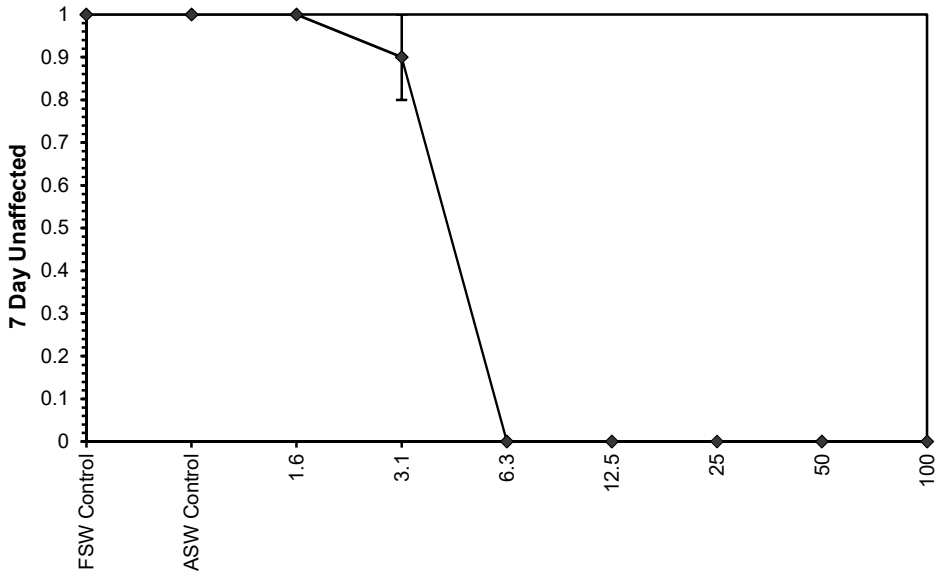
Point	%	SD	95% CL(Exp)		Skew
IC05	2.9058	0.3362	2.6477	4.6388	2.2724
IC10	3.1000	0.3172	2.7975	4.7113	2.2816
IC15	3.1971	0.3074	2.9101	4.7723	2.3154
IC20	3.2716	0.3016	2.9970	4.8185	2.3184
IC25	3.3342	0.2970	3.0630	4.8567	2.3162
IC40	3.4889	0.2852	3.2265	4.9496	2.3107
IC50	3.5819	0.2778	3.3251	5.0042	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

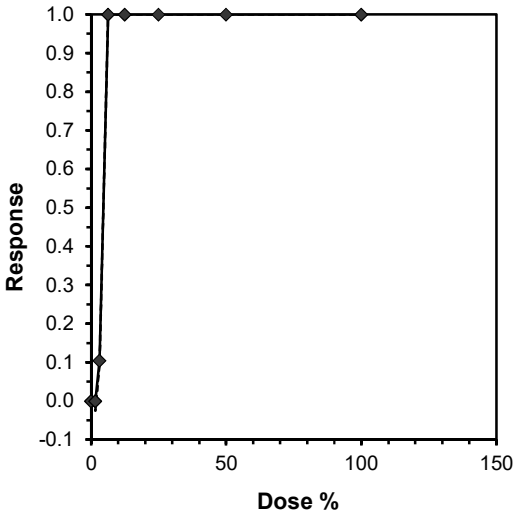
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	18.325	1.0074	18.325	18.080	18.900	2.132	4				
ASW Control	18.190	1.0000	18.190	17.940	18.440	1.357	4	*		18.420	1.0000
1.6	18.650	1.0253	18.650	18.340	18.960	1.919	4	22.00	11.00	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 Treatments vs ASW Control	3.1	6.3	4.419276	32.25806

Linear Interpolation (200 Resamples)

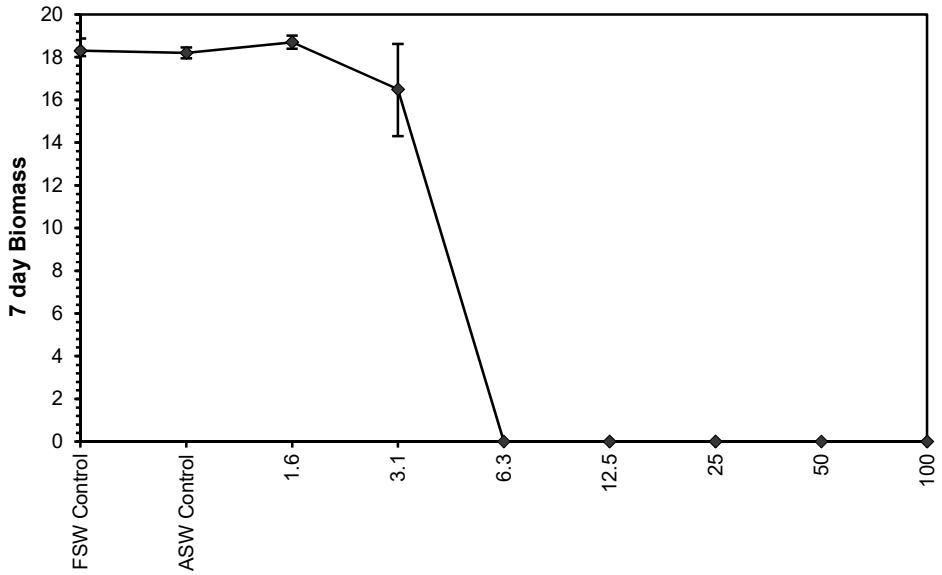
Point	%	SD	95% CL(Exp)		Skew
IC05	2.3195	0.4121	1.7253	3.8243	0.9570
IC10	3.0391	0.3229	1.8506	3.6486	-0.3338
IC15	3.2635	0.2130	2.2729	3.7699	-0.5991
IC20	3.4421	0.1706	2.7227	3.9187	-0.2542
IC25	3.6207	0.1557	3.0131	4.0676	-0.1057
IC40	4.1566	0.1246	3.6705	4.5141	-0.1057
IC50	4.5138	0.1038	4.1087	4.8117	-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

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Toxicity Test Report: TR2029/1

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 28 July 2021 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. 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

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 28 July 2021 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. 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.

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: TR2029/3

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 28 July 2021 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. 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* **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)% **72-hr EC50 = 6.0 (5.81-6.23)%** **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: TR2029/3

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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 28 July 2021 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. 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* **Concentration (%)**	**% Germination (Mean ± SD)**	*Vacant*	*Vacant*
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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 28 July 2021 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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 28 July 2021 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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	17.2x10^4 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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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: TR2029/7

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 28 July 2021 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. 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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Toxicity Test Report: TR2029/7

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.
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: TR2029/8

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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 03 August 2021 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. 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.

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: TR2029/10

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 03 August 2021 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. 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)%			
72-hr EC50 = 6.0 (5.79-6.21)%			
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: TR2029/10

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.

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: TR2029/11

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 03 August 2021 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. 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

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

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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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 03 August 2021 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. 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

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: TR2029/13

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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:**	PR2029
		Date Sampled:	03 August 2021
		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:	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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	19.7x10^4 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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Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 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: TR2029/15

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 03 August 2021 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. 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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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

Test Report Authorised by: Dr Rick Krassoi, Director on 8 September 2021

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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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 18 August 2021 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. 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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Toxicity Test Report: TR2029/17

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)

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 18 August 2021 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. 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)% **72-hr EC50 = 10.4 (10.14-10.75)%** **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)

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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

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: TR2029/19

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Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 18 August 2021 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. 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)%		
72-hr EC50 = 7.8 (7.43-8.23)%		
NOEC = 6.3%		
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

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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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 18 August 2021 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. 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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 18 August 2021 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. 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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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.
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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: TR2029/22

Client:	Beach Energy Limited Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 18 August 2021 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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	18.7x10^4 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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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 Level 15 150 Lonsdale Street Melbourne Vic 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2029 18 August 2021 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. 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

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.
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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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ABN 95 619 426 201

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

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: TR2029/24 (Page 2 of 2)

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

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

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 Early Life Stage	72-H Nitrosomonas	72-H Marine Microbial	48-H Sea Urchin Fertilisation	72-H Sea Urchin Larval Development	7-D Fish Growth	Sub Sample to Eurofins
28-7-21	0630	Wet Test - MW-5827	Grab	4x250ml	✓	✓	✓	✓	✓	✓	Test Requested As Per Emailed COC/Service Request

(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:	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 1-H Sea Urch - Fert.	72-H Sea Urch ????	7-d Gt + Growth	Sqr - Sampling for Eurofins	**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
03/08/21	18:00	YOO3082021	GRAB	4x 2.5L	✓	✓	✓	✓	✓	✓	✓	✓	

10°C
10167

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** • 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
		AI-5327-Wet Test	GRAB	4×25mL							

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
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:	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

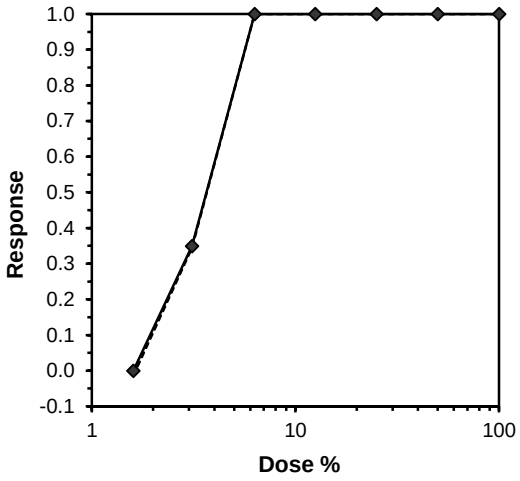
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9225	1.0082	1.2909	1.2490	1.3453	3.308	4					
ASW Control	0.9150	1.0000	1.2774	1.2490	1.3453	3.600	4	*			0.9213	1.0000
1.6	0.9275	1.0137	1.2992	1.2661	1.3233	2.217	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)

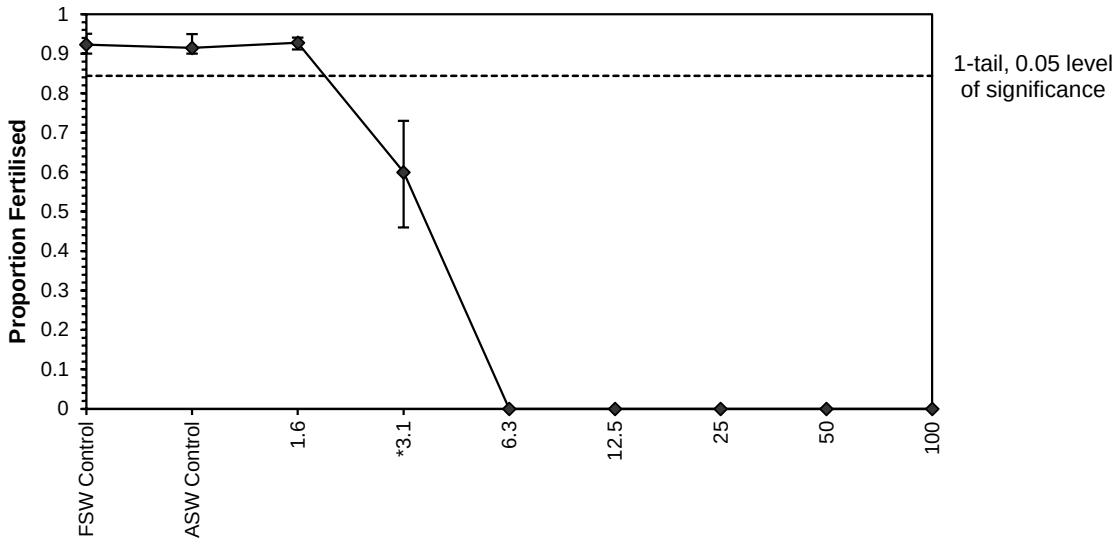
Point	%	SD	95% CL(Exp)		Skew
IC05	1.9125	0.0368	1.7905	2.0102	-0.1290
IC10	2.1603	0.0627	1.9969	2.3322	0.1280
IC15	2.3745	0.0885	2.1427	2.6266	0.1503
IC20	2.5694	0.1137	2.2729	2.9009	0.1712
IC25	2.7528	0.1372	2.3924	3.1700	0.1194
IC40	3.1479	0.0718	2.8064	3.2676	-1.5926
IC50	3.2409	0.0485	3.0754	3.3574	-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

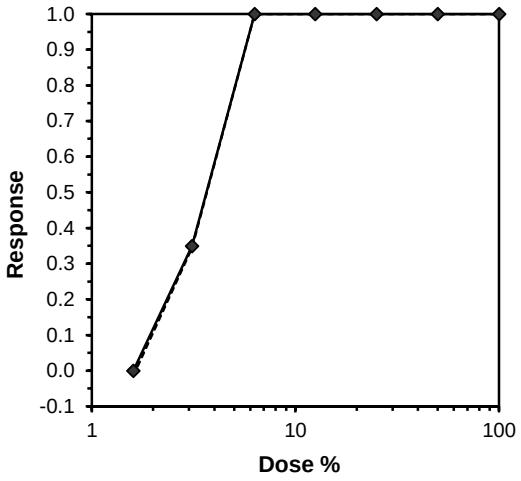
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9225	1.0082	1.2909	1.2490	1.3453	3.308	4					
ASW Control	0.9150	1.0000	1.2774	1.2490	1.3453	3.600	4	*			34	400
1.6	0.9275	1.0137	1.2992	1.2661	1.3233	2.217	4	-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 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

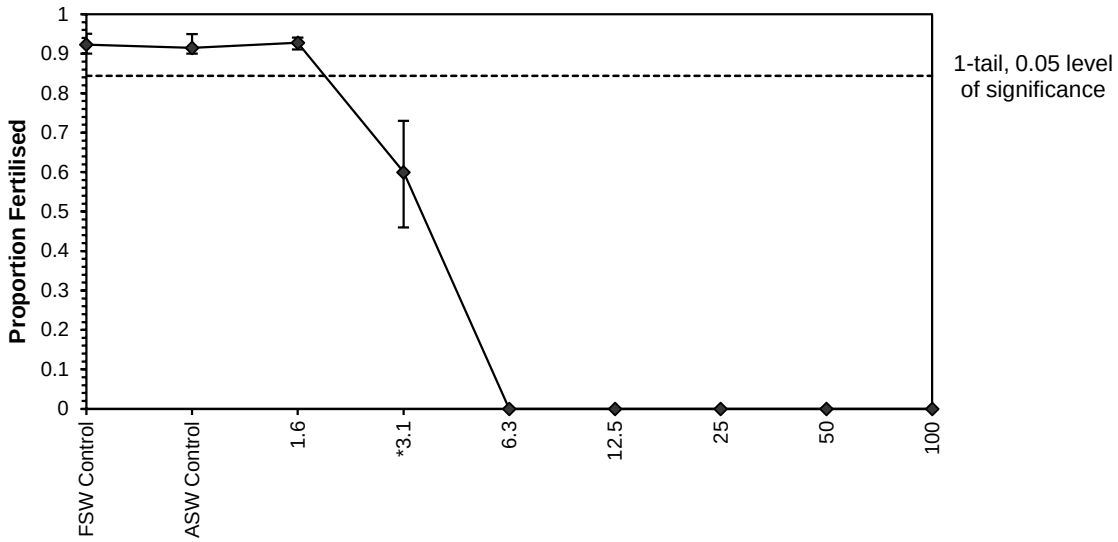
Trim Level	EC50	95% CL	
0.0%	3.4799	3.3681	3.5955
5.0%	3.5116	3.3857	3.6423
10.0%	3.5427	3.3972	3.6945
20.0%	3.6011	3.3900	3.8254
Auto-0.0%	3.4799	3.3681	3.5955



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

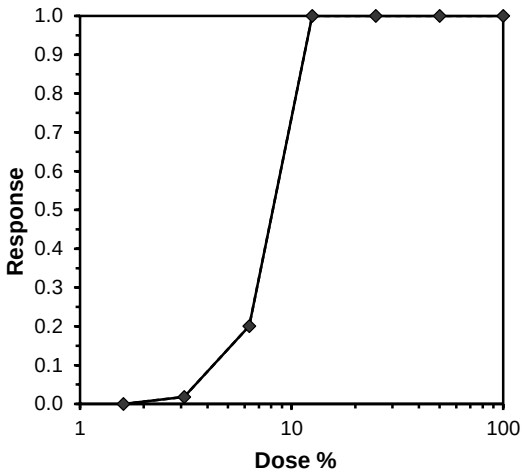
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9575	1.0132	1.3667	1.3233	1.4289	3.330	4					
ASW Control	0.9450	1.0000	1.3360	1.2840	1.3694	2.730	4	*			0.9450	1.0000
1.6	0.9450	1.0000	1.3360	1.2840	1.3694	2.730	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)

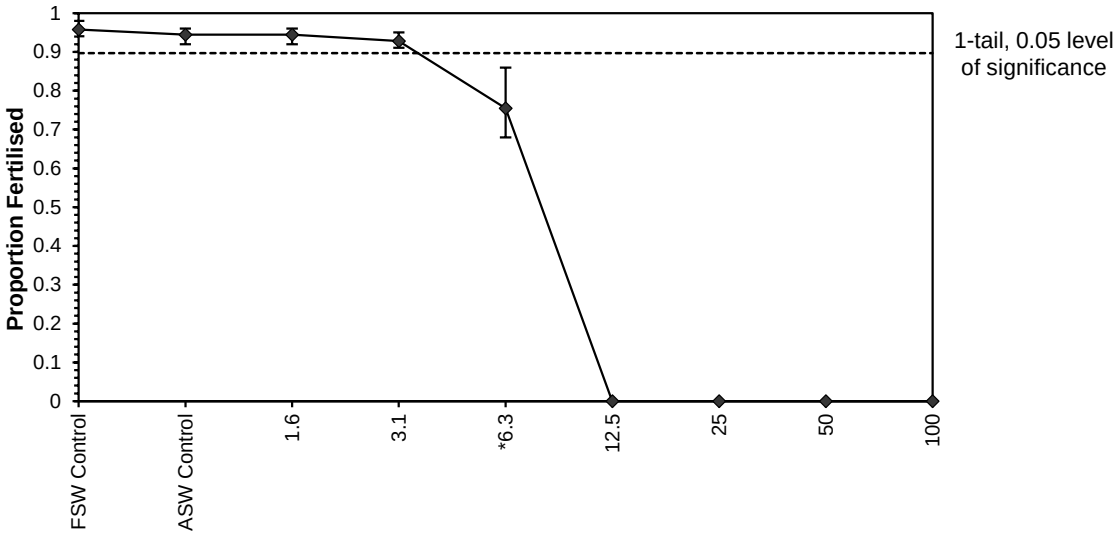
Point	%	SD	95% CL(Exp)		Skew
IC05	3.7757	0.2179	3.1005	4.4061	0.2227
IC10	4.6940	0.3012	3.9731	5.8046	0.8262
IC15	5.5135	0.3934	4.6297	6.8294	0.5078
IC20	6.2840	0.2715	5.1289	6.5593	-0.7717
IC25	6.4033	0.1000	5.9850	6.6561	-1.1808
IC40	6.6813	0.0756	6.4812	6.9241	0.2746
IC50	6.8567	0.0742	6.6612	7.0939	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

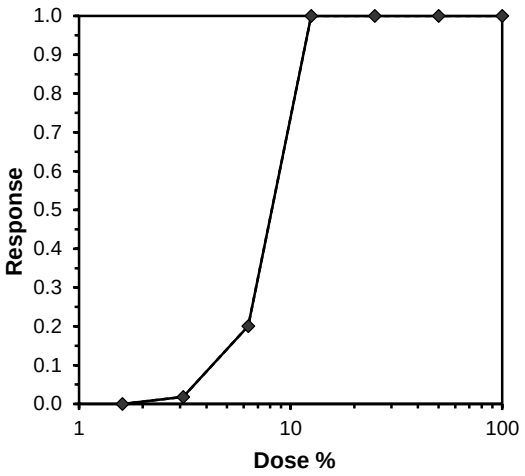
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9575	1.0132	1.3667	1.3233	1.4289	3.330	4					
ASW Control	0.9450	1.0000	1.3360	1.2840	1.3694	2.730	4	*			22	400
1.6	0.9450	1.0000	1.3360	1.2840	1.3694	2.730	4	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 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

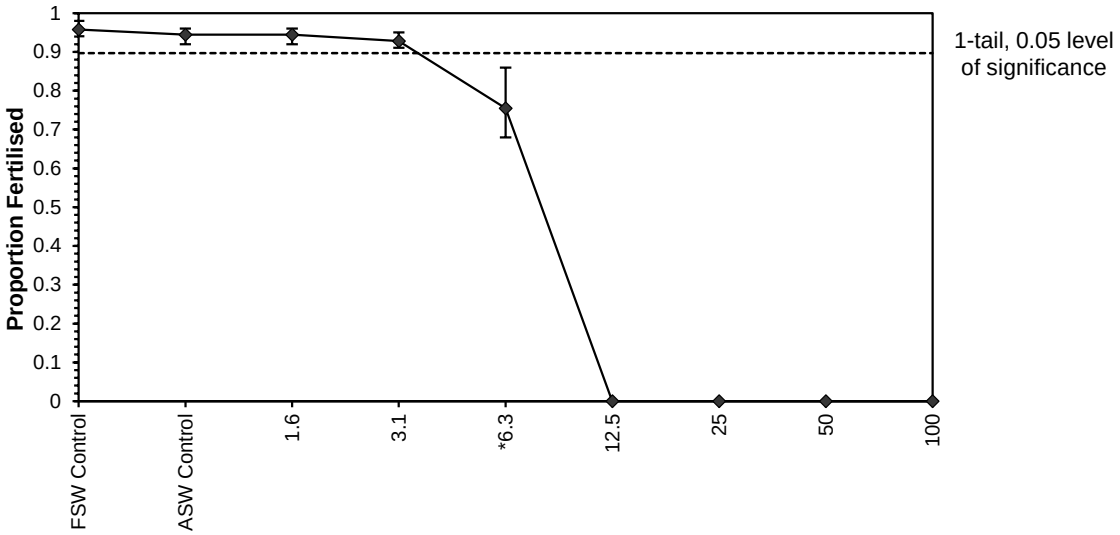
Trim Level	EC50	95% CL	
0.0%	7.6162	7.3953	7.8437
5.0%	7.8346	7.5904	8.0866
10.0%	7.9853	7.6857	8.2966
20.0%	8.1411	7.6017	8.7187
Auto-0.0%	7.6162	7.3953	7.8437



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

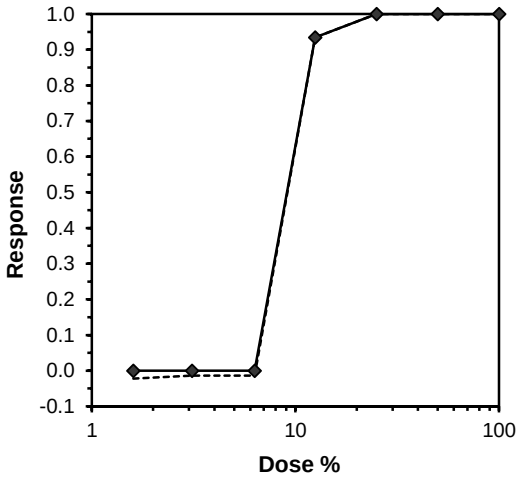
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9150	1.0139	1.2756	1.2490	1.3030	1.821	4				
ASW Control	0.9025	1.0000	1.2537	1.2327	1.2840	1.725	4	*		0.9138	1.0000
1.6	0.9225	1.0222	1.2894	1.2661	1.3233	1.874	4	24.00	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)

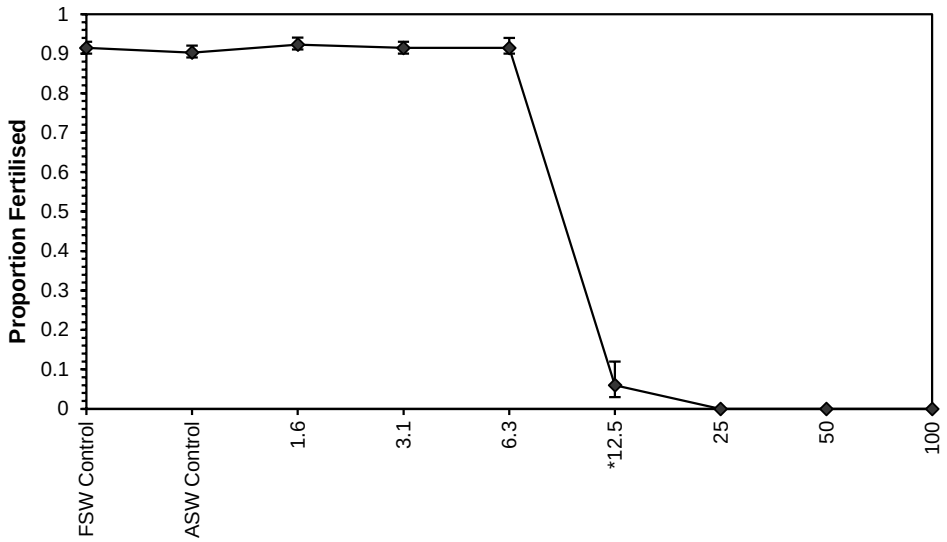
Point	%	SD	95% CL(Exp)		Skew
IC05	6.7305	0.0427	6.5396	6.8003	-0.4497
IC10	7.0642	0.0588	6.8408	7.1898	-0.0595
IC15	7.3465	0.0762	7.0796	7.5247	0.0090
IC20	7.5979	0.0934	7.2873	7.8172	0.0302
IC25	7.8299	0.1101	7.4767	8.0959	0.0424
IC40	8.4732	0.1599	7.9707	8.9168	0.0693
IC50	8.9002	0.1951	8.2938	9.4496	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

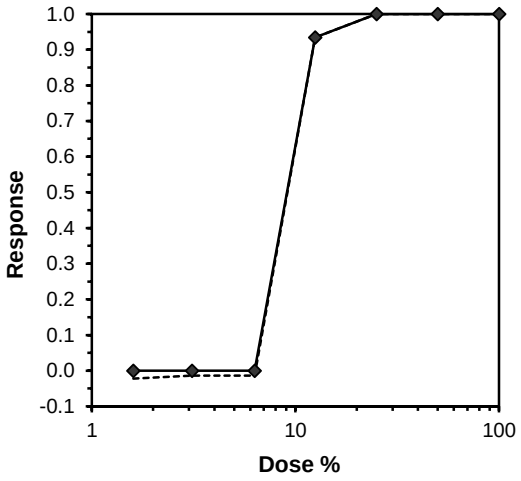
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9150	1.0139	1.2756	1.2490	1.3030	1.821	4				
ASW Control	0.9025	1.0000	1.2537	1.2327	1.2840	1.725	4	*		39	400
1.6	0.9225	1.0222	1.2894	1.2661	1.3233	1.874	4	24.00	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

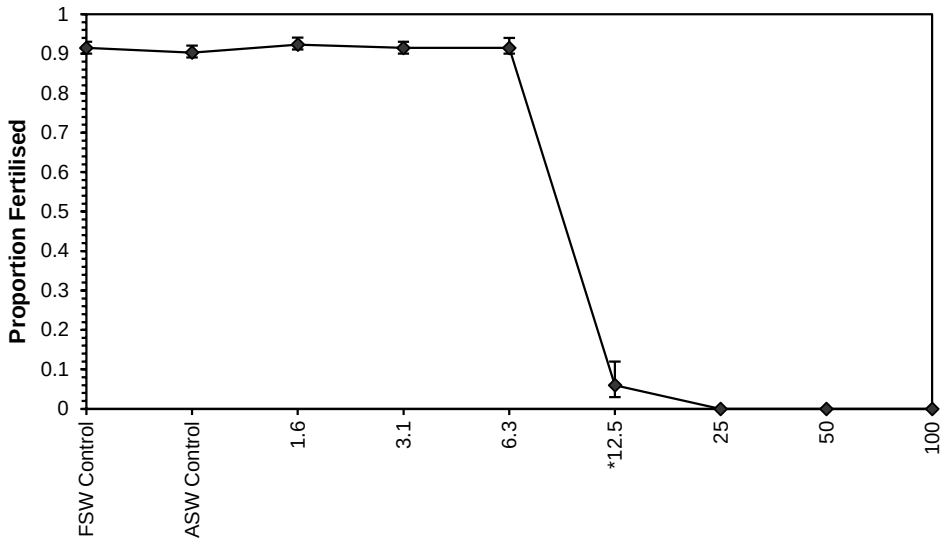
Trim Level	EC50	95% CL	
0.0%	9.2849	9.1278	9.4448
5.0%	9.1025	8.9808	9.2259
10.0%	9.0904	9.0024	9.1792
20.0%	9.0904	9.0024	9.1792
Auto-0.0%	9.2849	9.1278	9.4448



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

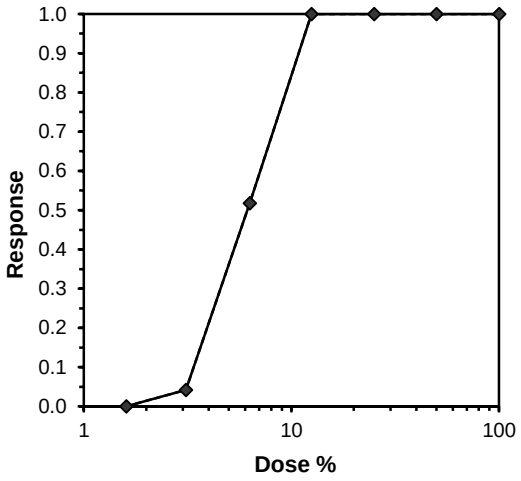
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9550	0.9948	1.3617	1.3030	1.4289	3.860	4					
ASW Control	0.9600	1.0000	1.3722	1.3453	1.4289	2.876	4	*			0.9600	1.0000
1.6	0.9600	1.0000	1.3722	1.3453	1.4289	2.876	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 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)

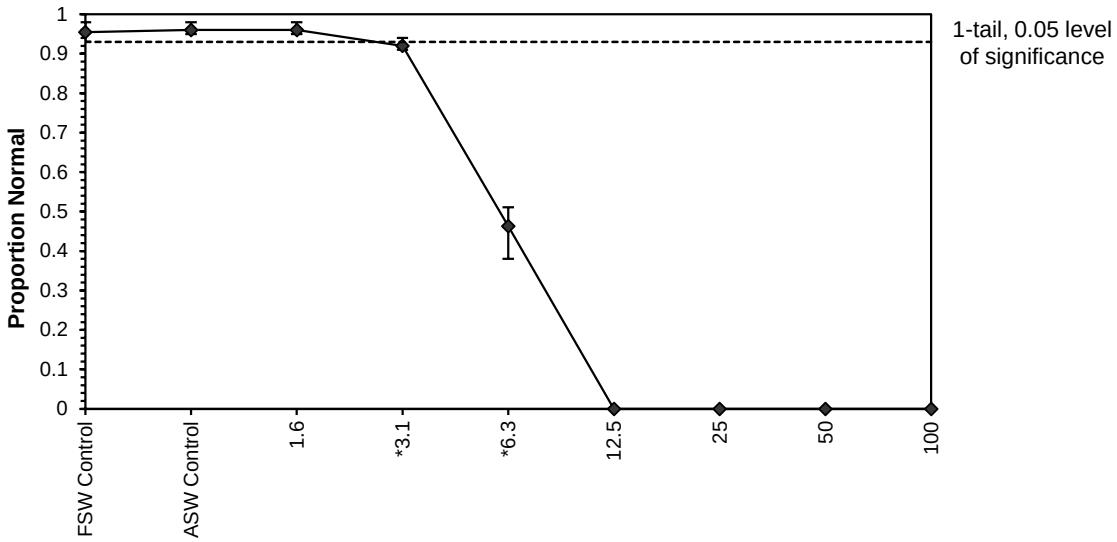
Point	%	SD	95% CL(Exp)		Skew
IC05	3.1960	0.1185	2.7264	3.4715	-0.7401
IC10	3.6788	0.0773	3.4479	3.9469	0.3239
IC15	4.0683	0.0745	3.8353	4.3218	0.2496
IC20	4.4091	0.0784	4.1692	4.6603	0.1249
IC25	4.7218	0.0866	4.4524	5.0043	0.0044
IC40	5.5947	0.1260	5.2239	5.9866	-0.1777
IC50	6.1868	0.1366	5.7140	6.4538	-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

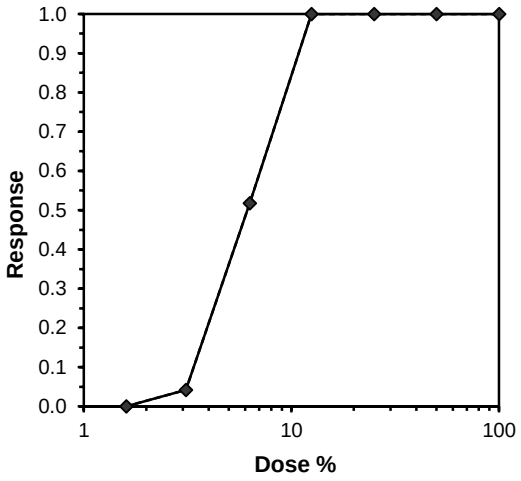
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9550	0.9948	1.3617	1.3030	1.4289	3.860	4					
ASW Control	0.9600	1.0000	1.3722	1.3453	1.4289	2.876	4	*			16	400
1.6	0.9600	1.0000	1.3722	1.3453	1.4289	2.876	4	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 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

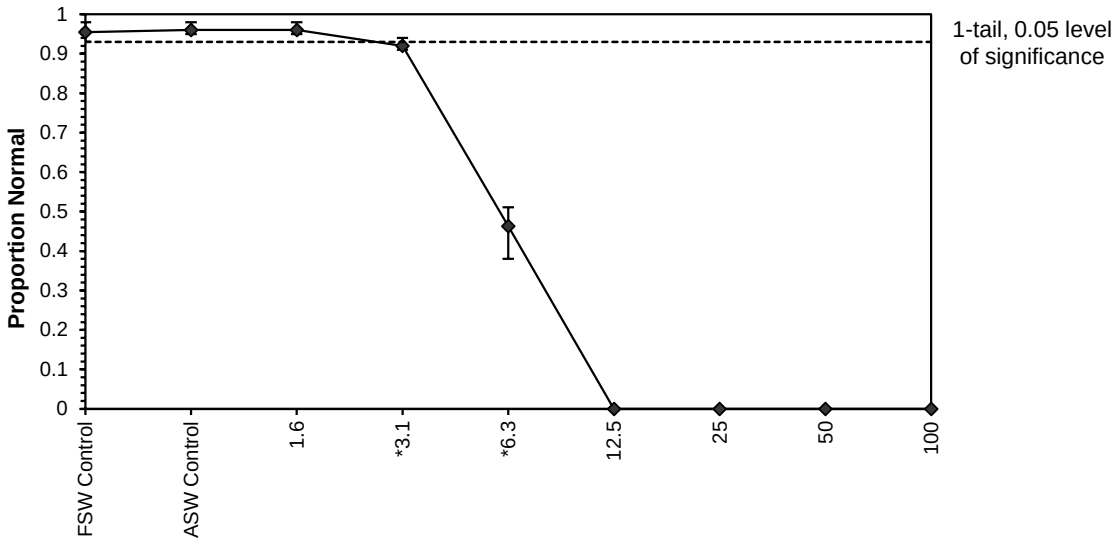
Trim Level	EC50	95% CL	
0.0%	6.0092	5.7885	6.2384
5.0%	6.0897	5.8553	6.3335
10.0%	6.0947	5.8354	6.3657
20.0%	6.1048	5.7686	6.4605
Auto-0.0%	6.0092	5.7885	6.2384



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

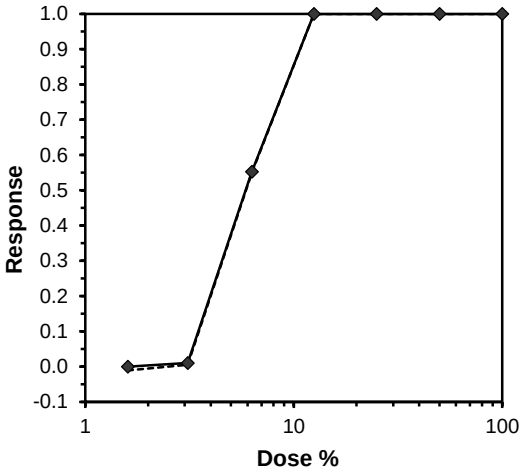
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9500	1.0053	1.3476	1.3030	1.3967	2.845	4					
ASW Control	0.9450	1.0000	1.3389	1.2661	1.3967	4.272	4	*			0.9500	1.0000
1.6	0.9550	1.0106	1.3617	1.3030	1.4289	3.860	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)

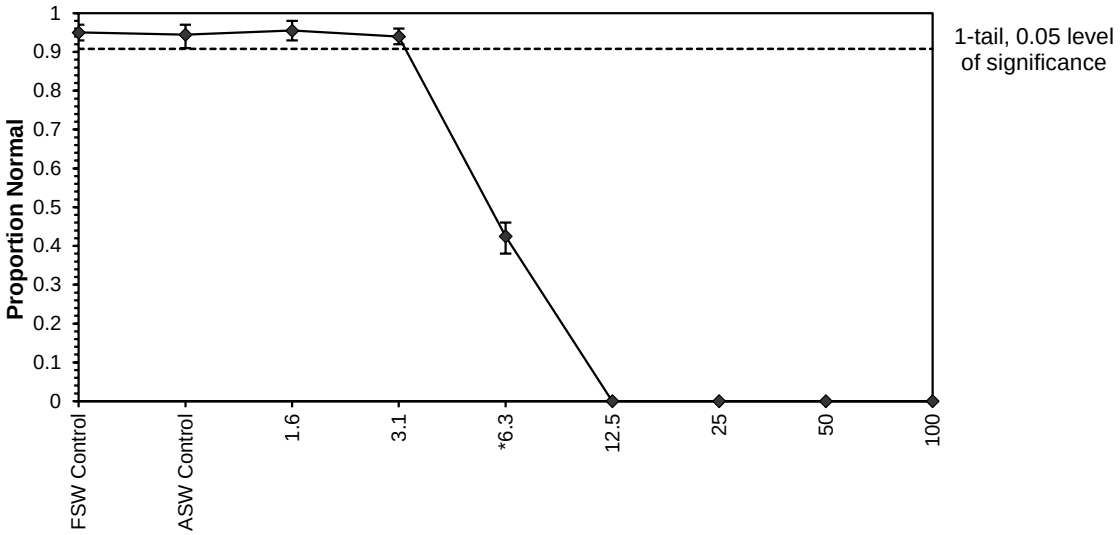
Point	%	SD	95% CL(Exp)		Skew
IC05	3.5285	0.1032	3.1492	3.7510	-0.4982
IC10	3.9312	0.0890	3.5916	4.1366	-0.4665
IC15	4.2588	0.0805	3.9714	4.4476	-0.4496
IC20	4.5457	0.0747	4.3051	4.7290	-0.4444
IC25	4.8085	0.0709	4.5901	4.9924	-0.4434
IC40	5.5373	0.0697	5.3183	5.7276	-0.3783
IC50	6.0264	0.0779	5.7777	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

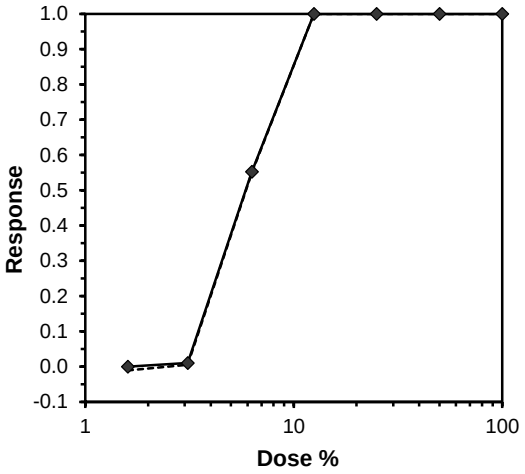
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9500	1.0053	1.3476	1.3030	1.3967	2.845	4					
ASW Control	0.9450	1.0000	1.3389	1.2661	1.3967	4.272	4	*			22	400
1.6	0.9550	1.0106	1.3617	1.3030	1.4289	3.860	4	-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

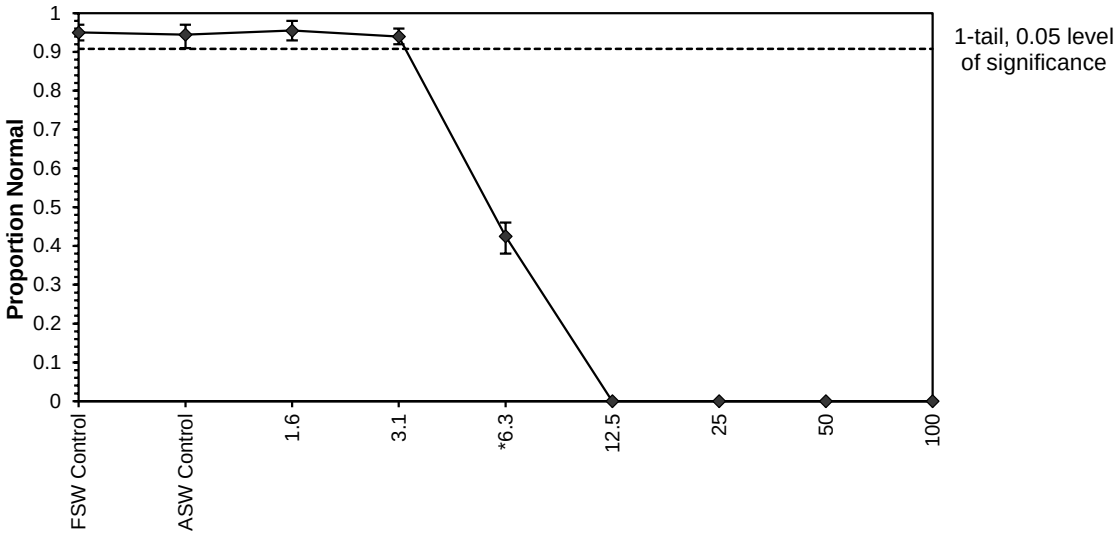
Trim Level	EC50	95% CL	
0.0%	5.9934	5.7851	6.2091
5.0%	5.9973	5.7705	6.2329
10.0%	5.9808	5.7292	6.2435
20.0%	5.9482	5.6257	6.2893
Auto-0.0%	5.9934	5.7851	6.2091



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

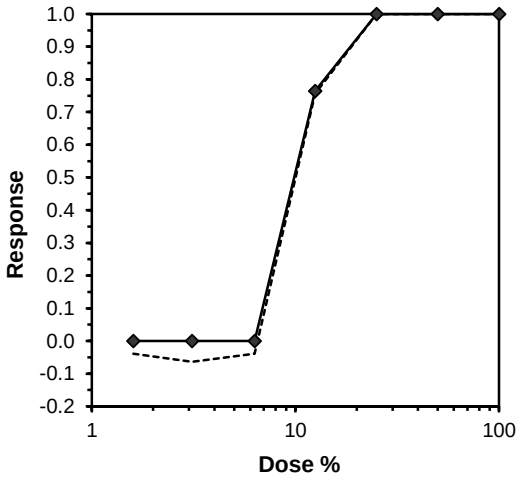
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9150	1.0139	1.2756	1.2490	1.3030	1.821	4				
ASW Control	0.9025	1.0000	1.2537	1.2327	1.2840	1.725	4	*		0.9344	1.0000
1.6	0.9375	1.0388	1.3210	1.2661	1.3694	3.461	4	25.00	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)

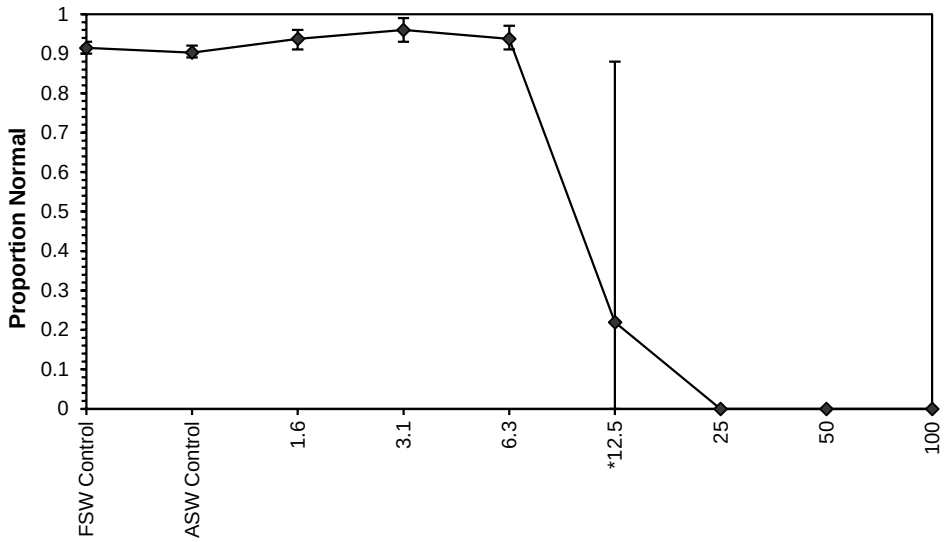
Point	%	SD	95% CL(Exp)		Skew
IC05	7.006	0.324	6.086	7.561	0.2516
IC10	7.527	0.576	6.036	9.181	0.2267
IC15	7.958	0.798	5.987	10.705	0.2566
IC20	8.338	1.003	5.942	12.157	0.2962
IC25	8.688	1.197	5.894	13.564	0.3375
IC40	9.655	1.641	5.737	14.815	0.0221
IC50	10.301	1.935	5.615	14.988	-0.1073



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

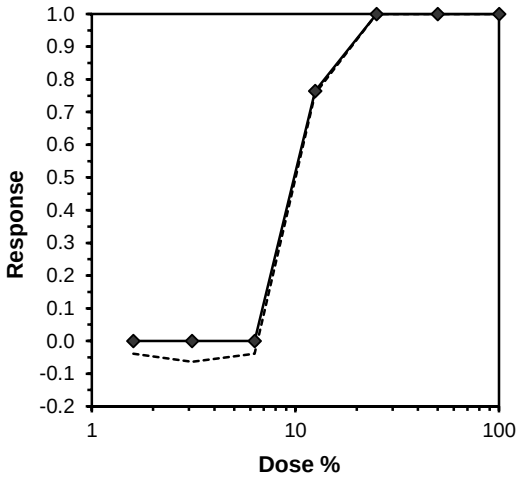
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9150	1.0139	1.2756	1.2490	1.3030	1.821	4				
ASW Control	0.9025	1.0000	1.2537	1.2327	1.2840	1.725	4	*		39	400
1.6	0.9375	1.0388	1.3210	1.2661	1.3694	3.461	4	25.00	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

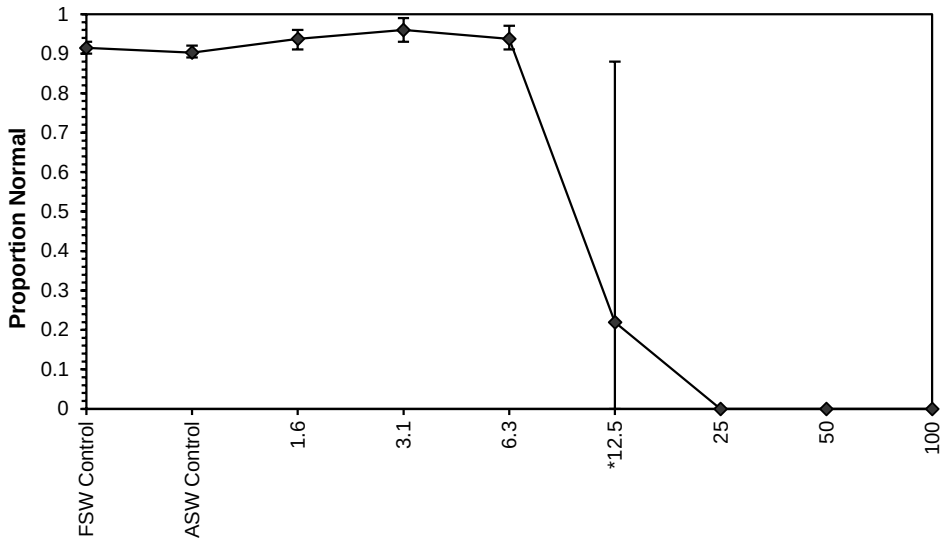
Trim Level	EC50	95% CL	
0.0%	10.437	10.137	10.747
5.0%	10.255	9.934	10.587
10.0%	10.096	9.763	10.440
20.0%	9.883	9.565	10.211
Auto-0.0%	10.437	10.137	10.747



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

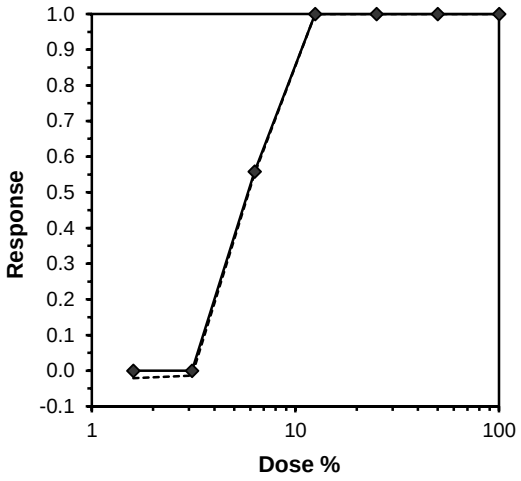
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7075	0.9895	0.9996	0.9695	1.0357	2.762	4					
ASW Control	0.7150	1.0000	1.0081	0.9589	1.0472	3.736	4	*			0.7233	1.0000
1.6	0.7300	1.0210	1.0255	0.9695	1.0826	5.246	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)

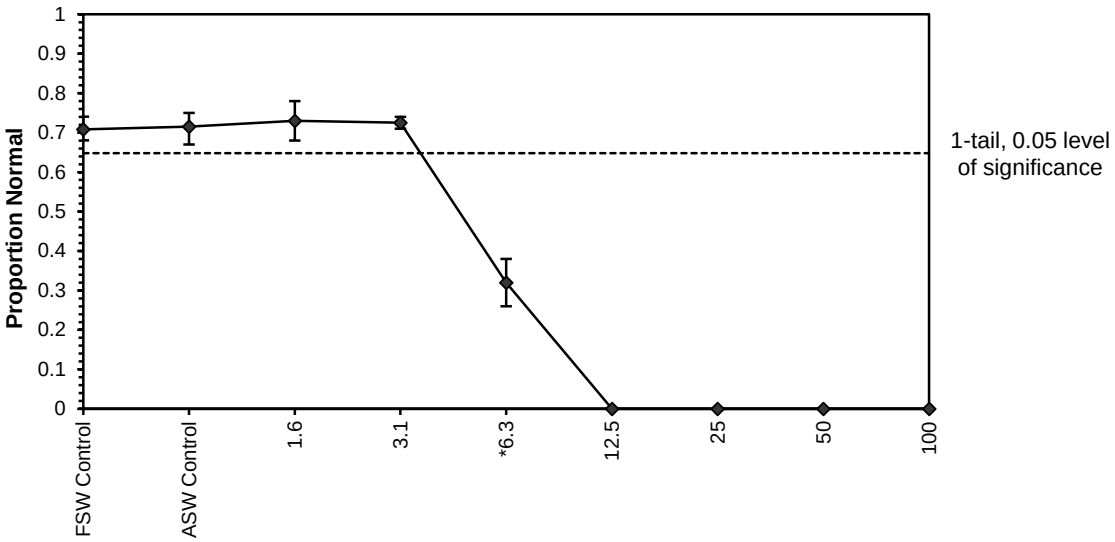
Point	%	SD	95% CL(Exp)		Skew
IC05	3.3474	0.1342	3.0737	3.3916	-10.9754
IC10	3.5931	0.0589	3.3355	3.6842	-0.9176
IC15	3.8402	0.0678	3.5734	3.9812	-0.4484
IC20	4.0914	0.0812	3.7956	4.2857	-0.1636
IC25	4.3493	0.0979	4.0381	4.6011	-0.0161
IC40	5.1943	0.1655	4.7030	5.6617	0.1343
IC50	5.8581	0.2230	5.2229	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

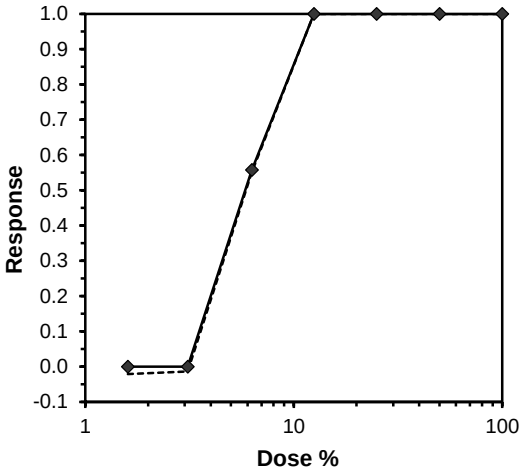
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7075	0.9895	0.9996	0.9695	1.0357	2.762	4					
ASW Control	0.7150	1.0000	1.0081	0.9589	1.0472	3.736	4	*			114	400
1.6	0.7300	1.0210	1.0255	0.9695	1.0826	5.246	4	-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 Treatments vs ASW Control	3.1	6.3	4.419276	32.25806	0.067342	0.094126	0.174308	0.001998	2.0E-08	3, 12

Trimmed Spearman-Karber

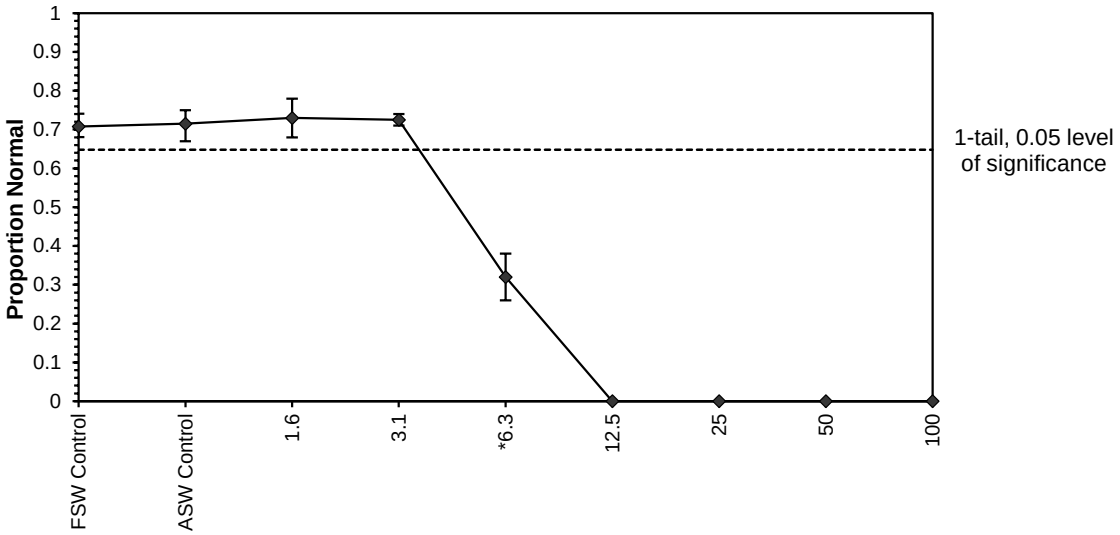
Trim Level	EC50	95% CL	
0.0%	6.0159	5.8111	6.2278
5.0%	5.9954	5.7696	6.2300
10.0%	5.9750	5.7241	6.2370
20.0%	5.9349	5.6134	6.2748
Auto-0.0%	6.0159	5.8111	6.2278



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

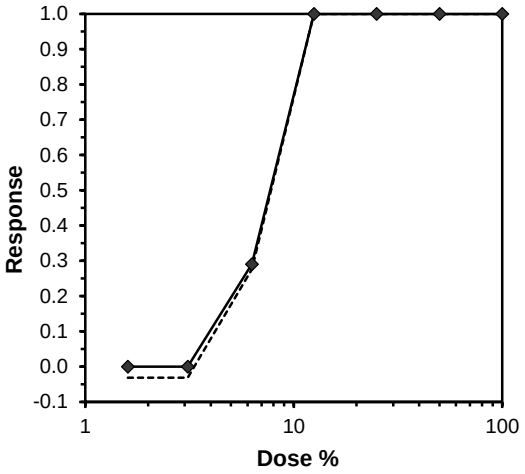
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.8325	1.0439	1.1497	1.1198	1.1873	2.605	4					
ASW Control	0.7975	1.0000	1.1048	1.0588	1.1458	3.354	4	*			0.8142	1.0000
1.6	0.8225	1.0313	1.1372	1.0826	1.1873	4.024	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)

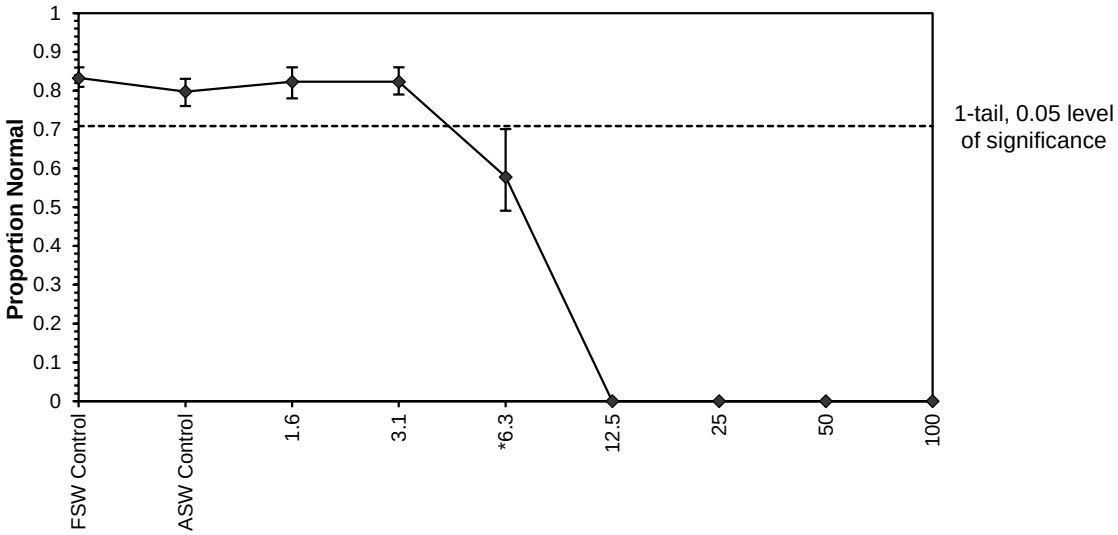
Point	%	SD	95% CL(Exp)		Skew
IC05	3.6390	0.1247	3.2747	4.0202	0.7050
IC10	4.1713	0.2401	3.7259	5.1005	1.4705
IC15	4.7067	0.3739	4.0262	6.2890	1.4895
IC20	5.2536	0.4547	4.3117	6.9797	0.7872
IC25	5.8197	0.4240	4.5938	6.7676	-0.0208
IC40	6.4709	0.0893	6.2005	6.7464	0.1392
IC50	6.6318	0.0868	6.3656	6.9024	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

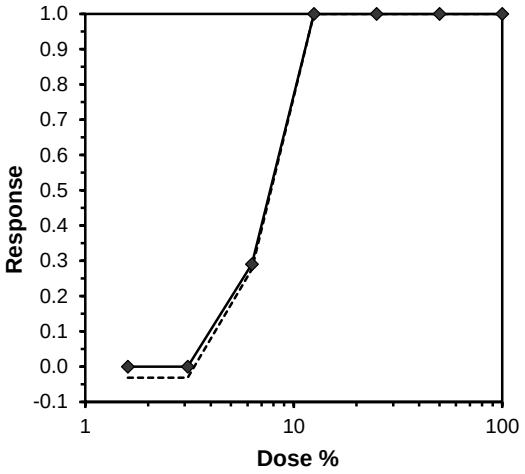
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.8325	1.0439	1.1497	1.1198	1.1873	2.605	4					
ASW Control	0.7975	1.0000	1.1048	1.0588	1.1458	3.354	4	*			81	400
1.6	0.8225	1.0313	1.1372	1.0826	1.1873	4.024	4	-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

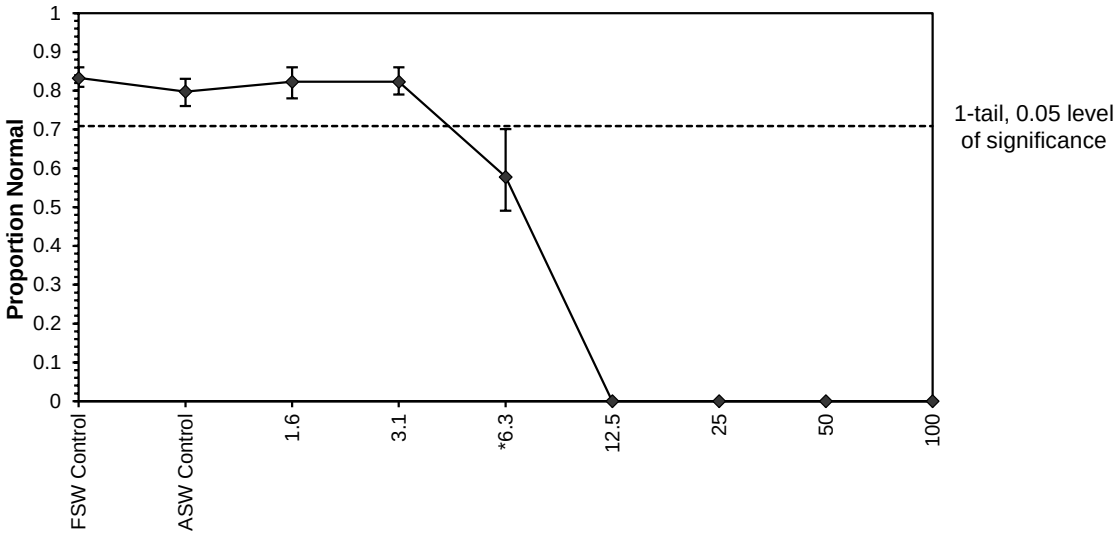
Trim Level	EC50	95% CL	
0.0%	7.2462	7.0204	7.4793
5.0%	7.3545	7.0972	7.6212
10.0%	7.4577	7.1541	7.7743
20.0%	7.6342	7.1652	8.1339
Auto-0.0%	7.2462	7.0204	7.4793



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

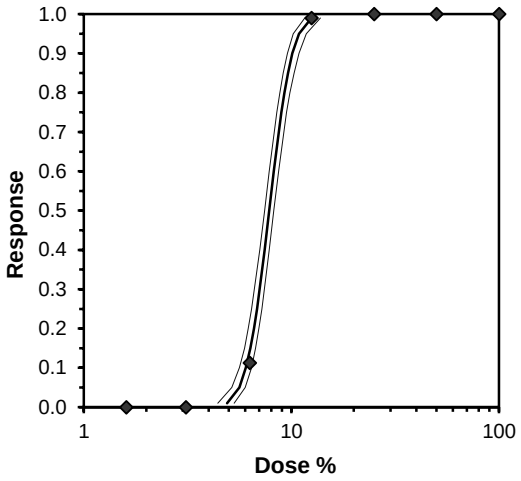
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.939862	0.905	-0.23612	0.741992
Bartlett's Test indicates equal variances (p = 0.36)	4.372557	13.2767		
The control means are not significantly different (p = 0.33)	1.05303	2.446912		

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							

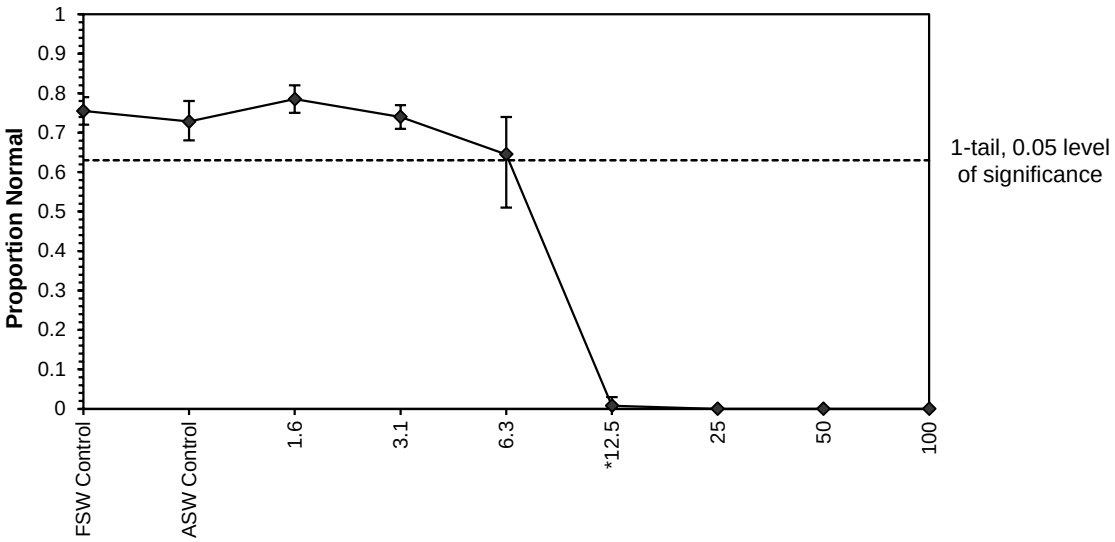
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	4.897809	4.41871	5.304506
EC05	3.355	5.618206	5.171699	6.002617
EC10	3.718	6.044605	5.618138	6.418552
EC15	3.964	6.350432	5.937205	6.719548
EC20	4.158	6.604491	6.200836	6.971984
EC25	4.326	6.830536	6.433864	7.198841
EC40	4.747	7.435038	7.047309	7.818511
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

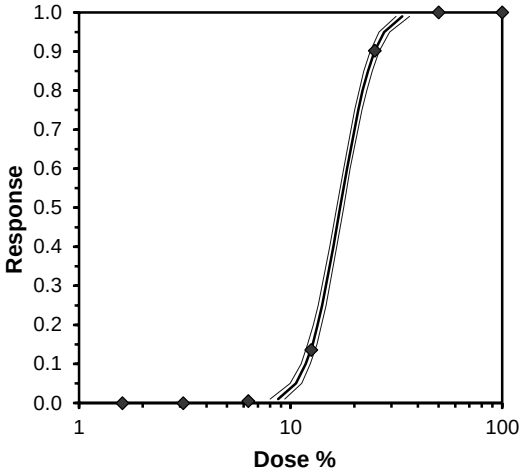
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.978289	0.916	0.094715	-0.22336
Bartlett's Test indicates equal variances (p = 0.68)	3.158997	15.08627		
The control means are not significantly different (p = 0.40)	0.902073	2.446912		

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							

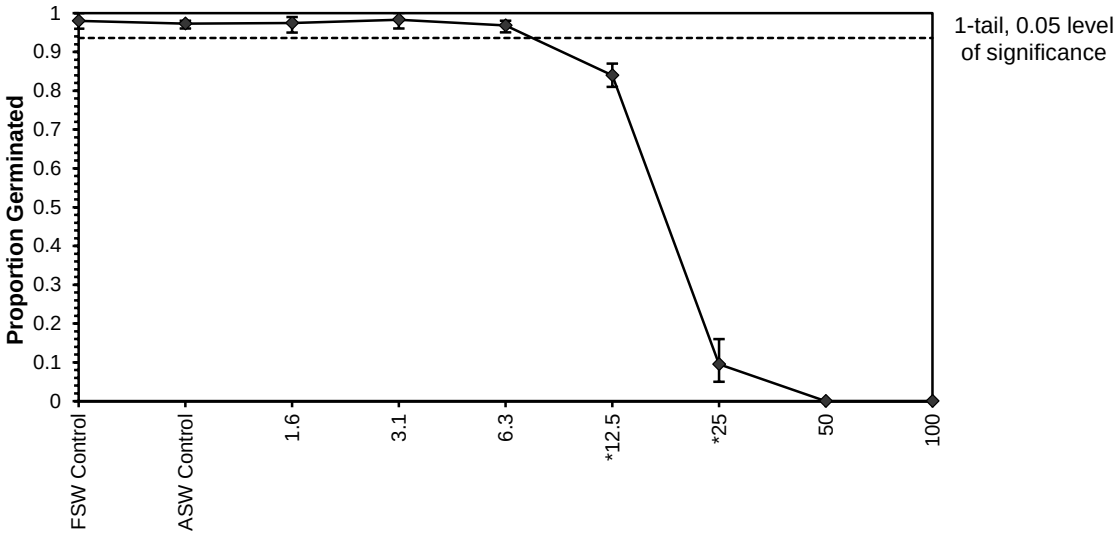
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	8.727219	8.002732	9.382743
EC05	3.355	10.63708	9.943638	11.26282
EC10	3.718	11.82061	11.15542	12.42411
EC15	3.964	12.69267	12.04943	13.28108
EC20	4.158	13.43141	12.80577	14.00963
EC25	4.326	14.09936	13.4876	14.67161
EC40	4.747	15.93352	15.341	16.51405
EC50	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

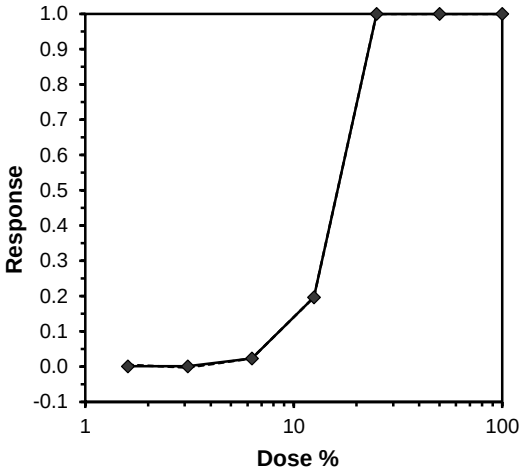
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9650	1.0000	1.3851	1.3453	1.4289	2.598	4					
ASW Control	0.9650	1.0000	1.3851	1.3453	1.4289	2.598	4	*			0.9650	1.0000
1.6	0.9600	0.9948	1.3722	1.3453	1.4289	2.876	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)

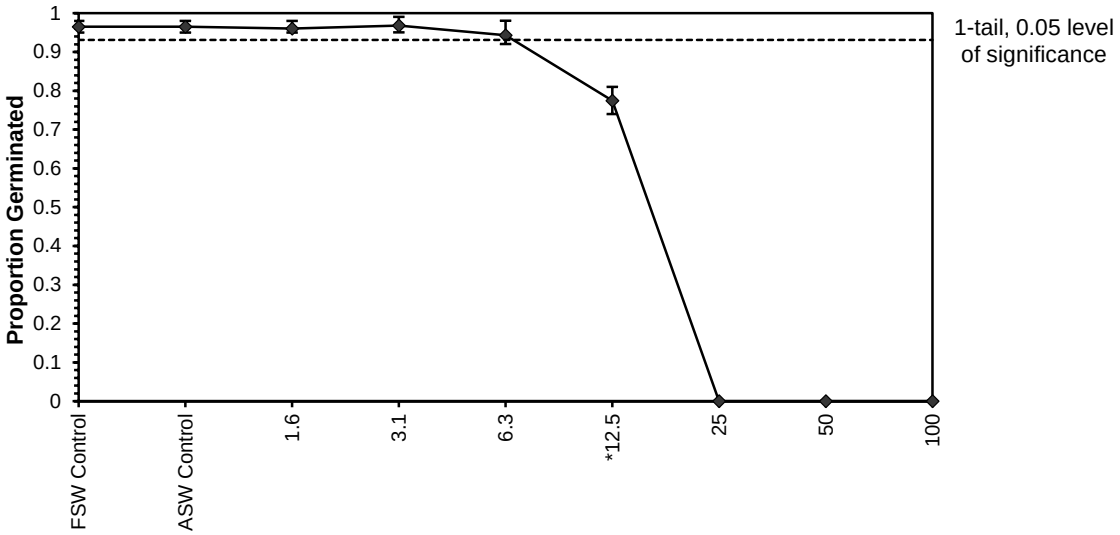
Point	%	SD	95% CL(Exp)		Skew
IC05	7.539	0.572	5.762	9.094	0.1594
IC10	9.445	0.438	8.035	10.586	0.0800
IC15	11.083	0.375	9.913	12.113	0.0380
IC20	12.515	0.227	11.369	12.700	-1.3564
IC25	12.734	0.064	12.520	12.914	-0.0208
IC40	13.300	0.062	13.091	13.475	-0.0390
IC50	13.653	0.061	13.446	13.825	-0.0467



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

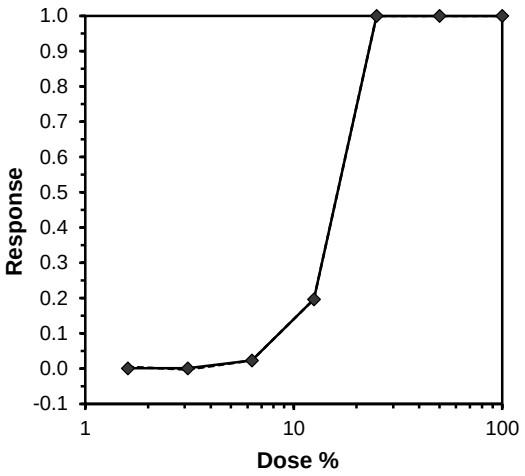
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9650	1.0000	1.3851	1.3453	1.4289	2.598	4					
ASW Control	0.9650	1.0000	1.3851	1.3453	1.4289	2.598	4	*			14	400
1.6	0.9600	0.9948	1.3722	1.3453	1.4289	2.876	4	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302	0.034674	0.035898	0.071557	0.002277	3.9E-07	4, 15

Trimmed Spearman-Karber

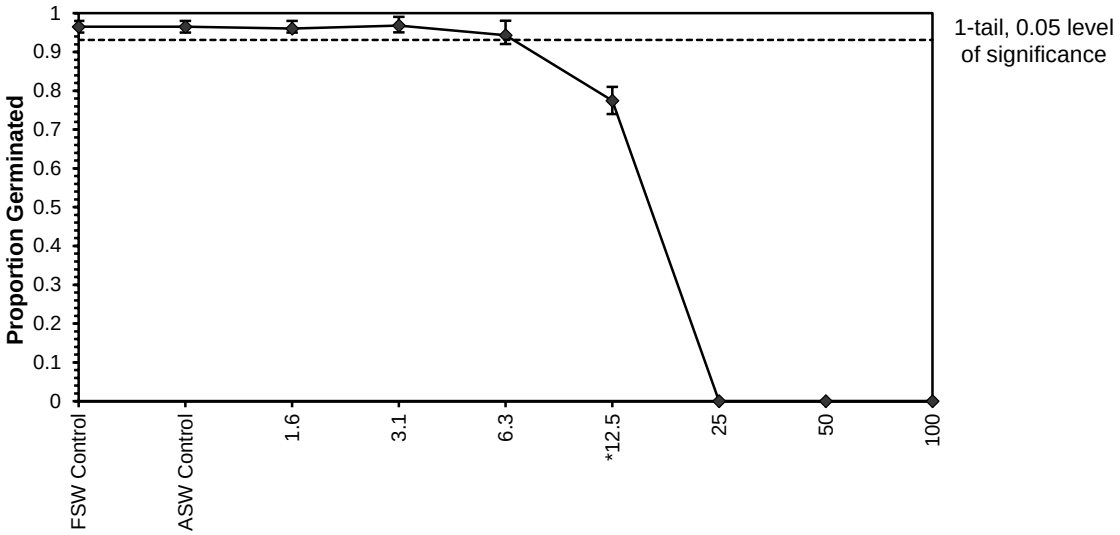
Trim Level	EC50	95% CL	
0.0%			
5.0%	15.648	15.170	16.141
10.0%	15.946	15.362	16.554
20.0%	16.238	15.894	16.588
Auto-0.1%	15.200	14.759	15.655



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

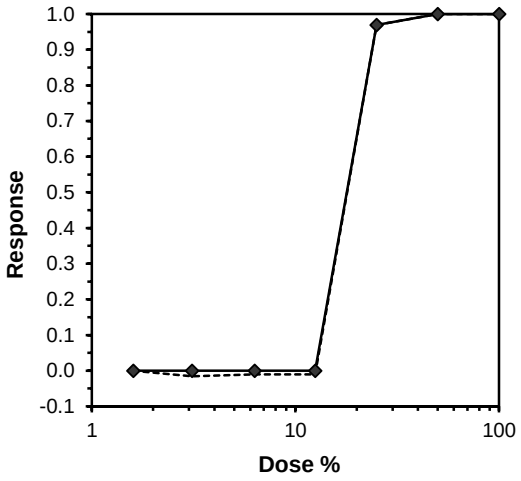
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9550	1.0000	1.3617	1.3030	1.4289	3.860	4					
ASW Control	0.9550	1.0000	1.3617	1.3030	1.4289	3.860	4	*			0.9620	1.0000
1.6	0.9550	1.0000	1.3617	1.3030	1.4289	3.860	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)

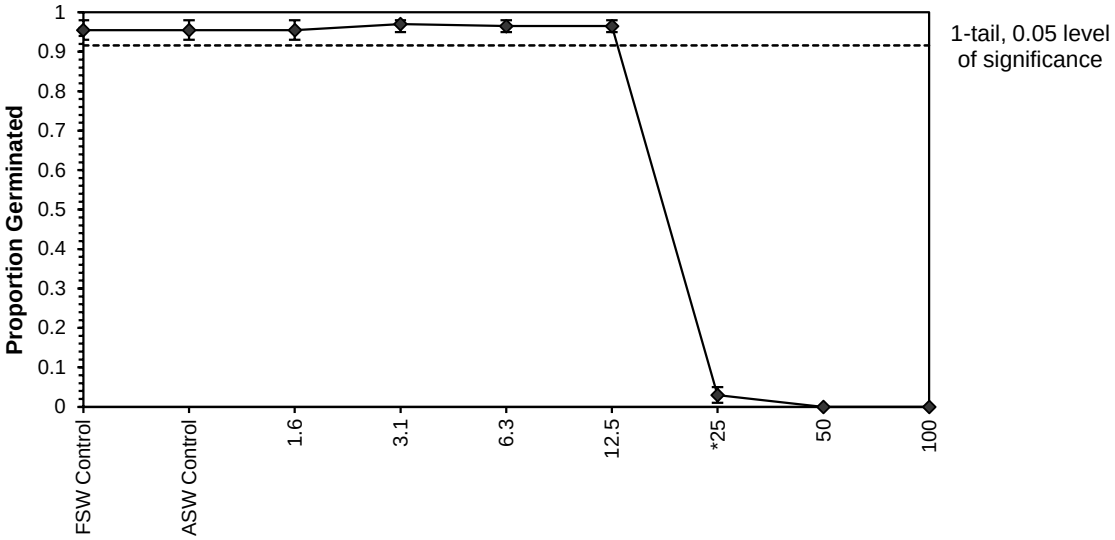
Point	%	SD	95% CL(Exp)		Skew
IC05	13.697	0.104	13.138	13.844	-0.8944
IC10	14.429	0.110	13.917	14.642	-0.4924
IC15	14.987	0.124	14.454	15.248	-0.4080
IC20	15.454	0.138	14.889	15.754	-0.3730
IC25	15.868	0.152	15.253	16.189	-0.3462
IC40	16.958	0.194	16.179	17.381	-0.2772
IC50	17.650	0.224	16.745	18.190	-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

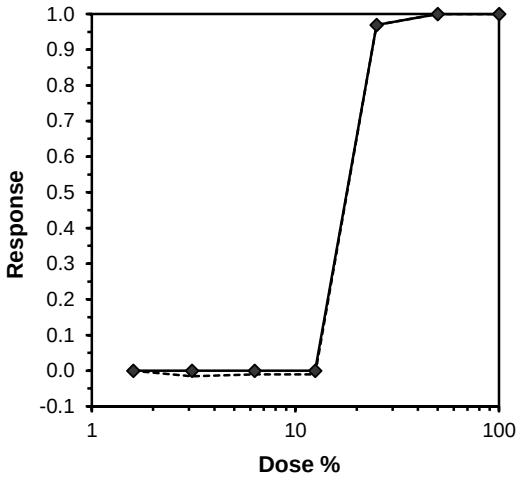
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9550	1.0000	1.3617	1.3030	1.4289	3.860	4					
ASW Control	0.9550	1.0000	1.3617	1.3030	1.4289	3.860	4	*			18	400
1.6	0.9550	1.0000	1.3617	1.3030	1.4289	3.860	4	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

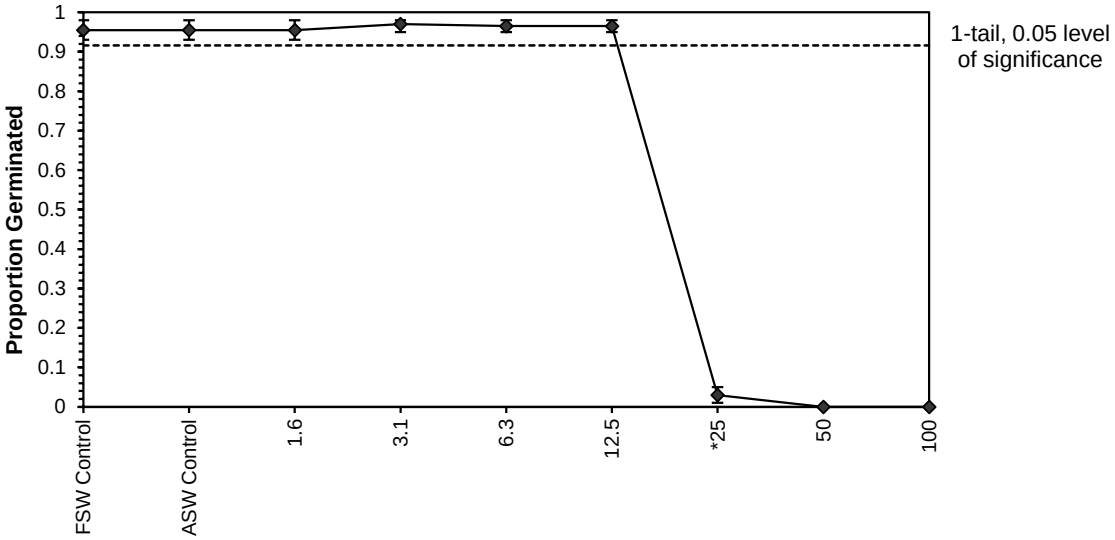
Trim Level	EC50	95% CL	
0.0%	18.064	17.848	18.283
5.0%	17.876	17.762	17.991
10.0%	17.876	17.762	17.991
20.0%	17.876	17.762	17.991
Auto-0.0%	18.064	17.848	18.283



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

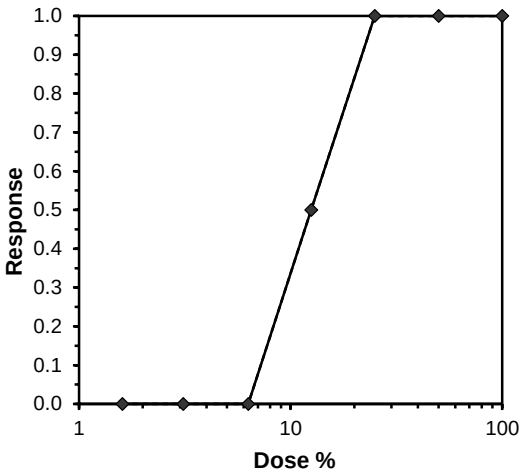
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

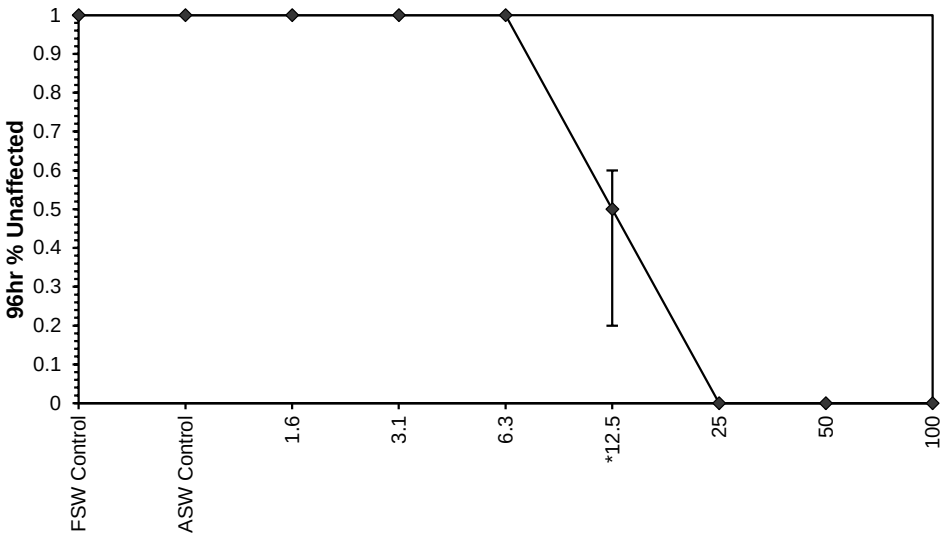
Point	%	SD	95% CL(Exp)		Skew
IC05	10.091	0.181	9.477	10.436	-0.3522
IC10	10.658	0.213	9.937	11.065	-0.3491
IC15	11.024	0.234	10.232	11.471	-0.3472
IC20	11.307	0.251	10.459	11.786	-0.3458
IC25	11.545	0.265	10.650	12.052	-0.3446
IC40	12.140	0.302	11.124	12.716	-0.3418
IC50	12.500	0.320	11.410	13.105	-0.3623



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

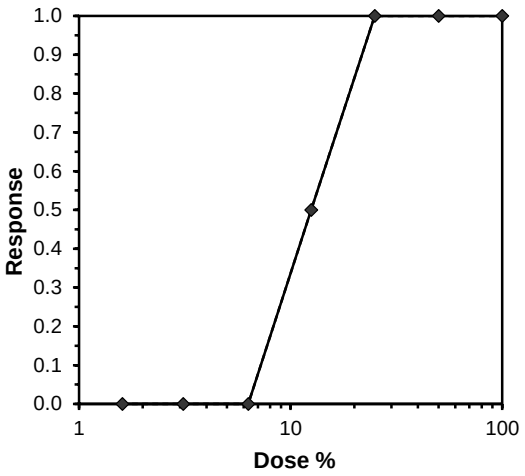
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

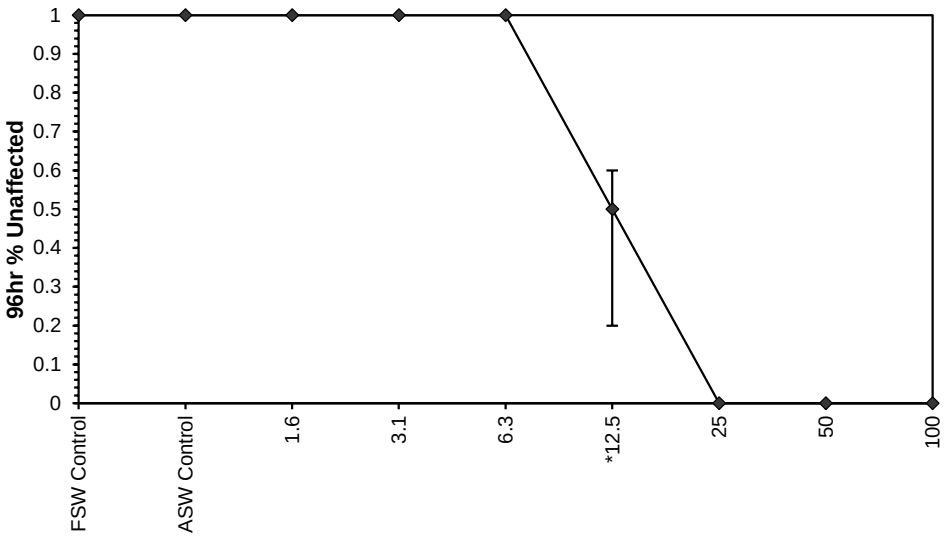
Trim Level	EC50	95% CL	
0.0%	12.525	10.736	14.612
5.0%	12.522	10.552	14.861
10.0%	12.520	10.327	15.179
20.0%	12.515	9.683	16.176
Auto-0.0%	12.525	10.736	14.612



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

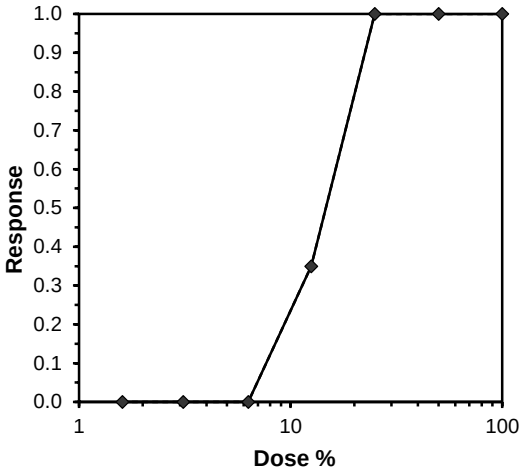
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

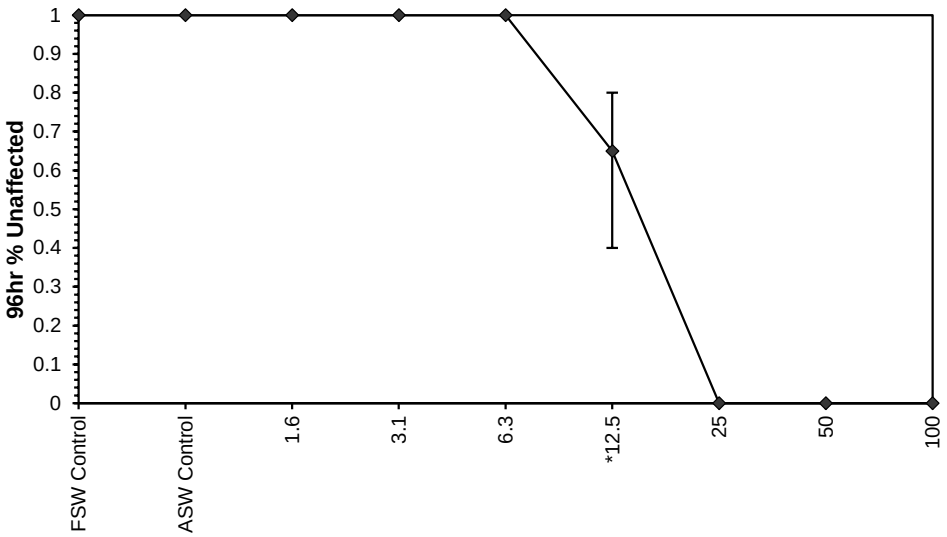
Point	%	SD	95% CL(Exp)		Skew
IC05	10.430	0.233	9.887	11.253	0.1908
IC10	11.058	0.275	10.418	12.032	0.1962
IC15	11.464	0.303	10.760	12.538	0.1996
IC20	11.779	0.325	11.024	12.933	0.2022
IC25	12.045	0.335	11.246	13.161	0.0968
IC40	12.694	0.337	11.807	13.735	-0.1021
IC50	13.069	0.336	12.159	14.092	-0.1593



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

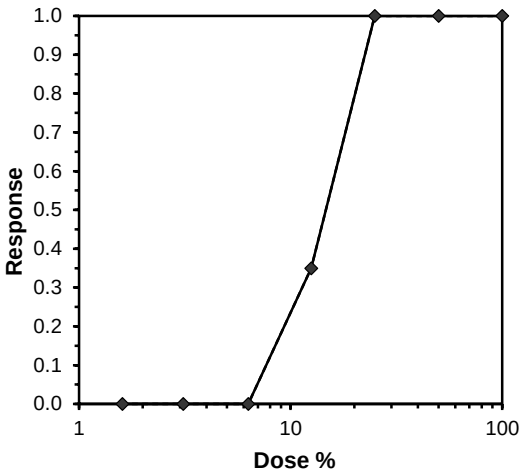
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

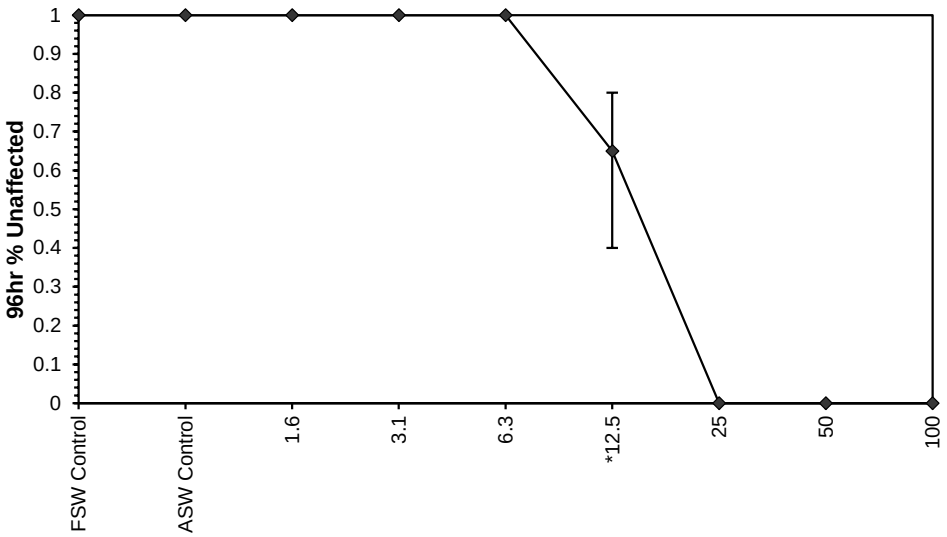
Trim Level	EC50	95% CL	
0.0%	13.889	11.990	16.088
5.0%	14.029	11.901	16.537
10.0%	14.166	11.726	17.114
20.0%	14.425	10.978	18.955
Auto-0.0%	13.889	11.990	16.088



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

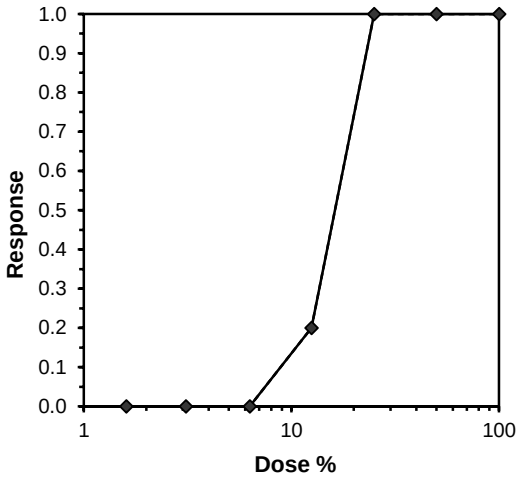
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

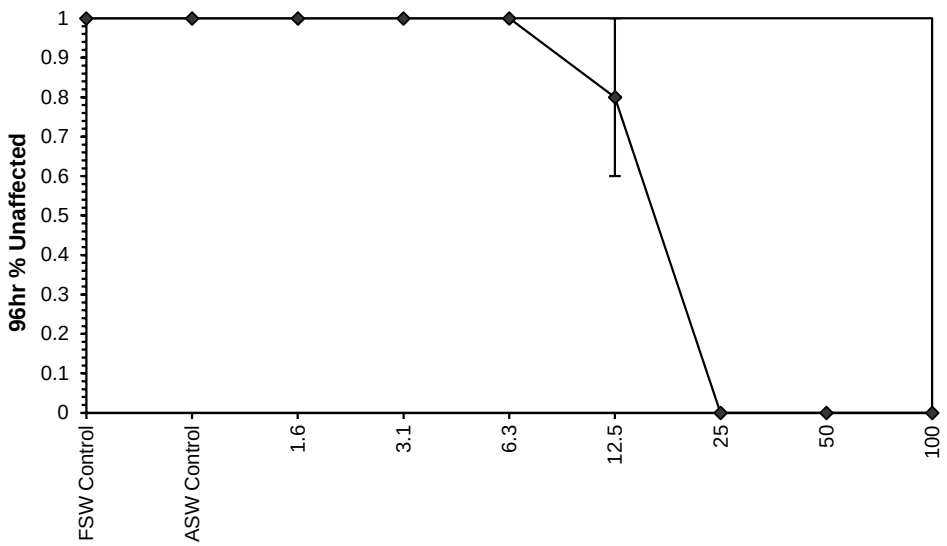
Point	%	SD	95% CL(Exp)		Skew
IC05	10.944	0.519	10.342	12.098	4.6389
IC10	11.667	0.539	10.953	13.022	3.5202
IC15	12.136	0.525	11.347	13.322	3.2990
IC20	12.500	0.503	11.653	13.552	3.4095
IC25	12.742	0.486	11.951	13.783	3.5948
IC40	13.344	0.466	12.616	14.356	3.6525
IC50	13.709	0.457	12.993	14.701	3.6209



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				

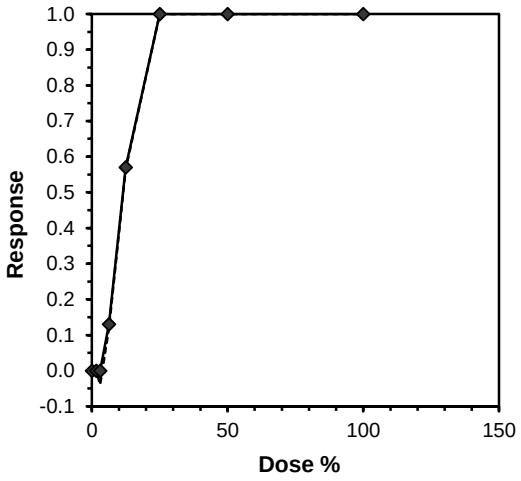
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	16.158	1.0000	16.158	15.608	16.908	2.708	8					
ASW Control	16.158	1.0000	16.158	15.608	16.808	3.409	4	*			16.366	1.0000
1.6	16.158	1.0000	16.158	15.108	17.008	5.015	4	0.000	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)

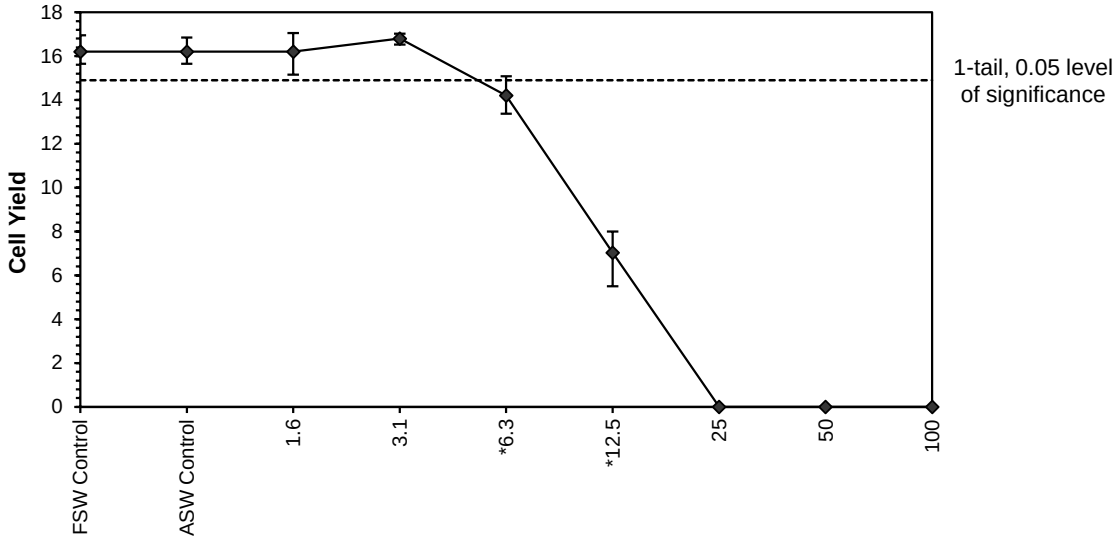
Point	%	SD	95% CL(Exp)		Skew
IC05	4.327	0.261	3.809	5.246	1.0171
IC10	5.555	0.422	4.657	6.924	0.5458
IC15	6.577	0.317	5.565	7.445	-0.0710
IC20	7.282	0.281	6.464	8.157	0.1657
IC25	7.986	0.270	7.227	8.902	0.1962
IC40	10.100	0.308	9.325	11.086	0.0566
IC50	11.509	0.379	10.599	12.690	0.0422



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				

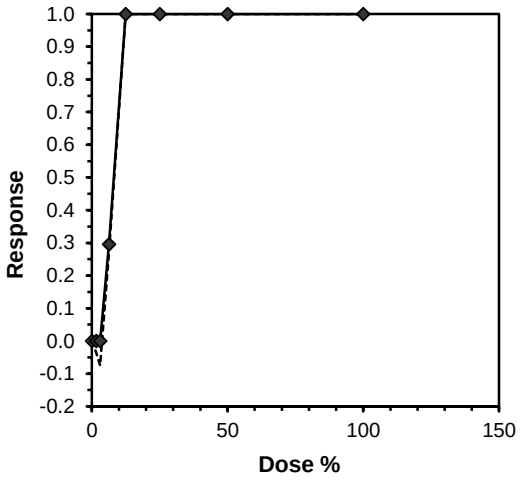
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	18.658	1.0559	18.658	17.670	19.970	4.116	8				
ASW Control	17.670	1.0000	17.670	17.070	18.370	3.427	4	*		18.320	1.0000
1.6	18.295	1.0354	18.295	17.770	18.970	2.800	4	22.50	10.00	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)

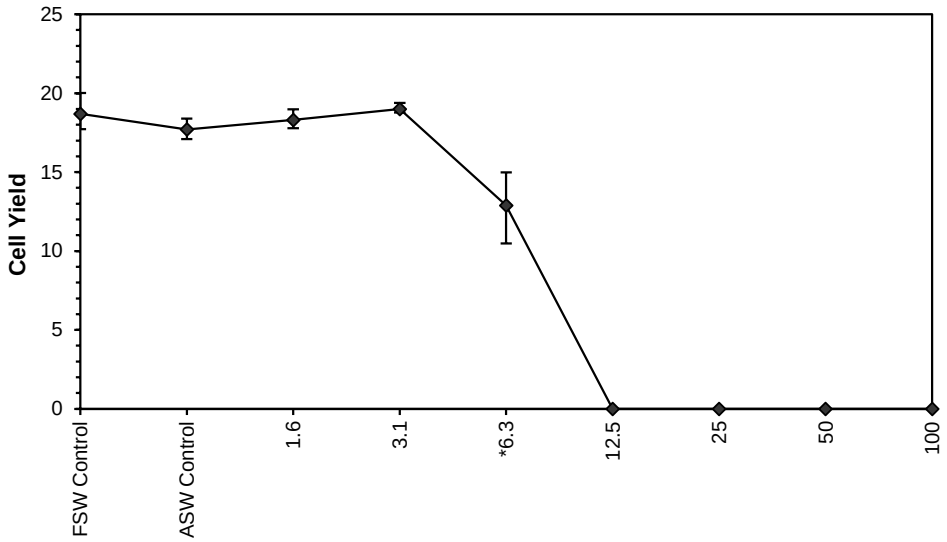
Point	%	SD	95% CL(Exp)		Skew
IC05	3.6403	0.0874	3.4663	3.9789	0.9880
IC10	4.1807	0.1749	3.8326	4.8579	0.9880
IC15	4.7210	0.2623	4.1989	5.7368	0.9880
IC20	5.2613	0.3427	4.5652	6.6158	0.8214
IC25	5.8016	0.3799	4.9315	7.0328	0.3581
IC40	7.2150	0.3290	6.1846	8.0894	-0.2693
IC50	8.0959	0.2743	7.2372	8.8245	-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			

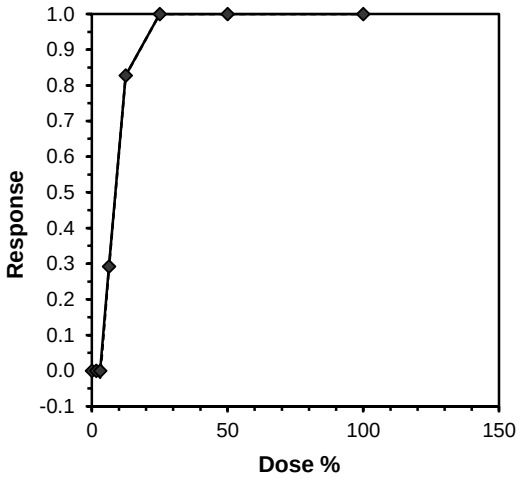
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	17.675	1.0094	17.675	16.861	18.361	3.417	7					
ASW Control	17.511	1.0000	17.511	16.761	18.261	4.628	4	*			17.627	1.0000
1.6	17.511	1.0000	17.511	17.161	18.261	2.893	4	0.000	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)

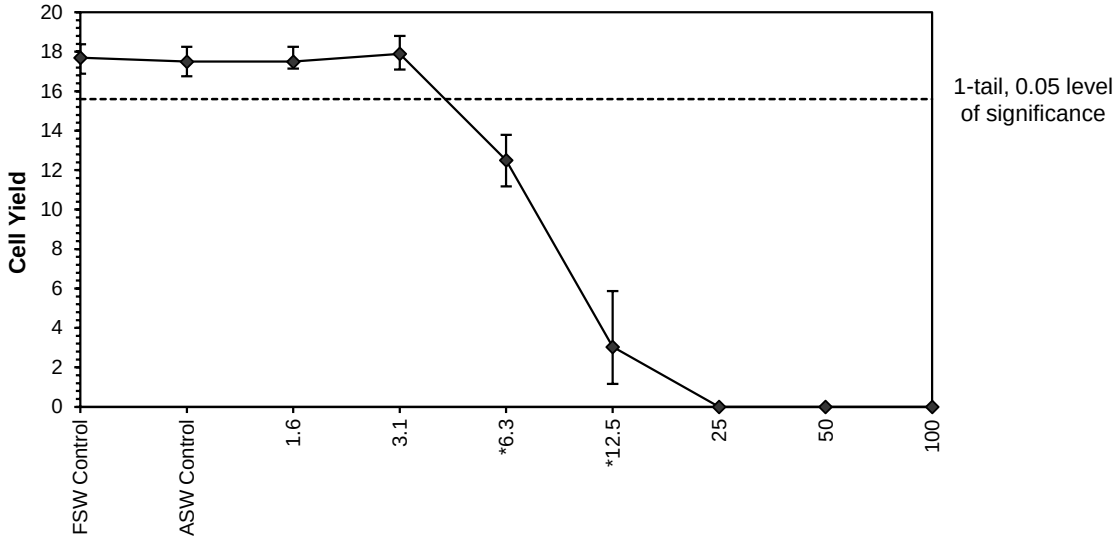
Point	%	SD	95% CL(Exp)		Skew
IC05	3.6485	0.1281	3.0738	3.7977	-2.4820
IC10	4.1971	0.1382	3.6429	4.4954	-0.4183
IC15	4.7456	0.1743	4.1095	5.1931	0.0585
IC20	5.2941	0.2182	4.6220	5.9036	0.2228
IC25	5.8426	0.2642	5.0753	6.6135	0.2408
IC40	7.5526	0.3140	6.6263	8.4938	0.2480
IC50	8.7091	0.3609	7.8681	9.9058	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

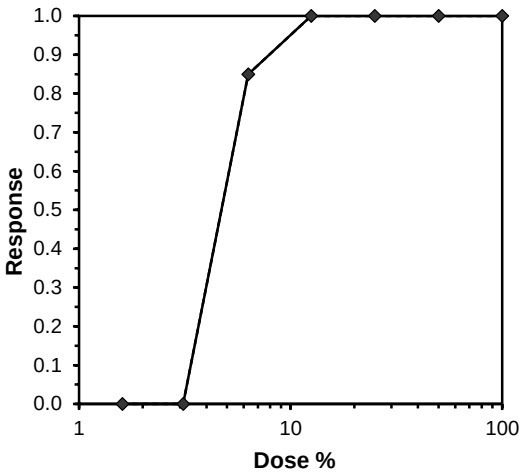
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

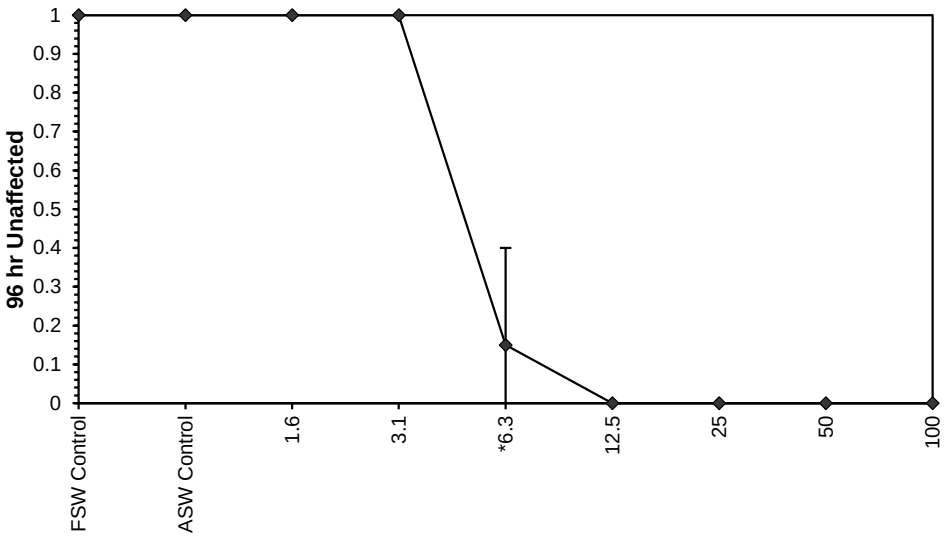
Point	%	SD	95% CL(Exp)		Skew
IC05	4.7045	0.2277	3.5596	4.9743	-1.9274
IC10	4.9336	0.2634	3.6111	5.2483	-1.9162
IC15	5.0801	0.2866	3.6425	5.4242	-1.9093
IC20	5.1927	0.3047	3.6658	5.5599	-1.9041
IC25	5.2873	0.3200	3.6849	5.6740	-1.8998
IC40	5.5213	0.3582	3.7301	5.9574	-1.8893
IC50	5.6622	0.3815	3.7560	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

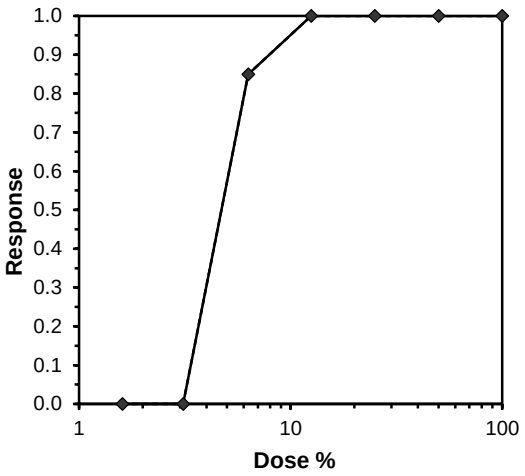
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

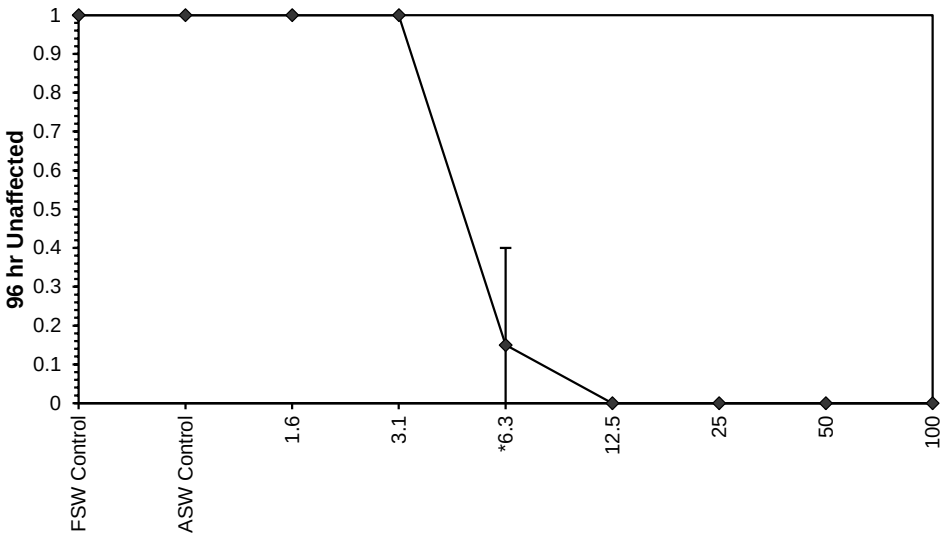
Trim Level	EC50	95% CL	
0.0%	4.9064	4.3895	5.4842
5.0%	4.8032	4.2722	5.4003
10.0%	4.7322	4.2403	5.2811
20.0%	4.7046	4.3500	5.0882
Auto-0.0%	4.9064	4.3895	5.4842



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

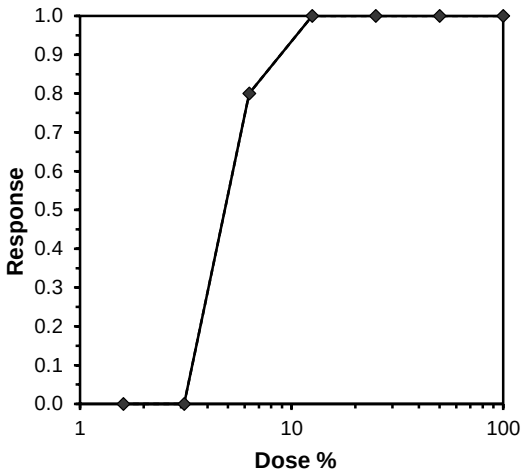
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

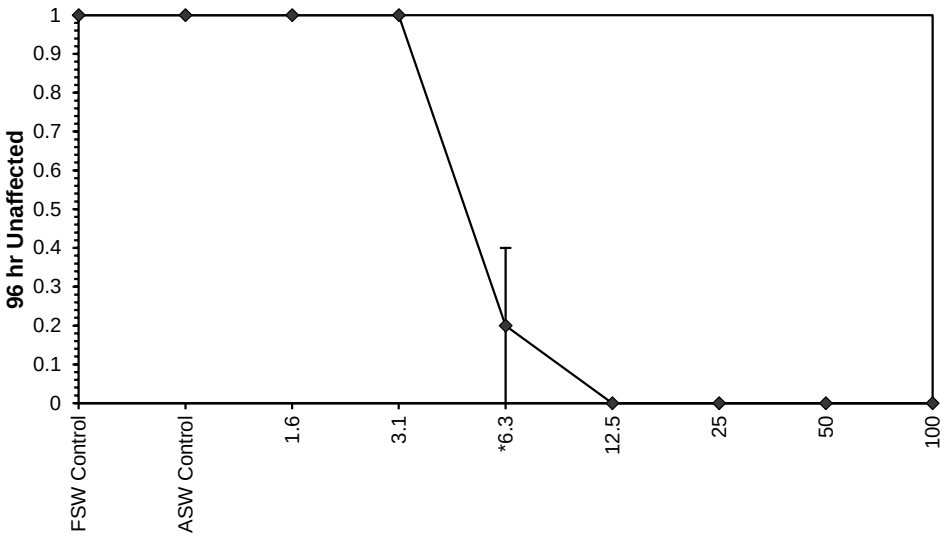
Point	%	SD	95% CL(Exp)		Skew
IC05	4.7667	0.1037	4.5413	5.0157	-2.1697
IC10	5.0061	0.1206	4.7438	5.2969	-2.1313
IC15	5.1593	0.1316	4.8728	5.4774	-2.1077
IC20	5.2772	0.1402	4.9718	5.6168	-2.0902
IC25	5.3763	0.1475	5.0549	5.7341	-2.0757
IC40	5.6215	0.1659	5.2597	6.0255	-2.0413
IC50	5.7693	0.1772	5.3827	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

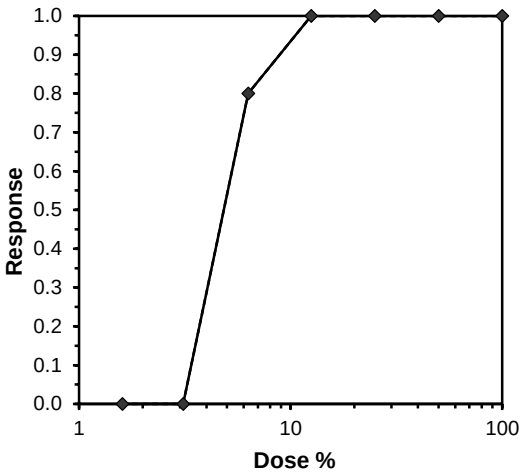
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

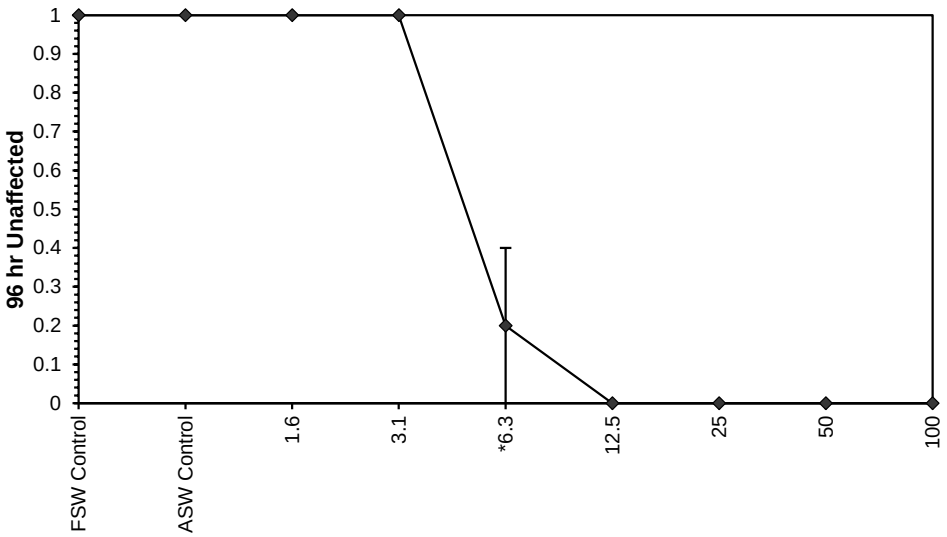
Trim Level	EC50	95% CL	
0.0%	5.0805	4.4848	5.7553
5.0%	4.9846	4.3570	5.7028
10.0%	4.9062	4.2738	5.6320
20.0%	4.8289	4.3733	5.3320
Auto-0.0%	5.0805	4.4848	5.7553



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

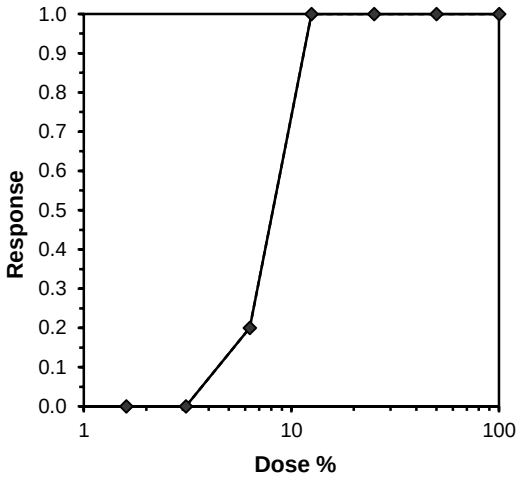
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

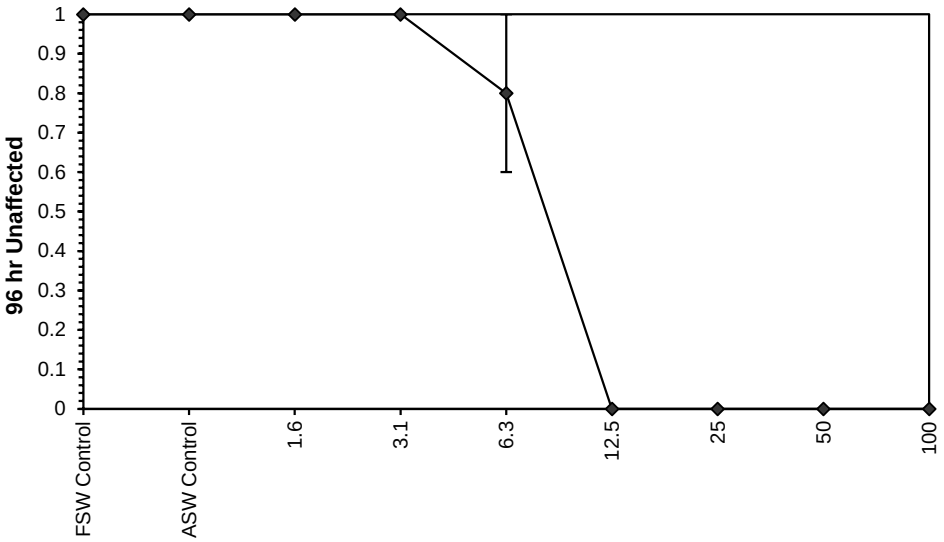
Point	%	SD	95% CL(Exp)		Skew
IC05	5.5077	0.3208	5.0868	6.7754	4.6773
IC10	5.8763	0.3228	5.3798	7.0041	3.8035
IC15	6.1149	0.3139	5.5681	7.1482	3.6024
IC20	6.3000	0.3025	5.7135	7.2578	3.6848
IC25	6.4229	0.2940	5.8561	7.3693	3.8154
IC40	6.7275	0.2816	6.2006	7.6441	3.8715
IC50	6.9114	0.2754	6.3943	7.8090	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

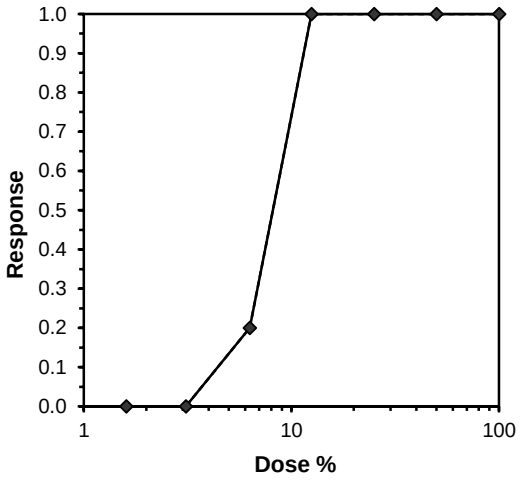
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

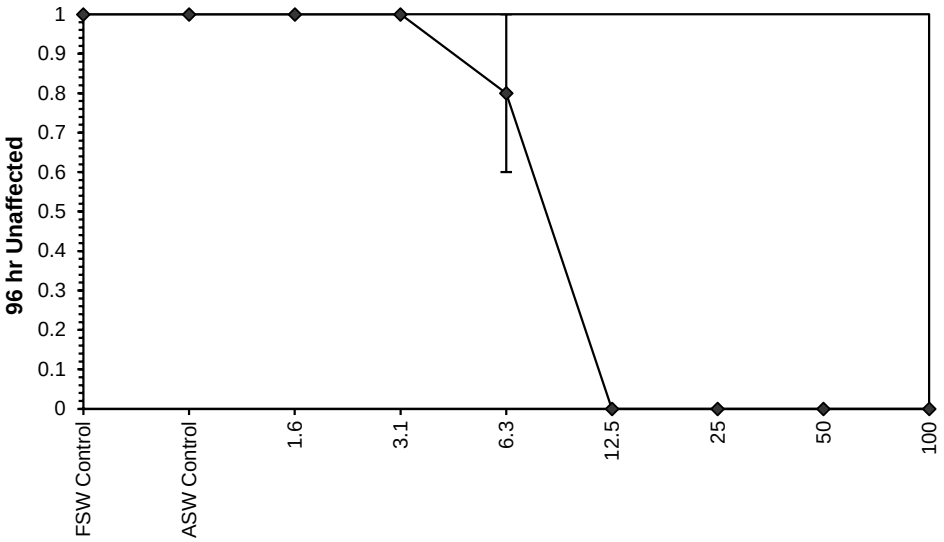
Trim Level	EC50	95% CL	
0.0%	7.7192	6.8141	8.7444
5.0%	7.8764	6.8289	9.0846
10.0%	8.0099	6.7273	9.5372
20.0%	8.1457	7.4019	8.9643
Auto-0.0%	7.7192	6.8141	8.7444



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

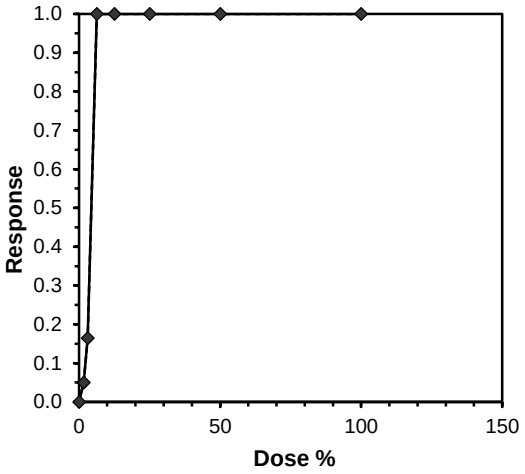
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.804848	0.859	1.834935	5.248119
Bartlett's Test indicates unequal variances (p = 4.69E-03)	10.72429	9.21034		
The control means are not significantly different (p = 0.56)	0.618571	2.446912		

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

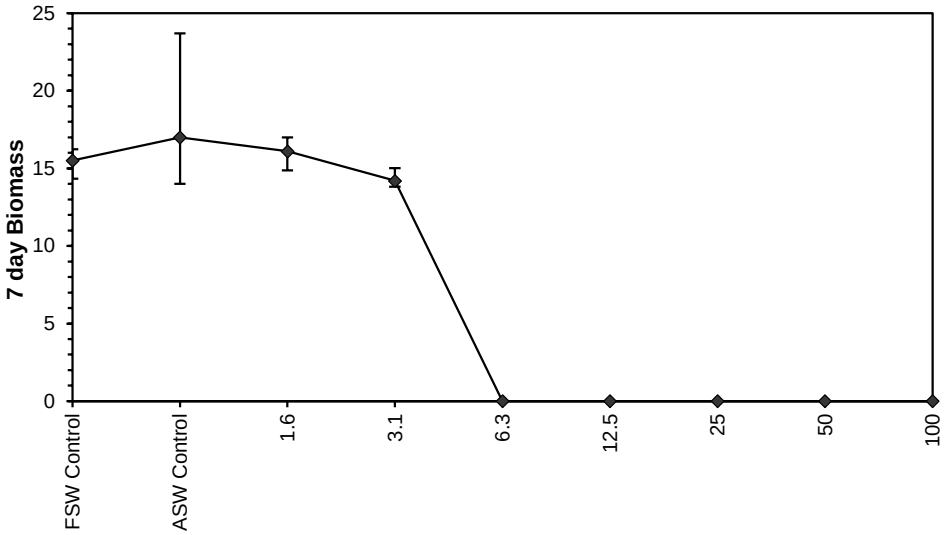
* indicates IC estimate less than the lowest concentration



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

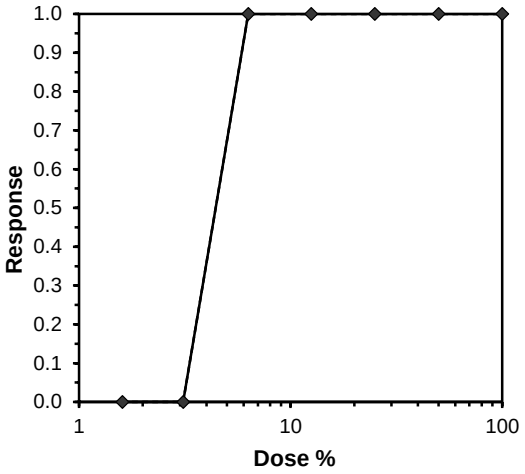
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

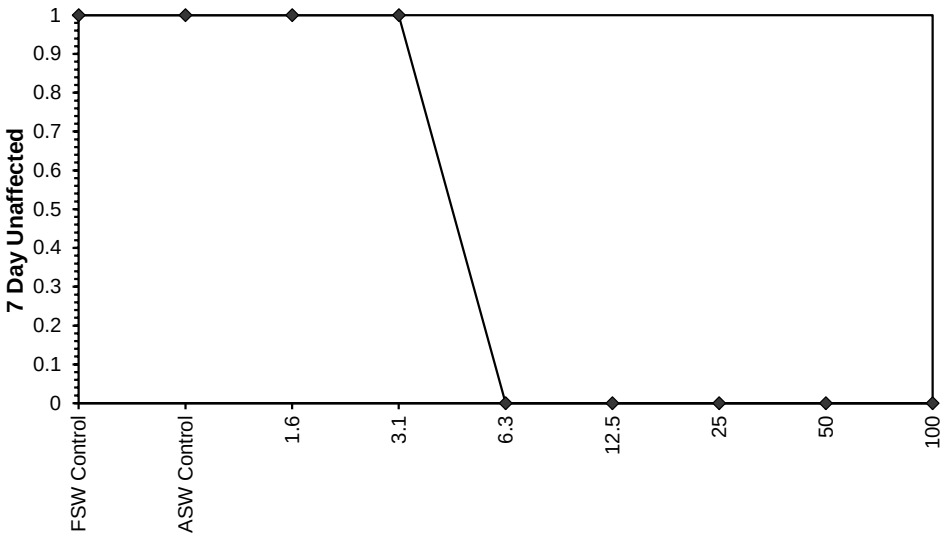
Point	%	SD	95% CL(Exp)		Skew
IC05	3.9889	0.0000	3.9889	3.9889	1.0076
IC10	4.1070	0.0000	4.1070	4.1070	-1.0076
IC15	4.1816	0.0000	4.1816	4.1816	-1.0076
IC20	4.2384	0.0000	4.2384	4.2384	1.0076
IC25	4.2858	0.0000	4.2858	4.2858	#DIV/0!
IC40	4.4018	0.0000	4.4018	4.4018	1.0076
IC50	4.4708	0.0000	4.4708	4.4708	-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

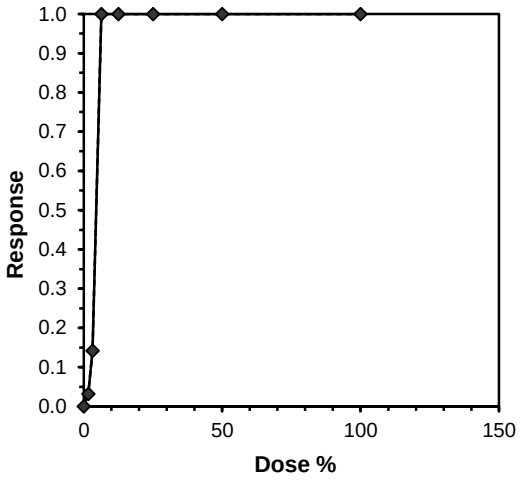
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	17.220	0.9818	17.220	16.940	17.380	1.154	4					
ASW Control	17.540	1.0000	17.540	17.140	17.860	1.696	4	*			17.540	1.0000
1.6	16.975	0.9678	16.975	15.980	18.080	5.692	4	0.989	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 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)

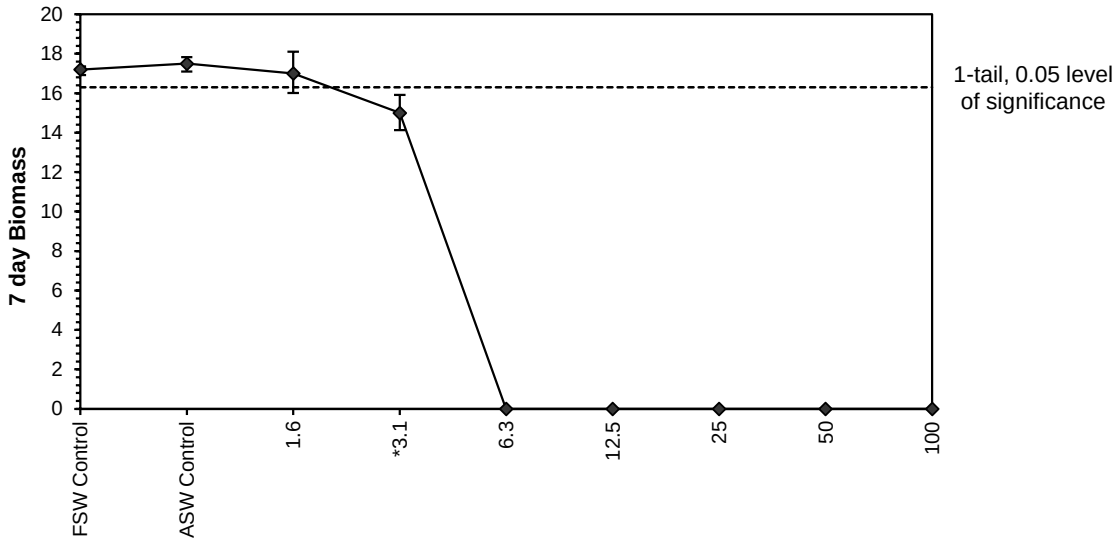
Point	%	SD	95% CL(Exp)		Skew
IC05	1.8425	0.3359	0.4305	2.5257	-0.7866
IC10	2.5241	0.2850	1.5938	3.4840	0.1884
IC15	3.1289	0.1569	2.5033	3.4034	-0.7034
IC20	3.3155	0.0834	3.0664	3.5738	0.2038
IC25	3.5020	0.0782	3.2685	3.7442	0.2038
IC40	4.0616	0.0625	3.8748	4.2553	0.2038
IC50	4.4347	0.0521	4.2790	4.5961	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

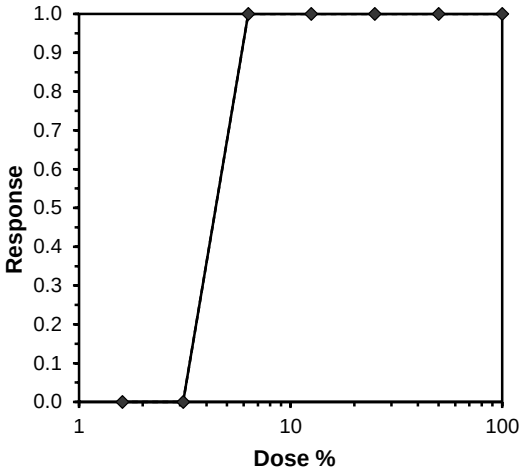
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

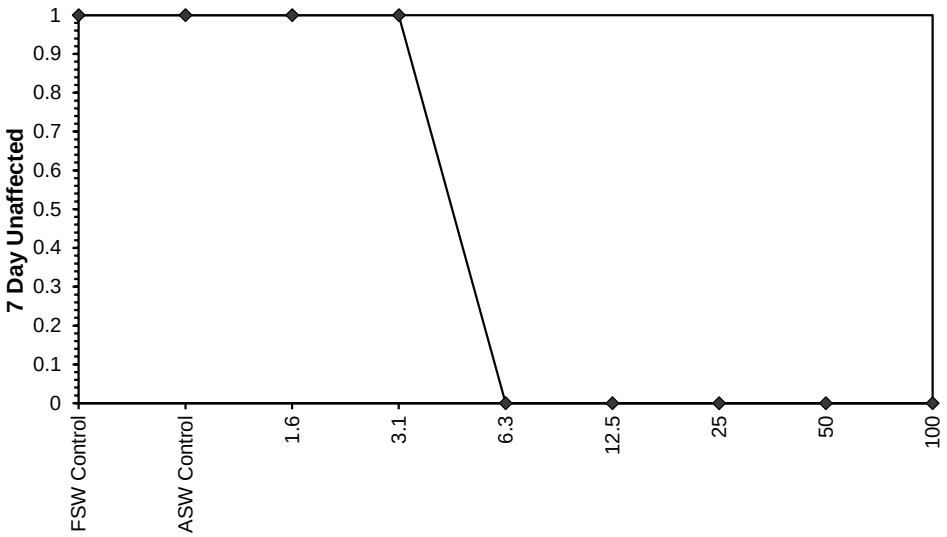
Point	%	SD	95% CL(Exp)		Skew
IC05	3.9889	0.0000	3.9889	3.9889	1.0076
IC10	4.1070	0.0000	4.1070	4.1070	-1.0076
IC15	4.1816	0.0000	4.1816	4.1816	-1.0076
IC20	4.2384	0.0000	4.2384	4.2384	1.0076
IC25	4.2858	0.0000	4.2858	4.2858	#DIV/0!
IC40	4.4018	0.0000	4.4018	4.4018	1.0076
IC50	4.4708	0.0000	4.4708	4.4708	-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

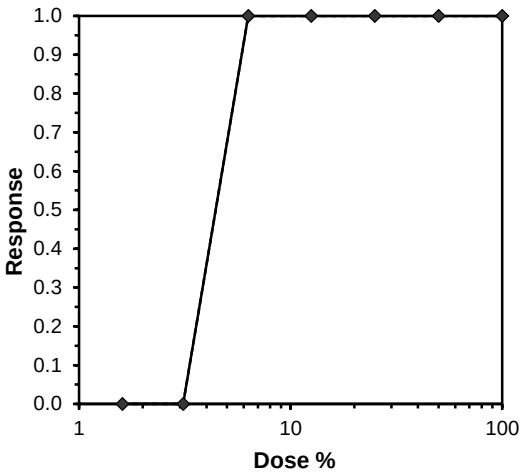
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	11.00	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

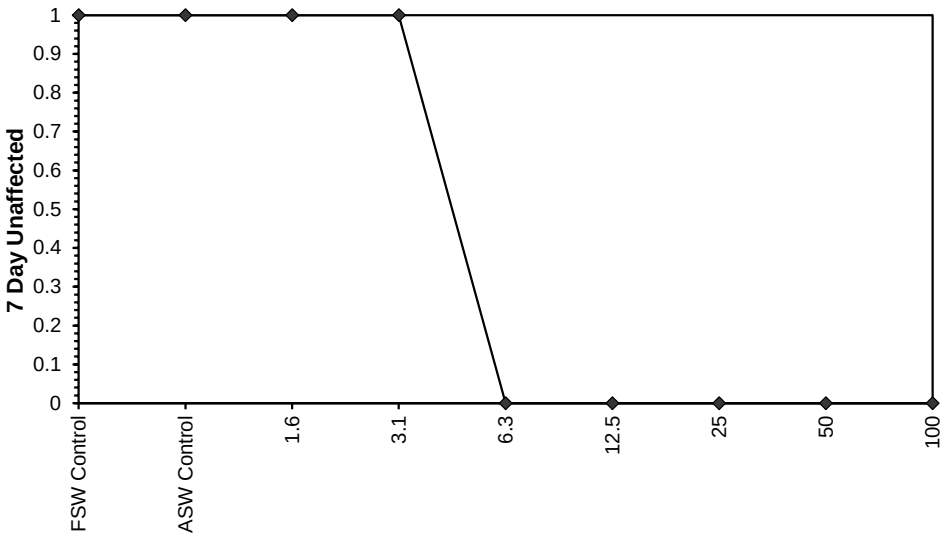
Trim Level	EC50
0.0%	4.4193
	4.4193



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

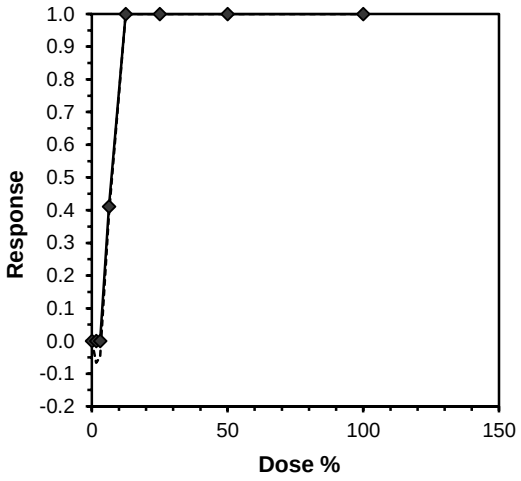
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	17.150	1.0294	17.150	16.120	17.920	4.601	4					
ASW Control	16.660	1.0000	16.660	15.980	17.440	3.942	4	*			17.303	1.0000
1.6	17.770	1.0666	17.770	16.980	18.280	3.471	4	-1.735	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)

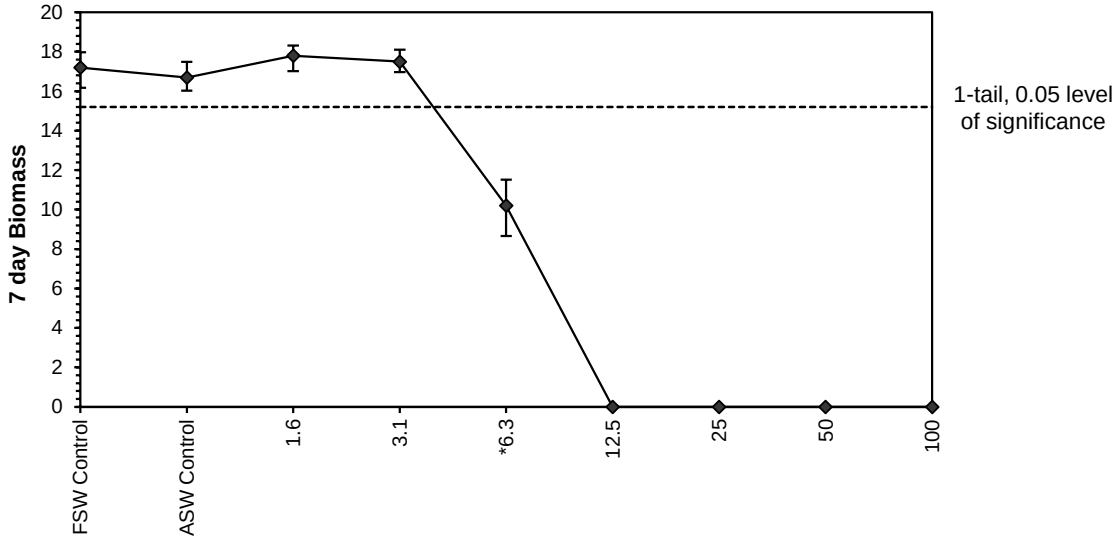
Point	%	SD	95% CL(Exp)		Skew
IC05	3.4895	0.0553	3.2187	3.5923	-1.2067
IC10	3.8790	0.0763	3.6126	4.0991	-0.0520
IC15	4.2684	0.1047	3.9617	4.6058	0.2572
IC20	4.6579	0.1360	4.2696	5.1126	0.3312
IC25	5.0474	0.1686	4.6053	5.6440	0.3491
IC40	6.2158	0.2779	5.5084	7.1875	0.3269
IC50	7.2386	0.3156	6.1413	8.0877	-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

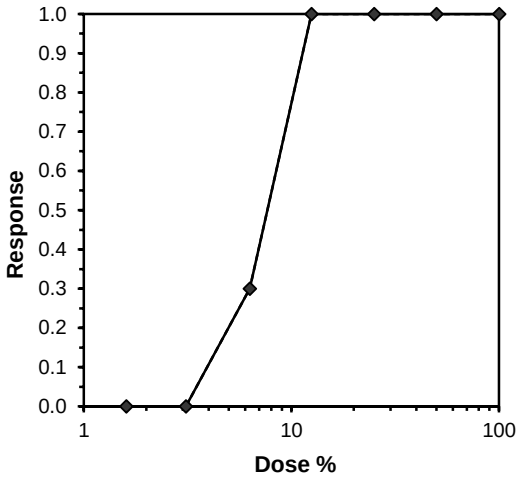
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

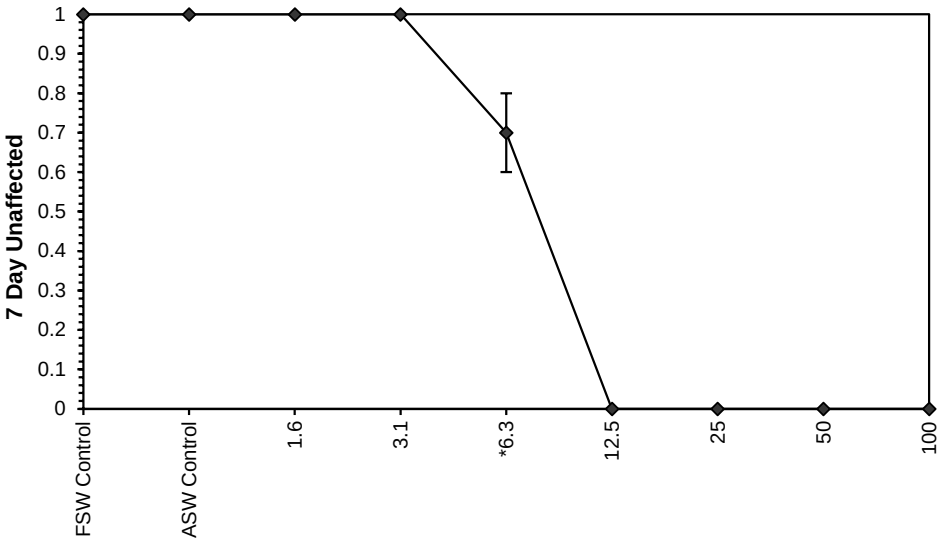
Point	%	SD	95% CL(Exp)		Skew
IC05	5.3168	0.0793	5.0999	5.6223	0.5130
IC10	5.6509	0.0935	5.3957	6.0115	0.5173
IC15	5.8666	0.1030	5.5859	6.2639	0.5200
IC20	6.0336	0.1104	5.7329	6.4599	0.5220
IC25	6.1745	0.1117	5.8567	6.5719	0.3311
IC40	6.4999	0.1045	6.1801	6.8641	0.2160
IC50	6.6881	0.1026	6.3739	7.0454	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

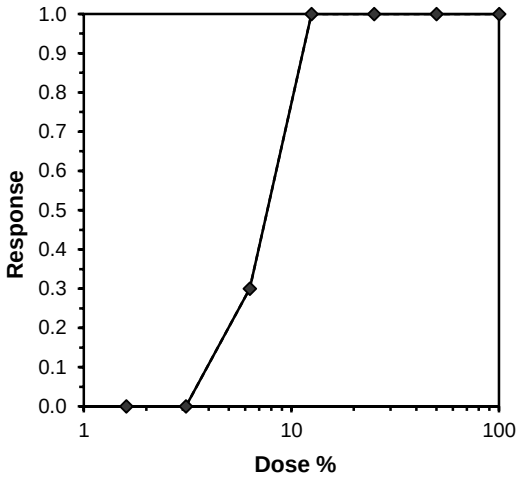
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

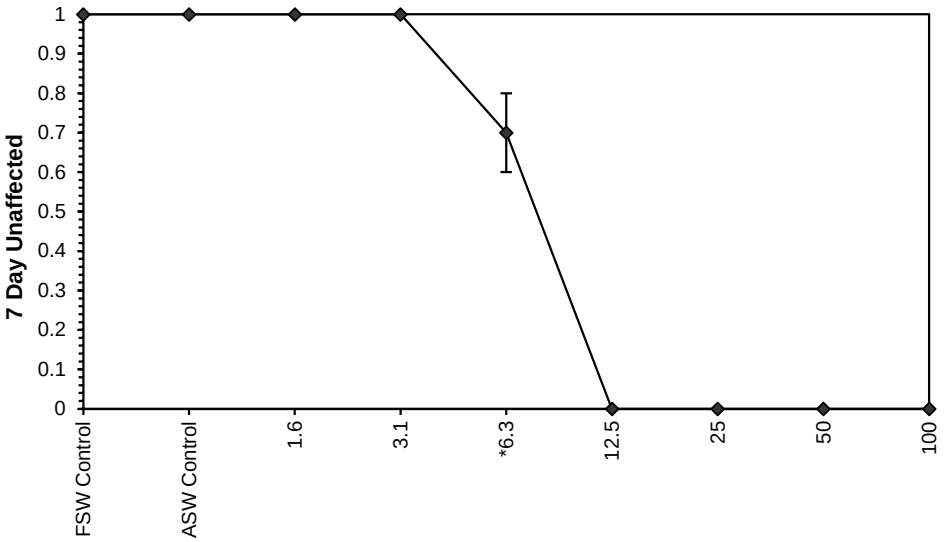
Trim Level	EC50	95% CL	
0.0%	7.1993	6.2408	8.3051
5.0%	7.3026	6.2191	8.5747
10.0%	7.4016	6.1398	8.9226
20.0%	7.5744	5.7109	10.0460
Auto-0.0%	7.1993	6.2408	8.3051



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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Toxicity Test Report: TR2113/1

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2113 31 August 2022 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. 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		
ASW Control	93.5 ± 2.7		
1.6	92.8 ± 1.7		
3.1	53.8 ± 14.8 *		
6.3	5.5 ± 1.5 *		
12.5	0.0 ± 0.0		
25	0.0 ± 0.0		
50	0.0 ± 0.0		
100	0.0 ± 0.0		
IC10 = 2.0 (1.86-2.22)% **EC50 = 3.4 (3.21-3.52)%** **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%	92.8%	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

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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.

Toxicity Test Report: TR2113/2

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2113 31 August 2022 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. 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* **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)% **72-hr EC50 = 3.4 (3.32-3.54)%** **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: 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.

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: TR2113/3

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2113 31 August 2022 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. 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* **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)% **48-hr EC50 = 3.5 (3.34-3.57)%** **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: 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.

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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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2113 31 August 2022 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. 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* **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.
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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: TR2113/5

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2113 31 August 2022 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. 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* **Concentration (%)**	**Cell Yield (Mean number of cells/mL x10^4 ± 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)% **72-hr IC50 = 9.9 (9.10-10.68)%** **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	≥16.0x10^4 cells/mL	16.4x10^4 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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2113 31 August 2022 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. 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* **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)% **96-hr EC50 = 13.4 (11.54-15.61)%** **NOEC = 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)

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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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2113 31 August 2022 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. 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

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Toxicity Test Report: TR2113/8

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2113 31 August 2022 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. 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
Contact Name: Adrian Cukrowski
Phone:
Email: Adrian.cukrowski@beachenergy.com.au (please provide an email address for sample receipt notification)
Sampled by: D. McCACHLAN

Ship To: Ecotox Services Aust
Attention: Rich Whitsett
Helen.Nottage@beachenergy.com.au

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
9 oc						**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
10677 31/8/22	06:00	YO3/0822-1	GRAB	~~8x125 GTL~~ 8x1L		3.75 FLU

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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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

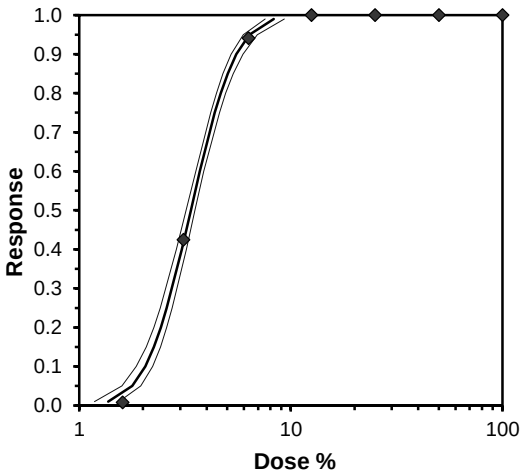
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.982269	0.887	0.079525	0.113428
Bartlett's Test indicates equal variances (p = 0.11)	5.960432	11.34487		
The control means are not significantly different (p = 0.61)	0.544263	2.446912		

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							

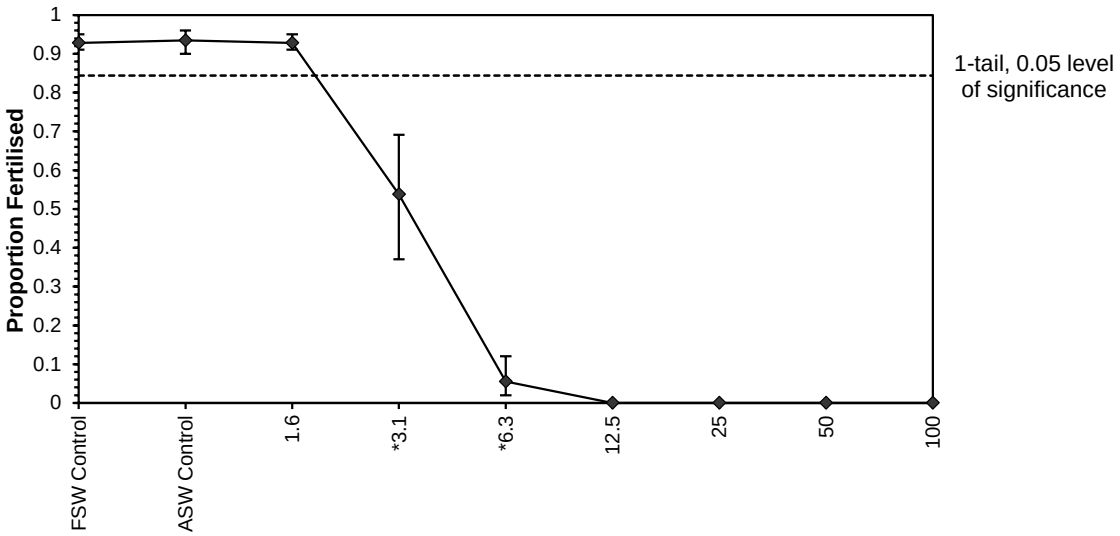
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	1.365636	1.177408	1.537088
EC05	3.355	1.778739	1.585791	1.951073
EC10	3.718	2.047857	1.857286	2.217151
EC15	3.964	2.252072	2.065294	2.418014
EC20	4.158	2.428805	2.24623	2.591562
EC25	4.326	2.591438	2.413142	2.751366
EC40	4.747	3.051193	2.884166	3.206507
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

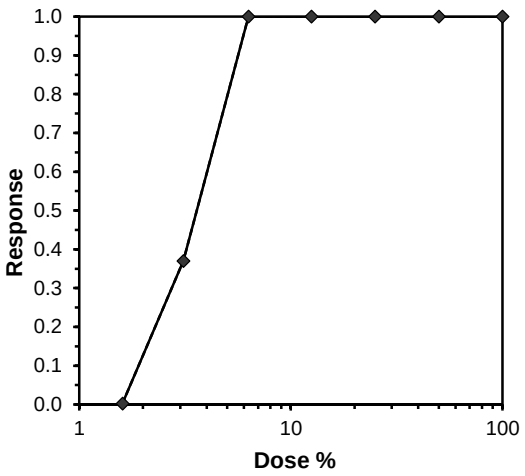
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9500	1.0188	1.3524	1.2661	1.4289	4.986	4					
ASW Control	0.9325	1.0000	1.3158	1.2661	1.4289	5.768	4	*			27	400
1.6	0.9300	0.9973	1.3047	1.2661	1.3453	2.767	4	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	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										

Trimmed Spearman-Karber

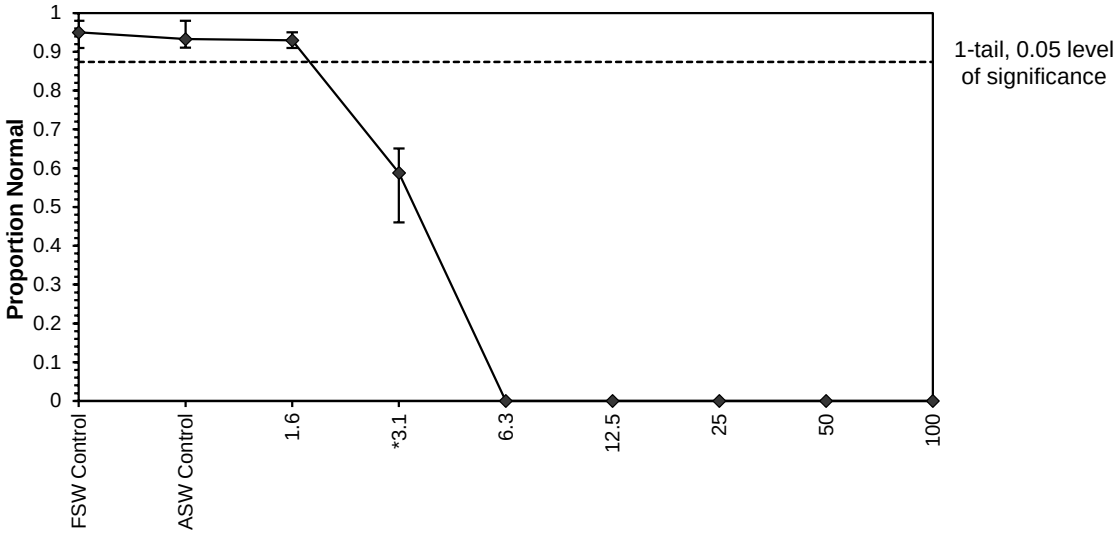
Trim Level	EC50	95% CL	
0.0%			
5.0%	3.4534	3.3281	3.5834
10.0%	3.4799	3.3360	3.6300
20.0%	3.5307	3.3253	3.7489
Auto-0.3%	3.4280	3.3157	3.5441



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

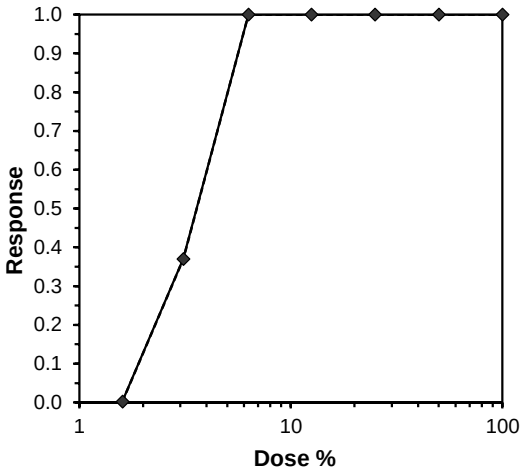
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9500	1.0188	1.3524	1.2661	1.4289	4.986	4					
ASW Control	0.9325	1.0000	1.3158	1.2661	1.4289	5.768	4	*			0.9325	1.0000
1.6	0.9300	0.9973	1.3047	1.2661	1.3453	2.767	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)

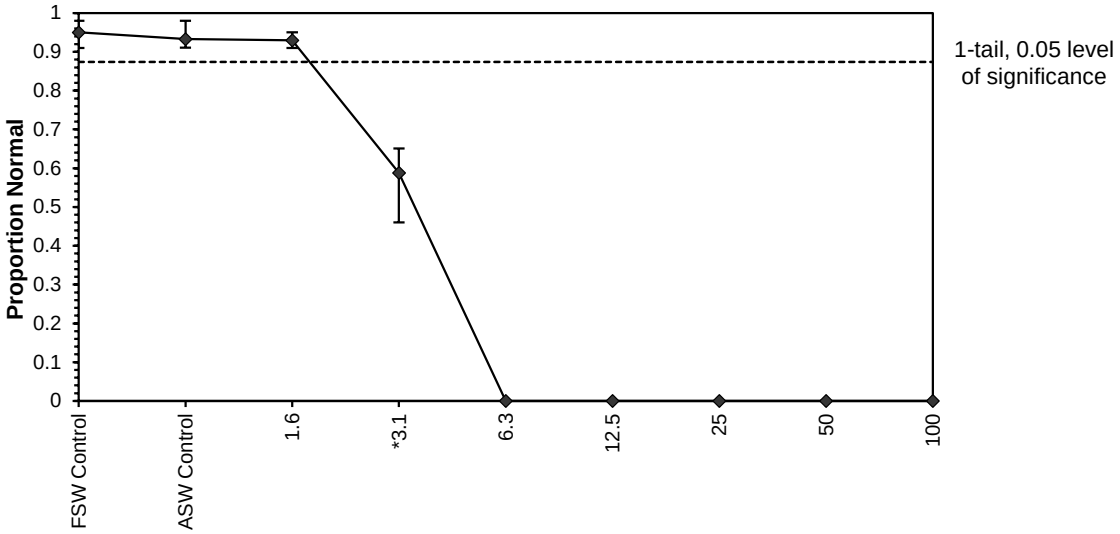
Point	%	SD	95% CL(Exp)		Skew
IC05	1.9012	0.0703	1.5740	1.9785	-1.6194
IC10	2.1457	0.0630	1.8779	2.2690	-0.8028
IC15	2.3522	0.0687	2.1180	2.5208	-0.4151
IC20	2.5373	0.0797	2.2493	2.7449	-0.3200
IC25	2.7095	0.0931	2.4118	2.9593	-0.3116
IC40	3.1284	0.0636	2.8133	3.2168	-2.0289
IC50	3.2227	0.0383	3.0833	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

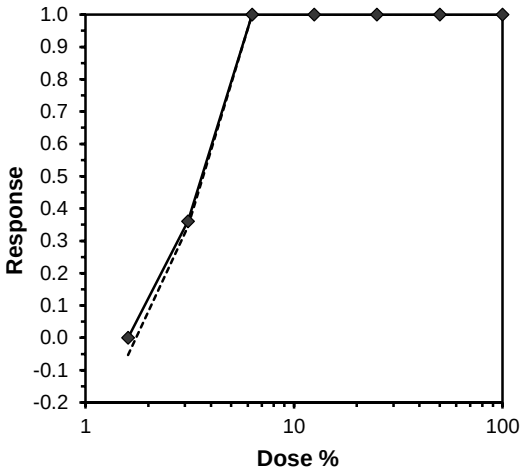
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7250	1.0284	1.0205	0.9589	1.0948	6.545	4					
ASW Control	0.7050	1.0000	0.9969	0.9695	1.0357	2.930	4	*			118	400
1.6	0.7425	1.0532	1.0387	1.0132	1.0588	1.874	4	-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

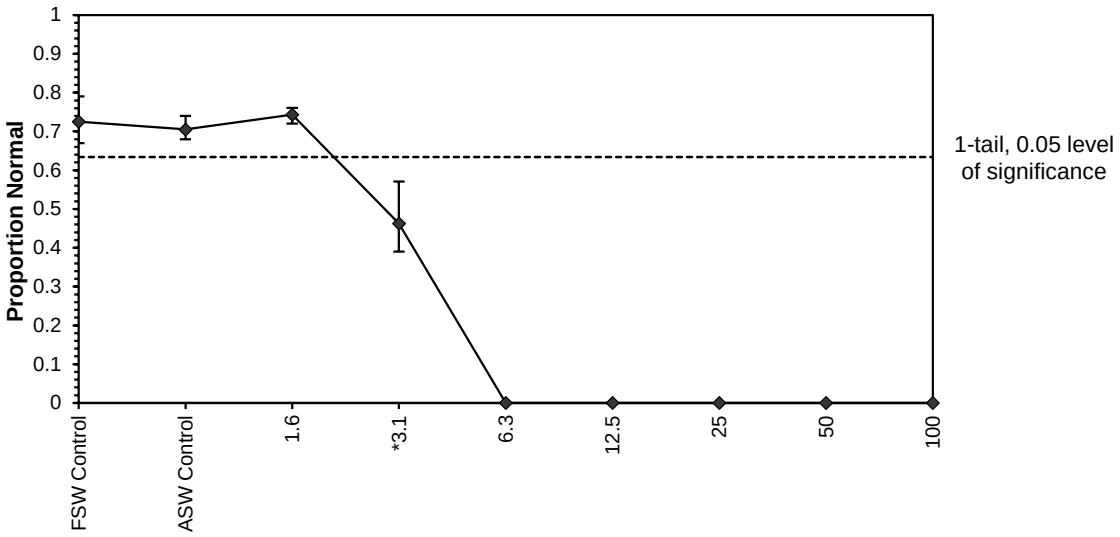
Trim Level	EC50	95% CL	
0.0%	3.4508	3.3391	3.5663
5.0%	3.4794	3.3537	3.6098
10.0%	3.5076	3.3629	3.6586
20.0%	3.5612	3.3531	3.7821
Auto-0.0%	3.4508	3.3391	3.5663



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

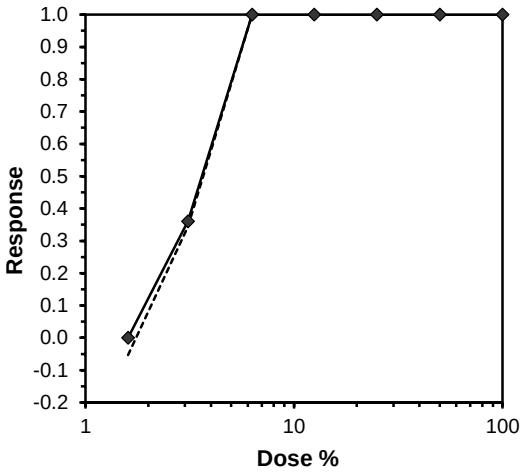
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7250	1.0284	1.0205	0.9589	1.0948	6.545	4					
ASW Control	0.7050	1.0000	0.9969	0.9695	1.0357	2.930	4	*			0.7238	1.0000
1.6	0.7425	1.0532	1.0387	1.0132	1.0588	1.874	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 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)

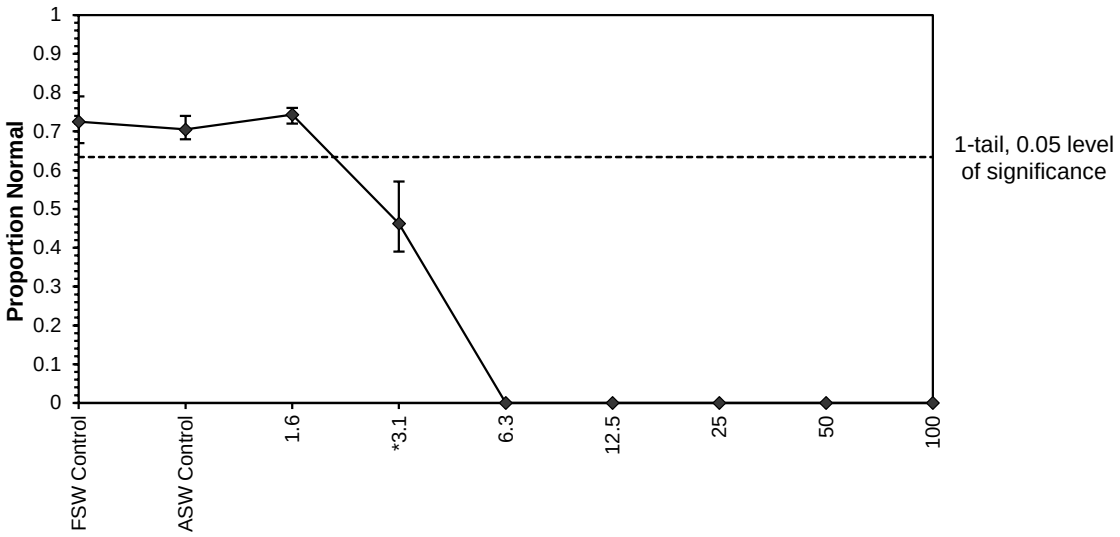
Point	%	SD	95% CL(Exp)		Skew
IC05	1.7923	0.0264	1.7383	1.8754	0.3169
IC10	1.9856	0.0531	1.8732	2.1613	0.7059
IC15	2.1822	0.0824	2.0066	2.4606	0.7813
IC20	2.3843	0.1144	2.1400	2.7769	0.8172
IC25	2.5941	0.1494	2.2750	3.1139	0.8319
IC40	3.1299	0.0682	2.8045	3.2248	-1.3708
IC50	3.2103	0.0343	3.1088	3.3030	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		

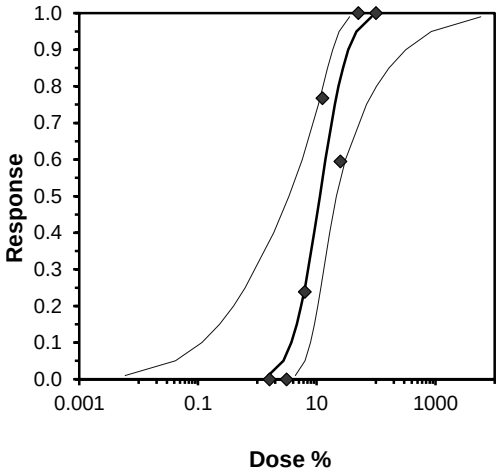
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	3.1	6.3	4.419276	32.25806	0.092411	0.097149	0.599256	0.009096	6.2E-11	5, 18
Treatments vs ASW Control										

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

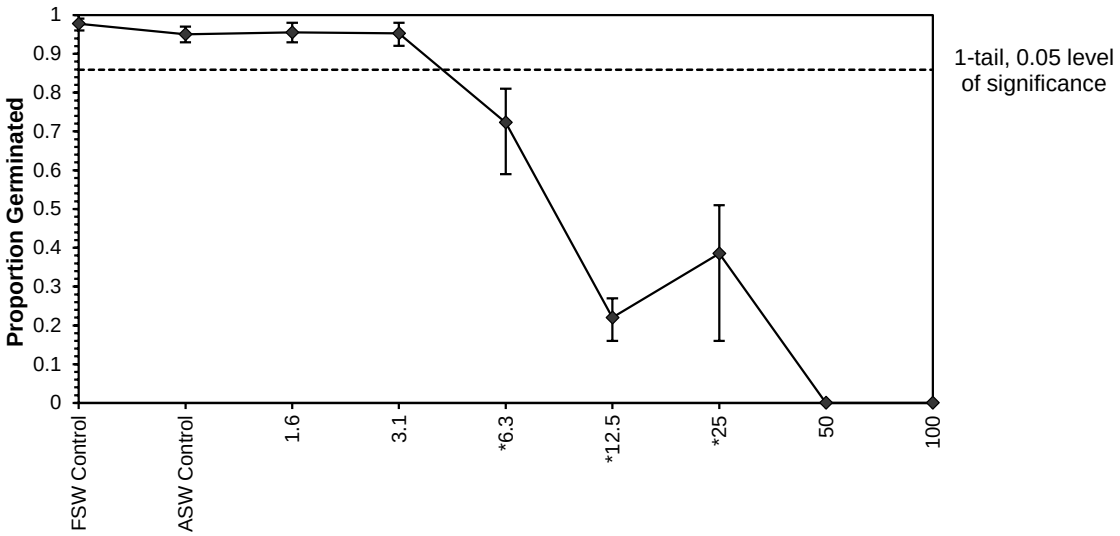
Significant heterogeneity detected (p = 8.11E-49)



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				

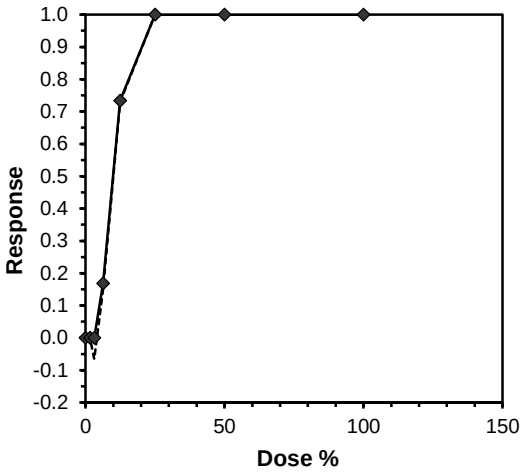
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	15.369	1.0613	15.369	14.407	16.507	4.143	8					
ASW Control	14.482	1.0000	14.482	13.907	15.507	4.927	4	*			14.807	1.0000
1.6	14.507	1.0017	14.507	13.407	15.907	7.274	4	-0.032	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)

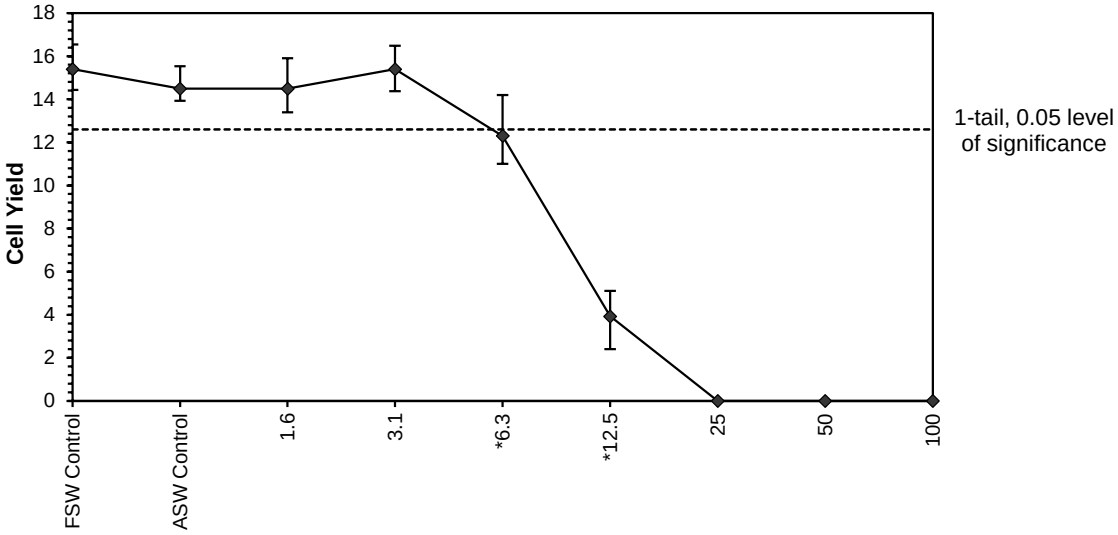
Point	%	SD	95% CL(Exp)		Skew
IC05	4.0476	0.4835	3.1788	5.5405	0.2727
IC10	4.9953	0.5797	3.9210	7.1943	1.0014
IC15	5.9429	0.5698	4.5593	7.4001	0.2270
IC20	6.6415	0.4724	5.2884	7.7580	-0.0050
IC25	7.1896	0.4153	5.9912	8.1827	0.0492
IC40	8.8338	0.3173	7.9679	9.6644	-0.0160
IC50	9.9299	0.2904	9.1049	10.6804	-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

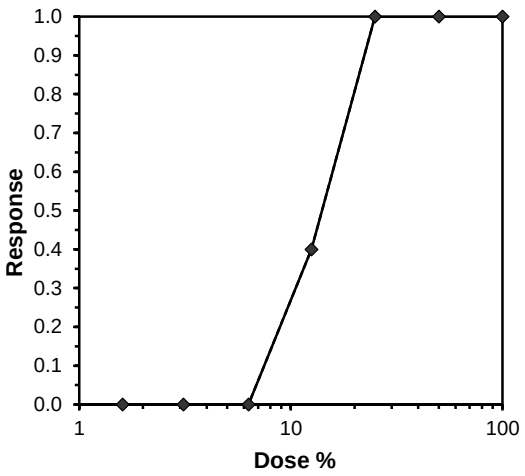
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

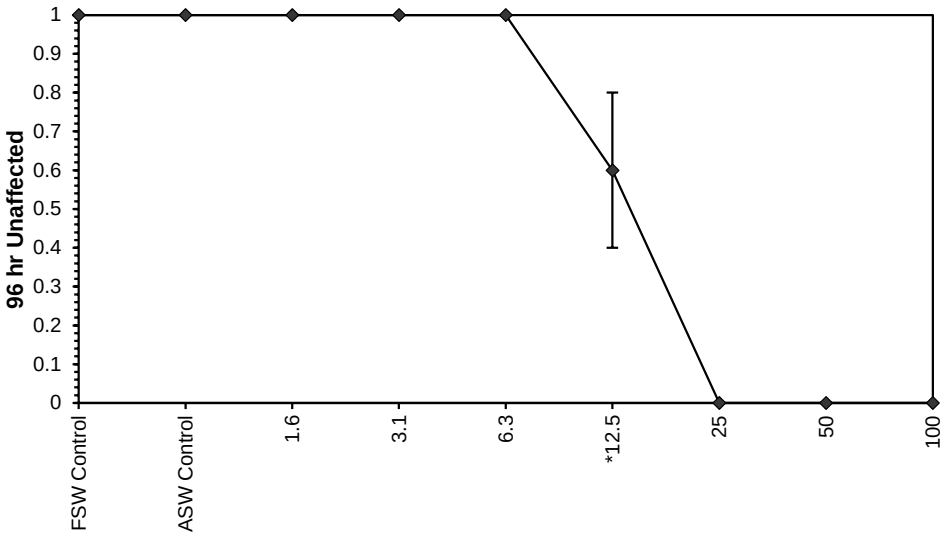
Trim Level	EC50	95% CL	
0.0%	13.419	11.538	15.606
5.0%	13.508	11.414	15.987
10.0%	13.597	11.222	16.475
20.0%	13.772	10.526	18.021
Auto-0.0%	13.419	11.538	15.606



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

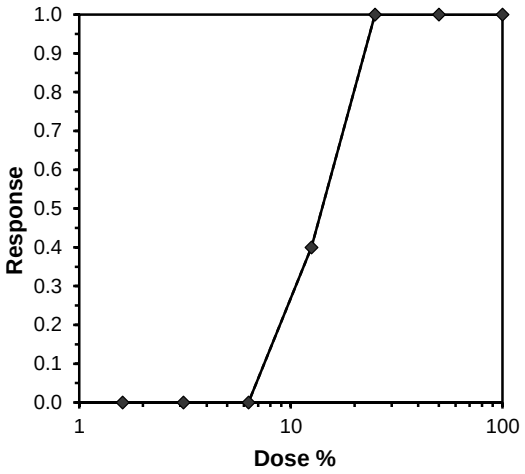
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

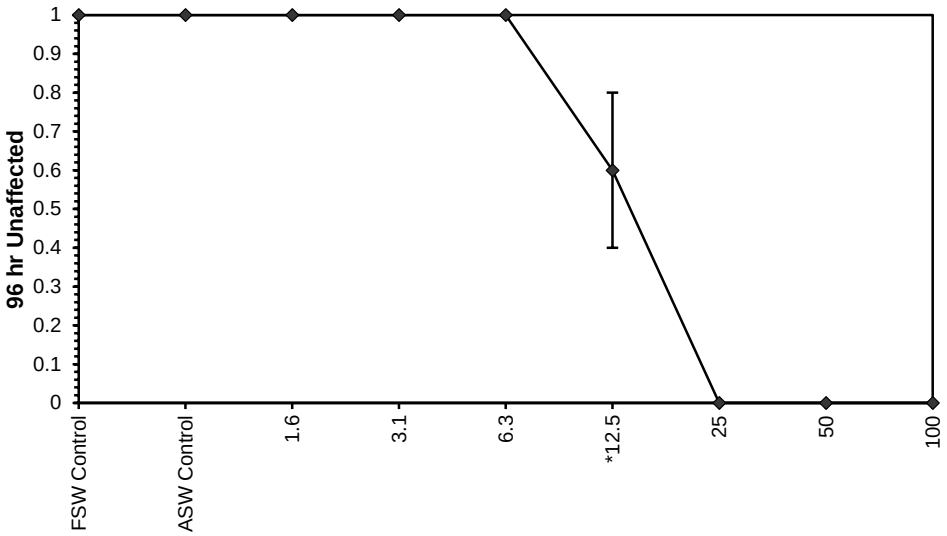
Point	%	SD	95% CL(Exp)		Skew
IC05	10.307	0.161	9.962	10.730	0.4767
IC10	10.912	0.189	10.506	11.412	0.4825
IC15	11.303	0.209	10.856	11.854	0.4861
IC20	11.606	0.224	11.127	12.197	0.4888
IC25	11.862	0.235	11.355	12.487	0.4400
IC40	12.500	0.251	11.923	13.131	0.2172
IC50	12.878	0.254	12.273	13.499	0.1310



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

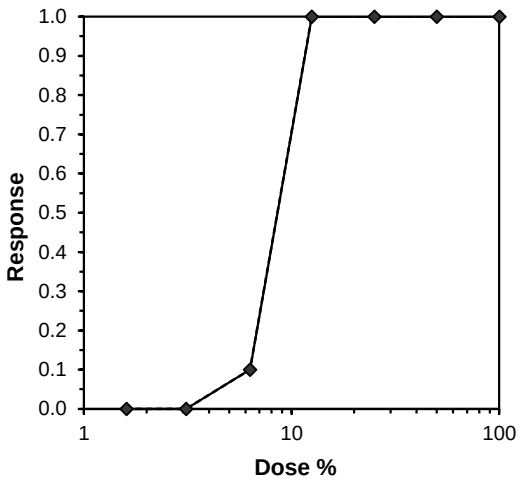
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

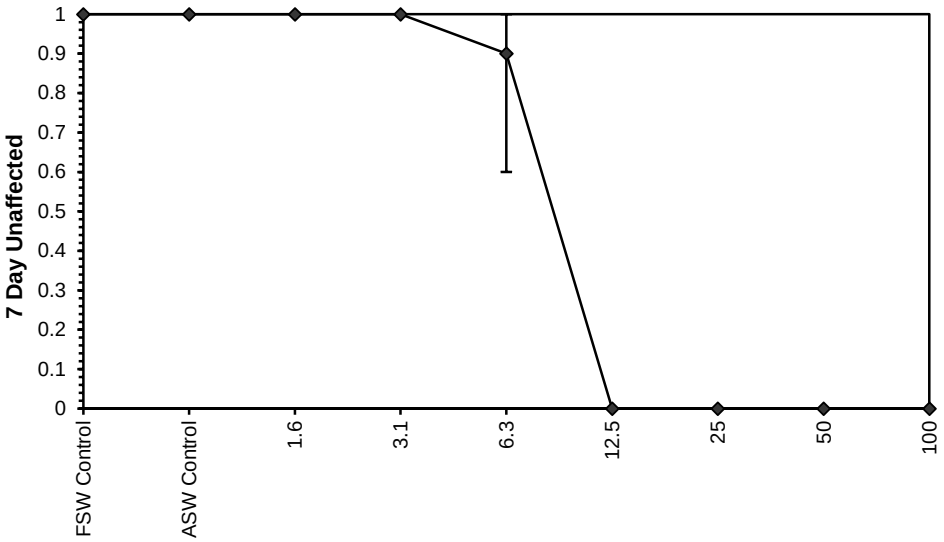
Trim Level	EC50	95% CL	
0.0%	8.2765	7.5375	9.0880
5.0%	8.4679	7.5330	9.5188
10.0%	8.5427	8.0714	9.0414
20.0%	8.5427	8.0714	9.0414
Auto-0.0%	8.2765	7.5375	9.0880



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

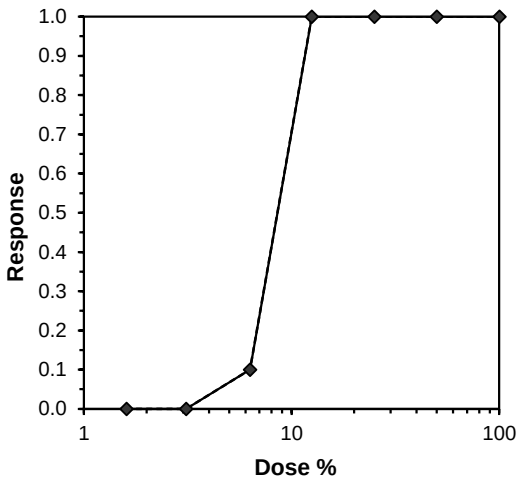
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

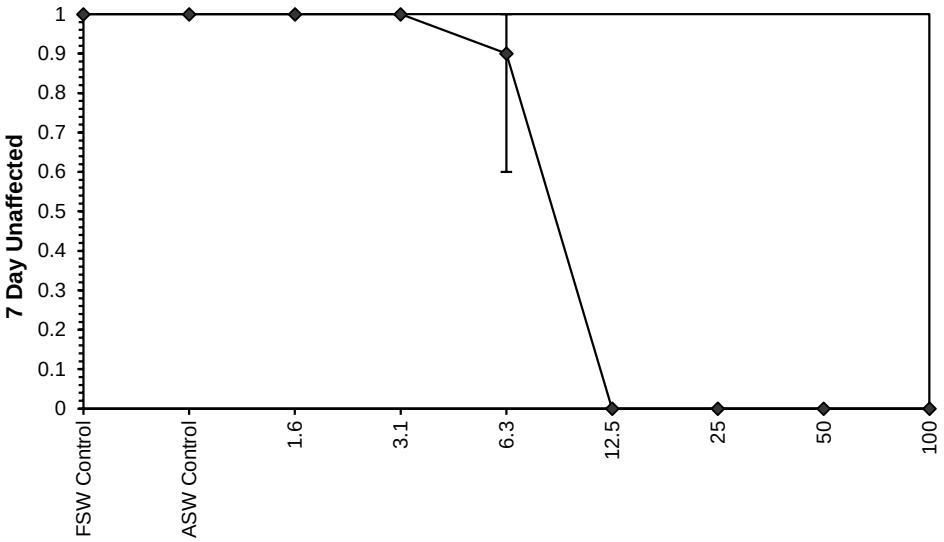
Point	%	SD	95% CL(Exp)		Skew
IC05	5.8648	1.1115	4.9880	9.2780	0.4981
IC10	6.3000	1.0302	5.2615	9.3804	0.4547
IC15	6.4843	0.9995	5.4960	9.4995	0.4672
IC20	6.6261	0.9752	5.6780	9.5897	0.4767
IC25	6.7453	0.9600	5.8321	9.6645	0.4788
IC40	7.0401	0.9226	6.1757	9.8460	0.4798
IC50	7.2177	0.8998	6.3703	9.9529	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

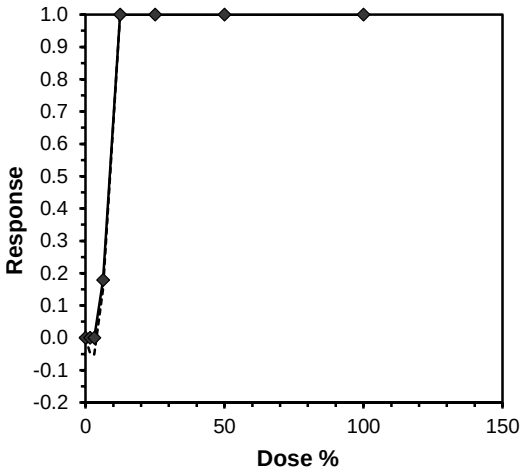
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	17.800	1.0471	17.800	16.280	18.960	6.273	4				
ASW Control	17.000	1.0000	17.000	15.960	18.620	7.593	4	*		17.557	1.0000
1.6	17.795	1.0468	17.795	16.940	18.280	3.576	4	21.00	10.00	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)

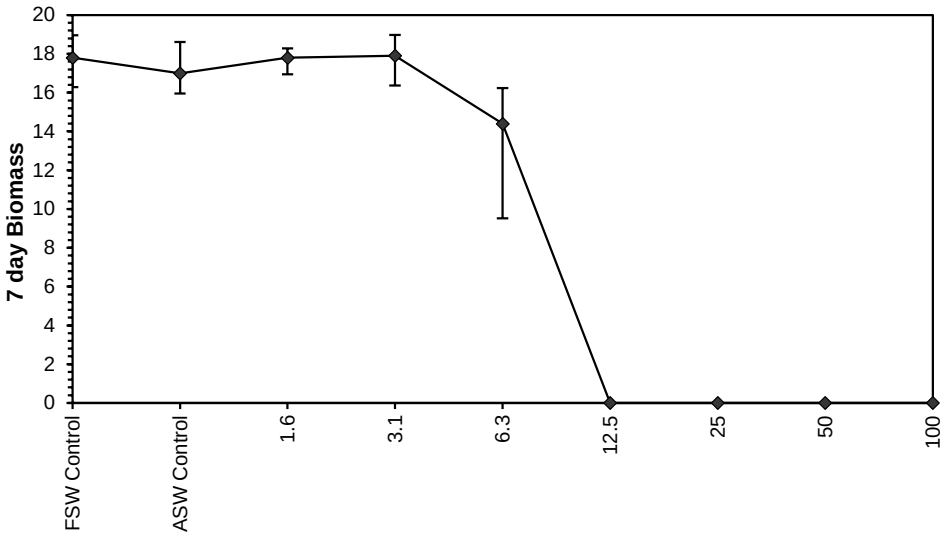
Point	%	SD	95% CL(Exp)		Skew
IC05	3.9941	0.6219	2.9801	6.3204	0.6828
IC10	4.8883	0.9092	3.3983	7.5073	0.3904
IC15	5.7824	0.8006	3.5685	7.5019	-0.1526
IC20	6.4590	0.7136	3.8769	7.6270	-0.6088
IC25	6.8366	0.6316	4.3626	7.9316	-0.7040
IC40	7.9692	0.5016	5.8571	8.8453	-0.8271
IC50	8.7244	0.4180	6.9643	9.4544	-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

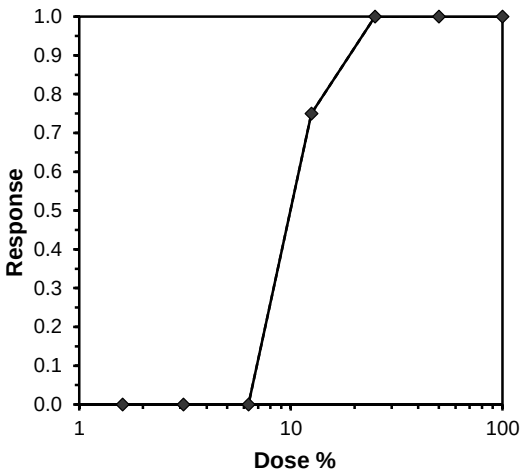
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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:					

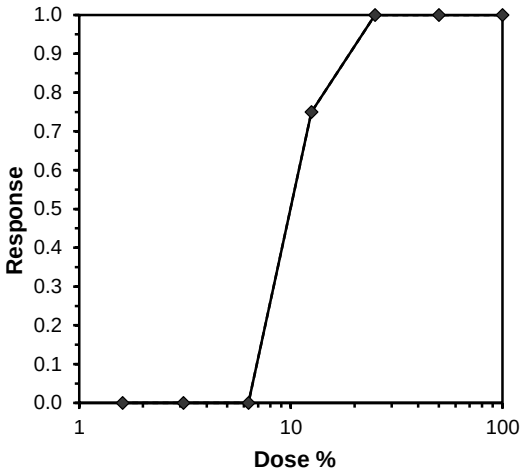
Conc-%	1	2	3	4
FSW Control	1.0000	1.0000	1.0000	1.0000
ASW Control	1.0000	1.0000	1.0000	1.0000
1.6	1.0000	1.0000	1.0000	1.0000
3.1	1.0000	1.0000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000
12.5	0.2000	0.4000	0.0000	0.4000
25	0.0000	0.0000	0.0000	0.0000
50	0.0000	0.0000	0.0000	0.0000
100	0.0000	0.0000	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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2187 23 August 2023 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. 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 **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)% **EC50 = 6.9 (6.65-7.13)%** **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: 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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2187 23 August 2023 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. 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 **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)% **72-hr EC50 = 13.3 (12.89-13.79)%** **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)

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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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2187 23 August 2023 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. 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		*Vacant*	*Vacant*
Concentration (%)	**% Normal larvae (Mean ± SD)**		
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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2187 23 August 2023 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. 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.
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: TR2187/6

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2187 23 August 2023 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. 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.

Toxicity Test Report: TR2187/7

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2187 23 August 2023 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. 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.
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: TR2187/8 (Page 1 of 2)

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2187 23 August 2023 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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	17.7x10^4 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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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.
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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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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
Contact Name: Adrian Cukovski
Phone:
Email: Adrian.cukovski@beachenergy.com.au
Sampled by: A. EVANS

Ship To: Ecotox Services Aust
Attention: Rach Kamsa
(please provide an email address for sample receipt notification)
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		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 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	✓ ✓ ✓ ✓ ✓ ✓	

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

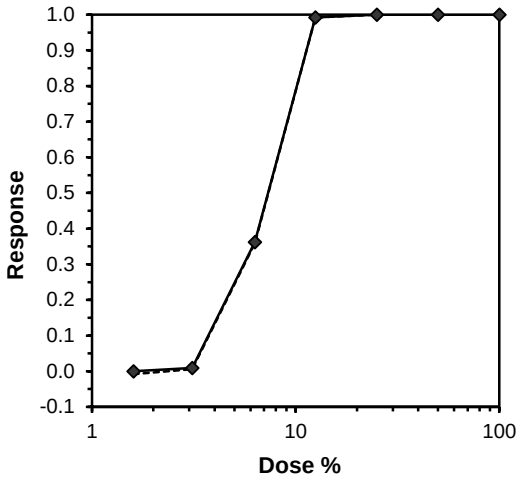
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9100	0.9838	1.2670	1.2327	1.3030	2.267	4					
ASW Control	0.9250	1.0000	1.2954	1.2490	1.3453	3.096	4	*			0.9288	1.0000
1.6	0.9325	1.0081	1.3107	1.2661	1.3694	3.499	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 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)

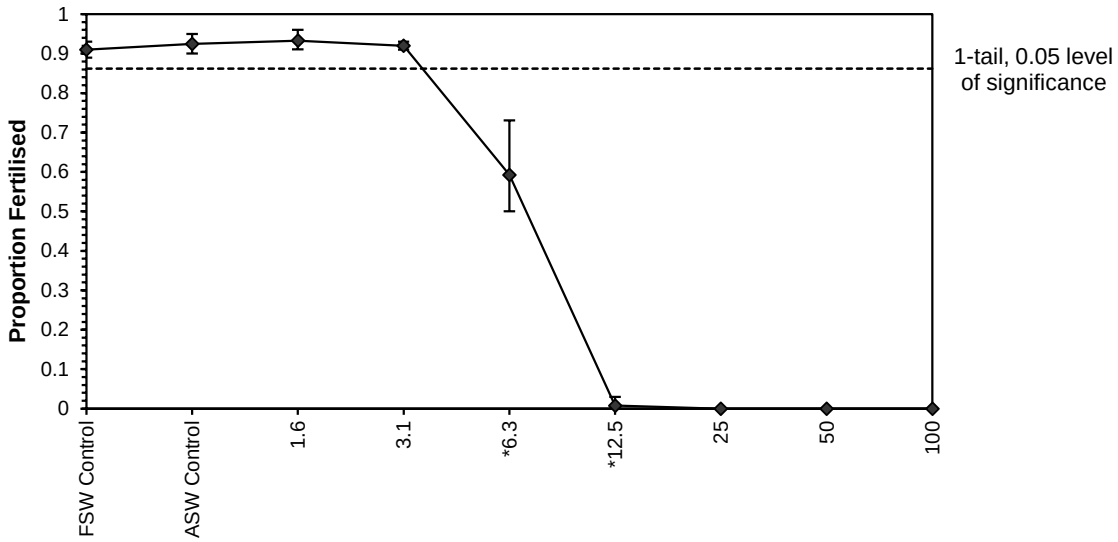
Point	%	SD	95% CL(Exp)		Skew
IC05	3.6197	0.1097	3.2440	3.9152	-0.0486
IC10	4.1459	0.1375	3.7598	4.6412	0.4508
IC15	4.6049	0.1837	4.1571	5.2882	0.6149
IC20	5.0264	0.2356	4.4986	5.8924	0.6658
IC25	5.4268	0.2892	4.8018	6.4753	0.6624
IC40	6.4242	0.1924	5.7022	6.9240	-0.3352
IC50	6.7548	0.1911	6.2043	7.3324	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

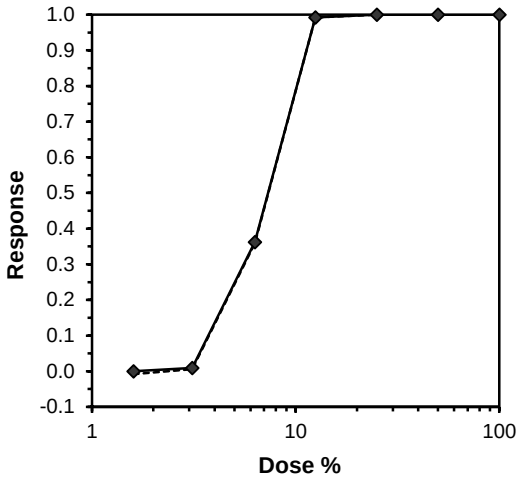
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9100	0.9838	1.2670	1.2327	1.3030	2.267	4					
ASW Control	0.9250	1.0000	1.2954	1.2490	1.3453	3.096	4	*			30	400
1.6	0.9325	1.0081	1.3107	1.2661	1.3694	3.499	4	-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 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

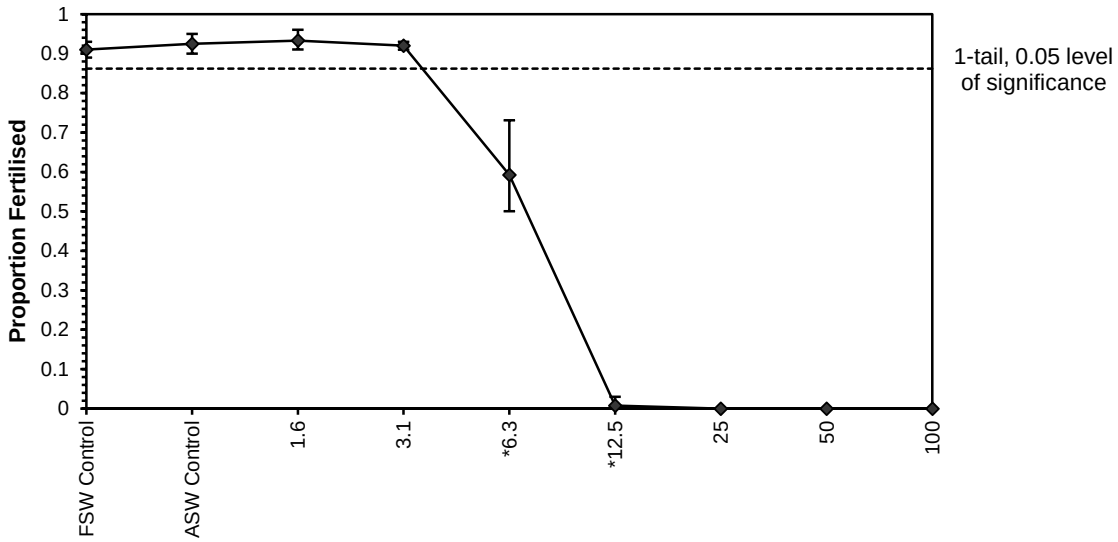
Trim Level	EC50	95% CL	
0.0%	6.8884	6.6535	7.1317
5.0%	6.9634	6.7062	7.2305
10.0%	7.0357	6.7395	7.3448
20.0%	7.1736	6.7447	7.6298
Auto-0.0%	6.8884	6.6535	7.1317



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

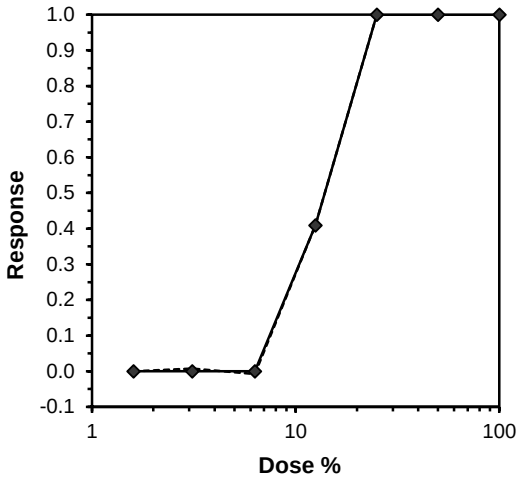
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9425	0.9895	1.3305	1.2840	1.3694	2.725	4				
ASW Control	0.9525	1.0000	1.3556	1.3030	1.4289	3.891	4	*		0.9525	1.0000
1.6	0.9525	1.0000	1.3569	1.2840	1.4289	4.419	4	18.50	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)

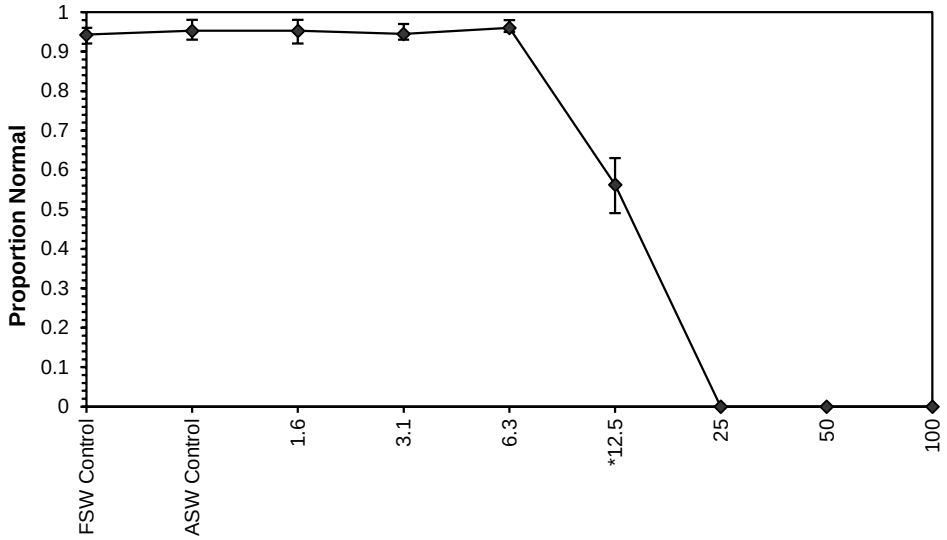
Point	%	SD	95% CL(Exp)		Skew
IC05	7.626	0.174	6.702	7.825	-0.5805
IC10	8.561	0.177	7.827	8.939	0.0088
IC15	9.329	0.204	8.612	9.850	0.2367
IC20	10.007	0.240	9.218	10.711	0.2986
IC25	10.632	0.279	9.767	11.516	0.3096
IC40	12.390	0.297	11.225	12.895	-0.6544
IC50	12.828	0.127	12.411	13.206	-0.0623



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

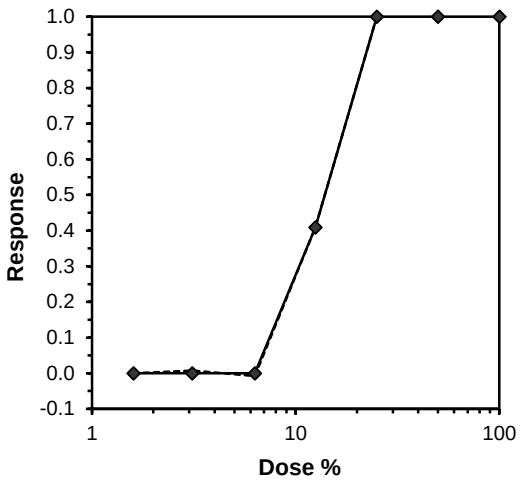
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9425	0.9895	1.3305	1.2840	1.3694	2.725	4				
ASW Control	0.9525	1.0000	1.3556	1.3030	1.4289	3.891	4	*		19	400
1.6	0.9525	1.0000	1.3569	1.2840	1.4289	4.419	4	18.50	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

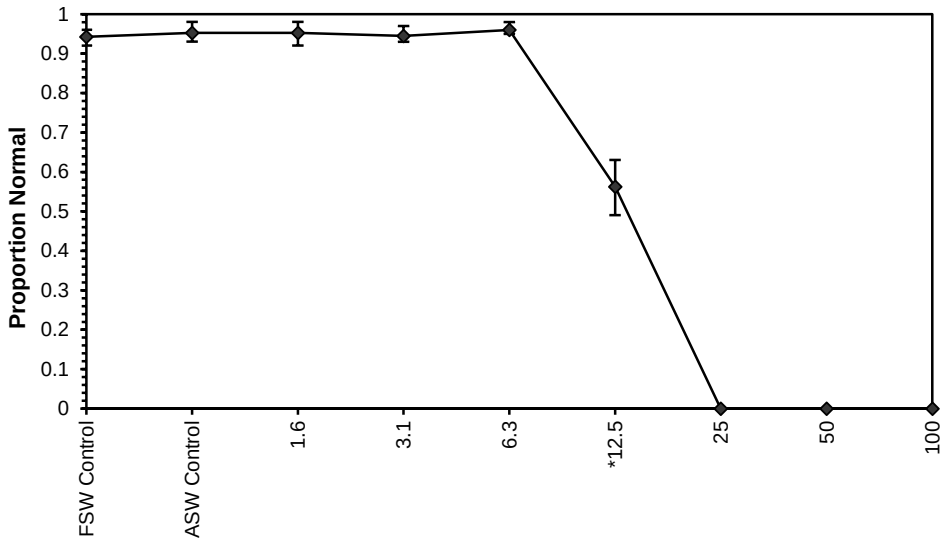
Trim Level	EC50	95% CL	
0.0%	13.331	12.887	13.791
5.0%	13.412	12.914	13.929
10.0%	13.492	12.924	14.085
20.0%	13.650	12.856	14.493
Auto-0.0%	13.331	12.887	13.791



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		

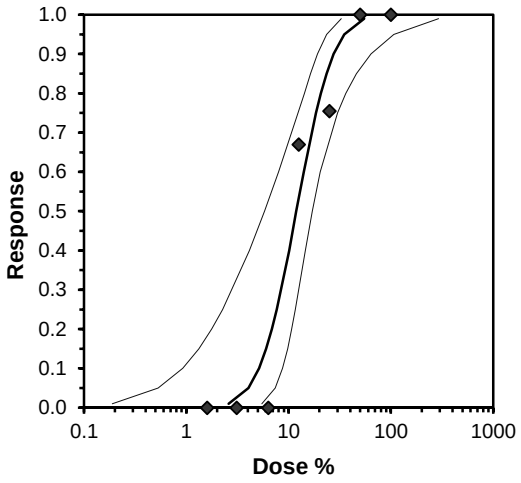
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	6.3	12.5	8.87412	15.87302
Treatments vs ASW Control				

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

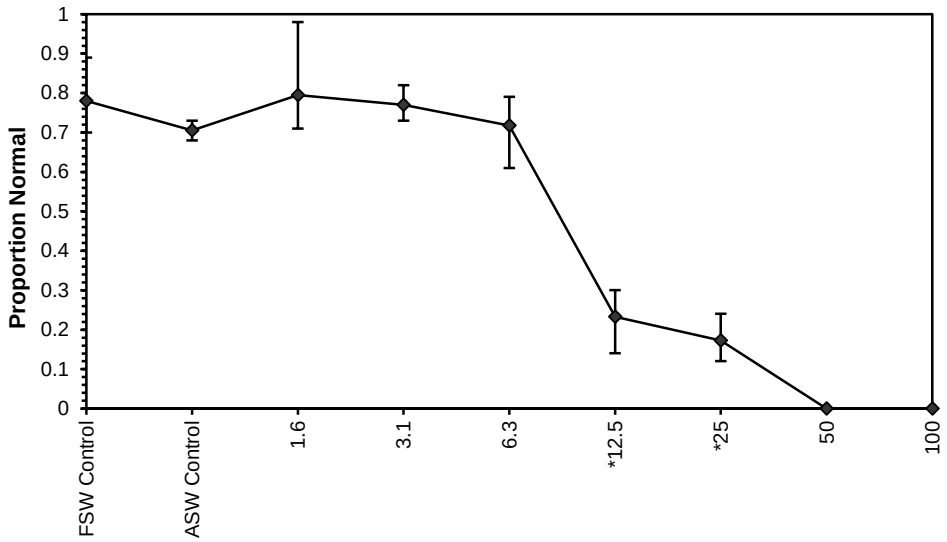
Significant heterogeneity detected (p = 9.40E-14)



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

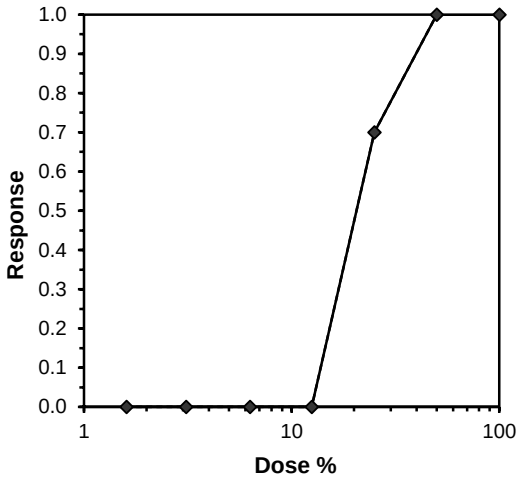
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

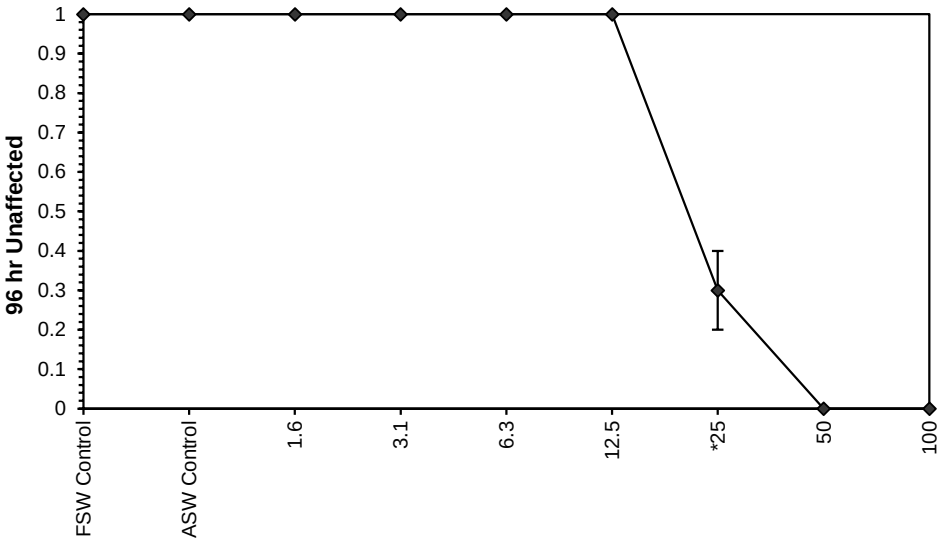
Point	%	SD	95% CL(Exp)		Skew
IC05	19.308	0.199	18.640	19.923	-0.1785
IC10	20.321	0.234	19.537	21.045	-0.1761
IC15	20.974	0.257	20.113	21.770	-0.1746
IC20	21.478	0.275	20.557	22.331	-0.1735
IC25	21.904	0.291	20.931	22.804	-0.1725
IC40	22.962	0.330	21.859	23.986	-0.1703
IC50	23.603	0.355	22.420	24.704	-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

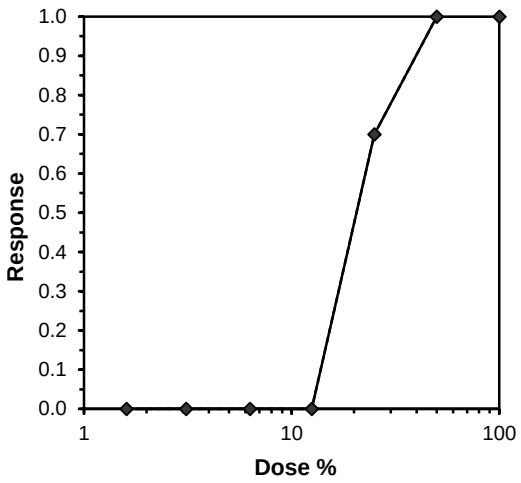
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

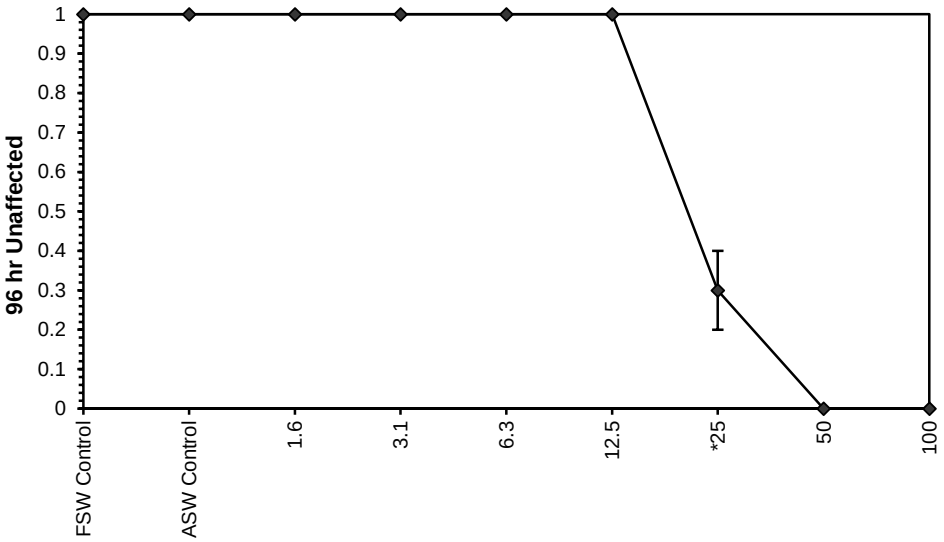
Trim Level	EC50	95% CL	
0.0%	21.764	18.882	25.086
5.0%	21.470	18.368	25.096
10.0%	21.197	17.892	25.112
20.0%	20.735	17.082	25.170
Auto-0.0%	21.764	18.882	25.086



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

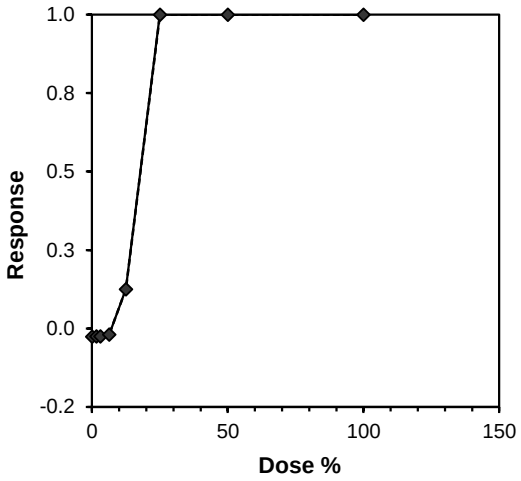
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	19.240	1.0372	19.240	18.940	19.740	1.800	4					
ASW Control	18.550	1.0000	18.550	17.500	19.740	5.490	4	*			18.550	1.0000
1.6	18.475	0.9960	18.475	17.580	19.140	4.001	4	0.100	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)

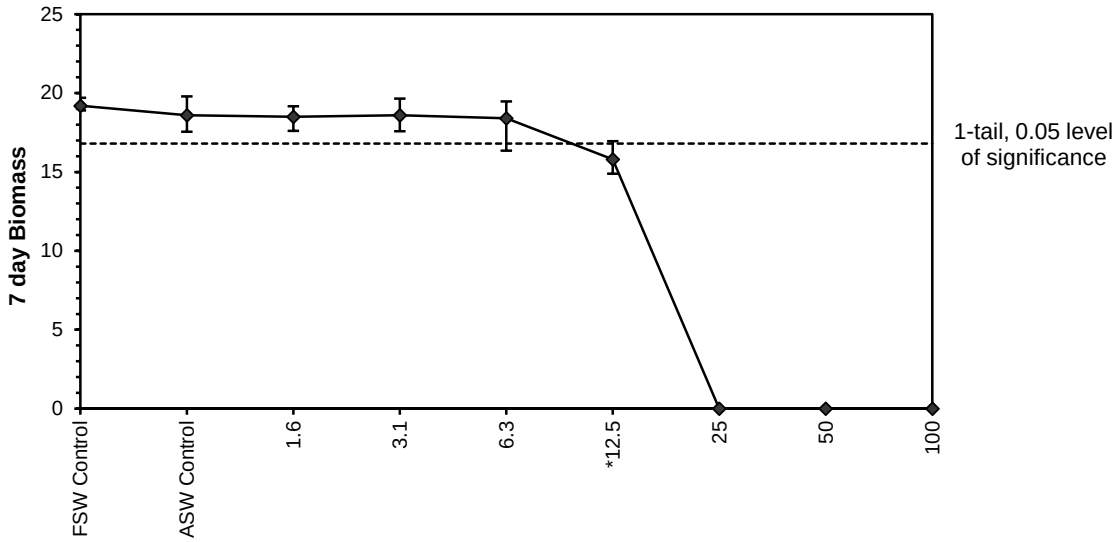
Point	%	SD	95% CL(Exp)		Skew
IC05	8.226	1.540	0.000	9.467	-1.5712
IC10	10.437	1.225	5.363	13.297	-0.7848
IC15	12.549	0.923	8.520	13.488	-2.0940
IC20	13.282	0.444	11.808	14.165	-2.2745
IC25	14.014	0.343	12.767	14.842	-0.1566
IC40	16.211	0.275	15.214	16.874	-0.1566
IC50	17.676	0.229	16.845	18.228	-0.1566



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

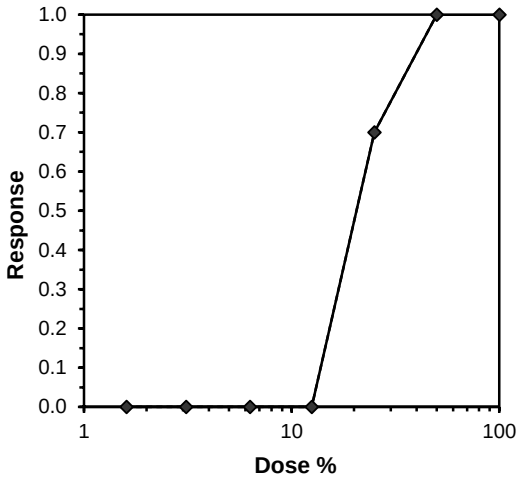
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

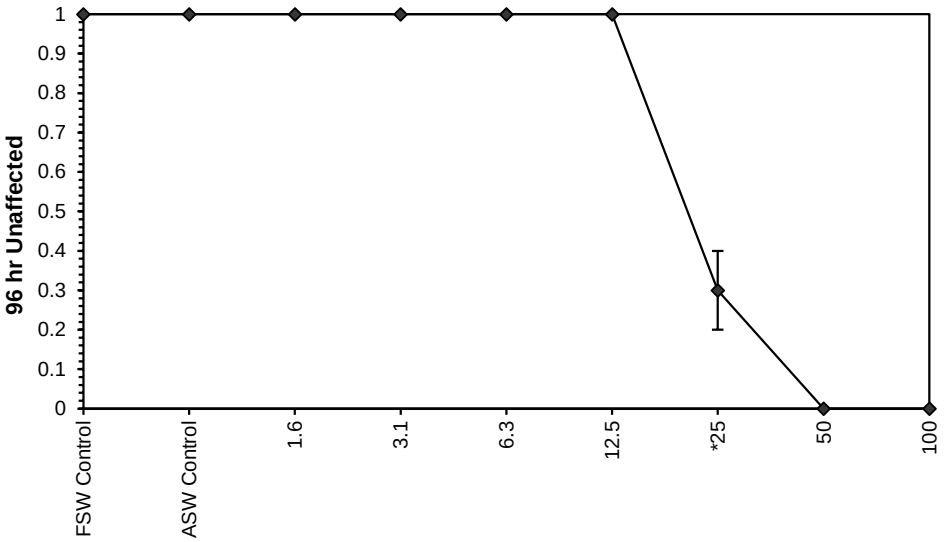
Point	%	SD	95% CL(Exp)		Skew
IC05	19.308	0.199	18.640	19.923	-0.1785
IC10	20.321	0.234	19.537	21.045	-0.1761
IC15	20.974	0.257	20.113	21.770	-0.1746
IC20	21.478	0.275	20.557	22.331	-0.1735
IC25	21.904	0.291	20.931	22.804	-0.1725
IC40	22.962	0.330	21.859	23.986	-0.1703
IC50	23.603	0.355	22.420	24.704	-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

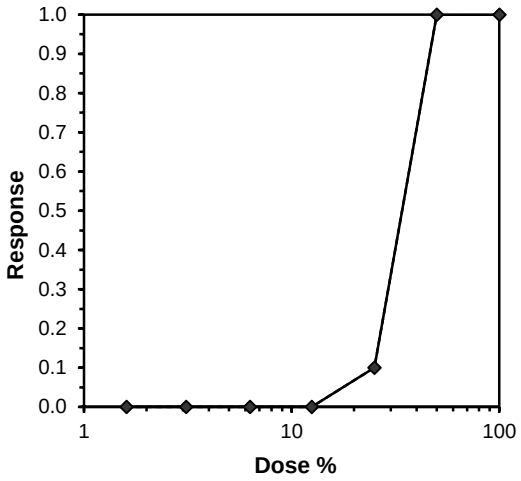
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

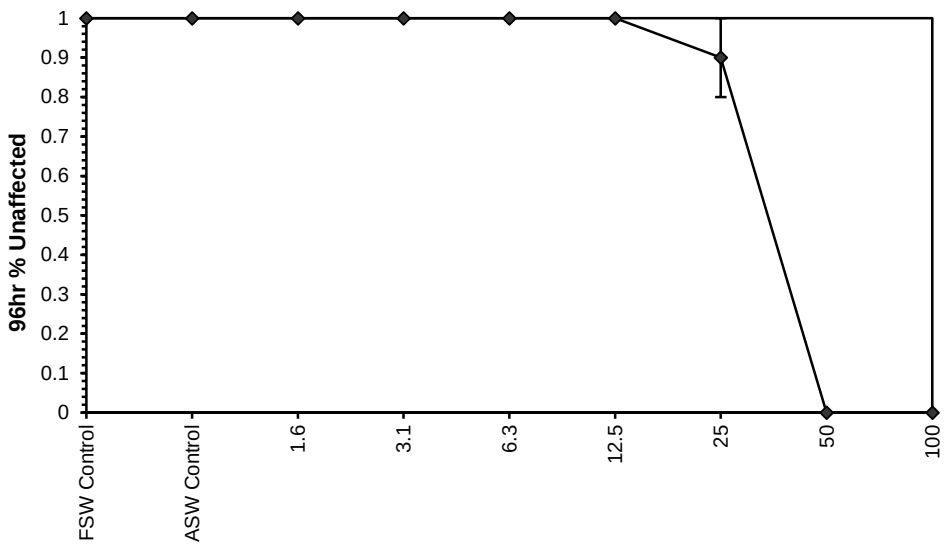
Point	%	SD	95% CL(Exp)		Skew
IC05	23.246	2.443	20.962	36.767	2.2460
IC10	25.000	2.229	22.268	37.164	2.3567
IC15	25.720	2.122	23.372	37.649	2.5052
IC20	26.276	2.078	24.235	38.017	2.5413
IC25	26.743	2.050	24.722	38.322	2.5374
IC40	27.902	1.979	25.935	39.064	2.5280
IC50	28.603	1.933	26.671	39.501	2.5224



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

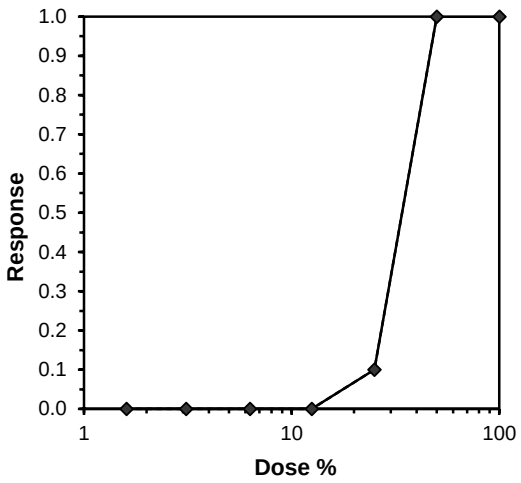
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

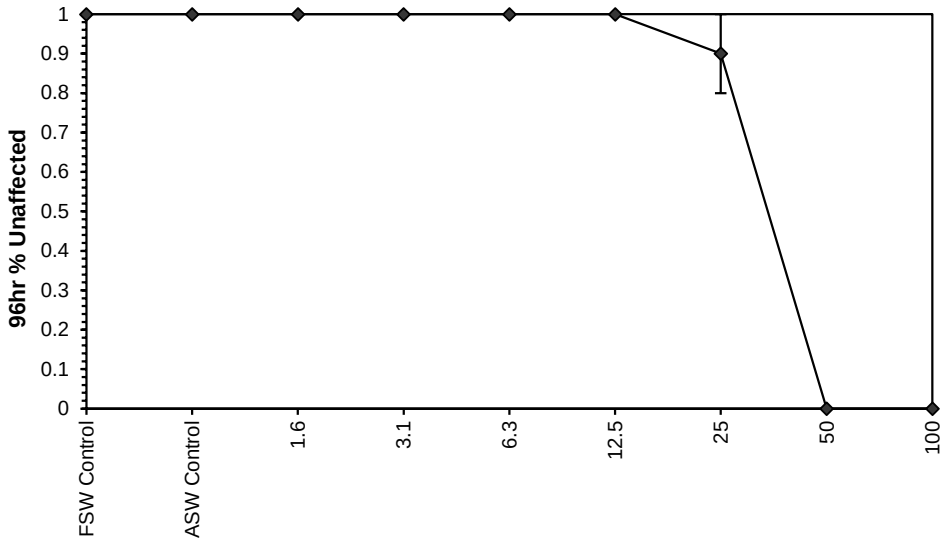
Trim Level	EC50	95% CL	
0.0%	32.988	30.058	36.203
5.0%	33.730	30.033	37.882
10.0%	34.020	32.122	36.030
20.0%	34.020	32.122	36.030
Auto-0.0%	32.988	30.058	36.203



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

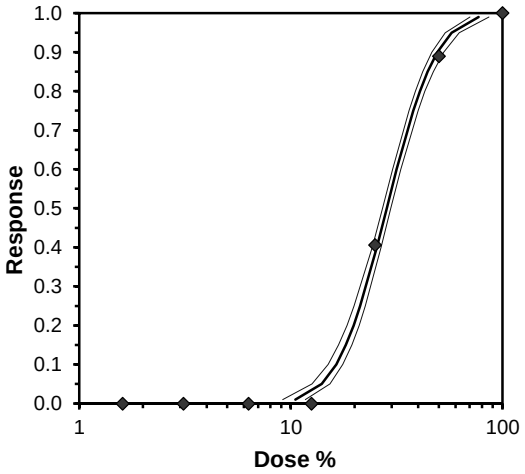
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.978578	0.924	-0.27794	-0.28183
Bartlett's Test indicates equal variances (p = 0.46)	5.697355	16.81189		
The control means are not significantly different (p = 0.54)	0.643295	2.446912		

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							

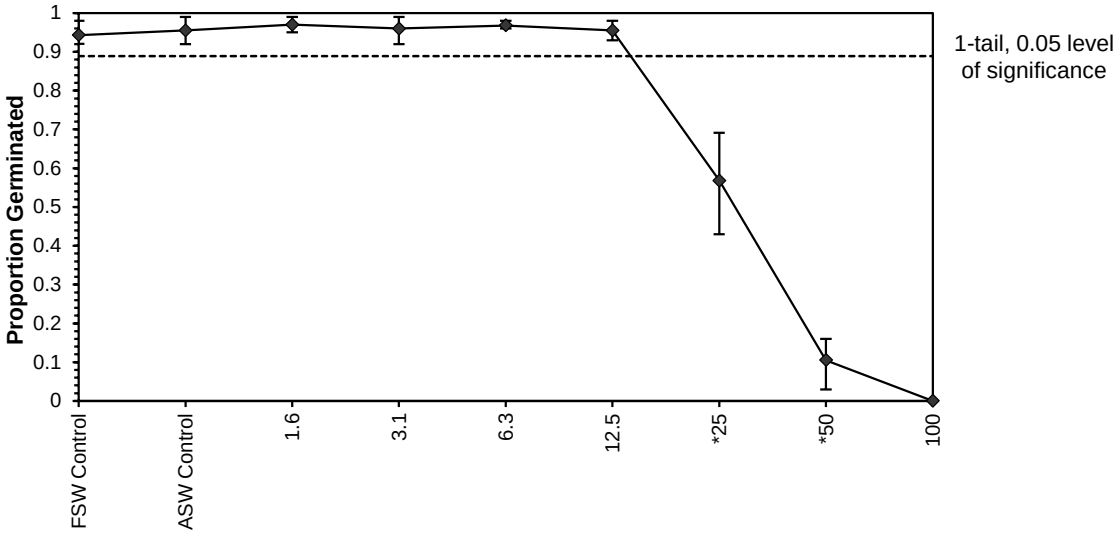
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	10.4543	9.147259	11.67215
EC05	3.355	14.00784	12.64032	15.25978
EC10	3.718	16.37249	15.00703	17.61754
EC15	3.964	18.18952	16.84039	19.42121
EC20	4.158	19.7764	18.4477	20.99489
EC25	4.326	21.24768	19.93987	22.45575
EC40	4.747	25.45896	24.19411	26.67317
EC50	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				

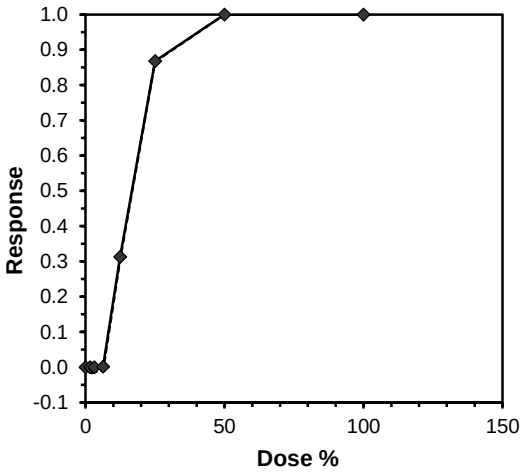
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	16.646	0.9955	16.646	15.771	17.971	4.281	8					
ASW Control	16.721	1.0000	16.721	16.071	17.171	3.030	4	*			16.904	1.0000
1.6	17.046	1.0194	17.046	16.371	17.771	3.433	4	-0.394	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)

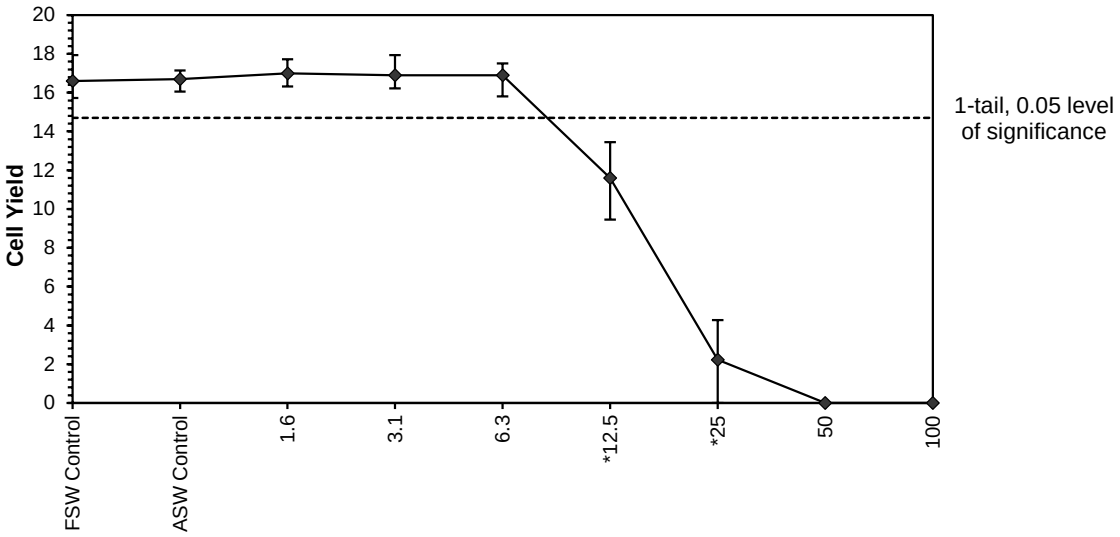
Point	%	SD	95% CL(Exp)		Skew
IC05	7.259	0.357	5.997	7.814	-2.5940
IC10	8.257	0.397	7.012	9.314	0.2087
IC15	9.255	0.534	7.900	10.980	0.5204
IC20	10.253	0.694	8.603	12.673	0.6221
IC25	11.251	0.820	9.328	13.899	0.4482
IC40	14.467	0.955	11.351	16.643	-0.3035
IC50	16.717	0.826	13.953	18.705	-0.3849



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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Toxicity Test Report: TR2234/1_R01

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2234 11 September 2024 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. 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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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.

Toxicity Test Report: TR2234/2

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2234 11 September 2024 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. 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)% **72-hr EC50 = 7.6 (7.37-7.81)%** **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: 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.

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: TR2234/3_R01

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2234 11 September 2024 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. 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)% **72-hr EC50 = 5.3 (5.16-5.50)%** **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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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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2234 11 September 2024 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. 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

NATA WORLD RECOGNISED ACCREDITATION

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Toxicity Test Report: TR2234/5

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:**	PR2234
		Date Sampled:	11 September 2024
		Date Received:	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. 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

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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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2234 11 September 2024 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. 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

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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: TR2234/7

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2234 11 September 2024 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. 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

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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: TR2234/8 (Page 1 of 2)

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2234 11 September 2024 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. 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.
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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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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 Allandale 60-h Bass FIT 72-h Nitzschia 72-h Hormosia 48-h mysid 1-h Seacrest Fert 72-h Sentinel Lamna 7 d FIT & Growth Sub-Sampling for Enrofloxacin	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.		

Note 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 2234

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.

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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

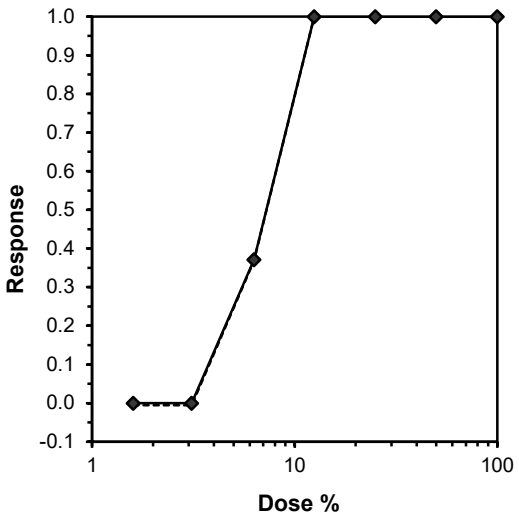
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9300	1.0164	1.3047	1.2661	1.3453	2.767	4					
ASW Control	0.9150	1.0000	1.2774	1.2490	1.3453	3.600	4	*			0.9183	1.0000
1.6	0.9200	1.0055	1.2854	1.2490	1.3233	2.636	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 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)

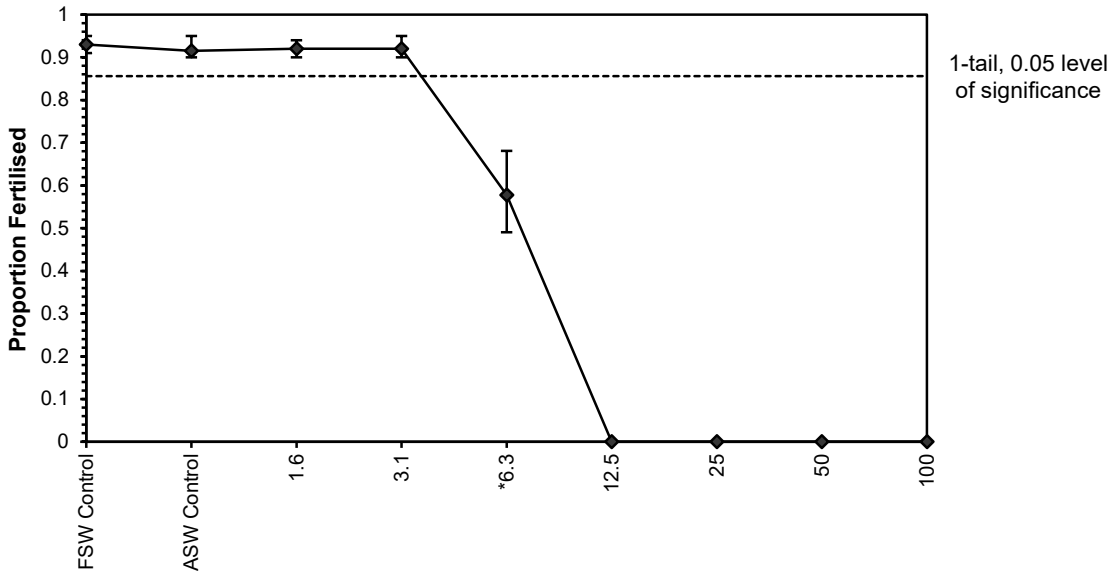
Point	%	SD	95% CL(Exp)		Skew
IC05	3.6981	0.0870	3.2838	3.8384	-1.2578
IC10	4.1867	0.1064	3.7743	4.4564	-0.0662
IC15	4.6183	0.1395	4.1602	5.0362	0.3176
IC20	5.0173	0.1778	4.4755	5.6007	0.4509
IC25	5.3981	0.2187	4.7489	6.1771	0.5186
IC40	6.3510	0.1365	5.6571	6.5799	-1.3010
IC50	6.5279	0.0729	6.2786	6.7547	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

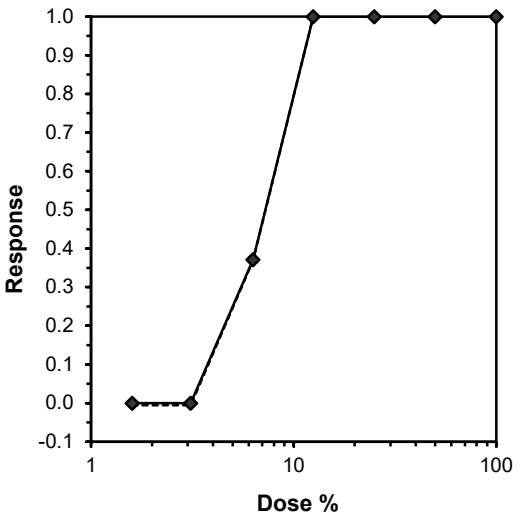
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9300	1.0164	1.3047	1.2661	1.3453	2.767	4					
ASW Control	0.9150	1.0000	1.2774	1.2490	1.3453	3.600	4	*			34	400
1.6	0.9200	1.0055	1.2854	1.2490	1.3233	2.636	4	-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 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

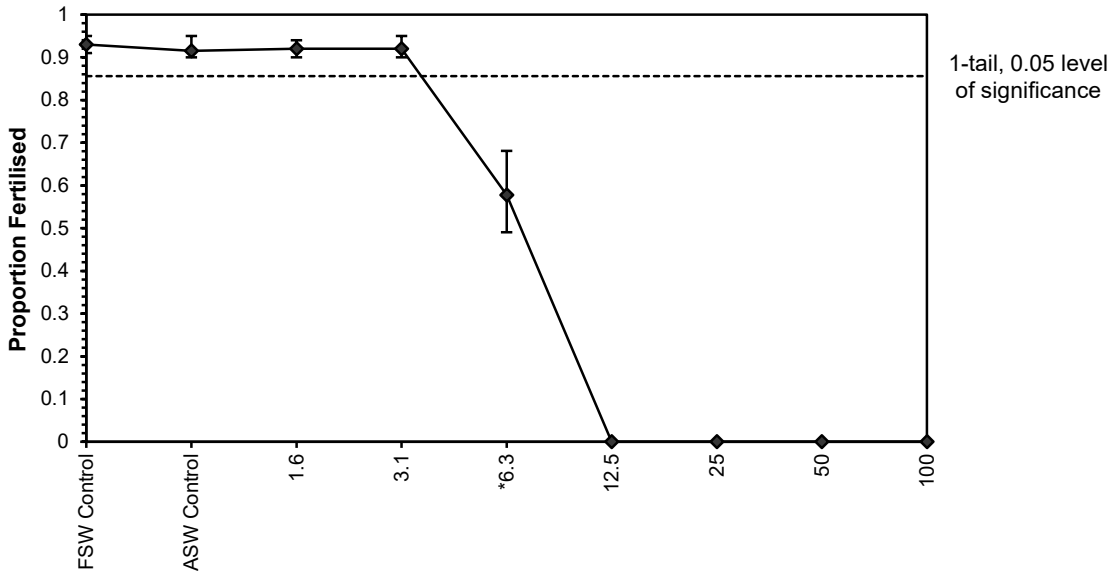
Trim Level	EC50	95% CL	
0.0%	6.8510	6.6241	7.0857
5.0%	6.9164	6.6608	7.1818
10.0%	6.9812	6.6865	7.2889
20.0%	7.1057	6.6810	7.5575
Auto-0.0%	6.8510	6.6241	7.0857



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

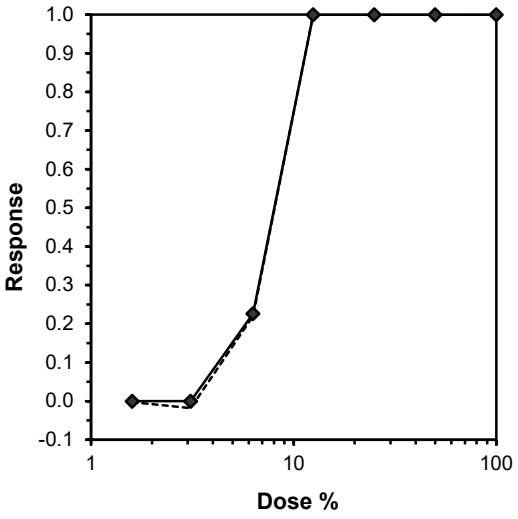
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9650	1.0000	1.3851	1.3453	1.4289	2.598	4					
ASW Control	0.9650	1.0000	1.3930	1.3030	1.4706	5.237	4	*			0.9717	1.0000
1.6	0.9675	1.0026	1.3931	1.3453	1.4289	3.048	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 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)

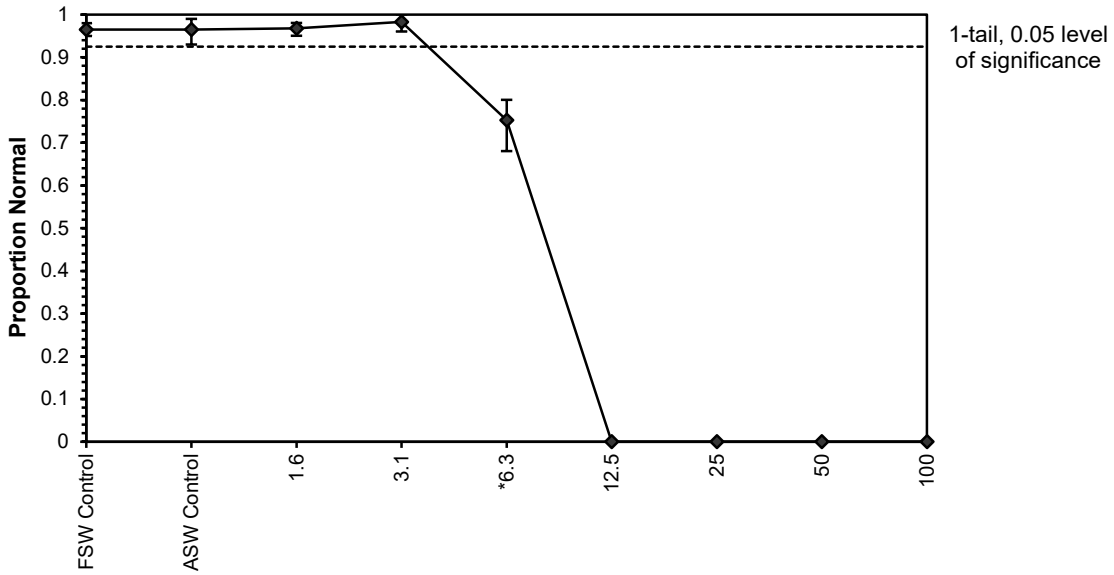
Point	%	SD	95% CL(Exp)		Skew
IC05	4.2644	0.0950	3.9733	4.5521	-0.1673
IC10	4.9919	0.1313	4.6117	5.4146	-0.0130
IC15	5.5662	0.1689	5.1296	6.0984	0.0259
IC20	6.0637	0.1859	5.5443	6.5064	-0.3298
IC25	6.3540	0.0870	6.0087	6.5111	-1.7330
IC40	6.6457	0.0546	6.4915	6.8011	-0.3078
IC50	6.8262	0.0536	6.6750	6.9796	-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

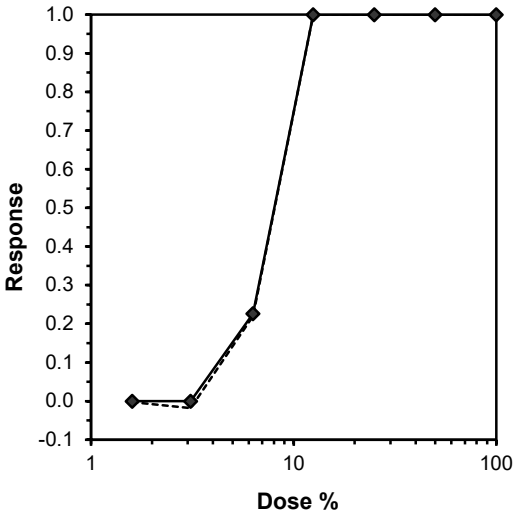
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9650	1.0000	1.3851	1.3453	1.4289	2.598	4					
ASW Control	0.9650	1.0000	1.3930	1.3030	1.4706	5.237	4	*			14	400
1.6	0.9675	1.0026	1.3931	1.3453	1.4289	3.048	4	-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 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

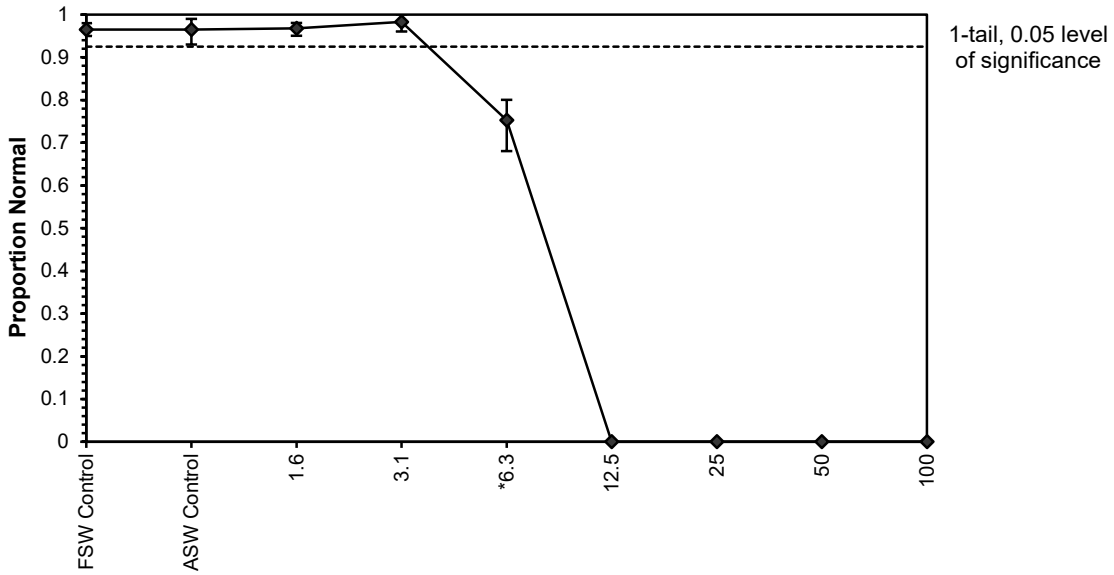
Trim Level	EC50	95% CL	
0.0%	7.5828	7.3651	7.8070
5.0%	7.7267	7.4750	7.9868
10.0%	7.8546	7.5484	8.1732
20.0%	8.0215	7.5063	8.5722
Auto-0.0%	7.5828	7.3651	7.8070



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

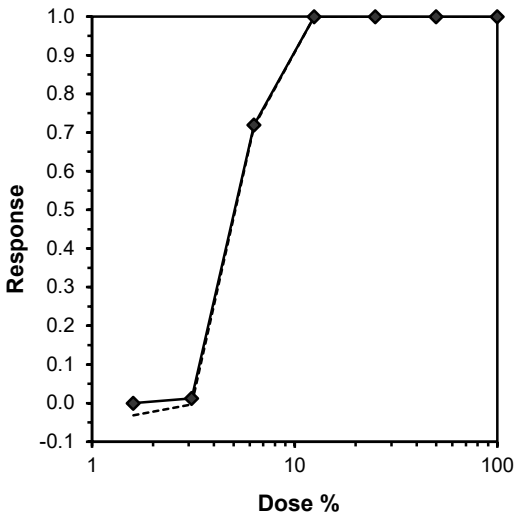
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7525	1.0561	1.0529	0.9803	1.1593	7.397	4					
ASW Control	0.7125	1.0000	1.0054	0.9695	1.0472	3.643	4	*			0.7238	1.0000
1.6	0.7350	1.0316	1.0303	1.0021	1.0588	2.291	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 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)

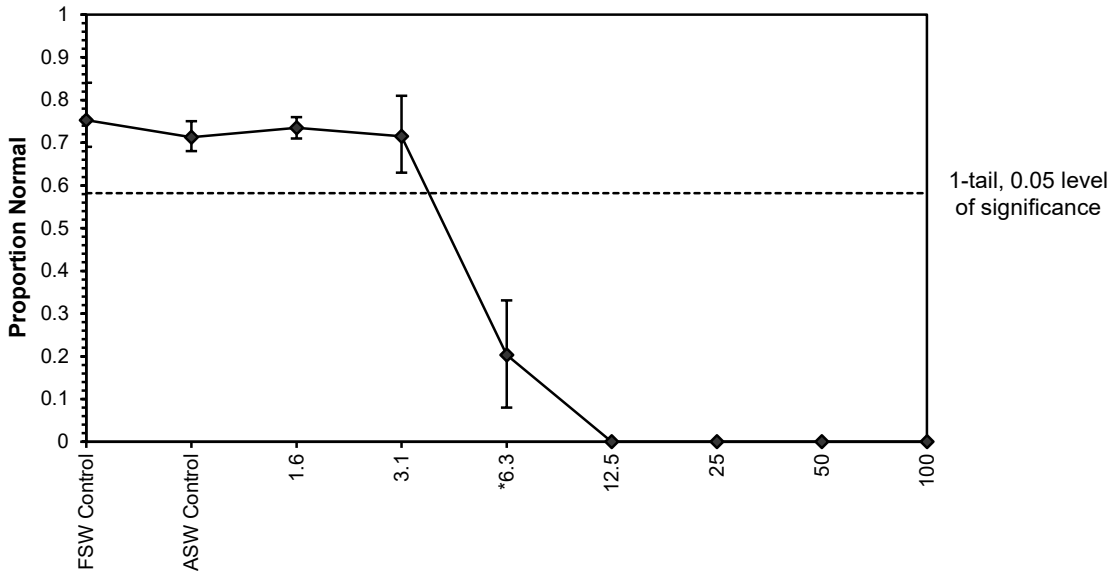
Point	%	SD	95% CL(Exp)		Skew
IC05	3.2376	0.2912	1.7344	3.3612	-1.9653
IC10	3.4159	0.1283	2.9196	3.5918	-1.7953
IC15	3.5928	0.1216	3.0805	3.8258	-0.6630
IC20	3.7702	0.1330	3.2188	4.0605	-0.3568
IC25	3.9501	0.1493	3.3873	4.3004	-0.1162
IC40	4.5249	0.2242	3.8899	5.2255	0.2625
IC50	4.9626	0.2965	4.1180	5.9850	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

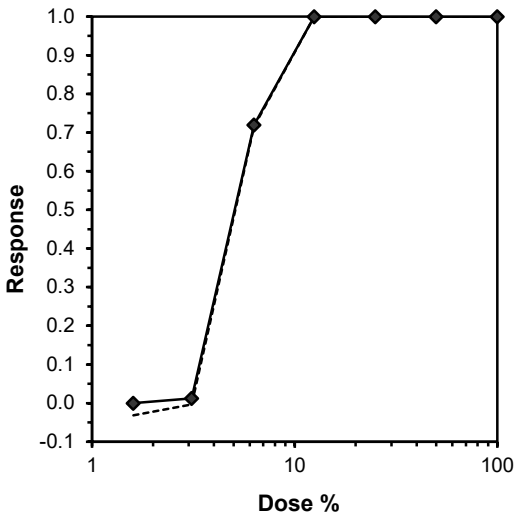
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7525	1.0561	1.0529	0.9803	1.1593	7.397	4					
ASW Control	0.7125	1.0000	1.0054	0.9695	1.0472	3.643	4	*			115	400
1.6	0.7350	1.0316	1.0303	1.0021	1.0588	2.291	4	-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 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

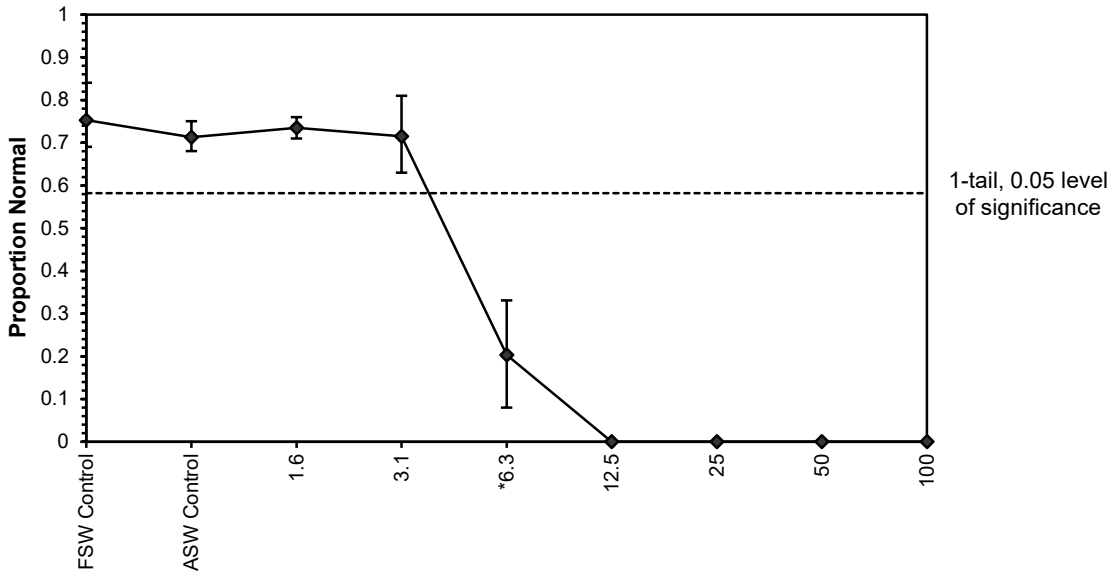
Trim Level	EC50	95% CL	
0.0%	5.3268	5.1581	5.5010
5.0%	5.2724	5.0936	5.4574
10.0%	5.2032	5.0134	5.4001
20.0%	5.0922	4.8872	5.3057
Auto-0.0%	5.3268	5.1581	5.5010



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

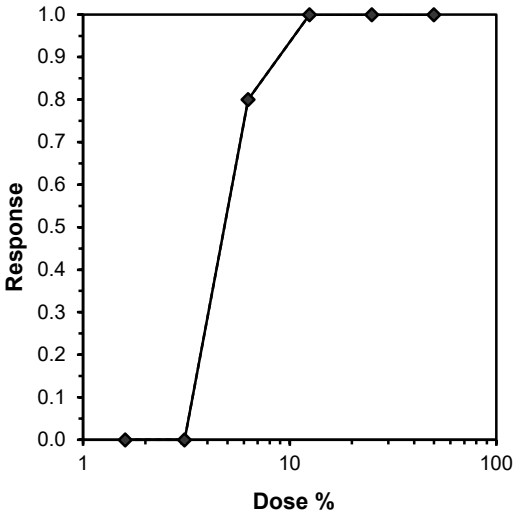
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

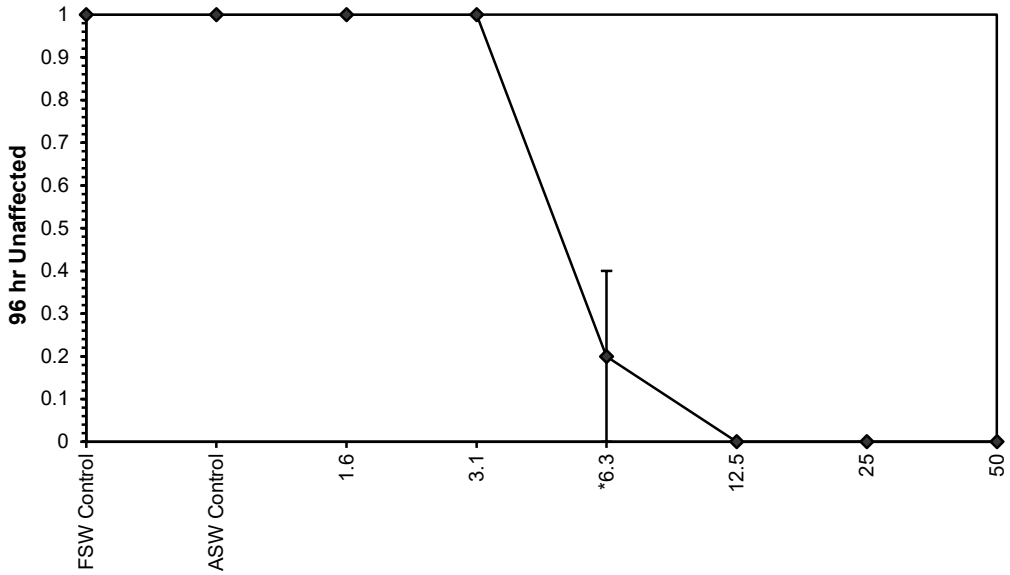
Point	%	SD	95% CL(Exp)		Skew
IC05	4.7667	0.2386	3.5222	5.0934	-2.1082
IC10	5.0061	0.2762	3.5676	5.3878	-2.0962
IC15	5.1593	0.3007	3.5949	5.5771	-2.0887
IC20	5.2772	0.3197	3.6151	5.7232	-2.0831
IC25	5.3763	0.3358	3.6315	5.8464	-2.0784
IC40	5.6215	0.3761	3.6700	6.1524	-2.0671
IC50	5.7693	0.4008	3.6917	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

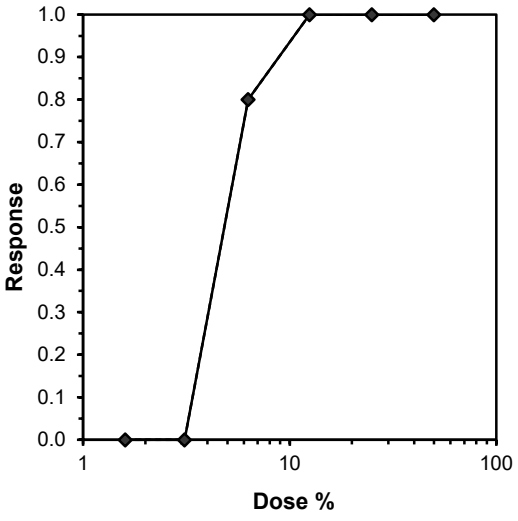
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

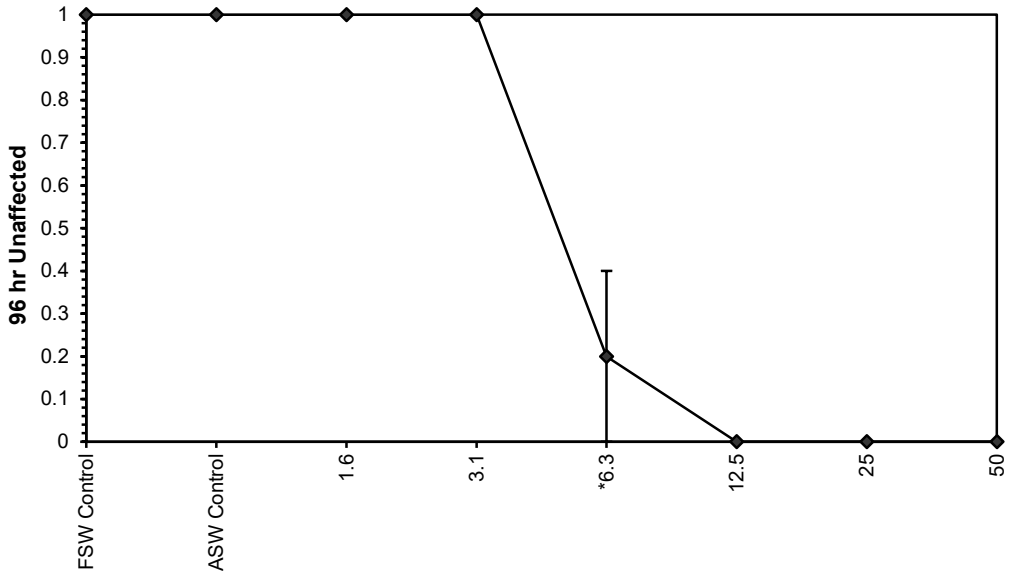
Trim Level	EC50	95% CL	
0.0%	5.0805	4.4848	5.7553
5.0%	4.9846	4.3570	5.7028
10.0%	4.9062	4.2738	5.6320
20.0%	4.8289	4.3733	5.3320
Auto-0.0%	5.0805	4.4848	5.7553



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

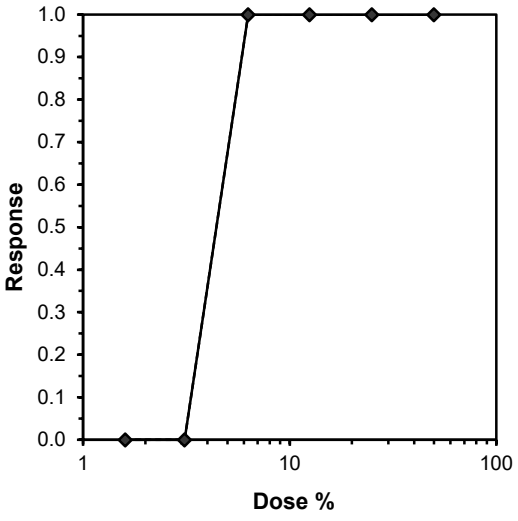
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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

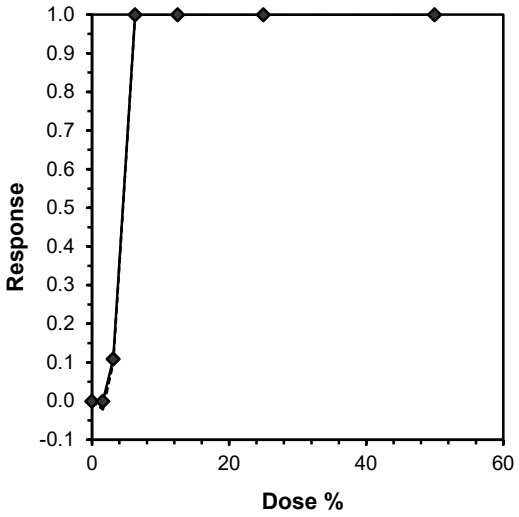
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	19.260	1.0185	19.260	18.540	19.740	2.832	4				
ASW Control	18.910	1.0000	18.910	17.940	19.460	3.524	4	*		19.115	1.0000
1.6	19.320	1.0217	19.320	19.020	19.500	1.189	4	22.00	11.00	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 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

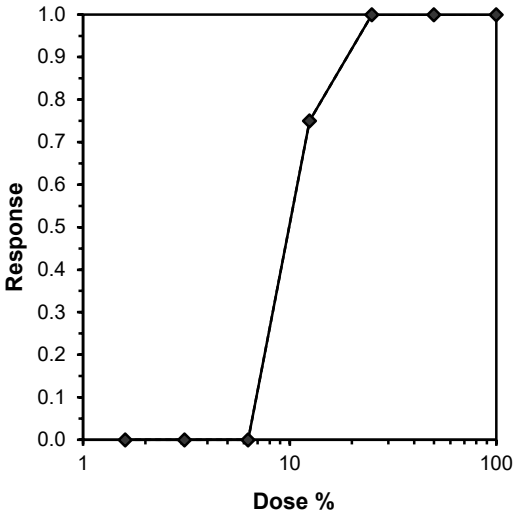
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

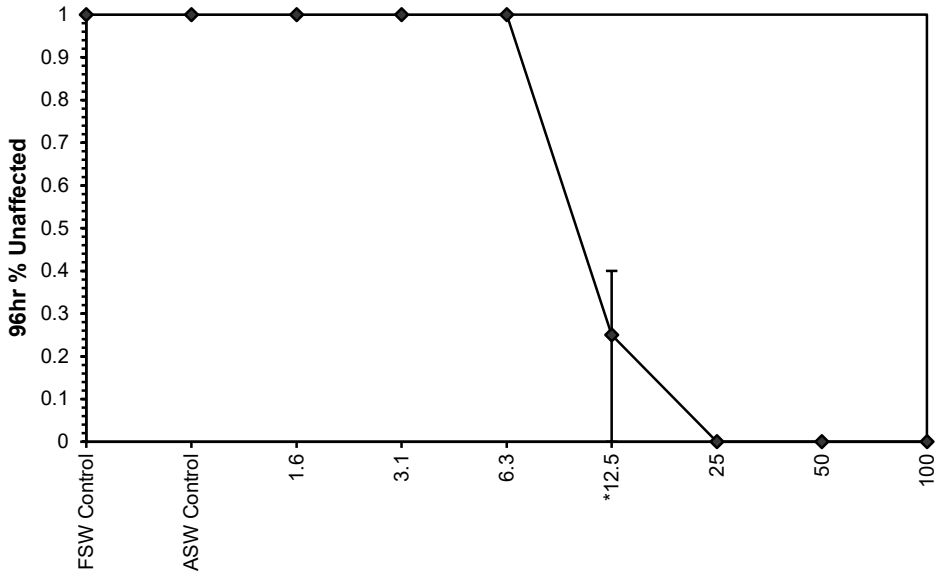
Point	%	SD	95% CL(Exp)		Skew
IC05	9.608	0.311	8.630	10.071	-3.2859
IC10	10.091	0.361	8.952	10.634	-3.2559
IC15	10.401	0.394	9.156	10.997	-3.2372
IC20	10.641	0.420	9.312	11.278	-3.2232
IC25	10.842	0.442	9.443	11.514	-3.2117
IC40	11.342	0.497	9.764	12.104	-3.1838
IC50	11.644	0.531	9.957	12.461	-3.1675



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

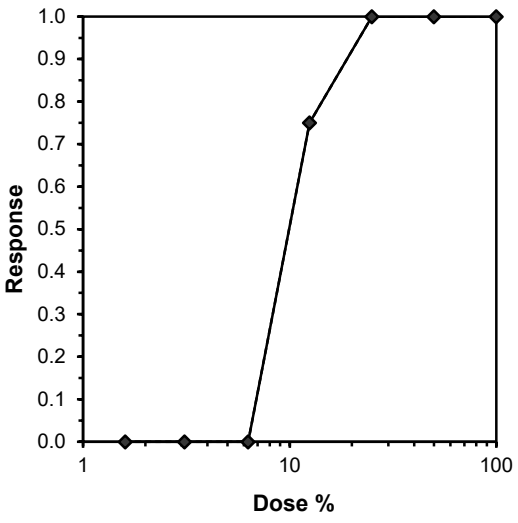
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

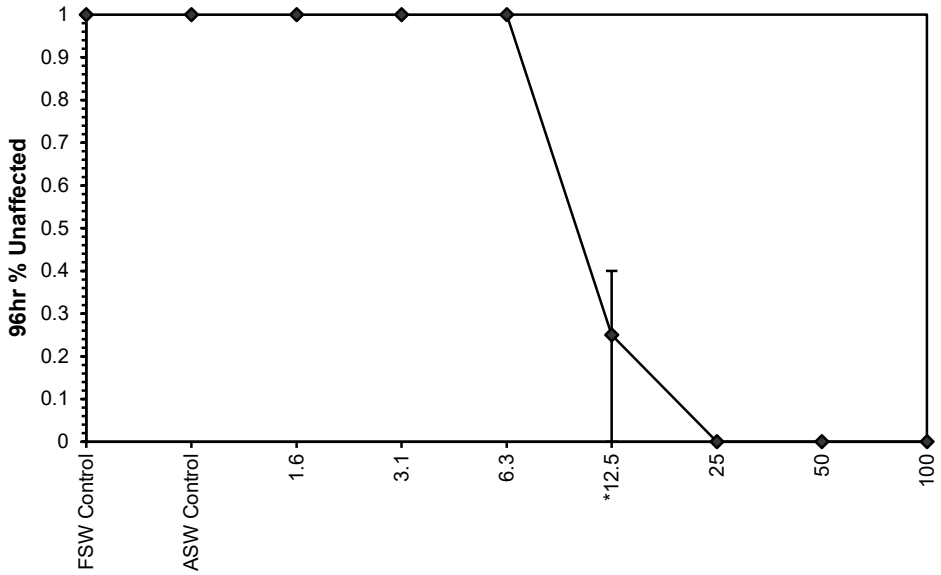
Trim Level	EC50	95% CL	
0.0%	10.543	9.226	12.048
5.0%	10.367	8.962	11.992
10.0%	10.211	8.746	11.922
20.0%	9.986	8.521	11.704
Auto-0.0%	10.543	9.226	12.048



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

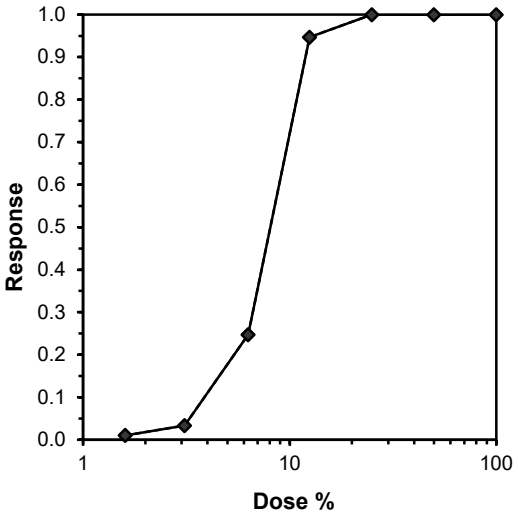
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9700	0.9873	1.4036	1.3453	1.4706	4.051	4				
ASW Control	0.9825	1.0000	1.4474	1.3694	1.5208	4.432	4	*		0.9825	1.0000
1.6	0.9725	0.9898	1.4161	1.3453	1.5208	5.517	4	15.50	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Log-Logit Interpolation (200 Resamples)

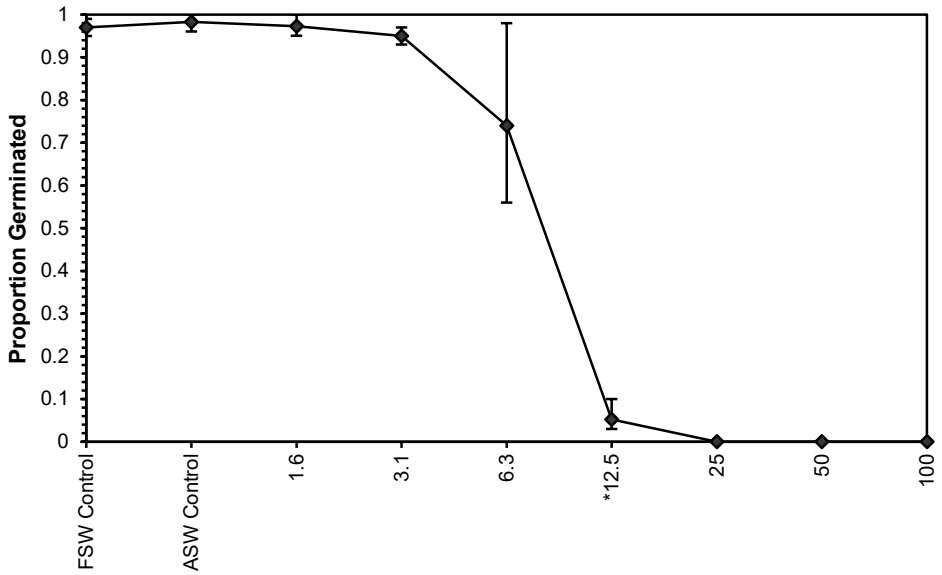
Point	%	SD	95% CL(Exp)		Skew
IC05	3.4978	0.4223	2.6103	4.7671	3.0763
IC10	4.4079	0.5482	3.5056	7.3710	2.1540
IC15	5.1271	0.6021	4.0103	7.5733	1.3300
IC20	5.7557	0.5812	4.4392	7.7031	0.7798
IC25	6.3185	0.5241	4.8372	7.8289	0.5007
IC40	7.1226	0.4083	6.1021	8.5728	0.7298
IC50	7.6417	0.3884	6.6355	8.9646	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

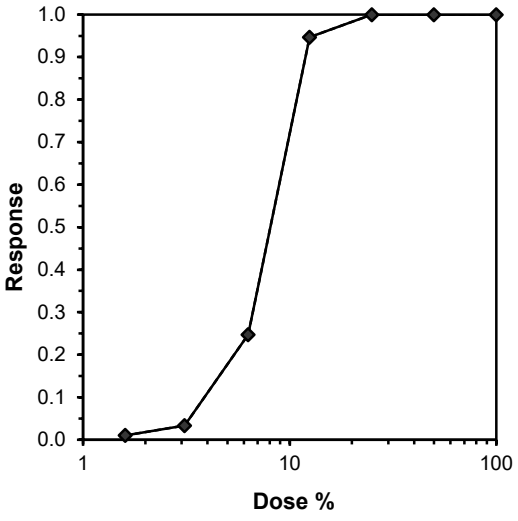
			Transform: Arcsin Square Root					Rank	1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical		Resp	Number
FSW Control	0.9700	0.9873	1.4036	1.3453	1.4706	4.051	4					
ASW Control	0.9825	1.0000	1.4474	1.3694	1.5208	4.432	4	*			7	400
1.6	0.9725	0.9898	1.4161	1.3453	1.5208	5.517	4	15.50	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Trimmed Spearman-Karber

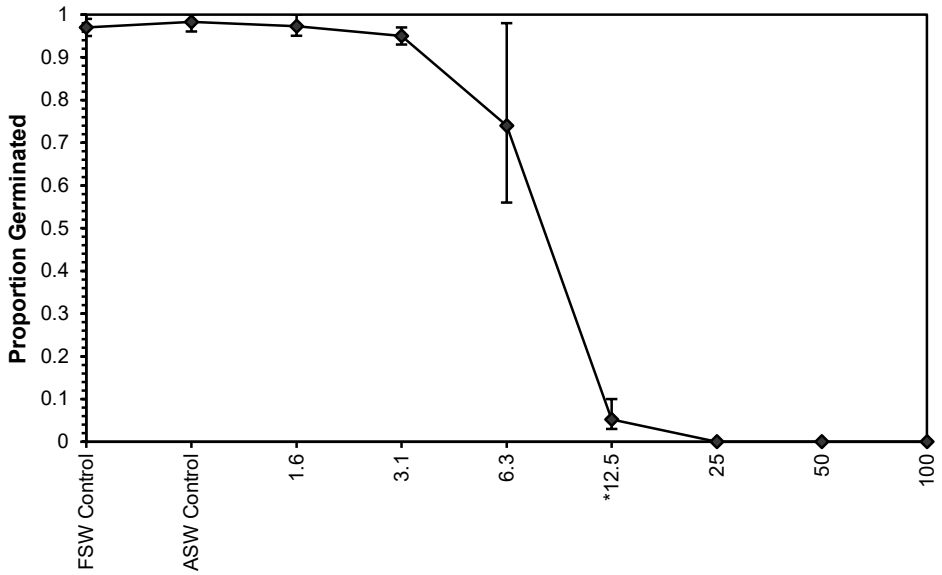
Trim Level	EC50	95% CL	
0.0%			
5.0%	7.6768	7.4115	7.9517
10.0%	7.8221	7.5122	8.1448
20.0%	8.0381	7.5318	8.5784
Auto-1.0%	7.5854	7.3117	7.8694



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				

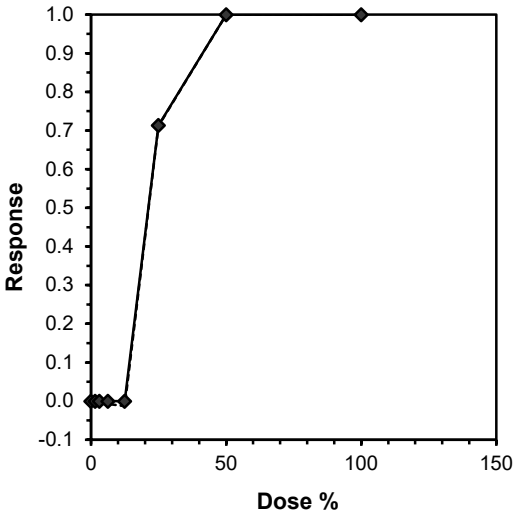
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	17.245	1.0000	17.245	16.170	18.070	3.918	8					
ASW Control	17.245	1.0000	17.245	16.370	18.570	5.468	4	*			17.345	1.0000
1.6	17.270	1.0014	17.270	16.370	18.270	5.452	4	-0.042	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 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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2293 07 November 2024 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. 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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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.

Toxicity Test Report: TR2293/2

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2293 07 November 2024 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. 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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Toxicity Test Report: TR2293/2

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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2293 07 November 2024 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. 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)%			
72-hr EC50 = 0.2 (0.21-0.22)%			
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?
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.

NATA Accredited Laboratory Number: 14709

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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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2293 07 November 2024 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. 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 Level 15, 150 Lonsdale Street 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. 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

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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 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 Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2293 07 November 2024 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. 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

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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: TR2293/7

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2293 07 November 2024 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. 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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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.
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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: TR2293/8 (Page 1 of 2)

Client:	Beach Energy Limited Level 15, 150 Lonsdale Street Melbourne VIC 3000	**ESA Job #:** **Date Sampled:** **Date Received:**	PR2293 07 November 2024 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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	17.5x10^4 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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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.
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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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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

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 4/4.

*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

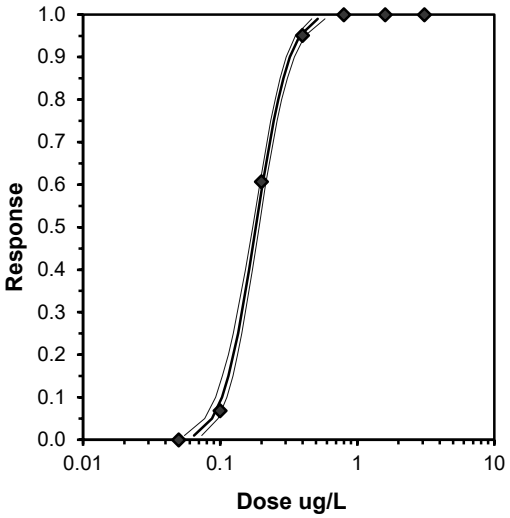
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.952363	0.905	0.147345	2.104759
Bartlett's Test indicates equal variances (p = 0.05)	9.357854	13.2767		
The control means are not significantly different (p = 0.62)	0.516755	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

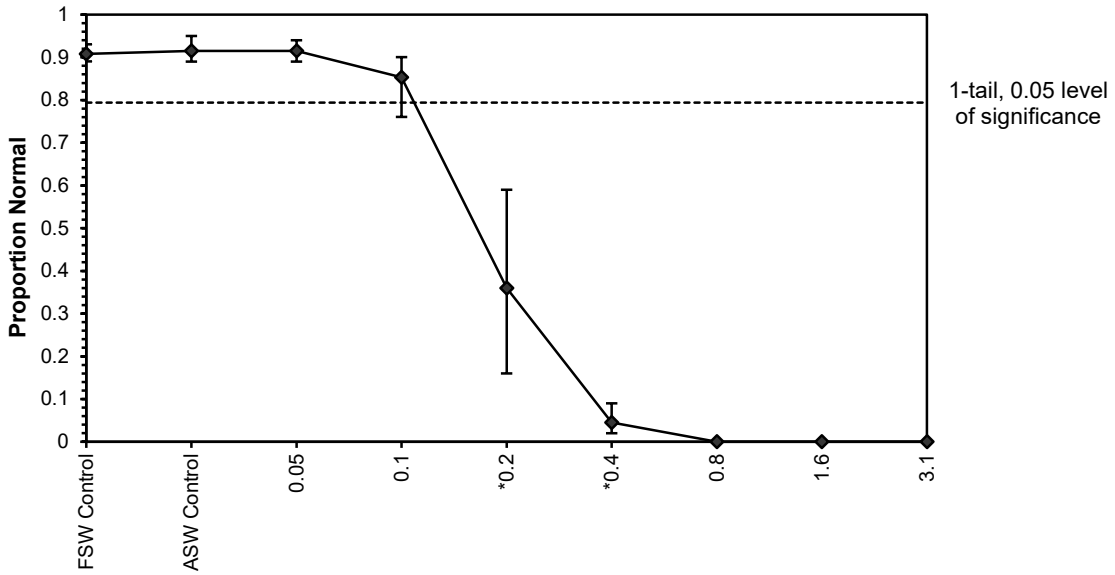
Point	Probits	ug/L	95% Fiducial Limits	
EC01	2.674	0.064485	0.054942	0.073413
EC05	3.355	0.087426	0.077192	0.09679
EC10	3.718	0.102828	0.092463	0.112242
EC15	3.964	0.114724	0.104386	0.124101
EC20	4.158	0.125153	0.114903	0.134468
EC25	4.326	0.134852	0.124717	0.144106
EC40	4.747	0.162759	0.15296	0.171978
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

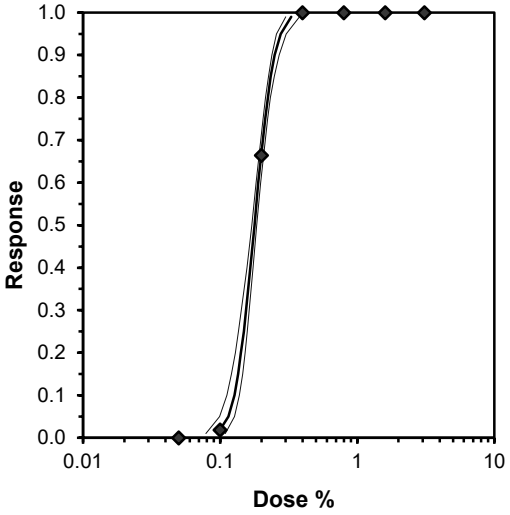
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.976044	0.887	0.291588	-0.36885
Bartlett's Test indicates equal variances (p = 0.30)	3.648114	11.34487		
The control means are not significantly different (p = 0.68)	0.431113	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

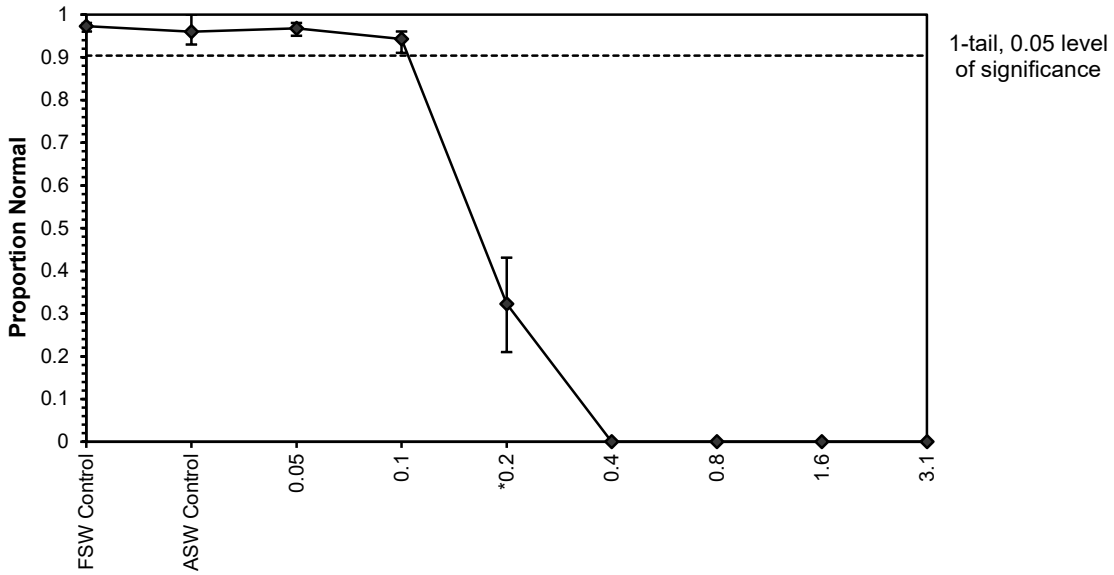
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	0.095887	0.078743	0.109226
EC05	3.355	0.114934	0.098887	0.127042
EC10	3.718	0.126589	0.111614	0.137749
EC15	3.964	0.135114	0.121083	0.145515
EC20	4.158	0.142296	0.129149	0.152033
EC25	4.326	0.148762	0.136465	0.157893
EC40	4.747	0.166386	0.15653	0.173968
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

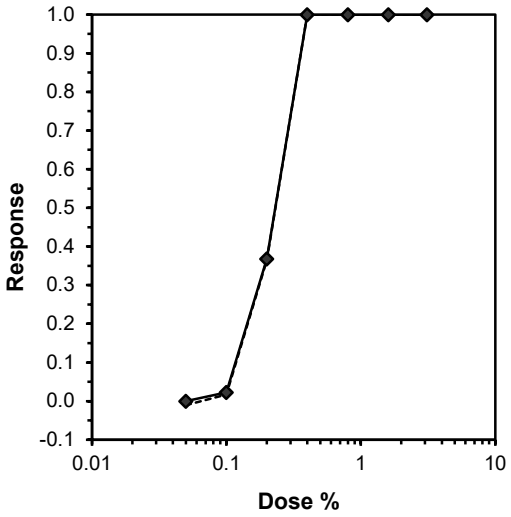
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7375	1.0243	1.0340	0.9695	1.0948	5.030	4					
ASW Control	0.7200	1.0000	1.0135	0.9695	1.0357	2.941	4	*			0.7238	1.0000
0.05	0.7275	1.0104	1.0228	0.9695	1.0948	5.410	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 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)

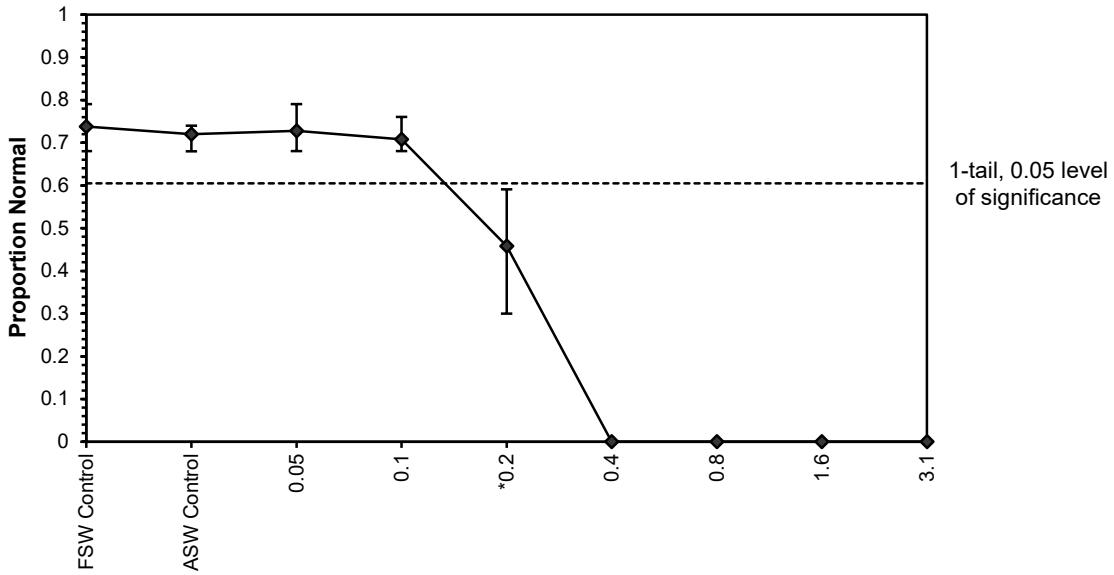
Point	%	SD	95% CL(Exp)		Skew
IC05	0.1086	0.0115	0.0650	0.1271	-1.8093
IC10	0.1237	0.0084	0.1001	0.1525	0.7522
IC15	0.1383	0.0110	0.1130	0.1773	1.0806
IC20	0.1525	0.0140	0.1240	0.2089	0.9655
IC25	0.1666	0.0158	0.1319	0.2220	0.5429
IC40	0.2019	0.0092	0.1586	0.2143	-1.2545
IC50	0.2081	0.0049	0.1899	0.2201	-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

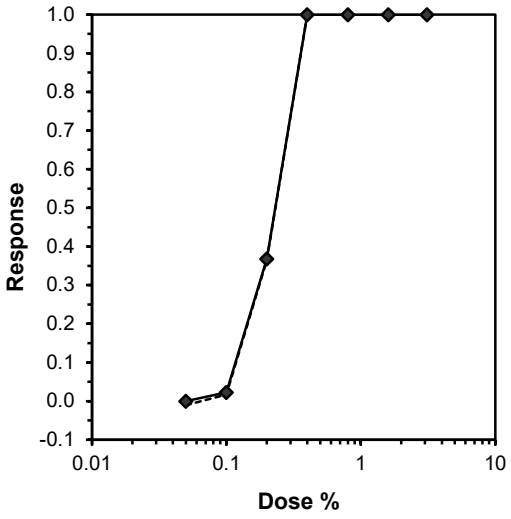
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7375	1.0243	1.0340	0.9695	1.0948	5.030	4					
ASW Control	0.7200	1.0000	1.0135	0.9695	1.0357	2.941	4	*			112	400
0.05	0.7275	1.0104	1.0228	0.9695	1.0948	5.410	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 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

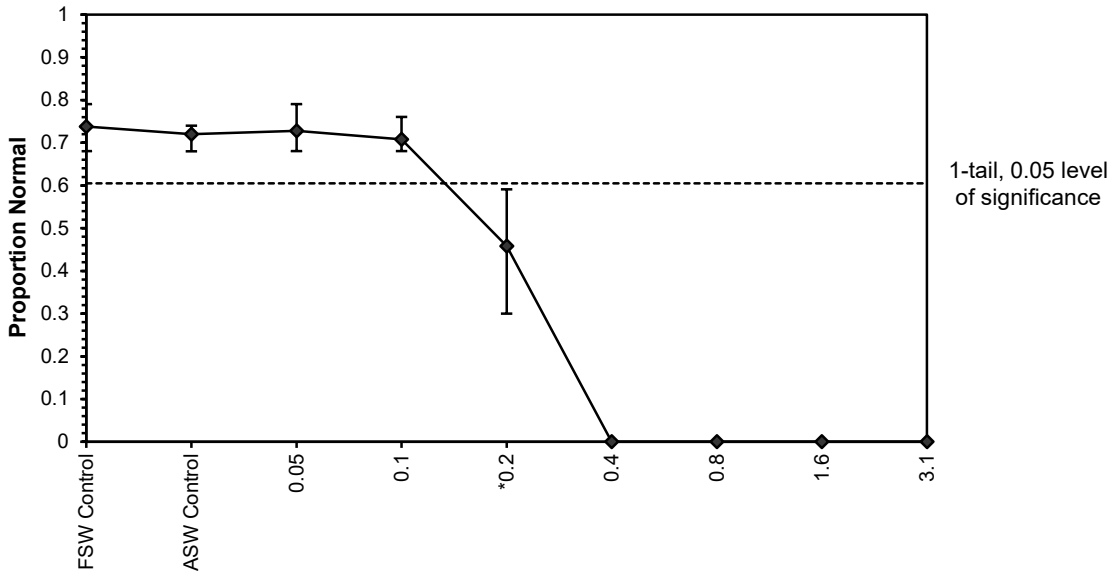
Trim Level	EC50	95% CL	
0.0%	0.2158	0.2084	0.2235
5.0%	0.2197	0.2116	0.2280
10.0%	0.2219	0.2127	0.2316
20.0%	0.2263	0.2130	0.2404
Auto-0.0%	0.2158	0.2084	0.2235



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

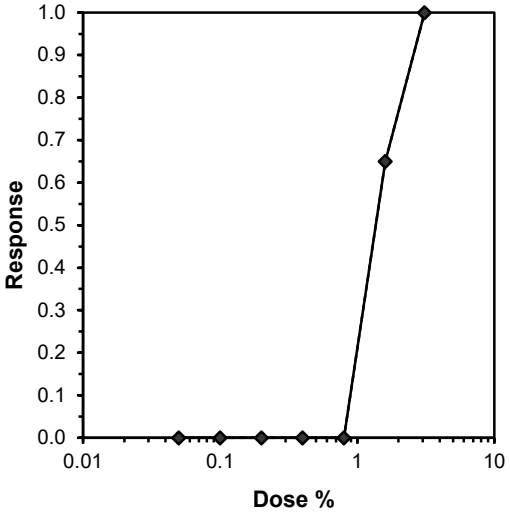
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
0.05	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

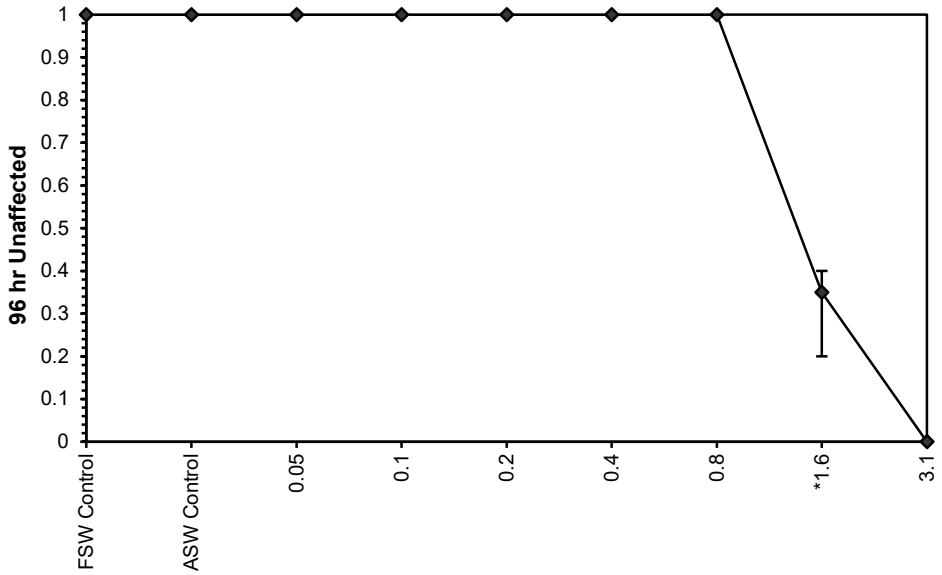
Point	%	SD	95% CL(Exp)		Skew
IC05	1.2755	0.0098	1.2557	1.2945	-0.6409
IC10	1.3400	0.0113	1.3172	1.3619	-0.6394
IC15	1.3809	0.0123	1.3561	1.4046	-0.6385
IC20	1.4121	0.0130	1.3859	1.4373	-0.6378
IC25	1.4382	0.0136	1.4107	1.4646	-0.6372
IC40	1.5022	0.0152	1.4716	1.5316	-0.6359
IC50	1.5405	0.0161	1.5080	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

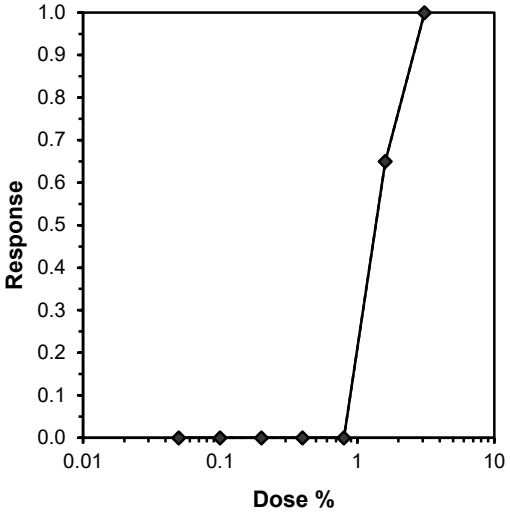
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
0.05	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

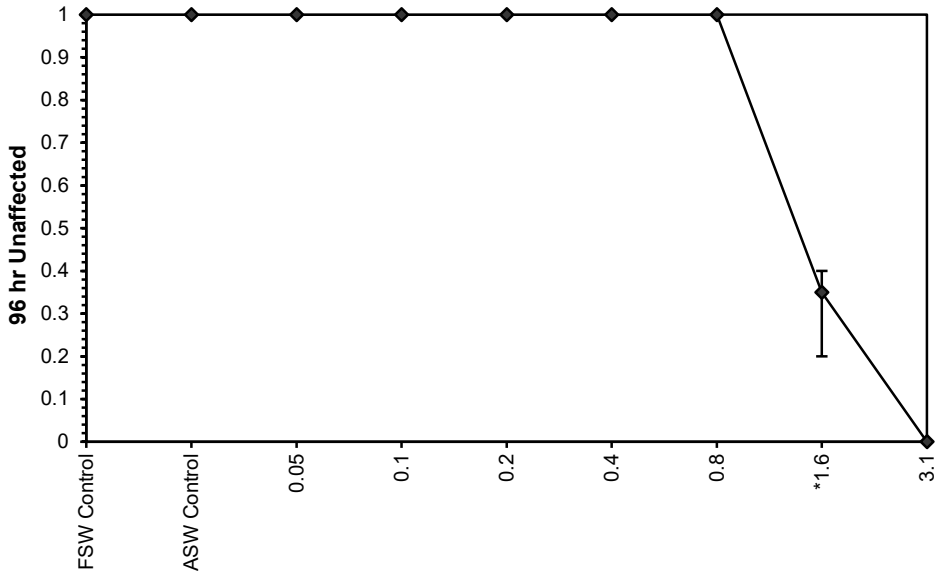
Trim Level	EC50	95% CL	
0.0%	1.4340	1.2411	1.6569
5.0%	1.4208	1.2114	1.6663
10.0%	1.4081	1.1813	1.6783
20.0%	1.3847	1.1179	1.7152
Auto-0.0%	1.4340	1.2411	1.6569



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

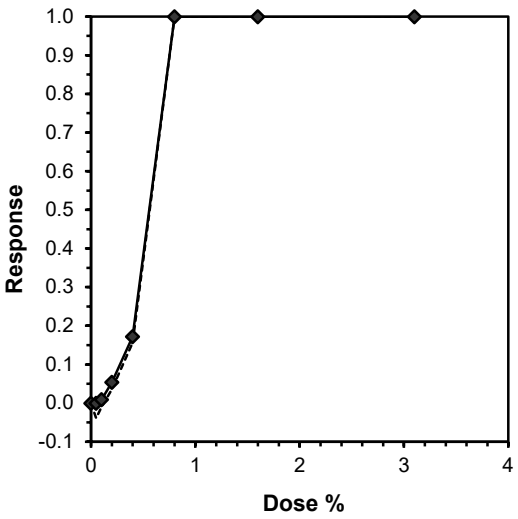
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW	18.545	1.0439	18.545	17.980	19.160	3.142	4					
ASW	17.765	1.0000	17.765	17.460	18.080	1.648	4	*			18.110	1.0000
0.05	18.455	1.0388	18.455	16.880	19.480	6.139	4	-0.679	2.360	2.398	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

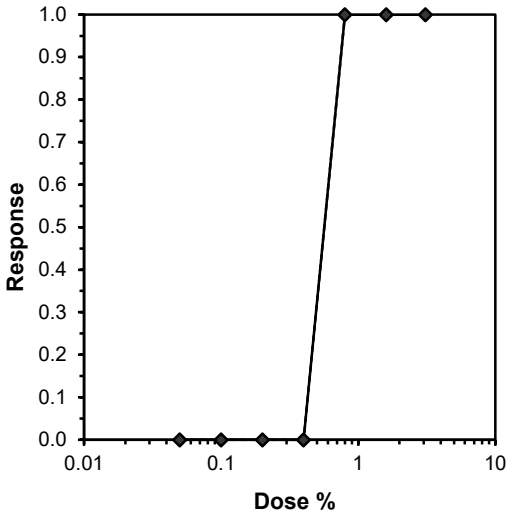
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
0.05	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
0.1	1.0000	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

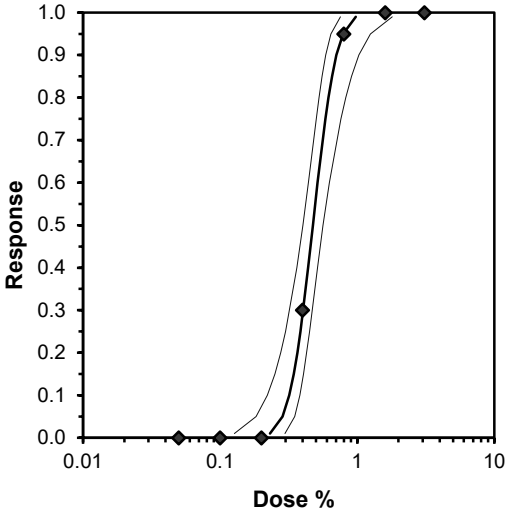
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.770387	0.916	0.958748	2.472429
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

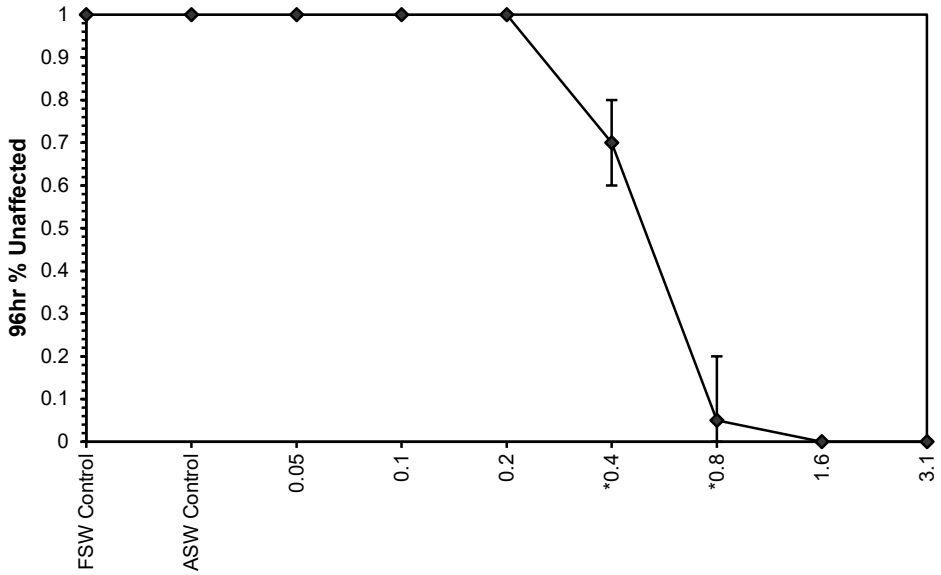
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	0.230906	0.126976	0.297322
EC05	3.355	0.285198	0.183018	0.348641
EC10	3.718	0.319182	0.221458	0.381142
EC15	3.964	0.34437	0.251117	0.405958
EC20	4.158	0.365799	0.276804	0.427897
EC25	4.326	0.385243	0.300208	0.44873
EC40	4.747	0.438945	0.36319	0.513006
EC50	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		

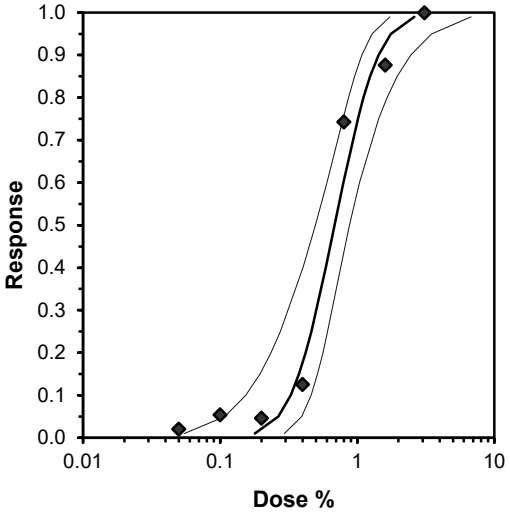
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	0.2	0.4	0.282843	500	0.055285	0.056732	0.760239	0.005436	8.1E-16	6, 21
Treatments vs ASW Control										

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

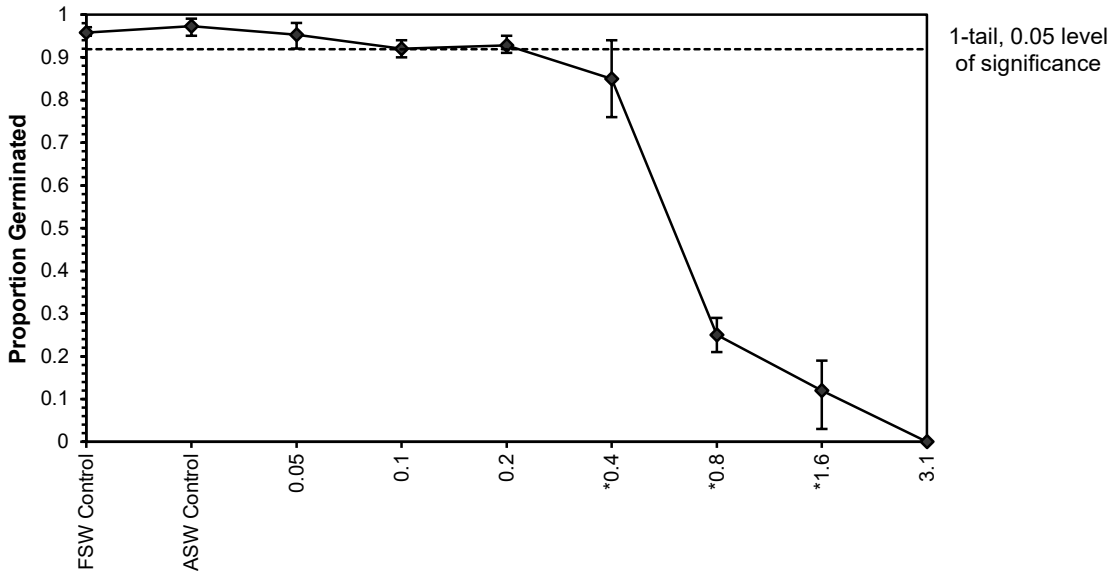
Significant heterogeneity detected (p = 1.68E-12)



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				

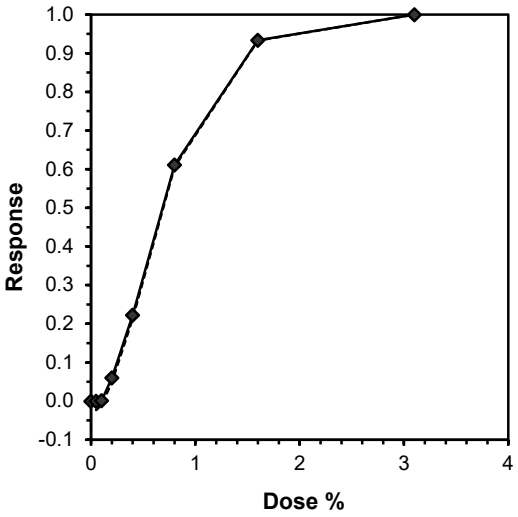
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	17.541	1.0152	17.541	16.503	19.103	5.493	8					
ASW Control	17.278	1.0000	17.278	16.503	18.403	4.639	4	*			17.478	1.0000
0.05	17.678	1.0232	17.678	17.003	18.103	2.708	4	-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 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)

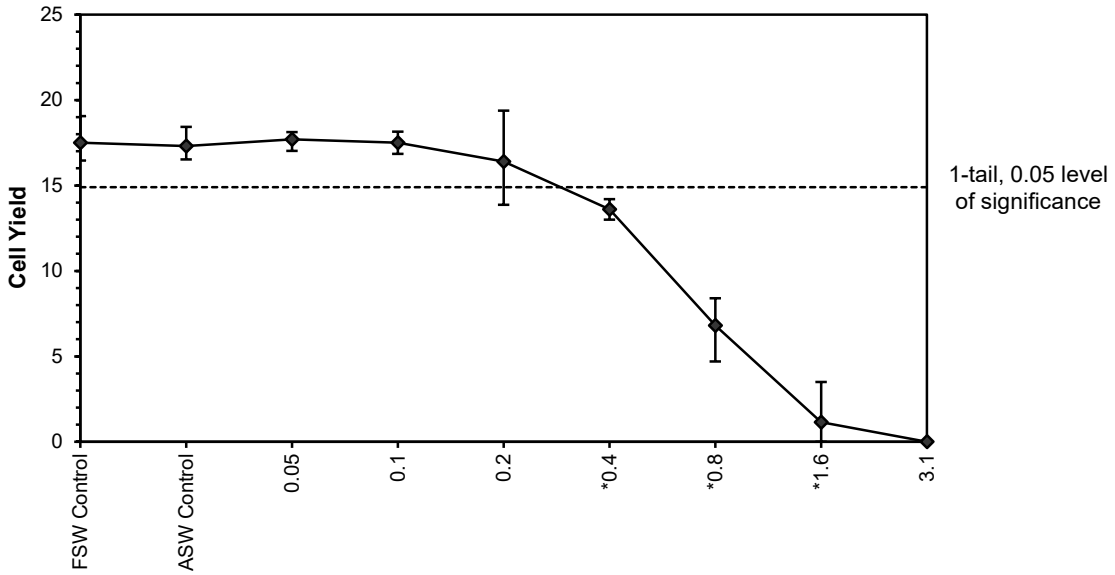
Point	%	SD	95% CL(Exp)		Skew
IC05	0.1828	0.0452	0.0841	0.2814	0.1357
IC10	0.2494	0.0464	0.1057	0.3228	-0.3111
IC15	0.3113	0.0449	0.1216	0.3668	-0.9744
IC20	0.3731	0.0319	0.2205	0.4226	-1.5908
IC25	0.4291	0.0192	0.3672	0.4747	-0.2315
IC40	0.5833	0.0232	0.5226	0.6641	0.4097
IC50	0.6861	0.0319	0.5953	0.8039	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

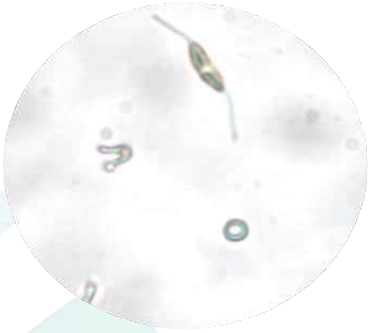
Start Date:	20/11/2024 19:00	Test ID:	PR2293/11	Sample ID:	Y0071124
End Date:	23/11/2024 19:00	Lab ID:	11798	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 110	Test Species:	NC-Nitzschia closterium
Comments:					

		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

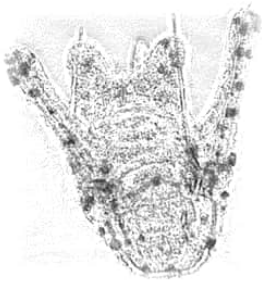
If toxicity is detected using the chronic Urchin Fertilisation test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

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

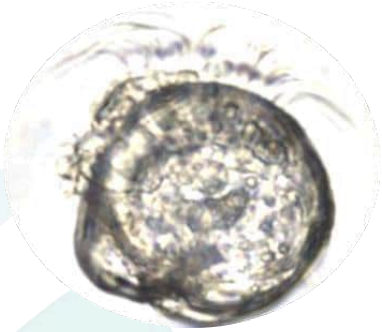
If toxicity is detected using the chronic Urchin Larval Development test, a Toxicity Identification Evaluation (TIE) programme can be initiated to identify the cause of the observed toxicity.

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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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 ≥16.0x10^4 cells/mL & Control CV <20%	Yes	Copper	4 - 8 replicates	ESA SOP 110 (ESA 2016), based on Stauber et al. (1994)	IC10	3.7 (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 ≥16.0x10^4 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 ≥16.0x10^4 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 ≥16.0x10^4 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)	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 ≥16.0x10^4 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)	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 ≥16.0x10^4 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)	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 ≥16.0x10⁴ 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)	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 ≥16.0x10^4 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)	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 ≥16.0x10^4 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)	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 ≥16.0x10^4 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)	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 ≥16.0x10^4 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)	5.0 (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 ≥16.0x10^4 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).

Appendix F - Burrlioz Input Toxicity Values

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

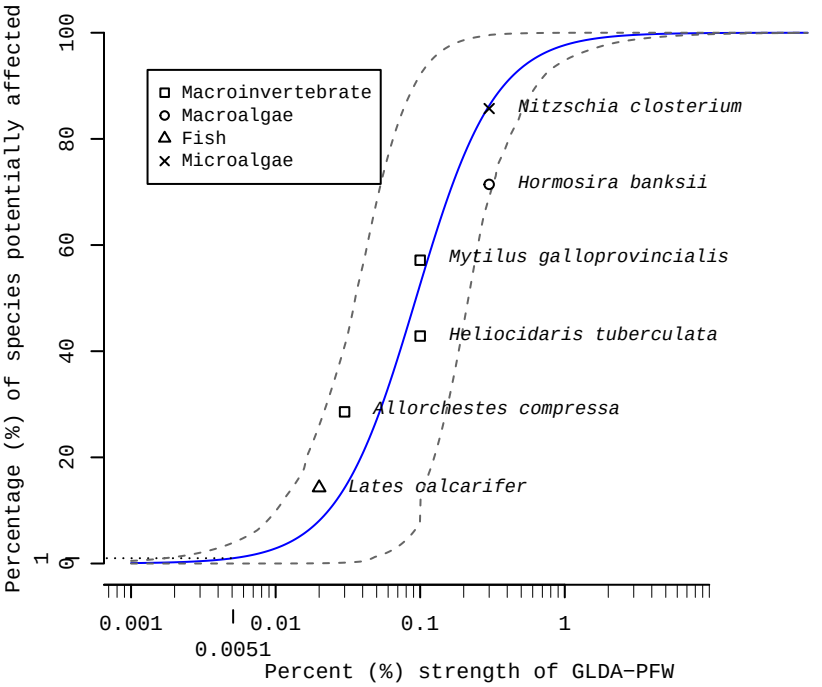
Burrlioz 2.0 report

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

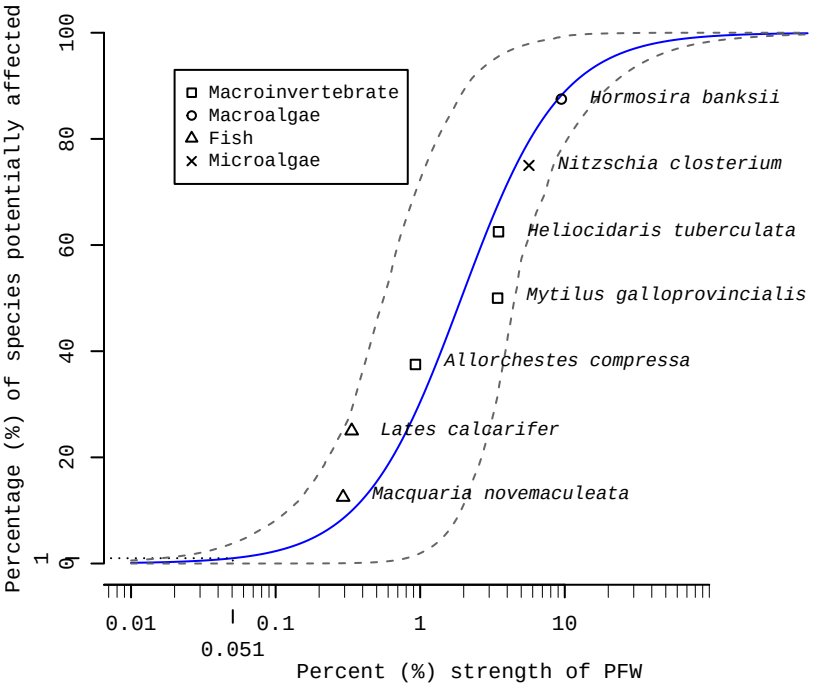
Burrlioz 2.0 report

Toxicant: PFW
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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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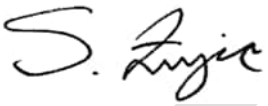
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Beach Yolla Platform PW
Rev0
23 September 2020

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Document status

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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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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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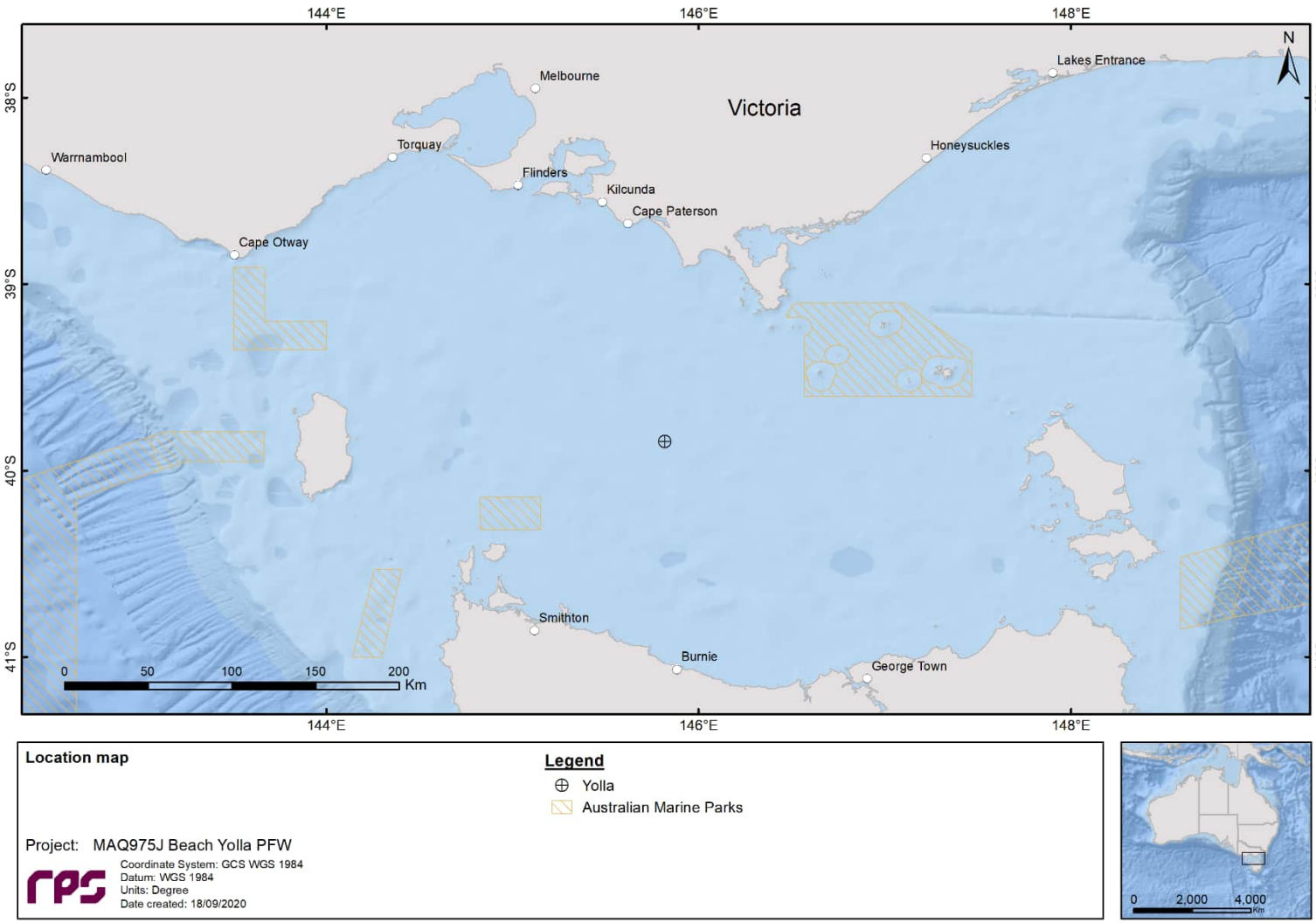


Figure 1.1 Map showing the location of the Yolla Platform used as the release location for the produced formation water dispersion modelling study.

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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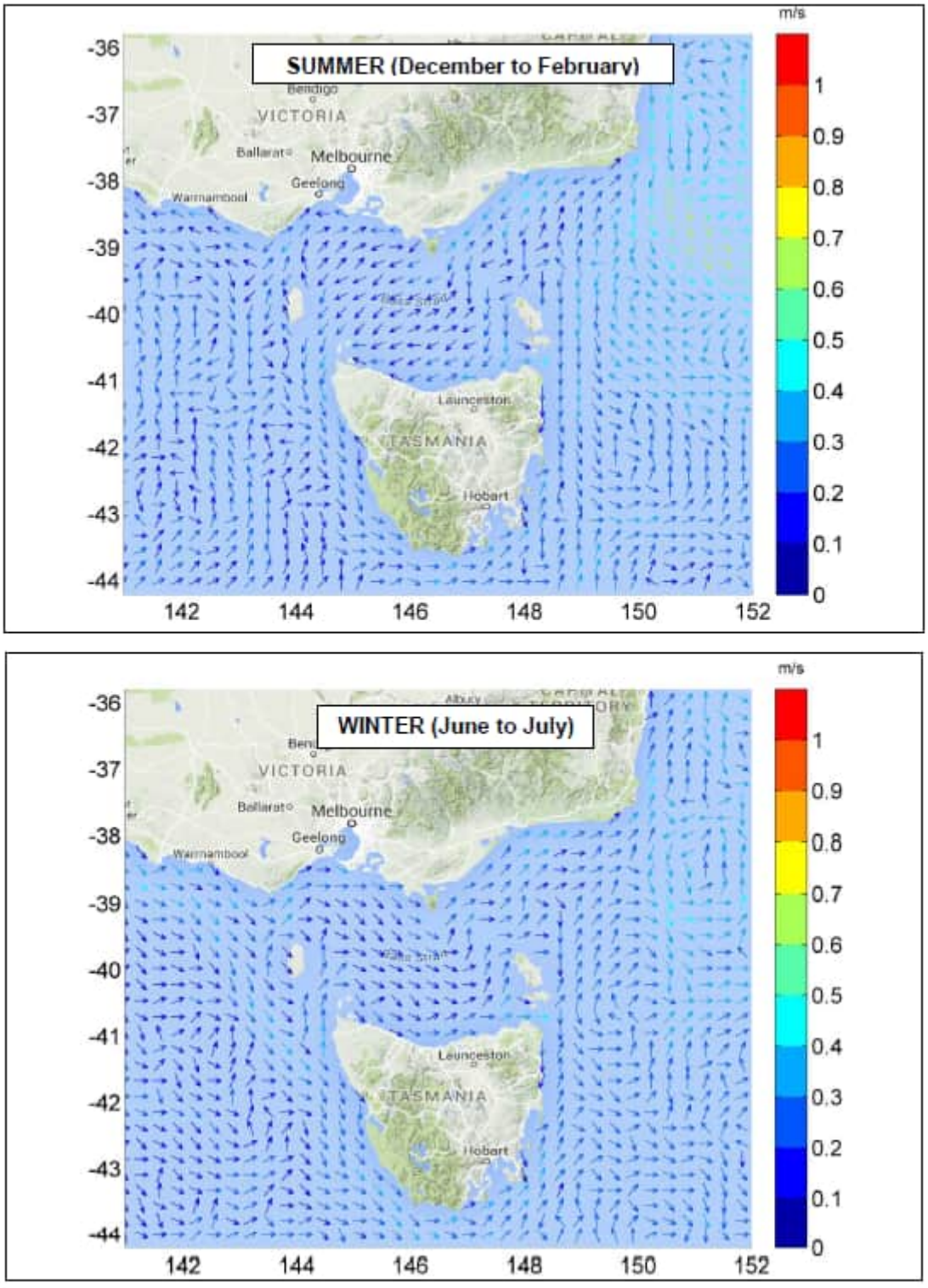


Figure 3.1 Example HYCOM averaged seasonal surface drift currents during summer and winter.

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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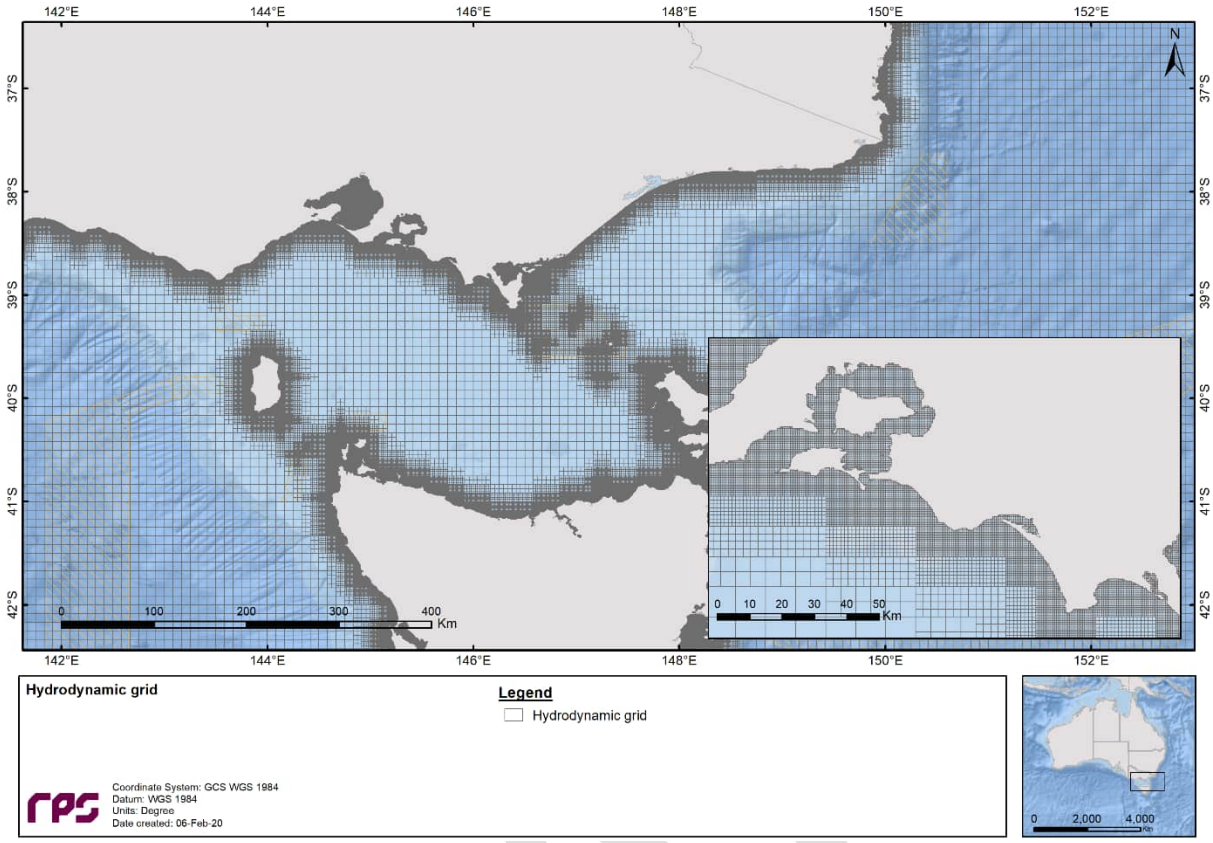


Figure 3.2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

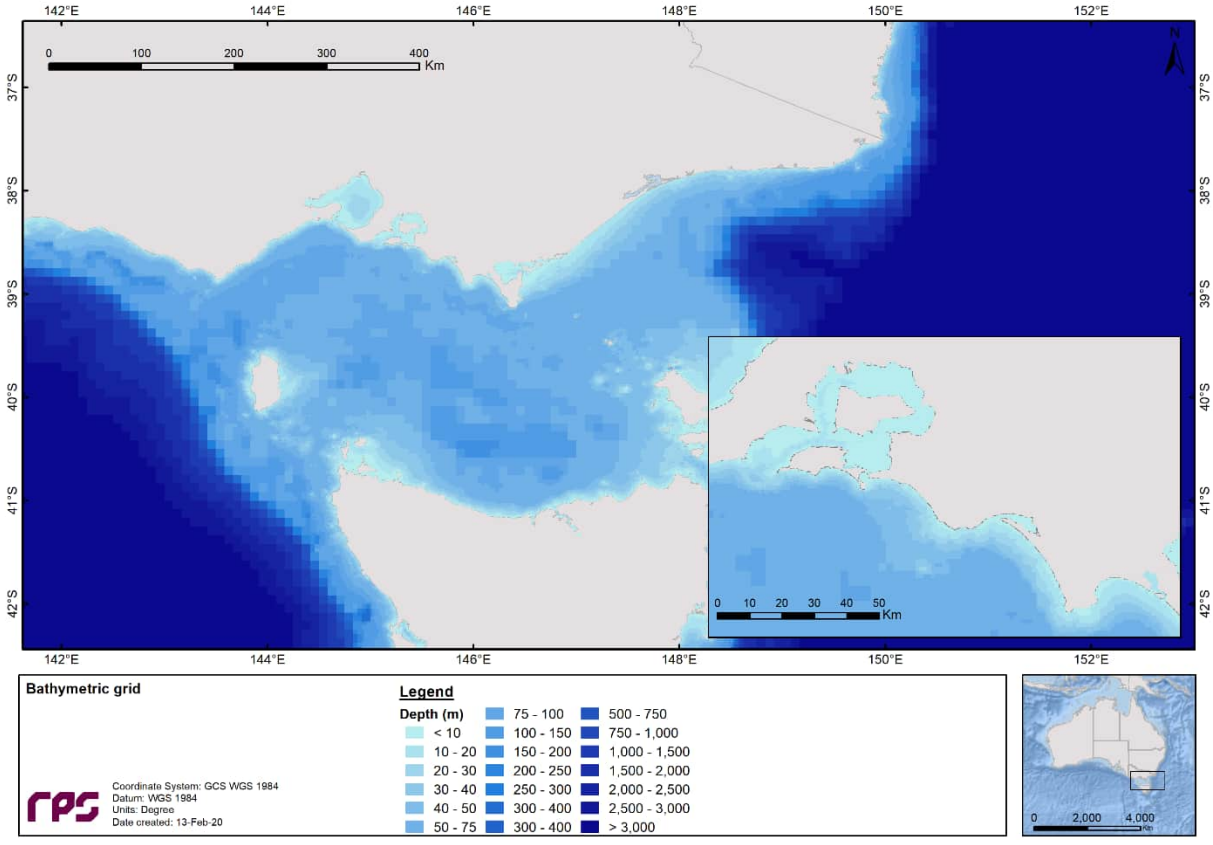


Figure 3.3 Bathymetry defined throughout the tidal model domain.

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

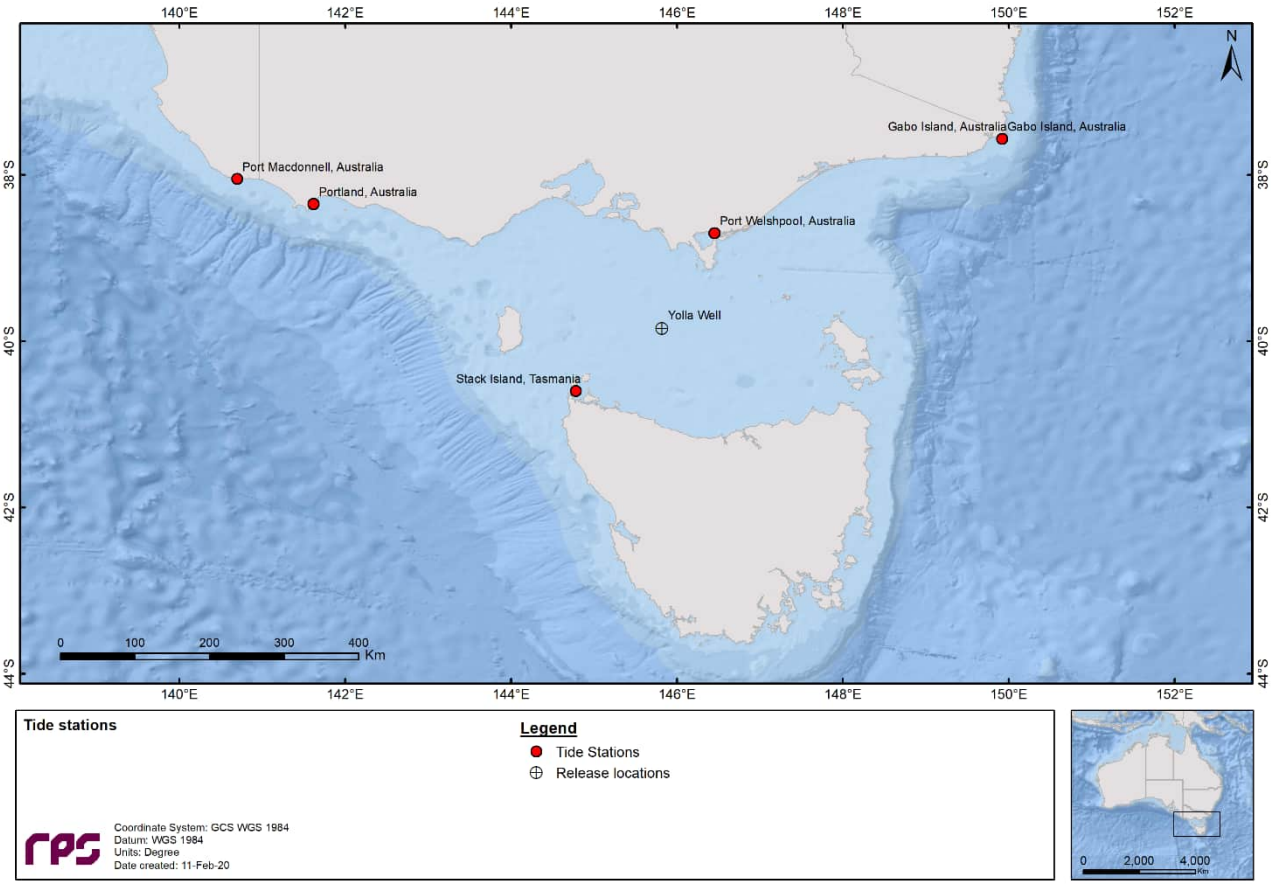


Figure 3.4 Location of the tide stations used in the surface elevation validation.

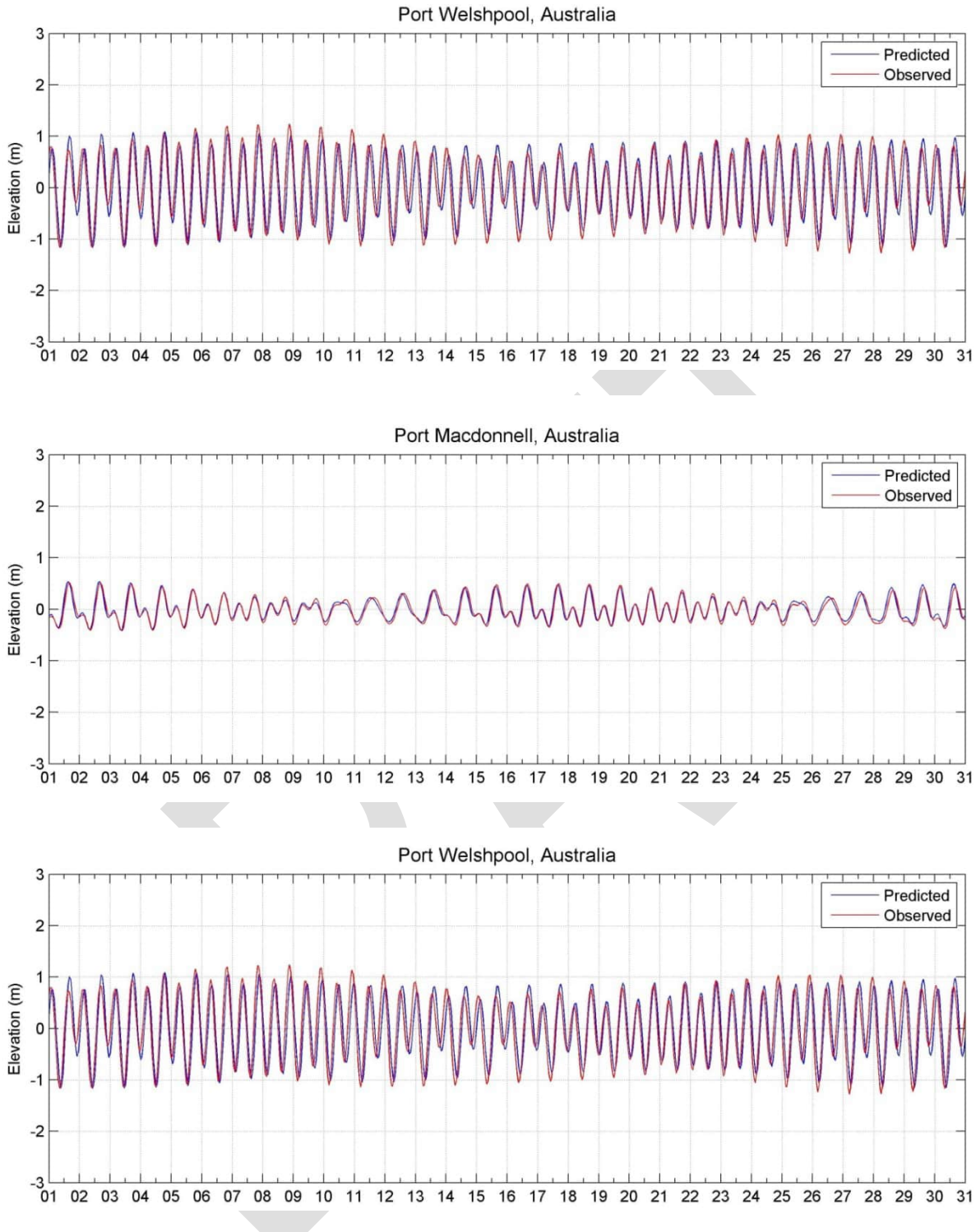


Figure 3.5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).

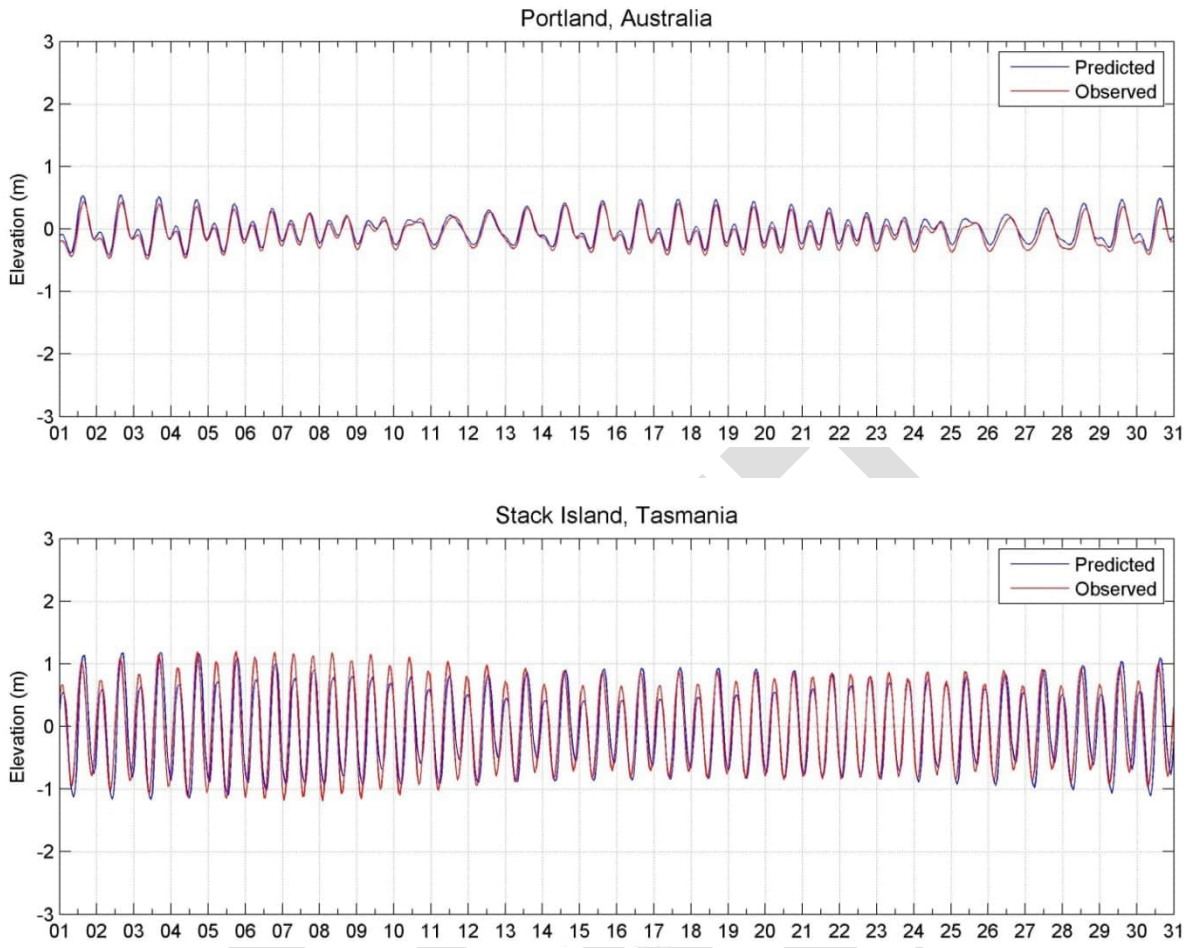


Figure 3.6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).

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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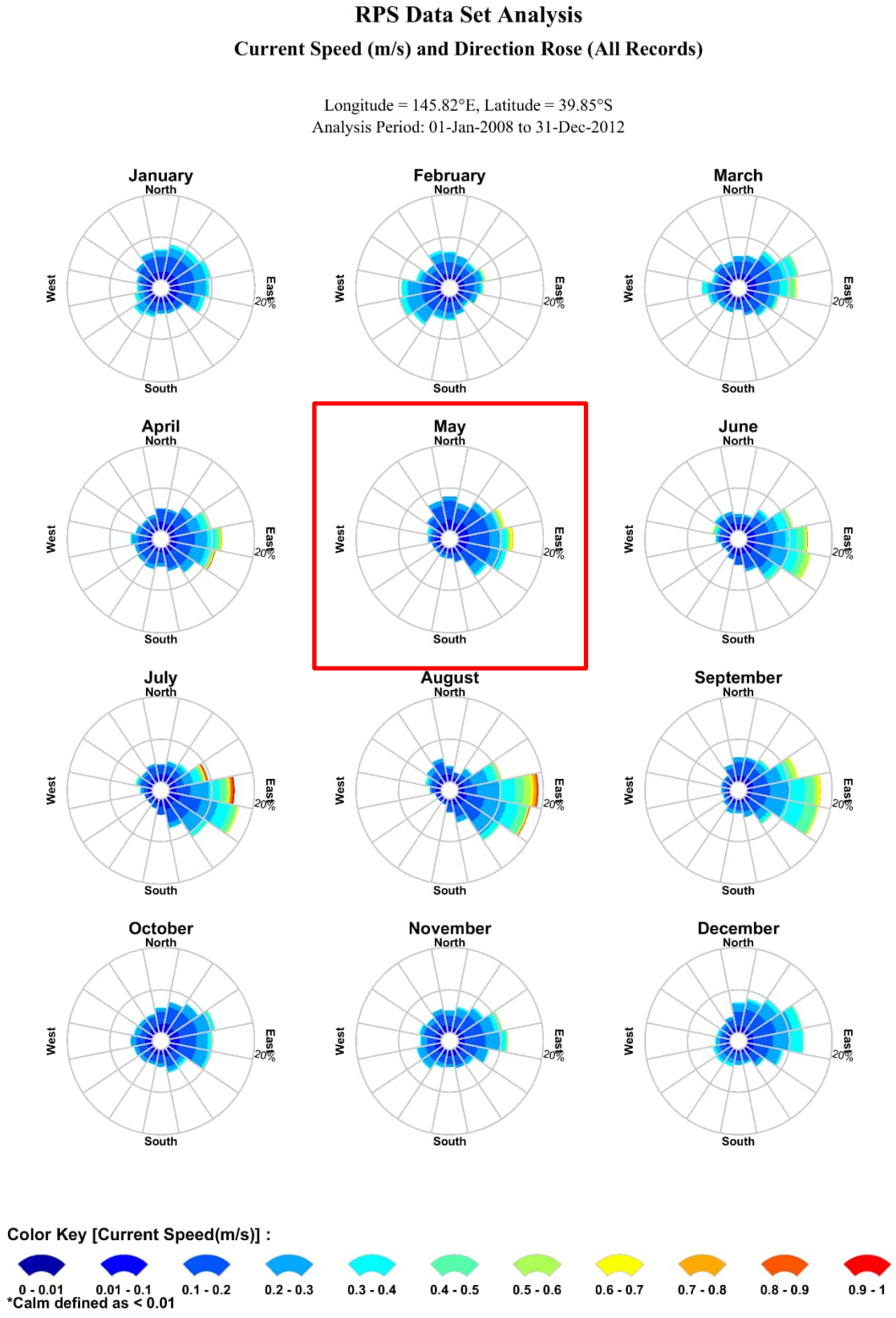


Figure 3.7 Monthly surface current rose plots nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The month of May used as model input for the far-field dispersion modelling is indicated for ease of reference

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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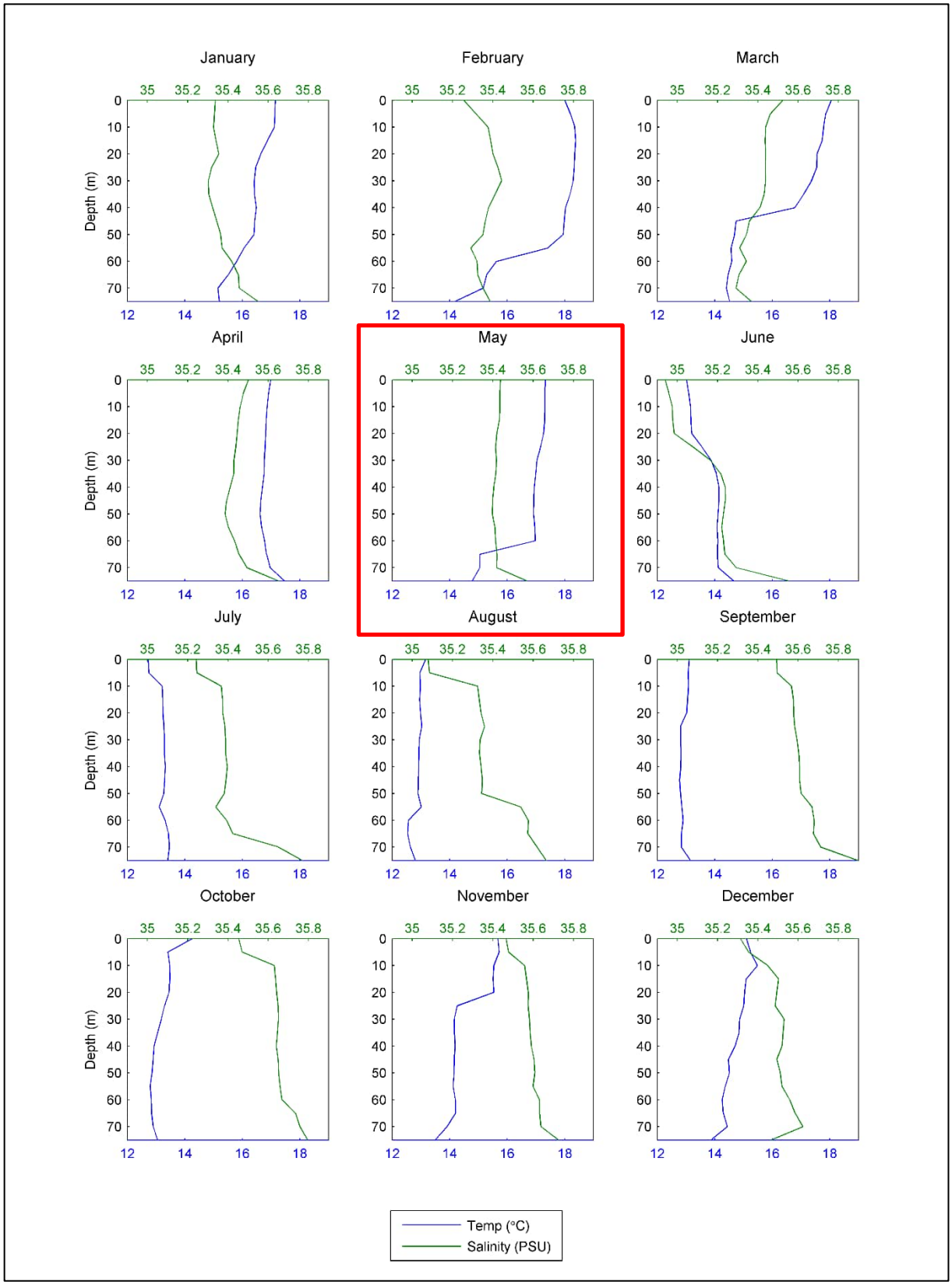


Figure 4.1 Temperature and salinity profiles nearby the release location. May conditions were used as the model input.

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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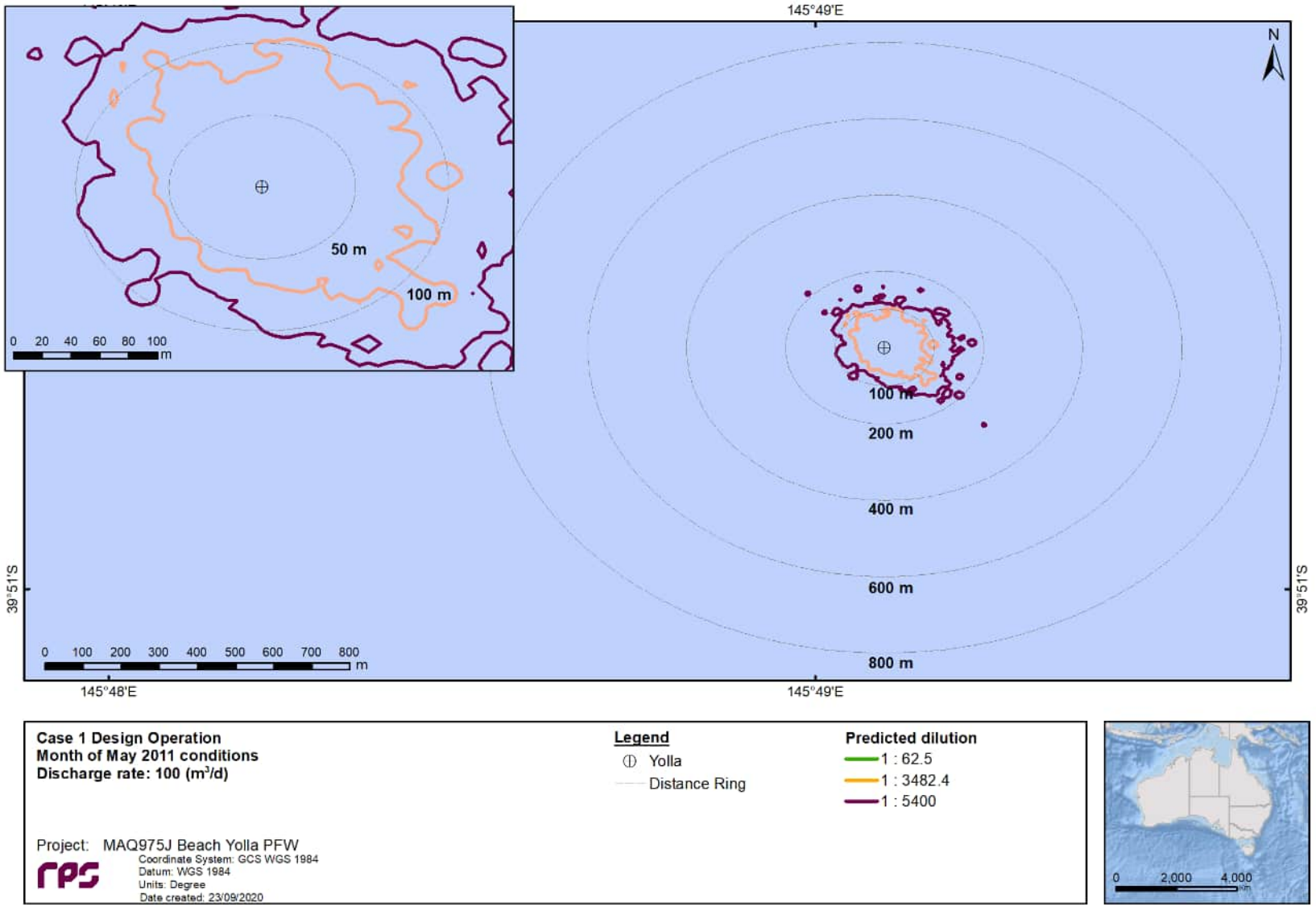


Figure 7.1 Predicted zones of dilution for the whole PW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 100 m^3/day over 31-days during May conditions representing design operation (Case 1).

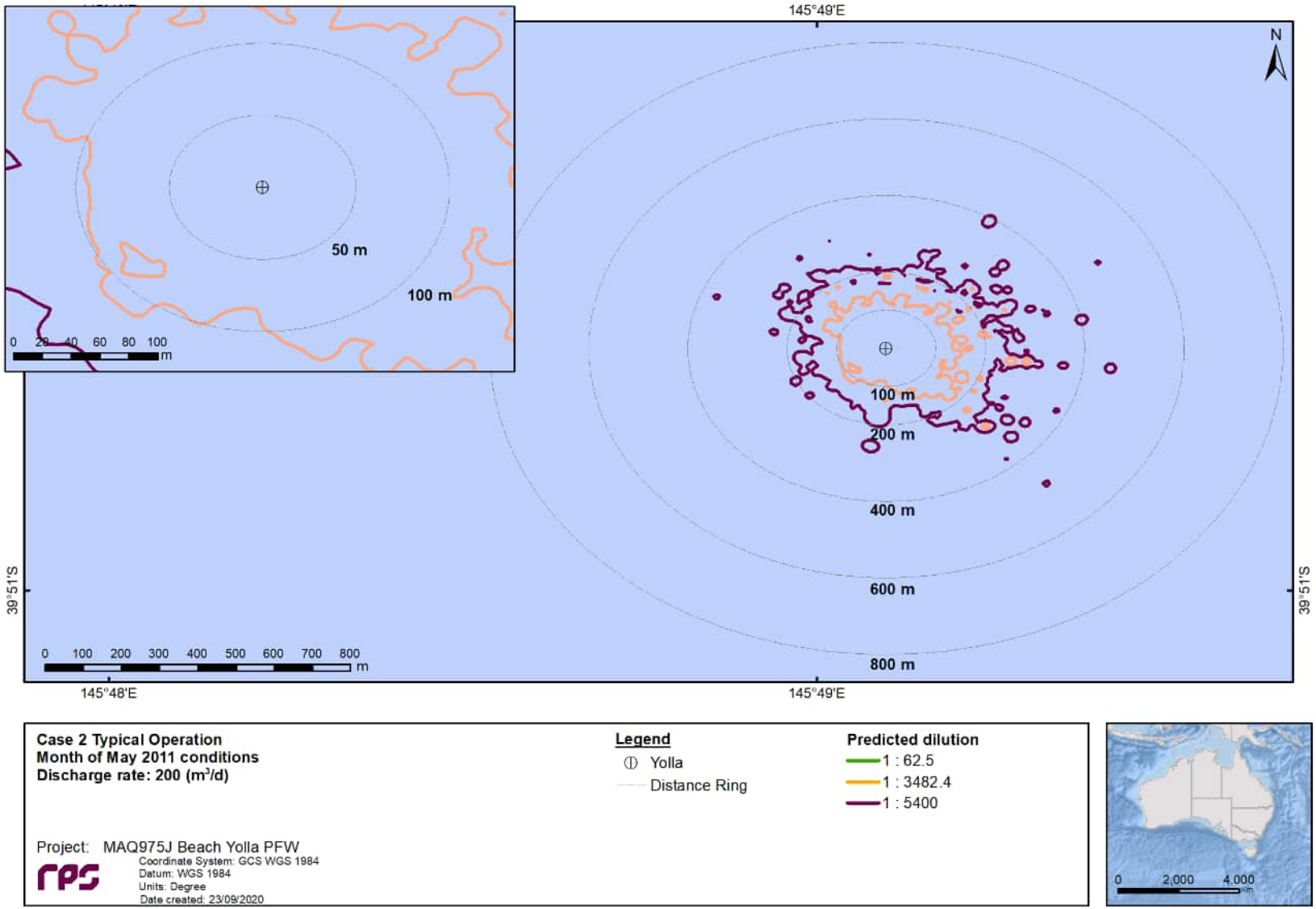


Figure 7.2 Predicted zones of dilution for the whole PFW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 200 m^3/day over 31-days during May conditions representing typical operation (Case2).

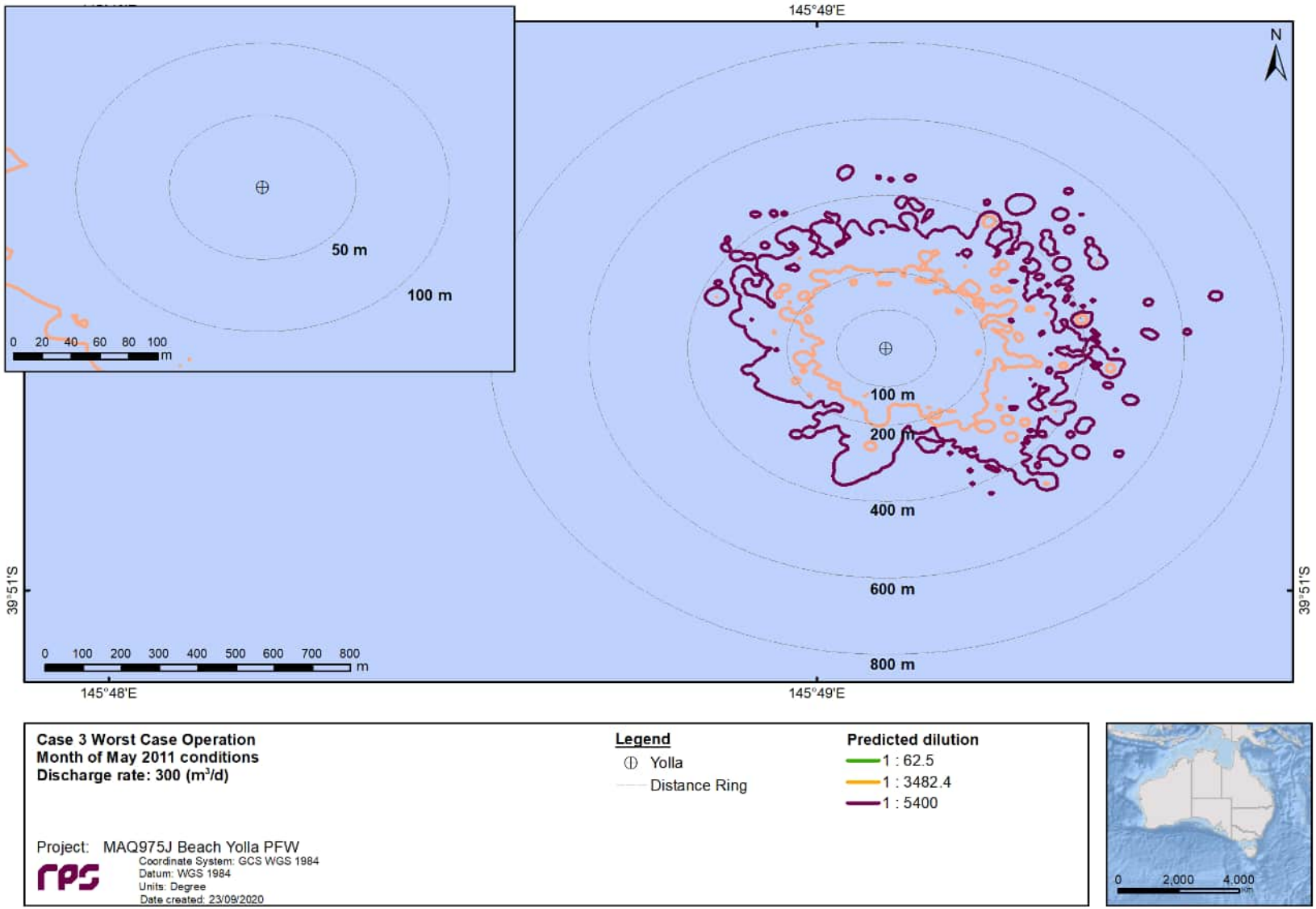


Figure 7.3 Predicted zones of dilution for the whole PFW stream up to a 1:5,400 dilution. Modelling based on a flow rate of 300 m^3/day over 31-days during May conditions representing worst case operation (Case 3).

8.0 REFERENCES

Becker, JJ, Sandwell, DT, Smith, WHF, Braud, J, Binder, B, Depner, J, Fabre, D, Factor, J, Ingalls, S, Kim, S-H, Ladner, R, Marks, K, Nelson, S, Pharaoh, A, Trimmer, R, Von Rosenberg, J, Wallace, G & Weatherall, P 2009, 'Global bathymetry and evaluation data at 30 arc seconds resolution: SRTM30_PLUS', *Marine Geodesy*, vol. 32, no. 4, pp. 355–371.

Brandsma, MG & Sauer Jr, TC 1983a, 'The OOC Model: Prediction of Short Term fate of Drilling fluid in the Ocean. Part 1: Model Description', *Proceedings of MMS Workshop on An Evaluation of Effluent Dispersion and Fate Models for OCS Platforms*, Minerals Management Service, Santa Barbara, California, pp. 58–84.

Brandsma, MG & Sauer Jr, TC 1983b, 'The OOC Model: Prediction of Short Term fate of Drilling fluid in the Ocean. Part 2: Model Results', *Proceedings of MMS Workshop on An Evaluation of Effluent Dispersion and Fate Models for OCS Platforms*, Minerals Management Service, Santa Barbara, California, pp. 86-106.

Burns, K., Codi, S., Furnas, M., Heggie, D., Holdway, D., King, B. and McAllister, F 1999, 'Dispersion and Fate of Produced Formation Water Constituents in an Australian Northwest Shelf Shallow Water Ecosystem'. *Marine Pollution Bulletin*, vol. 38, no. 7, pp. 593–603.

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R, Bleck, R 2007, 'The HYCOM (Hybrid Coordinate Ocean Model) data assimilative system'. *Journal of Marine Systems*, vol. 65, no. 1, pp. 60–83.

Chassignet, E, Hurlburt, H, Metzger, E, Smedstad, O, Cummings, J, Halliwell, G 2009, 'U.S. GODAE: Global Ocean Prediction with the HYbrid Coordinate Ocean Model (HYCOM)'. *Oceanography*, vol. 22, no. 2, pp. 64–75.

Davies, AM 1977a, The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile. In: Nihoul, J.C. (ed). Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 1–25.

Davies, AM 1977b, Three-dimensional model with depth-varying eddy viscosity. In: Nihoul, J.C. (ed), Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 27–48.

Gordon, R 1982, Wind driven circulation in Narragansett Bay, PhD thesis. Department of Ocean Engineering, University of Rhode Island.

Isaji, T, Spaulding, M 1984, 'A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank'. *Journal of Physical Oceanography*, vol. 14, no. 6, pp. 1119–1126.

Isaji, T, Howlett, E, Dalton C, Anderson, E 2001, 'Stepwise-continuous-variable-rectangular grid hydrodynamics model', Proceedings of the 24th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar (including 18th TSOCS and 3rd PHYTO). Environment Canada, Edmonton, pp. 597–610.

Jones, IS 1980, 'Tidal and wind-driven currents in Bass Strait', *Marine and Freshwater Research*, vol. 31, no. 2, pp. 109–117.

DRAFT

Khondaker, AN 2000, 'Modeling the fate of drilling waste in marine environment – an overview', *Journal of Computers and Geosciences*, vol. 26, no. 5, pp. 531–540.

King, B, McAllister, FA 1997, The Application of MUDMAP to Investigate the Dilution and Mixing of the Above Water Discharge at the 'Harriet A' Petroleum Platform on the Northwest Shelf. In: Modelling the Dispersion of Produced Water Discharge in Australia, Canberra, Australian Capital Territory.

King, B McAllister, FA 1998, 'Modelling the dispersion of produced water discharges', *APPEA Journal*, pp. 681–691.

Koh, RCY, Chang, YC 1973, Mathematical model for barged ocean disposal of waste. United States Environmental Protection Agency, Washington.

Kostianoy, AG, Ginzburg, AI, Lebedev, SA, Frankignoulle, M, Delille, B 2003, 'Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data'. *Oceanology*, vol. 43, no. 5, pp. 632–642.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, 'The World Ocean Database', *Data Science Journal*, vol.12, no. 0, pp. WDS229–WDS234.

Ludicone, D, Santoleri, R, Marullo, S, Gerosa, P 1998, 'Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data. *Journal of Geophysical Research*, vol. 103, no. C2, pp. 2995–3011.

Middleton, JF & Bye, JAT 2007, 'A review of the shelf-slope circulation along Australia's southern shelves: Cape Leeuwin to Portland', Progress in Oceanography, vol. 75, no. 1, p. 1–41.Owen, A 1980, 'A three-dimensional model of the Bristol Channel', *Journal of Physical Oceanography*, vol. 10, no. 8, pp. 1290–1302.

Owen, A 1980 'A three-dimensional model of the Bristol Channel'. *Journal of Physical Oceanography*, vol. 10, no. 8, pp. 1290–1302.

RPS 2017, Yolla Platform – Bass Strait, Produced Water Dispersion Near-Field Modelling. Report MAQ0573J. Prepared for Lattice Energy. RPS, Gold Coast, Australia.

Sandery, PA & Kämpf, J 2007, 'Transport timescales for identifying seasonal variation in Bass Strait, south-eastern Australia', *Estuarine, Coastal and Shelf Science*, vol. 74, no. 4, pp. 684–696.

Spaulding, ML 1994, 'Drilling, production fluids dispersion predicted by model', *Offshore*, vol. 54, no. 4, pp. 78–82.

Vikebø, F, Sundby, S, Adlansvik, B, Fiksen, O 2005, 'The combined effect of transport and temperature on distribution and growth of larvae and pelagic juveniles of Arcto-Norwegian cod', *Journal of Marine Science* vol. 62, no. 7, pp. 1375–1386.

Wallcraft, A, Carroll, SN, Kelly, KA, Rushing KV 2003, Hybrid Coordinate Ocean Model (HYCOM) - version 2.1 User's Guide, Naval Research Laboratory, Washington.

Willmott, CJ 1981, 'On the validation of models', *Physical Geography*, vol. 2, no. 2, pp.184–194.

DRAFT

Willmott, CJ 1982, 'Some comments on the evaluation of model performance', *Bulletin of the American Meteorological Society*, vol. 63, no. 11, pp.1309–1313.

Willmott CJ, Ackleson SG, Davis RE, Feddema JJ, Klink, KM, Legates, DR, O'Donnell, J & Rowe, CM 1985, 'Statistics for the evaluation of model performance', *Journal of Geophysical Research*, vol. I 90, no. C5, pp. 8995–9005.

Willmott, CJ & Matsuura, K 2005, 'Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance', *Journal of Climate Research*, vol. 30, no. 1, pp. 79–82.

Yaremchuk, M, Tangdong, Q 2004, 'Seasonal variability of the large-scale currents near the coast of the Philippines'. *Journal of Physical Oceanography*, vol. 34, no., 4, pp. 844–855.

Zigic, S, Zapata, M, Isaji, T, King, B, Lemckert, C 2003, 'Modelling of Moreton Bay using an ocean/coastal circulation model'. Proceedings of the 16th Australasian Coastal and Ocean Engineering Conference, the 9th Australasian Port and Harbour Conference and the Annual New Zealand Coastal Society Conference, Institution of Engineers Australia, Auckland, paper 170.

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Appendix I

Beach Yolla Platform Produced Water Dispersion Modelling (RPS, 2025)

MAKING COMPLEX EASY

A TETRA TECH COMPANY

YOLLA PLATFORM

Produced Water Dispersion Modelling



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Rev 2	Assessed new thresholds	L. Perez		N. Benfer	23/05/2025

Approval for issue

Nathan Benfer		23 May 2025

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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

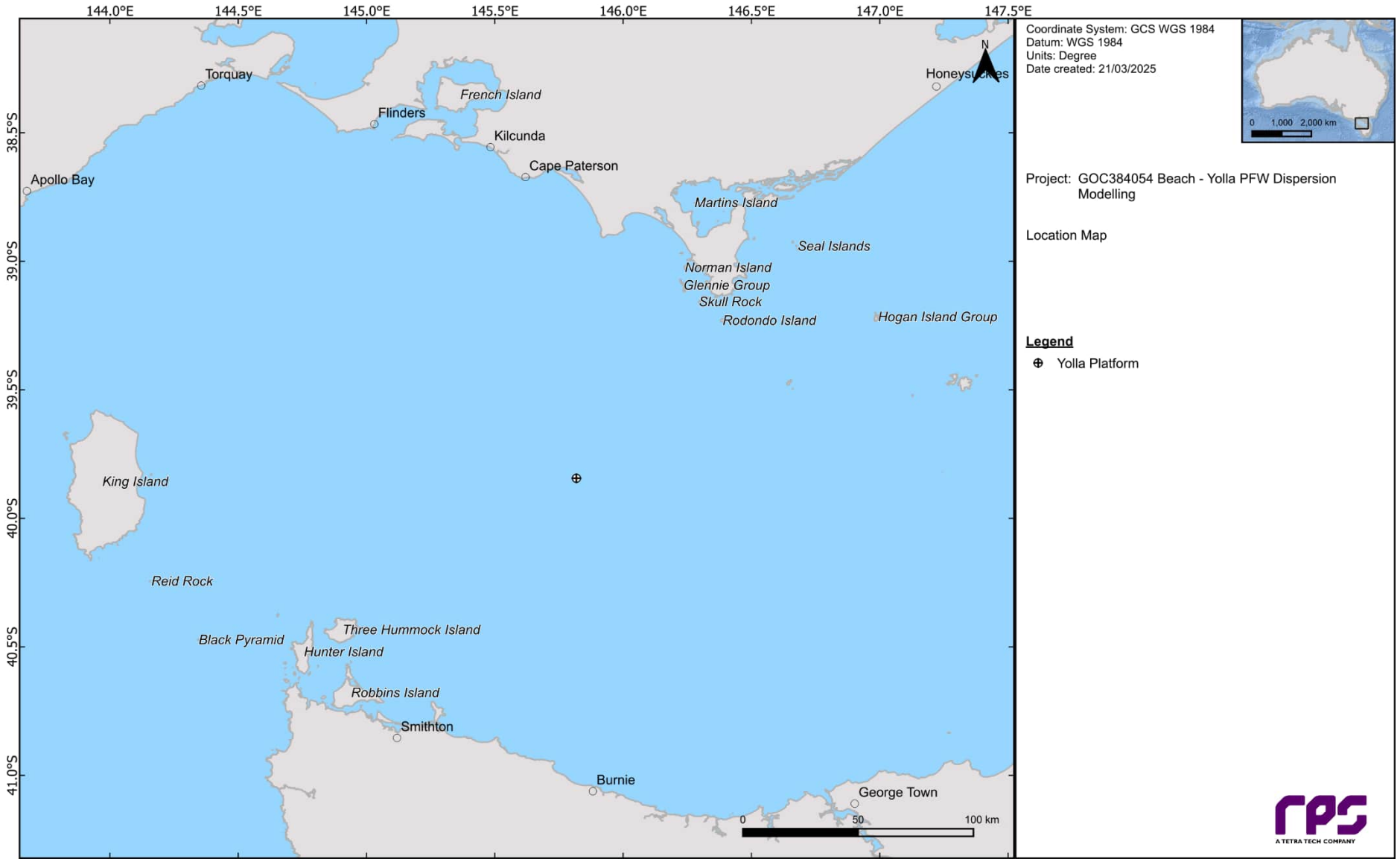


Figure 1-1 Location of the Yolla Platform.

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.

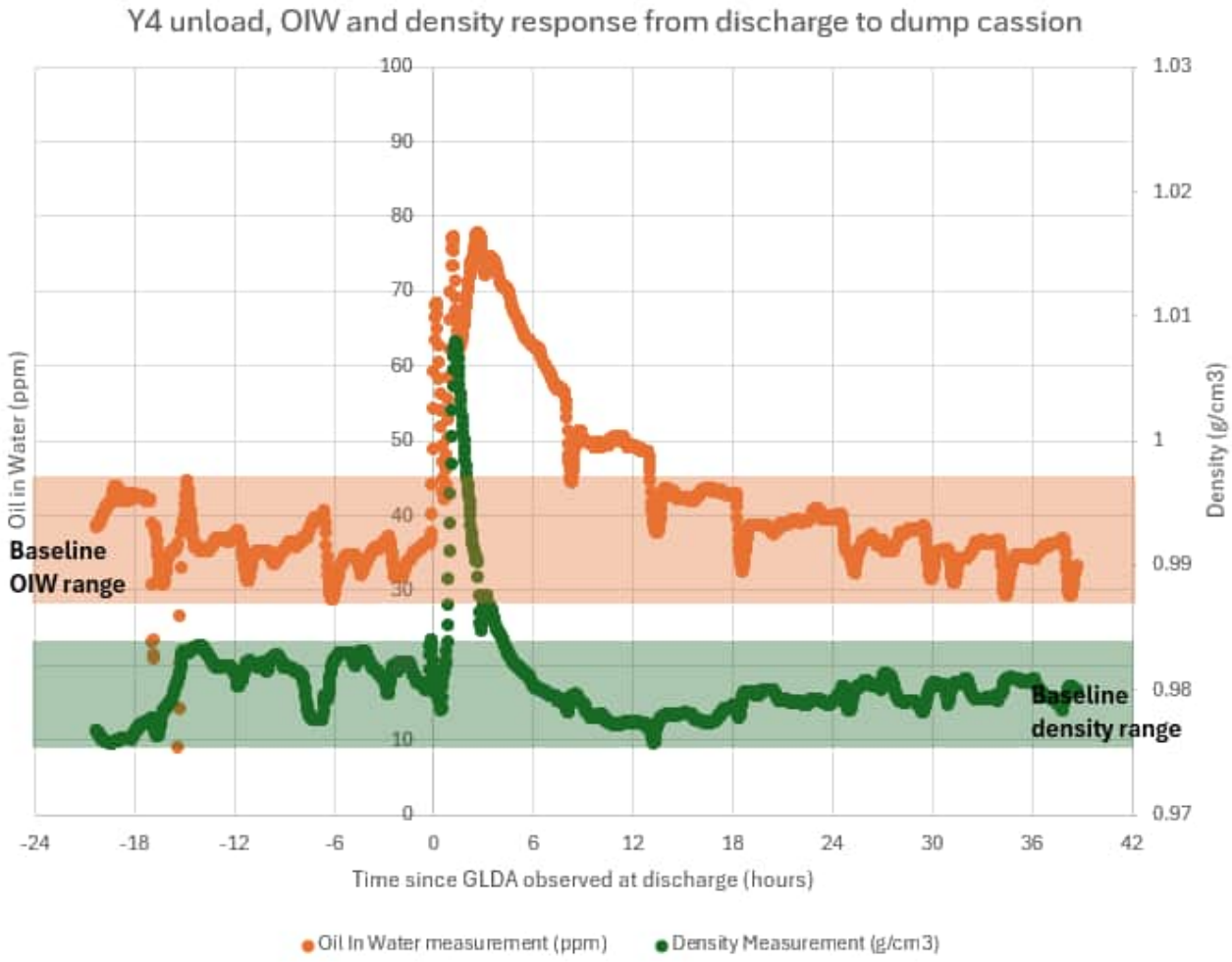


Figure 3-1 Time-series of density and oil in water measurements taken in the PFW outlet during normal and descaling activities. Image provided by Beach.

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.

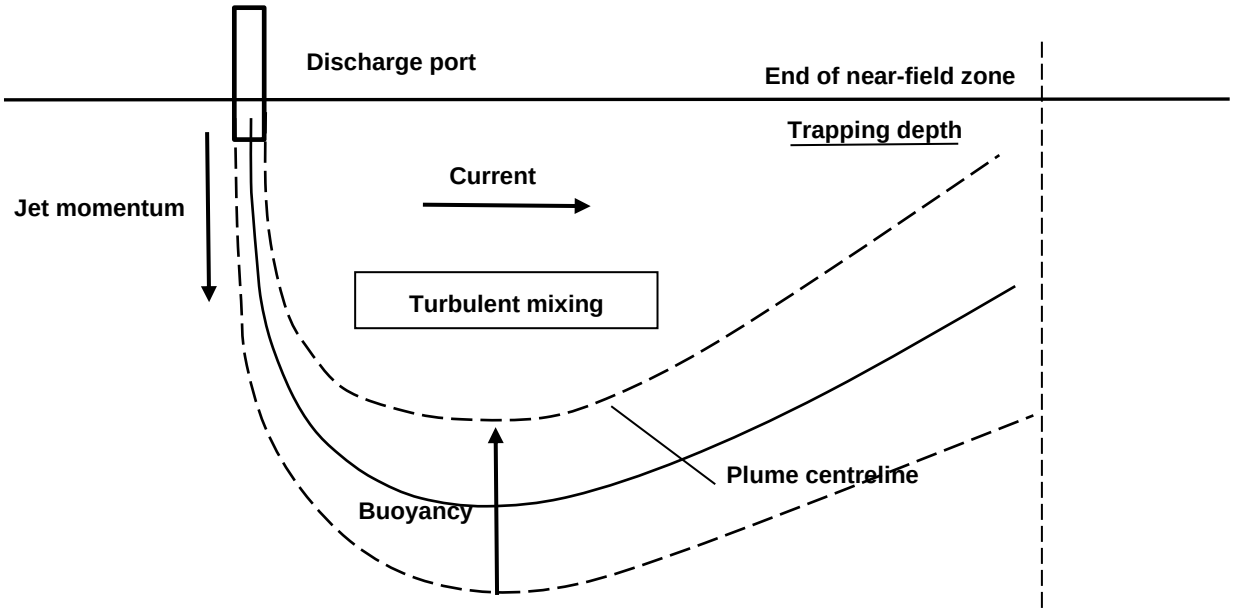


Figure 4-1 Conceptual diagram showing the general behaviour of a positively buoyant discharge discharged vertically into receiving water moving due to current.

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

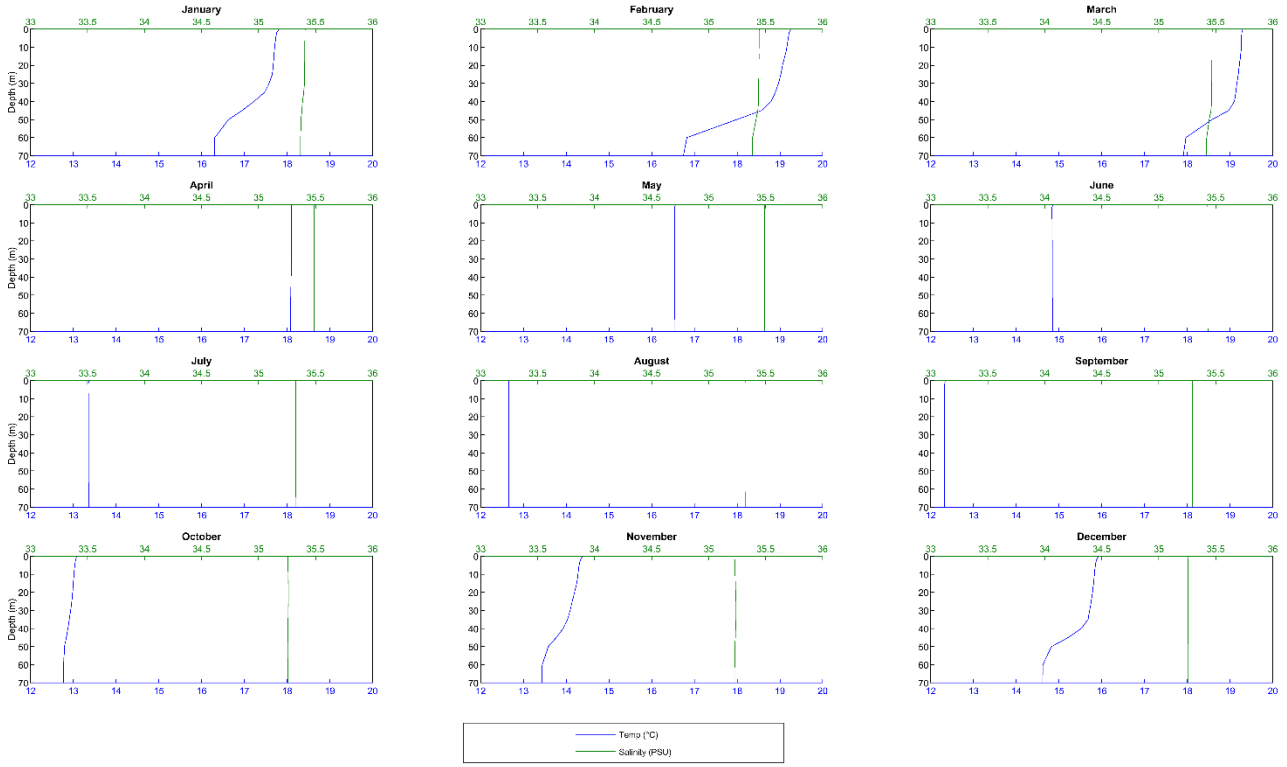


Figure 4-2 Monthly salinity and temperature profiles at the Yolla Platform

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 5th, 50th and 95th 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:

- 5th percentile current speed: weak currents, low dilution and slow advection.
- 50th percentile (median) current speed: average currents, moderate dilution and advection.
- 95th percentile current speed: strong currents, high dilution and rapid advection to nearby areas.

The 5th, 50th and 95th 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	5th Percentile (Weak) Current Speed (m/s)	50th Percentile (Medium) Current Speed (m/s)	95th 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 95th percentile dilution over time.

The 95th 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 95th 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.

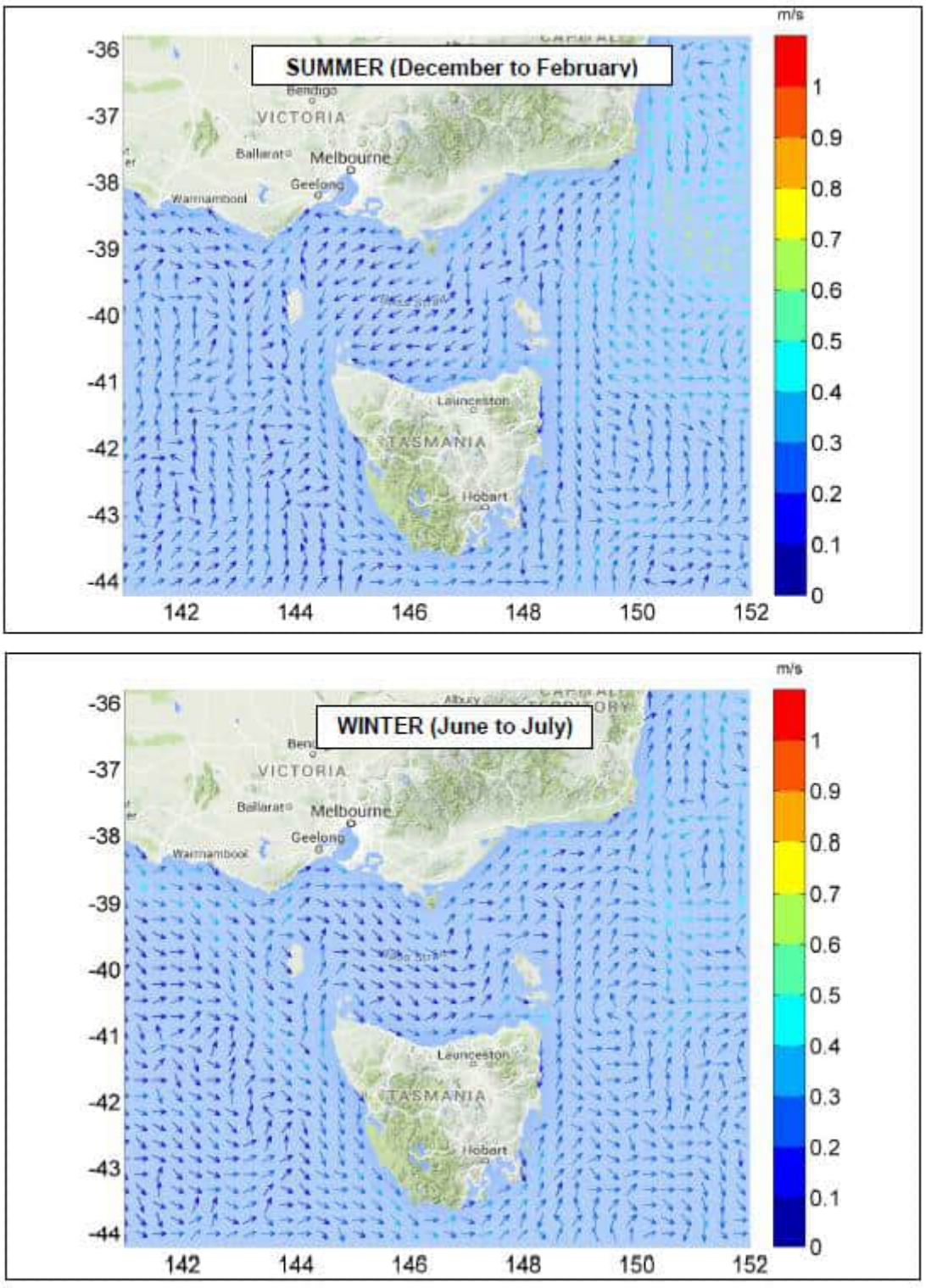


Figure 4-3 Example HYCOM averaged seasonal surface drift currents during summer (top) and winter (bottom).

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).

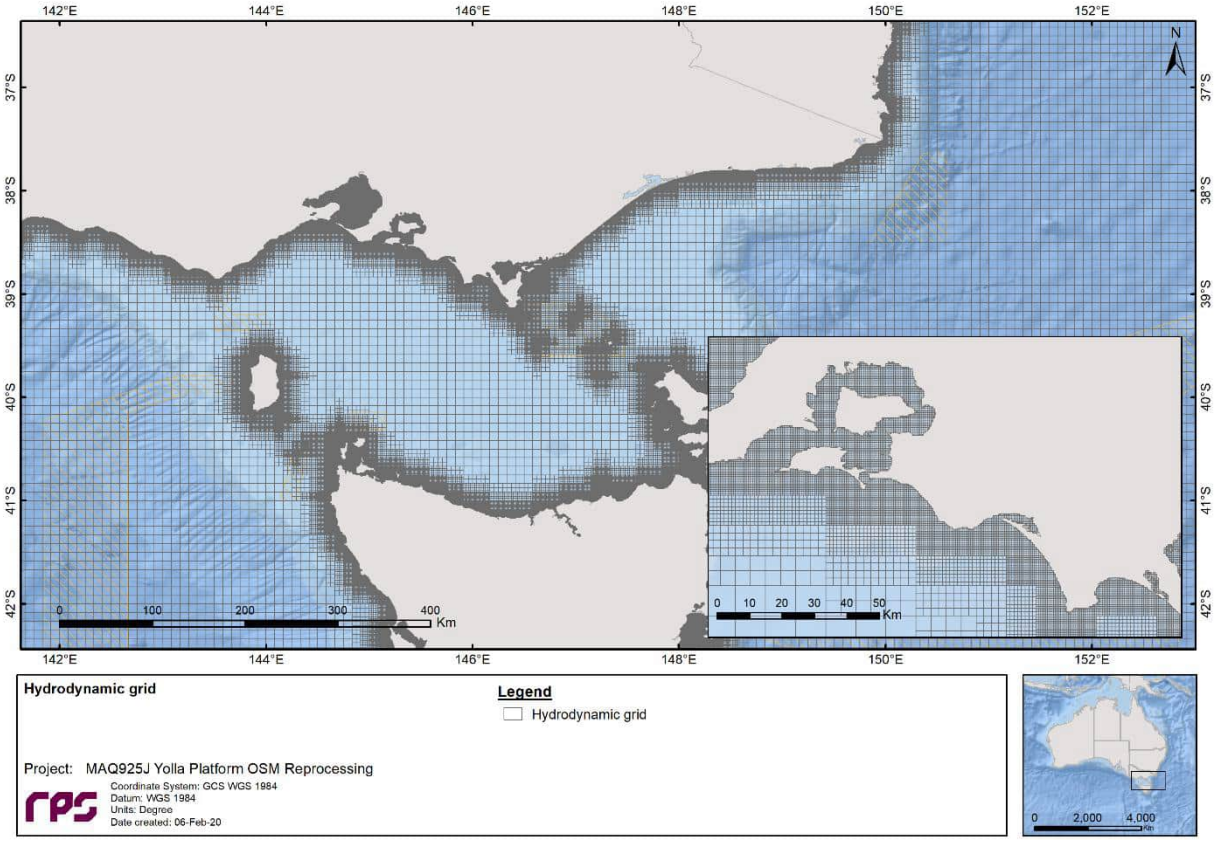


Figure 4-4 Zoomed in view of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

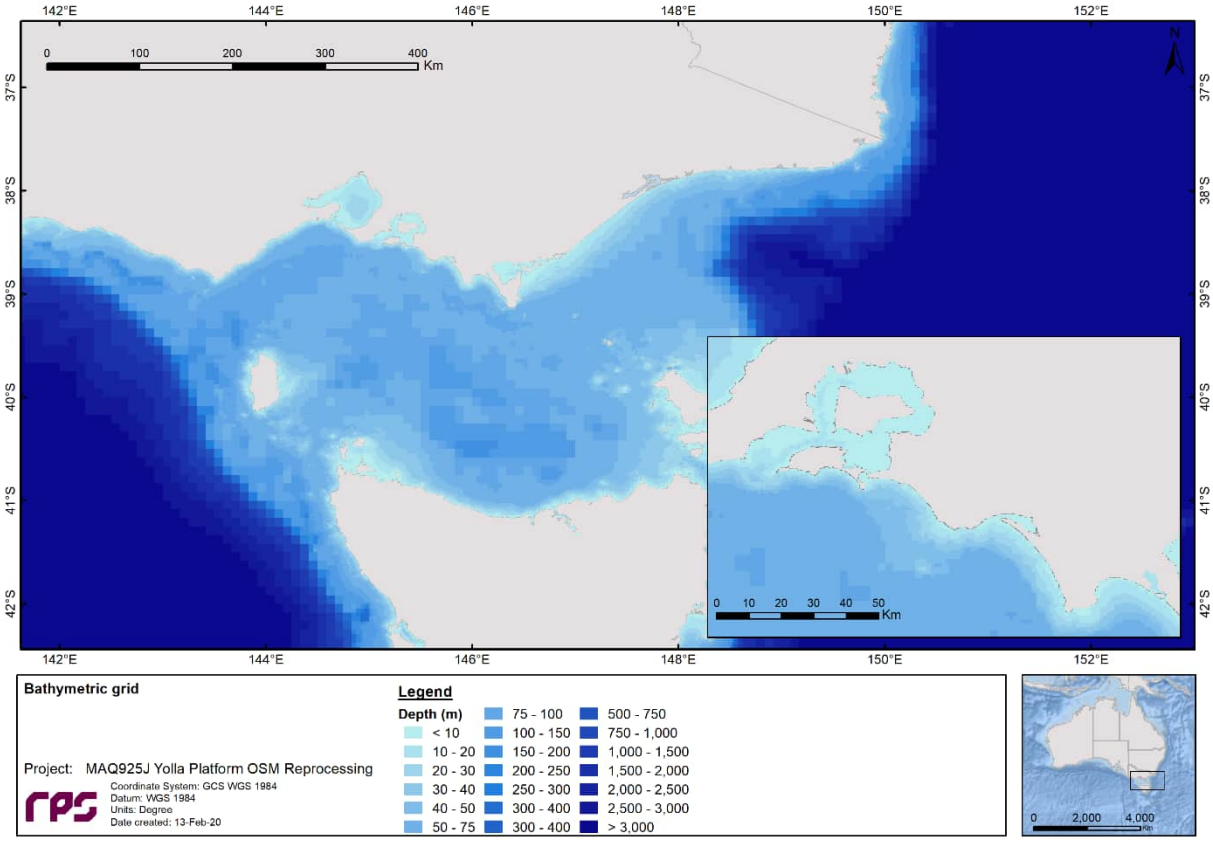


Figure 4-5 Bathymetry defined throughout the tidal model domain.

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 (1/12th 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**	-

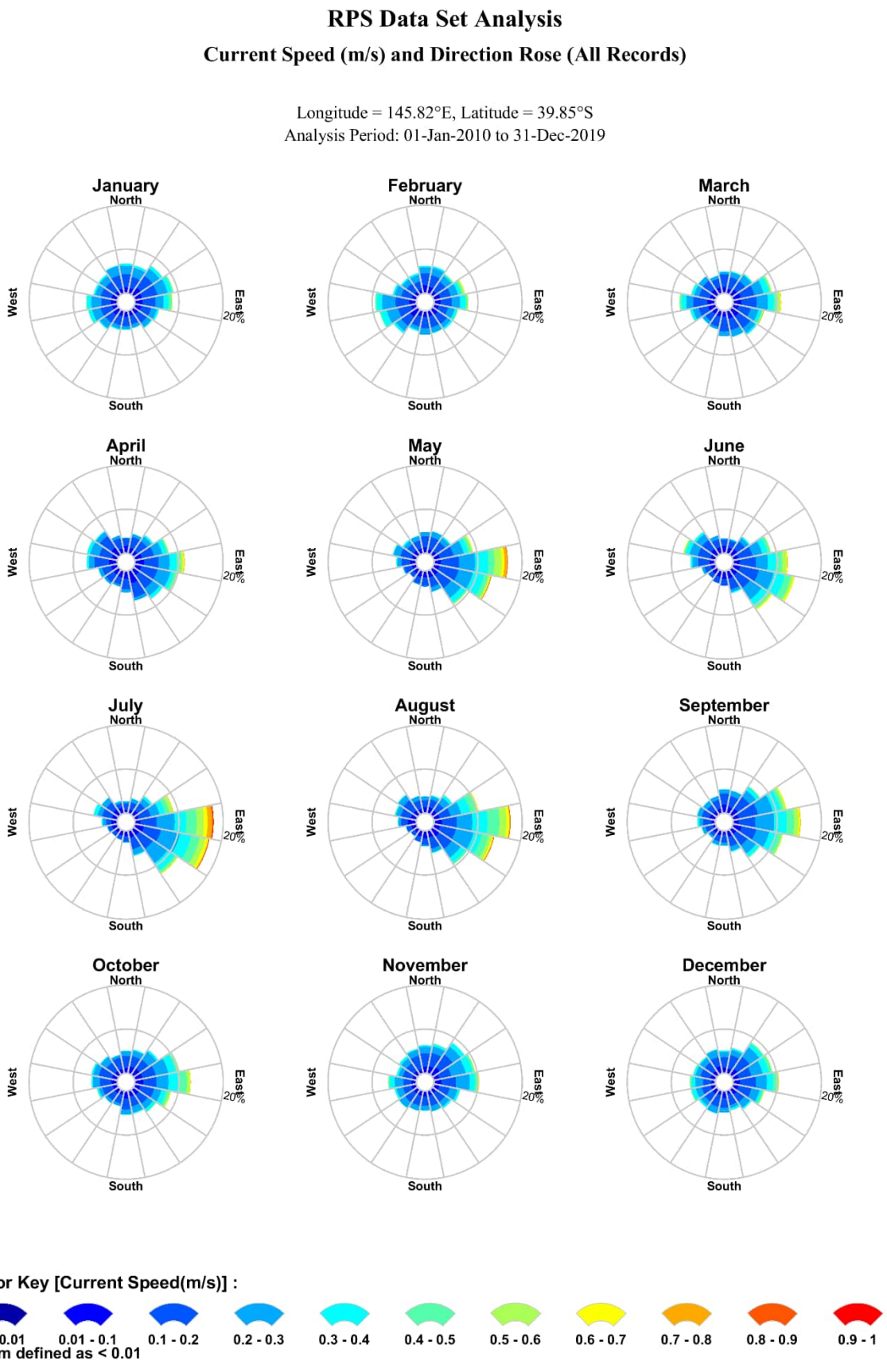


Figure 4-6 Monthly surface current rose distributions at the release location derived from the 2010 to 2019 modelled dataset.

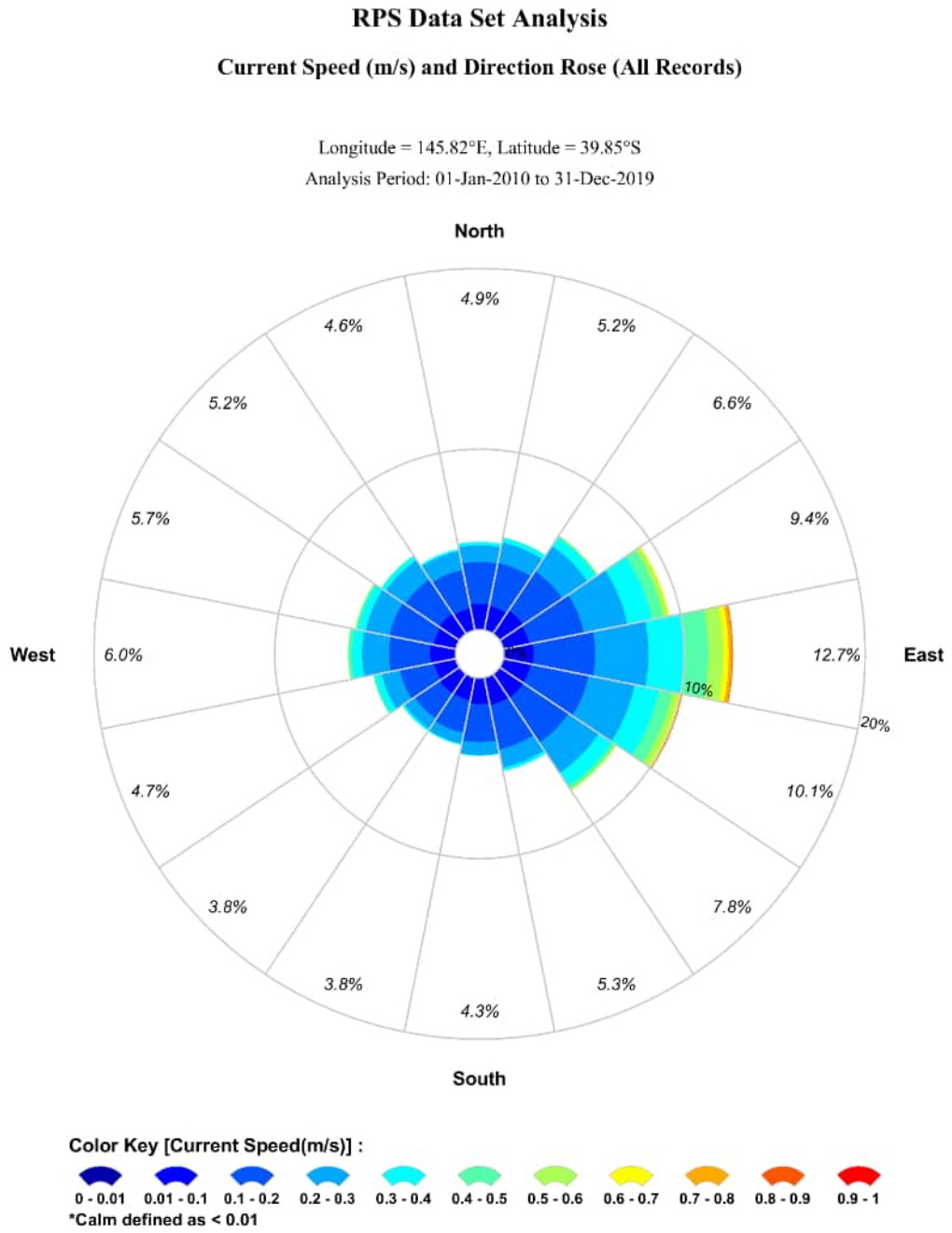


Figure 4-7 Total surface current rose plot at the release location derived from the 2010 to 2019 modelled dataset.

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

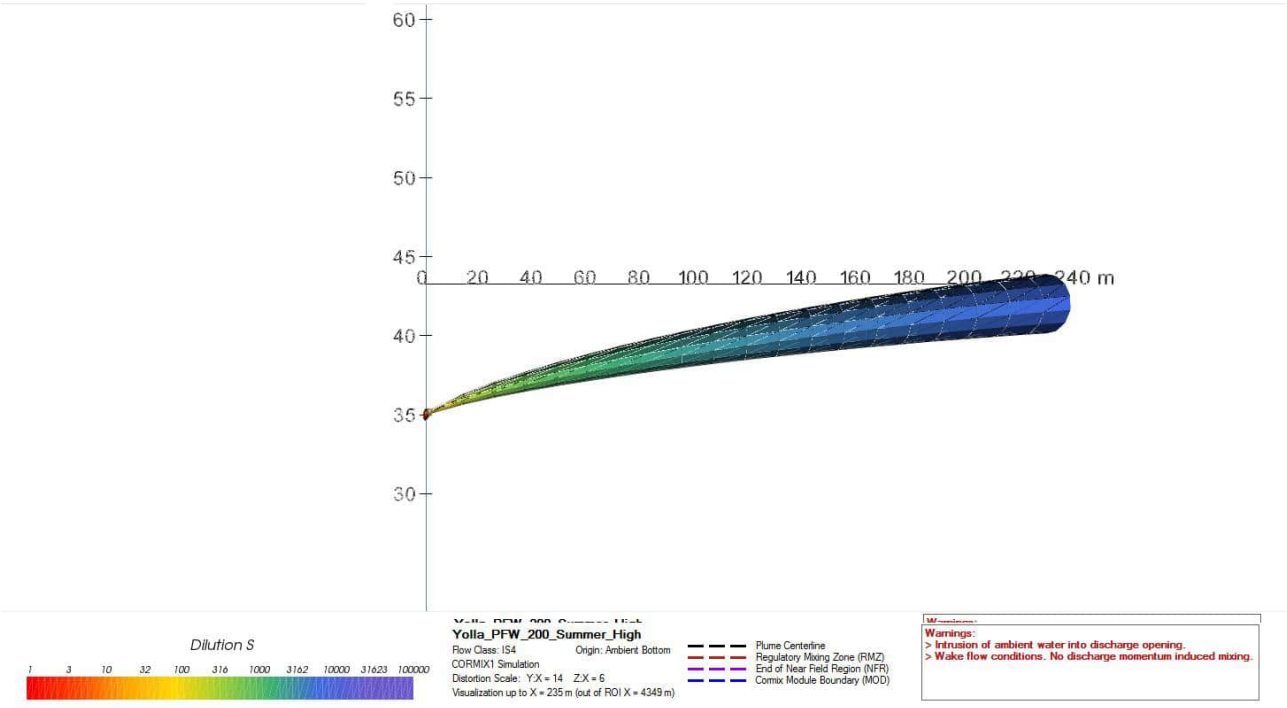


Figure 5-1 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

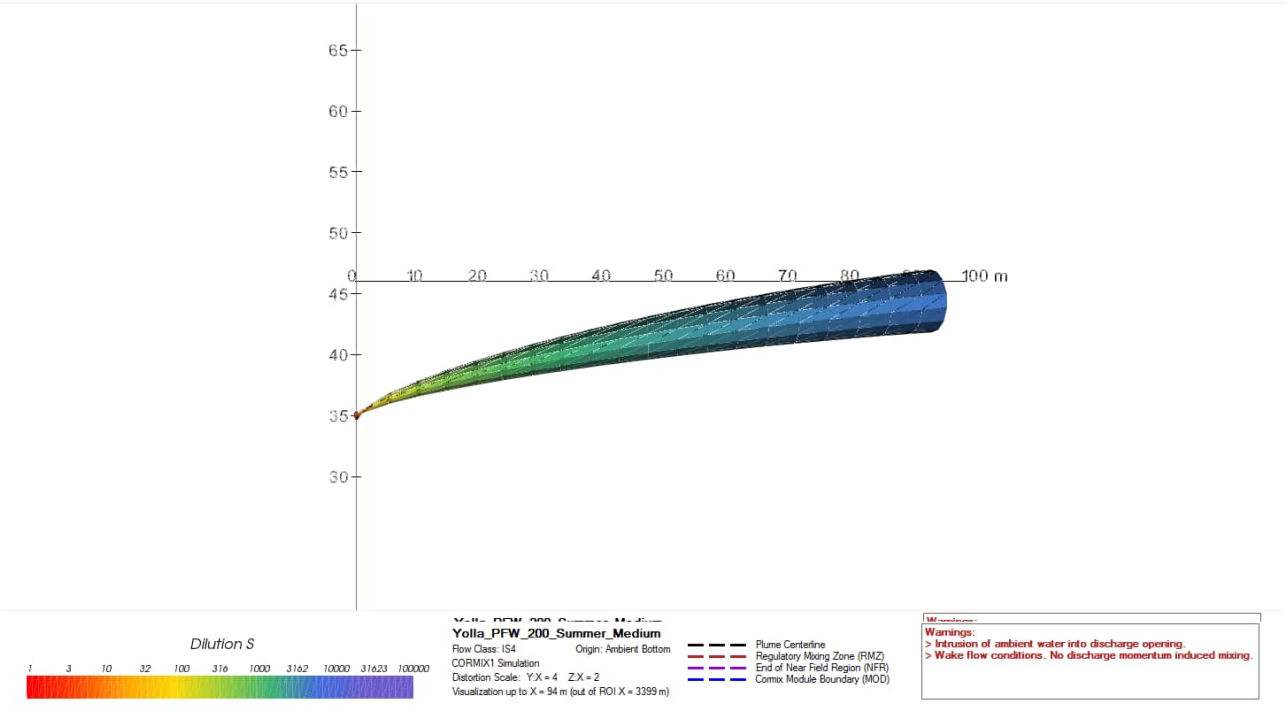


Figure 5-2 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

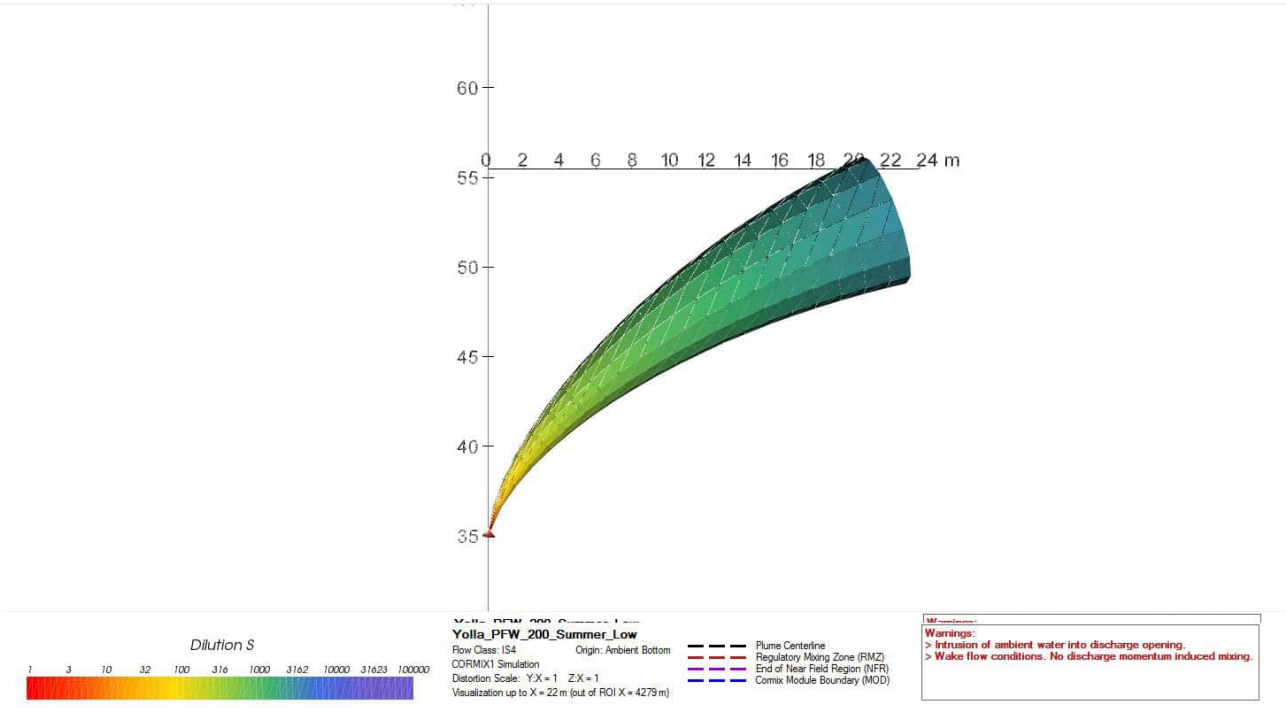


Figure 5-3 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

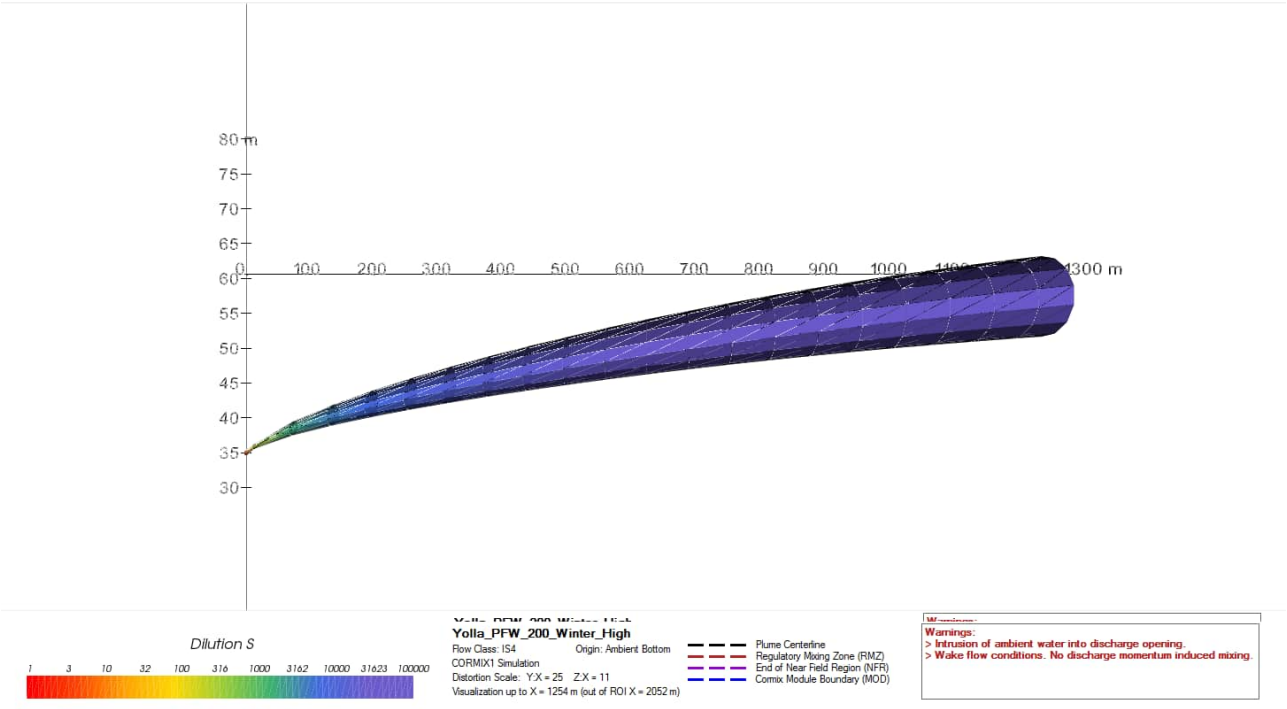


Figure 5-4 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

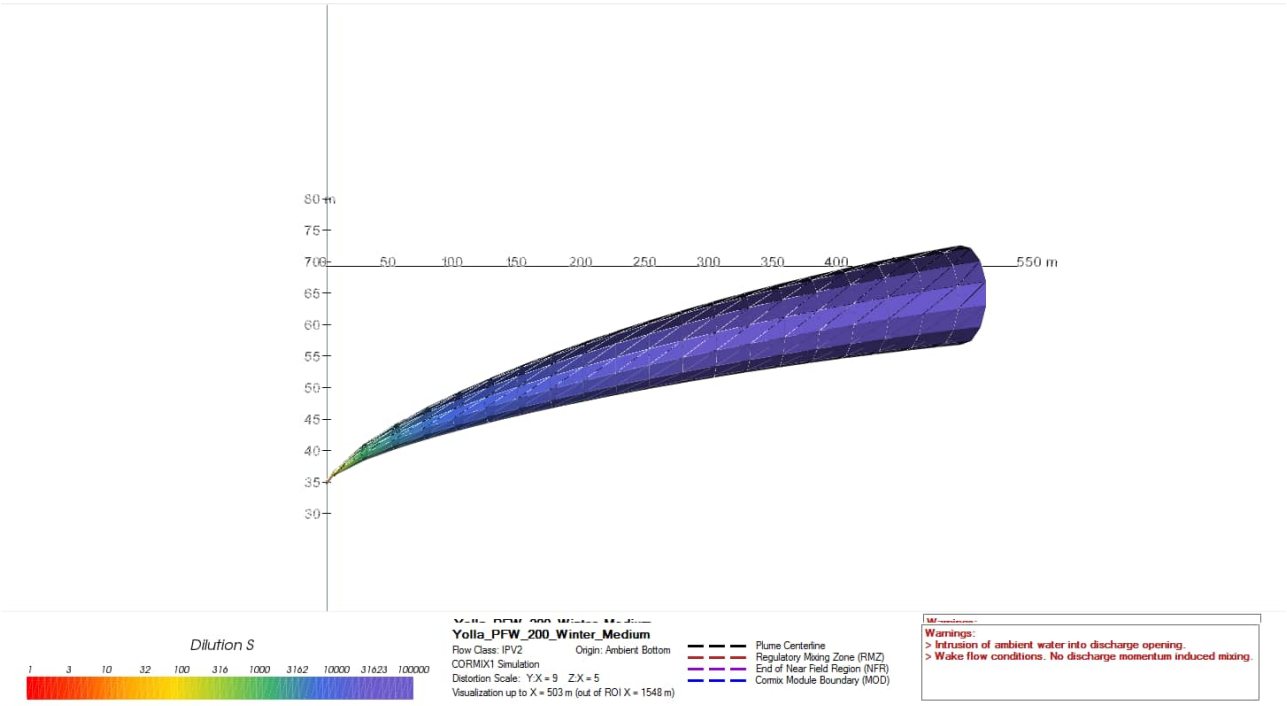


Figure 5-5 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

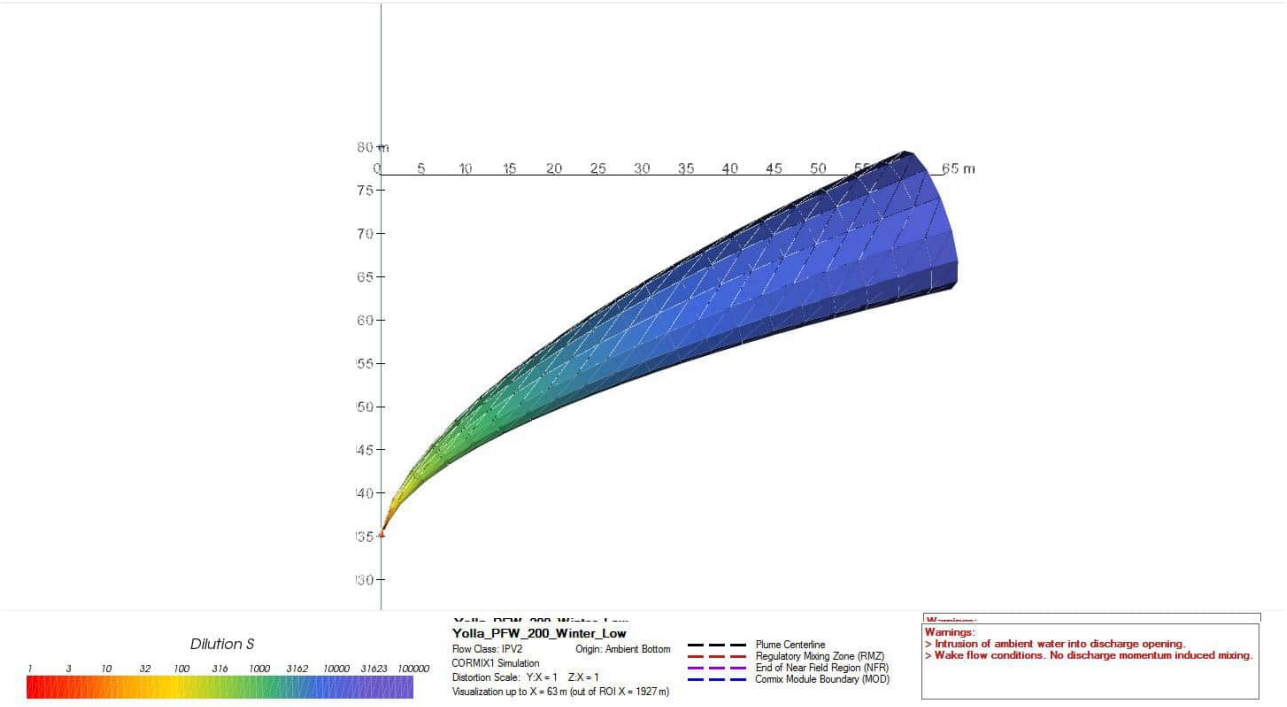


Figure 5-6 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 200 m^3/d at discharge height of 45 m below the sea surface.

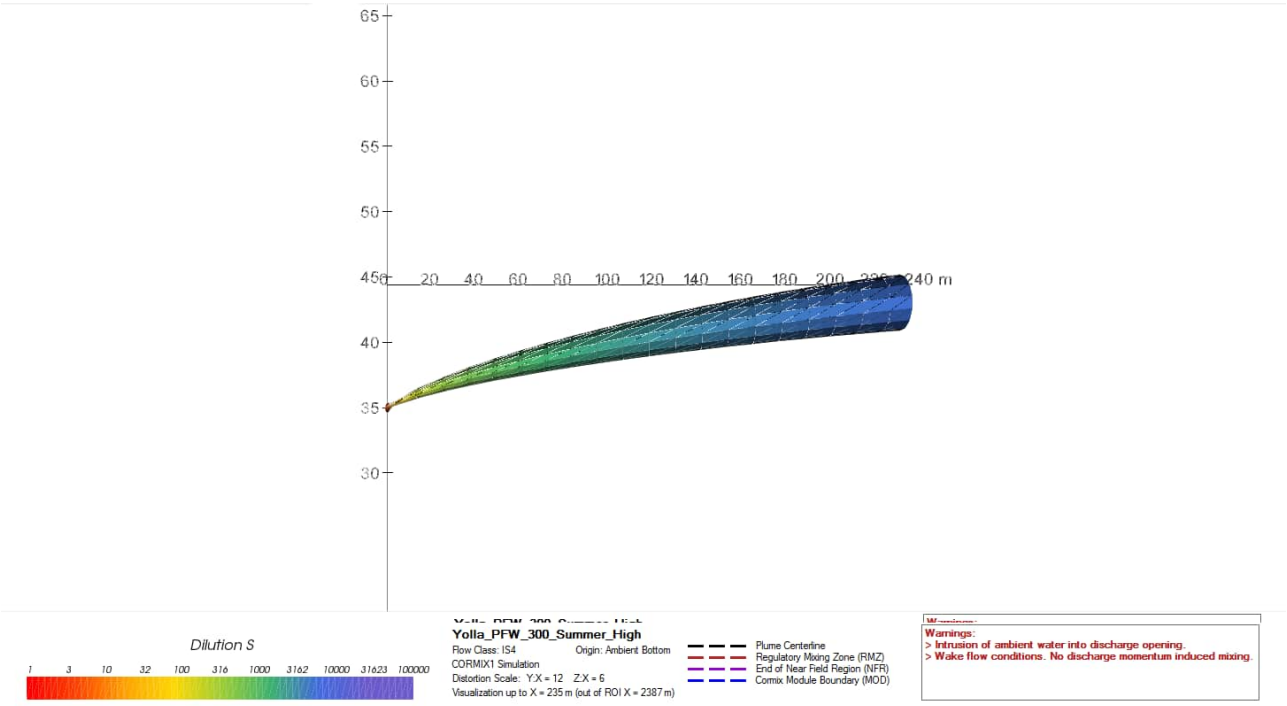


Figure 5-7 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 300 m^3/d at discharge height of 45 m below the sea surface.

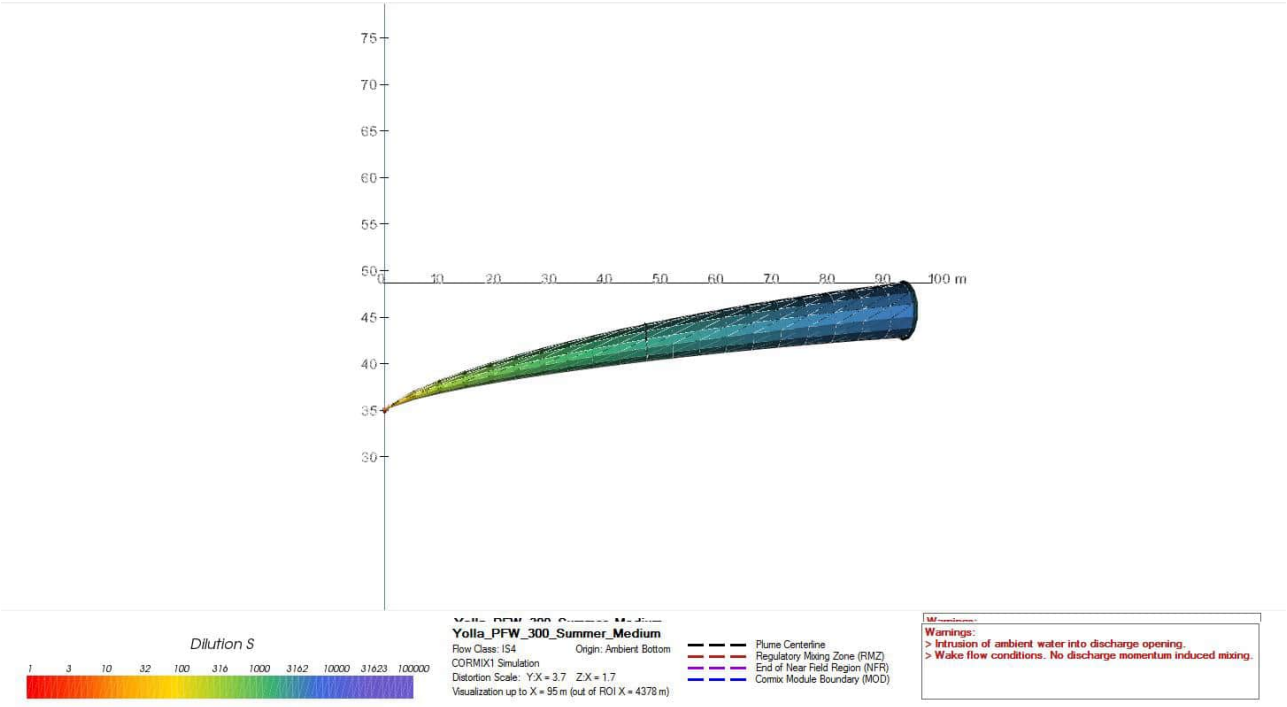


Figure 5-8 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 300 m^3/d at discharge height of 45 m below the sea surface.

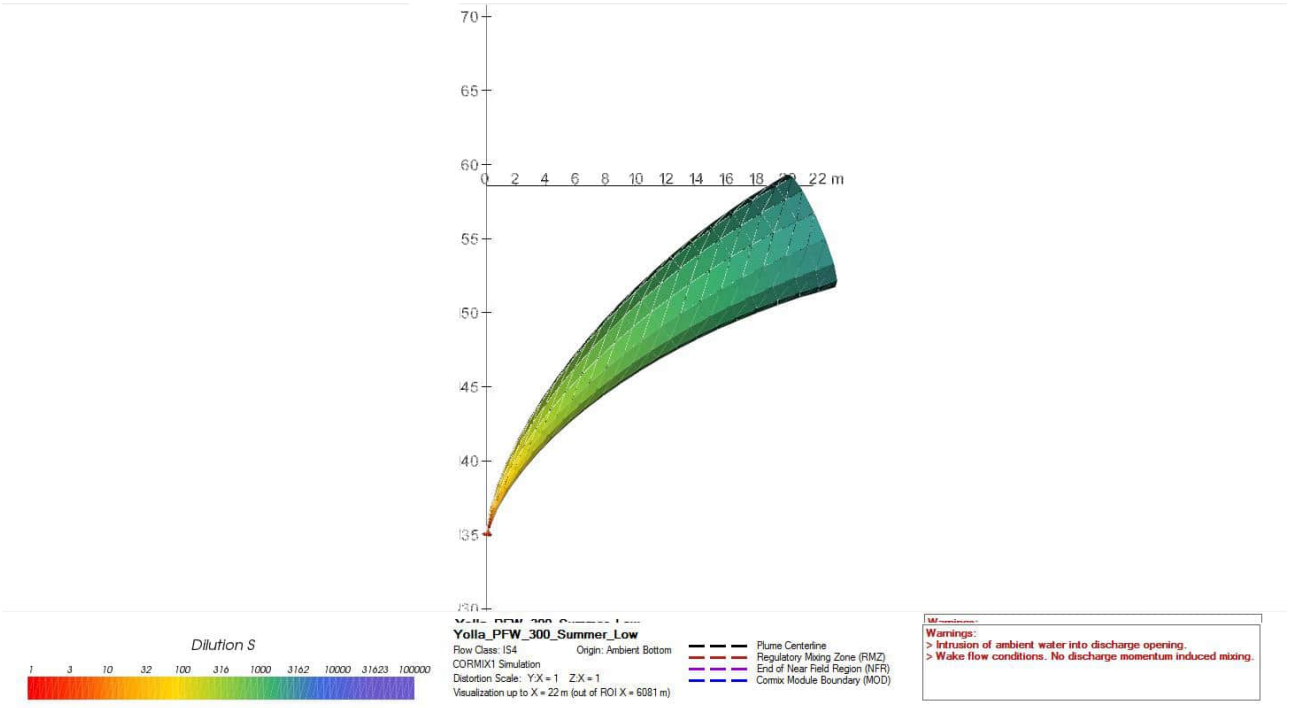


Figure 5-9 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

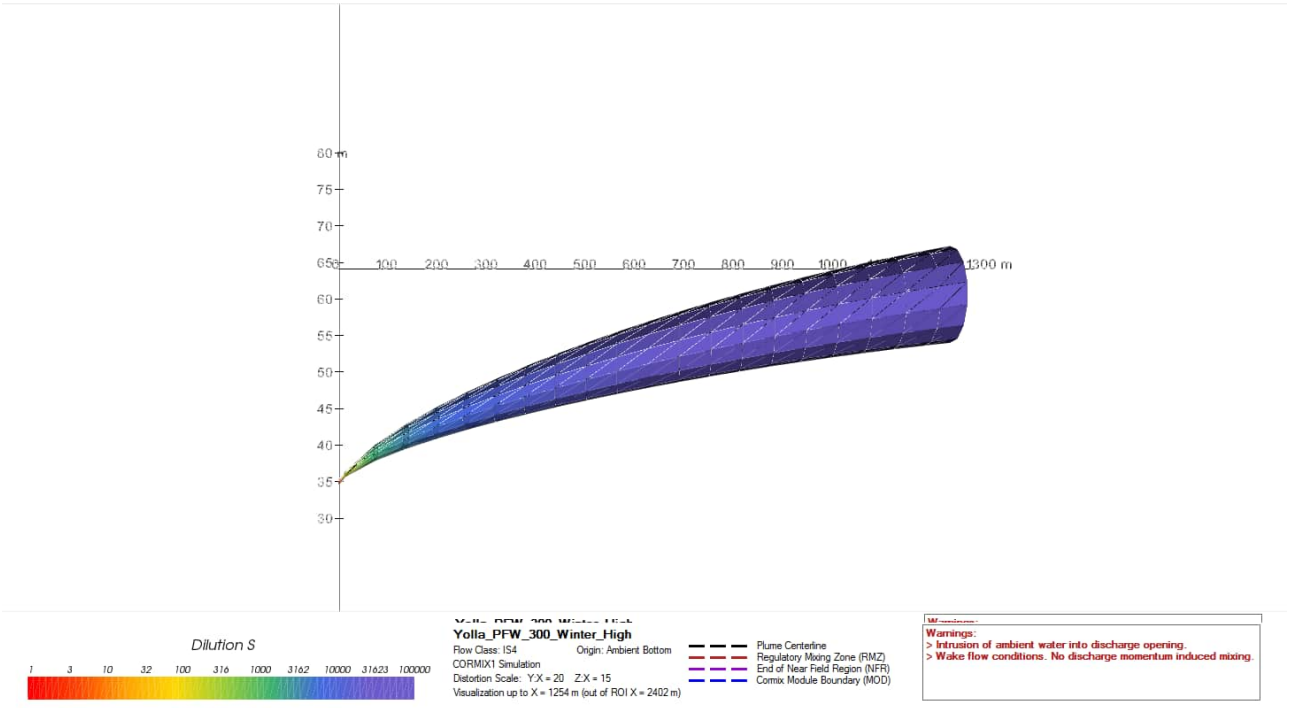


Figure 5-10 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

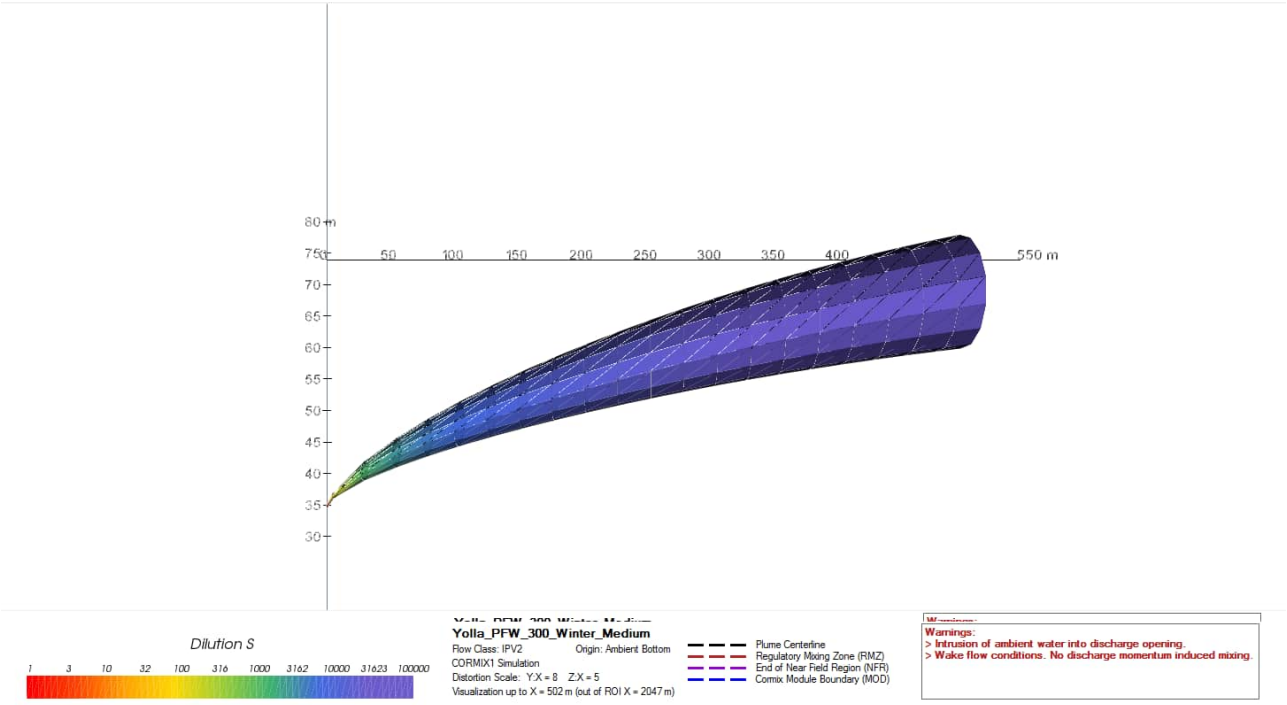


Figure 5-11 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 300 m^3/d at discharge height of 45 m below the sea surface.

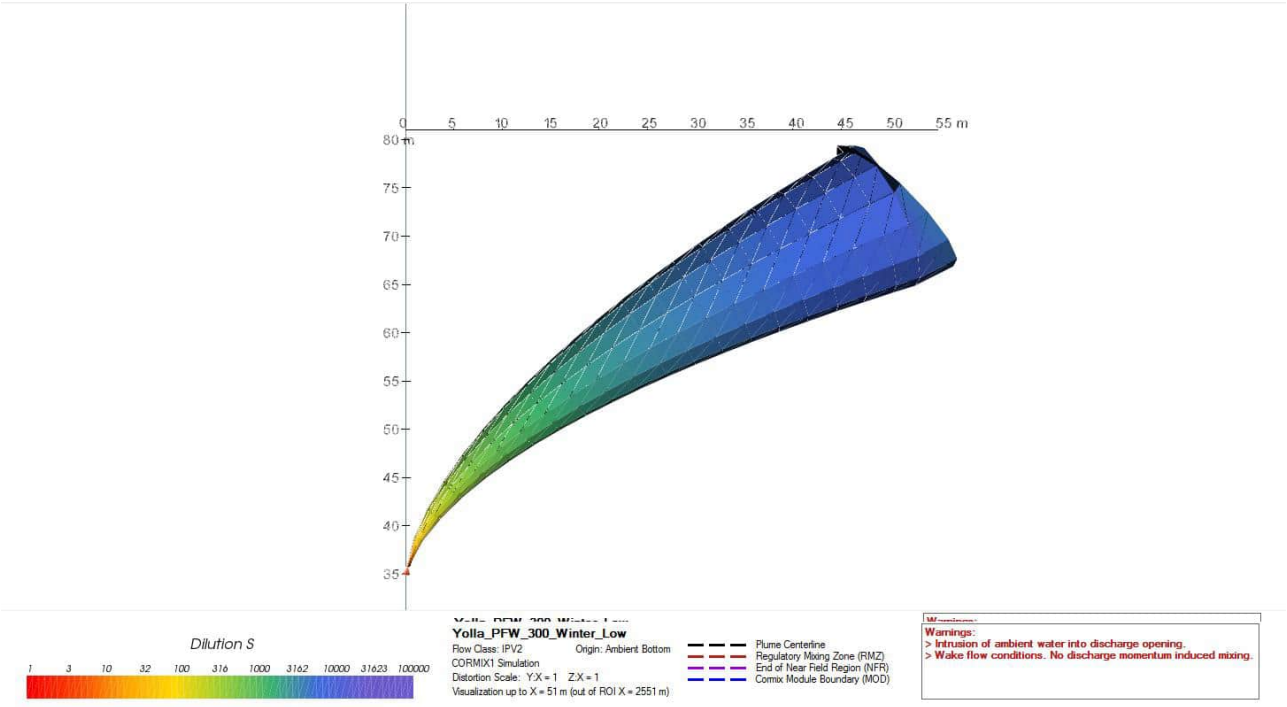


Figure 5-12 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 300 m^3/d at discharge height of 45 m below the sea surface.

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 95th 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 95th 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)
95th 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

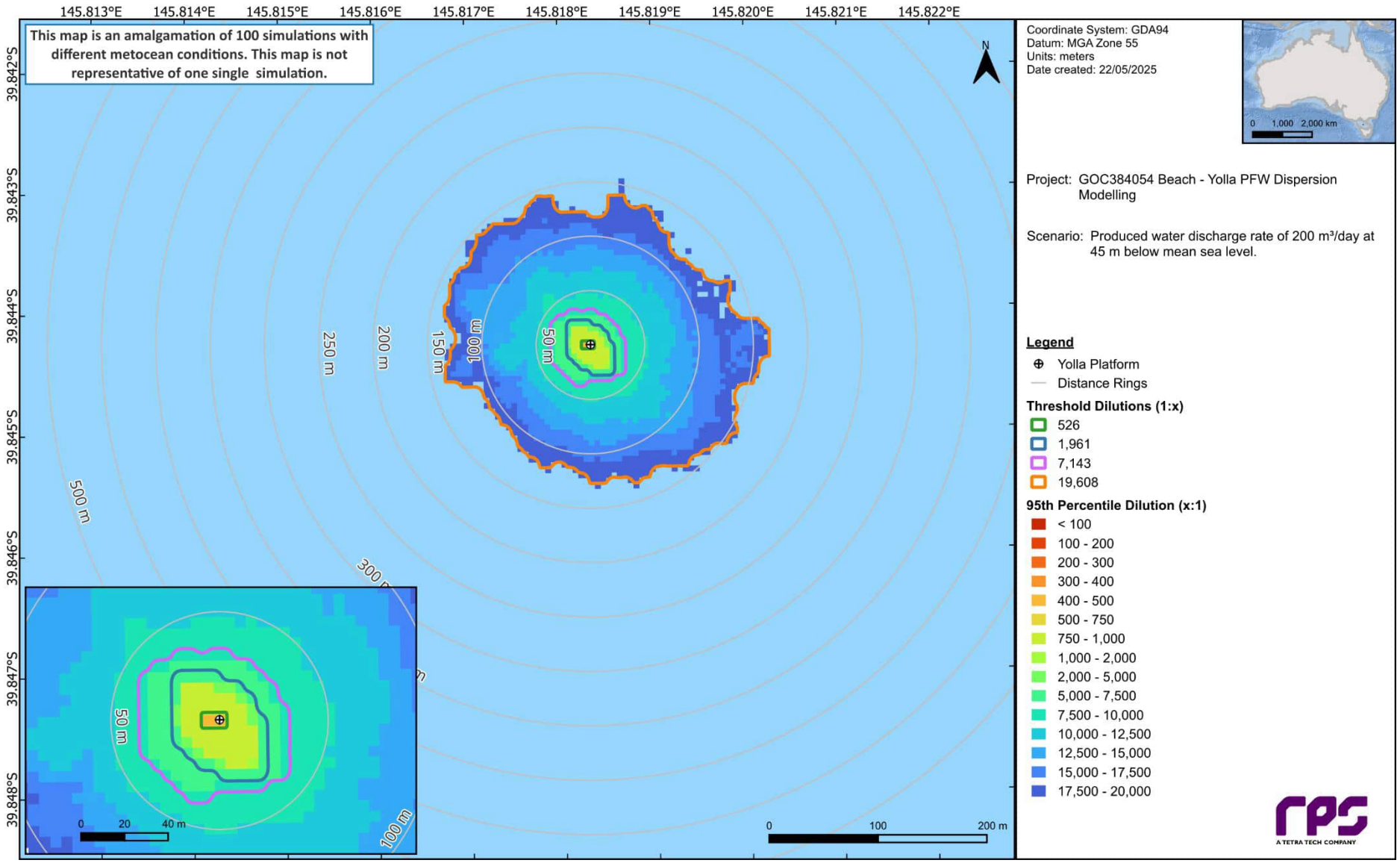


Figure 5-13 95th percentile dilution for a PFW discharge at 200 m³/d. Results refer to annual conditions.

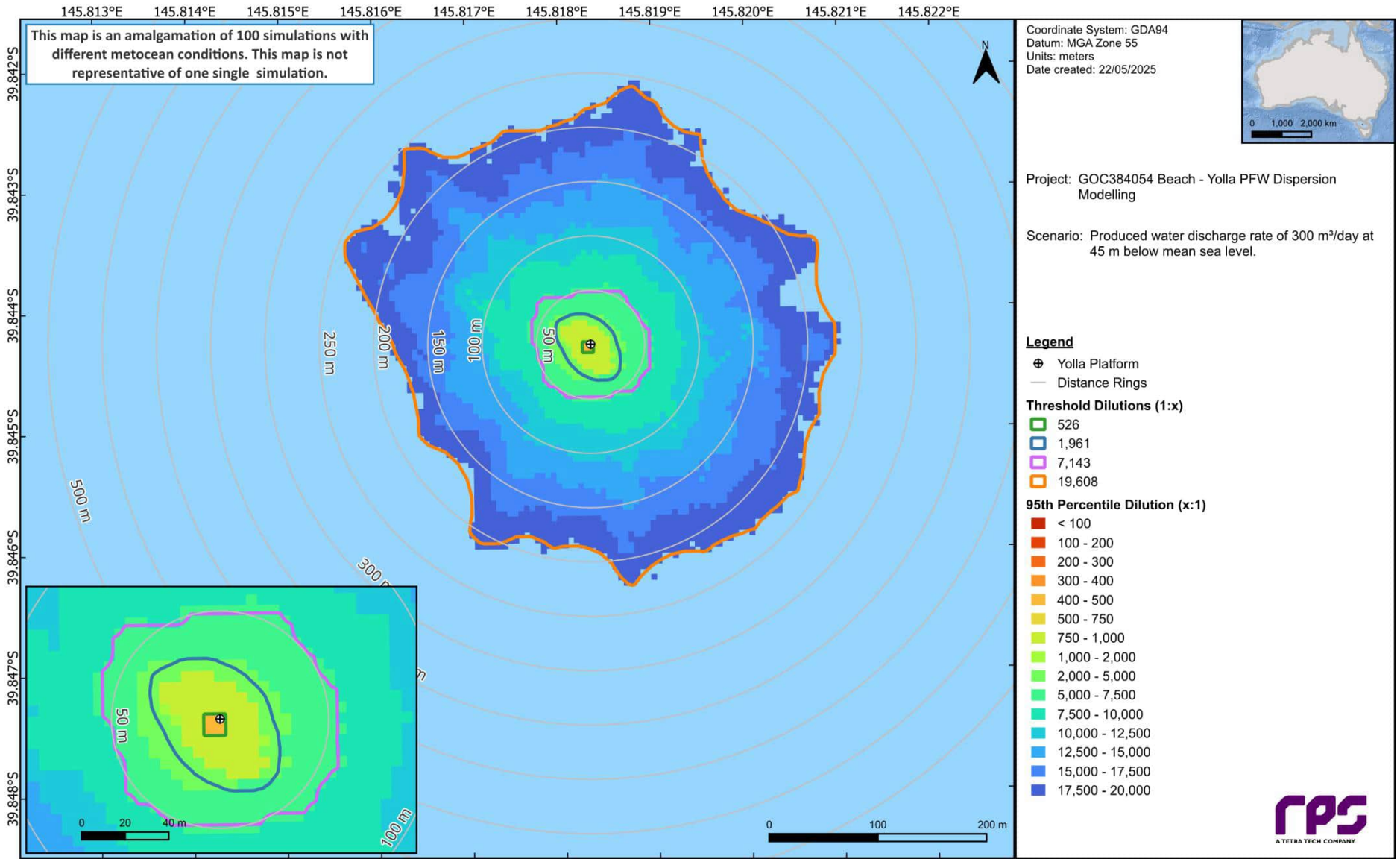


Figure 5-14 95th percentile dilution for a PFW discharge at 300 m³/d. Results refer to annual conditions.

6 REFERENCES

Andersen, OB 1995, 'Global ocean tides from ERS 1 and TOPEX/POSEIDON altimetry', Journal of Geophysical Research: Oceans, vol. 100, no. C12, pp. 25249-25259.

Burns, K, Codi, S, Furnas, M, Heggie, D, Holdway, D, King, B & McAllister, F 1999, 'Dispersion and fate of produced formation water constituents in an Australian Northwest Shelf shallow water ecosystem', Marine Pollution Bulletin, vol. 38, pp. 593-603.

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R & Bleck, R 2007, 'The HYCOM (HYbrid Coordinate Ocean Model) data assimilative system', Journal of Marine Systems, vol. 65, no. 1, pp. 60-83.

Chassignet, EP, Hurlburt, HE, Metzger, E, Smedstad, OM, Cummings, J & Halliwell, GR 2009, 'U.S. GODAE: Global ocean prediction with the HYbrid Coordinate Ocean Model (HYCOM)', Oceanography, vol. 22, no. 2, pp. 64-75.

Condie, SA., & Andrewartha, JR 2008, 'Circulation and connectivity on the Australian Northwest Shelf', Continental Shelf Research, 28, 1724–1739.

Davies, AM 1977a, 'The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile', in Bottom Turbulence: Proceedings of the 8th Liege Colloquium on Ocean Hydrodynamics, ed. Nihoul, JCJ, Elsevier.

Davies, AM 1977b, 'Three-dimensional model with depth-varying eddy viscosity', in Bottom Turbulence: Proceedings of the 8th Liege Colloquium on Ocean Hydrodynamics, ed. Nihoul, JCJ, Elsevier.

Doneker, R & Jirka, G 1990, 'Expert System for Hydrodynamic Mixing Zone Analysis of Conventional and Toxic Submerged Single Port Discharges (CORMIX1)', EPA/600/3-90/012, U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Gordon, R 1982, Wind driven circulation in Narragansett Bay, PhD thesis, University of Rhode Island, Kingston, RI, USA.

Isaji, T & Spaulding, ML 1984, 'A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank', Journal of Physical Oceanography, vol. 14, no. 6, pp. 1119-1126.

Isaji, T, Howlett, E, Dalton, C & Anderson, E 2001, 'Stepwise-continuous-variable-rectangular grid hydrodynamics model', in Proceedings of the 24th Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Edmonton, AB, Canada, pp. 597-610.

Jirka, GH, Doneker, RL, & Barnwell, TO, 1991, 'CORMIX: an expert system for mixing zone analysis', Water Science and Technology, vol. 24, no. 6, pp. 267–274.

Khondaker, AN 2000, 'Modeling the fate of drilling waste in marine environment – an overview', Journal of Computers and Geosciences, vol. 26, pp. 531-540.

King, B & McAllister, FA 1997, 'The application of MUDMAP to investigate the dilution and mixing of the above water discharge at the Harriet A petroleum platform on the Northwest Shelf', in Modelling the Dispersion of Produced Water Discharge in Australia, Australian Institute of Marine Science, Canberra, ACT, Australia.

King, B & McAllister, FA 1998, 'Modelling the dispersion of produced water discharges', APPEA Journal, pp. 681-691.

Koh, RCY & Chang, YC 1973, Mathematical model for barged ocean disposal of waste, Environmental Protection Technology Series, EPA 660/2-73-029, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, USA.

Kostianoy, AG, Ginzburg, AI, Lebedev, SA, Frankignoulle, M & Delille, B 2003, 'Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data', Oceanology, vol. 43, no. 5, pp. 632-642.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, 'The world ocean database', Data Science Journal, vol. 12, pp. WDS229-WDS234.

Ludicone, D, Santoleri, R, Marullo, S & Gerosa, P 1998, 'Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data', Journal of Geophysical Research I, vol. 103, no. C2, pp. 2995-3011.

Matsumoto, K, Takanezawa, T & Ooe, M 2000, 'Ocean tide models developed by assimilating TOPEX/POSEIDON altimeter data into hydrodynamical model: A global model and a regional model around Japan', Journal of Oceanography, vol. 56, no. 5, pp. 567-581.

Owen, A 1980, 'A three-dimensional model of the Bristol Channel', Journal of Physical Oceanography, vol. 10, no. 8, pp. 1290-1302.

Qiu, B & Chen, S 2010, 'Eddy-mean flow interaction in the decadally modulating Kuroshio Extension system', Deep-Sea Research II, vol. 57, no. 13, pp. 1098-1110.

RPS APASA 2016, Wandoo Operations, North West Shelf: Produced Formation Water - Oil in Water and Ammonia Discharge Modelling. Report Q0397. Prepared for Vermilion Oil and Gas Australia. RPS APASA Pty Ltd

Yaremchuk, M & Tangdong, Q 2004, 'Seasonal variability of the large-scale currents near the coast of the Philippines', Journal of Physical Oceanography, vol. 34, no. 4, pp. 844-855.

Zigic, S, Zapata, M, Isaji, T, King, B & Lemckert, C 2003, 'Modelling of Moreton Bay using an ocean/coastal circulation model', in Proceedings of the Coasts & Ports 2003 Australasian Conference, Auckland, New Zealand, paper no. 170.

APPENDIX 12

Prepared for
Beach Energy Ltd.
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.

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Appendix A
Yolla Platform ALARP Assessment (AECOM 2019) A

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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.

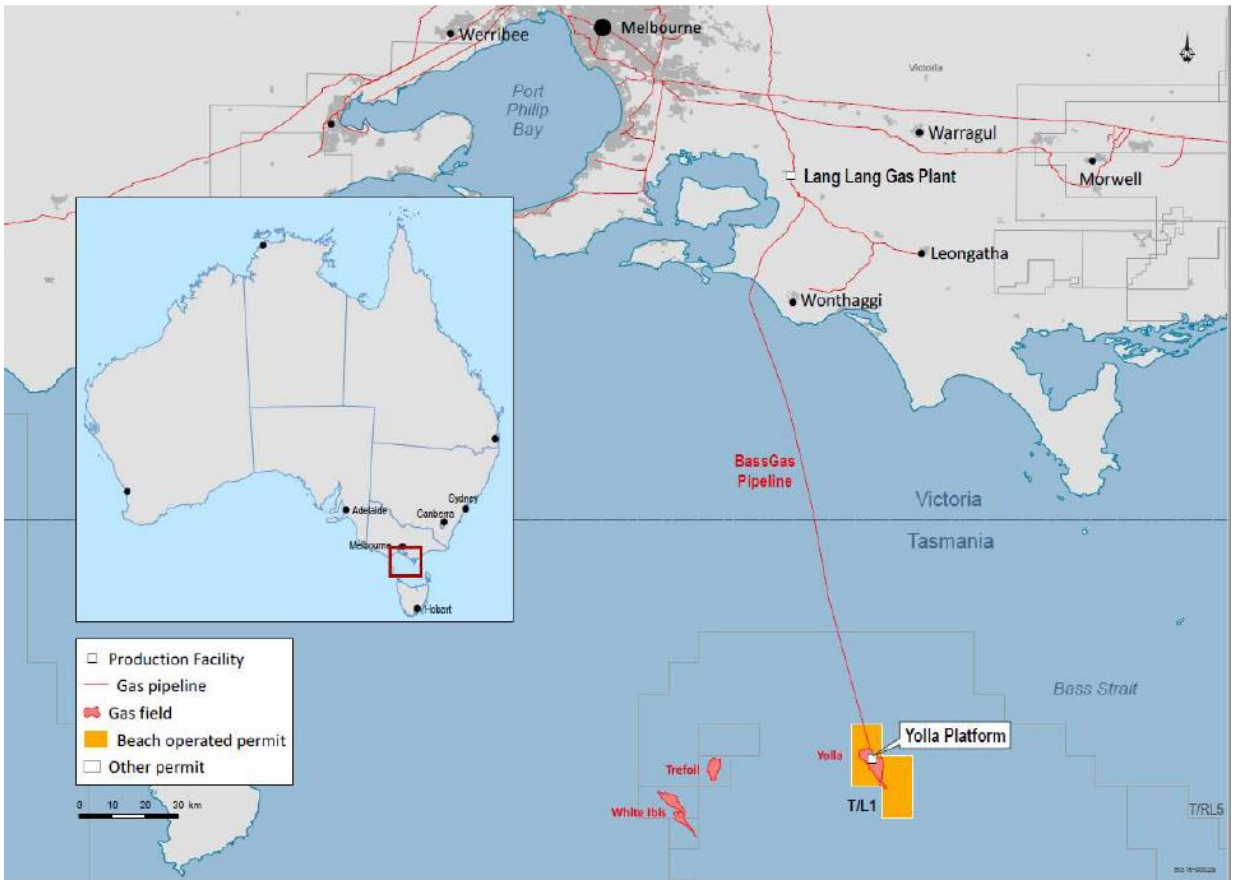


Figure 1 Yolla-A Platform location at the BassGas Development facility.

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.

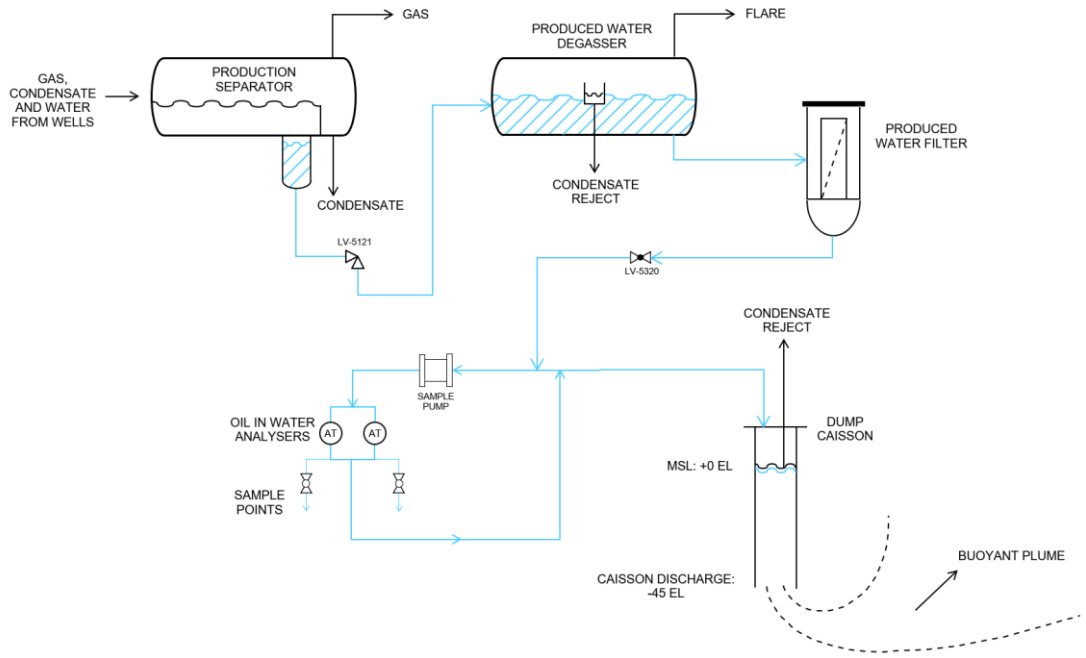


Figure 2 Schematic of Yolla-A PFW processing system

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.

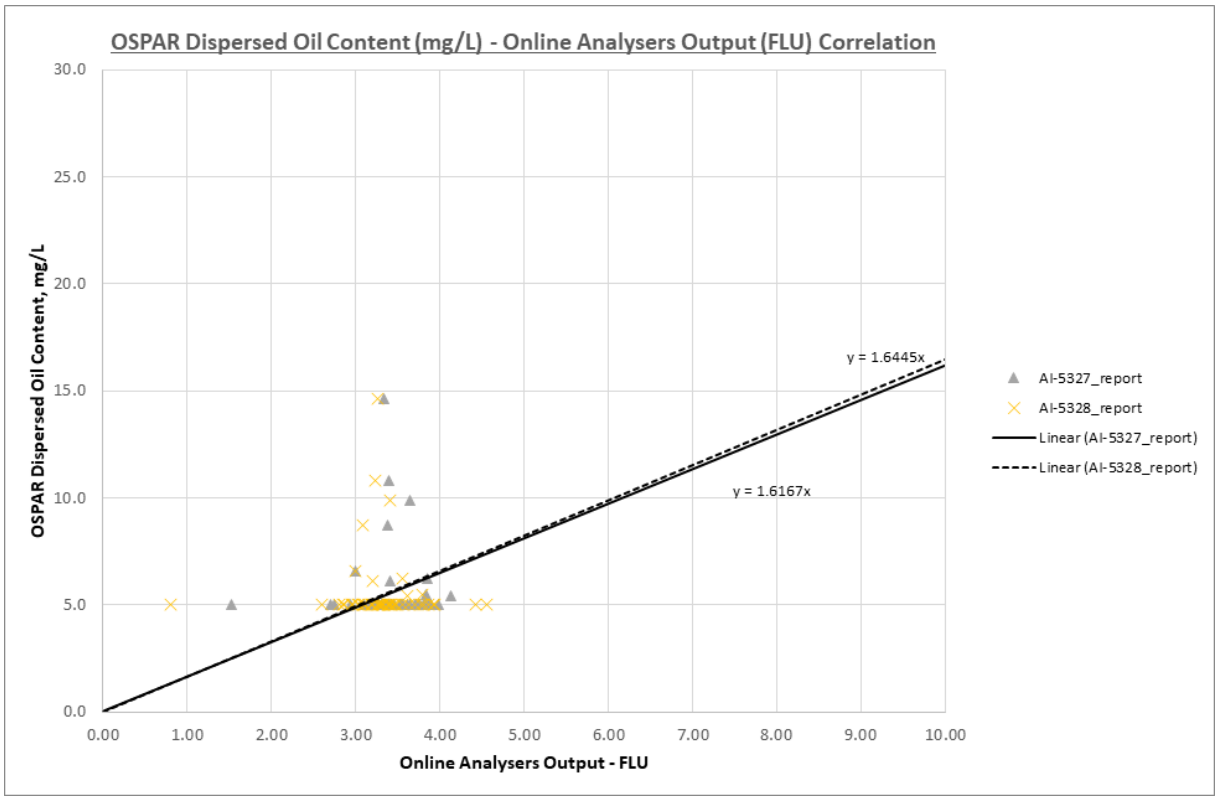


Figure 3 Correlation between OSPAR dispersed Oil and OIW analyser outputs

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).

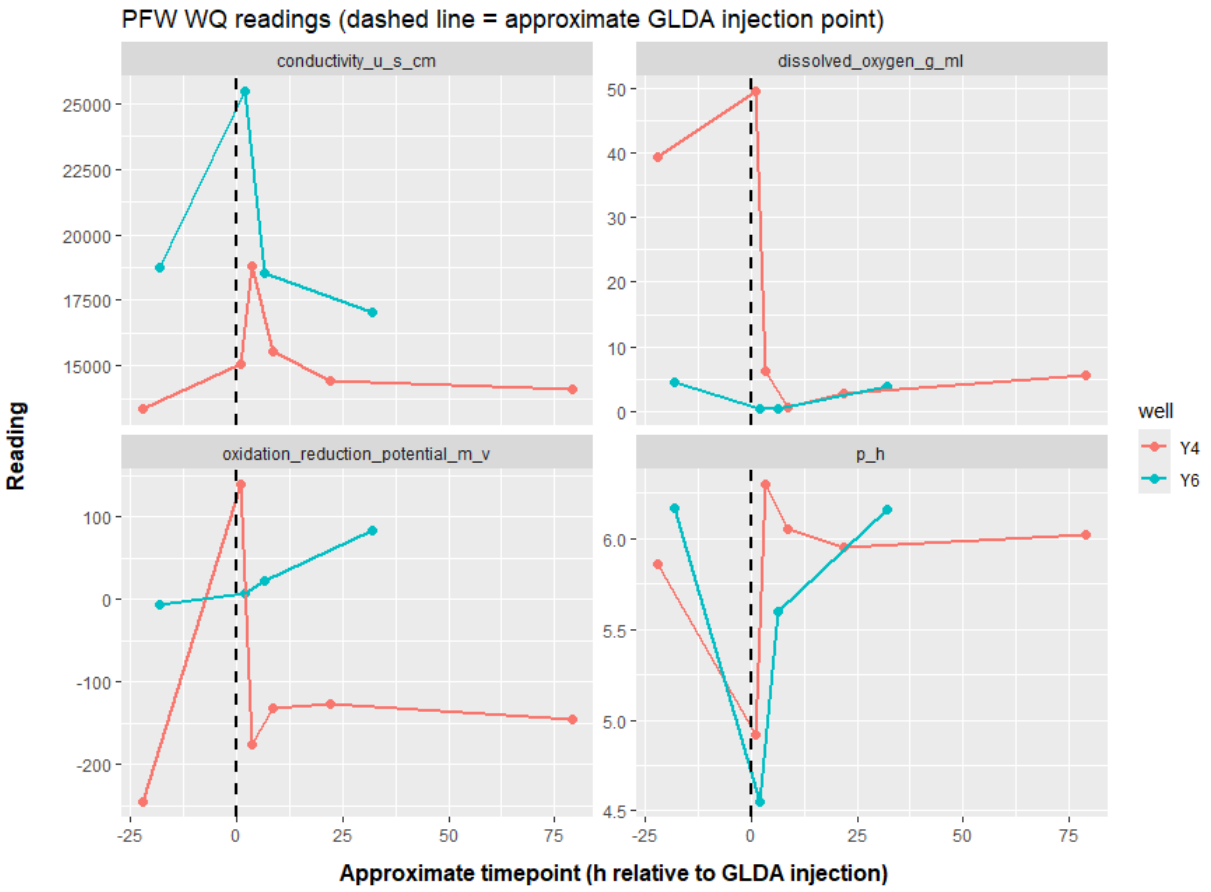


Figure 4 PFW Water Quality readings for Y4 and Y6 wells treated in June and July 2025 respectively

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.

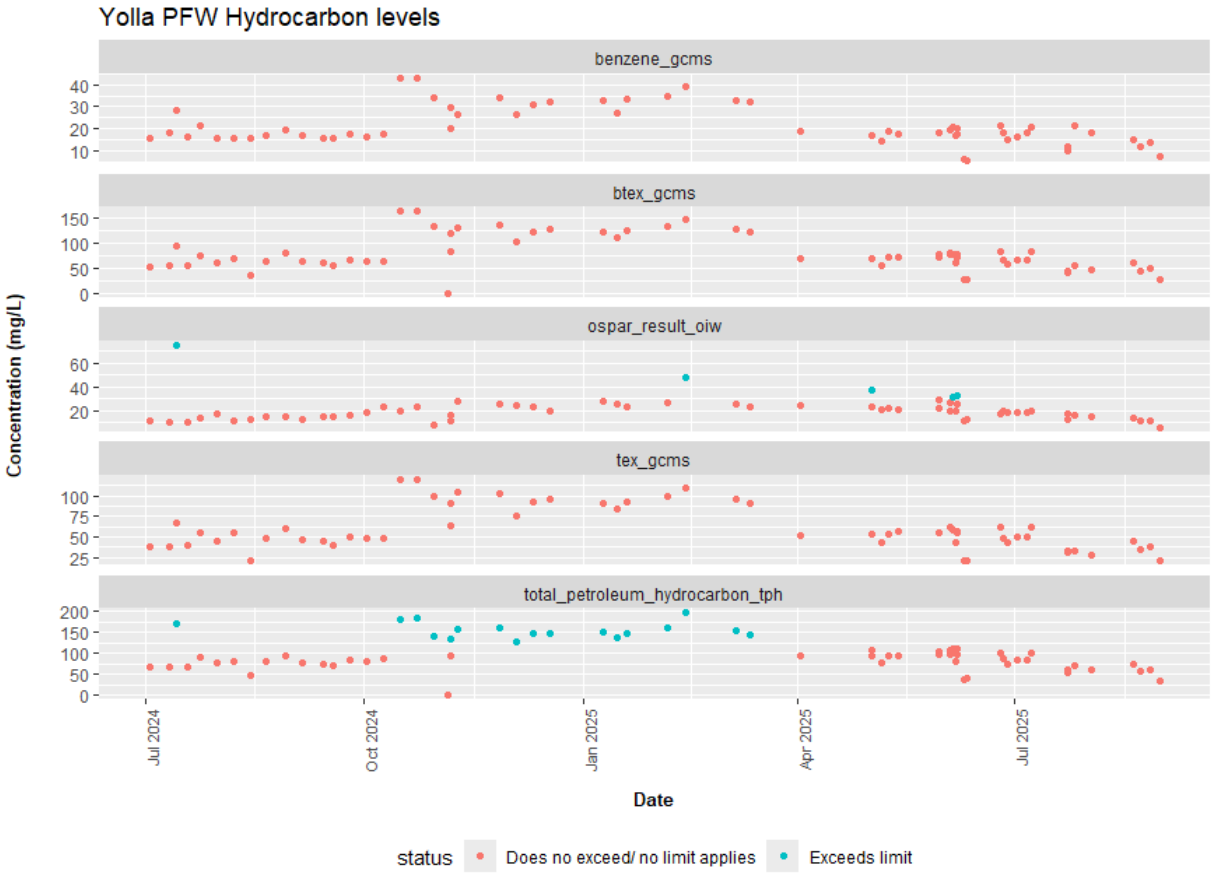


Figure 5 PFW hydrocarbon levels between June 2024 to August 2025

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. 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

Aventus, 2020. Environment Plan, BassGas Offshore Operations, Revision 3, Aventus Consulting (Doc No. CDN/ID 3972814), 30 November 2020.

Backus. F., 2024. EOSCA CHARM Calculator Online Software (ECCOS) modelling outputs across various production scenarios provided by Beach Energy, for the application and discharge of MC MX 2-5898 on Yolla 3, 4 and 5. Halliburton Multi-Chem. Received 1 November 2024. Pp 4.

Backus. F., 2025. Complete CHARM modelling outputs and CEFAS/OCNS Technical Details. Halliburton Multi-Chem. Received 29th August 2025.

Backus. F., 2024, “RE__EXTERNAL_RE_Yolla 4”, Email Received 1 November 2024.

Beach, 2020. Environment Plan BassGas Offshore Operations. Document no. CDN/ID 3972814.

Beach, 2025. Bass Gas Offshore Operations, Environment plan 5-year review, Consultation information sheet, July 2025

Gunn. M. & Hobbs. G. 2024. YOLLA 6 Scale Treatment and Assessment. Report for Beach Energy, received 31 May 2024. Strategic Chemistry Pty Ltd. Pp 31.

NOPSEMA, 2020. Key Matters Report, BassGas Offshore Operations, December 2020.

NOPSEMA, 2021. NOPSEMA Inspection of BassGas Operations (Draft for discussion with duty holders), NOPSEMA Inspection Report, Inspection No. 2448, 13 September 2021.

NOPSEMA, 2024, Environment Plan decision making. Document No: N-04750-GL1721 A524696, 10/01/2024

Nouryon. . Dissolvline StimWell HTF Product Data, July 2019

RPS, 2020. Beach Yolla Platform – Produced Water Dispersion Far-Field Modelling Study, RPS Group, 23 September 2020.

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 2m^3/hr or 5 tonnes for 66 m^3/hr	1.5 tonnes for 1 m^3/hr or 2 tonnes for 6m^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

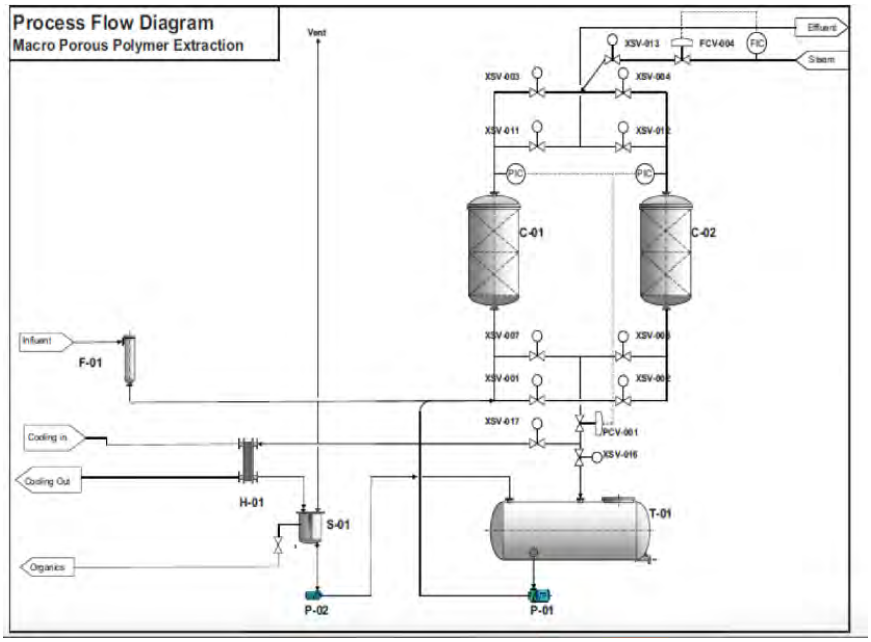
Removal of dissolved and dispersed hydrocarbons from oil and gas produced water with Macro Porous Polymer Extraction (MPPE) to reduce toxicity and allow water reuse (Dick Meijer and Chris Madin APPEA Journal 2010).

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

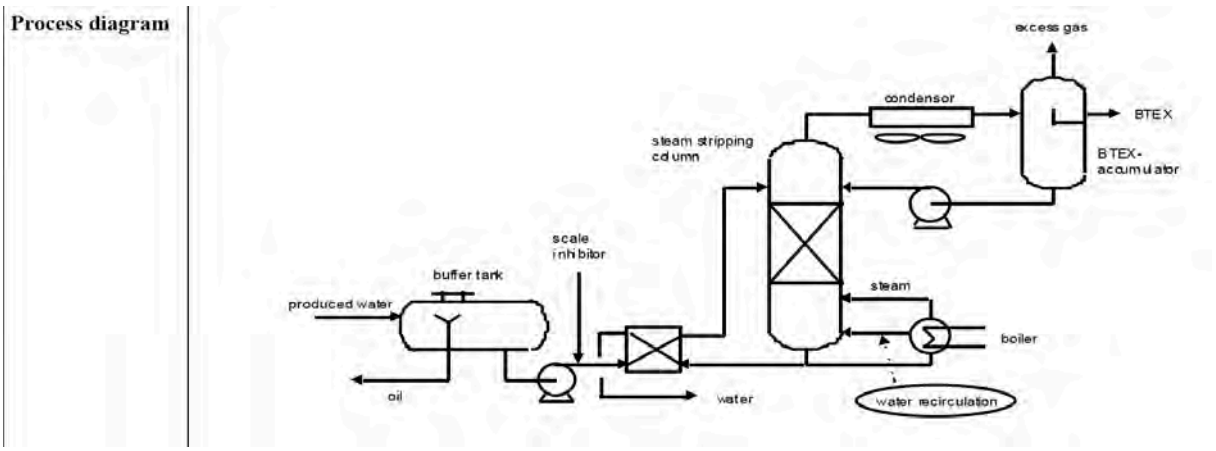
Based on the review of overseas experience, the suitable technologies that would be considered BAT and that could enhance the removal of the dissolved hydrocarbons and BTEX are steam stripping and MPPE. OSPAR (2012) provided the following process descriptions for these options.

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, 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 **Consequence: Moderate- Serious**	Unlikely	Medium	Improved Monitoring of dispersed oil	Highly unlikely/ Moderate: **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 **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 **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 300m^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

Advisian 2019, Yolla Produced Water Improvement TIC estimated Dec 2019

AECOM (2019), Potential Impact of Yolla Platform PFW Discharge on Marine Life December 2019

ALS Laboratory report 2017

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.

BassGas 2014/2018, Offshore Environment Plan BassGas (OEUP-T5100-PLN-ENV-005 dated 28/05/2018, 2014)

BASS Gas 2019, BassGasLIMS Rev3

Beach Energy, Risk Management Procedure

Dwyer and F. McDonald, Treatment of Oil & Gas Produced Water (B. P. Dwyer and F. McDonald Sandia SAND2016-11532016)

Ecotox 2019, Ecotox Australia Pty Ltd WET testing reports Sept Oct 2019

Eurofins 2018-2019, Laboratory Reports 2018-2019

IPIECA 2014, Efficiency in water use

E.T. Igunnu and G.Z. Chen 2014, Produced water treatment technologies (E.T. Igunnu and G.Z. Chen International Journal of Low-Carbon Technologies 2014, 9, 157–177)

Igwe et al 2013Optimal Options for Treatment of Produced Water in Offshore Petroleum Platforms (Igwe et al., J Pollut Eff Cont 2013),

Ming Tang 2014, Overview of Produced Water (PW) Treatment and Measurement (Ming Tang TUV SEL NEL 2014)

NOPSEMA 2019, Environmental Improvement Notice issued on the 27th August 2019,

NOPSEMA guidance such as Guidance Note GN1488 Oil Pollution Risk Management, N-04300-GN0166

NOPSEMA 2018, Environment plan decision making (GL1721-Rev5 June 2018),

CoA 2009, Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Environment Regulations)

NOPSEMA 2019, WEB site EPs for a number of offshore platforms

NOPSEMA 2018, Oil Pollution Risk Management Guidance Note Feb 2018 Doc. A382148;

NOPSEMA 2019, Environment plan content requirements Guidance note N-04750-GN1344 Revision 4 - 17 April 2019 Doc. A339814)

Meijer and Chris 2010, 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).

OSPAR Commission 2012, OSPAR Recommendation 2012/5 for a risk-based approach to the Management of Produced Water Discharges from Offshore Installations

OSPAR Commission 2006, Addendum to the OSPAR Background Document Concerning Techniques for the Management of Produced Water from Offshore Installations (Publication number 162/2002) OSPAR Commission 2006.

OSPAR Commission 2013, Background Document concerning Techniques for the Management of Produced Water from Offshore Installations. OSPAR Commission 2013 (p00602)

Van Dam, R and Chapman, J, 2002, Direct toxicity assessment (DTA) for water quality guidelines in Australia and New Zealand. *Australasian Journal of Ecotoxicology*, Jan 2002.

Thyara CM et al 2018, Produced water from oil - A review of the main treatment technologies. (Thyara CM Nonato PhD1, Alcione A De A Alves Prof, Mauricio L Sens Prof, Ramon Lucas Dalsasso ProfJ Environ Chem Toxicol Vol 2 No 1 March 2018)

USDI 2011, Oil and Gas Produced Water Management and Beneficial Use in the Western United States (Bureau of Reclamation US Department of the Interior. 2011).

RPS 2017, Yolla Platform Bass Strait Produced Water Dispersion Near-Field Modelling 28 Nov 2017

Worley Parsons 2009, BassGas Raw Gas Pipeline Feasibility Study, Worley Parsons May 2009

7.0 Limitations

AECOM Australia Pty Limited (AECOM) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Beach Energy Ltd (Beach) and only those third parties who have been authorised in writing by AECOM to rely on this Report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this Report.

It is prepared in accordance with the scope of work and for the purpose outlined in the proposal dated 9 August 2019.

Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in the Report. AECOM assumes no liability for any inaccuracies in or omissions to that information.

This Report was prepared between August and December 2019 and is based on the conditions encountered and information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time.

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Except as specifically stated in this section, AECOM does not authorise the use of this Report by any third party.

It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the site.

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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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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VIC 3984

NATA Accredited
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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: **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			

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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	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
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	
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
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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 # 20794

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NATA # 1261
Site # 23736

Company Name:	Beach Energy Limited	**Order No.:**	PO# BE 00016911
Address:	5775 South Gippsland Highway Lang Lang VIC 3984	**Report #:**	681835
		Phone:	03 5654 9103
		Fax:	03 5659 0178
Project Name:	PRODUCED WATER A15327 DISCHARGE		

Received:	Oct 10, 2019 11:12 AM
Due:	Oct 17, 2019
Priority:	5 Day
Contact Name:	Adrian Cukovski

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
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
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

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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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: TR1858/1

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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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ABN 95 619 426 201

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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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.

Toxicity Test Report: TR1858/3

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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)% **72-hr EC50 =3.4 (3.28-3.50)%** **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: TR1858/3

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.

Toxicity Test Report: TR1858/4

Performed in compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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

Concentration (%)	**% Unaffected (Mean ± SD)**
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%

Vacant	*Vacant*

*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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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* **Concentration (%)**	**Cell Yield (Mean number of cells/mL x10^4 ± 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)% **72-hr IC50 = 6.0 (5.43-6.93)%** **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: 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 GPO Box 175 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. 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 GPO Box 175 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 25 September 2019 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. 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

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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 : 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	1x2.5L			**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
"	"	YO250919-2	"	1x2.5L		
"	"	YO250919-3	"	1x2.5L		
"	"	YO250919-4	"	1x2L		

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

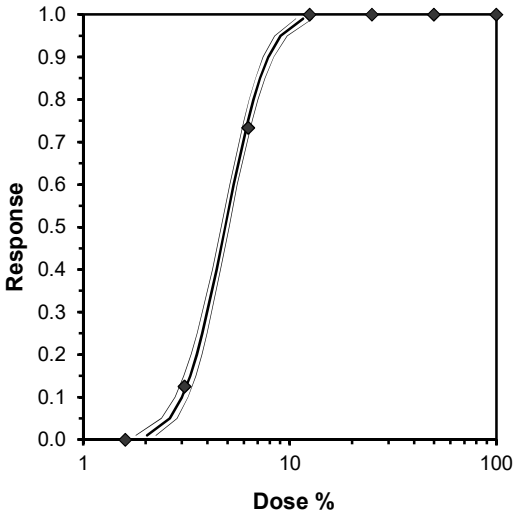
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.975273	0.887	-0.42954	0.482187
Bartlett's Test indicates equal variances (p = 0.41)	2.877388	11.34487		
The control means are not significantly different (p = 0.64)	0.498347	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

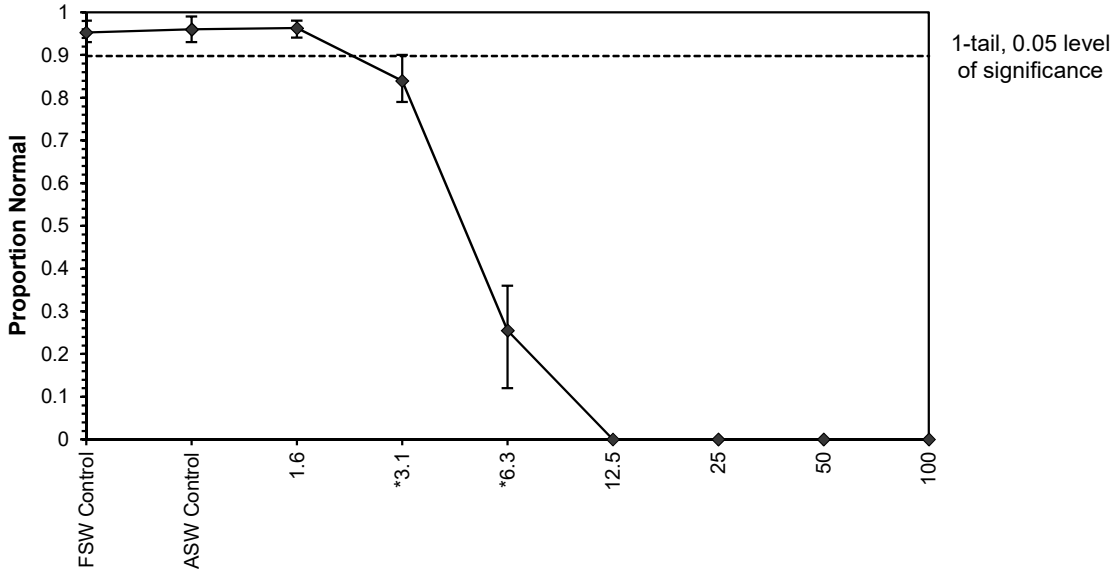
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	2.03712	1.801262	2.253447
EC05	3.355	2.629277	2.390429	2.845354
EC10	3.718	3.012408	2.777552	3.224509
EC15	3.964	3.301971	3.07203	3.51023
EC20	4.158	3.55183	3.326811	3.756811
EC25	4.326	3.781202	3.560788	3.983656
EC40	4.747	4.427037	4.216199	4.628583
EC50	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

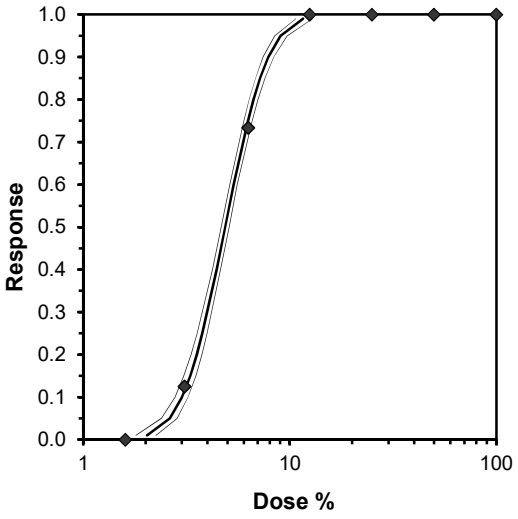
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.975273	0.887	-0.42954	0.482187
Bartlett's Test indicates equal variances (p = 0.41)	2.877388	11.34487		
The control means are not significantly different (p = 0.64)	0.498347	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

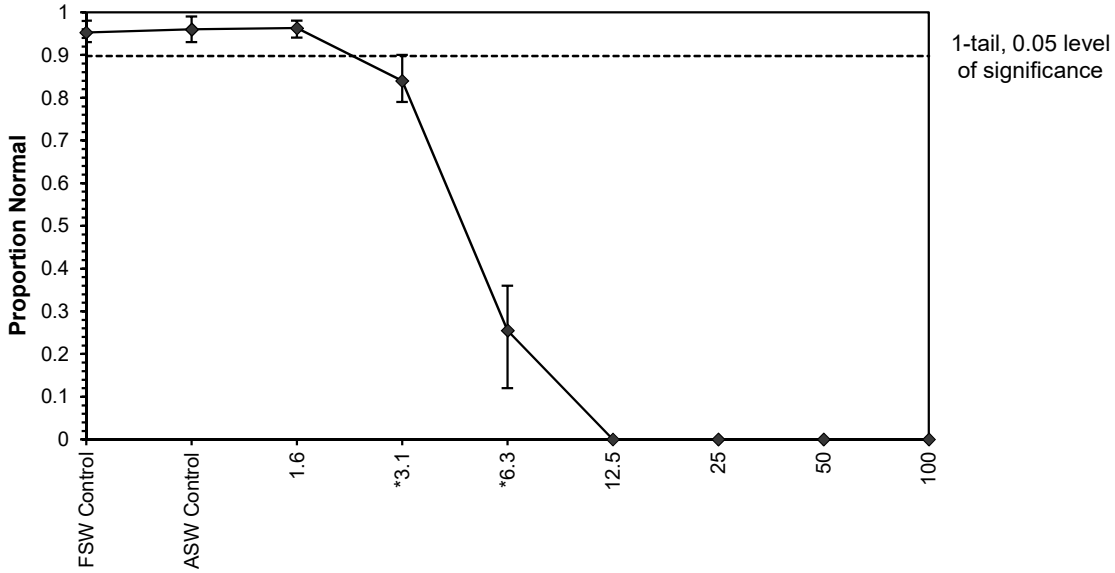
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	2.03712	1.801262	2.253447
EC05	3.355	2.629277	2.390429	2.845354
EC10	3.718	3.012408	2.777552	3.224509
EC15	3.964	3.301971	3.07203	3.51023
EC20	4.158	3.55183	3.326811	3.756811
EC25	4.326	3.781202	3.560788	3.983656
EC40	4.747	4.427037	4.216199	4.628583
EC50	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

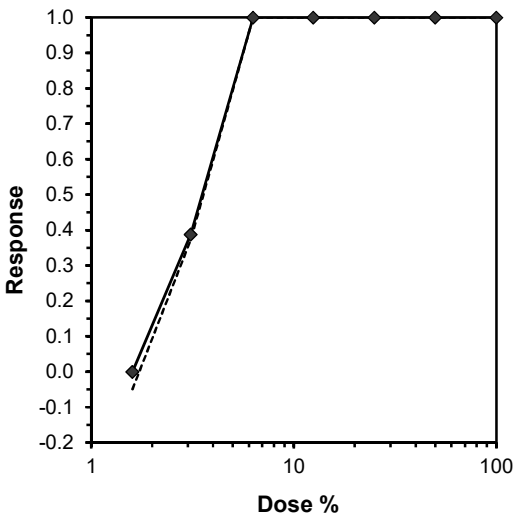
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7825	1.0229	1.0869	1.0357	1.1458	4.535	4					
ASW Control	0.7650	1.0000	1.0655	1.0244	1.1198	3.830	4	*			94	400
1.6	0.8025	1.0490	1.1119	1.0357	1.1593	4.799	4	-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 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

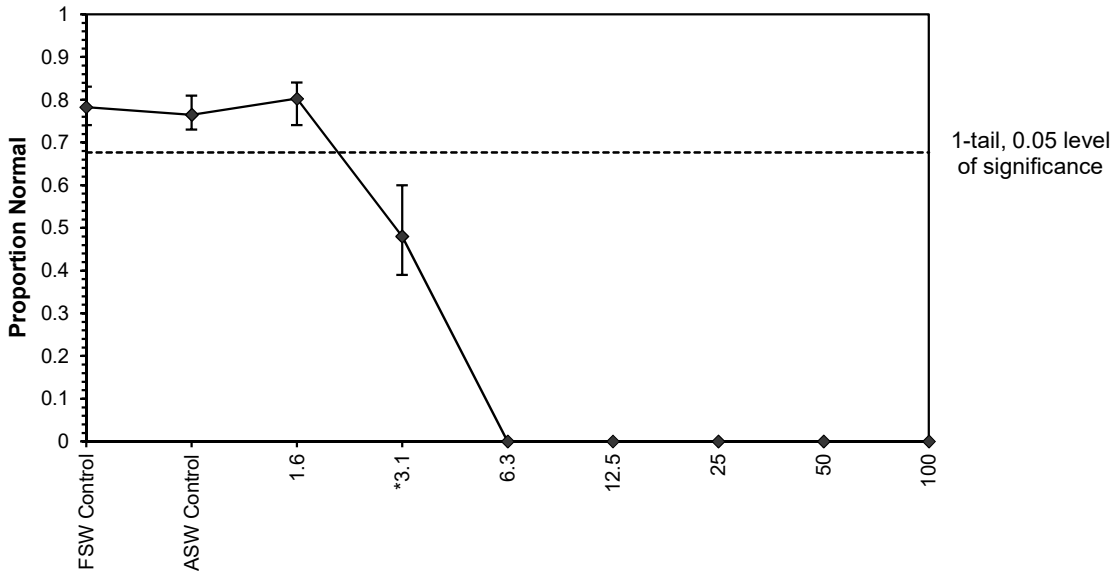
Trim Level	EC50	95% CL	
0.0%	3.3885	3.2773	3.5036
5.0%	3.4105	3.2858	3.5400
10.0%	3.4323	3.2895	3.5813
20.0%	3.4747	3.2733	3.6886
Auto-0.0%	3.3885	3.2773	3.5036



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

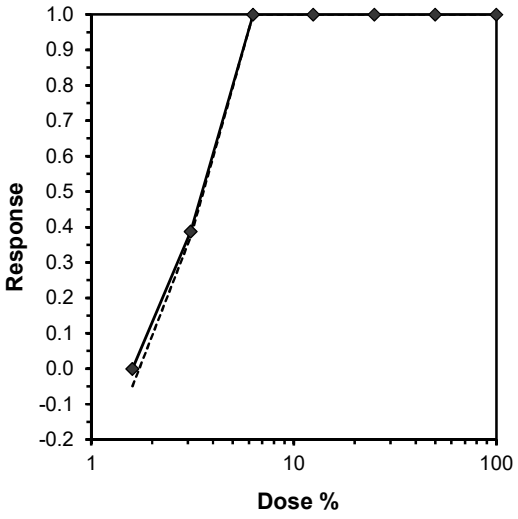
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7825	1.0229	1.0869	1.0357	1.1458	4.535	4					
ASW Control	0.7650	1.0000	1.0655	1.0244	1.1198	3.830	4	*			0.7838	1.0000
1.6	0.8025	1.0490	1.1119	1.0357	1.1593	4.799	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 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

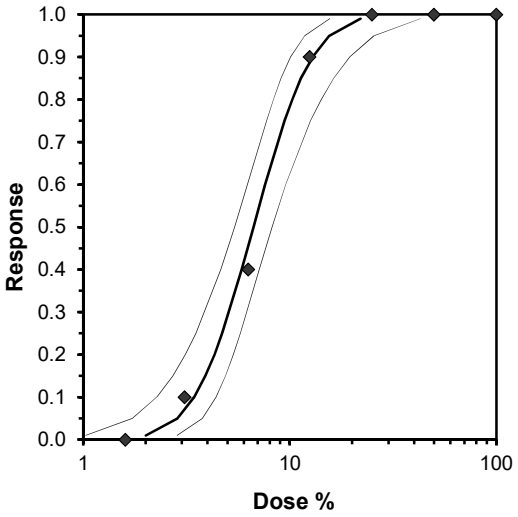
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.874764	0.905	-1.01023	1.925233
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

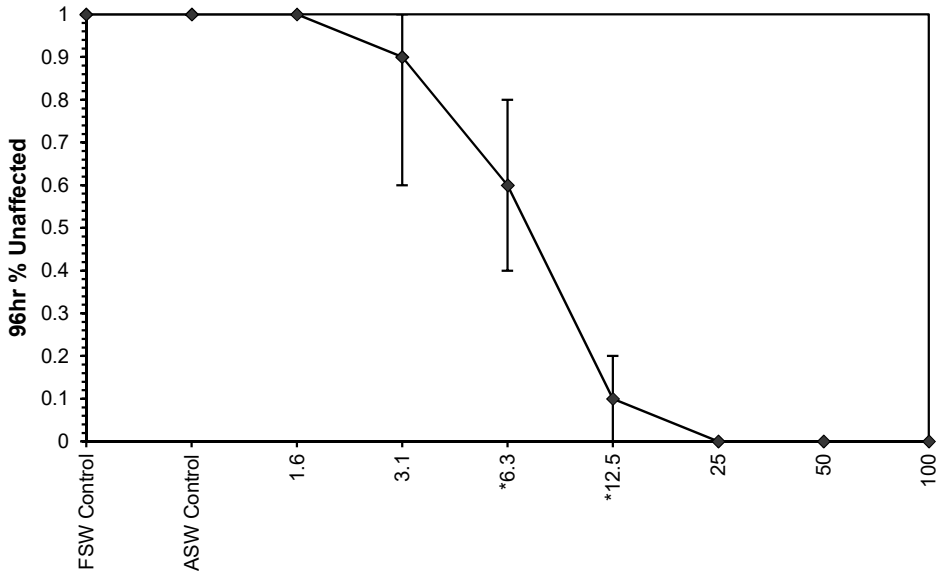
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	2.012376	1.034186	2.85415
EC05	3.355	2.857278	1.733282	3.765561
EC10	3.718	3.444395	2.271134	4.387061
EC15	3.964	3.907252	2.716143	4.87997
EC20	4.158	4.319085	3.122326	5.326055
EC25	4.326	4.706828	3.509488	5.756475
EC40	4.747	5.845344	4.639124	7.111008
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				

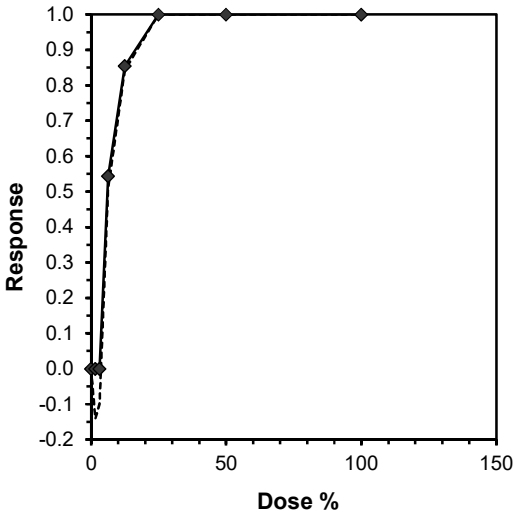
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	18.064	1.0840	18.064	16.614	19.514	5.472	8					
ASW Control	16.664	1.0000	16.664	15.914	17.314	3.482	4	*			17.997	1.0000
1.6	19.014	1.1410	19.014	17.714	20.714	6.611	4	-2.327	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 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)

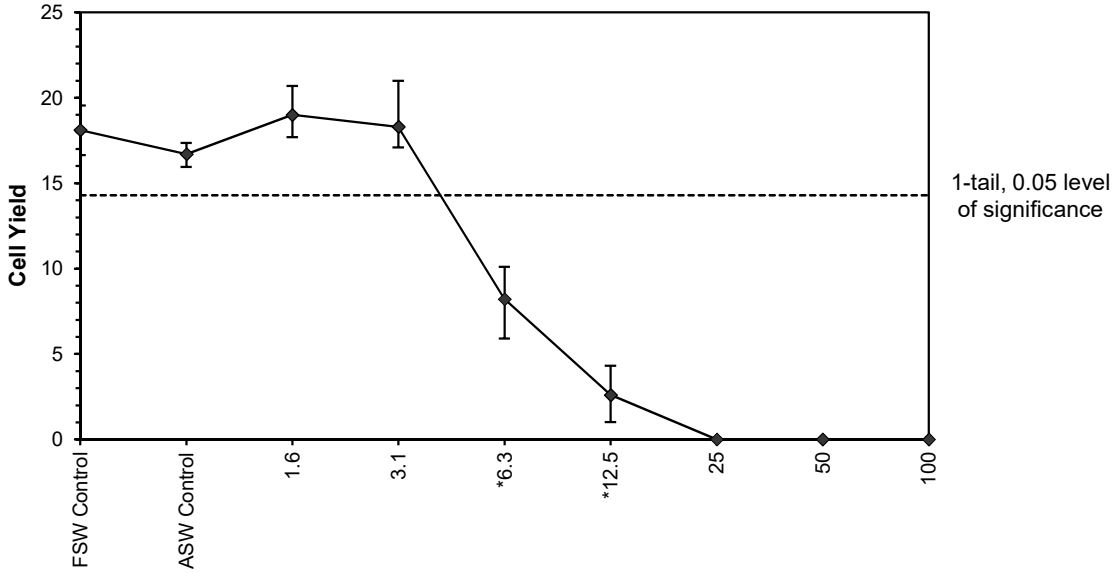
Point	%	SD	95% CL(Exp)		Skew
IC05	3.3943	0.0843	2.9935	3.4479	-1.8951
IC10	3.6887	0.0779	3.3296	3.8001	-1.1331
IC15	3.9830	0.0832	3.6401	4.1536	-0.6121
IC20	4.2773	0.0953	3.9400	4.5055	-0.2673
IC25	4.5717	0.1121	4.2001	4.8608	-0.0793
IC40	5.4547	0.1757	4.9306	5.9203	0.1581
IC50	6.0433	0.2582	5.4339	6.9275	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		

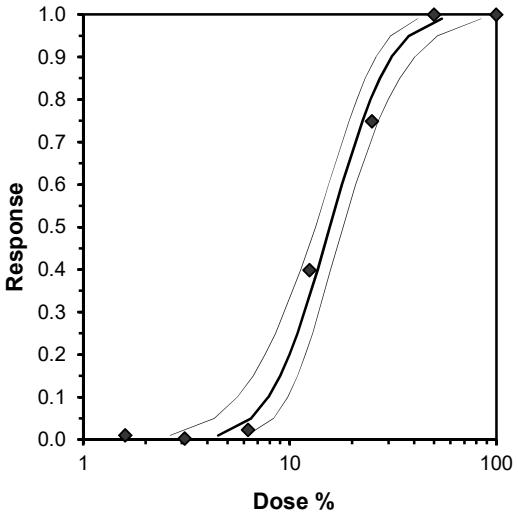
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test Treatments vs ASW Control	6.3	12.5	8.87412	15.87302	0.078607	0.081794	0.526421	0.007882	5.5E-11	5, 18

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

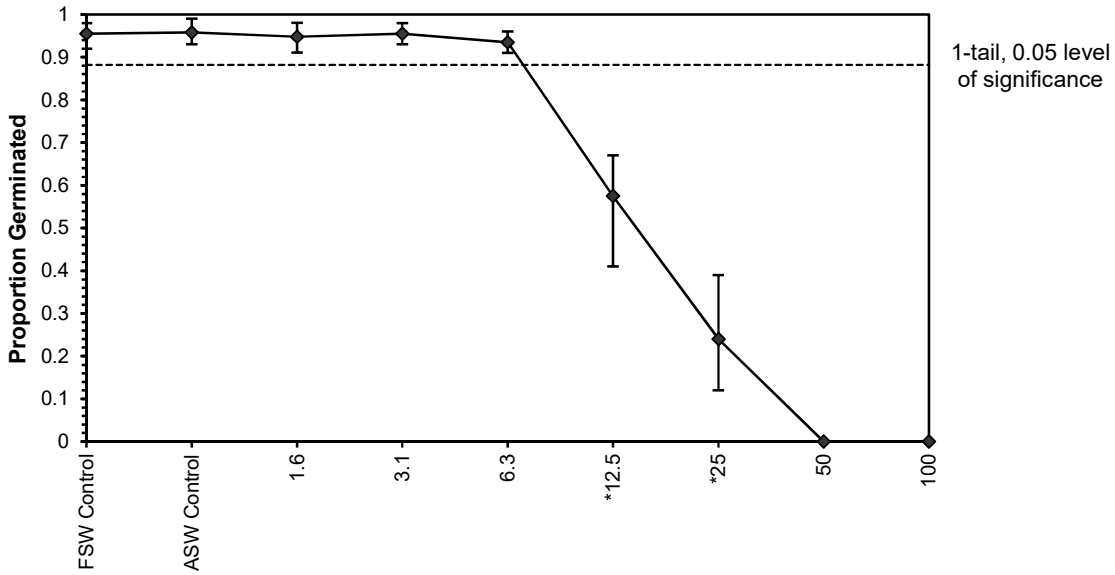
Significant heterogeneity detected (p = 2.40E-04)



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

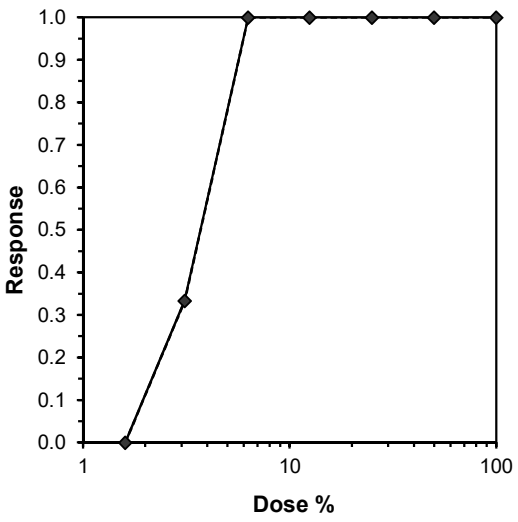
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4					
ASW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4	*			2	20
1.6	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4	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 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

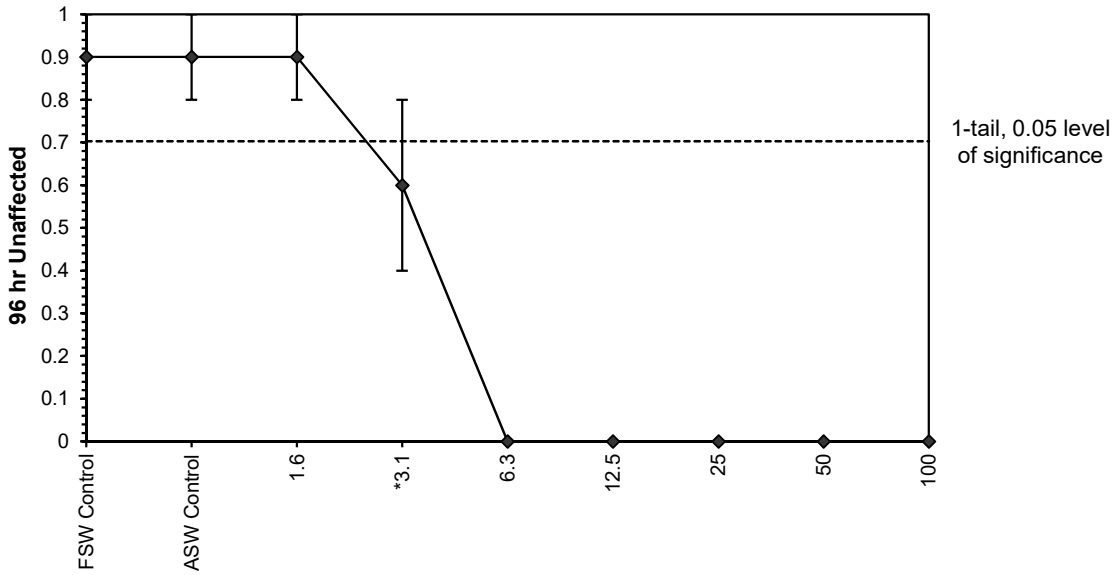
Trim Level	EC50	95% CL	
0.0%	3.5168	3.0437	4.0634
5.0%	3.5524	3.0218	4.1763
10.0%	3.5872	2.9774	4.3219
20.0%	3.6512	2.7833	4.7896
Auto-0.0%	3.5168	3.0437	4.0634



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

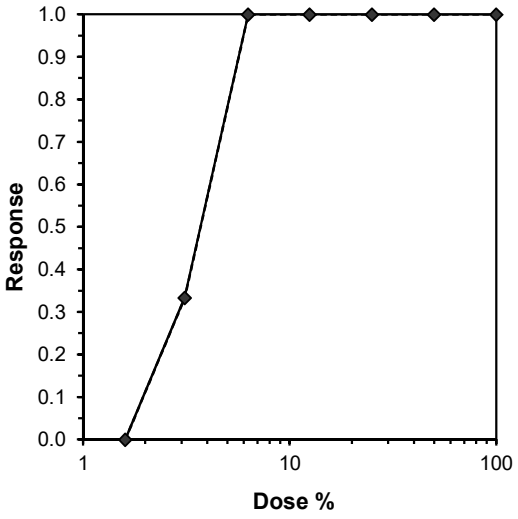
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4					
ASW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4	*			0.9000	1.0000
1.6	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	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 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

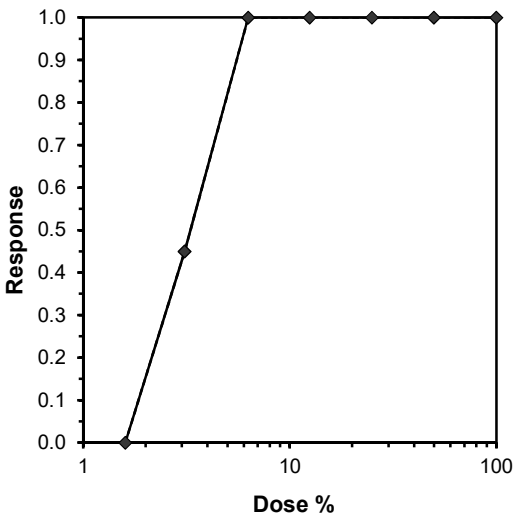
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	11.00	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

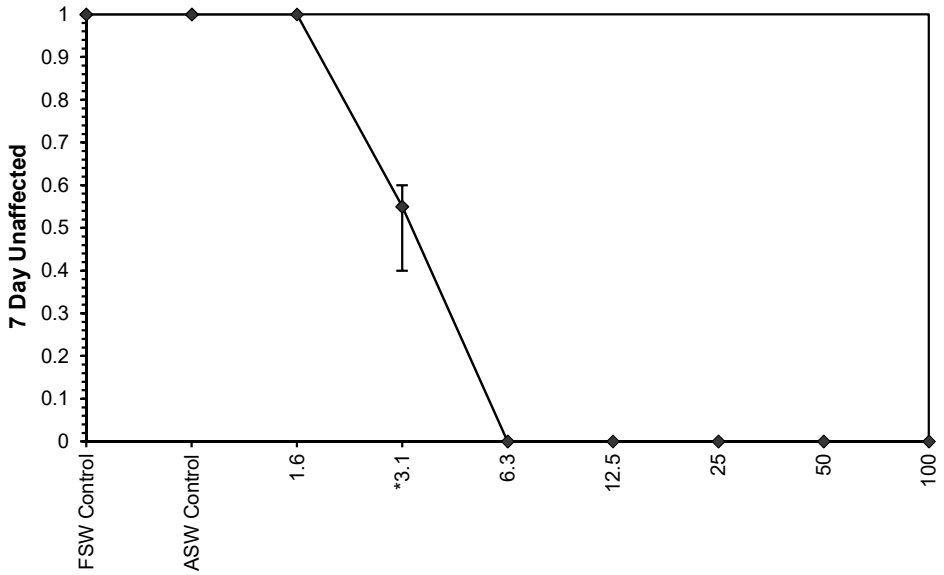
Trim Level	EC50	95% CL	
0.0%	3.2466	2.7875	3.7813
5.0%	3.2538	2.7460	3.8556
10.0%	3.2611	2.6918	3.9508
20.0%	3.2755	2.5232	4.2521
Auto-0.0%	3.2466	2.7875	3.7813



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

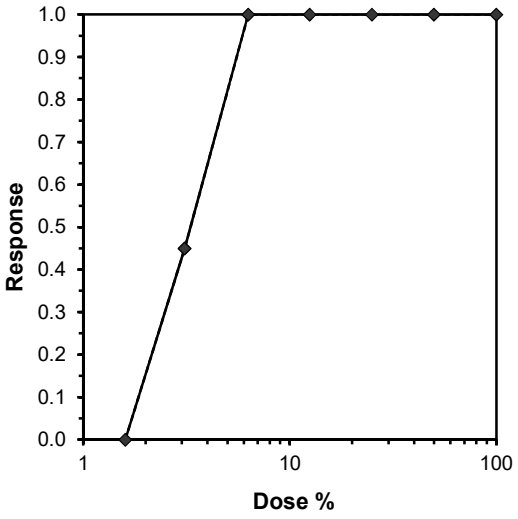
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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

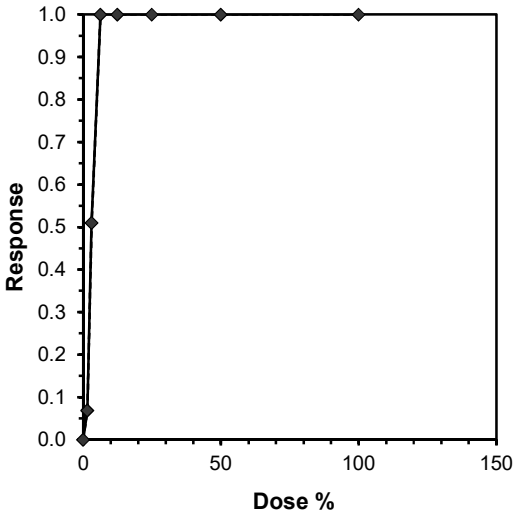
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.882251	0.859	-0.34393	-1.65716
Bartlett's Test indicates equal variances (p = 0.76)	0.551451	9.21034		
The control means are not significantly different (p = 0.85)	0.196645	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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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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

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.

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Toxicity Test Report: TR1858/10

Accredited for compliance with ISO/IEC 17025 - Testing

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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.

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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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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* **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)% **72-hr EC50 =3.9 (3.75-3.96)%** **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: TR1858/11

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.

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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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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* **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)% **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

Client:	Beach Energy Ltd GPO Box 175 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:	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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	17.7x10^4 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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.
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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 2 October 2019 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. 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

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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
					96 h Algal toxicity 96 h Blue Fit	72 h Nitrosomonas 72 h Hormesis	48 h Invertebrate 1-h Sediment Fert.	72 h Seed cress	7 d Fish & Crocodile	Soil - Sampling for Fingerprint	**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** 18558
9°C											
X 2/10/19	X 06:00	X Y0021019-1	Grab	4 x 2.5L	✓	✓	✓	✓	✓	✓	
9259 "	06:00	Y0021019-2	"	"	✓	✓	✓	✓	✓	✓	
"	06:00	Y0021019-3	"	"	✓	✓	✓	✓	✓	✓	
"	06:00	Y0021019-4	"	"	✓	✓	✓	✓	✓	✓	

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

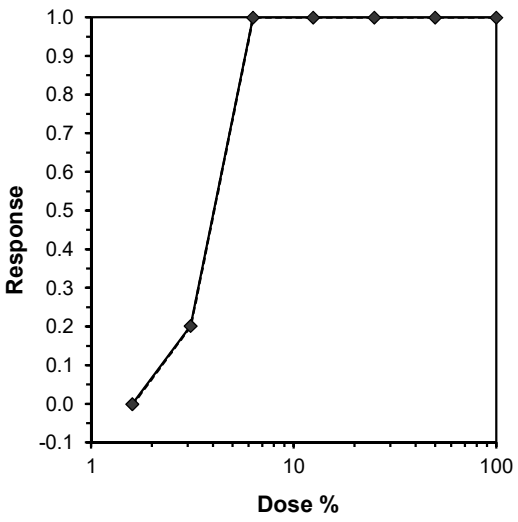
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9525	1.0079	1.3536	1.3030	1.3967	2.935	4				
ASW Control	0.9450	1.0000	1.3353	1.3030	1.3694	2.140	4	*		22	400
1.6	0.9475	1.0026	1.3413	1.3030	1.3694	2.499	4	19.00	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 Treatments vs ASW Control	1.6	3.1	2.227106	62.5

Trimmed Spearman-Karber

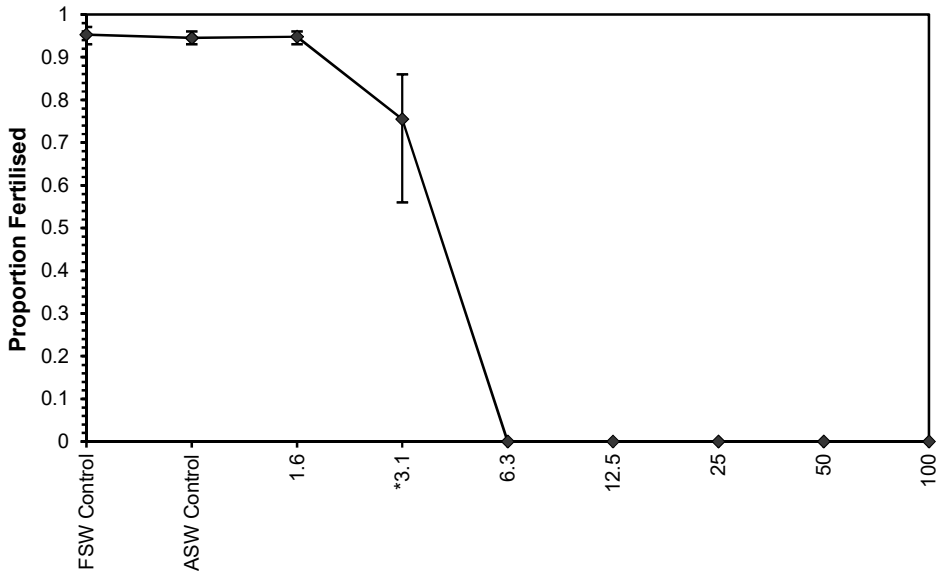
Trim Level	EC50	95% CL	
0.0%	3.8477	3.7432	3.9550
5.0%	3.9177	3.7966	4.0428
10.0%	3.9774	3.8284	4.1322
20.0%	4.0396	3.7814	4.3154
Auto-0.0%	3.8477	3.7432	3.9550



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

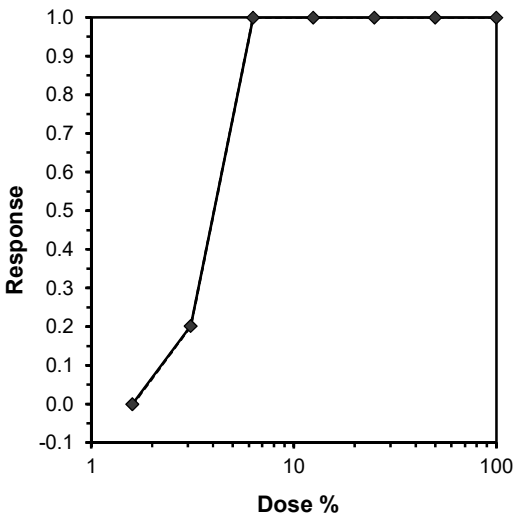
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9525	1.0079	1.3536	1.3030	1.3967	2.935	4				
ASW Control	0.9450	1.0000	1.3353	1.3030	1.3694	2.140	4	*		0.9463	1.0000
1.6	0.9475	1.0026	1.3413	1.3030	1.3694	2.499	4	19.00	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 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

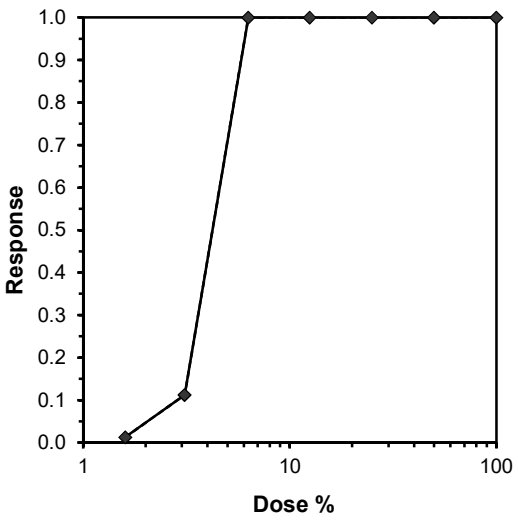
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9400	0.9766	1.3316	1.2490	1.4289	5.701	4					
ASW Control	0.9625	1.0000	1.3770	1.3453	1.3967	1.799	4	*			15	400
1.6	0.9500	0.9870	1.3481	1.3030	1.3967	3.165	4	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 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

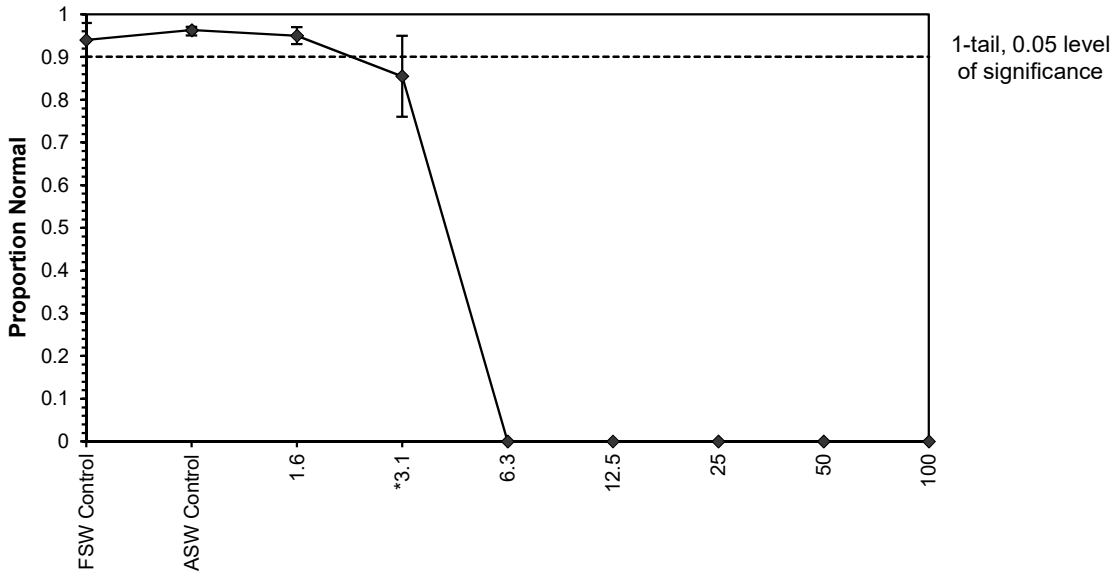
Trim Level	EC50	95% CL	
0.0%			
5.0%	4.1742	4.0686	4.2825
10.0%	4.2245	4.0713	4.3834
20.0%	4.2266	4.1672	4.2868
Auto-1.3%	4.1036	4.0124	4.1970



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

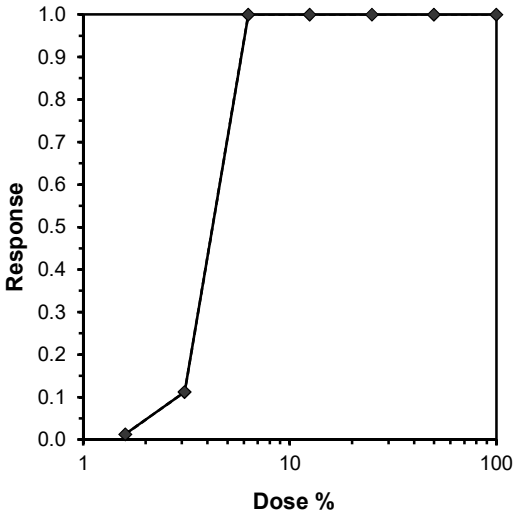
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9400	0.9766	1.3316	1.2490	1.4289	5.701	4					
ASW Control	0.9625	1.0000	1.3770	1.3453	1.3967	1.799	4	*			0.9625	1.0000
1.6	0.9500	0.9870	1.3481	1.3030	1.3967	3.165	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 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

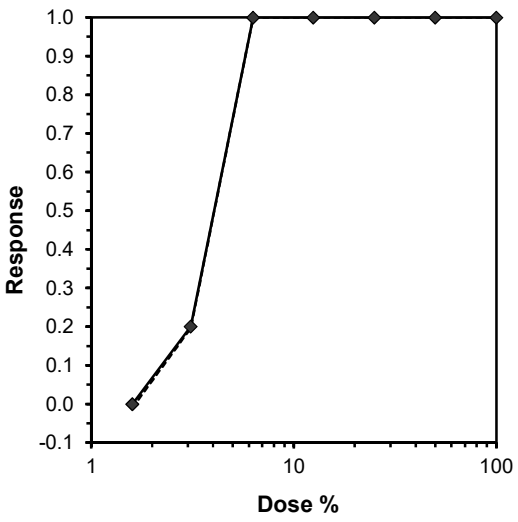
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7875	0.9813	1.0919	1.0706	1.1198	1.924	4					
ASW Control	0.8025	1.0000	1.1113	1.0588	1.1593	3.727	4	*			79	400
1.6	0.8100	1.0093	1.1209	1.0588	1.1593	3.972	4	-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 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

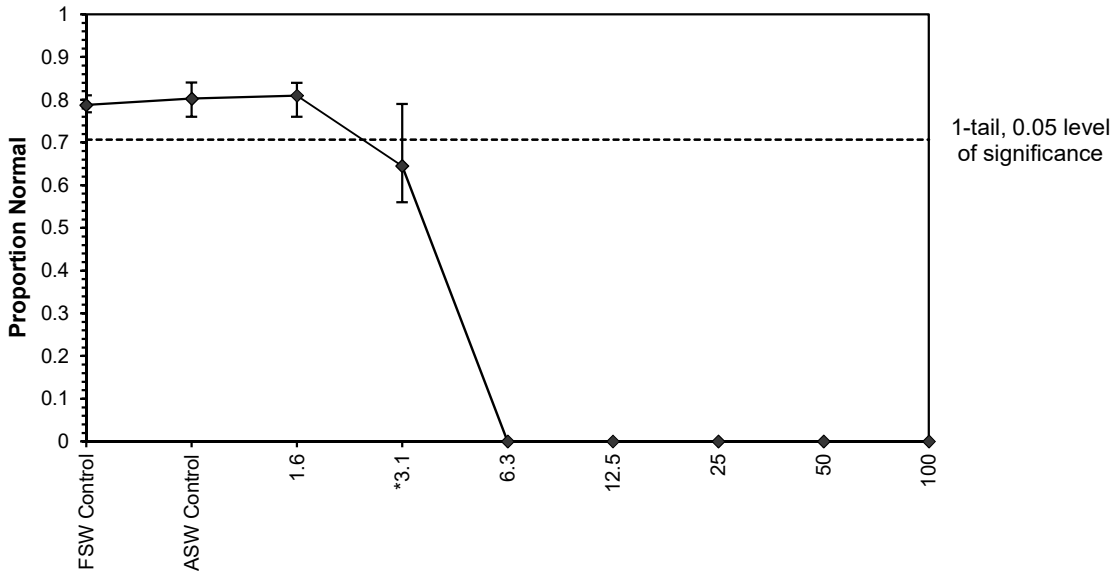
Trim Level	EC50	95% CL	
0.0%	3.8533	3.7491	3.9603
5.0%	3.9239	3.8029	4.0487
10.0%	3.9837	3.8347	4.1385
20.0%	4.0444	3.9558	4.1350
Auto-0.0%	3.8533	3.7491	3.9603



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

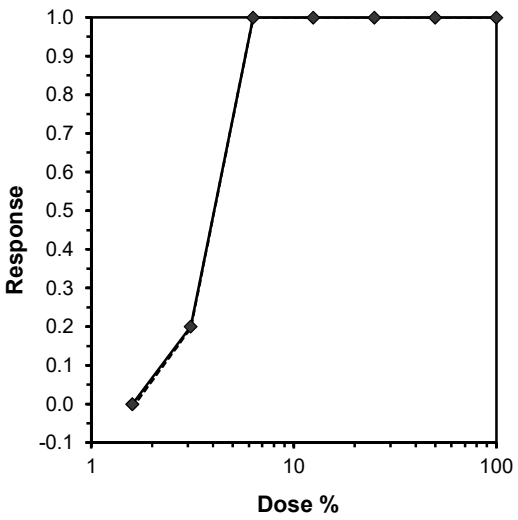
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7875	0.9813	1.0919	1.0706	1.1198	1.924	4					
ASW Control	0.8025	1.0000	1.1113	1.0588	1.1593	3.727	4	*			0.8063	1.0000
1.6	0.8100	1.0093	1.1209	1.0588	1.1593	3.972	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 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

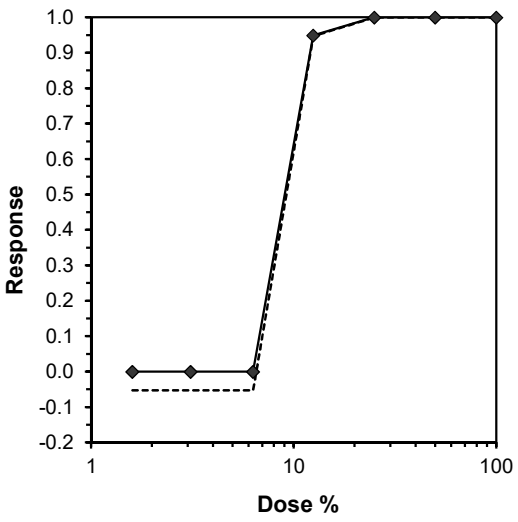
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4				
ASW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	*		1	20
1.6	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4	20.00	10.00	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

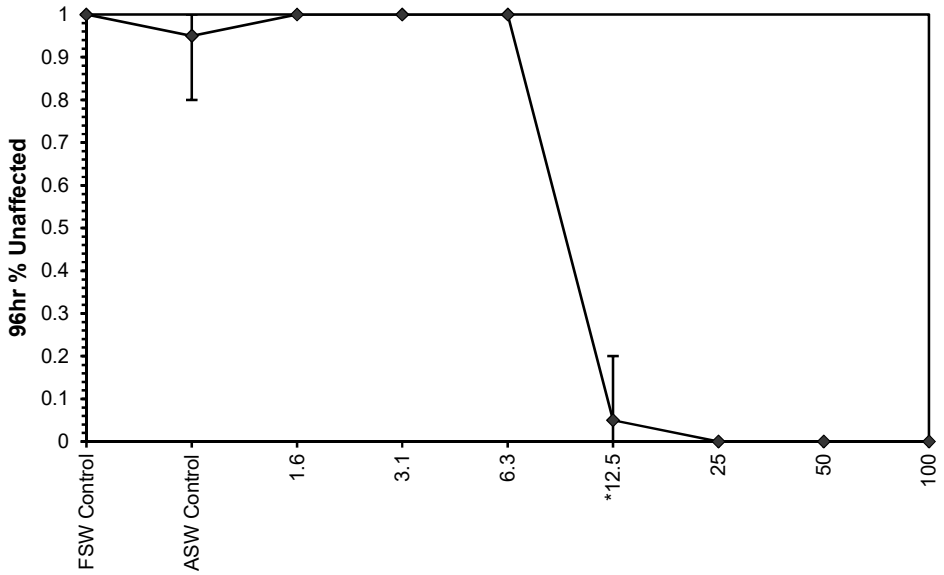
Trim Level	EC50	95% CL	
0.0%	9.1892	8.5888	9.8316
5.0%	9.0378	8.6976	9.3912
10.0%	9.0378	8.7071	9.3809
20.0%	9.0378	8.7071	9.3809
Auto-0.0%	9.1892	8.5888	9.8316



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

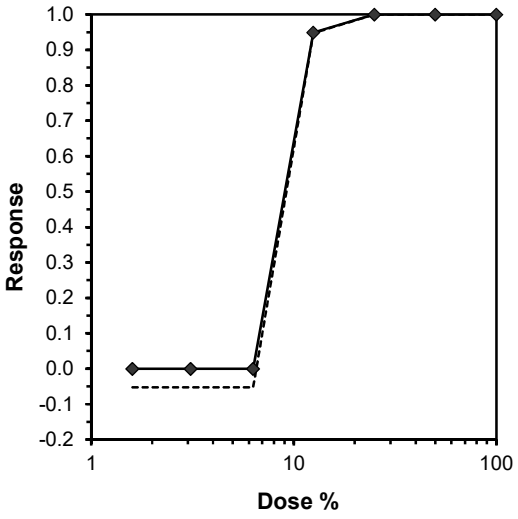
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4				
ASW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	*		0.9875	1.0000
1.6	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4	20.00	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)

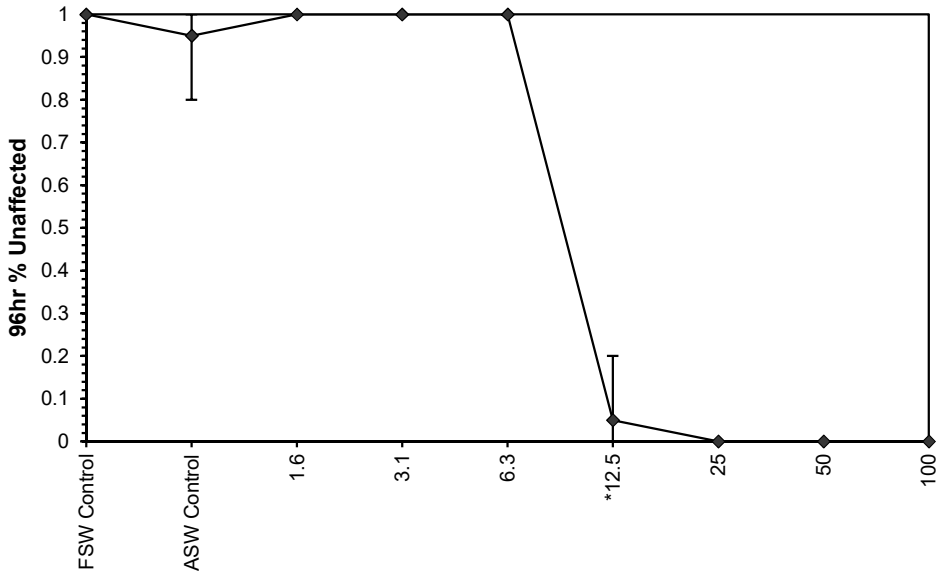
Point	%	SD	95% CL(Exp)		Skew
IC05	7.3866	0.8671	6.2975	10.3402	0.7131
IC10	7.8507	0.8948	6.3541	10.7345	0.5631
IC15	8.1722	0.9114	6.4007	10.9719	0.4202
IC20	8.4291	0.9264	6.4397	11.1489	0.2870
IC25	8.6502	0.9415	6.4736	11.2945	0.1633
IC40	9.2135	0.9922	6.5588	11.6449	-0.1592
IC50	9.5622	1.0336	6.6092	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				

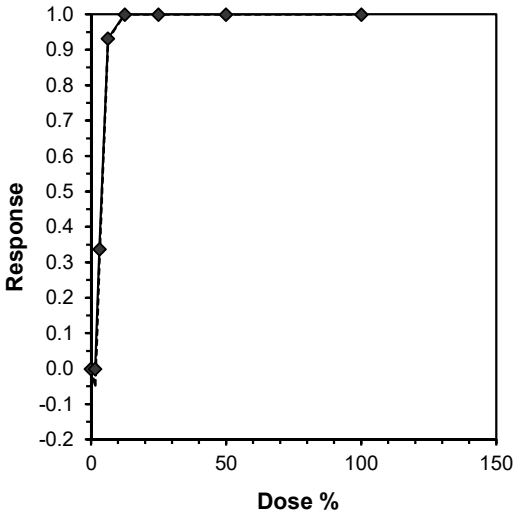
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	16.642	1.0568	16.642	15.260	17.969	5.320	8					
ASW Control	15.748	1.0000	15.748	14.935	16.777	5.040	4	*			16.154	1.0000
1.6	16.560	1.0516	16.560	15.585	17.860	5.728	4	-0.855	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 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)

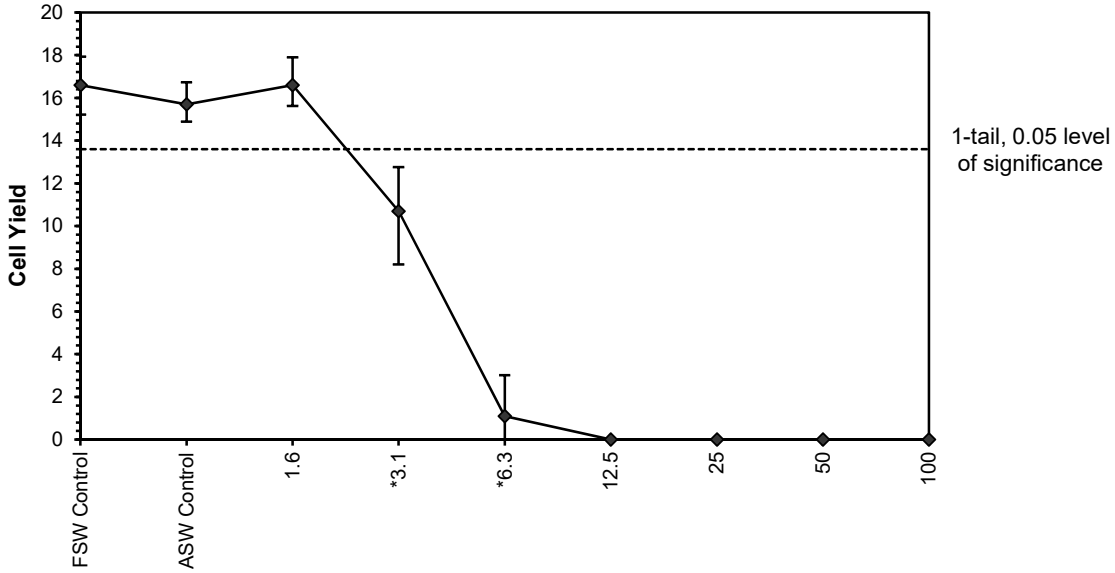
Point	%	SD	95% CL(Exp)		Skew
IC05	1.8226	0.0445	1.7147	1.9580	-1.5970
IC10	2.0451	0.0709	1.8906	2.3161	0.5371
IC15	2.2677	0.1038	2.0359	2.6741	0.6902
IC20	2.4902	0.1382	2.1812	3.0321	0.7386
IC25	2.7128	0.1700	2.3266	3.3674	0.6835
IC40	3.4390	0.2288	2.7656	4.0806	-0.0785
IC50	3.9771	0.2087	3.3138	4.5373	-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

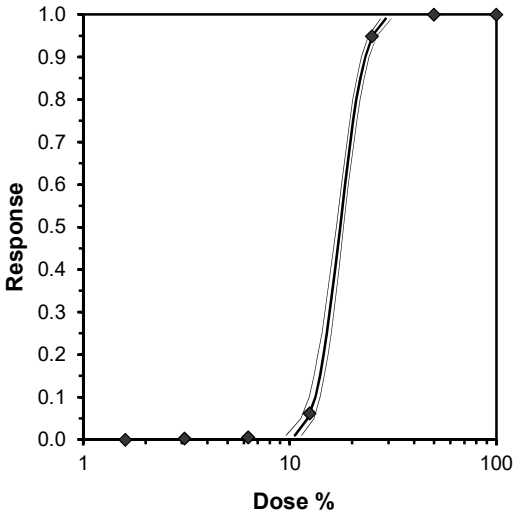
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.990604	0.916	0.038641	-0.27548
Bartlett's Test indicates equal variances (p = 0.57)	3.828166	15.08627		
The control means are not significantly different (p = 0.68)	0.431366	2.446912		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test 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							

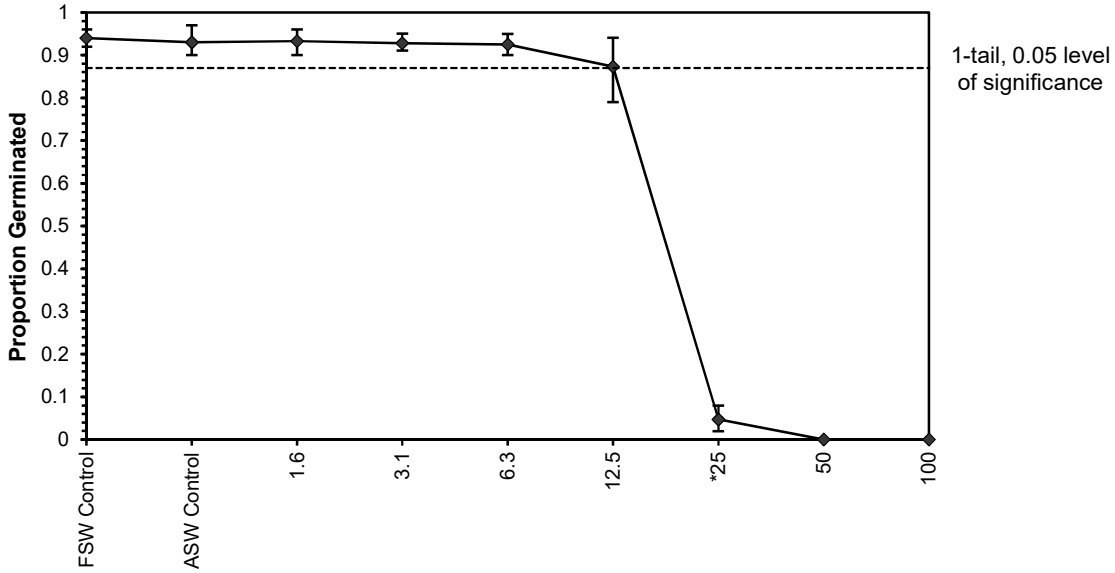
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	10.55641	9.597342	11.40222
EC05	3.355	12.24471	11.32893	13.0509
EC10	3.718	13.25248	12.37001	14.03231
EC15	3.964	13.97887	13.12206	14.74019
EC20	4.158	14.58448	13.7492	15.33156
EC25	4.326	15.1249	14.30833	15.86081
EC40	4.747	16.57714	15.80406	17.29447
EC50	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

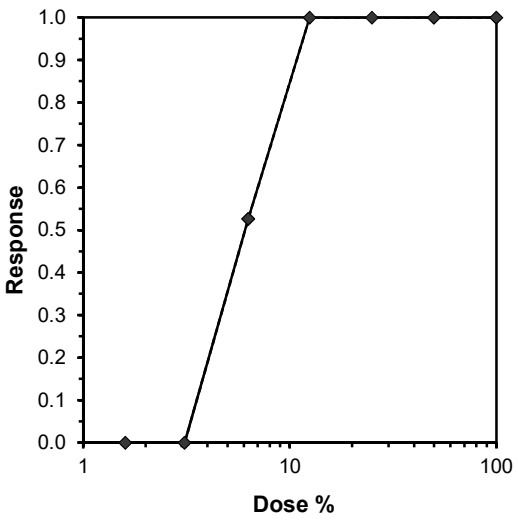
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9000	0.9474	1.2262	1.1071	1.3453	11.212	4				
ASW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	*		1	20
1.6	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	18.00	10.00	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Trimmed Spearman-Karber

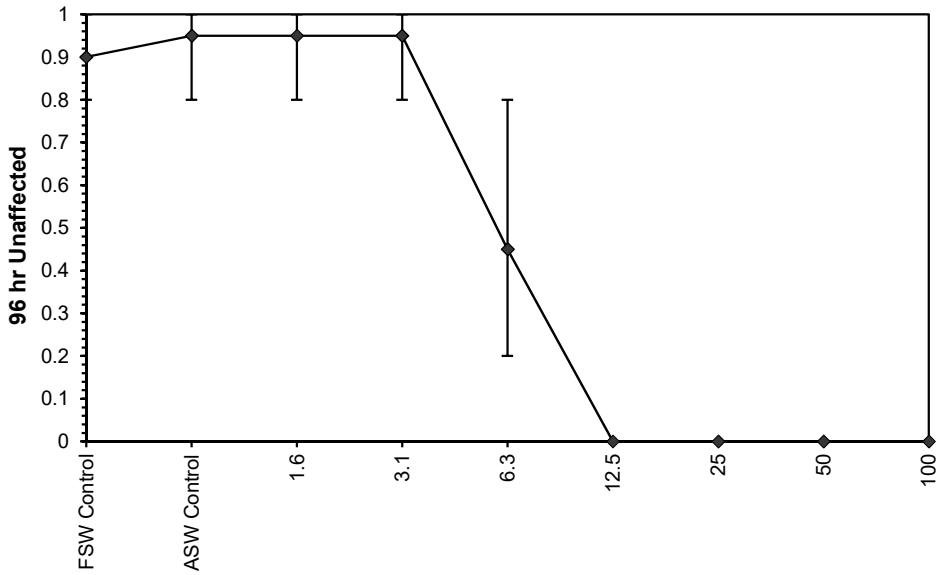
Trim Level	EC50	95% CL	
0.0%	6.1485	5.2621	7.1842
5.0%	6.1409	5.1663	7.2994
10.0%	6.1334	5.0523	7.4458
20.0%	6.1183	4.7374	7.9016
Auto-0.0%	6.1485	5.2621	7.1842



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

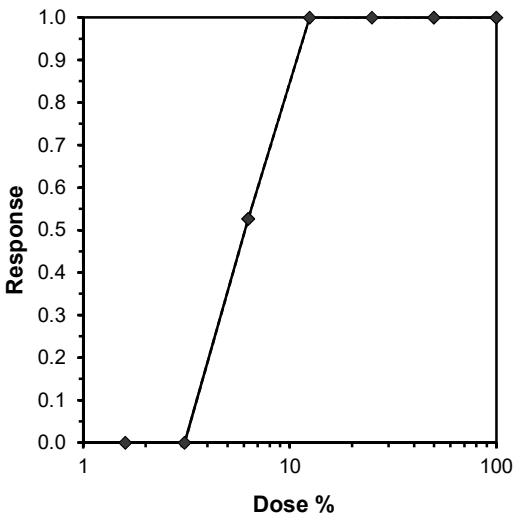
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9000	0.9474	1.2262	1.1071	1.3453	11.212	4				
ASW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	*		0.9500	1.0000
1.6	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	18.00	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Log-Logit Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05	3.6781	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

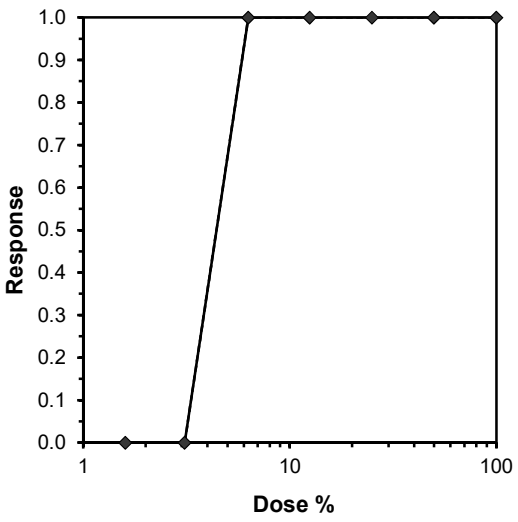
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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)

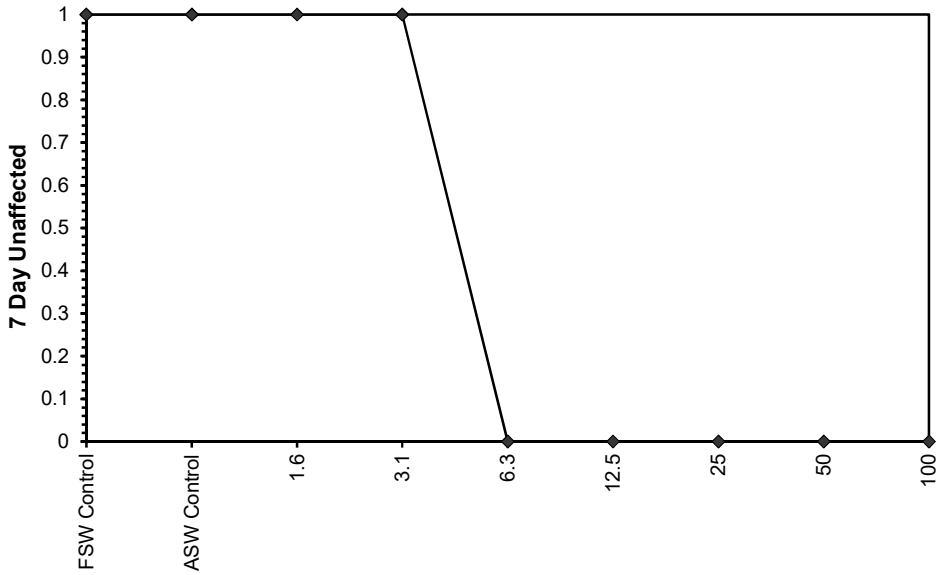
Point	%	SD	95% CL(Exp)		Skew
IC05	3.9889	0.0000	3.9889	3.9889	1.0076
IC10	4.1070	0.0000	4.1070	4.1070	-1.0076
IC15	4.1816	0.0000	4.1816	4.1816	-1.0076
IC20	4.2384	0.0000	4.2384	4.2384	1.0076
IC25	4.2858	0.0000	4.2858	4.2858	#DIV/0!
IC40	4.4018	0.0000	4.4018	4.4018	1.0076
IC50	4.4708	0.0000	4.4708	4.4708	-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

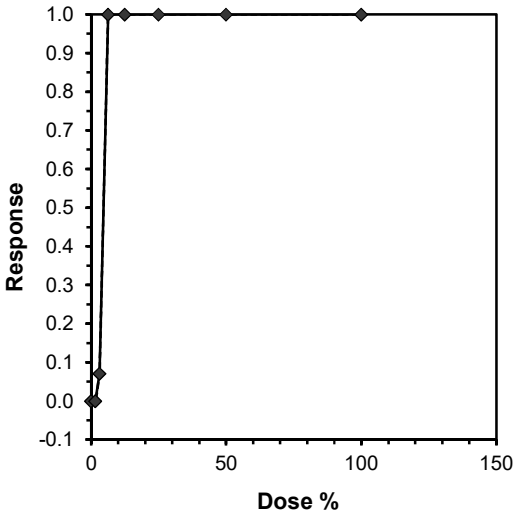
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	16.810	0.9529	16.810	15.760	18.200	6.170	4					
ASW Control	17.640	1.0000	17.640	15.980	19.980	9.971	4	*			17.693	1.0000
1.6	17.745	1.0060	17.745	16.540	18.740	5.583	4	-0.116	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 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 GPO Box 175 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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)% **72-hr EC50 = 13.9 (13.41-14.34)%** **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)

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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.

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 GPO Box 175 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. 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)% **72-hr EC50 =12.3 (11.93-12.78)%** **NOEC = 6.3%** **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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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 x10^4 ± 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	≥16.0x10^4 cells/mL	16.9x10^4 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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ABN 95 619 426 201

Toxicity Test Report: TR1858/22

Client:	Beach Energy Ltd GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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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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.
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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 GPO Box 175 Adelaide SA 5002	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1858 9 October 2019 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. 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
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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: Rob McFadyen

Ship To: Ecotox Services Australia
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
					ecotox Alkalinity Acute EC50 Bass FIT	72 hr Acute Toxicity 72-hr Inhibition	48 hr Toxicity Screening Test 1-hr	72 hr Screening Test	7 d FIT & Growth	Sediment - Sampling for Freezing	**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** 15583
14 OV											
0262 X 9-10-19	X 0600	X 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:
X	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

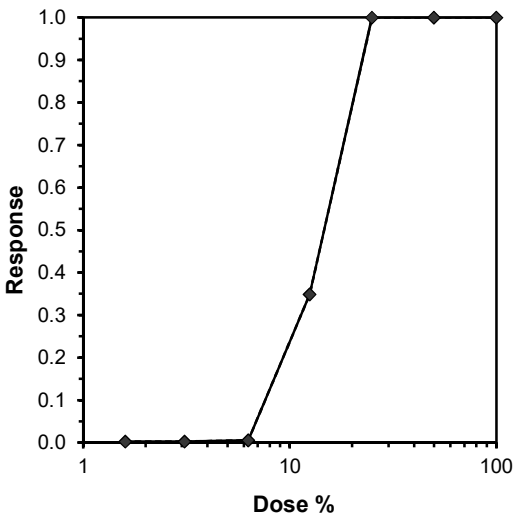
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9525	0.9922	1.3562	1.3030	1.4289	4.120	4				
ASW Control	0.9600	1.0000	1.3736	1.3233	1.4289	3.497	4	*		16	400
1.6	0.9575	0.9974	1.3667	1.3233	1.4289	3.330	4	17.50	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Trimmed Spearman-Karber

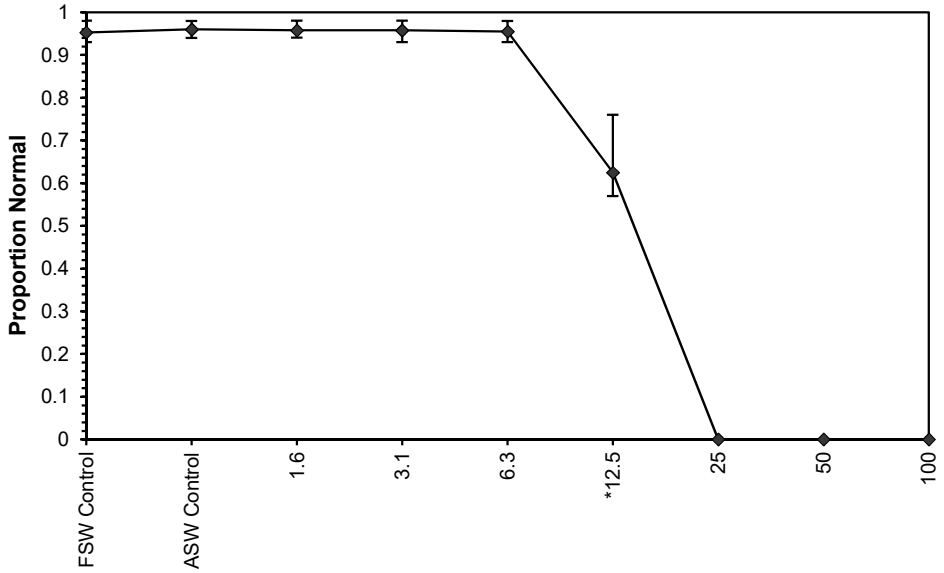
Trim Level	EC50	95% CL	
0.0%			
5.0%	14.019	13.513	14.544
10.0%	14.162	13.577	14.772
20.0%	14.431	13.578	15.337
Auto-0.3%	13.869	13.412	14.340



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

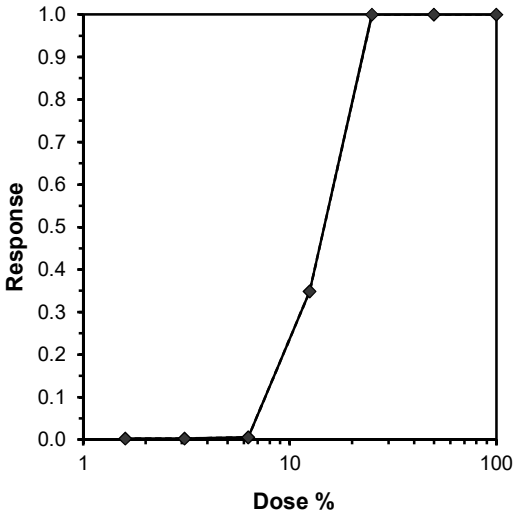
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9525	0.9922	1.3562	1.3030	1.4289	4.120	4				
ASW Control	0.9600	1.0000	1.3736	1.3233	1.4289	3.497	4	*		0.9600	1.0000
1.6	0.9575	0.9974	1.3667	1.3233	1.4289	3.330	4	17.50	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 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

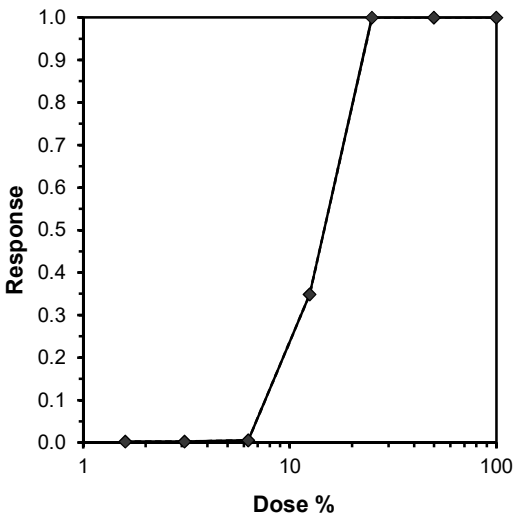
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	0.9525	0.9922	1.3562	1.3030	1.4289	4.120	4				
ASW Control	0.9600	1.0000	1.3736	1.3233	1.4289	3.497	4	*		16	400
1.6	0.9575	0.9974	1.3667	1.3233	1.4289	3.330	4	17.50	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 Treatments vs ASW Control	6.3	12.5	8.87412	15.87302

Trimmed Spearman-Karber

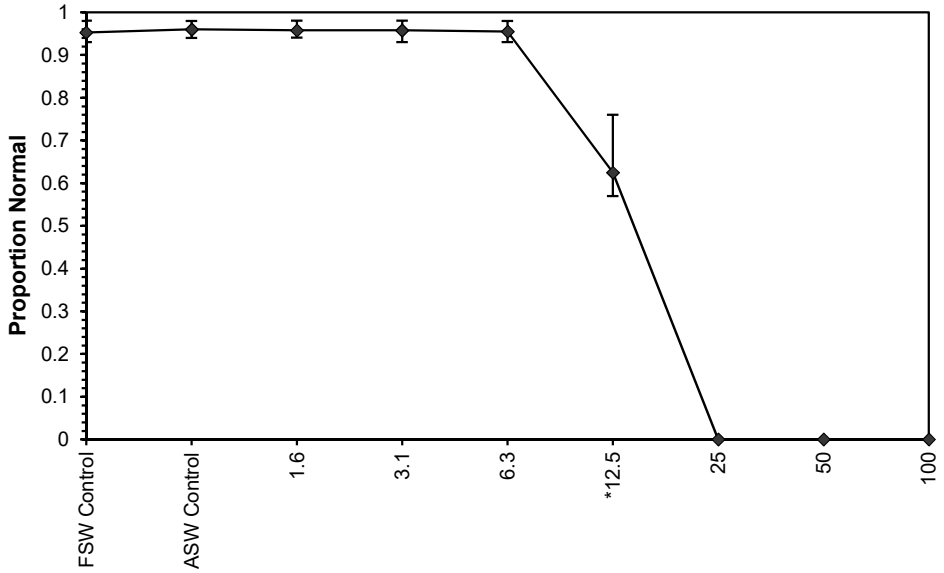
Trim Level	EC50	95% CL	
0.0%			
5.0%	14.019	13.513	14.544
10.0%	14.162	13.577	14.772
20.0%	14.431	13.578	15.337
Auto-0.3%	13.869	13.412	14.340



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

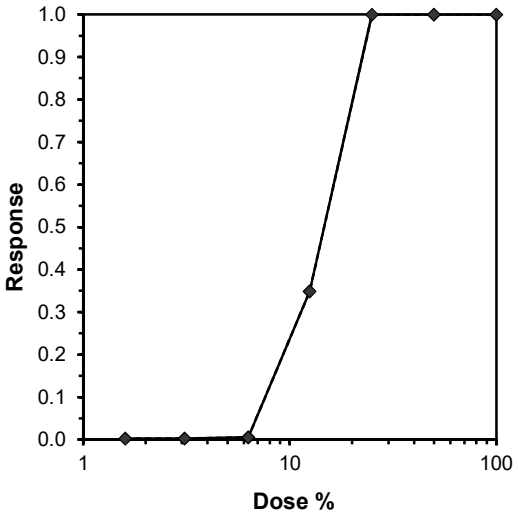
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	0.9525	0.9922	1.3562	1.3030	1.4289	4.120	4				
ASW Control	0.9600	1.0000	1.3736	1.3233	1.4289	3.497	4	*		0.9600	1.0000
1.6	0.9575	0.9974	1.3667	1.3233	1.4289	3.330	4	17.50	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 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

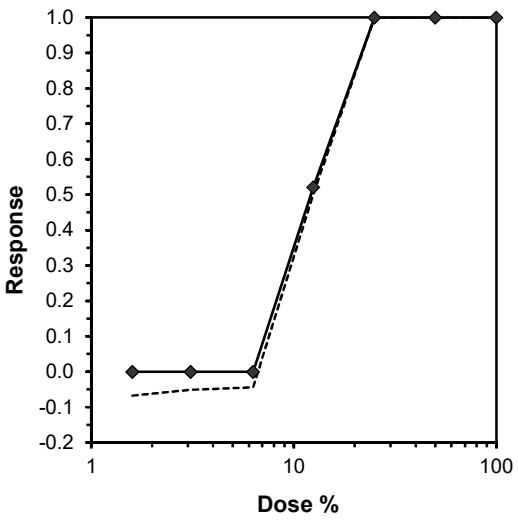
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.7675	1.0337	1.0684	1.0244	1.1198	3.694	4					
ASW Control	0.7425	1.0000	1.0391	1.0021	1.0826	3.306	4	*			103	400
1.6	0.7925	1.0673	1.0989	1.0588	1.1593	3.909	4	-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 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

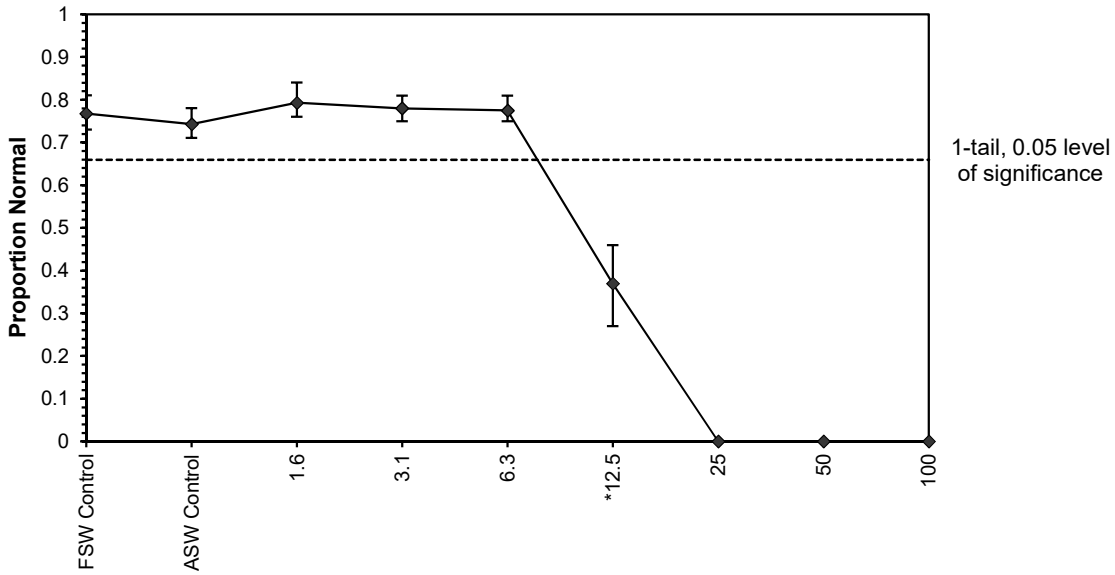
Trim Level	EC50	95% CL	
0.0%	12.345	11.927	12.777
5.0%	12.324	11.862	12.804
10.0%	12.304	11.788	12.843
20.0%	12.264	11.589	12.977
Auto-0.0%	12.345	11.927	12.777



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

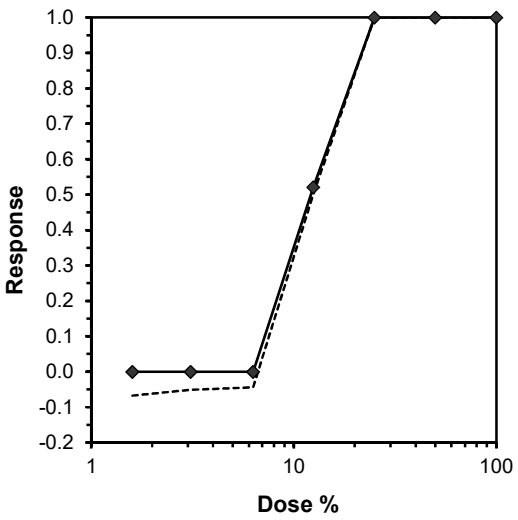
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.7675	1.0337	1.0684	1.0244	1.1198	3.694	4					
ASW Control	0.7425	1.0000	1.0391	1.0021	1.0826	3.306	4	*			0.7725	1.0000
1.6	0.7925	1.0673	1.0989	1.0588	1.1593	3.909	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 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

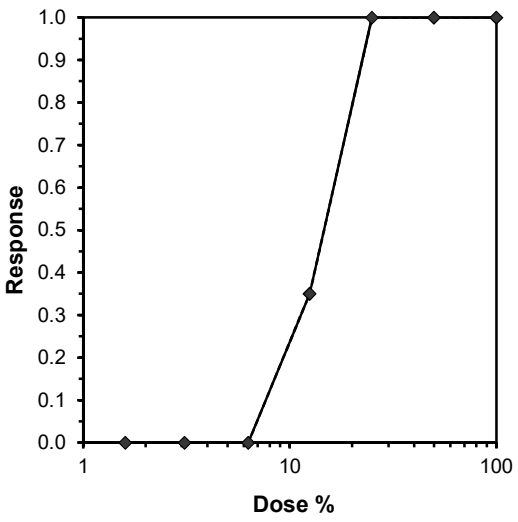
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

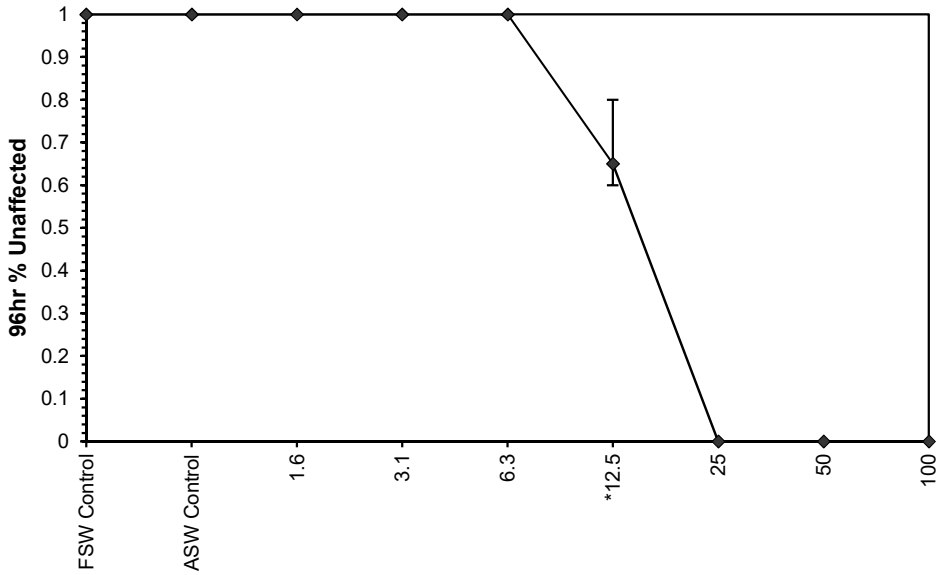
Trim Level	EC50	95% CL	
0.0%	13.889	11.990	16.088
5.0%	14.029	11.901	16.537
10.0%	14.166	11.726	17.114
20.0%	14.425	10.978	18.955
Auto-0.0%	13.889	11.990	16.088



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

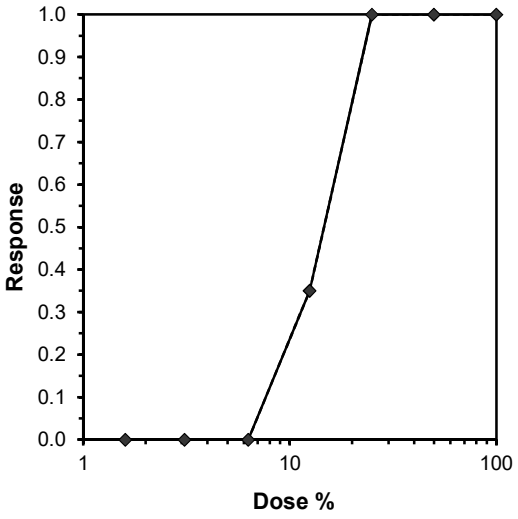
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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				

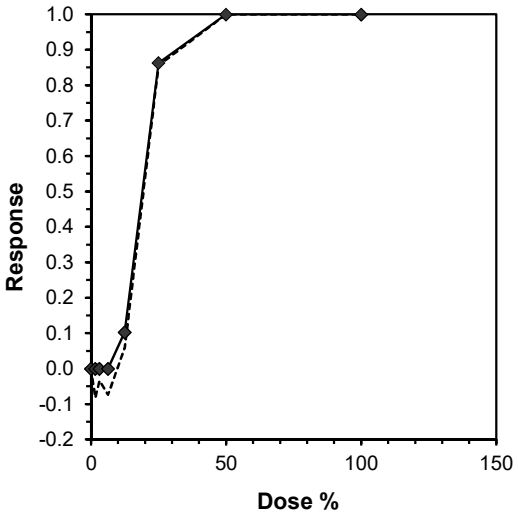
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	15.888	1.0618	15.888	14.463	16.863	5.464	8					
ASW Control	14.963	1.0000	14.963	13.563	15.763	6.988	4	*			15.669	1.0000
1.6	16.188	1.0819	16.188	15.363	16.863	4.109	4	-1.247	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 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)

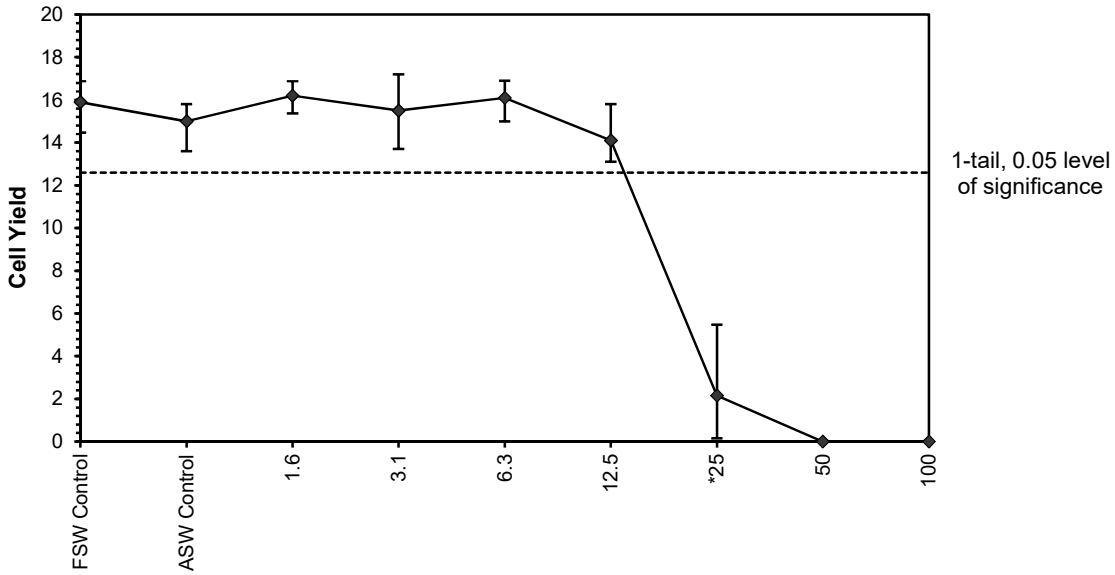
Point	%	SD	95% CL(Exp)		Skew
IC05	9.324	1.595	4.966	14.219	-0.7465
IC10	12.348	1.105	8.325	13.878	-0.2383
IC15	13.281	0.566	11.506	14.673	-0.0083
IC20	14.103	0.510	12.737	15.539	0.5533
IC25	14.924	0.505	13.615	16.409	0.6795
IC40	17.390	0.565	15.933	18.952	0.7747
IC50	19.034	0.654	17.457	21.013	0.7583



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

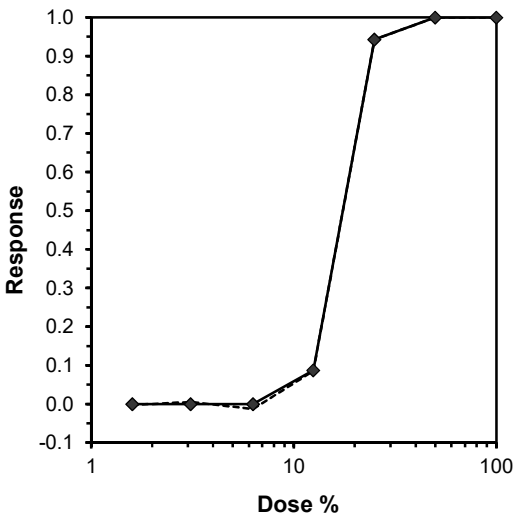
			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
FSW Control	0.9725	1.0026	1.4060	1.3694	1.4289	2.042	4					
ASW Control	0.9700	1.0000	1.4085	1.3233	1.4706	5.265	4	*			12	400
1.6	0.9725	1.0026	1.4060	1.3694	1.4289	2.042	4	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 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

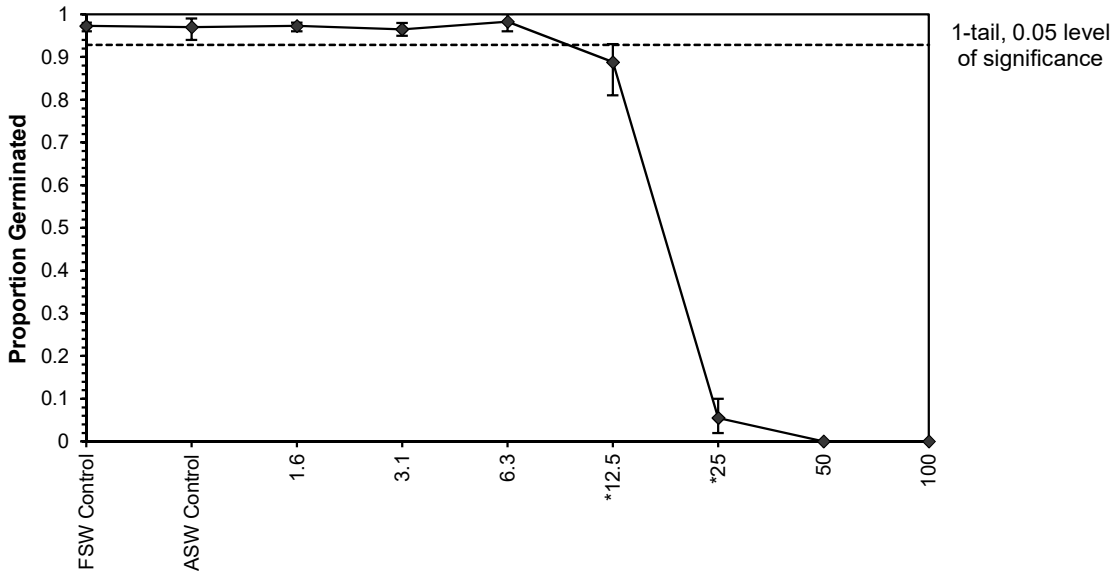
Trim Level	EC50	95% CL	
0.0%	17.310	16.879	17.752
5.0%	17.368	17.005	17.738
10.0%	17.458	17.200	17.720
20.0%	17.458	17.200	17.720
Auto-0.0%	17.310	16.879	17.752



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

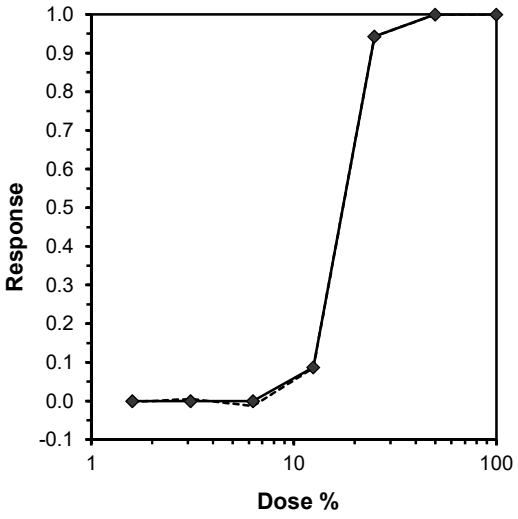
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	0.9725	1.0026	1.4060	1.3694	1.4289	2.042	4					
ASW Control	0.9700	1.0000	1.4085	1.3233	1.4706	5.265	4	*			0.9725	1.0000
1.6	0.9725	1.0026	1.4060	1.3694	1.4289	2.042	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 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

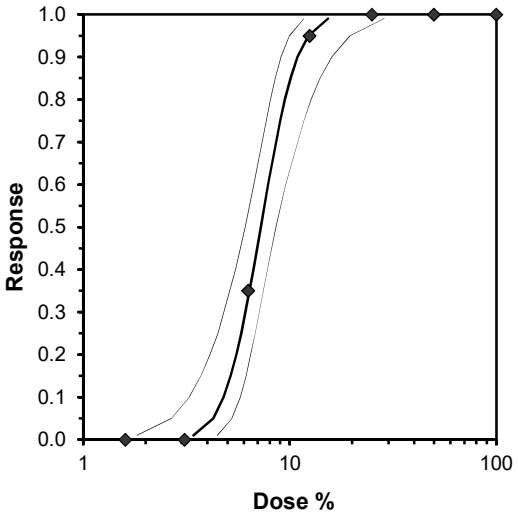
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.772021	0.905	-0.337	3.142347
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.446912		

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											

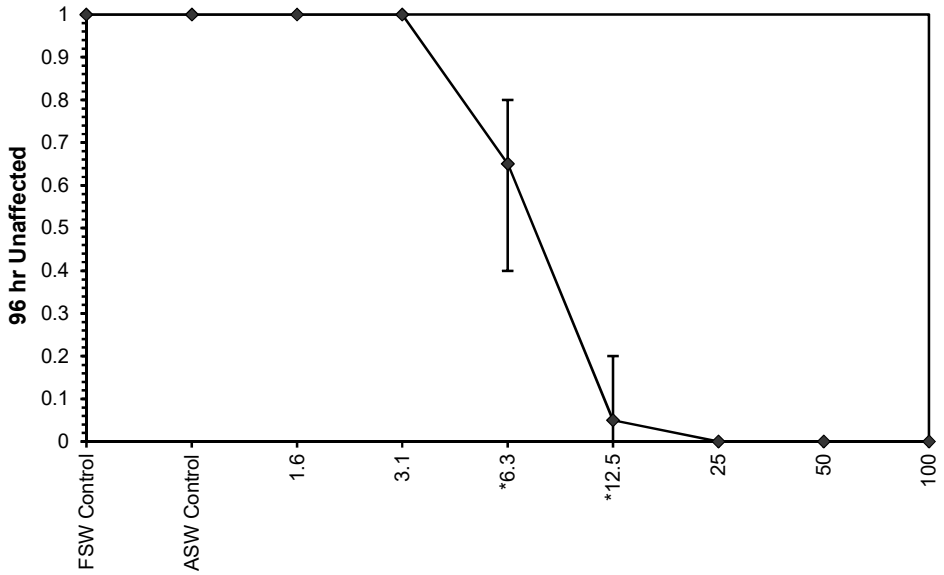
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	3.424425	1.823373	4.459235
EC05	3.355	4.262061	2.668168	5.253962
EC10	3.718	4.789397	3.255165	5.757561
EC15	3.964	5.181574	3.711936	6.141831
EC20	4.158	5.516042	4.110225	6.481224
EC25	4.326	5.820141	4.475316	6.80322
EC40	4.747	6.662855	5.467963	7.796544
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

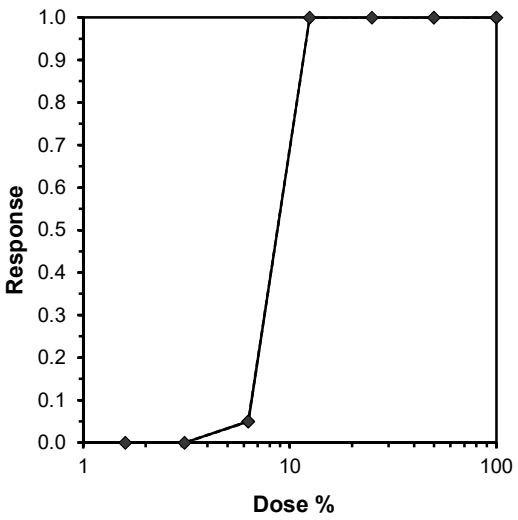
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		0	20
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	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

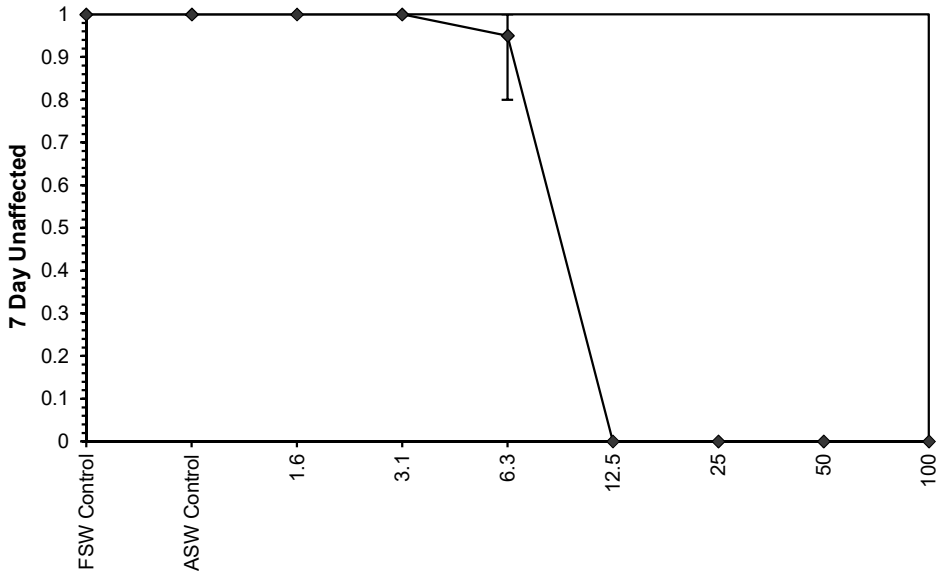
Trim Level	EC50	95% CL	
0.0%	8.5701	8.0071	9.1727
5.0%	8.7155	8.3990	9.0440
10.0%	8.7155	8.3990	9.0440
20.0%	8.7155	8.3990	9.0440
Auto-0.0%	8.5701	8.0071	9.1727



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

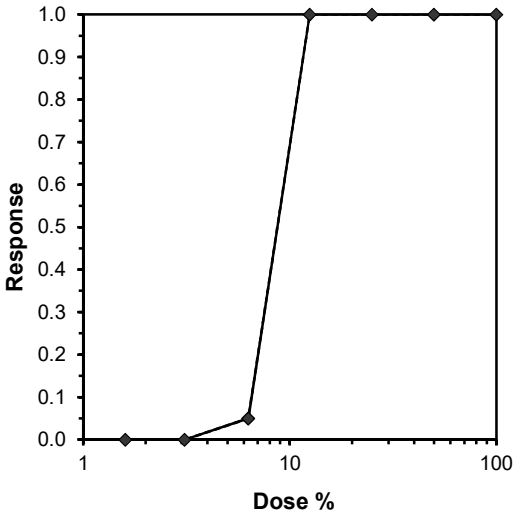
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
FSW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4				
ASW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	*		1.0000	1.0000
1.6	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	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

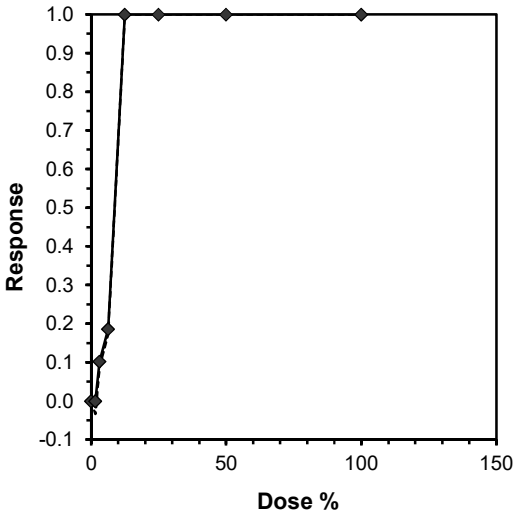
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
FSW Control	23.060	1.0197	23.060	22.160	24.140	3.536	4					
ASW Control	22.615	1.0000	22.615	21.740	23.260	3.077	4	*			22.995	1.0000
1.6	23.375	1.0336	23.375	21.240	26.140	8.708	4	-0.739	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 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

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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.

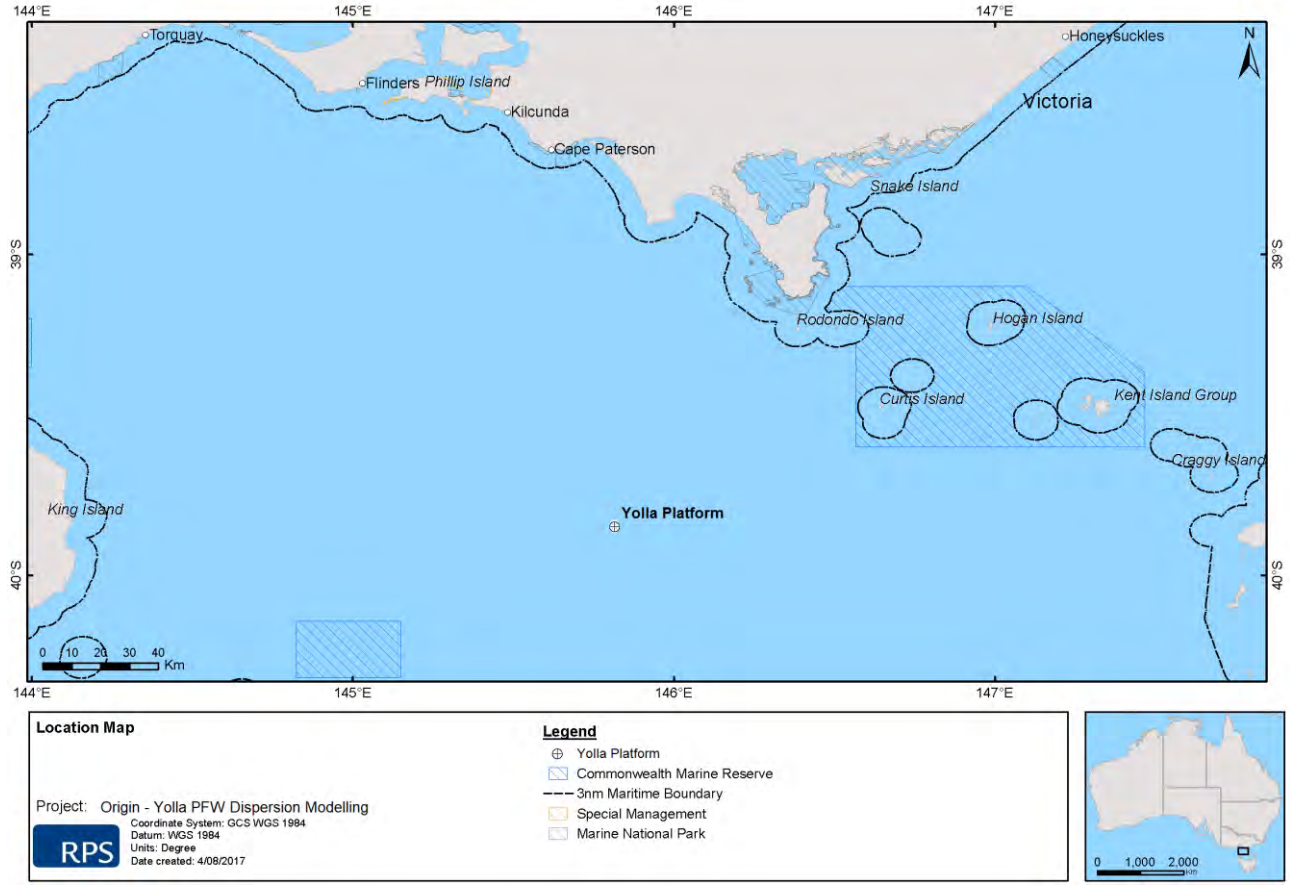


Figure 1 Location of the Yolla Platform used in the dispersion modelling study.

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.

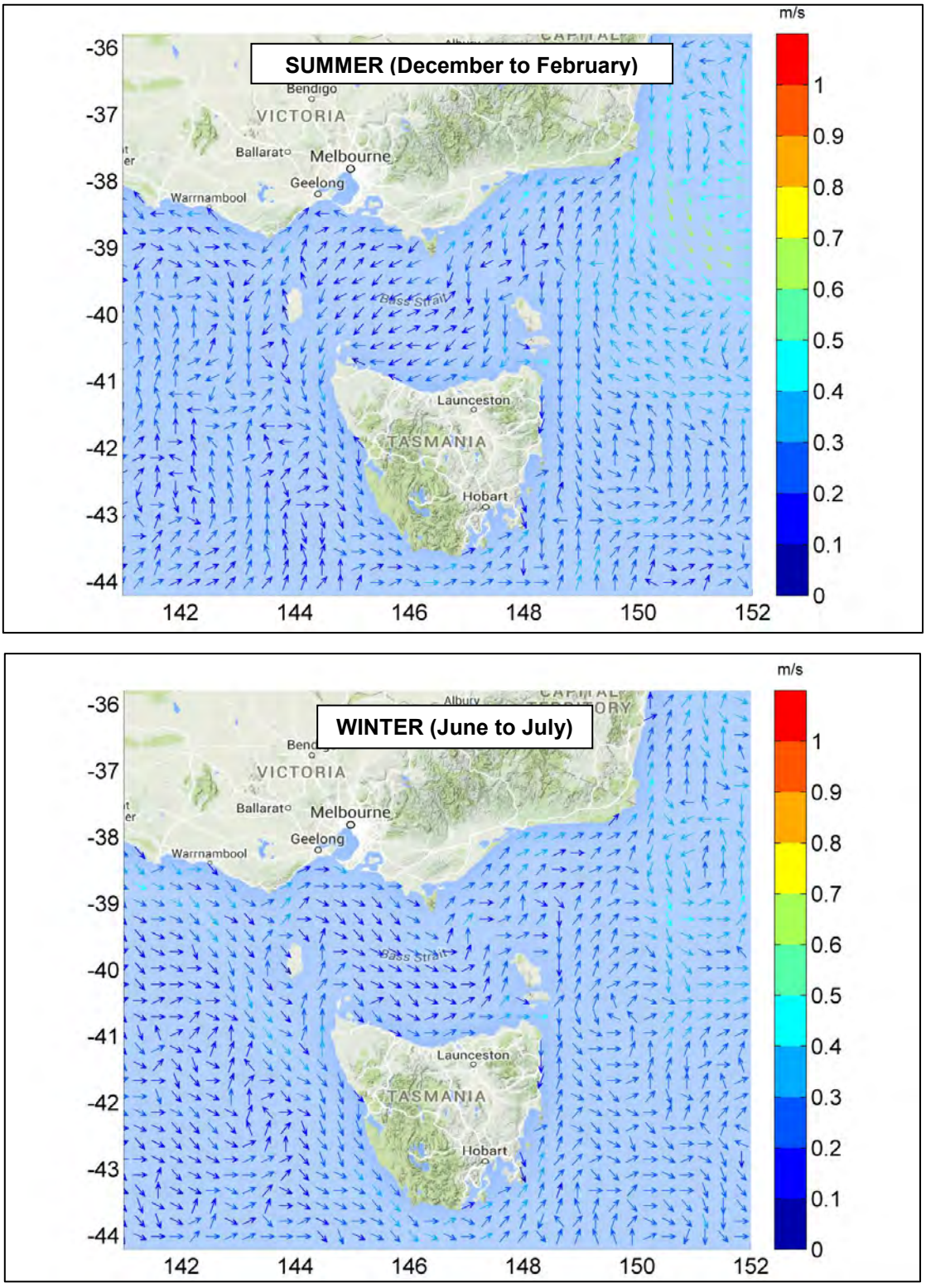


Figure 2 HYCOM averaged seasonal surface drift currents during summer and winter.

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).

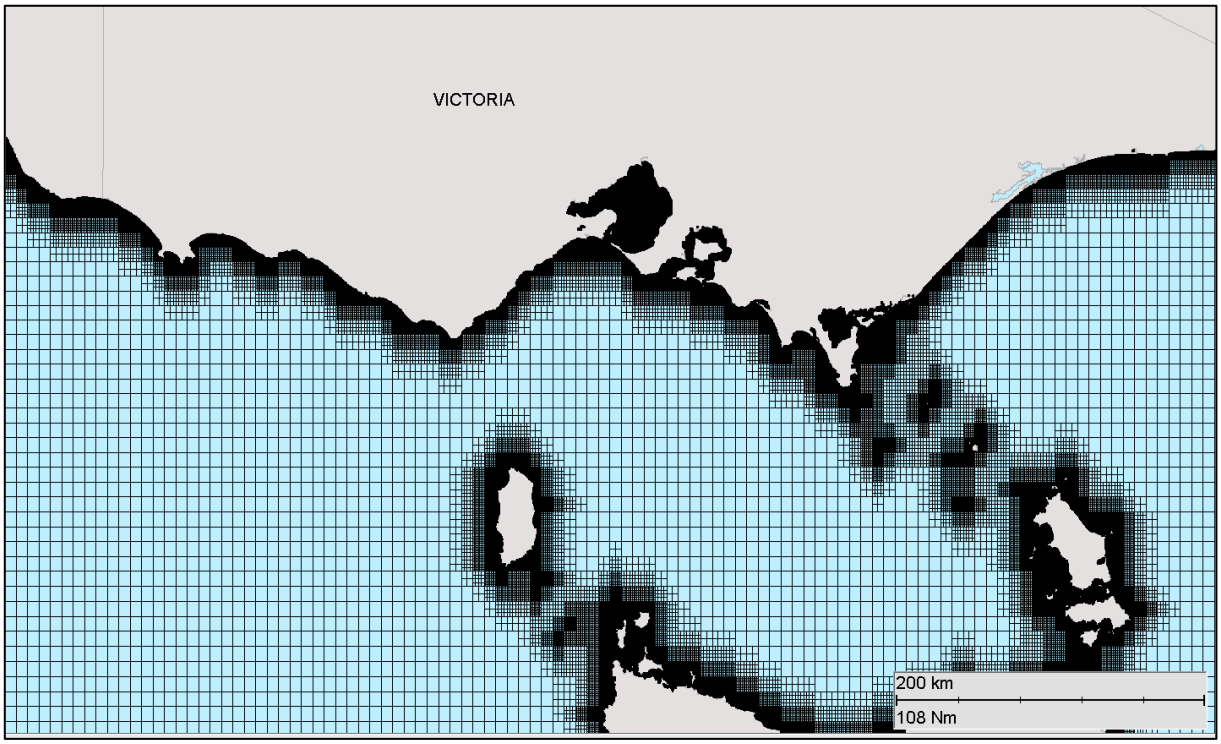


Figure 3 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

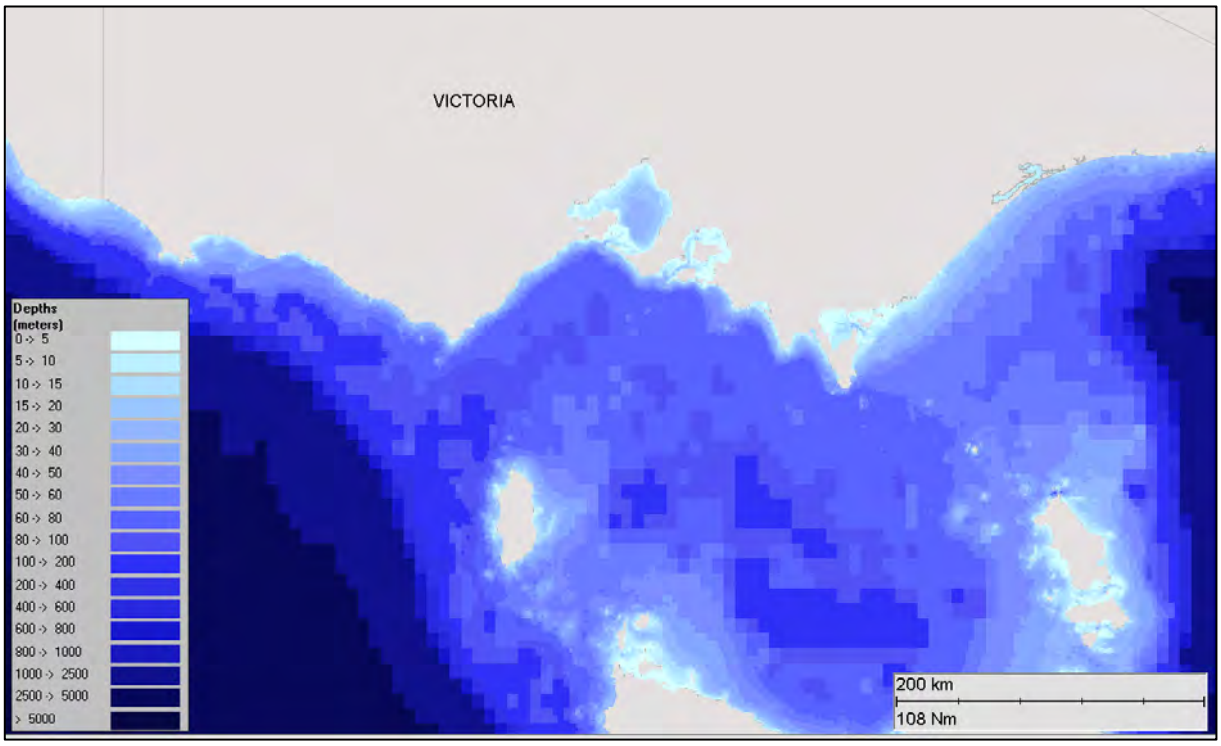


Figure 4 Bathymetry defined throughout the tidal model domain.

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

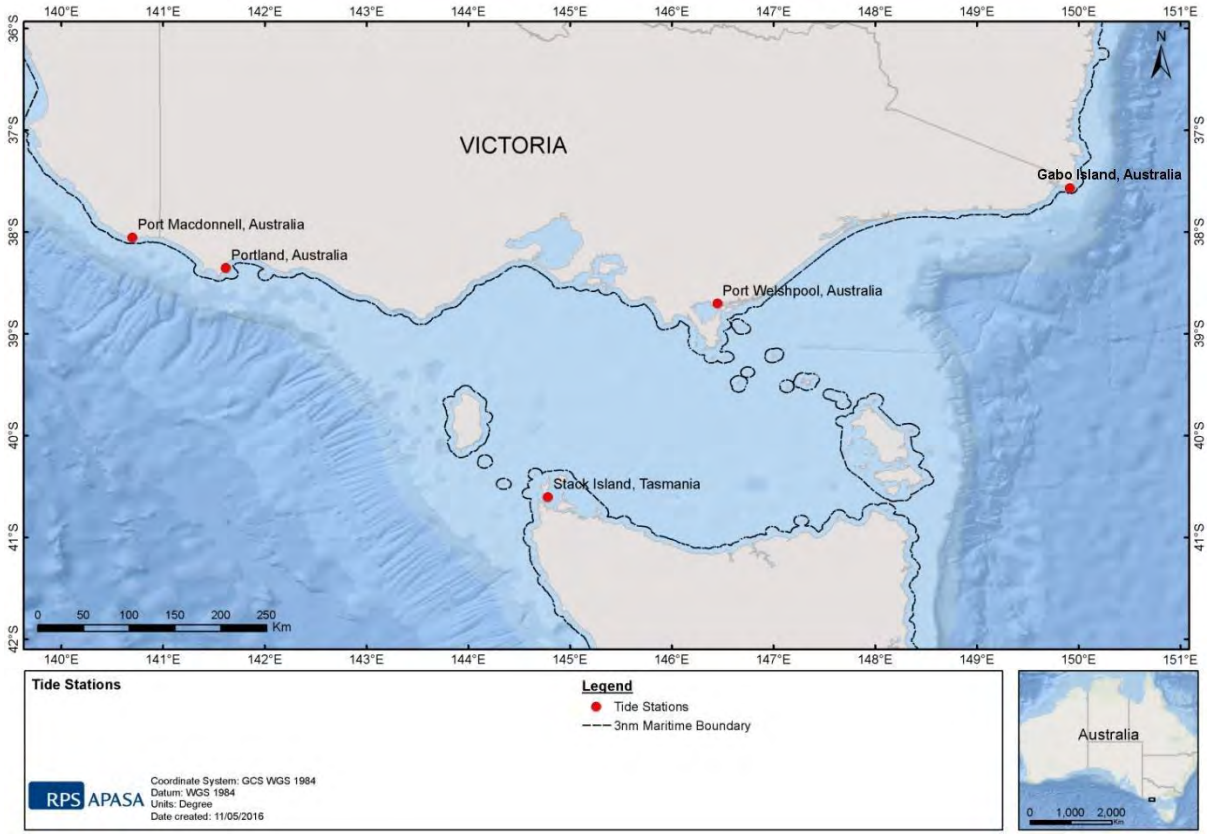


Figure 5 Location of the tide stations used in the surface elevation validation.

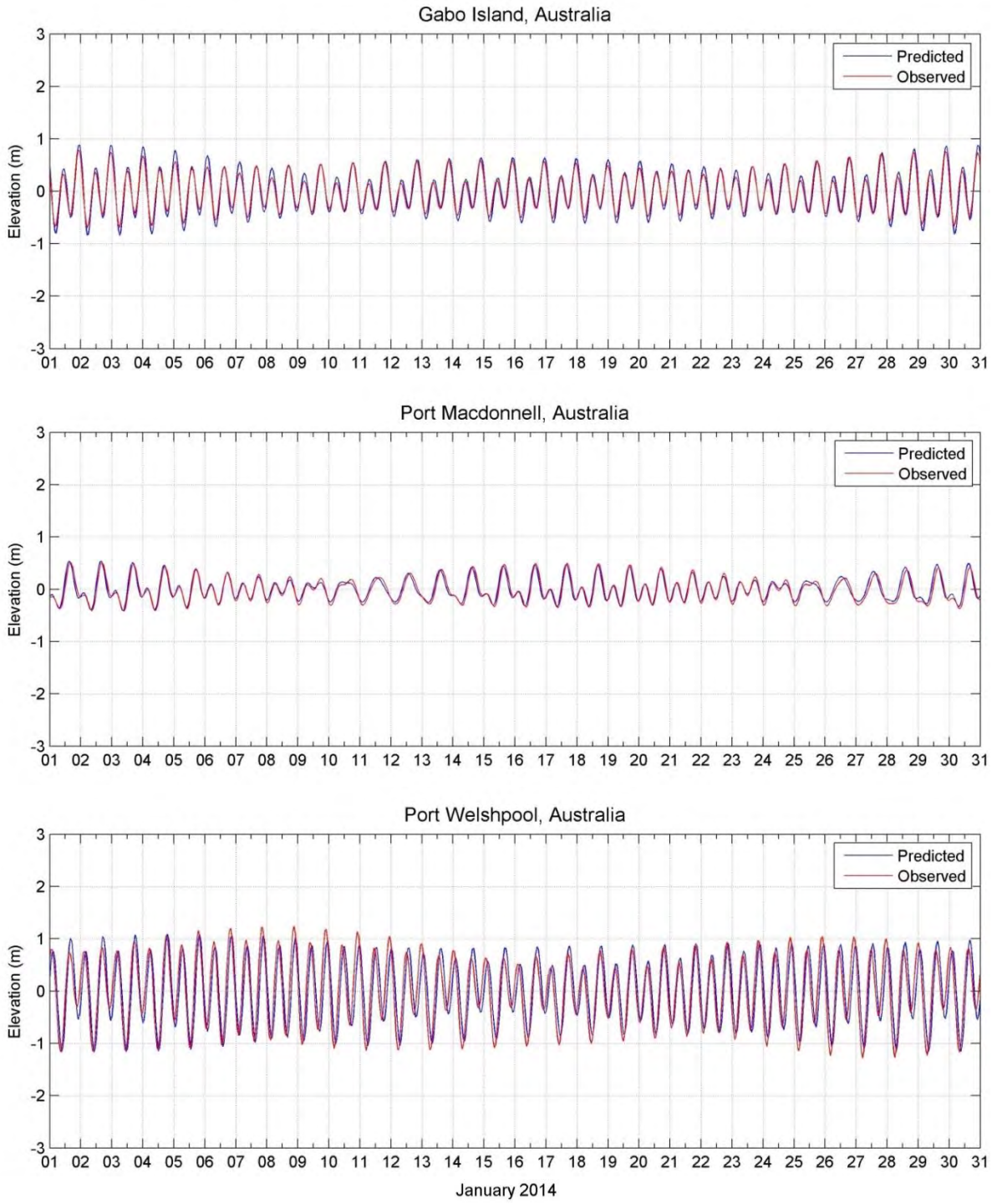


Figure 6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).

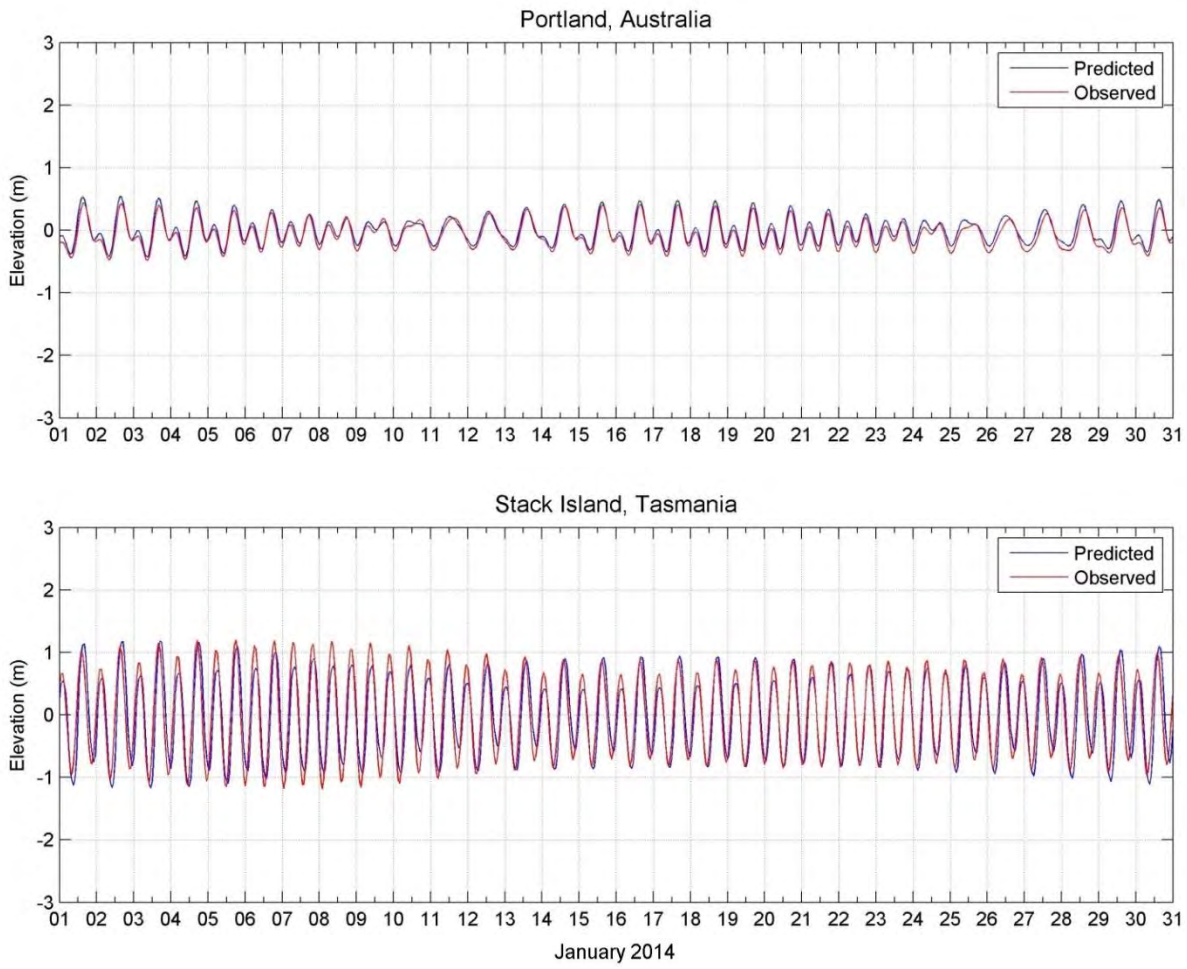


Figure 7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).

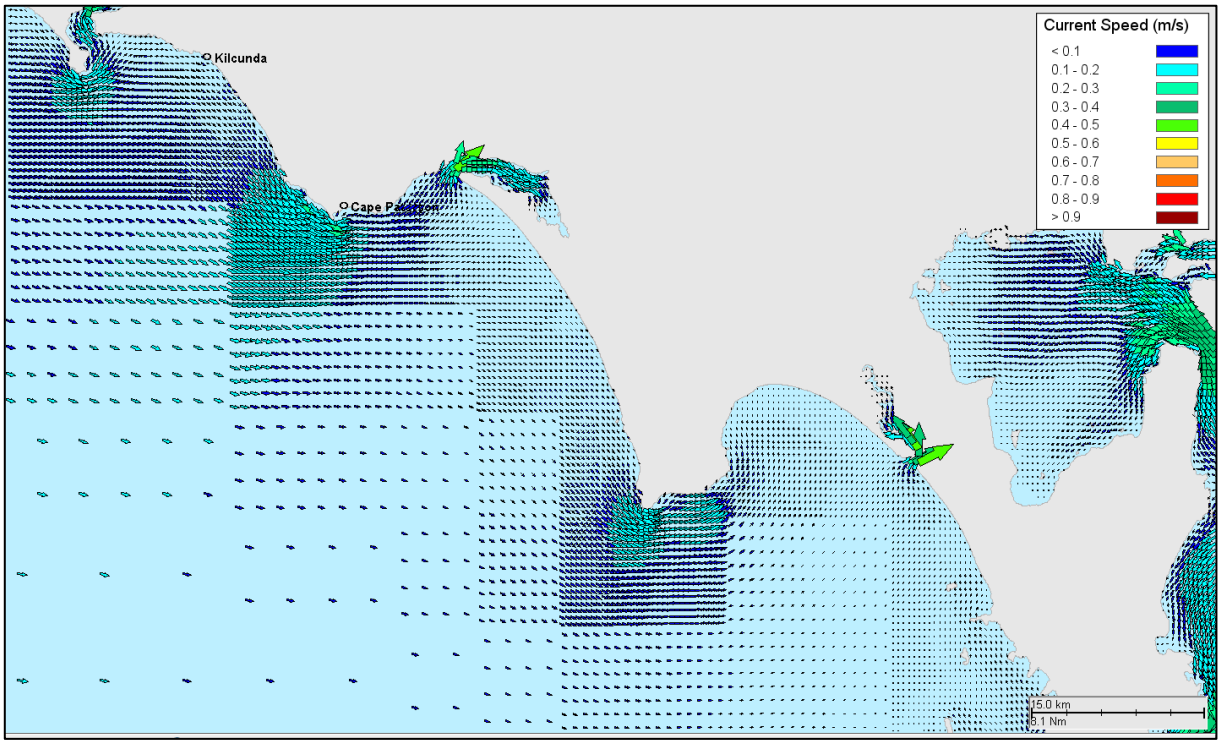


Figure 8 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and sholas. Colourations of individual vectors indicate current speed.

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.

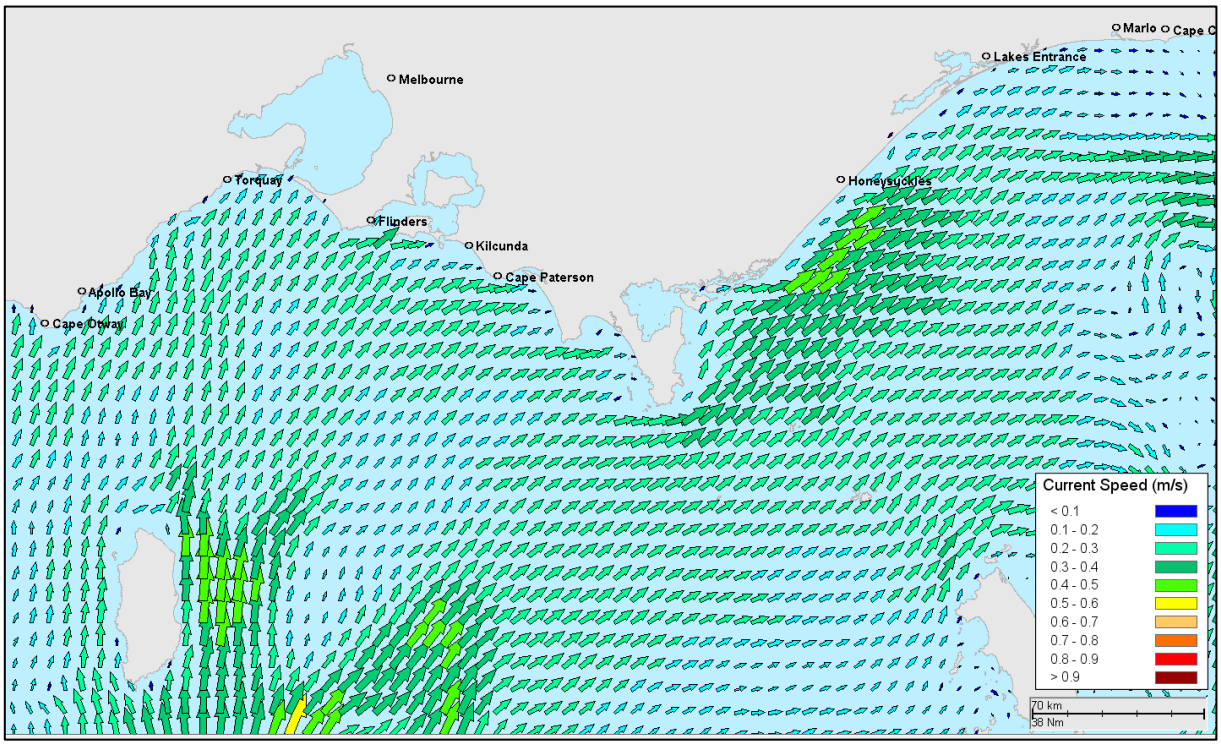


Figure 9 Modelled surface ocean currents presented for the 1st May 2012. Derived from the HYCOM ocean hindcast model. The colours of the vectors indicate current speed in m/s.

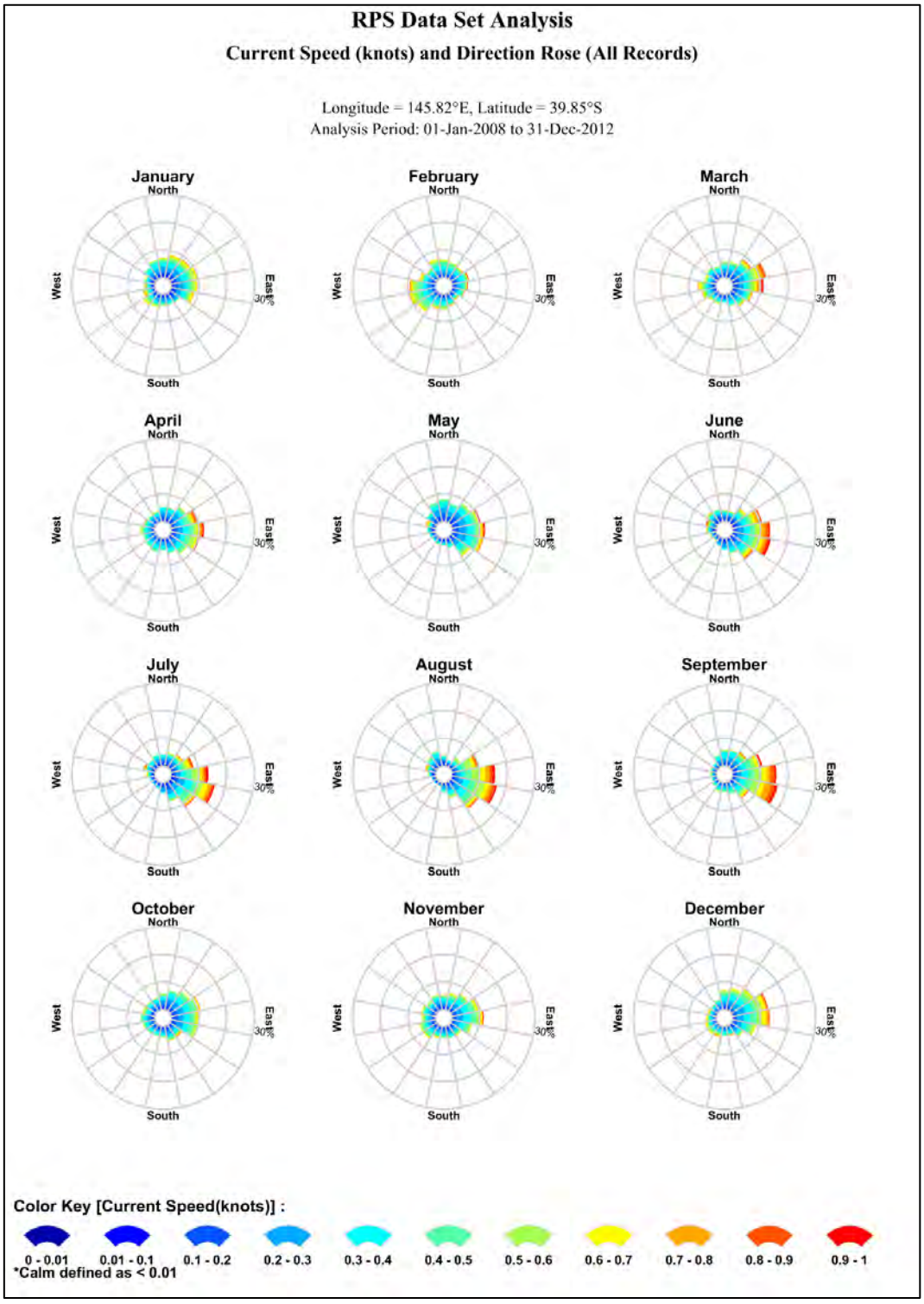


Figure 10 Monthly surface current rose plots nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination.

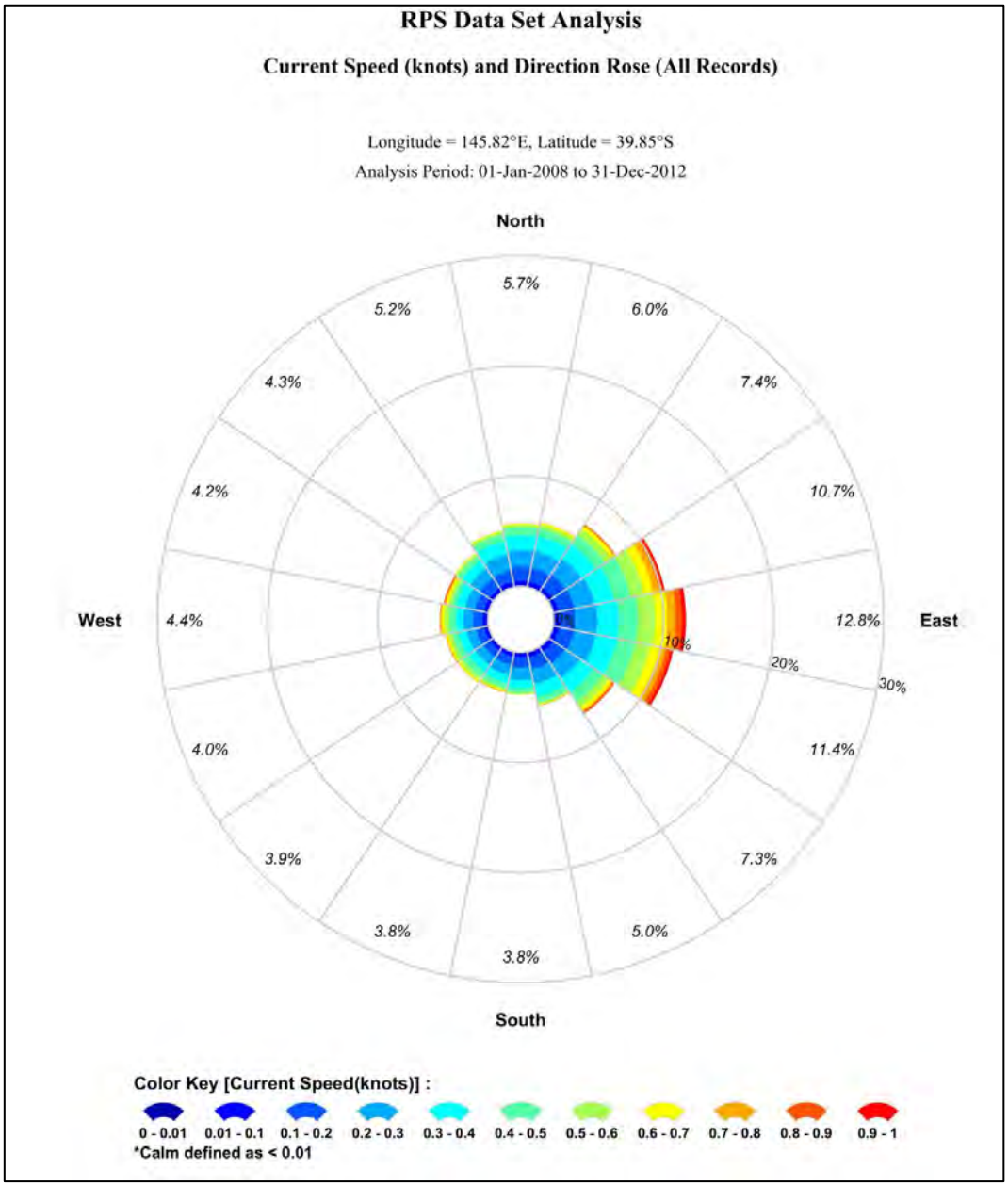


Figure 11 Modelled total surface current rose plot nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS 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 5th and 95th percentile current speeds as input into the near-field model, representative of low and high current speeds, respectively.

Table 6 presents the 5th and 95th percentiles of current speeds through the water column, which produce contrasting dilution and advection cases:

- 5th percentile current speed: low current speed, low dilution and slow advection;
- 95th percentile current speed: high current speed, high dilution and rapid advection to nearby areas.

The 5th and 95th 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)	5th Percentile or low current speed (m/s)	95th 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

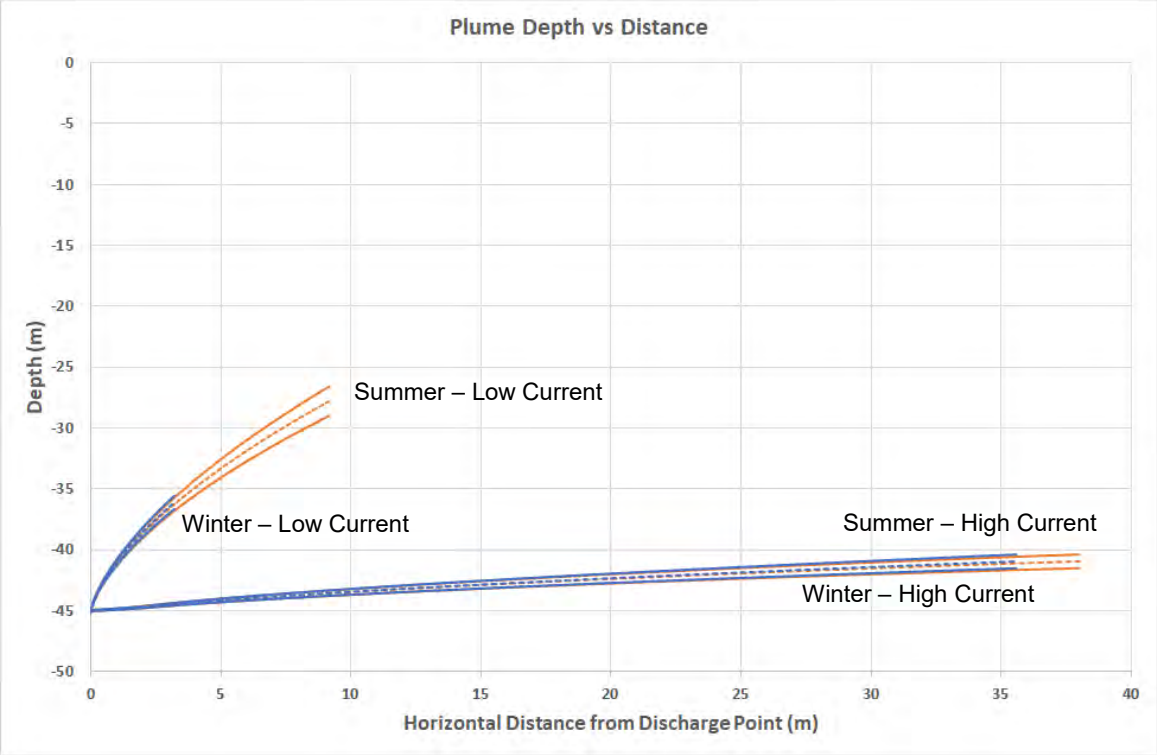


Figure 12 Plume depth versus distance for Case 1 Design Operation (100 m^3/day flow) for summer and winter under low and high current flow conditions.

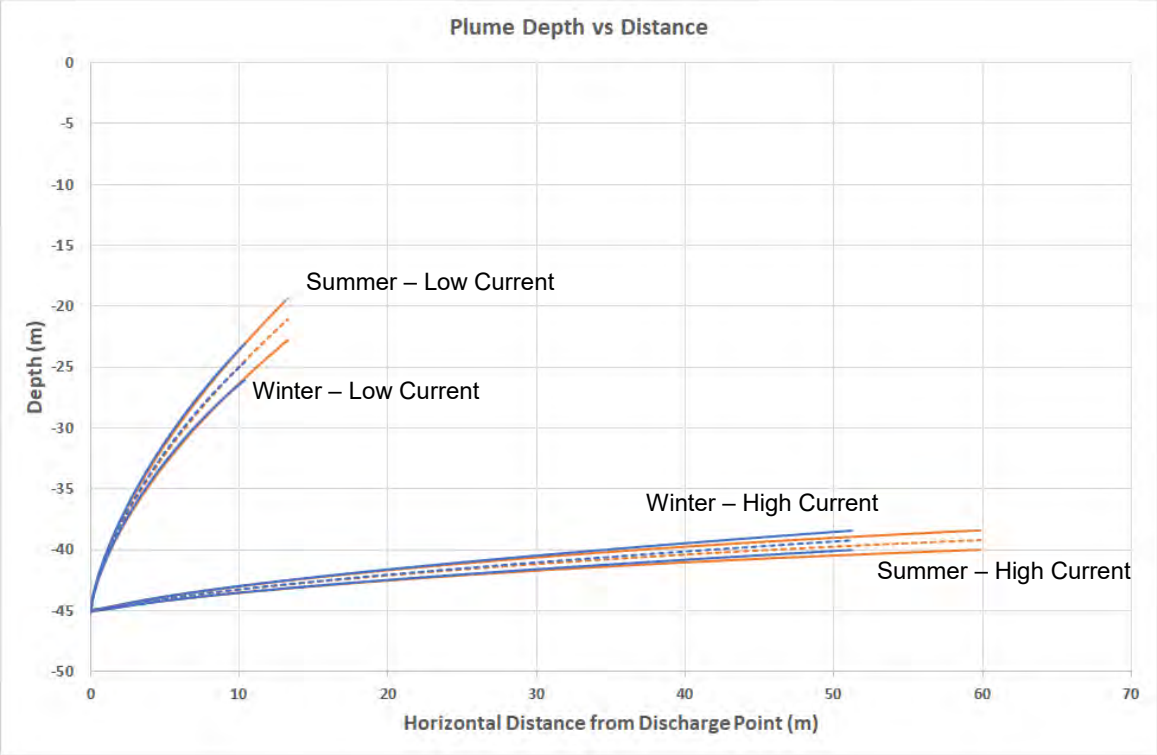


Figure 13 Plume depth versus distance for Case 2 Typical Operation (200 m^3/day flow) for summer and winter under low and high current flow conditions.

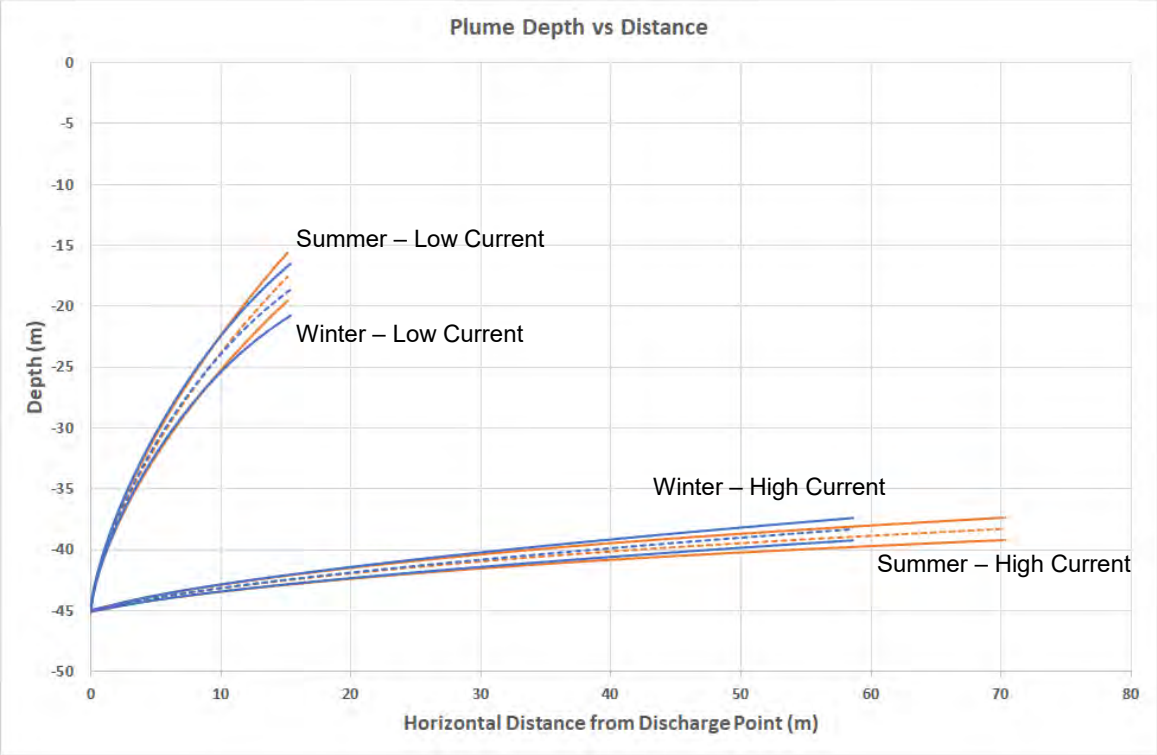


Figure 14 Plume depth versus distance for Case 3 Worst-Case Operation (300 m^3/day flow) for summer and winter under low and high current flow conditions.

6.0 References

Andersen, OB 1995, 'Global ocean tides from ERS 1 and TOPEX/POSEIDON altimetry', *Journal of Geophysical Research: Oceans*, vol. 100, no. C12, pp. 25249–25259.

Becker, JJ, Sandwell, DT, Smith, WHF, Braud, J, Binder, B, Depner, J, Fabre, D, Factor, J, Ingalls, S, Kim, S-H, Ladner, R, Marks, K, Nelson, S, Pharaoh, A, Trimmer, R, Von Rosenberg, J, Wallace, G & Weatherall, P 2009, 'Global bathymetry and evaluation data at 30 arc seconds resolution: SRTM30_PLUS', *Marine Geodesy*, vol. 32, no. 4, pp. 355–371.

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R & Bleck, R 2007, 'The HYCOM (hybrid coordinate ocean model) data assimilative system', *Journal of Marine Systems,* vol. 65, no. 1, pp. 60–83.

Chassignet, E, Hurlburt, H, Metzger, E, Smedstad, O, Cummings, J & Halliwell, G 2009, 'U.S. GODAE: Global Ocean Prediction with the HYbrid Coordinate Ocean Model (HYCOM)', *Oceanography*, vol. 22, no. 2, pp. 64–75.

Davies, AM 1977a, 'The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile', *Bottom turbulence: Proceedings of the 8th Liege Colloquium on Ocean Hydrodynamics,* vol. 19, pp. 1-25.

Davies, AM, 1977b, 'Three-dimensional model with depth-varying eddy viscosity', *Bottom Turbulence: Proceedings of the 8th Liege Colloquium on Ocean Hydrodynamics,* vol. 19, pp. 27-48.

Doneker, R & Jirka, G 1990, '*Expert System for Hydrodynamic Mixing Zone Analysis of Conventional and Toxic Submerged Single Port Discharges (CORMIX1)*', EPA/600/3-90/012, U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Gordon, R 1982, *Wind driven circulation in Narragansett Bay*, Ph.D. Thesis, Department of Ocean Engineering, University of Rhode Island, Kingston, RI, USA.

Isaji, T & Spaulding, ML 1984, 'A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank', *Journal of Physical Oceanography*, vol. 14, no. 6, pp. 1119-1126.

Isaji, T, Howlett, E, Dalton, C &Anderson, E 2001, 'Stepwise-continuous-variable-rectangular grid', *Proceedings of the 24th Arctic and Marine Oil Spill Program Technical Seminar*, 12 June 2001, Emergencies Science Division, Environment Canada, Canada, pp. 597-610.

Jirka, GH, Doneker, RL, & Barnwell, TO 1991, 'CORMIX: an expert system for mixing zone analysis', *Water Science and Technology*, vol. 24, no. 6, pp. 267–274.

Jones, IS 1980, 'Tidal and wind-driven currents in Bass Strait', *Marine and Freshwater Research*, vol. 31, no. 2, pp. 109–117.

Kostianoy, AG, Ginzburg, AI ,Lebedev, SA, Frankignoulle, M & Delille, B 2003, 'Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data', *Oceanology*, vol. 43, no. 5, pp. 632–642.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, 'The World Ocean Database', *Data Science Journal*, vol. 12, no. 0, pp. WDS229–WDS234.

Ludicone, D, Santoleri, R, Marullo, S & Gerosa, P 1998, 'Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data', *Journal of Geophysical Research*, vol. 103, no. C2, pp. 2995–3011.

Matsumoto, K, Takanezawa, T & Ooe, M 2000, Ocean tide models developed by assimilating TOPEX/POSEIDON altimeter data into hydro dynamical model: A global model and a regional model around Japan. *Journal of Oceanography*, vol. 56, no. 5, pp. 567–581.

Middleton, JF & Bye, JAT 2007, 'A review of the shelf-slope circulation along Australia's southern shelves: Cape Leeuwin to Portland', *Progress in Oceanography*, vol. 75, no. 1, p. 1–41.Owen, A 1980, 'A three-dimensional model of the Bristol Channel', *Journal of Physical Oceanography*, vol. 10, no. 8, pp. 1290–1302.

Qiu, B & Chen, S 2010, 'Eddy-mean flow interaction in the decadally modulating Kuroshio Extension system', *Deep-Sea Research II*, vol. 57, no. 13, pp. 1098–1110.

Sandery, PA & Kämpf, J 2007, 'Transport timescales for identifying seasonal variation in Bass Strait, south-eastern Australia', *Estuarine, Coastal and Shelf Science*, vol. 74, no. 4, pp. 684–696.

Willmott, CJ 1981, 'On the validation of models', *Physical Geography*, vol. 2, no. 2, pp. 184–194.

Willmott, CJ 1982, 'Some comments on the evaluation of model performance', *Bulletin of the American Meteorological Society*, vol. 63, no. 11, pp. 1309–1313.

Willmott CJ, Ackleson SG, Davis RE, Feddema JJ, Klink, KM, Legates, DR, O'Donnell, J & Rowe, CM 1985, 'Statistics for the evaluation of model performance', *Journal of Geophysical Research*, vol. I 90, no. C5, pp. 8995–9005.

Willmott, CJ & Matsuura, K 2005, 'Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance', *Journal of Climate Research*, vol. 30, no. 1, pp. 79–82.

Yaremchuk, M & Tangdong, Q 2004, 'Seasonal variability of the large-scale currents near the coast of the Philippines', *Journal of Physical Oceanography*, vol. 34, no., 4, pp. 844–855.

Zigic, S, Zapata, M, Isaji,T, King, B, & Lemckert, C 2003, 'Modelling of Moreton Bay using an ocean/coastal circulation model', *Proceedings of the 16th Australasian Coastal and Ocean Engineering Conference, the 9th Australasian Port and Harbour Conference and the Annual New Zealand Coastal Society Conference,* Institution of Engineers Australia, Auckland, paper 170.

Appendix D

Advisian Report 2019



Yolla Produced Water Improvements

TIC estimates

Beach Energy

11-December-2019

411010-00050-GE-REP-0001

Advisian
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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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.

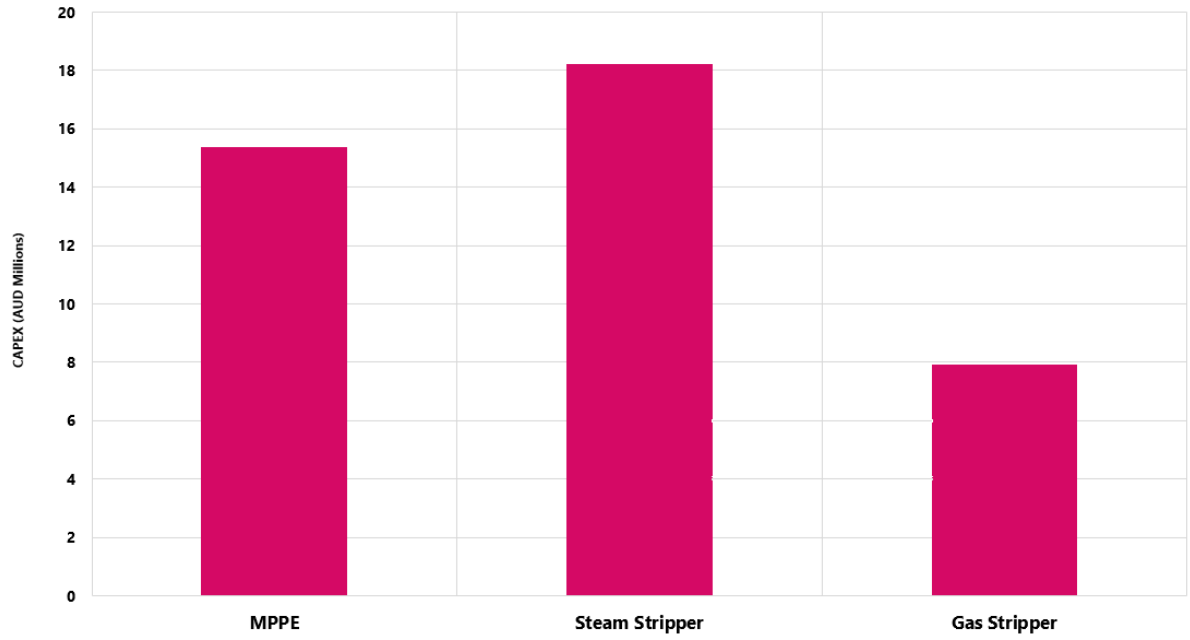


Figure 0-1: Total Installed Cost Comparison of the 3 options

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.

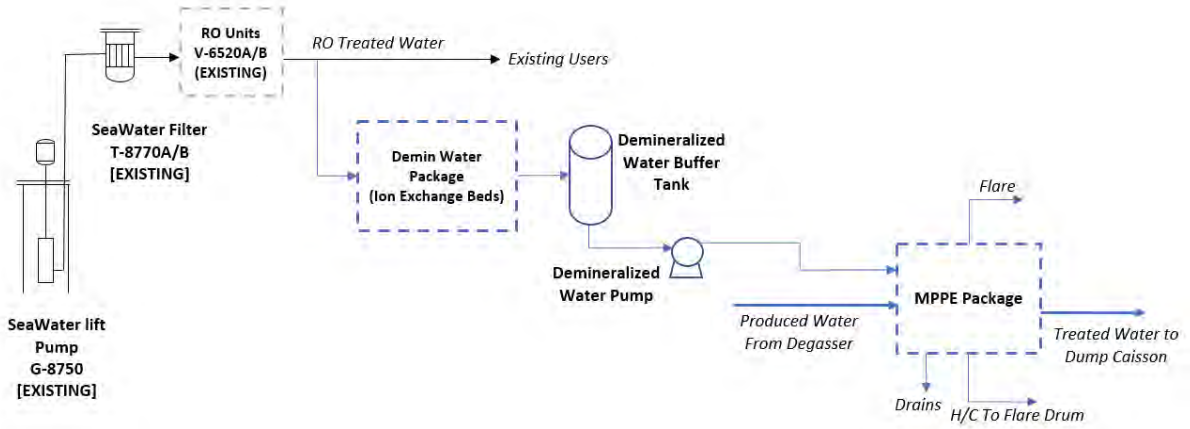


Figure 2-1: Sketch for MPPE Option

- 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).

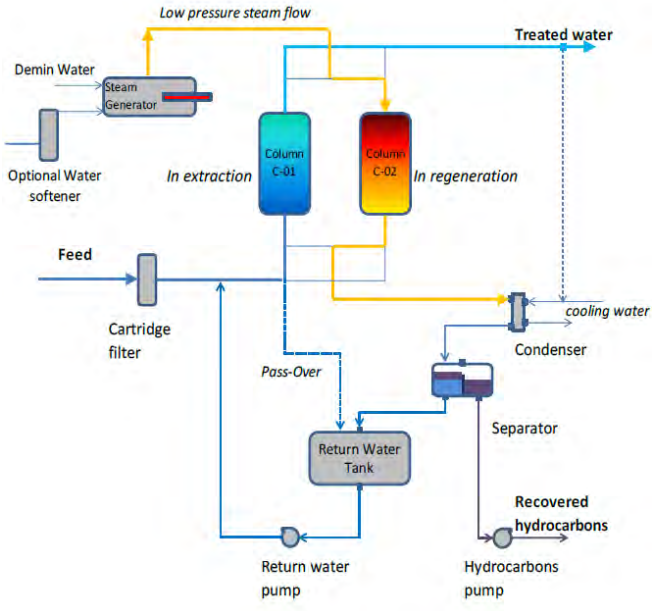


Figure 2-2: MPPE Package

- 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 1m^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 (0.38m^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 (2m^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.

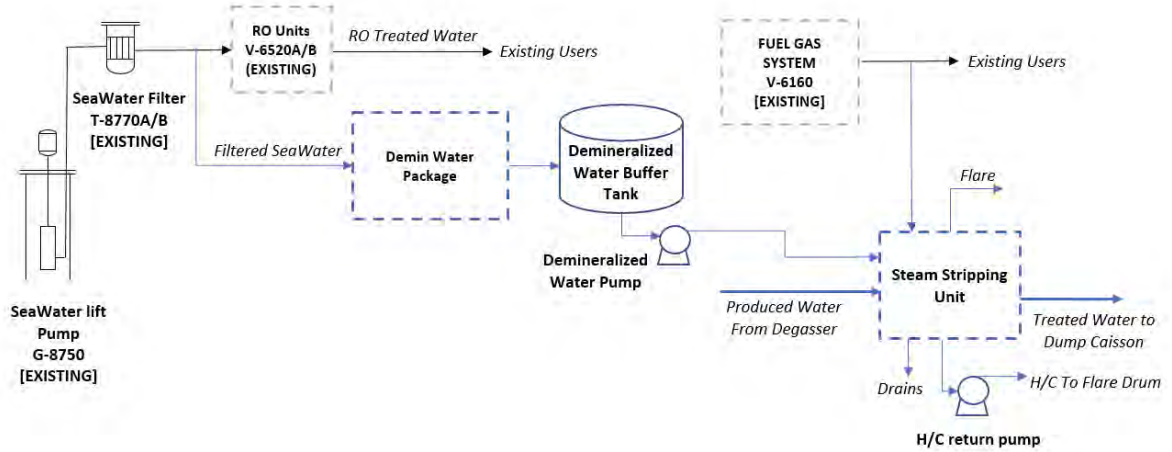


Figure 3-1: Sketch for Steam Stripping option

- 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.

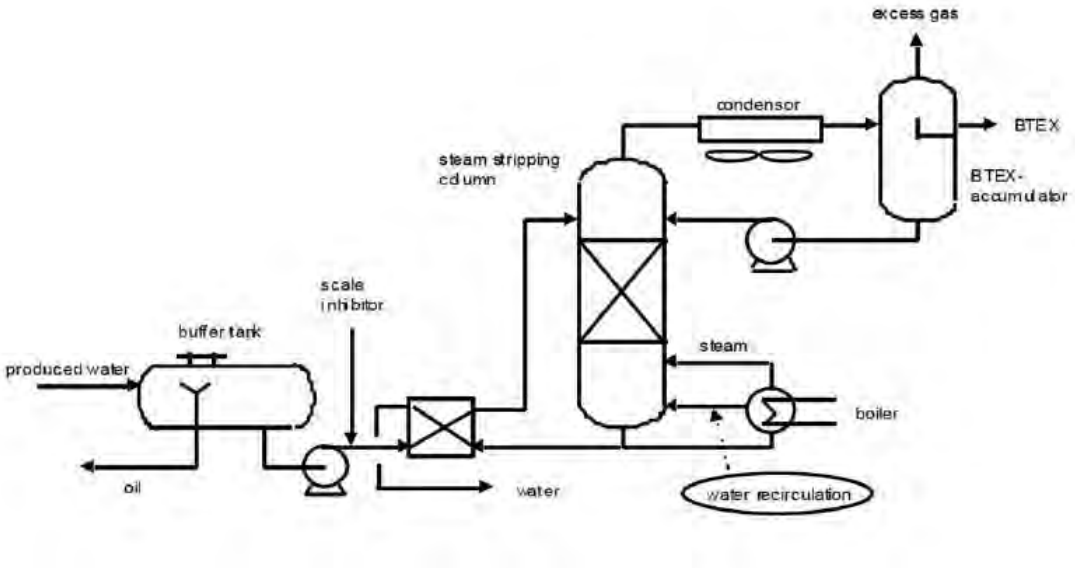


Figure 3-2: Steam stripping unit

- 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 300m^3/d (12.5 m^3/h) his equates to 10m^3/d (0.42m^3/h) or ~420 kg/h of steam required.
    - Allowing a margin, a demineralised water package of 0.5m^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 12m^3/h with a discharge pressure of 1000 kPag. It is assumed it has spare capacity to supply the additional 0.5m^3/h through the demineralised water package to the buffer tank without modification.
    - It has also been assumed that a demineralised buffer tank (~12m^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]

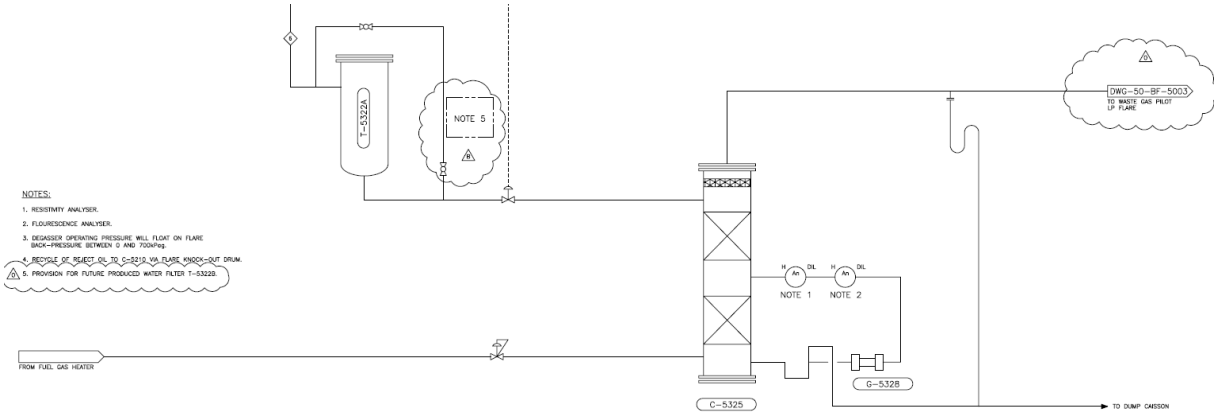


Figure 4-1: Original PW Stripper (with fuel gas)

- 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.

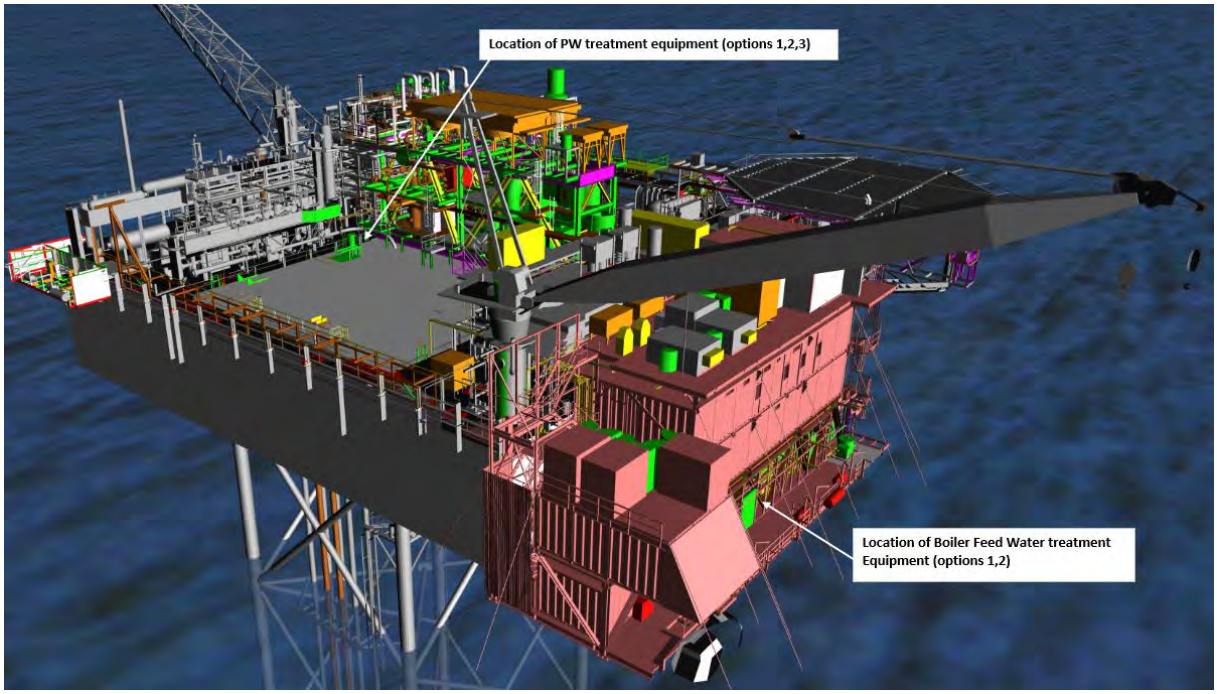


Figure 5-1: Potential Equipment Locations

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.

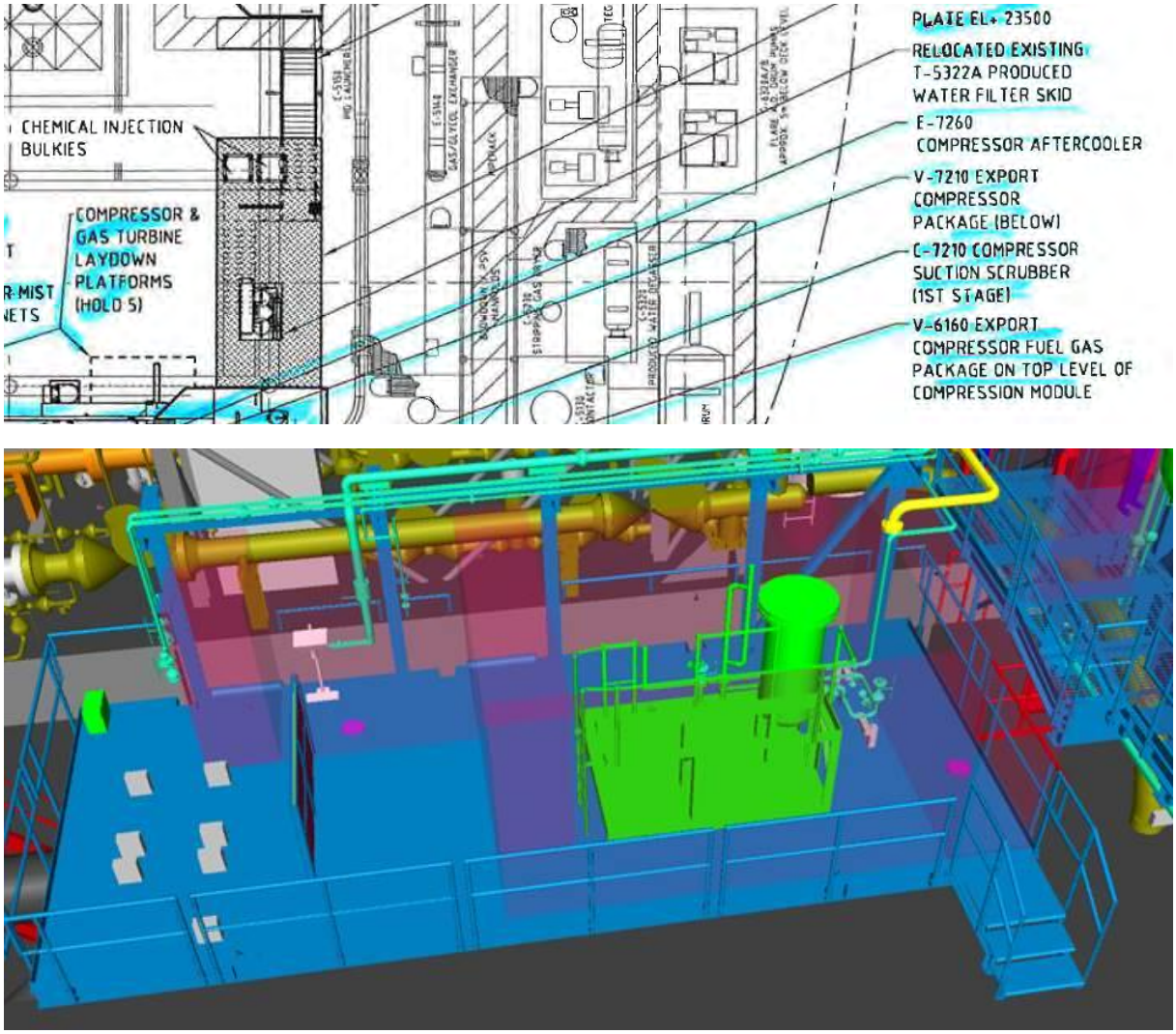


Figure 5-2: Existing PW Filters

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.

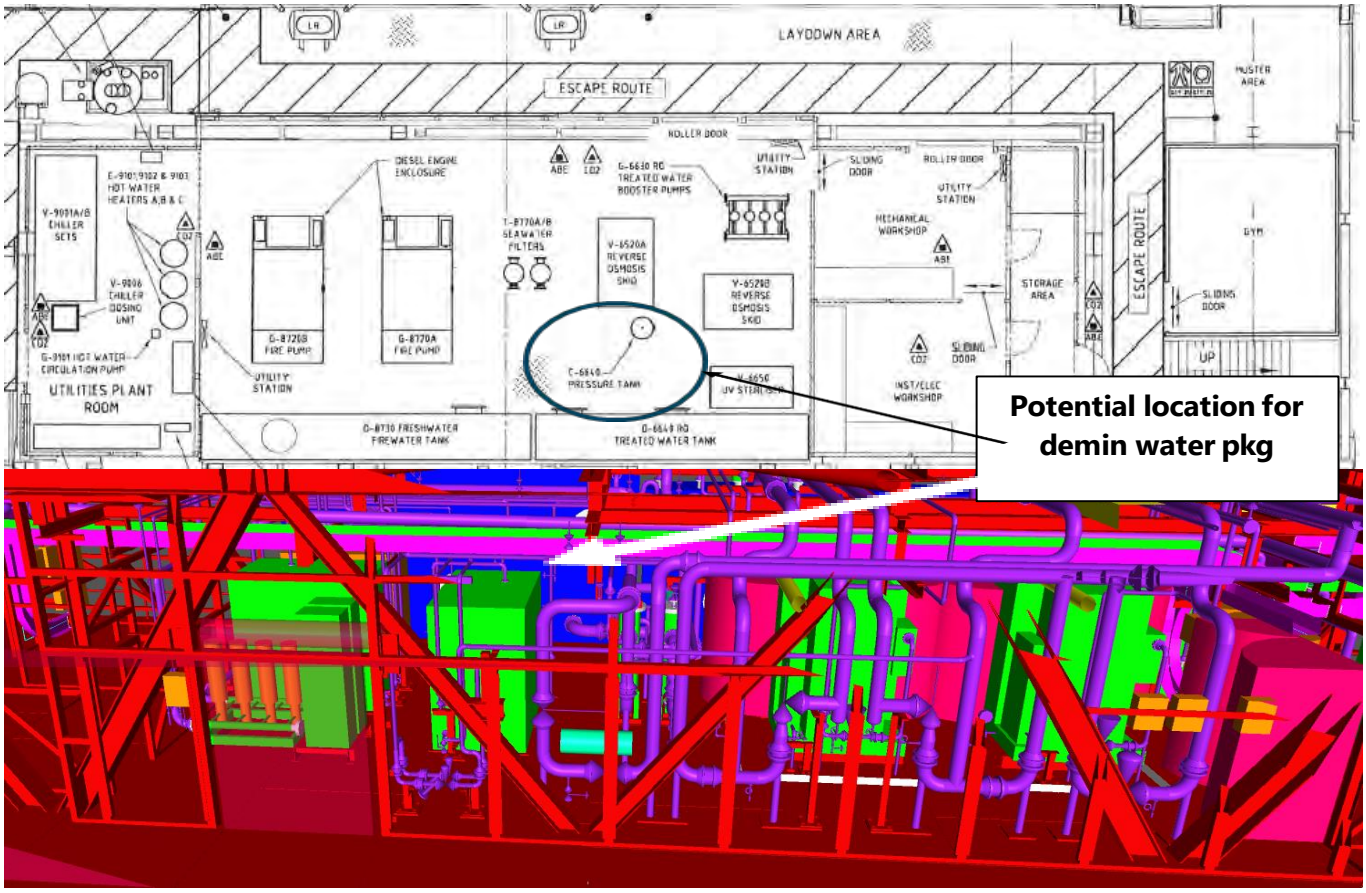


Figure 5-3: Existing water handling facilities

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**

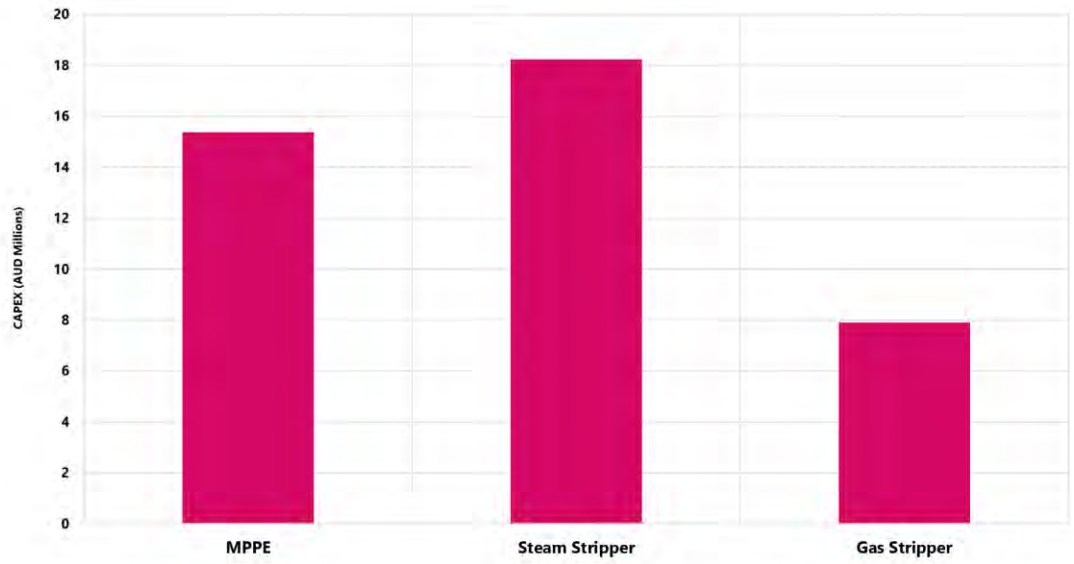


Figure 6-1 CAPEX by option

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
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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.

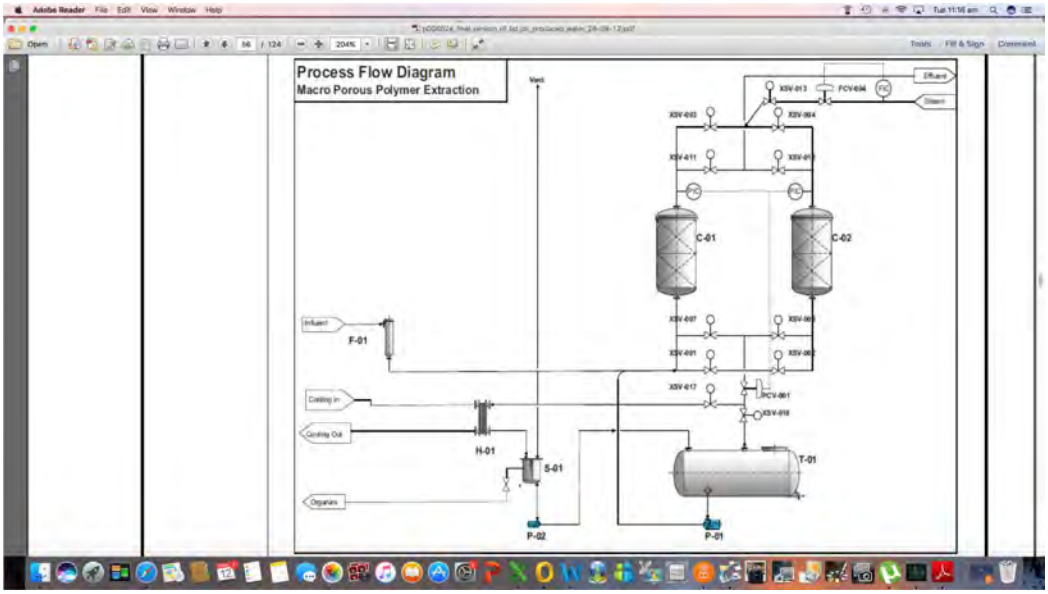
Allowance for utility/process connections include flare/drains:

- 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

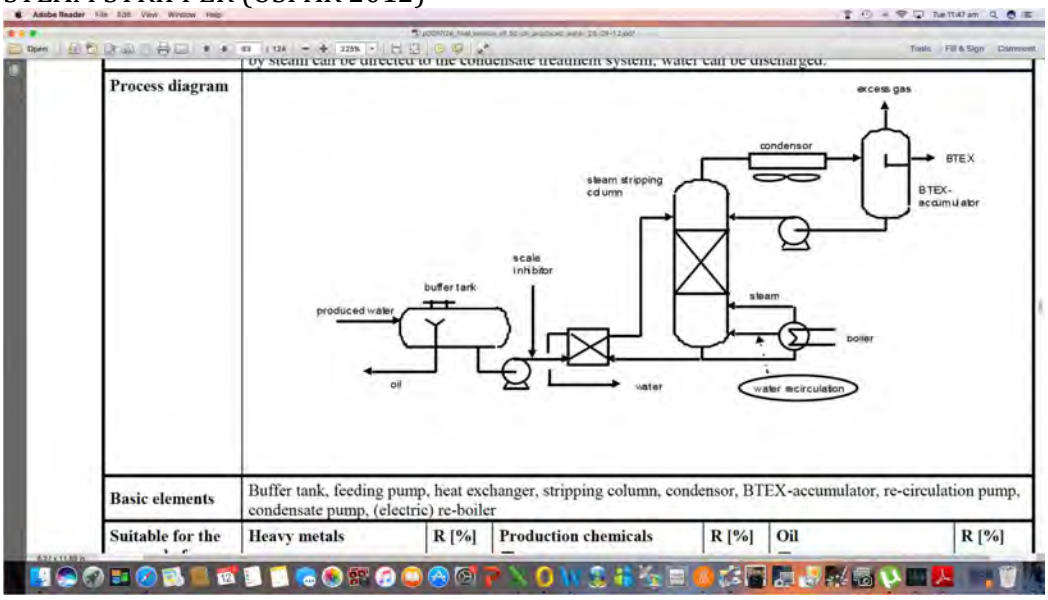
Critical operational parameters

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

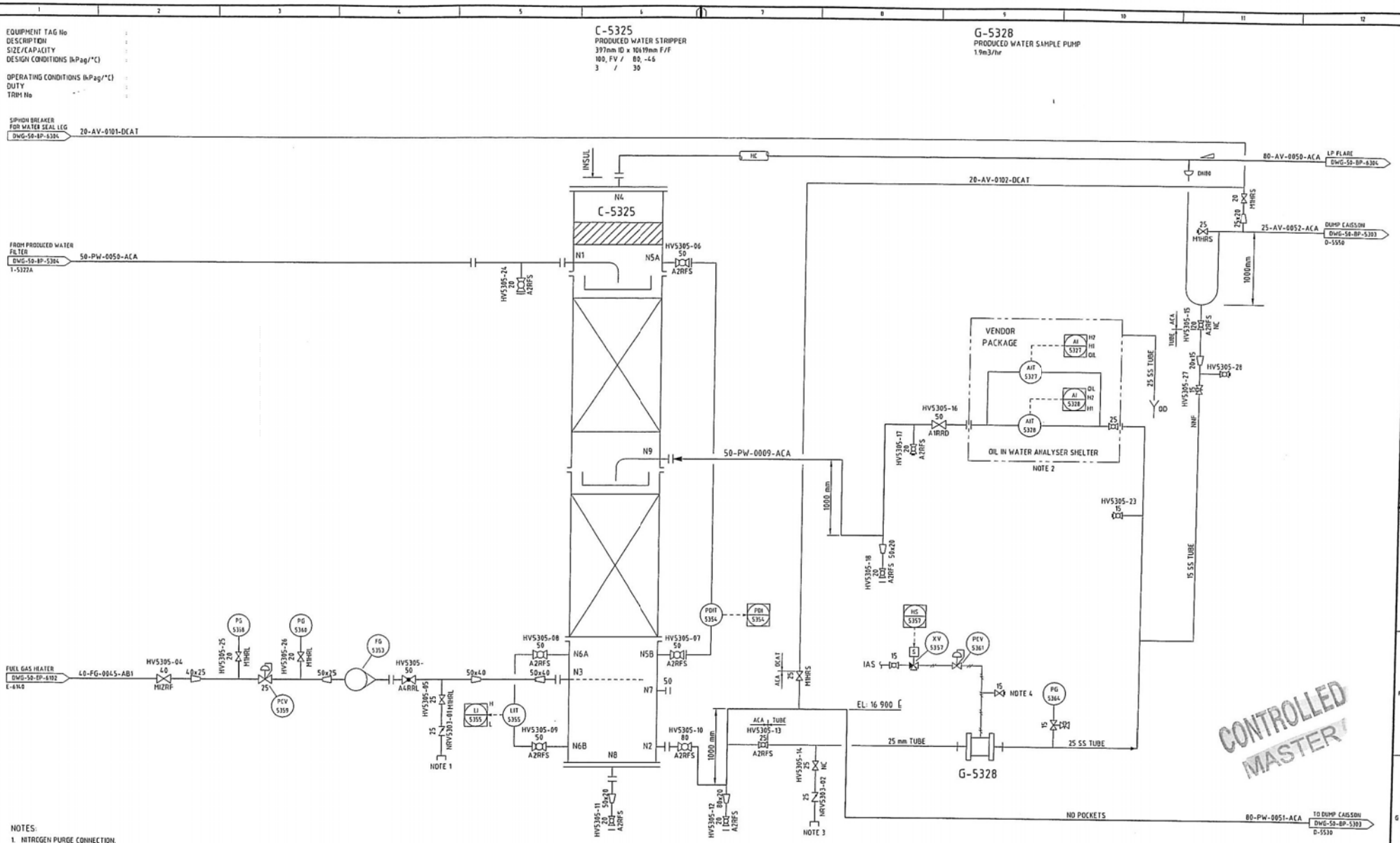
Since produced water usually contains salts and solid particles, problems with depositions (scale) may occur in the boiler and the heat exchanger. In order to prevent concentration of salts in the boiler, it is recommended to create a slight throughput by means of a re-circulation line from the boiler 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.



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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Origin energy

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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

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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

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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

Richard Walls | Service Provider to Production Optimisation Team LEad VIC/NZ | Beach Energy Lim

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From: Adinolfi, Carolina (Melbourne) <Carolina.Adinolfi@advisian.com>
Sent: Thursday, 28 November 2019 11:14 AM
To: Richard Walls <Richard.Walls@beachenergy.com.au>

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

Disclaimer

Veolia offers this service for free and warrants that the bid is based in accordance with generally accepted professional practices, supplier information and to the best of our Knowledge and without obligations. In no event shall Veolia Water Technologies Techno Center Netherlands B.V. be held liable for any damages, claims, demands, suits, causes of action, losses, costs, expenses and/or liabilities, regardless of whether such liability arises out of breach of contract, guarantee or warranty, tort, product liability, indemnity, contribution, strict liability or any other legal theory .

Revision	Date	Status	Issued by	Checked by
A	21-11-2019	Budget	JBK	JBO

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IBAN:NL74INGB0007285522 – Trade Register: 14 62 47 92
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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* • *Fully regenerable system providing certainty of OPEX costs & performance irrespective of influent hydrocarbon levels* • *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%). • 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 • 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. • No special equipment requiring dedicated maintenance.
4. Flexible Operation	• Turndown ratio up to 10%. • 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. At lower feed concentrations, higher flows can be treated while still meeting the effluent demand. • Immediate performance at start up • 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. • 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. Spent media are collected by Veolia, cleaned and refilled with extraction fluid to be reused. • Low energy consumption • Low noise • 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 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.

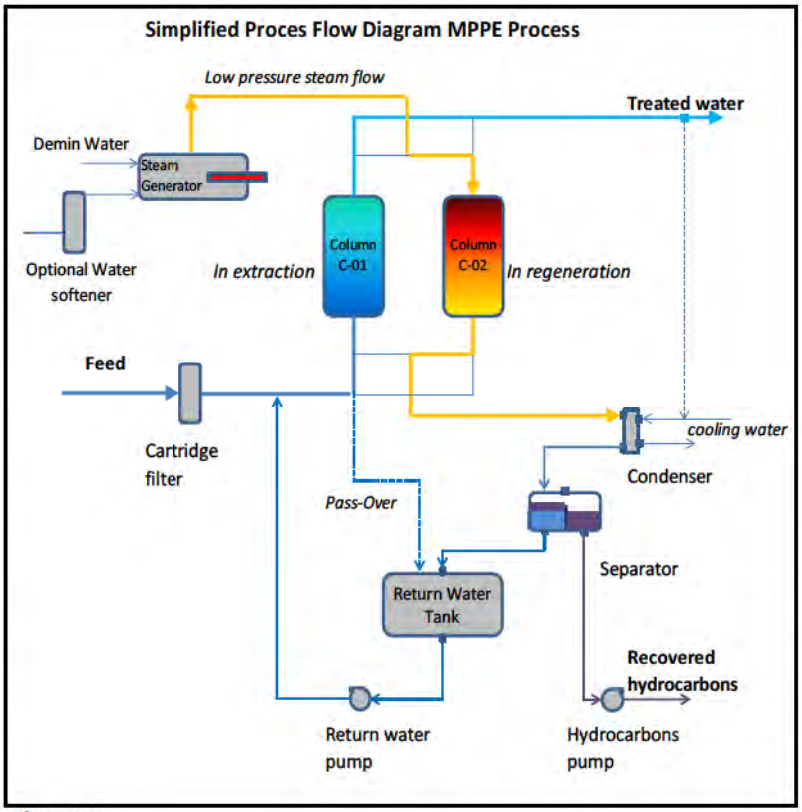


Figure 1

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.

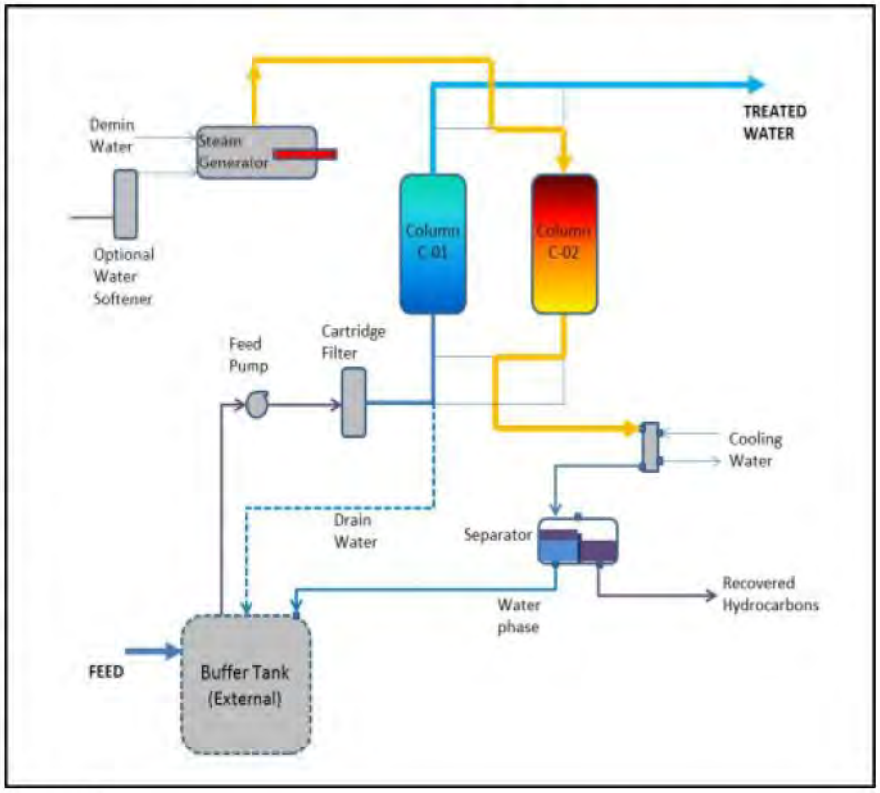


Figure 2

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) *Assuming Cooling water temp. 25 C; max. temp. increase 15 C*	m3/y m3/h	5.762 1
Feed water Steam Boiler (design conditions) *Feed water quality should be better than 0.5 German hardness*	m3/y l/h	494 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: • Project Management • Structural analysis and design, • MPPE Process design • Pipe stress analysis • Thermal & Mechanical design of exchanger(s), • Mechanical design of equipment • Assembly of equipment, piping and MPPE skid (at Veolia Workshop) • Inspections Equipment and at works Veolia workshop • Packing	
Participation and technical support at - Kick-Off meeting (1 meetings of 2 days) - Progress meetings (max 2 meetings of 2 days), - HAZOP (1 meeting of max 2 days), - 30% 3D, 60% 3D and 90% 3D meetings (each meeting of max 2 days) - 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 *(not in No Return Tank option)*
Return Water Pump	Duplex	1	Magnetic Type *(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.

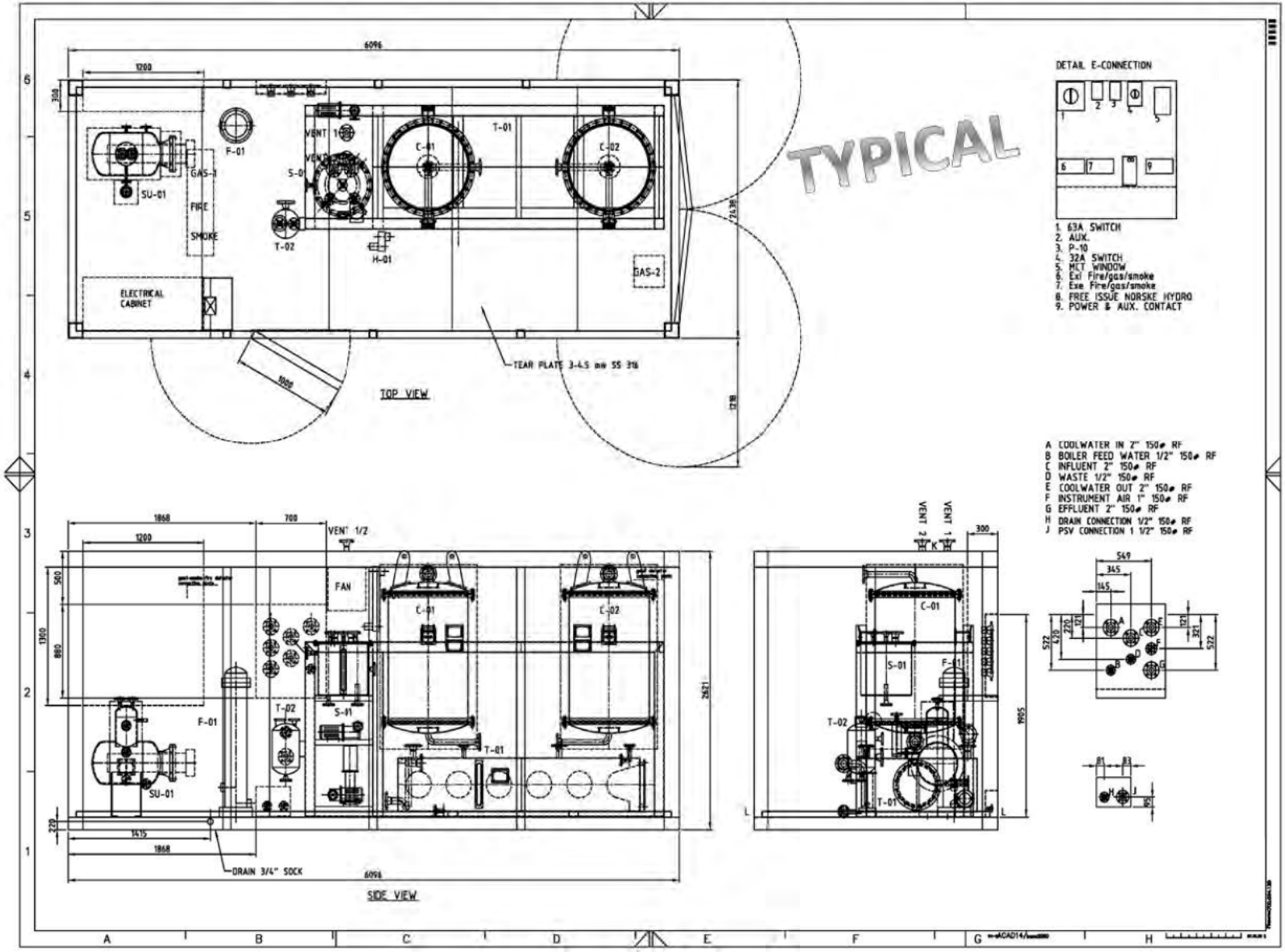
8.3 References

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

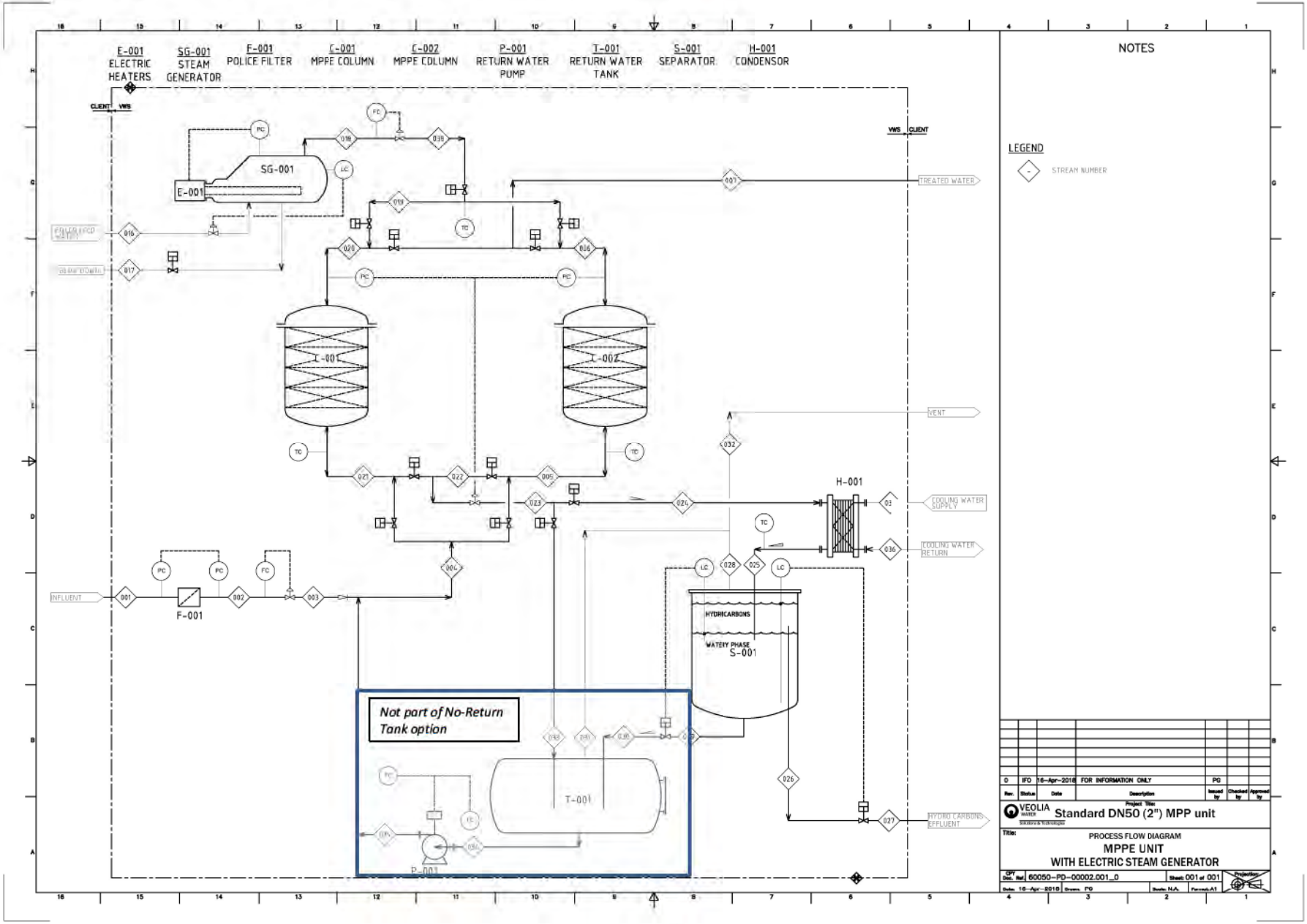
(1) AL: Aliphatics – Ar: Aromatics – PAH: PolyAromatic Hydrocarbons – CHC: Chlorinated Hydrocarbons
(2) Long duration test
(3) Combined groundwater and process water
(4) Combined with biotreatment
(5) MEG-Regen upstream
(6) 1m3/hr = 4.4 gpm

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 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 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.

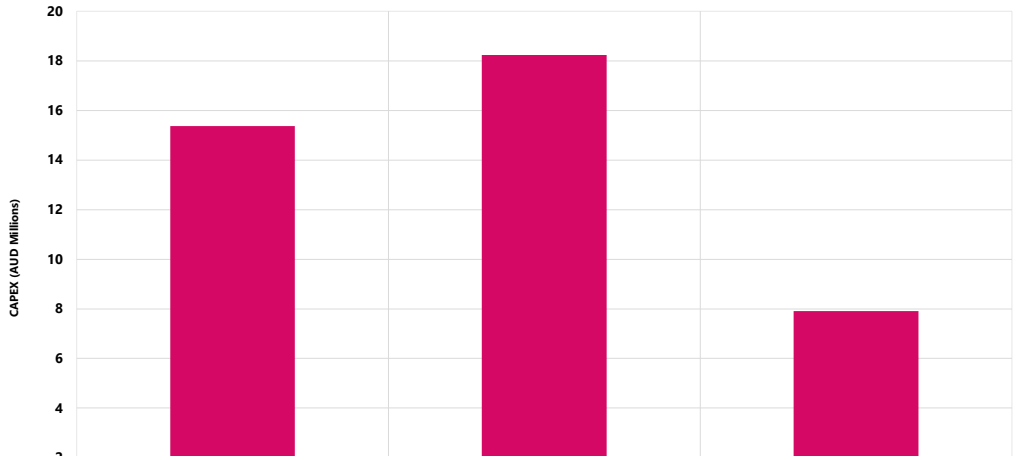
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Appendix C
Cost Estimates

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**	
																		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%											

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 Risk reviewed monthly by Risk owner	Exco for review and approval of the treatment plan	Exco
SEVERE	Risk treatment must be considered Risk reviewed monthly by Risk owner	Exco for review and approval of associated treatment plan (if applicable)	Exco
HIGH	Risk treatment must be considered 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 Risk reviewed annually by Risk owner	Project / Operations Manager	Exco direct report (Exco -1)
LOW	No risk treatment required 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

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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.

References

Alonso Á and Camargo JA 2014, Assessment of drift as a recovery endpoint in aquatic snails exposed to ammonia. *Bulletin of Environmental Contamination and Toxicology* 92(5) pp 520-524.

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.

Armstrong BM, Lazorchak JM, Murphy CA, Haring HJ, Jensen KM and Smith ME 2015, Determining the effects of a mixture of an endocrine disrupting compound, 17α-ethinylestradiol, and ammonia on fathead minnow (*Pimephales promelas*) reproduction. *Chemosphere* 120 pp 108-14.

Arnould JPK., et al. (2015). Use of Anthropogenic Sea Floor Structures by Australian Fur Seals: Potential Positive Ecological Impacts of Marine Industrial Development. PLoS ONE 10(7): e0130581. Doi:10.1371/journal.pone.0130581

ATSDR 2004, *Toxicological Profile for Ammonia*. Agency for Toxic Substances and Disease Registry, US Public Health Service.

ATSDR 2007, *Toxicological Profile for Benzene*. Agency for Toxic Substances and Disease Registry, US Public Health Service.

Ayres DM, Davis AP and Gietka PM 1994, *Removing Heavy Metals from Wastewater*. University of Maryland Engineering Research Centre Report, August 1994.

Black, KP et al. 1994, *Environmental implications of offshore oil and gas development in Australia – Production Activities*, pp 209 - 408 in Swan JM, Neff JM and Young PC (eds) *Environmental implications of offshore oil and gas development in Australia: the findings of an independent scientific review.*

Bruland KW 1989. Complexation of zinc by natural ligands in the central north Pacific. *Limnology and Oceanography* 34 pp 269–285.

CCREM 1987, *Canadian water quality guidelines*. Canadian Council of Resource and Environment Ministers, Ontario.

Cheng CH, Yang FF, Liao SA, Miao YT, Ye CX and Wang AL 2015, Effect of acute ammonia exposure on expression of GH/IGF axis genes GHR1, GHR2 and IGF-1 in pufferfish (*Takifugu obscurus*). *Fish Physiology and Biochemistry* 41(2) pp 495-507.

Crookes MJ and Howe PD 1996, *Environmental hazard assessment: Phenol*. TSD 25. Toxic Substances Division, Department of Environment, Garston, UK.

Dalela RC, Sarov R, Rani S and Verma SR 1980, Influence of pH on the toxicity of phenol and its two derivatives pentachlorophenol and dinitrophenol. *Acta Hydrochimica et Hydrobiologia* 8 pp 623−627.

Denton GRW and Burdon-Jones C 1986, Environmental effects on toxicity of heavy metals to two species of tropical marine fish from northern Australia. *Chemistry and Ecology* 2 pp 233–249.

Dzombak DA and Morel FMM 1990, *Surface complexation modeling: Hydrous ferric oxide*. John Wiley & Sons, New York.

Everall NC, Macfarlane NAA and Sedgwick RW 1989, The interactions of water hardness and pH with the acute toxicity of zinc to the brown trout, *Salmo trutta* L. *Journal of Fish Biology* 35 pp 27–36

Florence TM and Batley GE 1980, Chemical speciation in natural waters. *Critical Reviews in Analytical Chemistry* 9 pp 219–296.

Gibbs CF 1992, Oceanography of Bass Strait: implications for the food supply of Little penguins *Eudyptula minor*. *Emu* 91 pp 395–401.

Gorsuch JW and Purcell TW 1999, Eight years of silver research: What have we learned and how may it influence silver regulation? *SETAC News* 19(4) pp 19–21

Hamilton SJ and Buhl KJ 1990, Safety assessment of selected inorganic elements to fry of chinook salmon (*Orcorhynchus tshawytscha*). *Ecotoxicology and Environmental Safety* 20 pp 307–324.

Hogstrand C and Wood C M 1998, Toward a better understanding of the bioavailability, physiology and toxicity of silver in fish: Implications for water quality criteria. *Environmental Toxicology and Chemistry* 17, 547–561.

IHCP 2006. *European Union Risk Assessment Report – Phenol.* Institute of Health and Consumer Protection, European Chemicals Bureau.

Jones A and Zabel T 1996, *Proposed Environmental Quality Standards for Toluene in Water*. Final Report to the DoE. WRc Report No DoE 2986.

Johnson I, Sorokin N, Atkinson C, Rule K and Hope S-J 2007, *Proposed EQS for Water Framework Directive Annex VIII substances: ammonia (un-ionised).* Environment Agency Science Report: SC040038/SR2 SNIFFER Report: WFD52(ii), February 2007.

Krahn MM and Stein JE 1998, Assessing exposure of marine biota and habitats to petroleum compounds. *Analytical Chemistry* 70 pp 186a-192a.

Kolarevic J, Takle H, Felip O, Ytteborg E, Selset R, Good CM, Baeverfjord G, Asgård T and Terjesen BF 2012, Molecular and physiological responses to long-term sublethal ammonia exposure in Atlantic salmon (*Salmo salar*). *Aquatic Toxicology* 15 (124-125) pp 48-57.

Lee CH, Sung CG, Moon SD and Lee JH 2013, Effects of ammonia on fertilization, development, and larval survival in the Northern Pacific asteroid, *Asterias amurensis. Bulletin of Environmental Contamination and Toxicology* 91(1) pp 102-106.

Meador JP, Stein JE, Reichert, WL and Varanasi U 1995. Bioaccumulation of polycyclic aromatic hydrocarbons by marine organisms. *Reviews of Environmental Contamination and Toxicology* 143 pp 79-165.

Montresor LC, Miranda-Filho KC, Paglia A, Luz DM, Araújo JM, dos S Silva MJ, Gerhard L, Martinez CB and Vidigal TH 2013, Short-term toxicity of ammonia, sodium hydroxide and a commercial biocide to golden mussel *Limnoperna fortunei* (Dunker, 1857). *Ecotoxicology and Environmental Safety* 92 pp 150-154.

NOAA 1992, *An introduction to coastal habitats and biological resources for oil spill response*. National Oceanic and Atmospheric Administration Report no. HMRAD 92-4.

Nazir M, Khan F, Amyotte P and Sadiq R 2008, Subsea Release of Oil from a Riser: An Ecological Risk Assessment. *Risk Analysis* 28(5) pp 1173-1196.

Neff JM 1979, *Polycyclic Aromatic Hydrocarbons in the Aquatic Environment: Sources, Fates, and Biological Effects*. Applied Science, London, UK.

OECD 2002. *SIDS Initial Assessment Report - Ethylbenzene*. Organisation for Economic Co-operation and Development Screening Information Dataset.

OECD 2003. *SIDS Initial Assessment Profile - Xylenes*. Organisation for Economic Co-operation and Development Screening Information Dataset.

Ogata M, Fujisawa K, Ogino Y and Mano E 1984, Partition coefficients as a measure of bioconcentration potential of crude oil compounds in fish and shellfish. *Bulletin of Environmental Contamination and Toxicology* 33(5) pp 561-567.

Pidcock S, Burton C and Lunney M 2003, *The potential sensitivity of marine mammals to mining and exploration in the Great Australian Bight Marine Park Marine Mammal Protection Zone*. An independent review and risk assessment report to Environment Australia, Prepared for the Natural Heritage Trust.

Randall DJ and Tsui TKN 2002, Ammonia toxicity in fish. *Marine Pollution Bulletin* 45(1-12) pp 17-23.

Roy R and Campbell PGC 1995, Survival time modeling of exposure of juvenile Atlantic salmon (*Salmo salar*) to mixtures of aluminium and zinc in soft water at low pH. *Aquatic Toxicology* 33 pp 155–176.

Rust AJ, Burgess RM, Brownawell BJ and McElroy AE 2004, Relationship between metabolism and bioaccumulation of benzo[a]pyrene in benthic invertebrates. *Environmental Toxicology and Chemistry* 23(11) pp 2587-2593.

Spear PA and Pierce RC 1979, *Copper in the aquatic environment: Chemistry, distribution and toxicology*. NRCC No 16454. Associate Committee on Scientific Criteria for Environmental Quality, National Research Council of Canada, Ottawa.

Stauber JL 1995, Toxicity testing using marine and freshwater unicellular algae. *Australasian Journal of Ecotoxicology* 1 pp 15–24.

Taylor HH and Anstiss JM 1999, Copper and haemocyanin dynamics in aquatic invertebrates. *Marine and Freshwater Research* 50(8) pp 907 – 931.

Toxnet 2017a, *Naphthalene.* US National Library of Medicine Toxicology Data Network http://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@DOCNO+184

Toxnet 2017b, *Benzene*. US National Library of Medicine Toxicology Data Network http://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@DOCNO+35

Toxnet 2017c, *Toluene*. US National Library of Medicine Toxicology Data Network http://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@DOCNO+131

Toxnet 2017d, *Ethylbenzene*. US National Library of Medicine Toxicology Data Network http://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@DOCNO+84

Toxnet 2017e, *Phenol*. US National Library of Medicine Toxicology Data Network http://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@DOCNO+113

Vercauteren K and Blust R 1996, Bioavailability of dissolved zinc to the common mussel *Mytilus edulis* in complexing environments. *Marine Ecology Progress Series* 137 pp 123–132.

Verma SR, Rani S, Tyagi AK and Dalela RC 1980, Evaluation of the acute toxicity of phenol and its chloro and nitro derivatives to certain teleosts. *Water Air and Soil Pollution* 14 pp 95−102.

Wakeham SG, Davis AC and Karas JL 1983, Mesocosm experiments to determine the fate and persistence of volatile organic compounds in coastal seawater. *Environmental Science & Technology* 17 pp 611–617.

Ward BB 1996, Nitrification and ammonification in aquatic systems. *Life Support & Biosphere Science* 3(1-2) pp 25-9.

APPENDIX 13

YOLLA PLATFORM

Produced Water Dispersion Modelling



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19 May 2026
Rev 5

rpsgroup.com

Document status

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Rev A	Internal Draft	L. Perez	N. Benfer	N. Benfer	4/04/2025
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Rev 5	Updated thresholds	N. Benfer		N. Benfer	19/05/2026
Rev 6	Added CORMIX vs MUDMAP wording	N. Benfer		N. Benfer	25/05/2026

Approval for issue

Nathan Benfer  25 May 2026

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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 without and with the presence of the GLDA, and the 99% species protection dilution thresholds were determined to be 483 and 6,667 dilutions, respectively. In order to achieve 95% species protection dilution thresholds decreased to 157 and 3,030 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.

The near-field modelling results are reported to document the initial plume behaviour and to support the far-field model setup; they should not be interpreted as a direct estimate of the operational mixing zone, which is assessed using the far-field modelling results.

Near-Field Modelling

- Under strong currents, the distance where the lower dilution threshold of 157 was reached ranged from 18 m to 23 m across the different seasons and flow rates, while the higher dilution threshold (6,667) was reached within 375 m to 450 m.
- Under moderate currents, the distance where the lower dilution threshold of 157 was reached ranged from 10 m to 12 m across the different seasons and flow rates, while the higher dilution threshold (6,667) was reached within 190 m to 490 m.
- Under low currents, the distance where the lower dilution threshold of 157 was reached within 5 m across the different seasons and flow rates, while the higher dilution threshold (6,667) was reached within 63 m to 62 m.

Far-Field Modelling

- In the 24-hour moving average evaluation, the two lower thresholds (157 and 483) were not observed.
- The model indicated 3,303 dilutions at distances of 10 meters and 13 meters for the Base Case and Future Case, respectively.
- The model recorded 6,667 dilutions at 19 meters for the Base Case and 25 meters for the Future Case.
- In the 1-hour moving average evaluation, the three lower thresholds (16, 48 and 303) were not observed.
- The model indicated 666 dilutions at distances of 7 meters for the Base Case and 10 meters for the Future Case.

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 without and with the presence of the GLDA, and the 99% species protection dilution thresholds were determined to be 483 and 6,667 dilutions, respectively. In order to achieve 95% species protection dilution thresholds decreased to 157 and 3,030 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

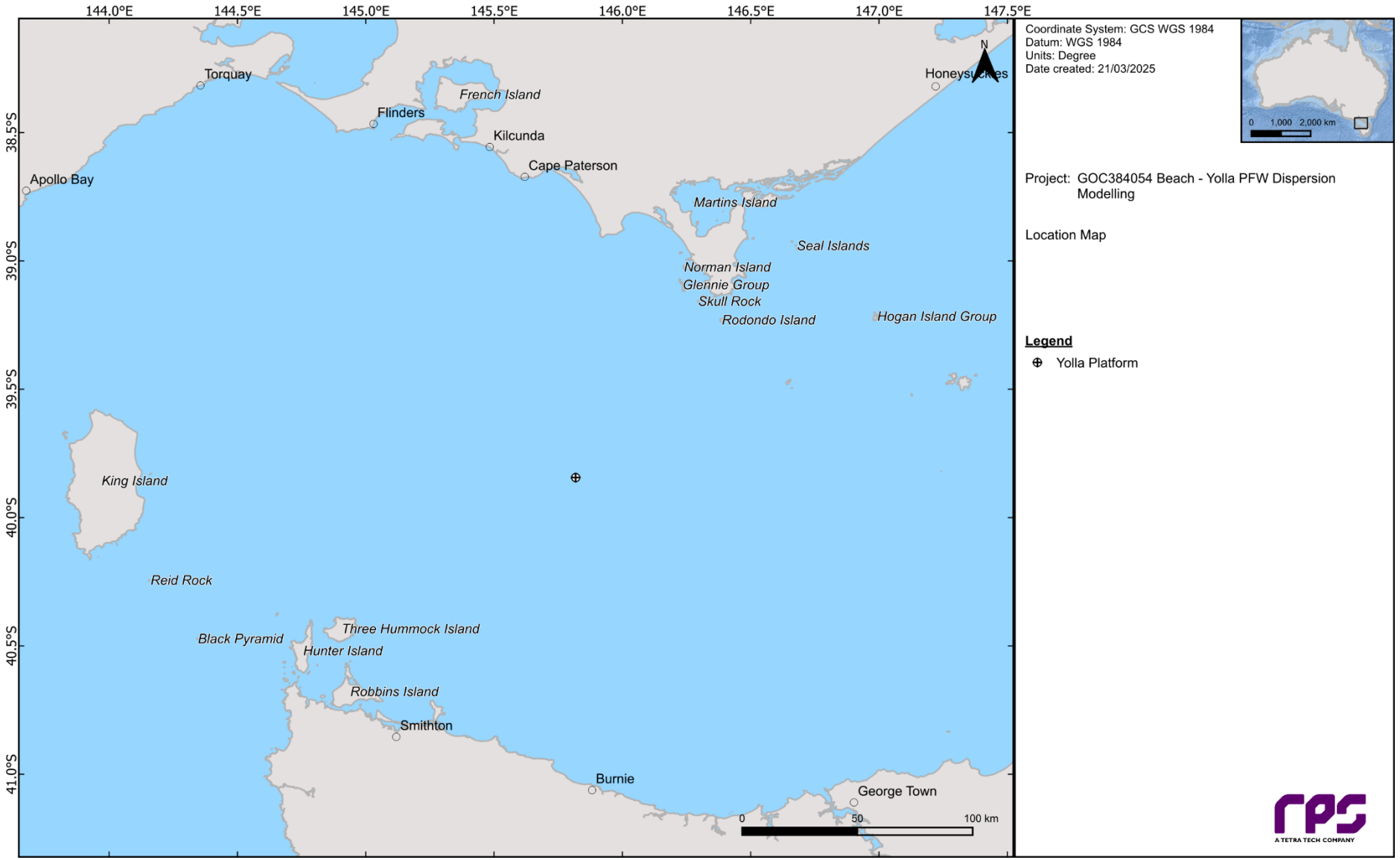


Figure 1-1 Location of the Yolla Platform.

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.

2 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 2-1.

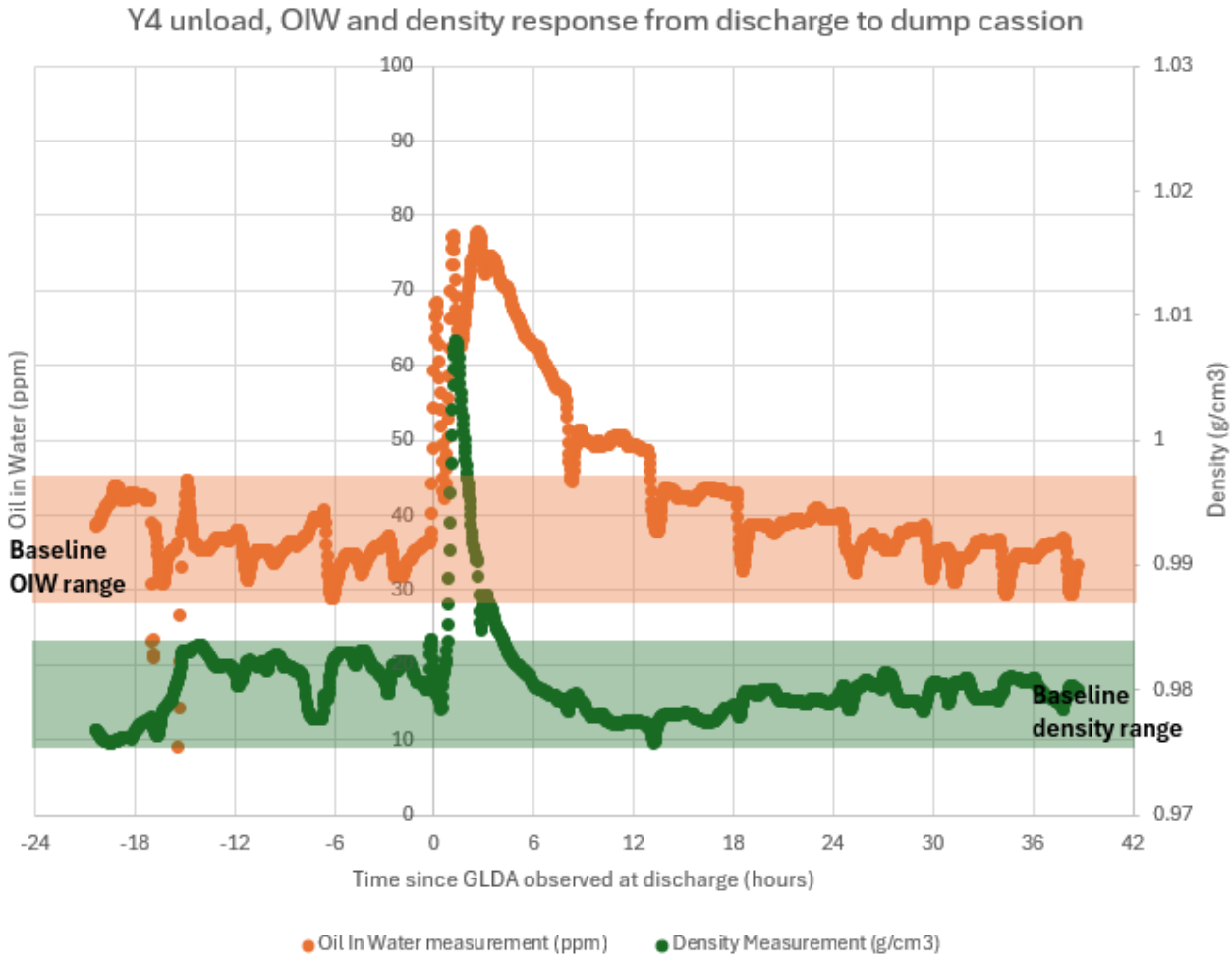


Figure 2-1 Time-series of density and oil in water measurements taken in the PFW outlet during normal and descaling activities. Image provided by Beach.

3 MODELLING METHODOLOGY

3.1 Near-Field Modelling

3.1.1 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.

3.1.2 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 3-1.

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 3-1 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 3-1 shows a conceptual diagram of the dispersion and fates of a positively buoyant discharge and the idealised representation of the discharge phases.

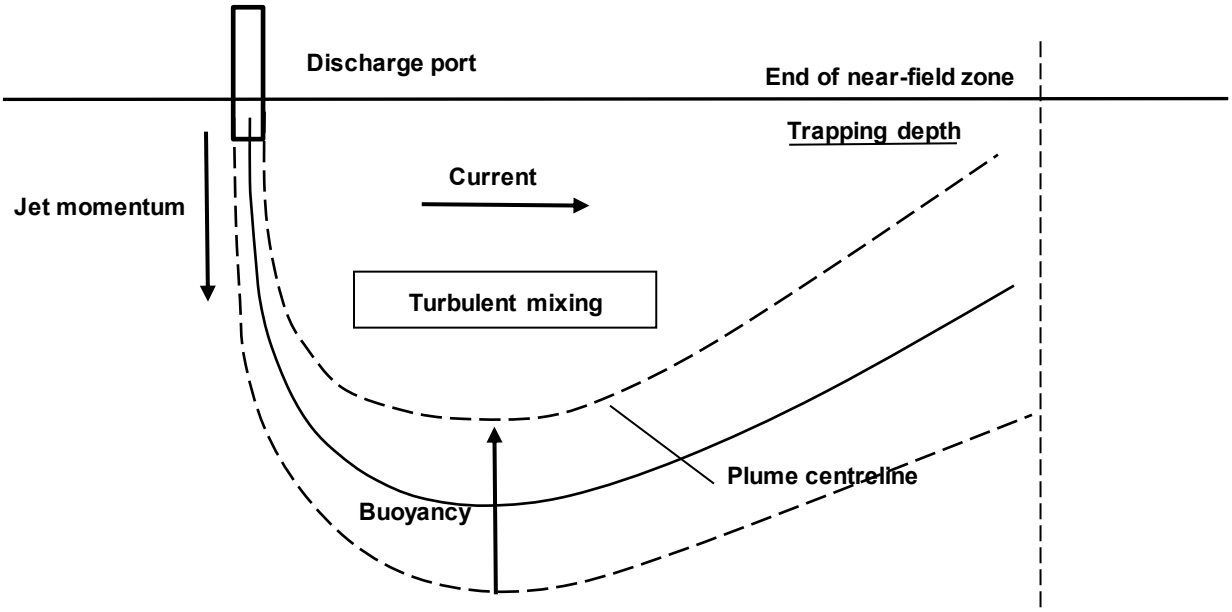


Figure 3-1 Conceptual diagram showing the general behaviour of a positively buoyant discharge discharged vertically into receiving water moving due to current.

3.1.3 Setup of Near-Field Model

3.1.3.1 Discharge Characteristics

The PFW discharge characteristics for the discharge case are summarised in Table 3-2. 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 3-2 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)

3.1.3.2 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.

3.1.3.2.1 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 Centre for Oceanography (Levitus *et al.*, 2013).

Figure 3-2 shows the vertical profiles of temperature and salinity for each month at Yolla Platform. Table 3-3 shows the average water temperature and salinity near surface and seabed at the Yolla Platform location for summer and winter.

Table 3-3 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

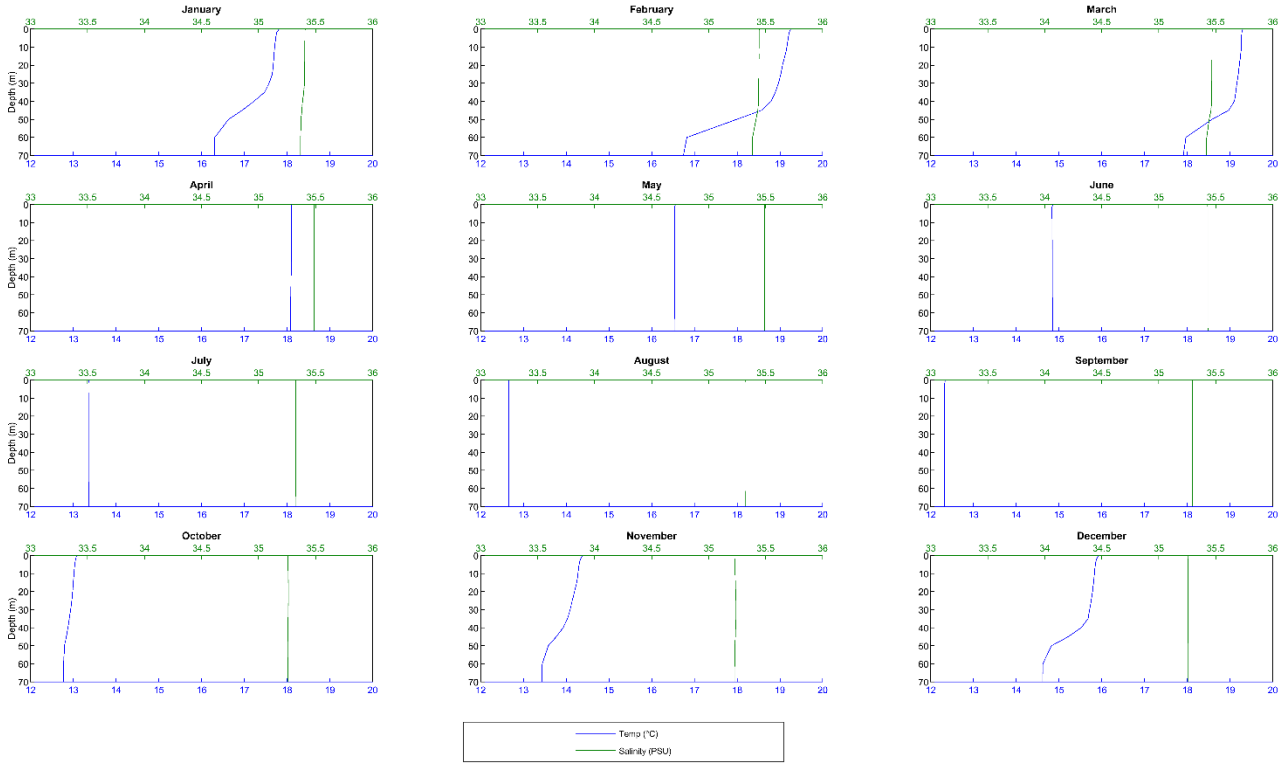


Figure 3-2 Monthly salinity and temperature profiles at the Yolla Platform

3.1.3.2.2 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 5th, 50th and 95th 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 3-4 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:

- 5th percentile current speed: weak currents, low dilution and slow advection.
- 50th percentile (median) current speed: average currents, moderate dilution and advection.
- 95th percentile current speed: strong currents, high dilution and rapid advection to nearby areas.

The 5th, 50th and 95th percentile values are referenced as weak, medium and strong current speeds, respectively.

Table 3-4 Adopted ambient current conditions adjacent to the Yolla Platform location.

Season	5th Percentile (Weak) Current Speed (m/s)	50th Percentile (Medium) Current Speed (m/s)	95th Percentile (Strong) Current Speed (m/s)
Annual	0.04	0.17	0.42

3.2 Far-Field Modelling

3.2.1 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.

3.2.2 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).

3.2.3 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 3.1. 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 3-5.

For each simulation, minimum dilutions throughout the water column were recorded at 5-minute intervals within each grid cell. These time series were then used to calculate the lowest 1-hour and 24-hour moving average dilutions for each simulation. Following completion of all simulations, results were aggregated to identify the minimum 1-hour and 24-hour moving average dilutions for each discharge case.

For the purposes of ecotoxicological assessment, laboratory toxicity data are typically based on exposure durations of 48 to 96 hours. On this basis, comparison with modelled 24-hour average dilutions is considered conservative. In addition, a conservative acute-to-chronic ratio of 10 was applied to convert chronic toxicity thresholds to equivalent acute benchmarks, allowing comparison with modelled 1-hour average dilution conditions.

The use of time-averaged dilution metrics is particularly relevant for environmental impact assessment. Instantaneous minimum dilution values may be misleading, as they can reflect brief, potentially rare events lasting less than five minutes and may not be representative of sustained environmental exposure. Ecotoxicological thresholds are generally derived from time-averaged exposure scenarios; therefore, one-

hour and 24-hour moving average dilutions provide a more meaningful, while still conservative, basis for assessing potential environmental effects. These metrics also align more closely with laboratory-derived exposure thresholds than transient instantaneous minima, making them more appropriate for regulatory comparison and ecological risk assessment.

The reported dilutions assume zero background concentrations of the contaminants of interest in receiving waters and do not account for biodegradation or other attenuation processes.

3.2.4 Setup of Far-Field Model

3.2.4.1 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 3.1.

The near-field model outputs were used to define the initial plume behaviour entering the far-field model, including the initial dilution, plume geometry and likely trajectory immediately after discharge. The near-field results are therefore not intended to provide a separate estimate of the operational mixing zone. Rather, they provide a diagnostic assessment of the initial discharge behaviour and support the configuration of the far-field model, which is used to assess plume exposure under time-varying ambient current conditions.

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 4.1).

Table 3-5 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 3-5 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

3.2.4.2 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).

3.2.4.3 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.

3.2.5 Regional Ocean Currents

3.2.5.1 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 3-3 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.

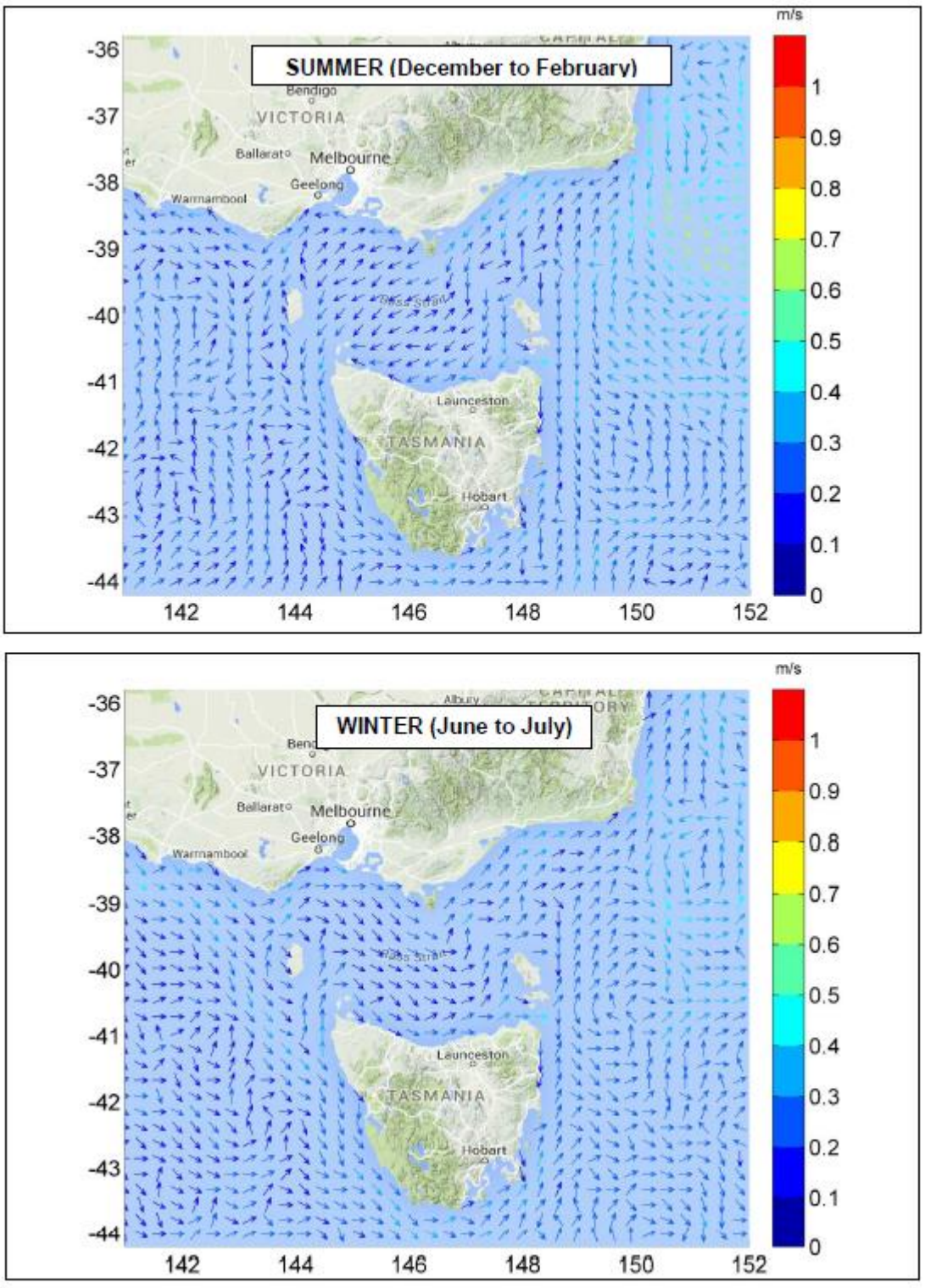


Figure 3-3 Example HYCOM averaged seasonal surface drift currents during summer (top) and winter (bottom).

3.2.5.1 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).

3.2.5.2 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 3-4 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 3-5). 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).

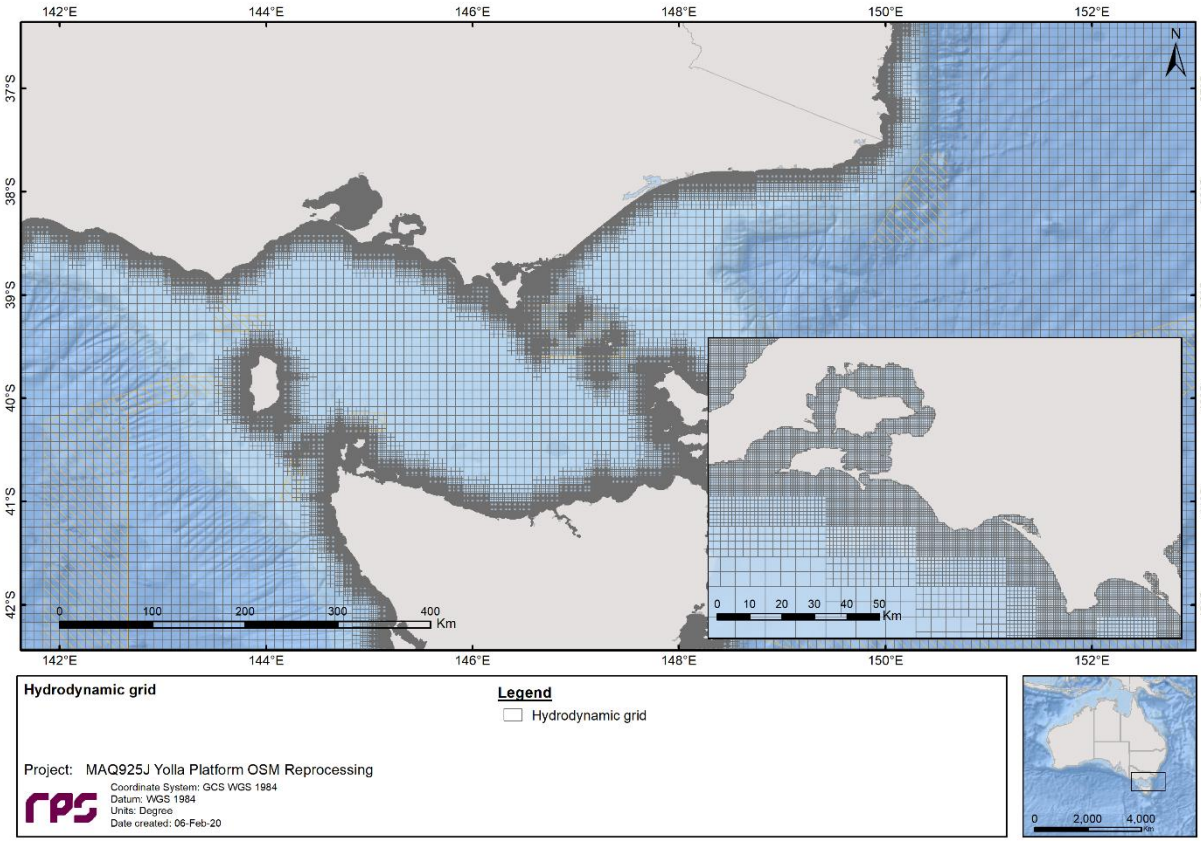


Figure 3-4 Zoomed in view of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

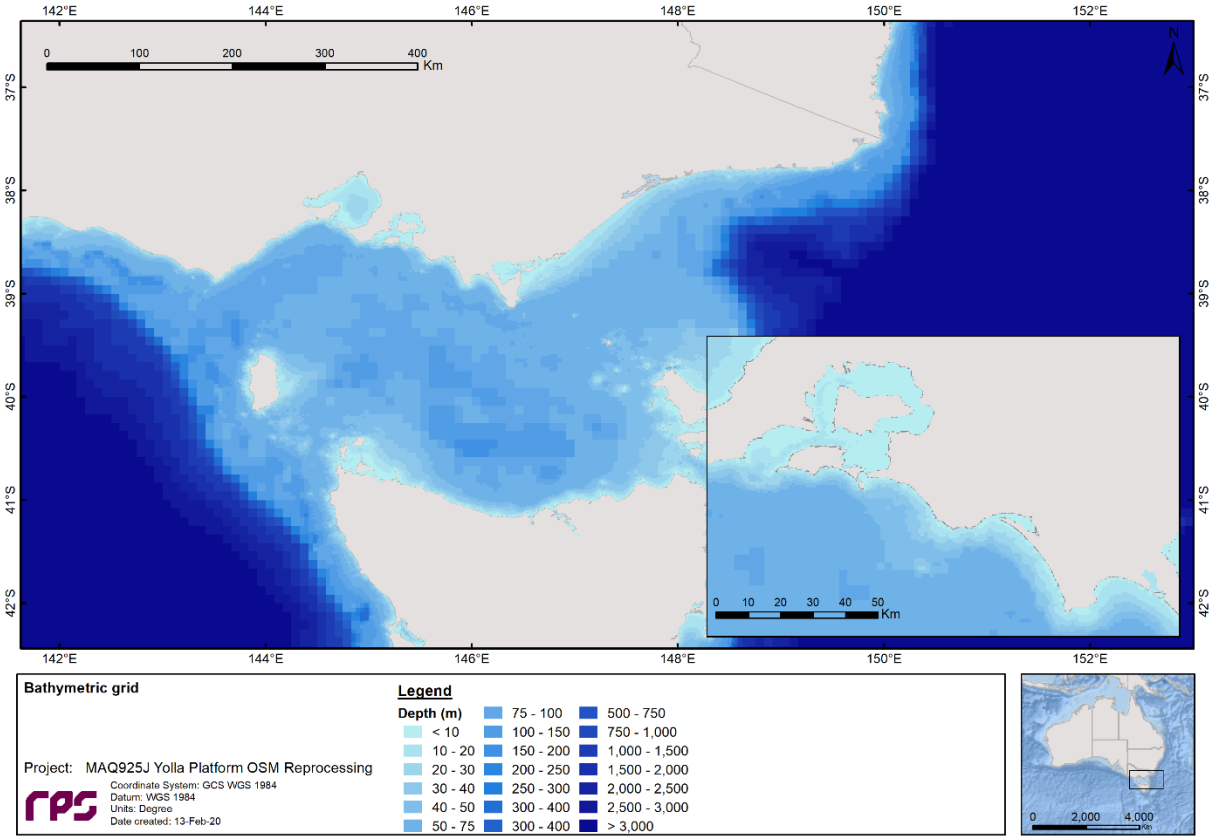


Figure 3-5 Bathymetry defined throughout the tidal model domain.

3.2.5.3 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.

3.2.5.4 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 (1/12th 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.

3.2.5.5 Surface Currents

Table 3-6 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 3-6 and Figure 3-7 present the monthly and total current rose distributions, respectively.

Table 3-6 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**	-

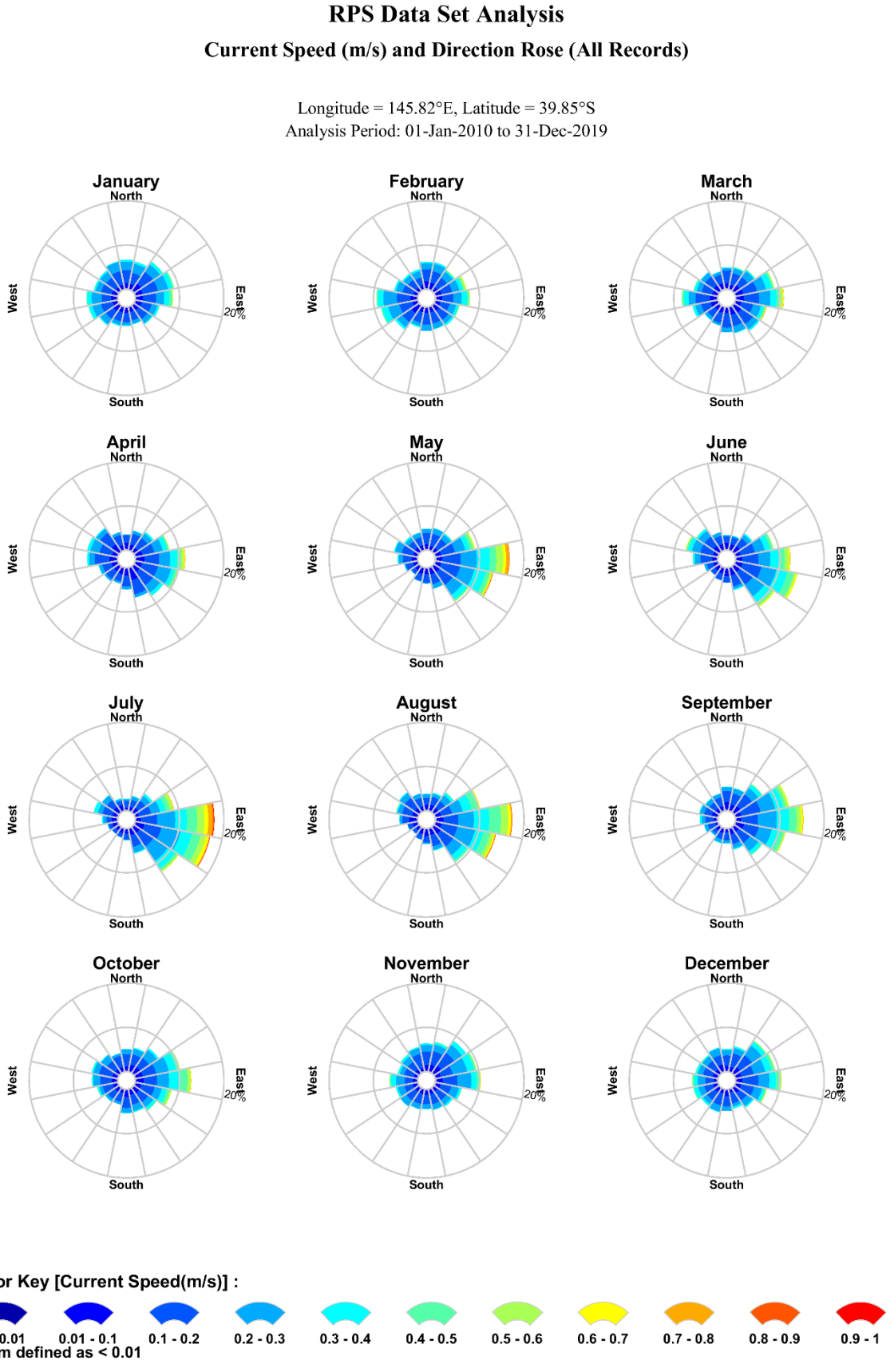


Figure 3-6 Monthly surface current rose distributions at the release location derived from the 2010 to 2019 modelled dataset.

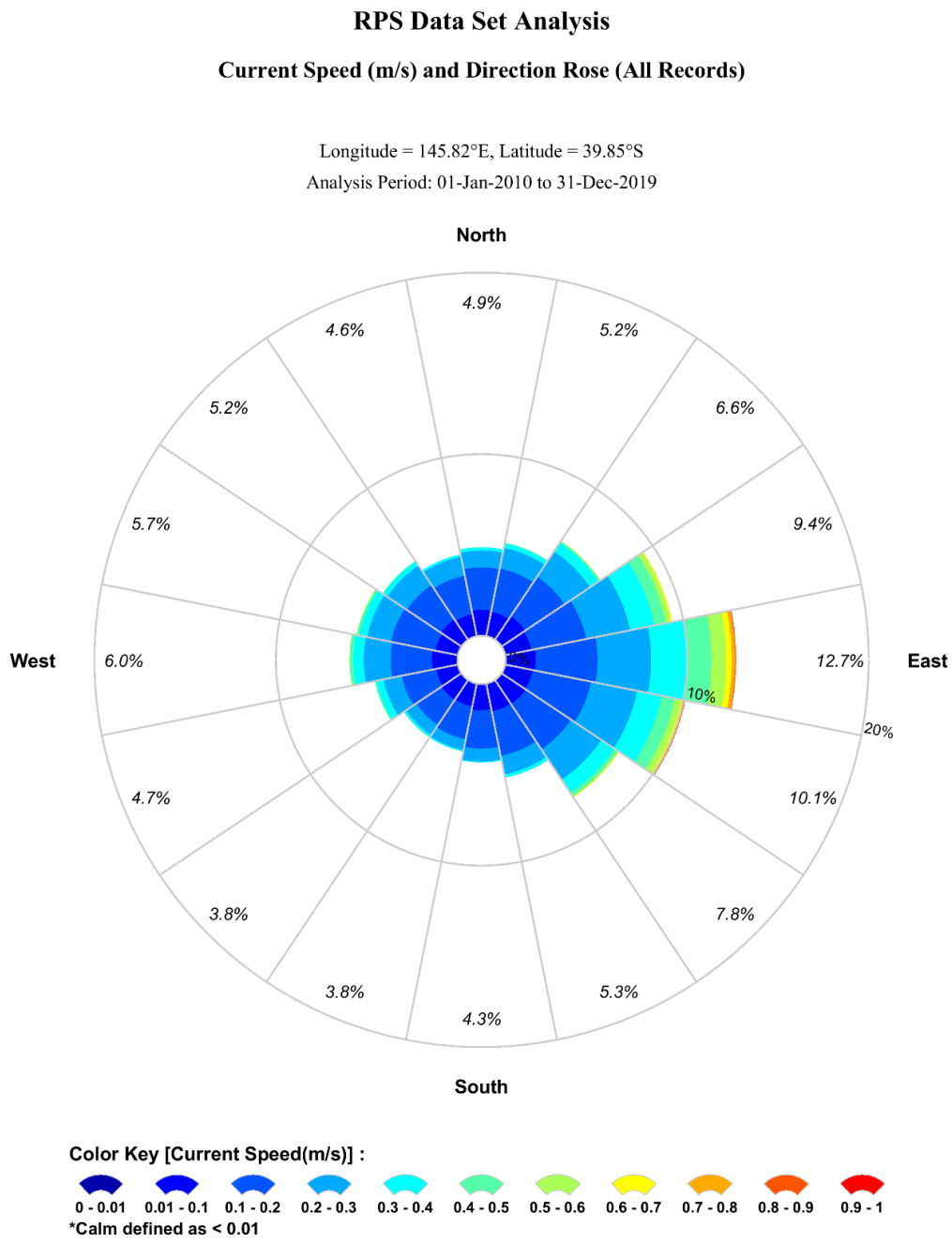


Figure 3-7 Total surface current rose plot at the release location derived from the 2010 to 2019 modelled dataset.

4 MODELLING RESULTS

4.1 Near-Field Modelling

4.1.1 Overview

Figure 4-1 to Figure 4-12 show 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 157 was reached ranged from 18 m to 23 m across the different seasons and flow rates, while the higher dilution threshold (6,667) was reached within 375 m to 450 m.

Under moderate currents, the distance where the lower dilution threshold of 157 was reached ranged from 10 m to 12 m across the different seasons and flow rates, while the higher dilution threshold (6,667) was reached within 190 m to 490 m.

Under low currents, the distance where the lower dilution threshold of 157 was reached within 5 m across the different seasons and flow rates, while the higher dilution threshold (6,667) was reached within 63 m to 62 m.

Table 4-1 and Table 4-2 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 4-1 Distances from release location to reach threshold dilutions for the 200 m^3/day base case.

Current speed condition	Summer				Winter			
	157 dilutions	483 dilutions	3,030 dilutions	6,667 dilutions	157 dilutions	483 dilutions	3,030 dilutions	6,667 dilutions
High	21	51	235	450	18	50	205	375
Medium	11	26	96	410	10	25	100	190
Low	4.5	10	108	475	4.5	10	37	63

Table 4-2 Distances from release location to reach threshold dilutions for the 300 m^3/day future case.

Current speed condition	Summer				Winter			
	157 dilutions	483 dilutions	3,030 dilutions	6,667 dilutions	157 dilutions	483 dilutions	3,030 dilutions	6,667 dilutions
High	23	57	237	380	19	52	225	420
Medium	12	28	97	490	11	26	110	207
Low	5	11	184	622	5	11	42	65

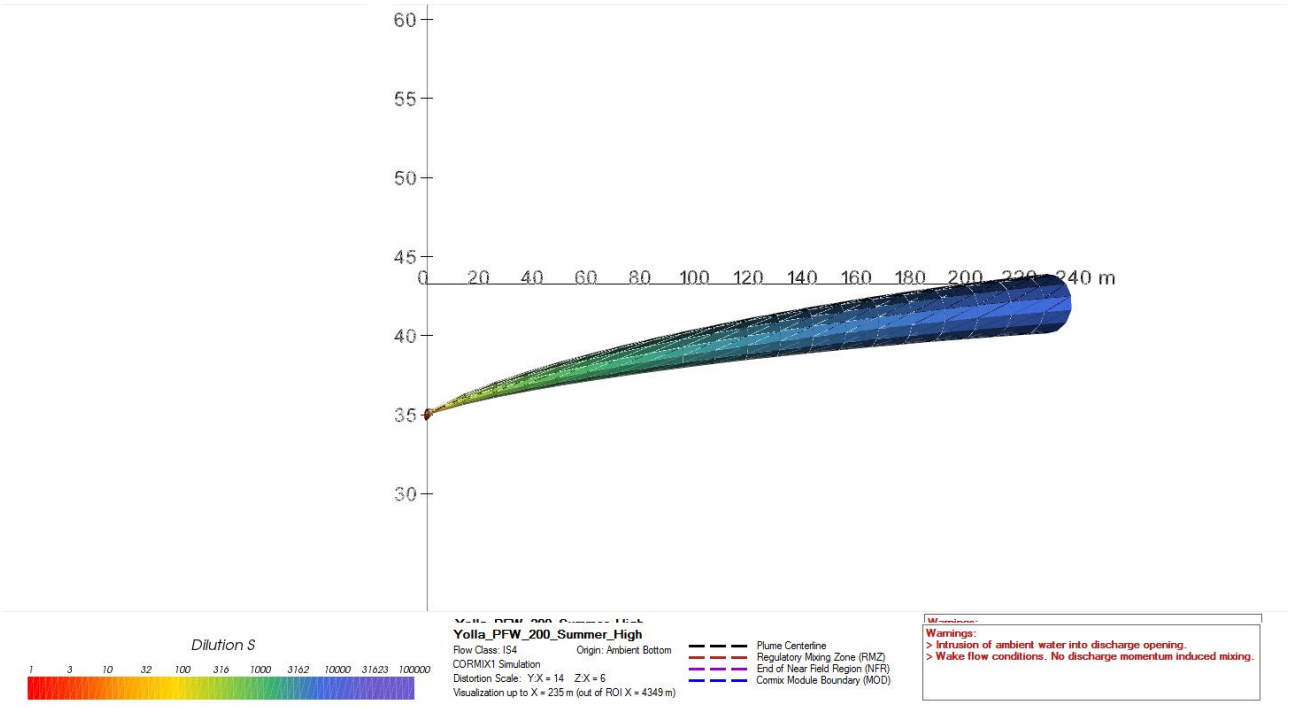


Figure 4-1 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 200 m³/d at discharge height of 45 m below the sea surface.

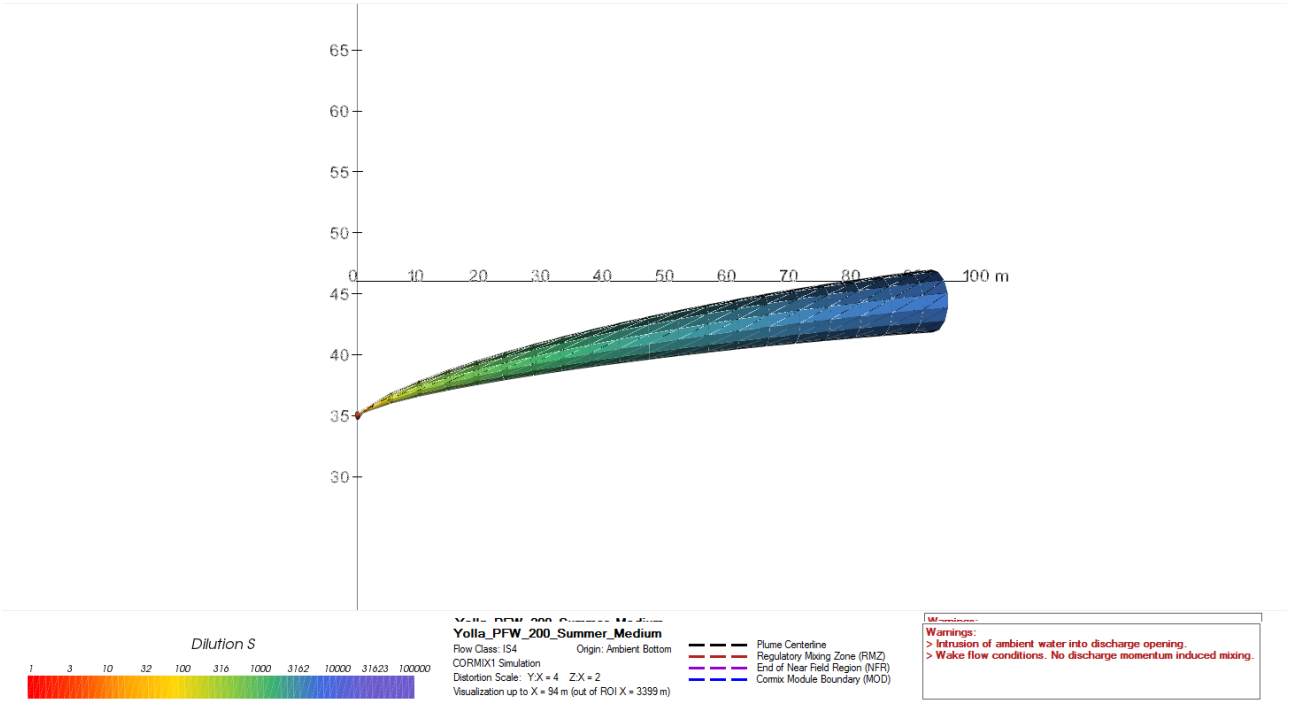


Figure 4-2 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 200 m³/d at discharge height of 45 m below the sea surface.

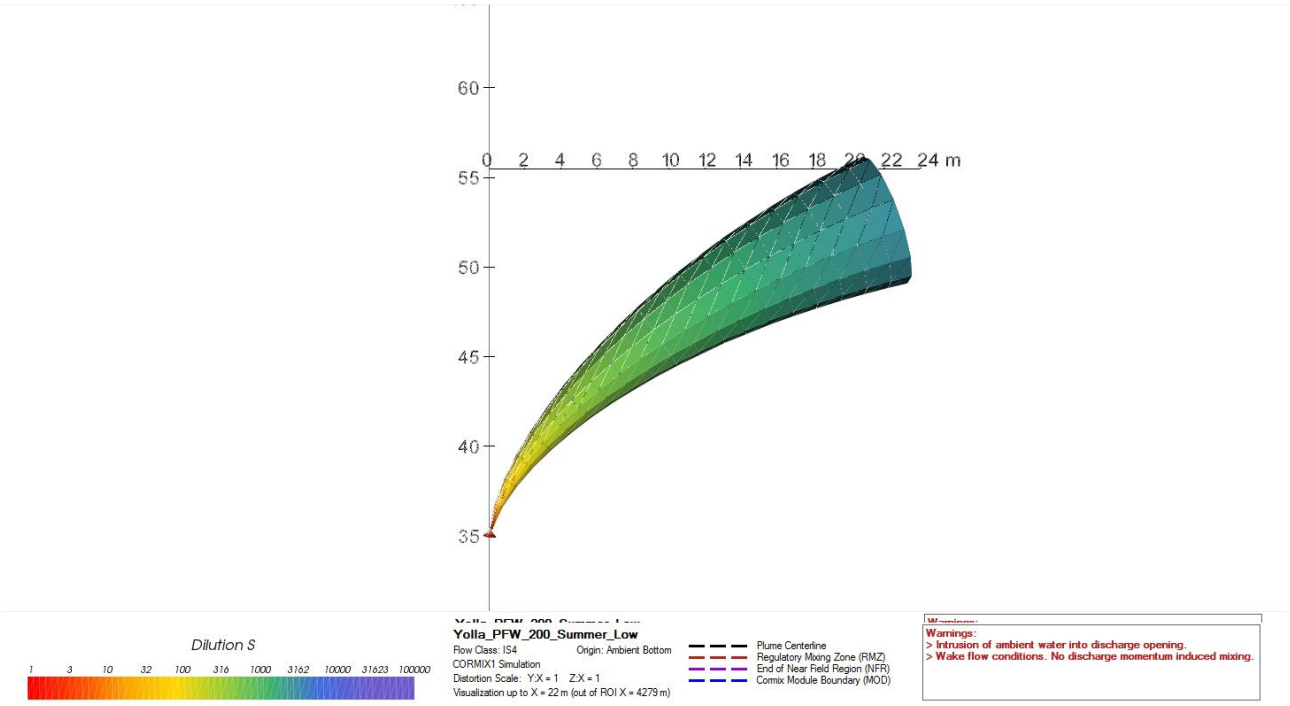


Figure 4-3 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 200 m³/d at discharge height of 45 m below the sea surface.

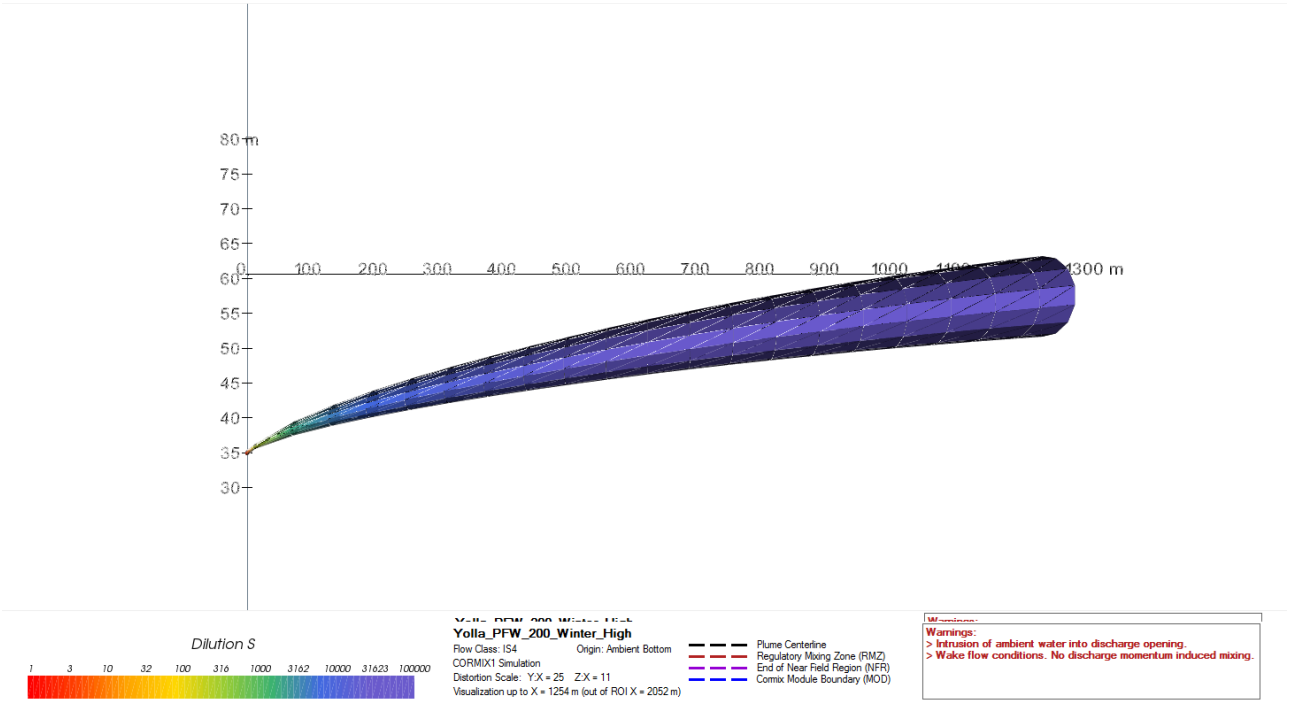


Figure 4-4 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 200 m³/d at discharge height of 45 m below the sea surface.

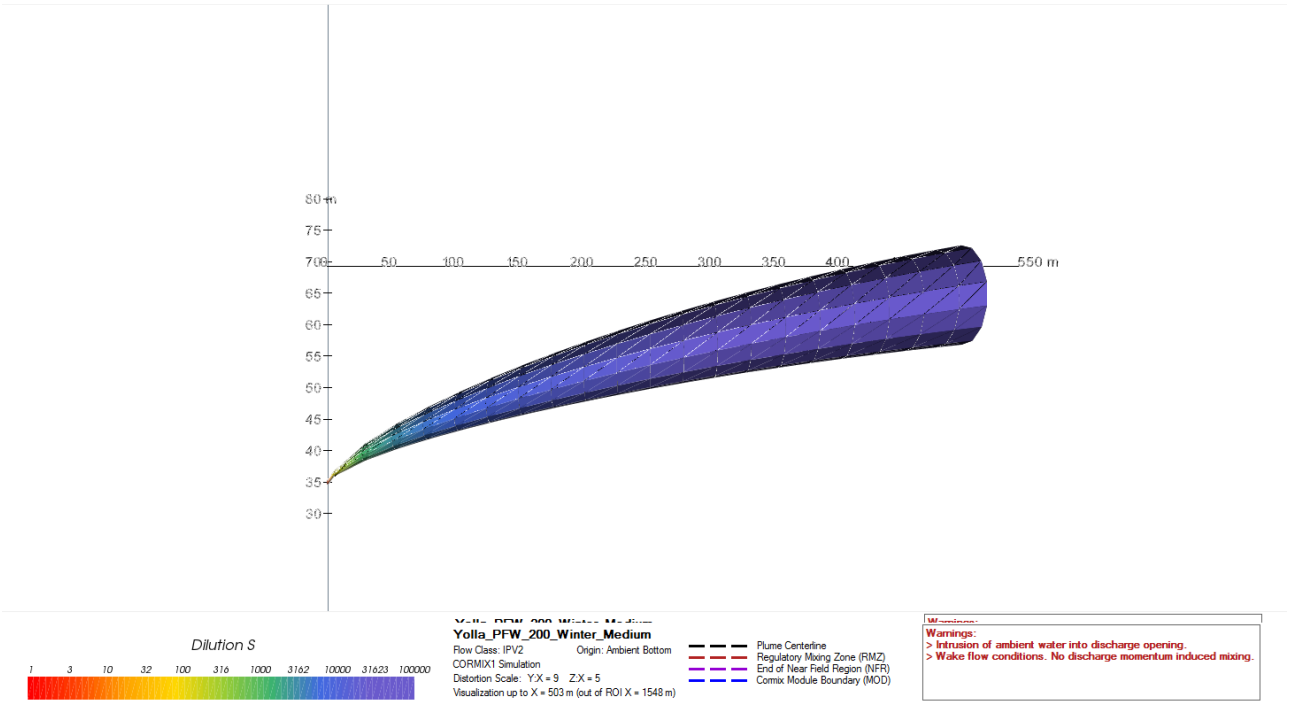


Figure 4-5 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 200 m³/d at discharge height of 45 m below the sea surface.

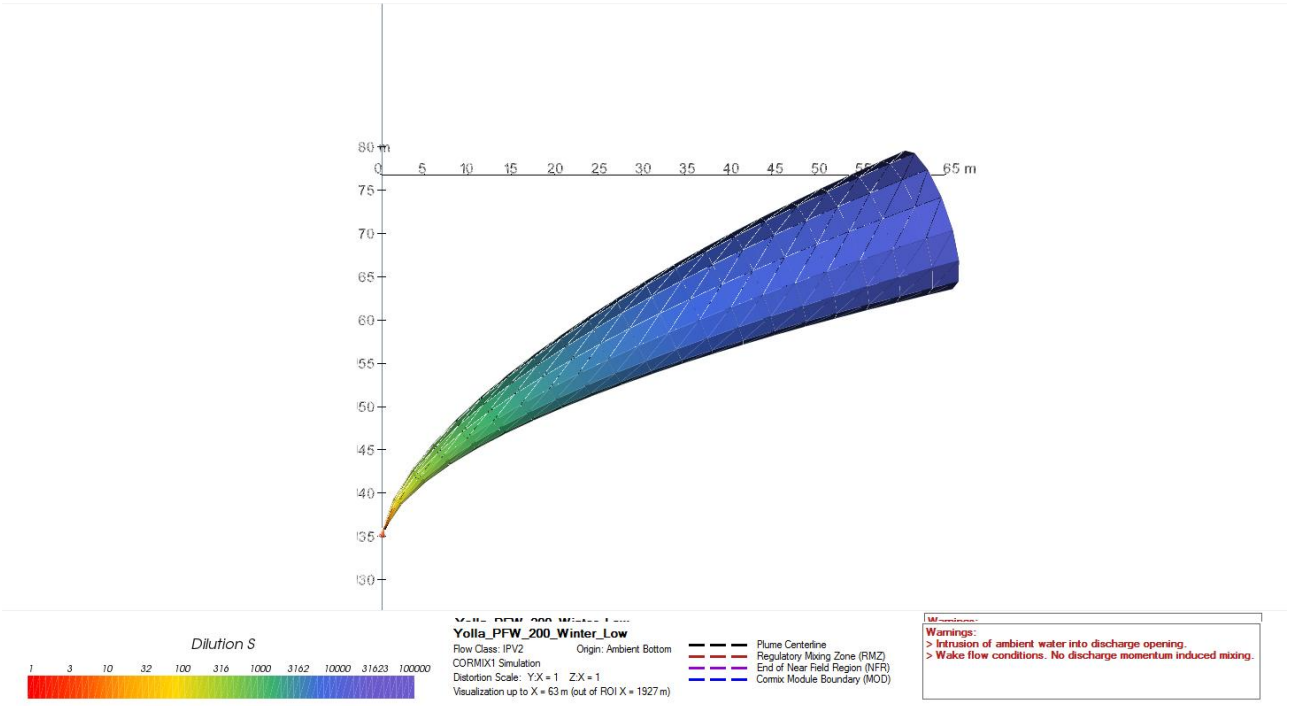


Figure 4-6 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 200 m³/d at discharge height of 45 m below the sea surface.

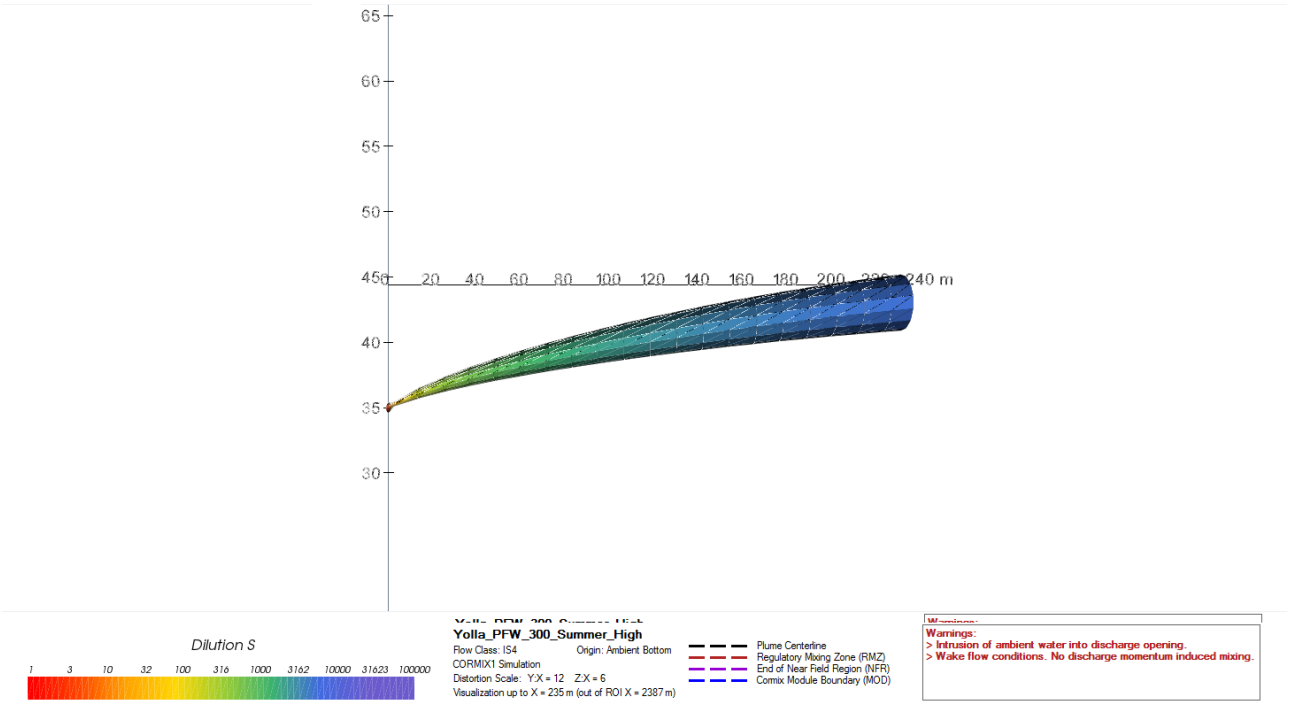


Figure 4-7 Near-field average dilution results for constant strong currents in summer with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

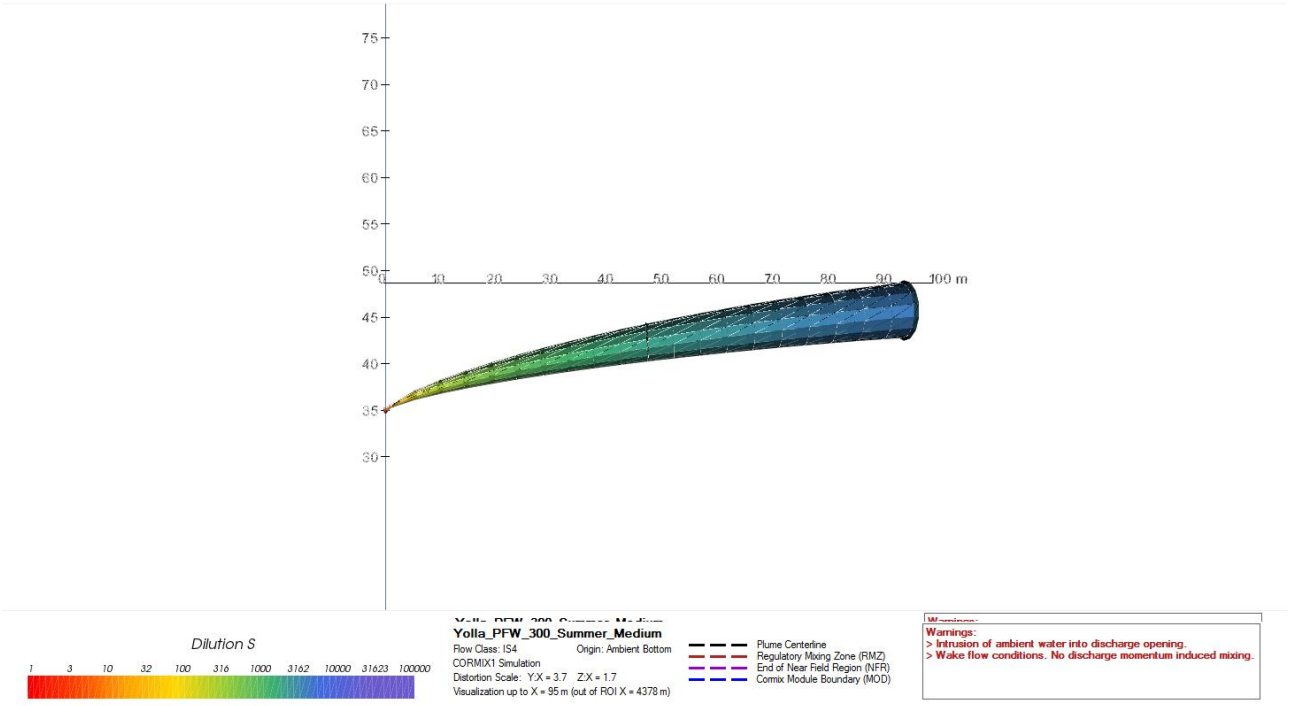


Figure 4-8 Near-field average dilution results for constant medium currents in summer with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

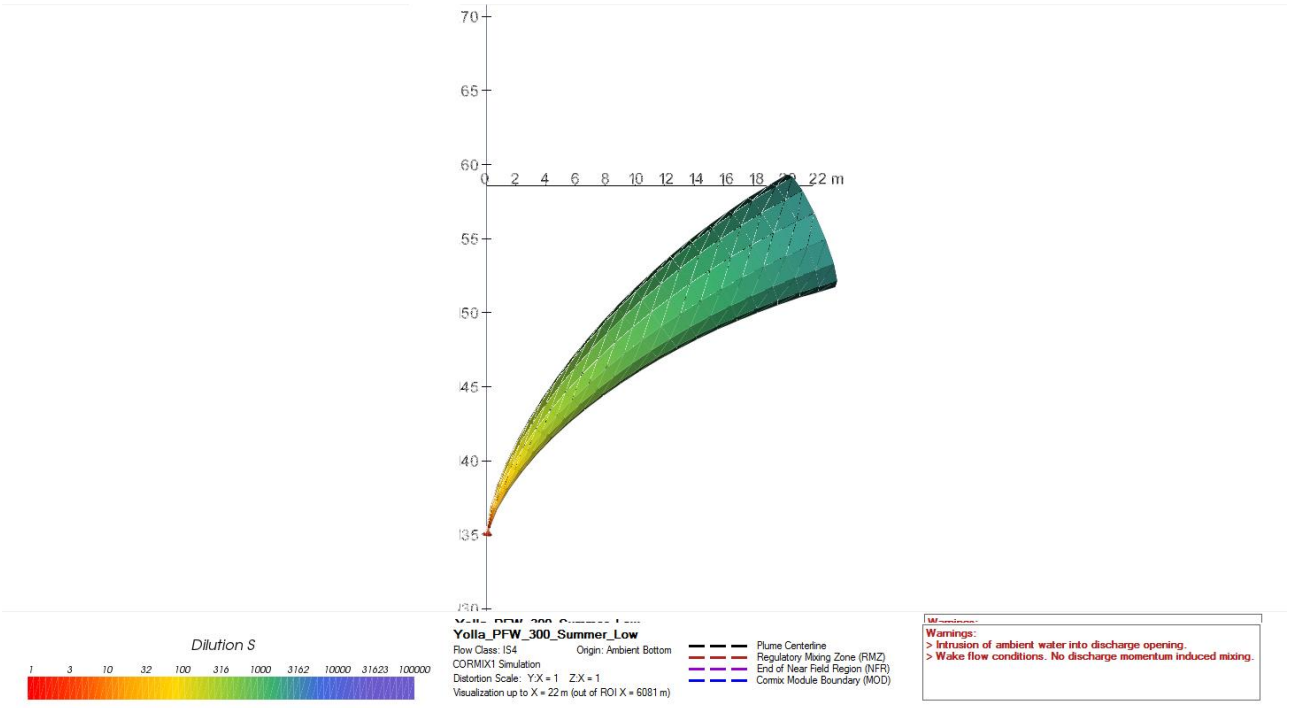


Figure 4-9 Near-field average dilution results for constant weak currents in summer with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

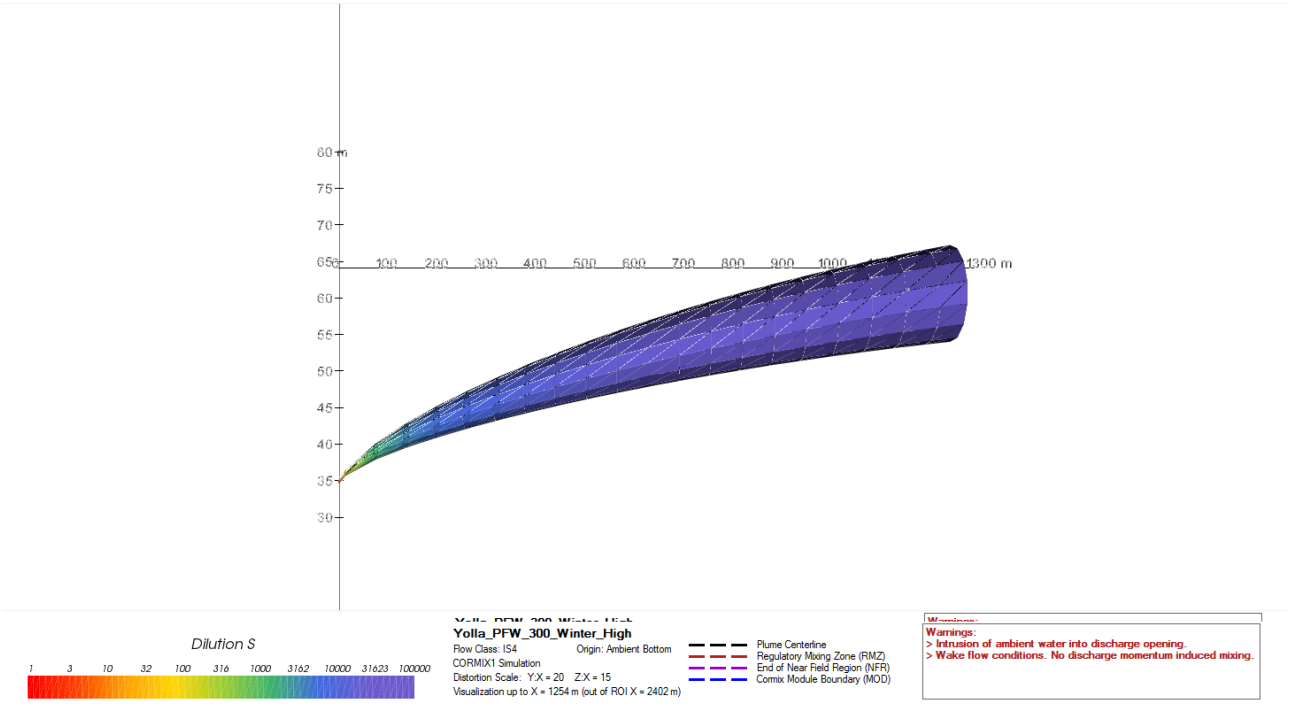


Figure 4-10 Near-field average dilution results for constant strong currents in winter with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

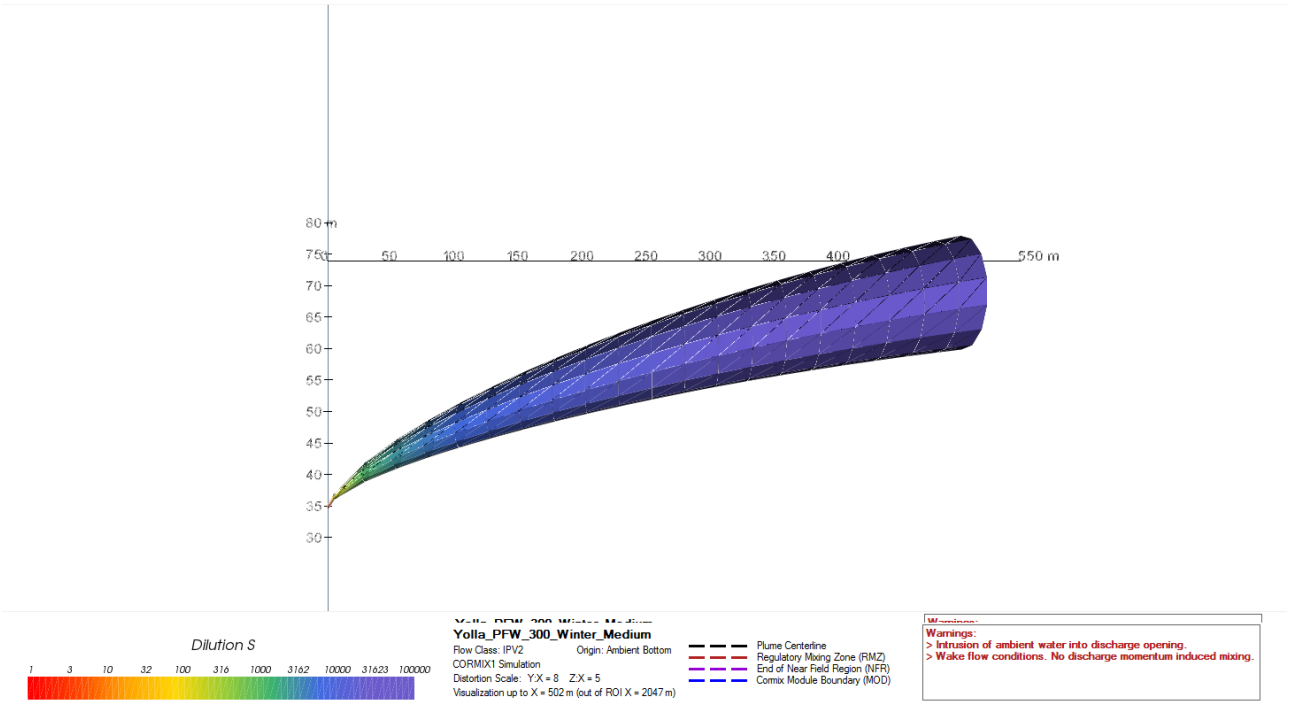


Figure 4-11 Near-field average dilution results for constant medium currents in winter with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

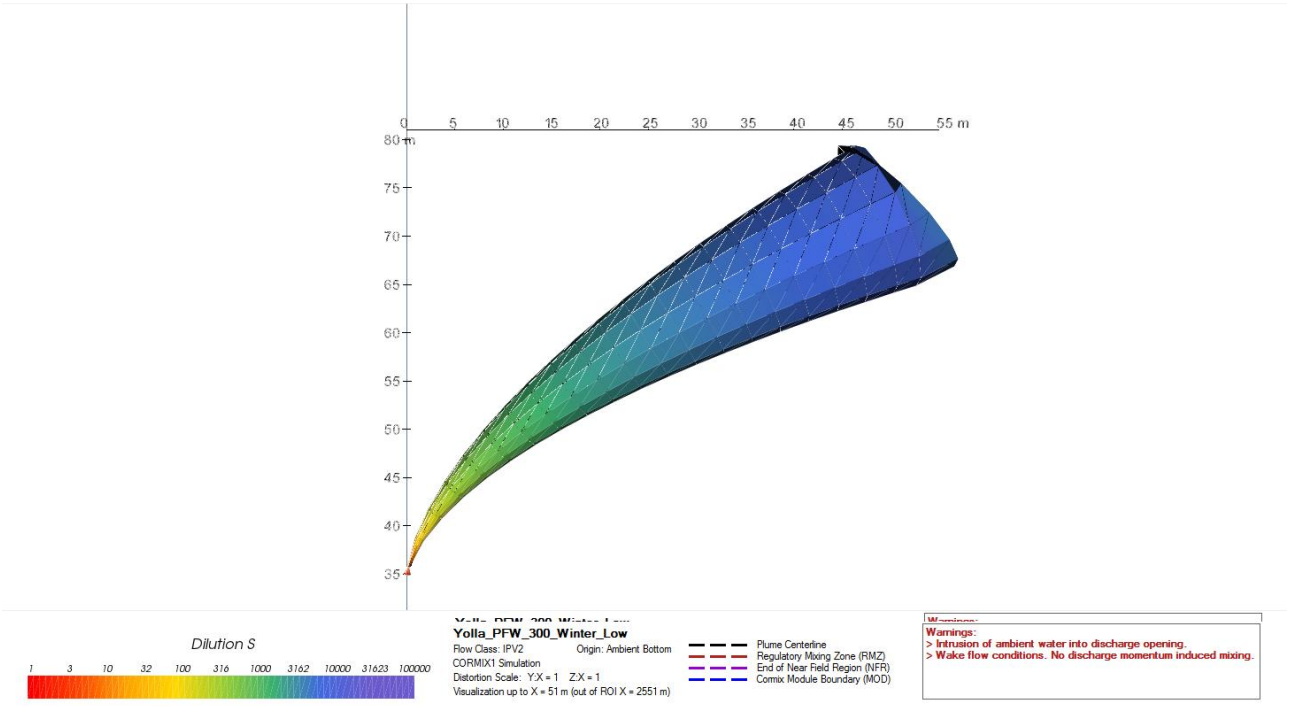


Figure 4-12 Near-field average dilution results for constant weak currents in winter with a discharge flow rate of 300 m³/d at discharge height of 45 m below the sea surface.

4.2 Far-Field Modelling

4.2.1 Overview

The near-field and far-field model results should not be directly compared because the two models are designed to represent different physical processes operating over different spatial and temporal scales. The near-field model, CORMIX, was applied to characterise the initial jet and buoyant plume behaviour immediately after discharge, where dilution is dominated by discharge momentum, buoyancy, outlet geometry and entrainment of ambient water. This phase occurs over short distances and short time scales and provides information on plume trajectory, bending under current forcing, initial dilution, and the approximate shape and orientation of the plume as it transitions from the discharge-dominated near-field to the ambient-current-dominated far-field.

By contrast, MUDMAP was applied to simulate the subsequent transport and passive dispersion of the remnant plume under time-varying three-dimensional current conditions. The far-field modelling incorporates temporal variability in current speed and direction, including periods of weak current, tidal turning, plume accumulation and potential recirculation, which cannot be represented by a single steady-state CORMIX current case. MUDMAP also distributes discharged mass across a three-dimensional computational grid and reports grid-cell based concentrations and dilutions through time, rather than plume centreline dilution along an idealised near-field plume trajectory.

The CORMIX results should therefore be interpreted as diagnostic outputs used to understand the initial plume behaviour and to inform the far-field model configuration. They are useful for confirming whether the discharge behaves as a rising or sinking plume, estimating the initial dilution achieved before the far-field phase, and defining the initial plume characteristics used by MUDMAP. They should not, however, be interpreted as a direct estimate of the operational mixing zone, because they are based on steady, idealised current conditions and simplified analytical assumptions that are appropriate for near-field assessment but do not capture the temporal variability, plume history, or time-averaging used in the far-field assessment.

For assessment of the operational mixing zone, the far-field MUDMAP results provide the more appropriate basis because they simulate continuous discharge under representative current variability and are post-processed using 1-hour and 24-hour moving average dilution metrics. These time-averaged metrics are more relevant to ecological exposure assessment than instantaneous near-field plume centreline values, particularly where toxicity thresholds relate to sustained exposure durations rather than transient short-duration concentration maxima. The near-field results are therefore reported for completeness and to document the basis for the far-field model setup, while the far-field results are used to assess the potential area of influence and operational mixing zone.

4.2.2 Stochastic Analysis

The model outputs over the ten-year hindcast period (2010-2019) were combined and analysed on an annual basis.

Table 4-3 summarises the maximum distances from the discharge location to achieve various dilution levels for each moving average period.

In the 24-hour moving average evaluation, the two lower thresholds (157 and 483) were not observed. The model indicated 3,303 dilutions at distances of 10 meters and 13 meters for the Base Case and Future Case, respectively. Additionally, the model recorded 6,667 dilutions at 19 meters for the Base Case and 25 meters for the Future Case.

In the 1-hour moving average evaluation, the three lower thresholds (16, 48 and 303) were not observed. The model indicated 666 dilutions at distances of 7 meters for the Base Case and 10 meters for the Future Case.

The dilution maps for each dilution period for each discharge case are depicted in Figure 4-13 and Figure 4-16, along with contours illustrating the dilution thresholds. Note, not all thresholds were exceeded in the far-field modelling, hence only the exceeded threshold contours can be shown in the figures.

Table 4-3 Maximum distance from the PFW discharge location to achieve threshold dilutions.

Metric	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)
24-hr moving average	157	< 5	< 5
	483	< 5	< 5
	3,030	10	13
	6,667	19	25
1-hr moving average	16	< 5	< 5
	48	< 5	< 5
	303	< 5	< 5
	666	7	10

Values provided as < 5m have not registered a result in the far-field modelling.

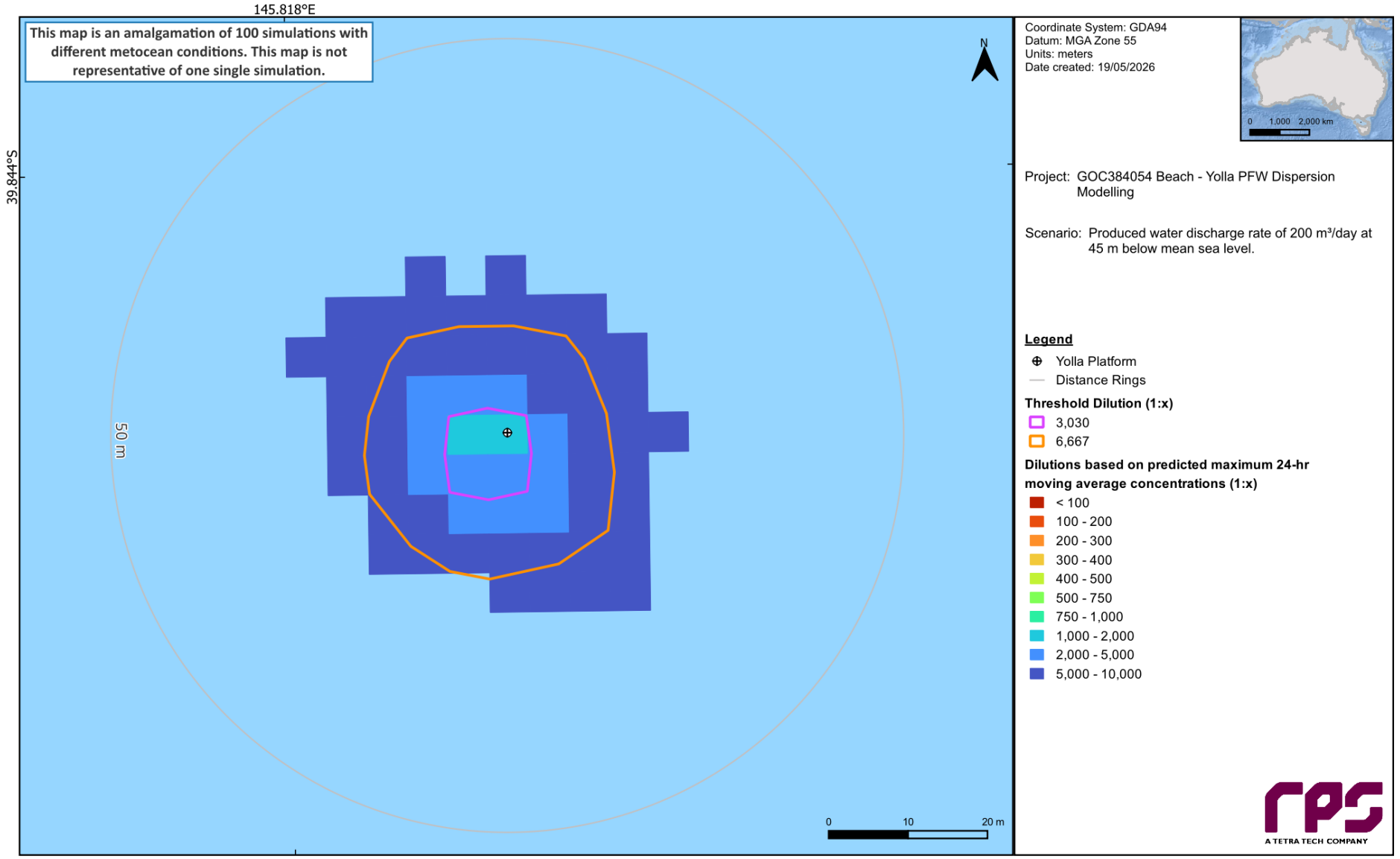


Figure 4-13 Minimum 24-hr moving average dilution for PFW discharged at 200 m³/d. Results refer to annual conditions.

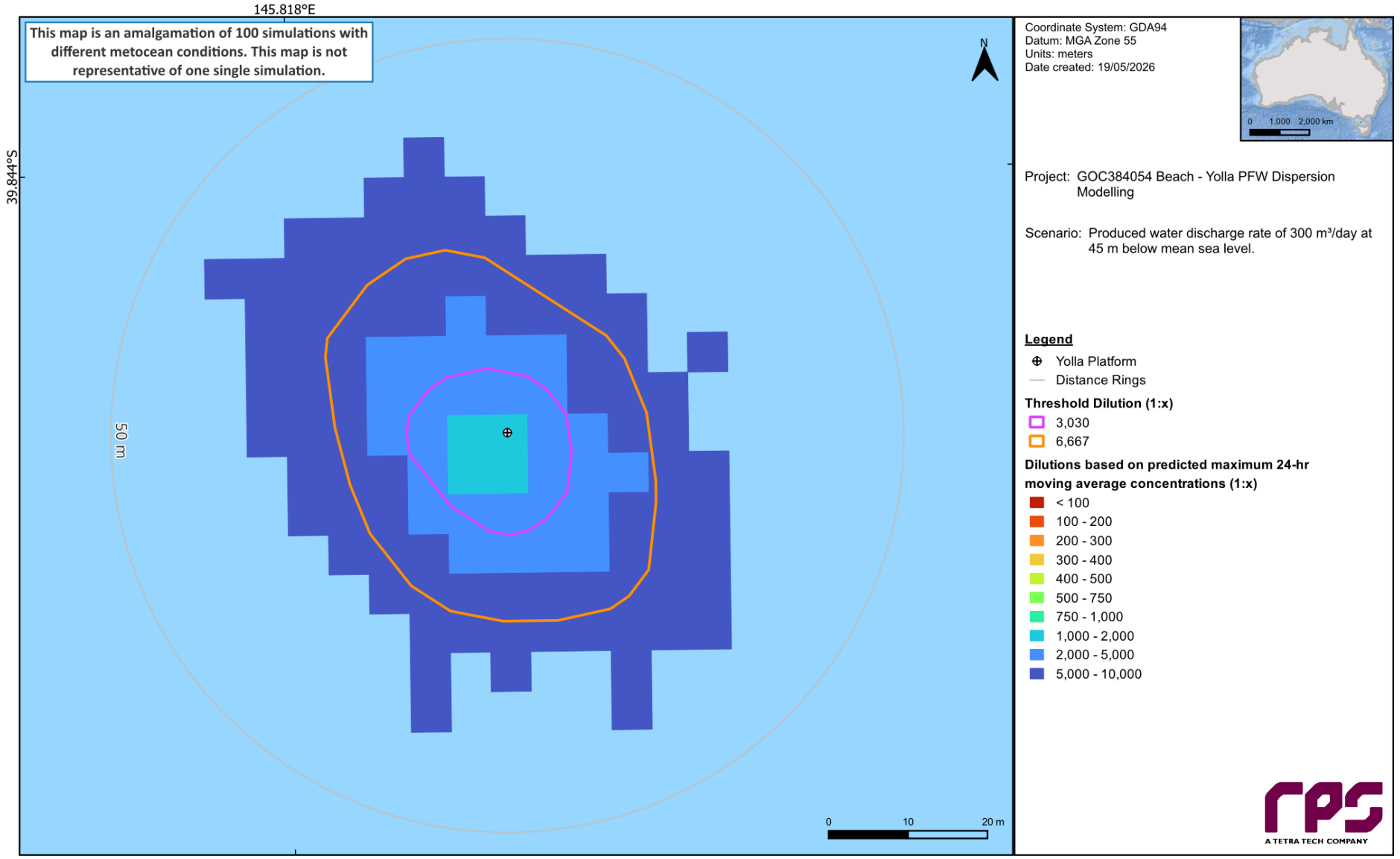


Figure 4-14 Minimum 24-hr moving average dilution for PFW discharged at 300 m³/d. Results refer to annual conditions.

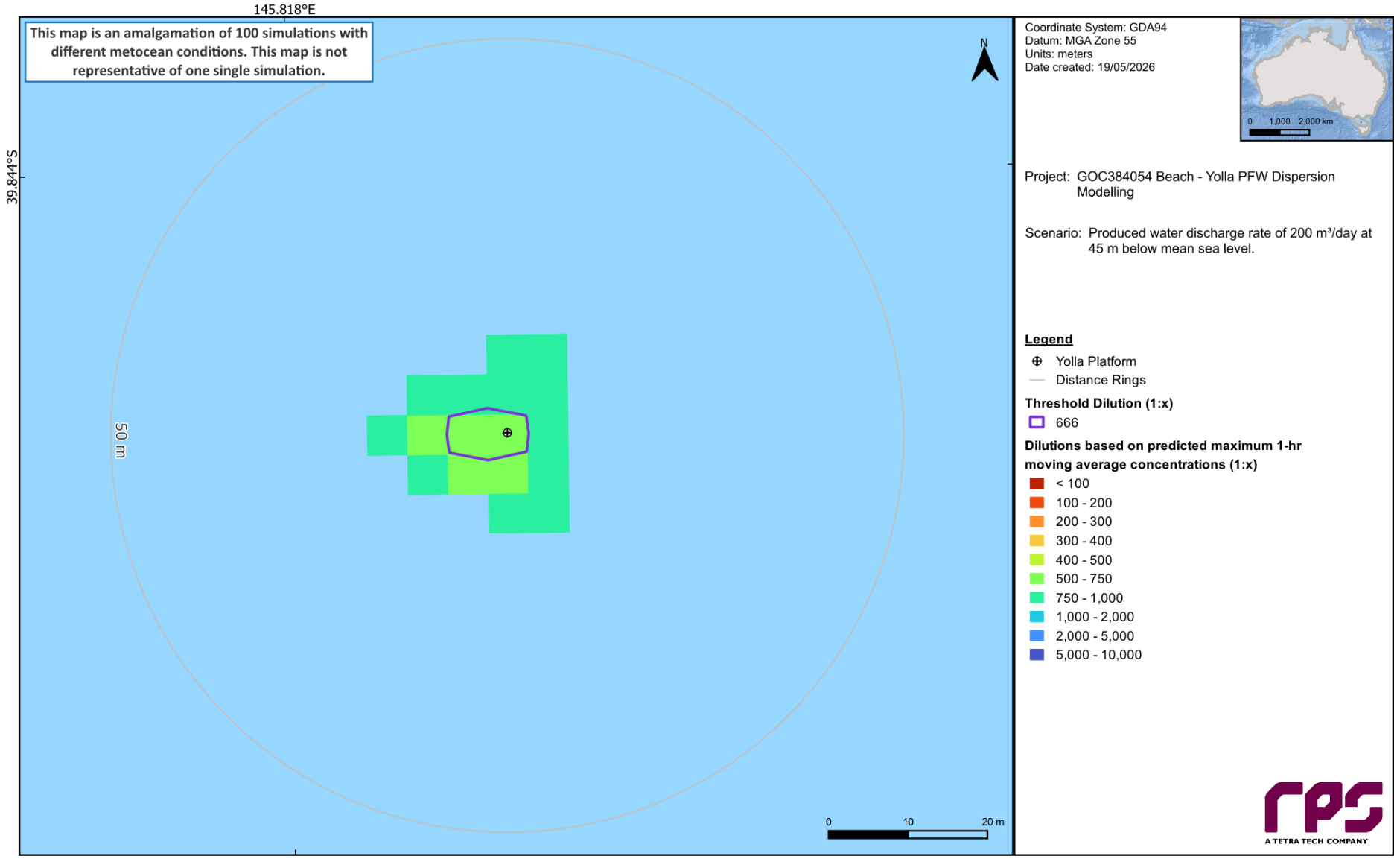


Figure 4-15 Minimum 1-hr moving average dilution for PFW discharged at 200 m³/d. Results refer to annual conditions.

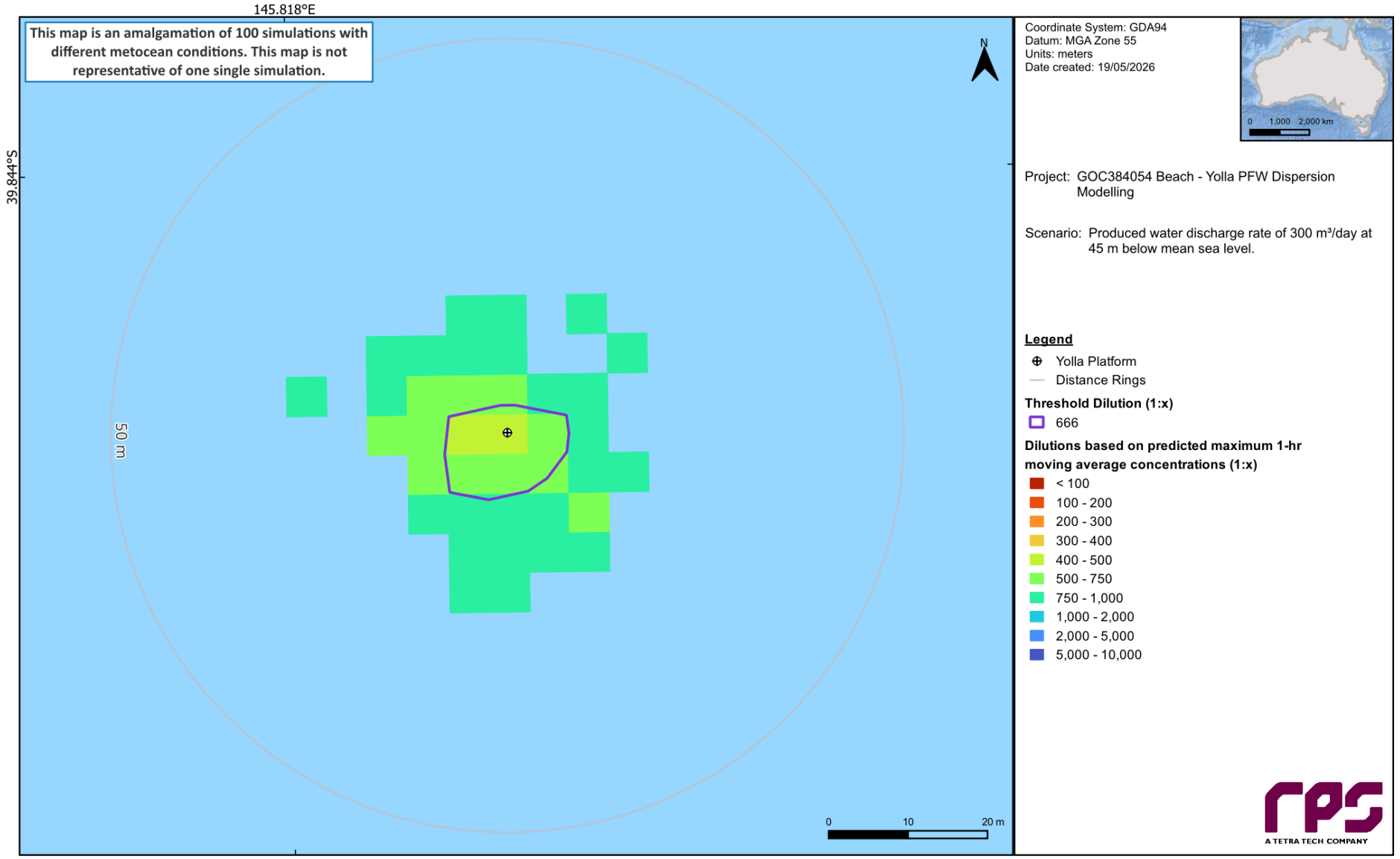


Figure 4-16 Minimum 1-hr moving average dilution for PFW discharged at 300 m³/d. Results refer to annual conditions.

5 REFERENCES

Andersen, OB 1995, 'Global ocean tides from ERS 1 and TOPEX/POSEIDON altimetry', Journal of Geophysical Research: Oceans, vol. 100, no. C12, pp. 25249-25259.

Burns, K, Codi, S, Furnas, M, Heggie, D, Holdway, D, King, B & McAllister, F 1999, 'Dispersion and fate of produced formation water constituents in an Australian Northwest Shelf shallow water ecosystem', Marine Pollution Bulletin, vol. 38, pp. 593-603.

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R & Bleck, R 2007, 'The HYCOM (HYbrid Coordinate Ocean Model) data assimilative system', Journal of Marine Systems, vol. 65, no. 1, pp. 60-83.

Chassignet, EP, Hurlburt, HE, Metzger, E, Smedstad, OM, Cummings, J & Halliwell, GR 2009, 'U.S. GODAE: Global ocean prediction with the HYbrid Coordinate Ocean Model (HYCOM)', Oceanography, vol. 22, no. 2, pp. 64-75.

Condie, SA., & Andrewartha, JR 2008, 'Circulation and connectivity on the Australian Northwest Shelf', Continental Shelf Research, 28, 1724–1739.

Davies, AM 1977a, 'The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile', in Bottom Turbulence: Proceedings of the 8th Liege Colloquium on Ocean Hydrodynamics, ed. Nihoul, JCJ, Elsevier.

Davies, AM 1977b, 'Three-dimensional model with depth-varying eddy viscosity', in Bottom Turbulence: Proceedings of the 8th Liege Colloquium on Ocean Hydrodynamics, ed. Nihoul, JCJ, Elsevier.

Doneker, R & Jirka, G 1990, 'Expert System for Hydrodynamic Mixing Zone Analysis of Conventional and Toxic Submerged Single Port Discharges (CORMIX1)', EPA/600/3-90/012, U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Gordon, R 1982, Wind driven circulation in Narragansett Bay, PhD thesis, University of Rhode Island, Kingston, RI, USA.

Isaji, T & Spaulding, ML 1984, 'A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank', Journal of Physical Oceanography, vol. 14, no. 6, pp. 1119-1126.

Isaji, T, Howlett, E, Dalton, C & Anderson, E 2001, 'Stepwise-continuous-variable-rectangular grid hydrodynamics model', in Proceedings of the 24th Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Edmonton, AB, Canada, pp. 597-610.

Jirka, GH, Doneker, RL, & Barnwell, TO, 1991, 'CORMIX: an expert system for mixing zone analysis', Water Science and Technology, vol. 24, no. 6, pp. 267–274.

Khondaker, AN 2000, 'Modeling the fate of drilling waste in marine environment – an overview', Journal of Computers and Geosciences, vol. 26, pp. 531-540.

King, B & McAllister, FA 1997, 'The application of MUDMAP to investigate the dilution and mixing of the above water discharge at the Harriet A petroleum platform on the Northwest Shelf', in Modelling the Dispersion of Produced Water Discharge in Australia, Australian Institute of Marine Science, Canberra, ACT, Australia.

King, B & McAllister, FA 1998, 'Modelling the dispersion of produced water discharges', APPEA Journal, pp. 681-691.

Koh, RCY & Chang, YC 1973, Mathematical model for barged ocean disposal of waste, Environmental Protection Technology Series, EPA 660/2-73-029, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, USA.

Kostianoy, AG, Ginzburg, AI, Lebedev, SA, Frankignoulle, M & Delille, B 2003, 'Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data', Oceanology, vol. 43, no. 5, pp. 632-642.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, 'The world ocean database', Data Science Journal, vol. 12, pp. WDS229-WDS234.

Ludicone, D, Santoleri, R, Marullo, S & Gerosa, P 1998, 'Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data', Journal of Geophysical Research I, vol. 103, no. C2, pp. 2995-3011.

Matsumoto, K, Takanezawa, T & Ooe, M 2000, 'Ocean tide models developed by assimilating TOPEX/POSEIDON altimeter data into hydrodynamical model: A global model and a regional model around Japan', Journal of Oceanography, vol. 56, no. 5, pp. 567-581.

Owen, A 1980, 'A three-dimensional model of the Bristol Channel', Journal of Physical Oceanography, vol. 10, no. 8, pp. 1290-1302.

Qiu, B & Chen, S 2010, 'Eddy-mean flow interaction in the decadally modulating Kuroshio Extension system', Deep-Sea Research II, vol. 57, no. 13, pp. 1098-1110.

RPS APASA 2016, Wandoo Operations, North West Shelf: Produced Formation Water - Oil in Water and Ammonia Discharge Modelling. Report Q0397. Prepared for Vermilion Oil and Gas Australia. RPS APASA Pty Ltd

Yaremchuk, M & Tangdong, Q 2004, 'Seasonal variability of the large-scale currents near the coast of the Philippines', Journal of Physical Oceanography, vol. 34, no. 4, pp. 844-855.

Zigic, S, Zapata, M, Isaji, T, King, B & Lemckert, C 2003, 'Modelling of Moreton Bay using an ocean/coastal circulation model', in Proceedings of the Coasts & Ports 2003 Australasian Conference, Auckland, New Zealand, paper no. 170.

APPENDIX 14

MAKING COMPLEX EASY

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BEACH - YOLLA PLATFORM

Oil Spill Modelling Report



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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% Winter – 84%	Summer – 94% Winter – 100%
	Absolute minimum time for oil to accumulate on shoreline cells at, or above, 10 g/m^2	NC	Summer – 0.52 days Winter – 0.59 days	Summer – 0.51 days 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 Winter – 23.71 m^3	Summer – 51.64 m^3 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 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

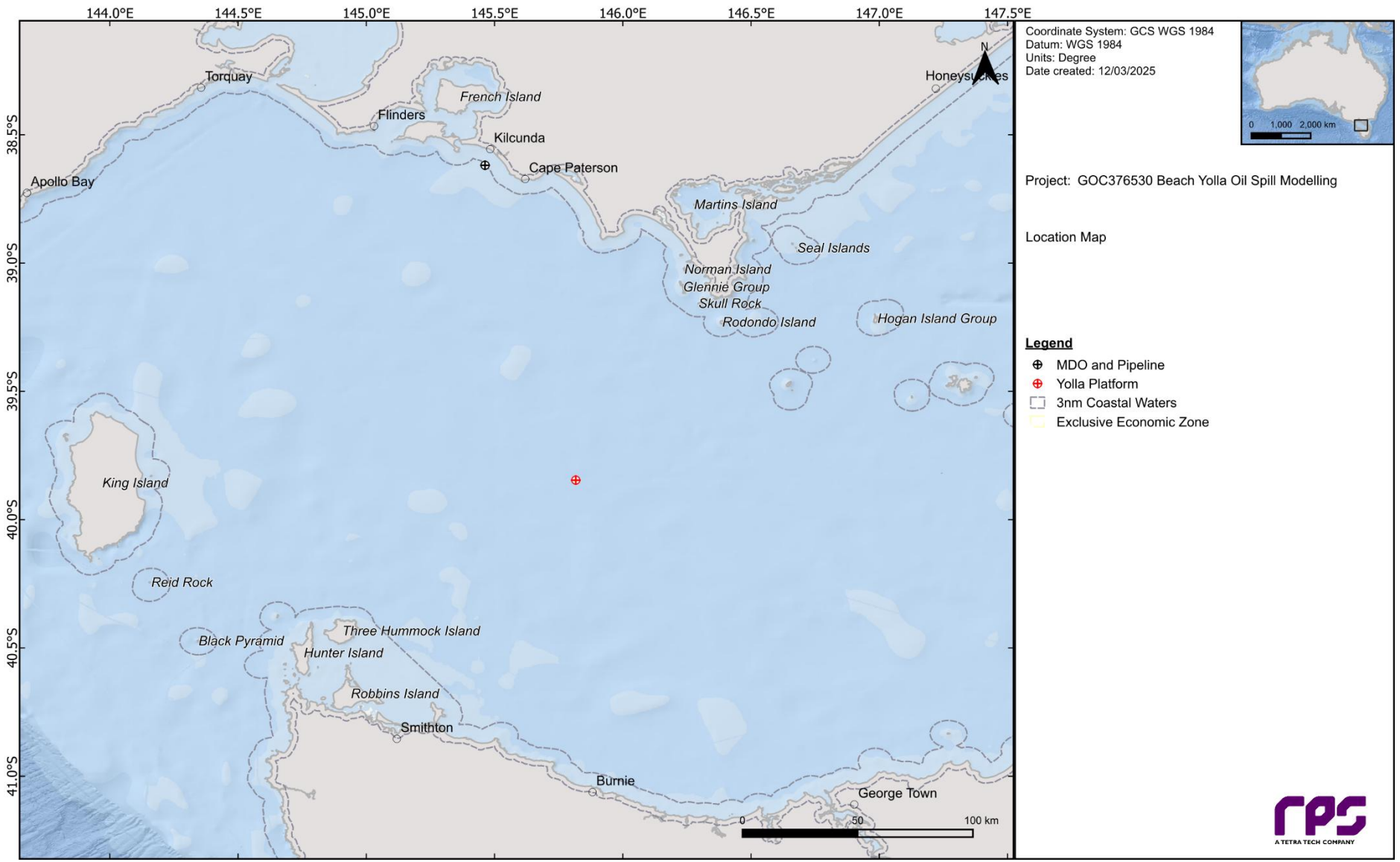


Figure 1.1 Location of the hypothetical spill release sites as used in the oil spill modelling.

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.

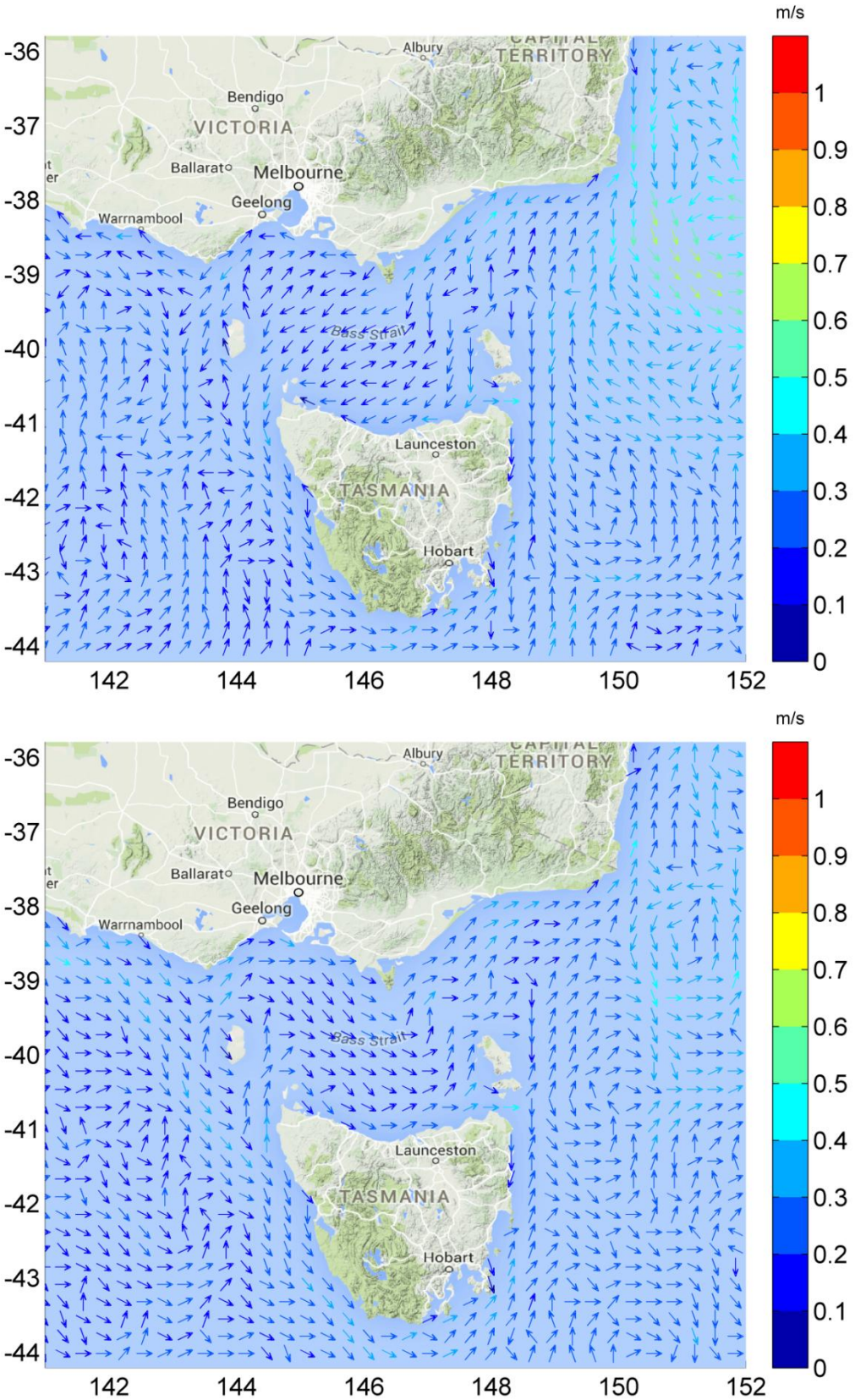


Figure 3.1 HYCOM averaged seasonal surface drift currents during summer and winter.

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).

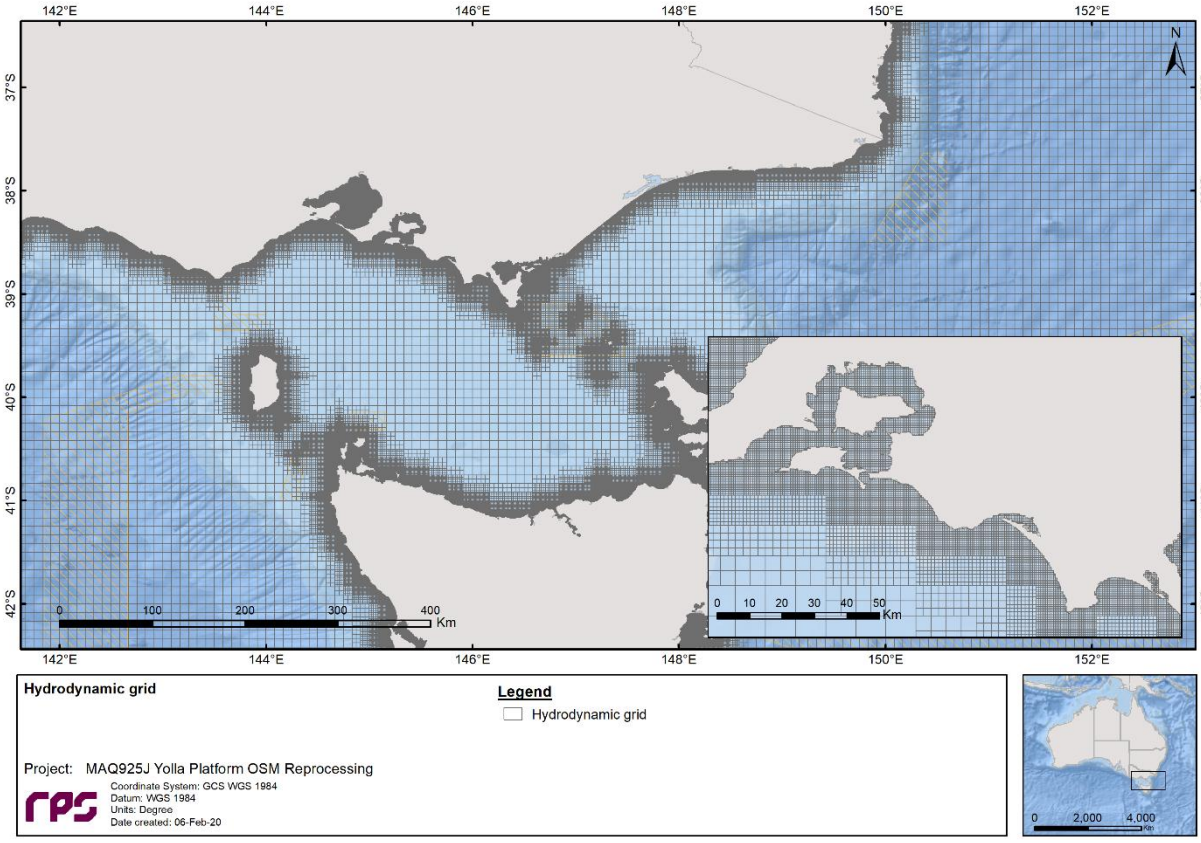


Figure 3.2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

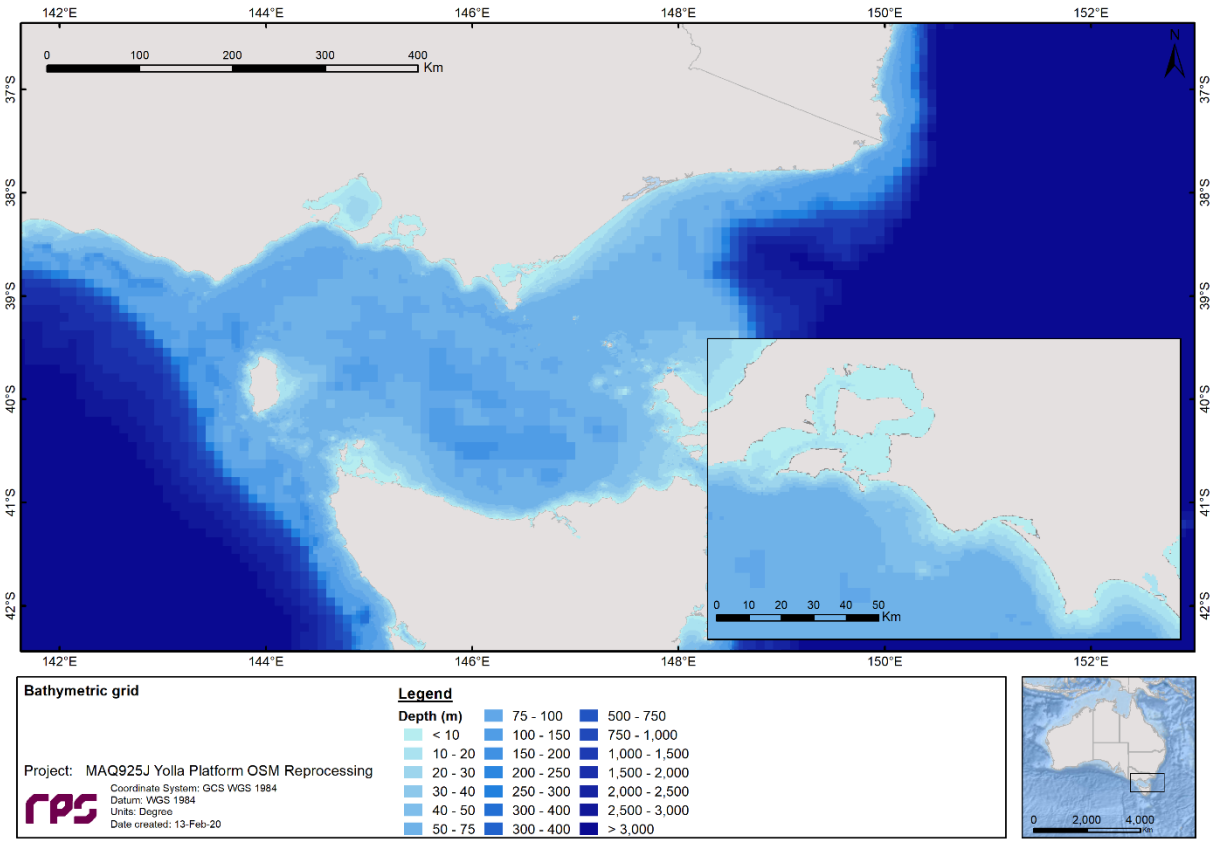


Figure 3.3 Bathymetry defined throughout the tidal model domain.

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

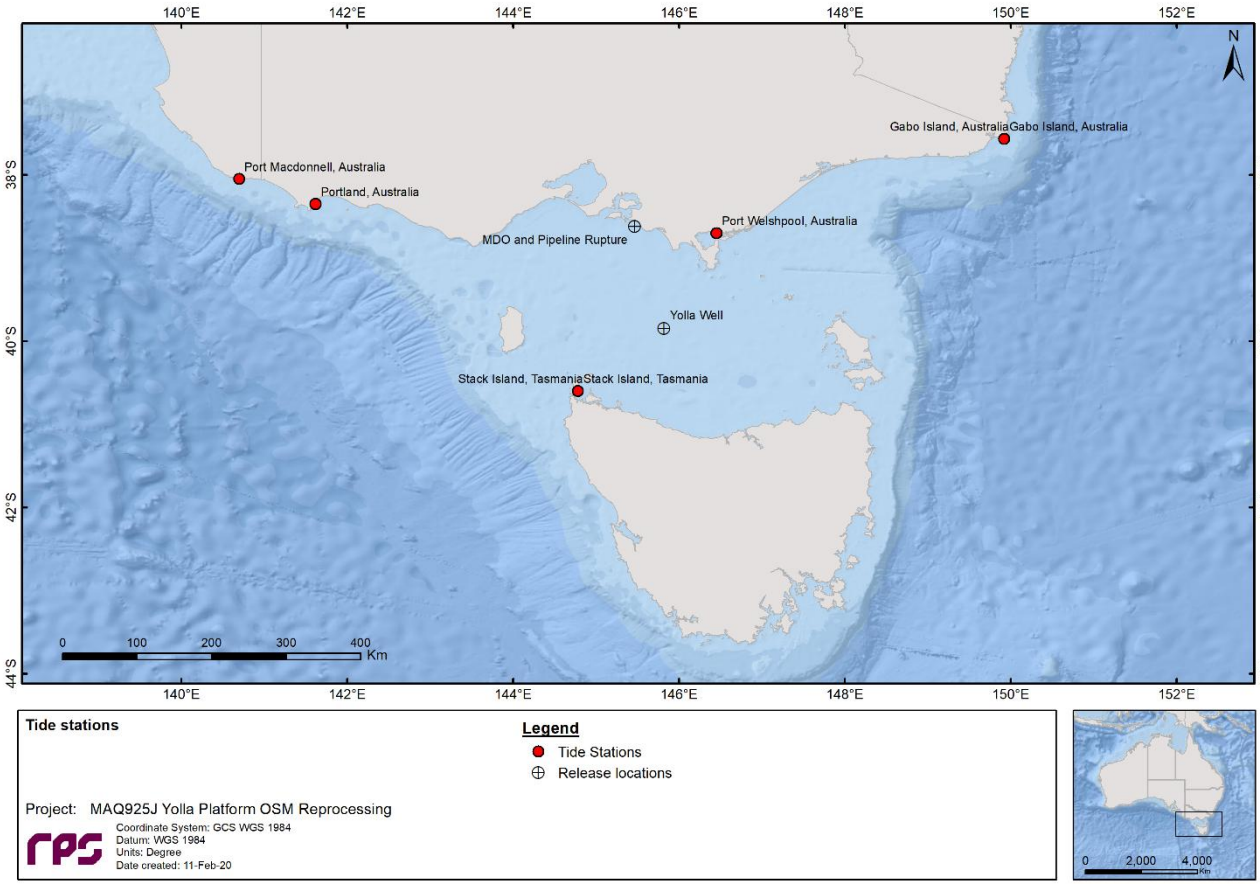


Figure 3.4 Location of the tide stations used in the surface elevation validation.

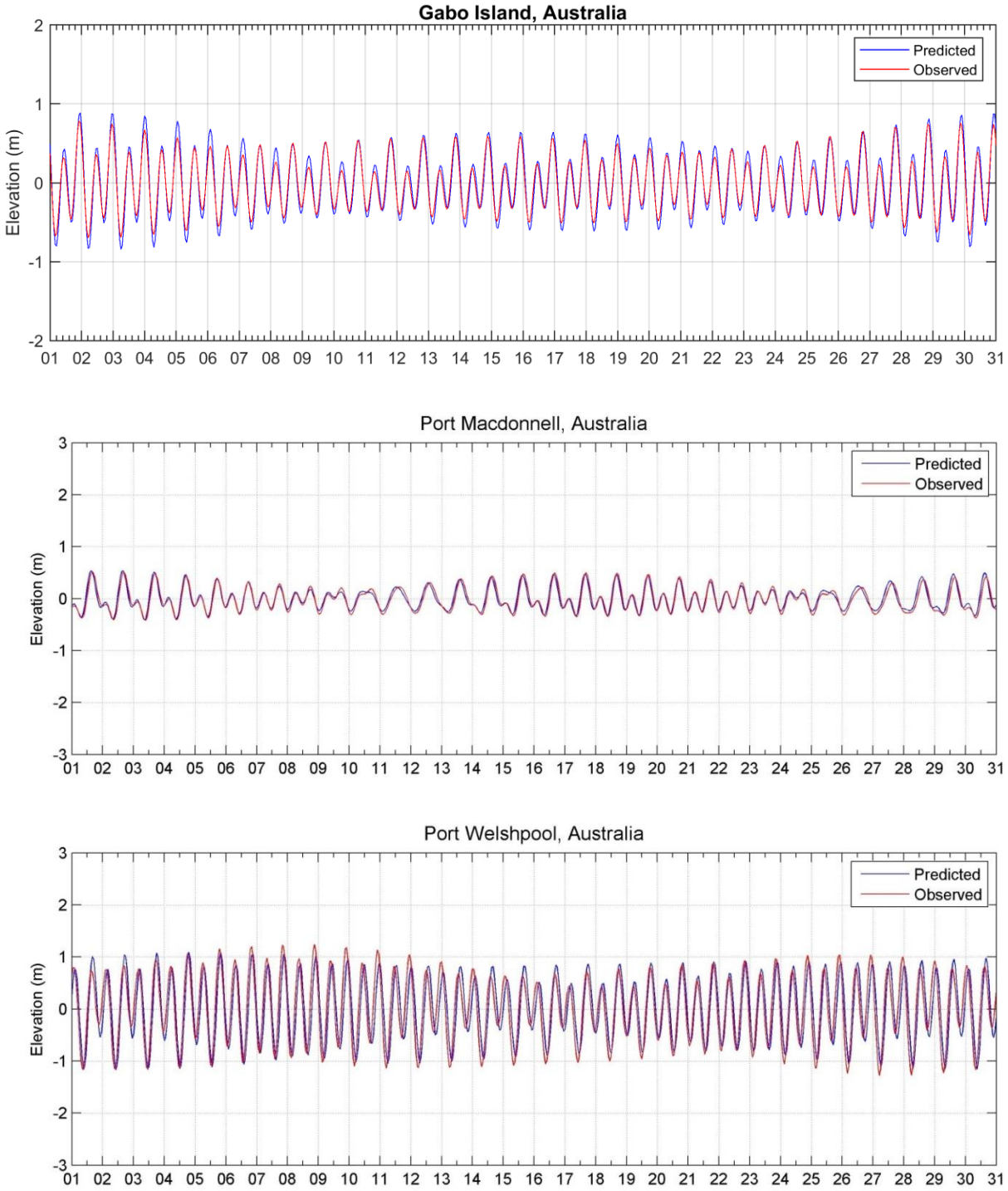


Figure 3.5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).

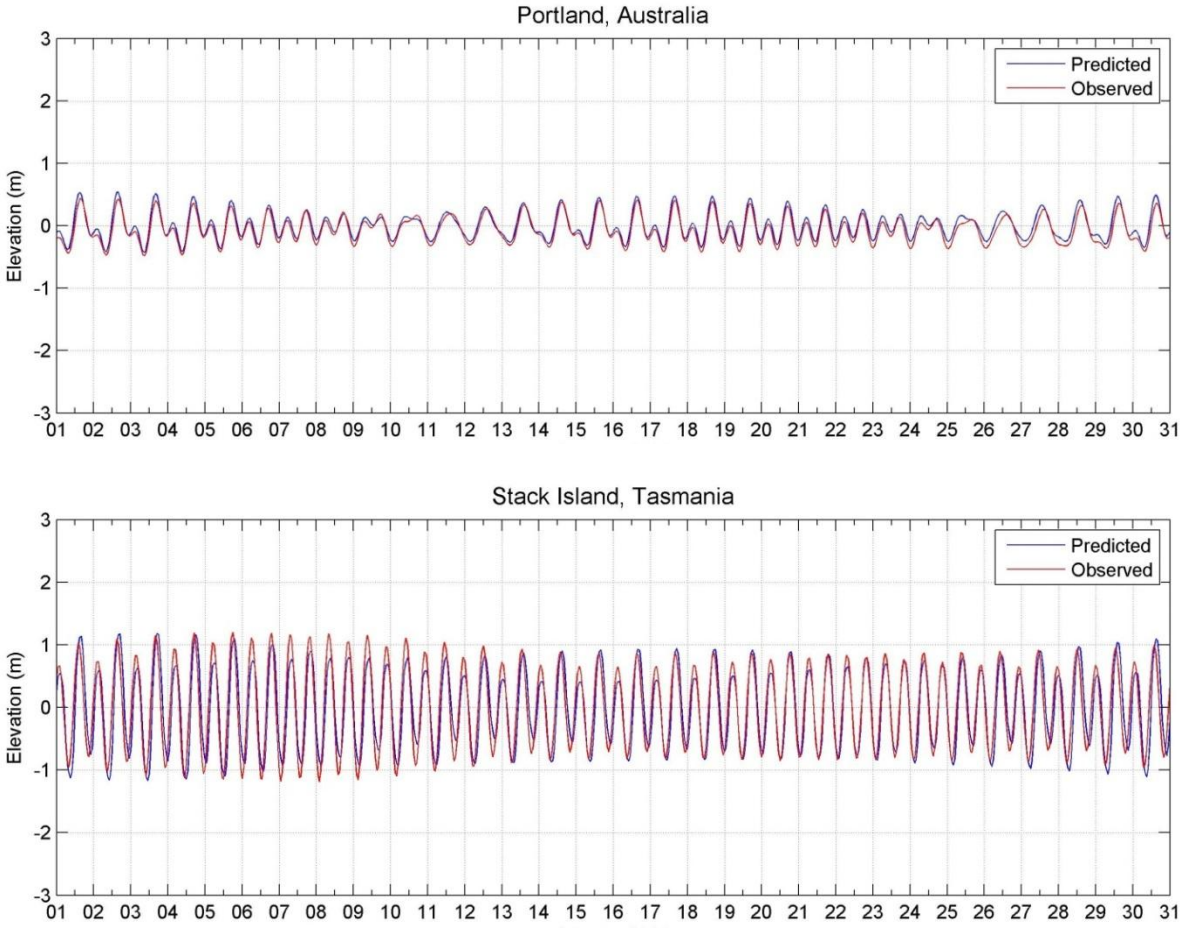


Figure 3.6 **Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).**

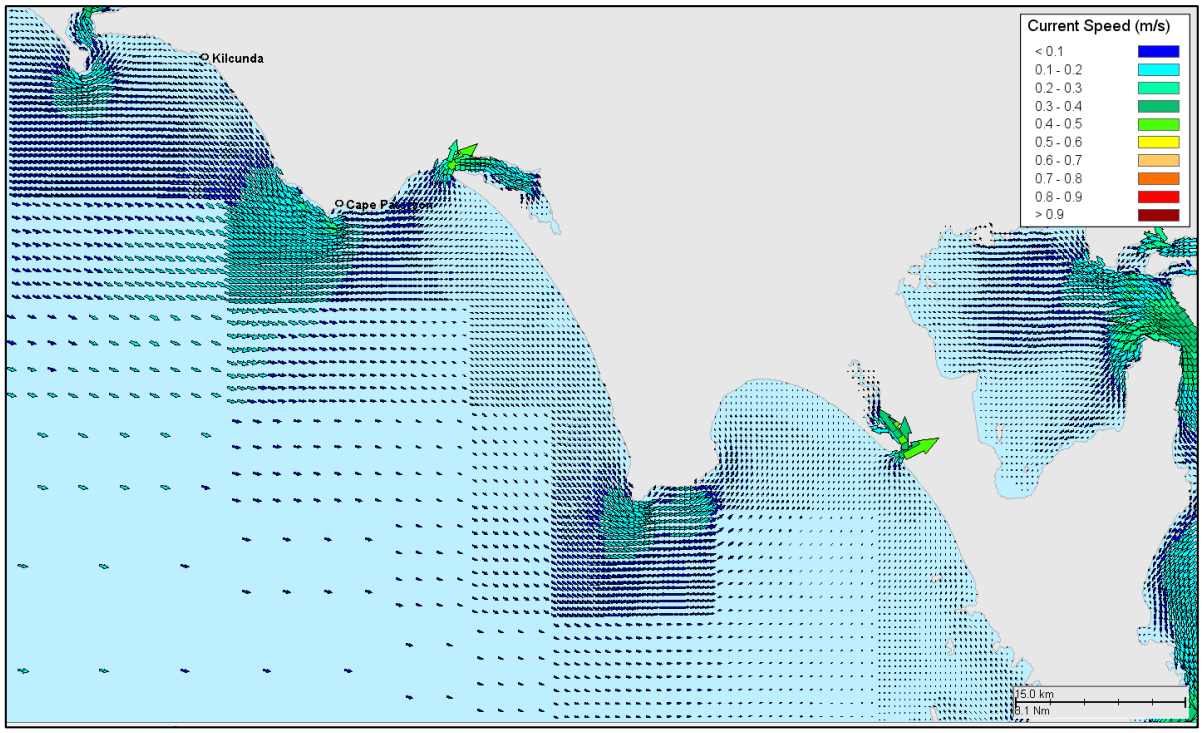


Figure 3.7 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and shoals. Colourations of individual vectors indicate current speed.

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).

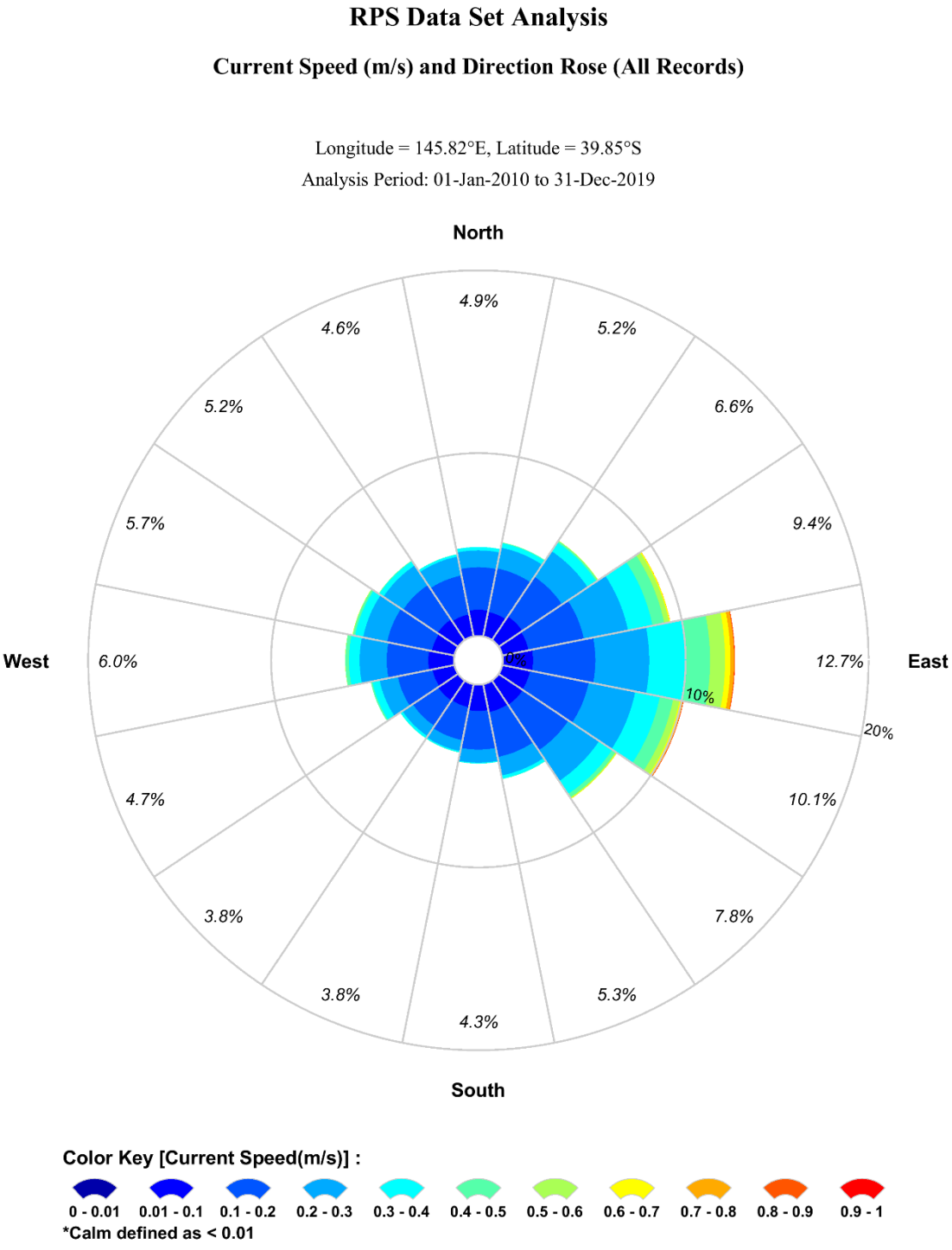


Figure 3-9 Total surface current rose plot nearby the Yolla Well Head (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

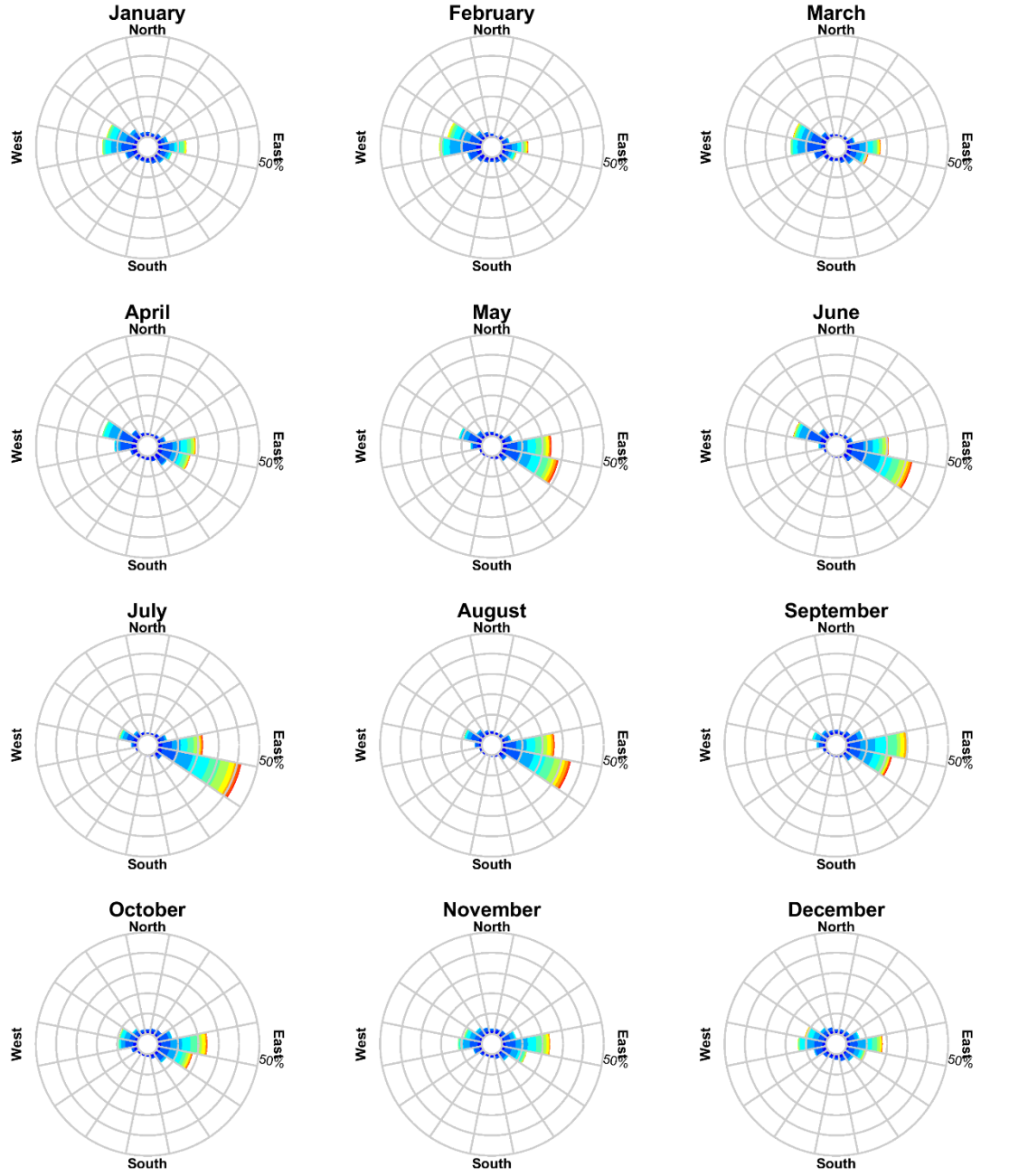


Figure 3-10 Monthly surface current rose plots nearby the MDO and Pipeline release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

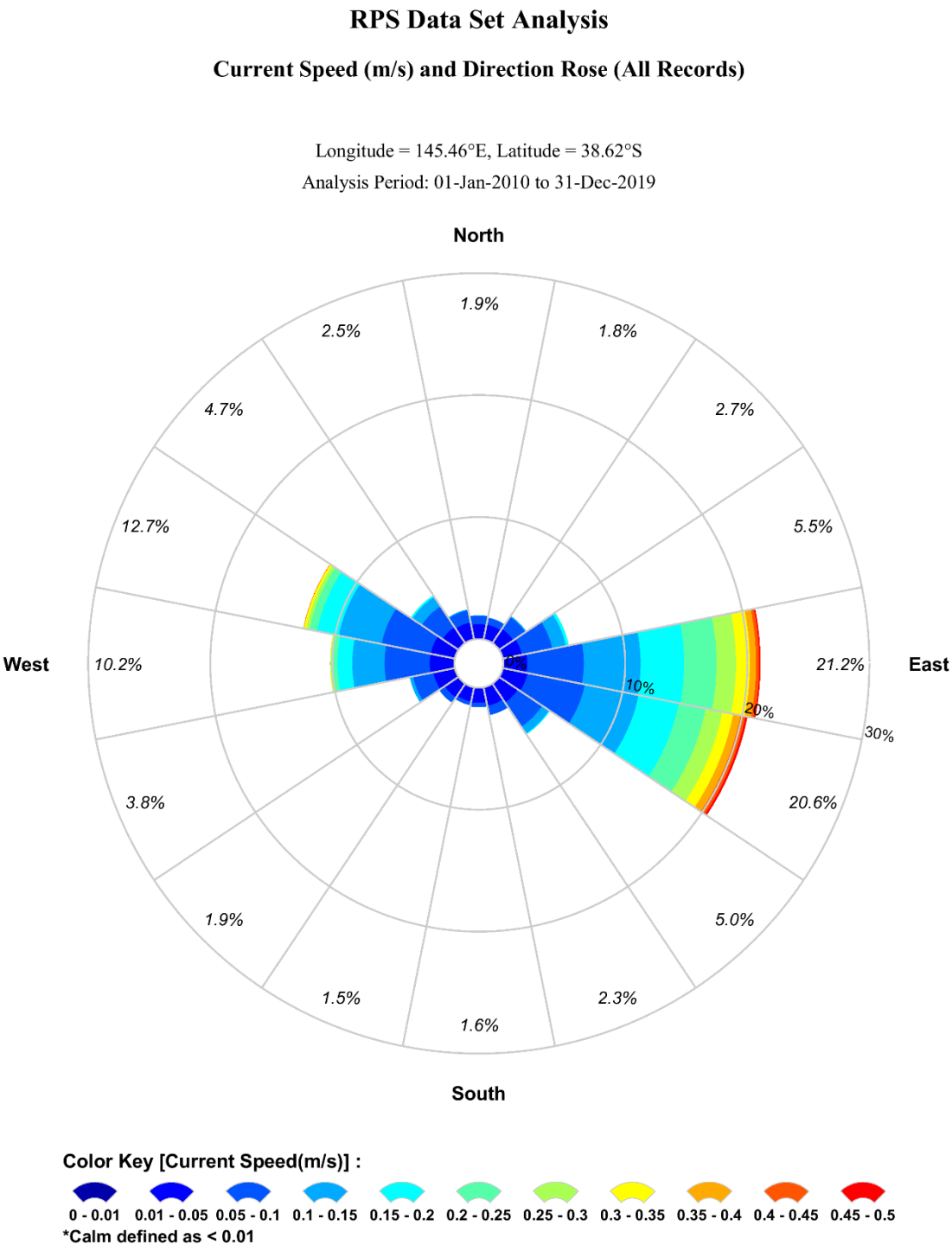


Figure 3-11 Total surface current rose plot nearby the MDO and Pipeline release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

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).

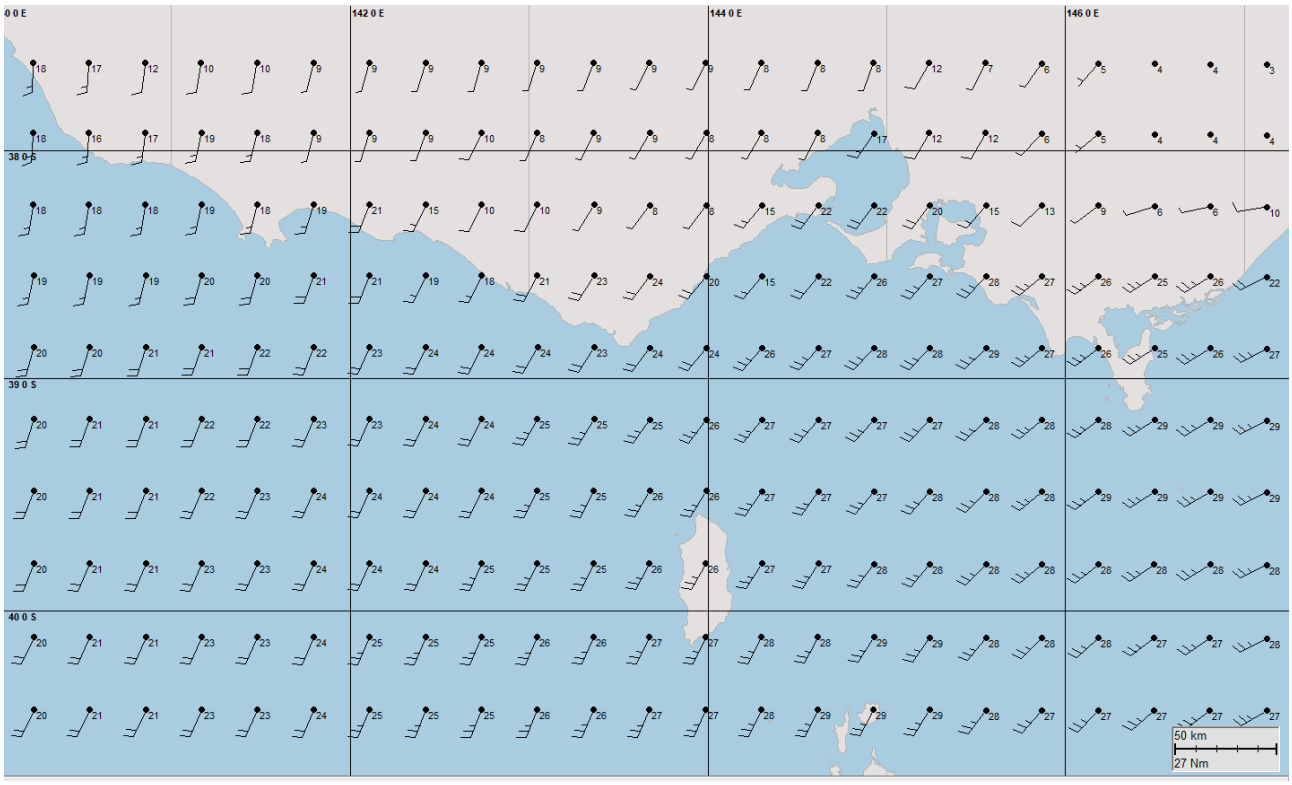


Figure 4-1 Spatial resolution of the CFSR modelled wind data used as input into the oil spill model.

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**	-

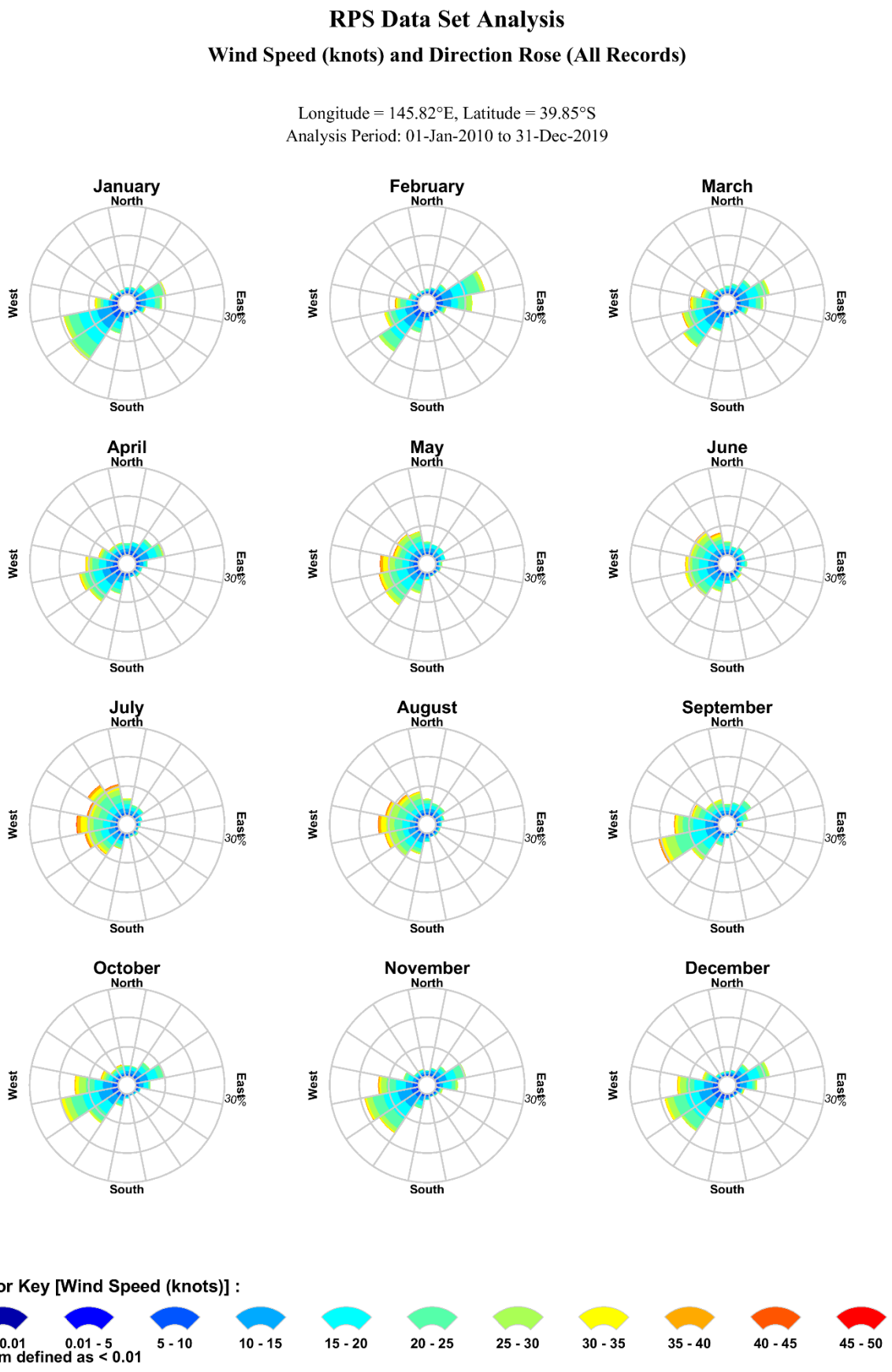


Figure 4-2 Modelled monthly wind rose distributions from 2010–2019 (inclusive) for the node nearby the Yolla Well Head.

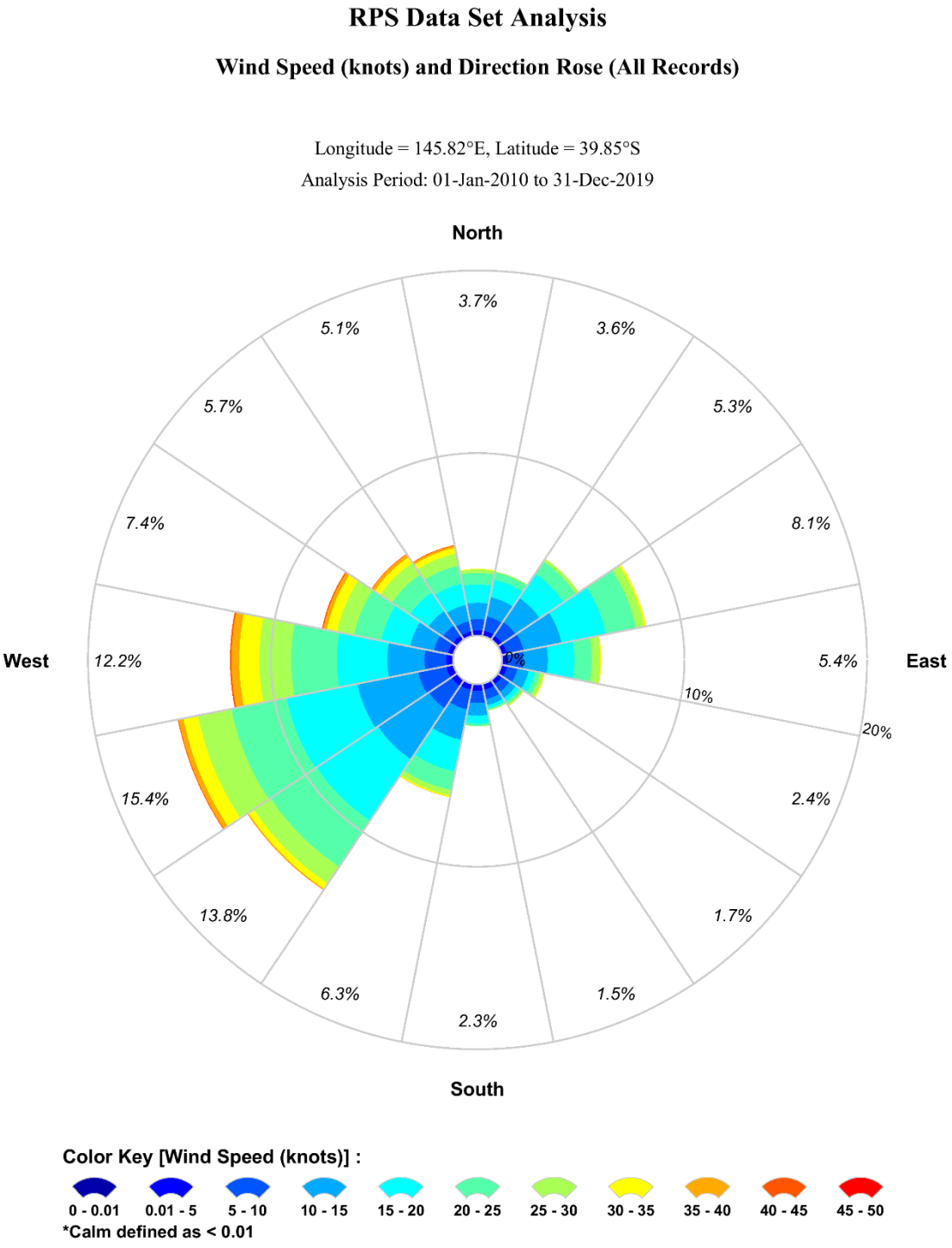


Figure 4-3 **Modelled total wind rose distributions from 2010–2019 (inclusive) for the node nearby the Yolla Well Head.**



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

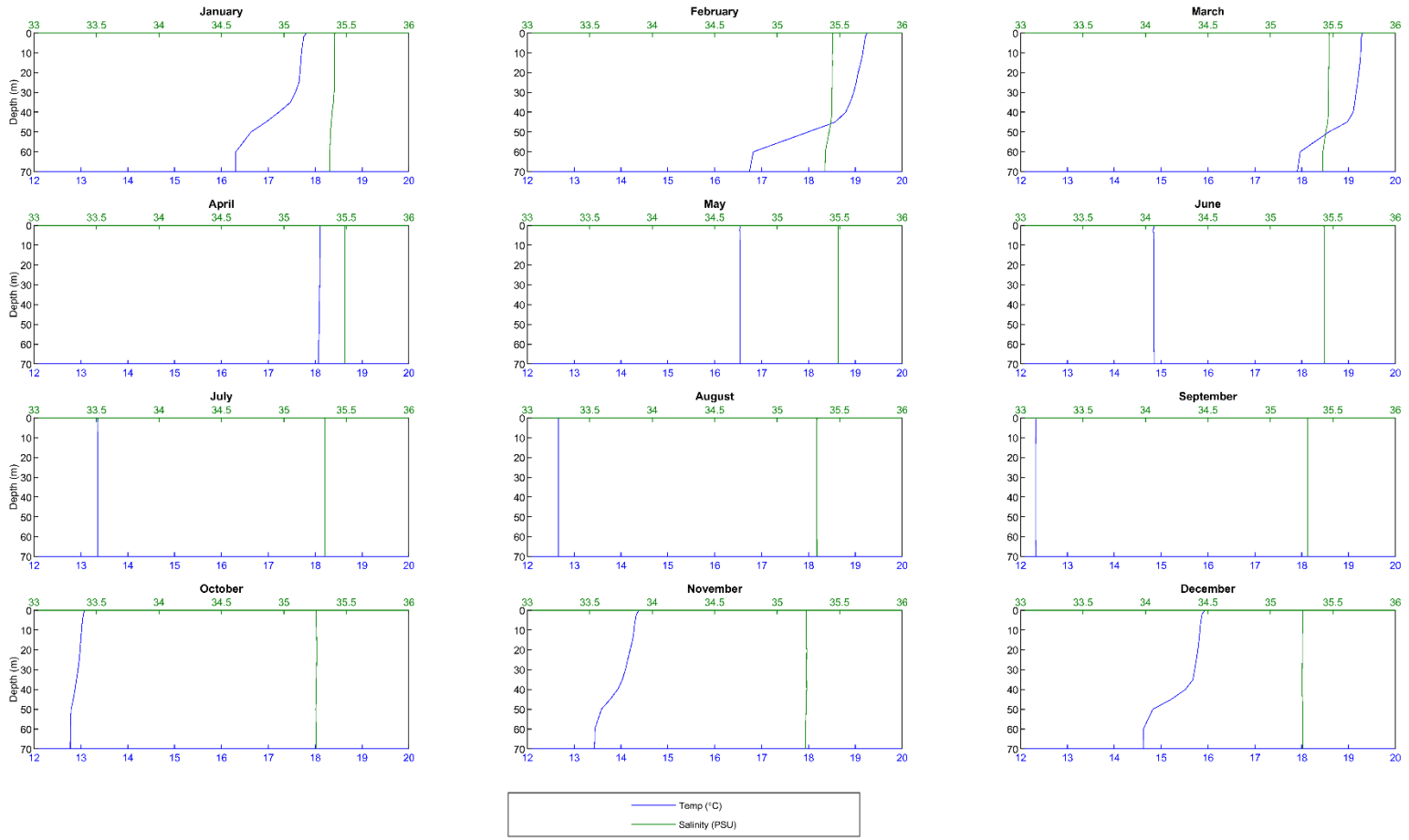


Figure 5.1 Temperature and salinity profiles nearby the Yolla Well Head.

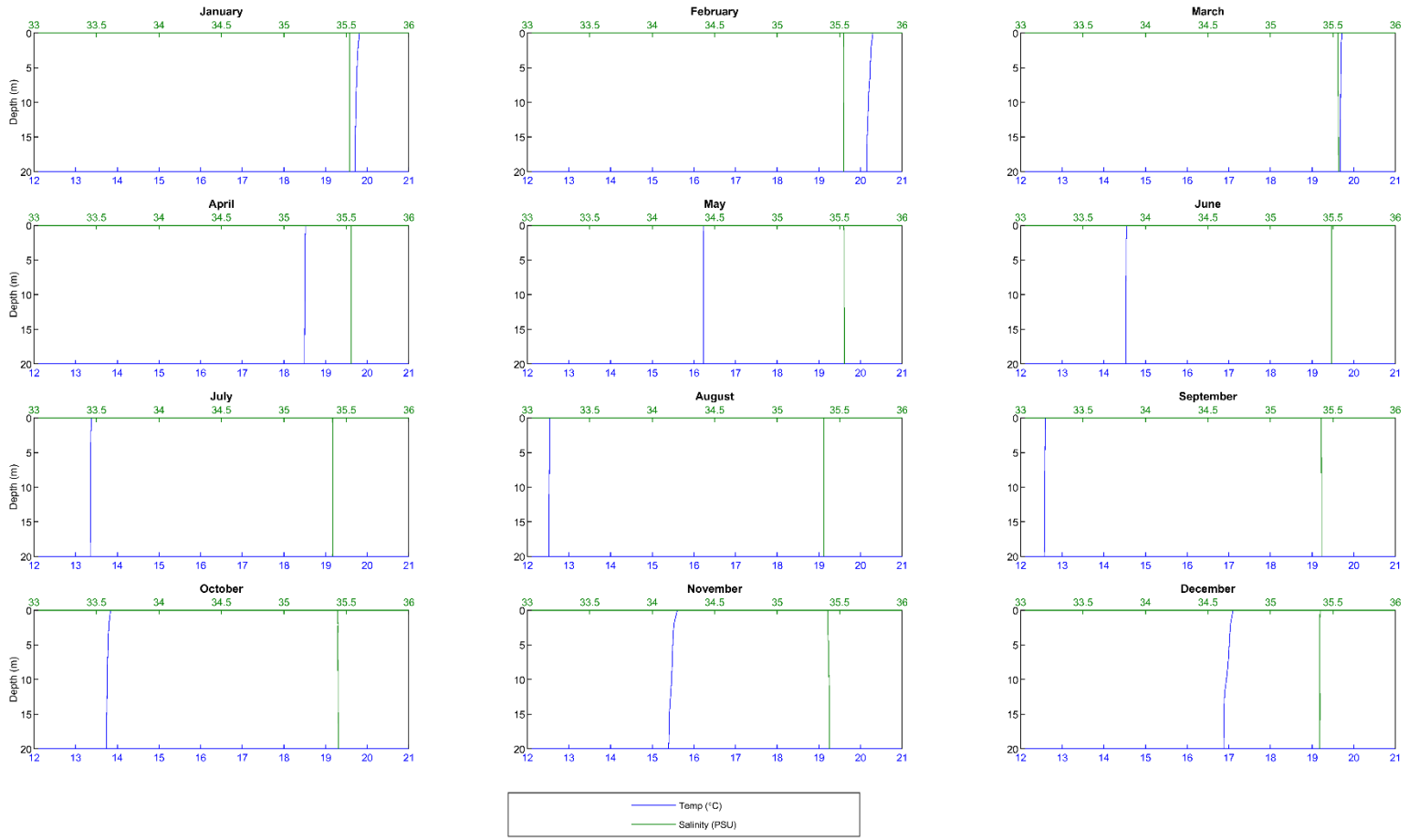


Figure 5.2 Temperature and salinity profiles nearby the MDO and Pipeline release location.

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).

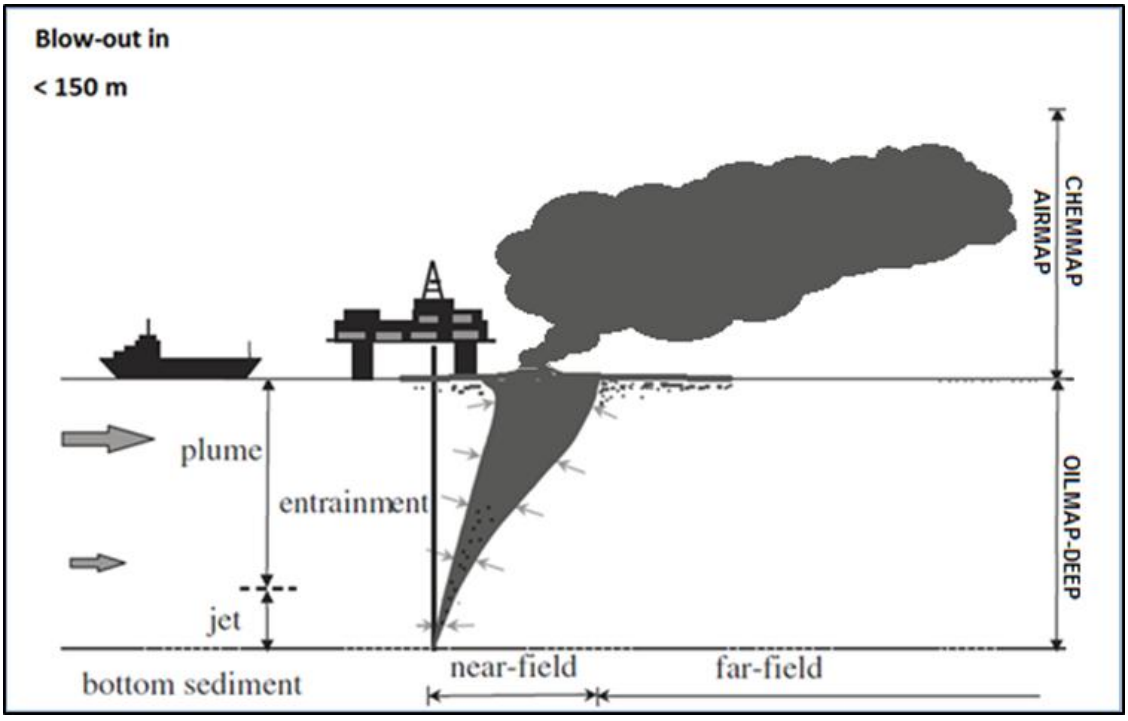


Figure 6-1 Schematic of the various stages of the plume in the water column (Source: ASA, 2011).

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 Day-86: 802.9 STB/day	24,167 STB/hour
Gas discharge rate	Day-1: 28.3 MMscf/day Day-86: 27.1 MMscf/day	23,450 scf/hour
Formation water discharge rate	Day-1: 646.0 STB/day Day-86: 2611.3 STB/day	NIL
Key Results		
Plume execution depth (m BMSL)	0 (Breach the sea surface)	0 (Breach the sea surface)
Droplet sizes (µm)	Day-1: 82 to 354 Day-86: 105 to 370	65 to 280

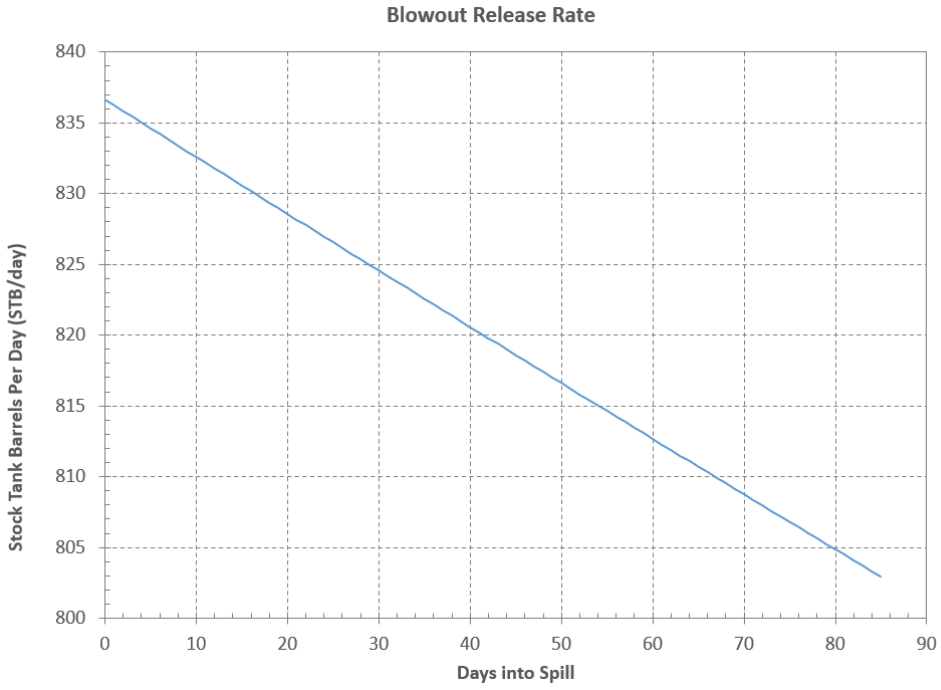


Figure 6-2 Plot of time-varying release rate for the Yolla Well Head release location.

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

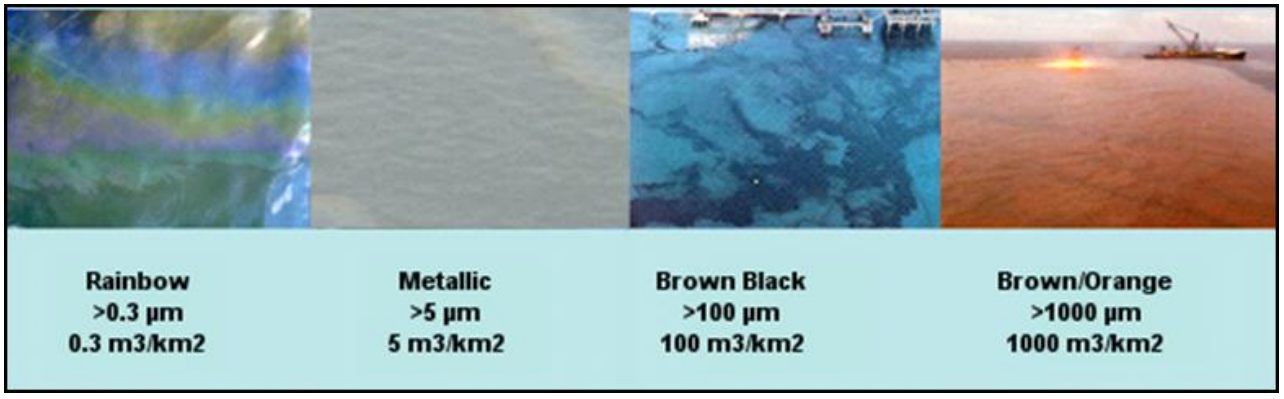


Figure 8-1 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oil Spill Solutions, 2015).

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 50th 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 50th 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.

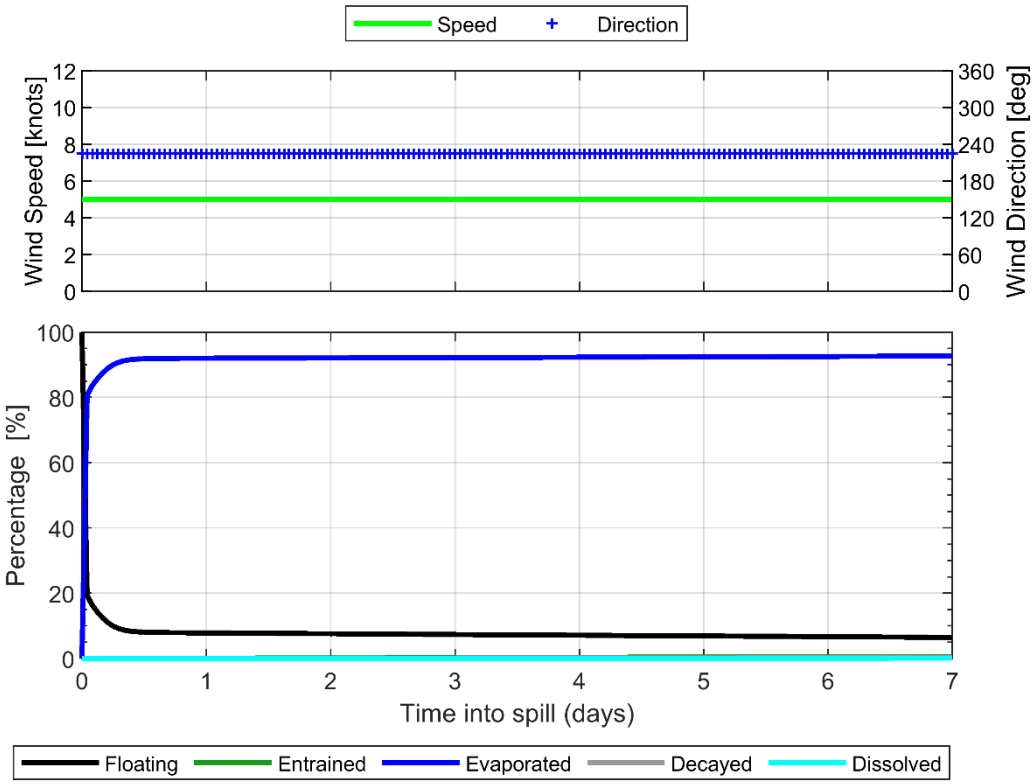


Figure 10-1 Proportional mass balance plot representing the weathering of Yolla condensate spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature.

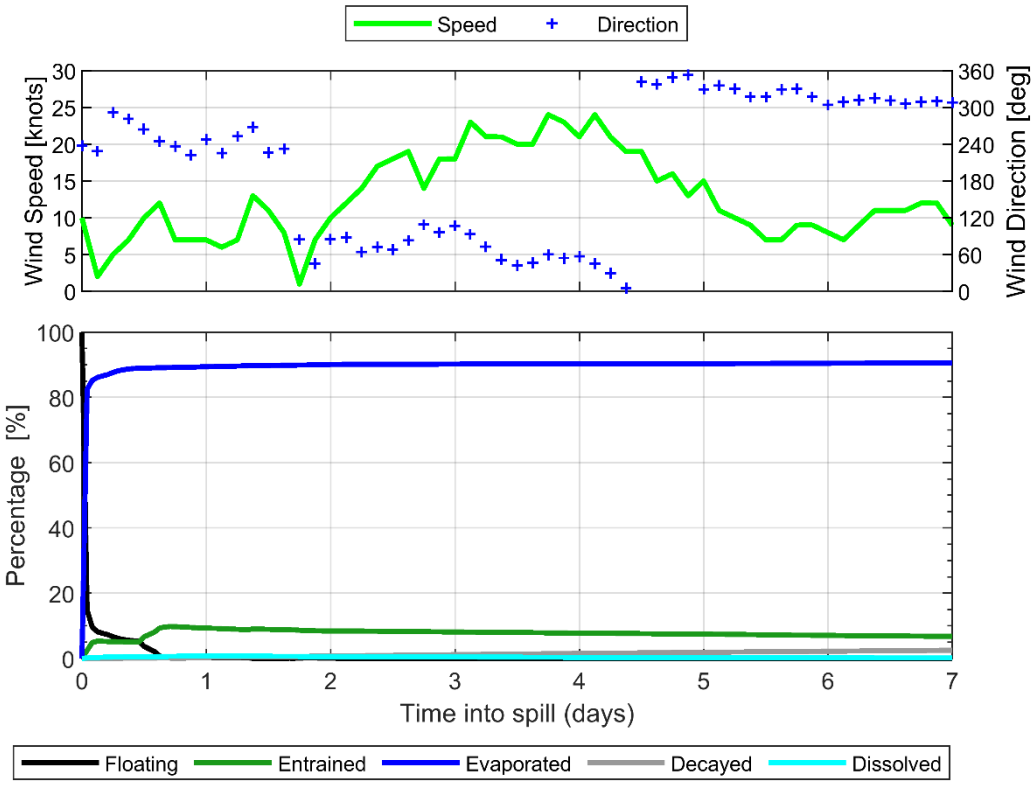


Figure 10-2 Proportional mass balance plot representing the weathering of Yolla condensate spilled onto the water over 1 hour and subject to variable wind speeds (1-12 knots or 1.9-23 m/s) at 15°C water temperature.

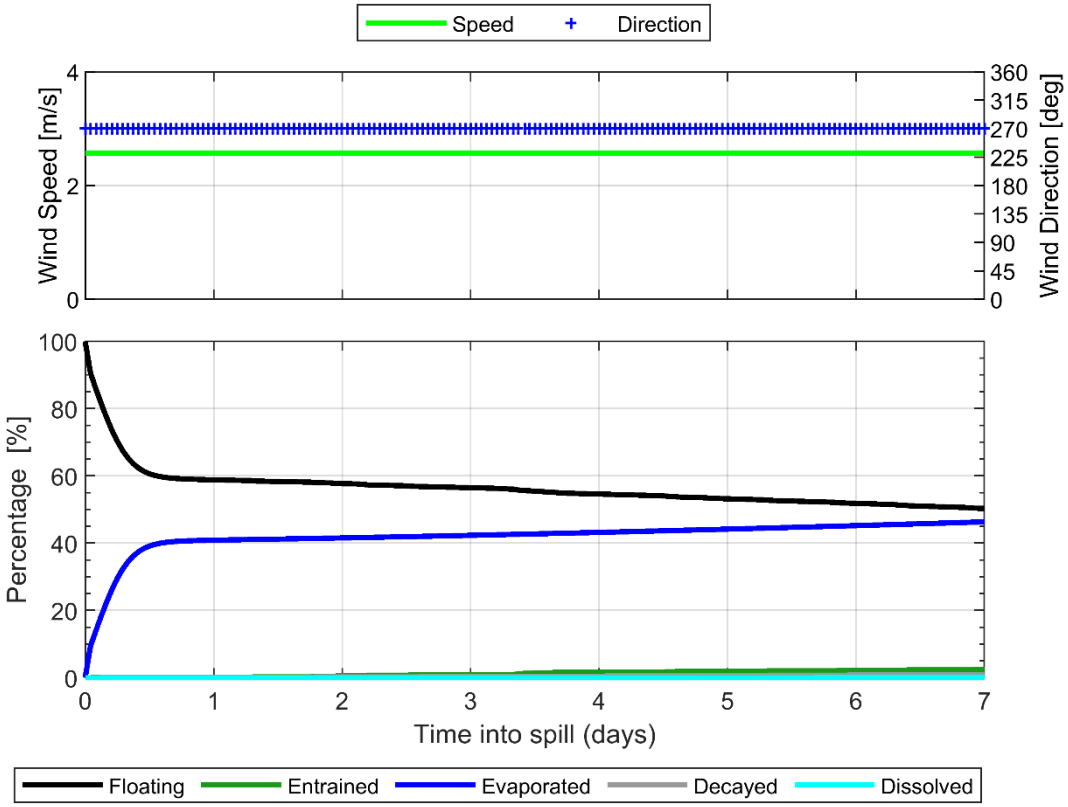


Figure 10-3 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature.

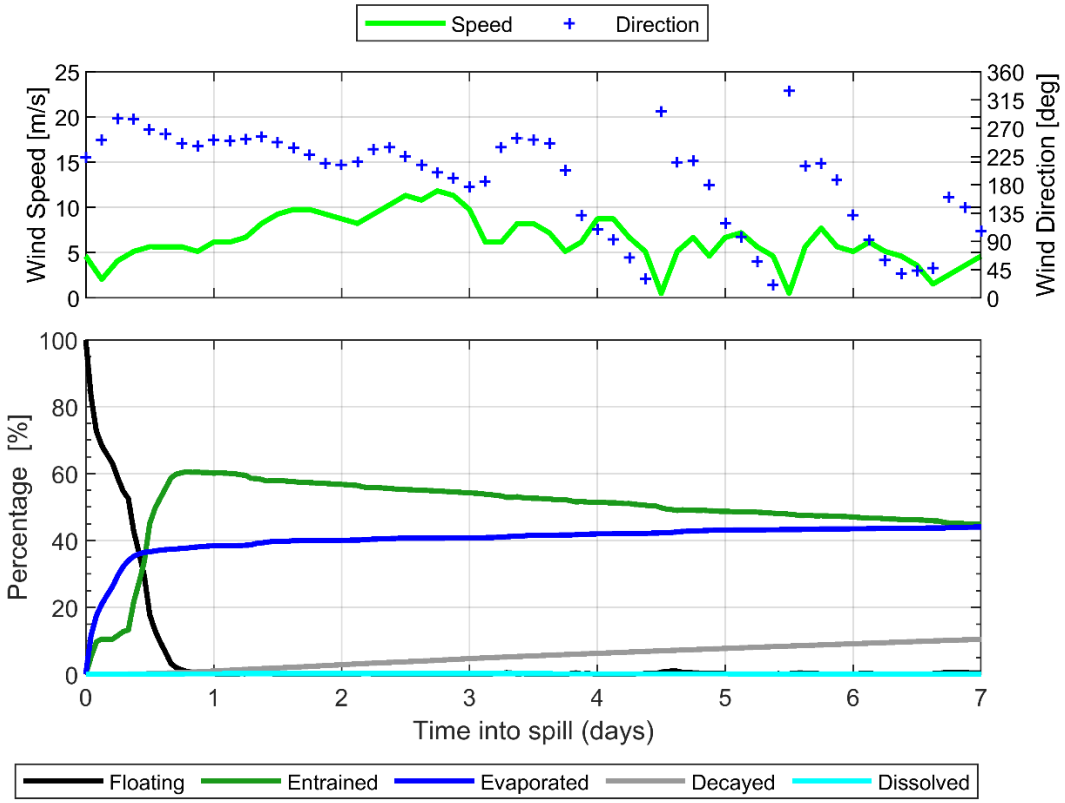


Figure 10-4 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to variable wind speeds (1-12 knots) at 15°C water temperature.

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 99th 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.

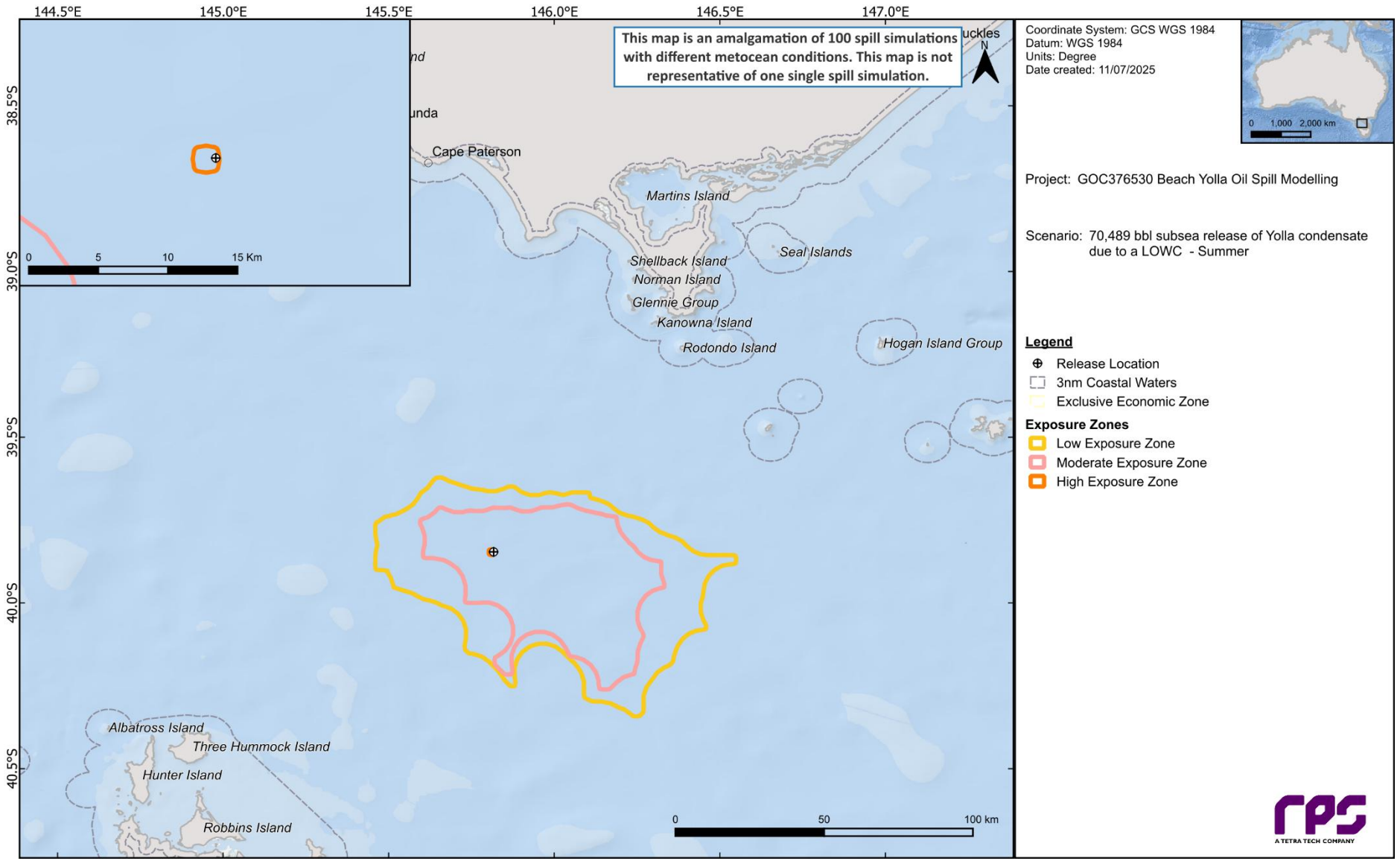


Figure 13-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head during summer conditions.

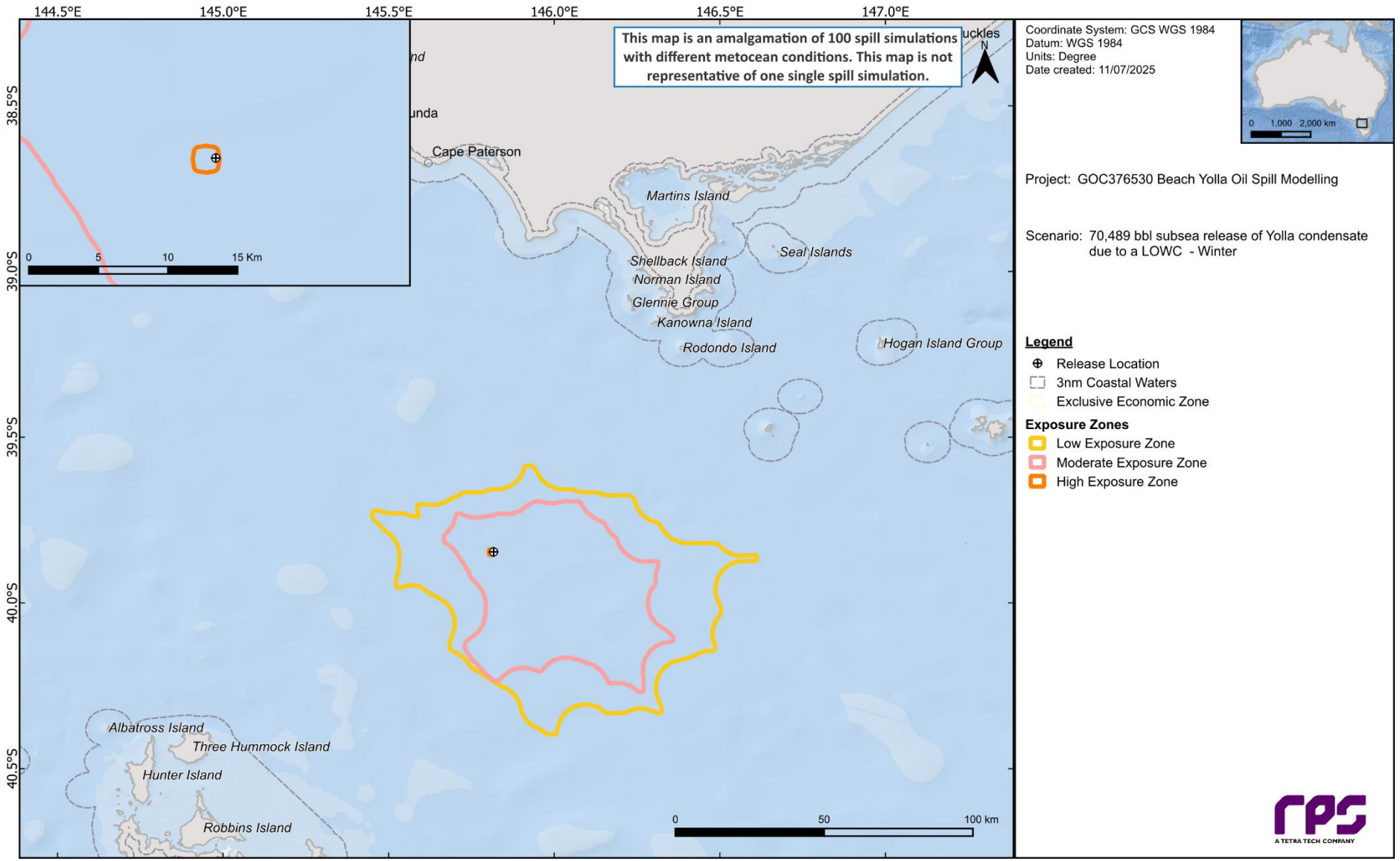


Figure 13-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head during winter conditions.

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.

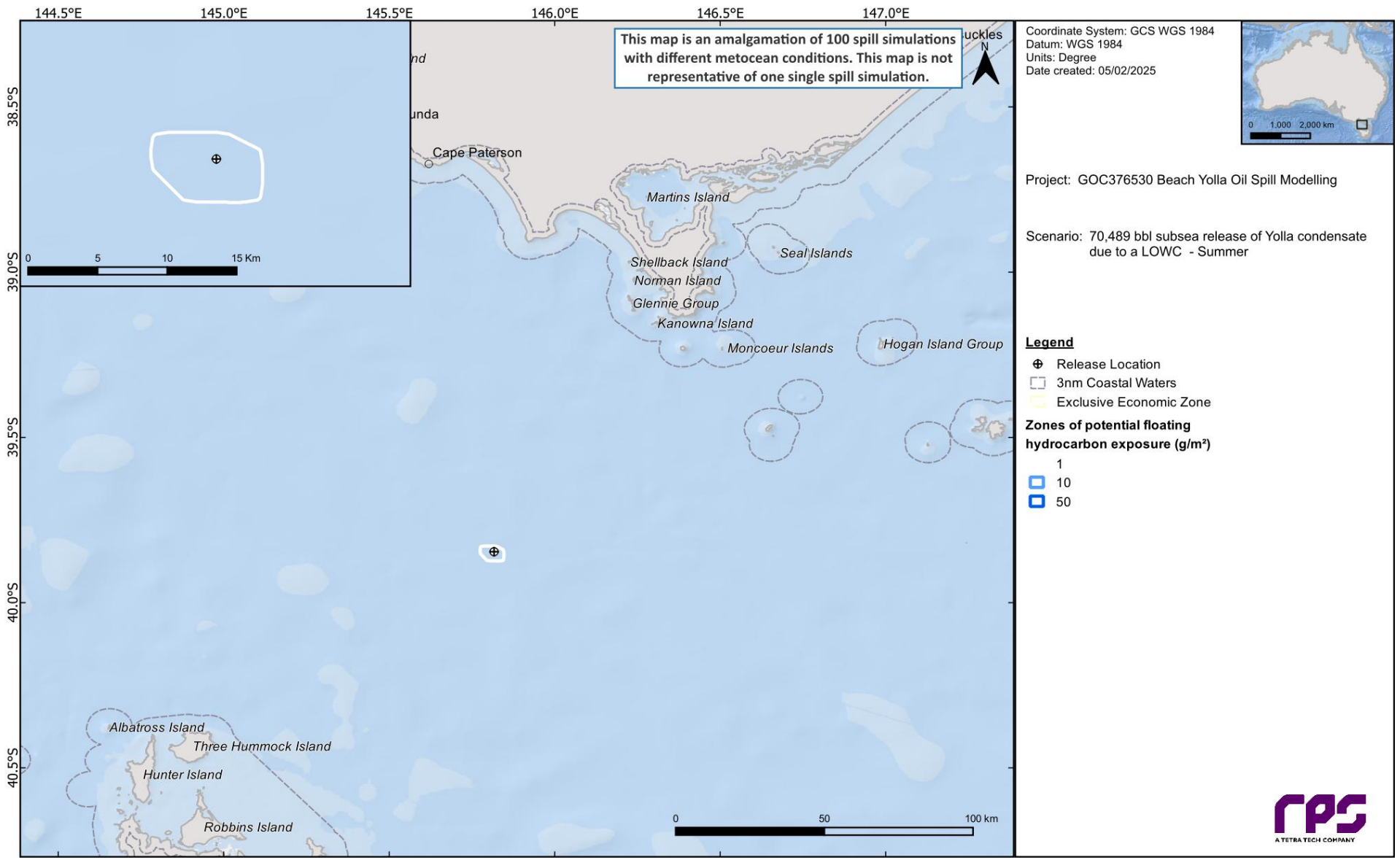


Figure 13-3 Zones of potential floating oil exposure in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

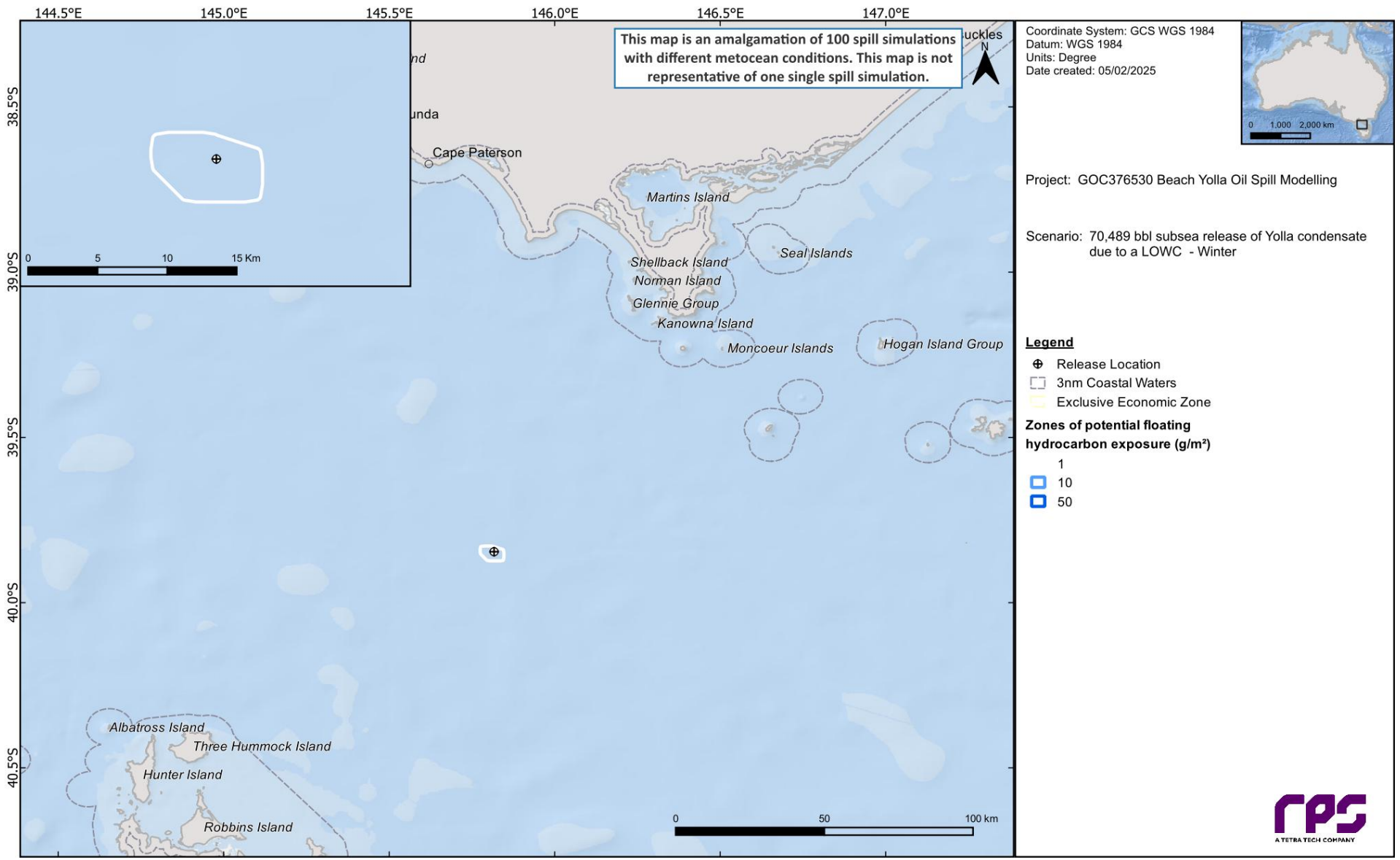


Figure 13-4 Zones of potential floating oil exposure in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

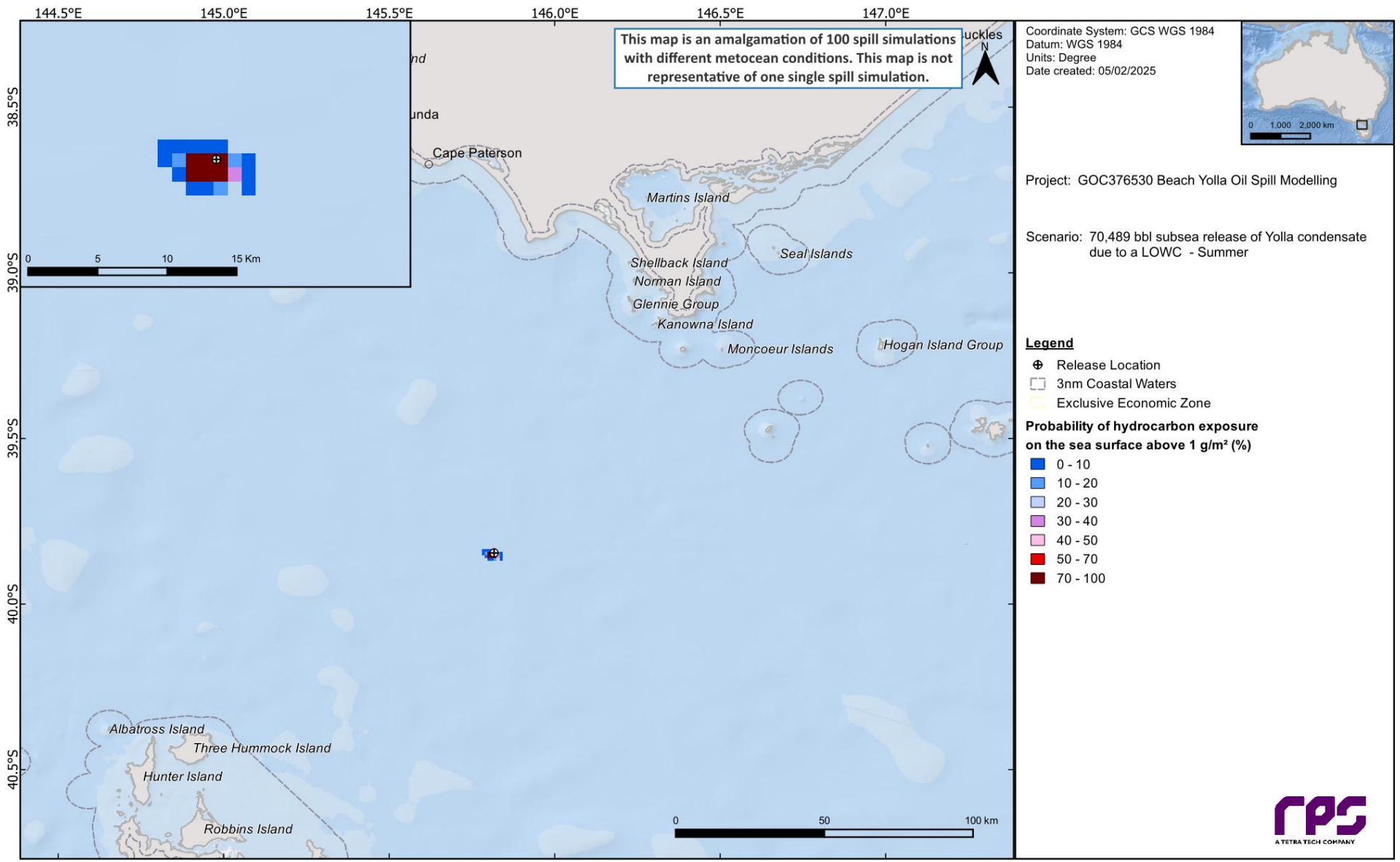


Figure 13-5 Probability of floating oil exposure above 1 g/m², in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

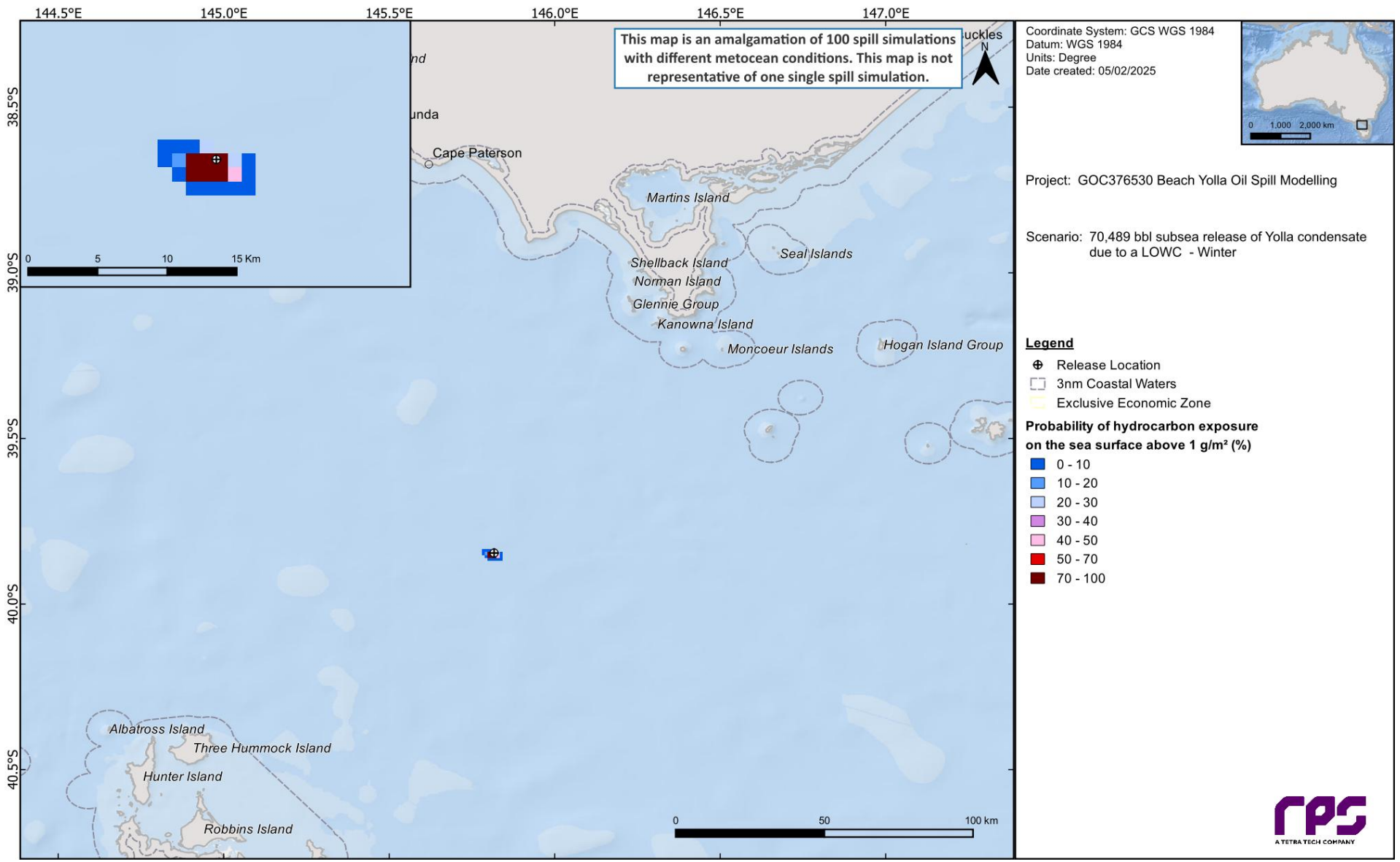


Figure 13-6 Probability of floating oil exposure above 1 g/m², in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

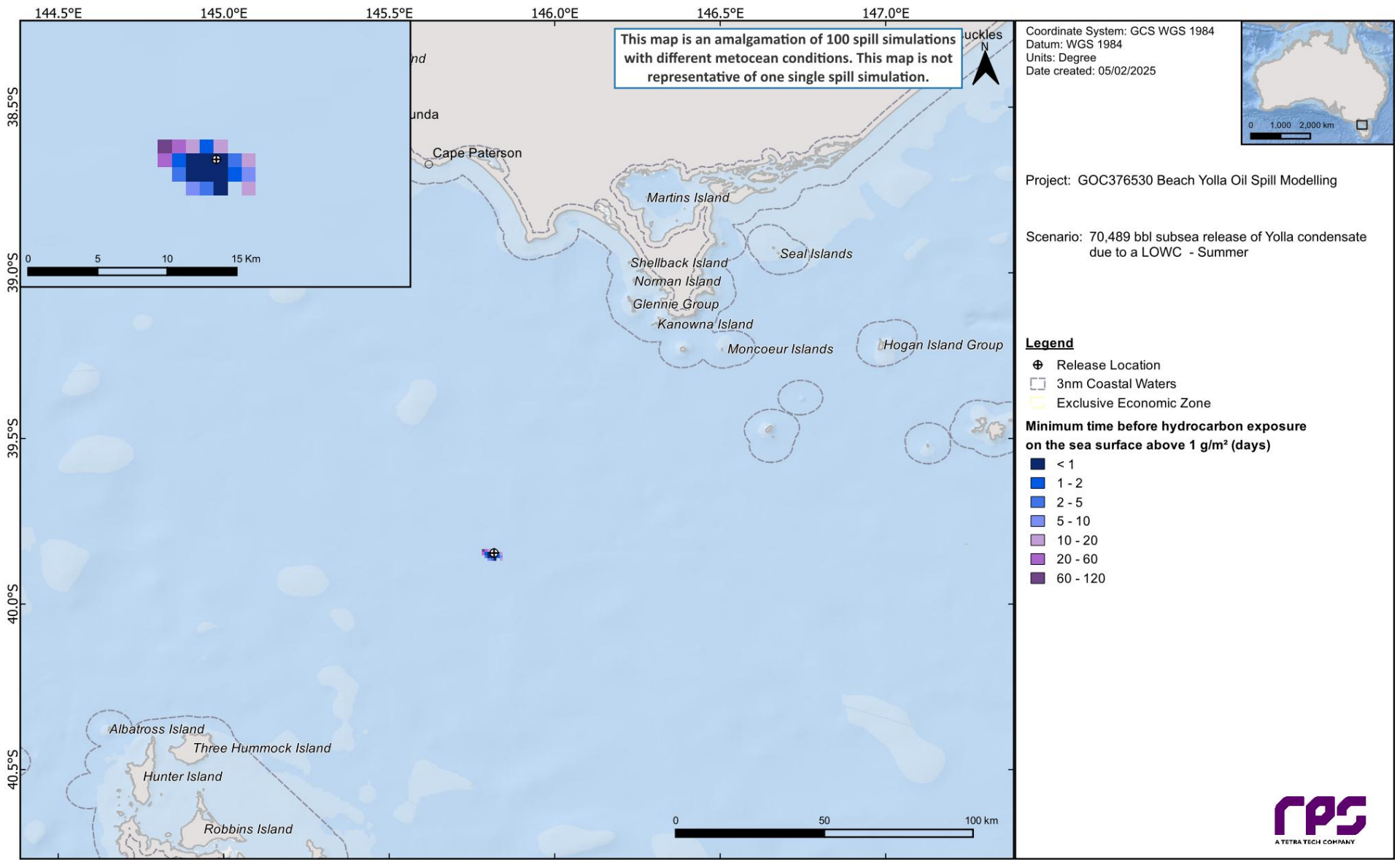


Figure 13-7 Minimum time before floating oil exposure above 1 g/m^2, in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

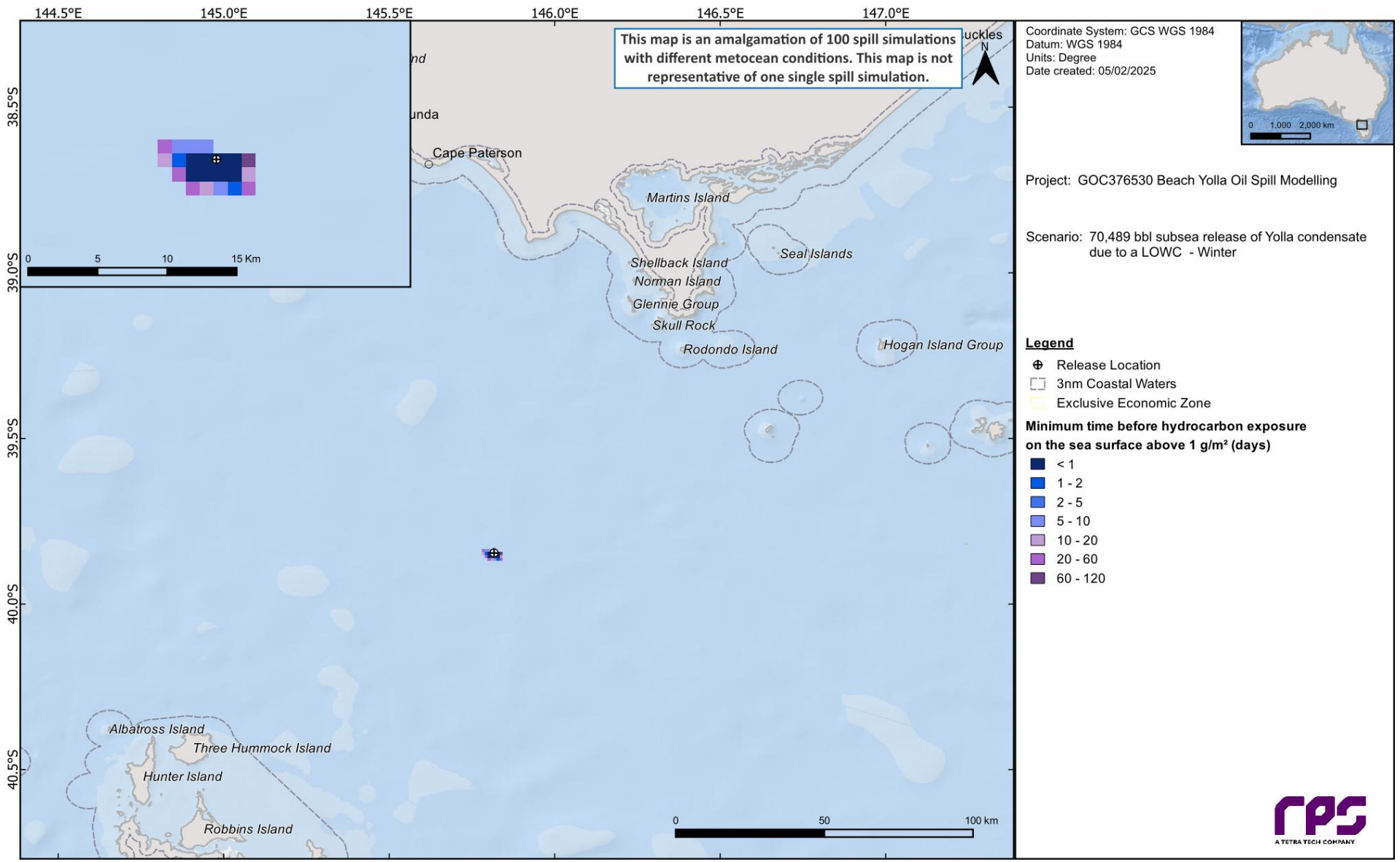


Figure 13-8 Minimum time before floating oil exposure above 1 g/m^2, in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

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.

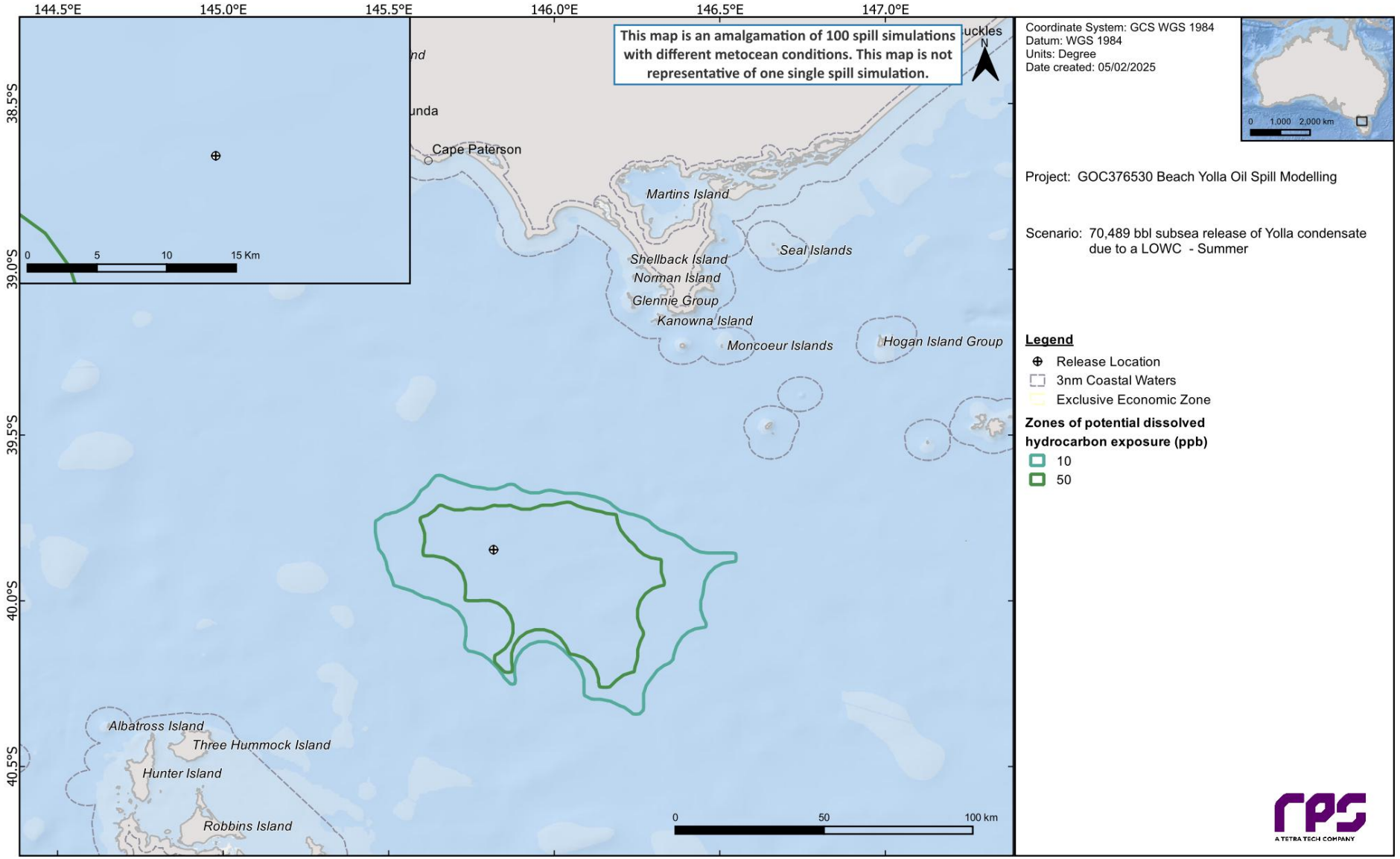


Figure 13-9 **Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.**

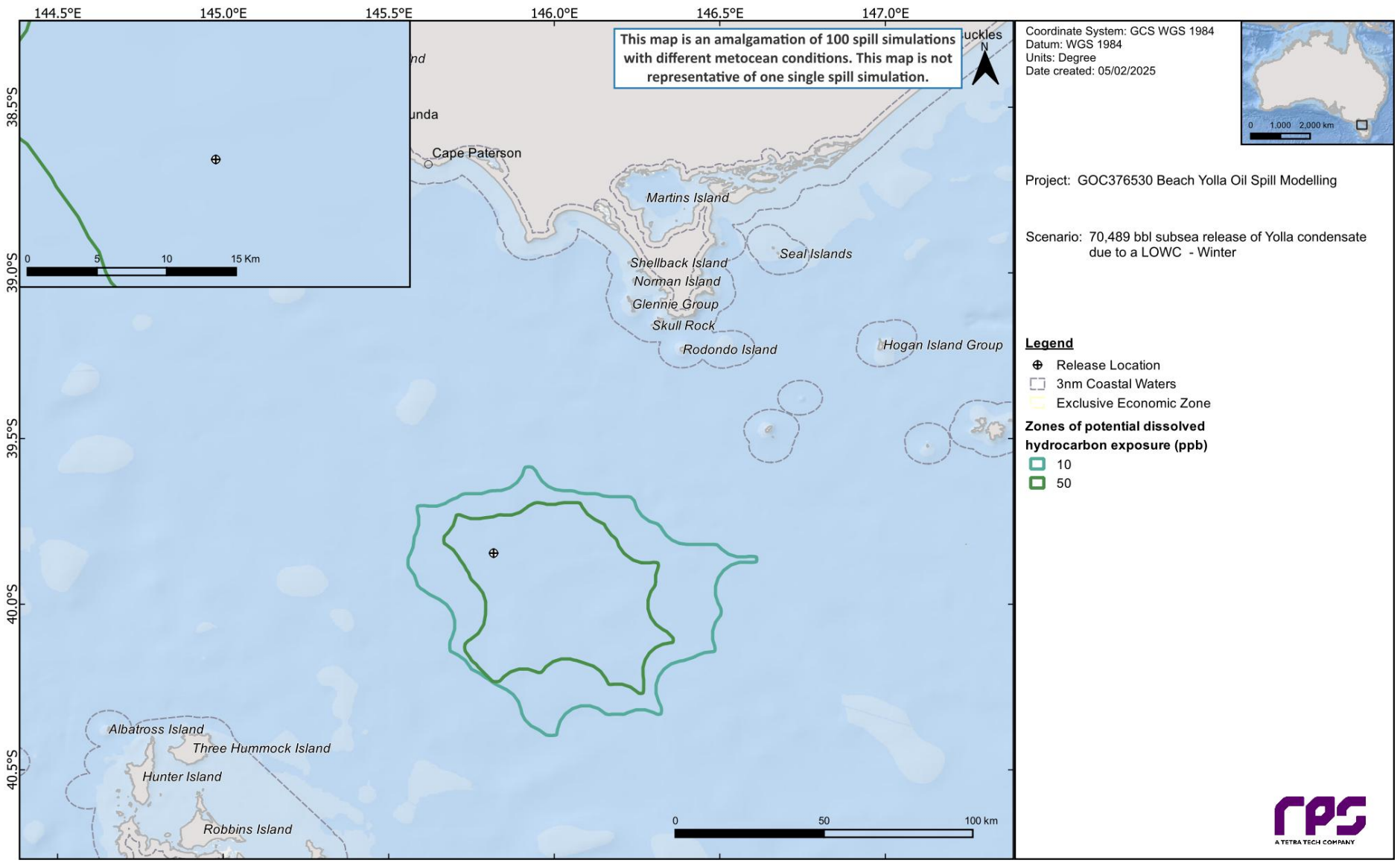


Figure 13-10 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

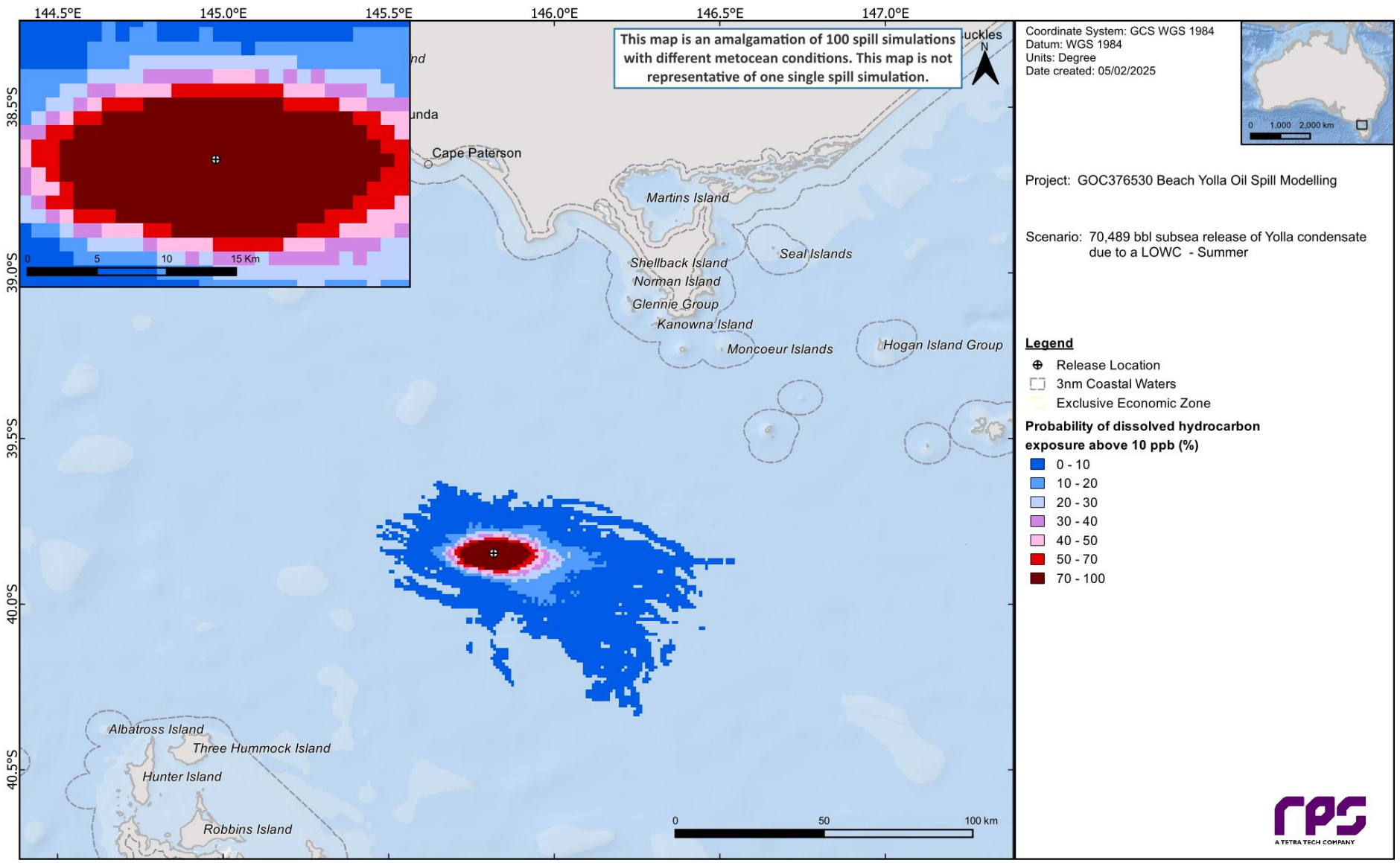


Figure 13-11 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

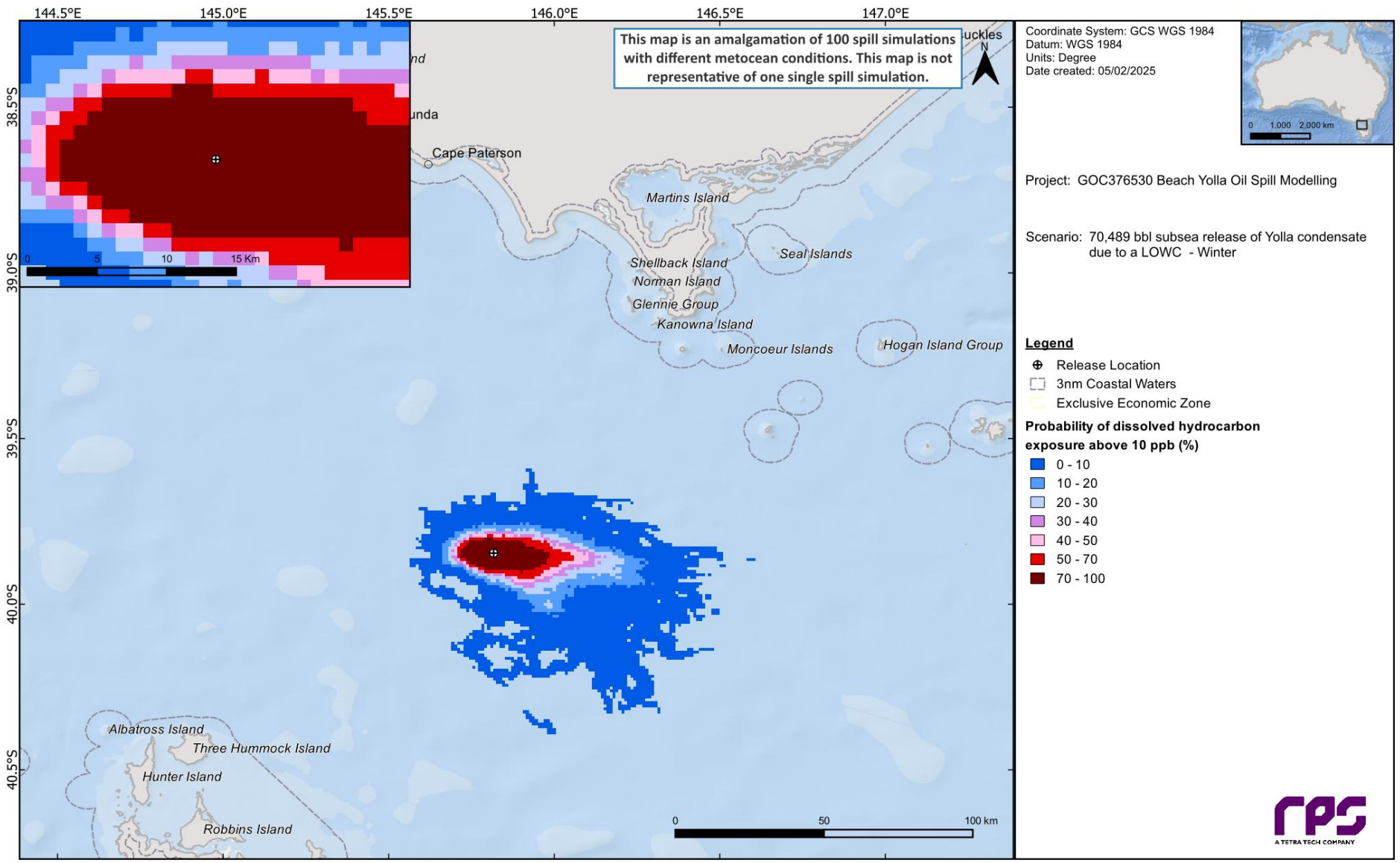


Figure 13-12 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

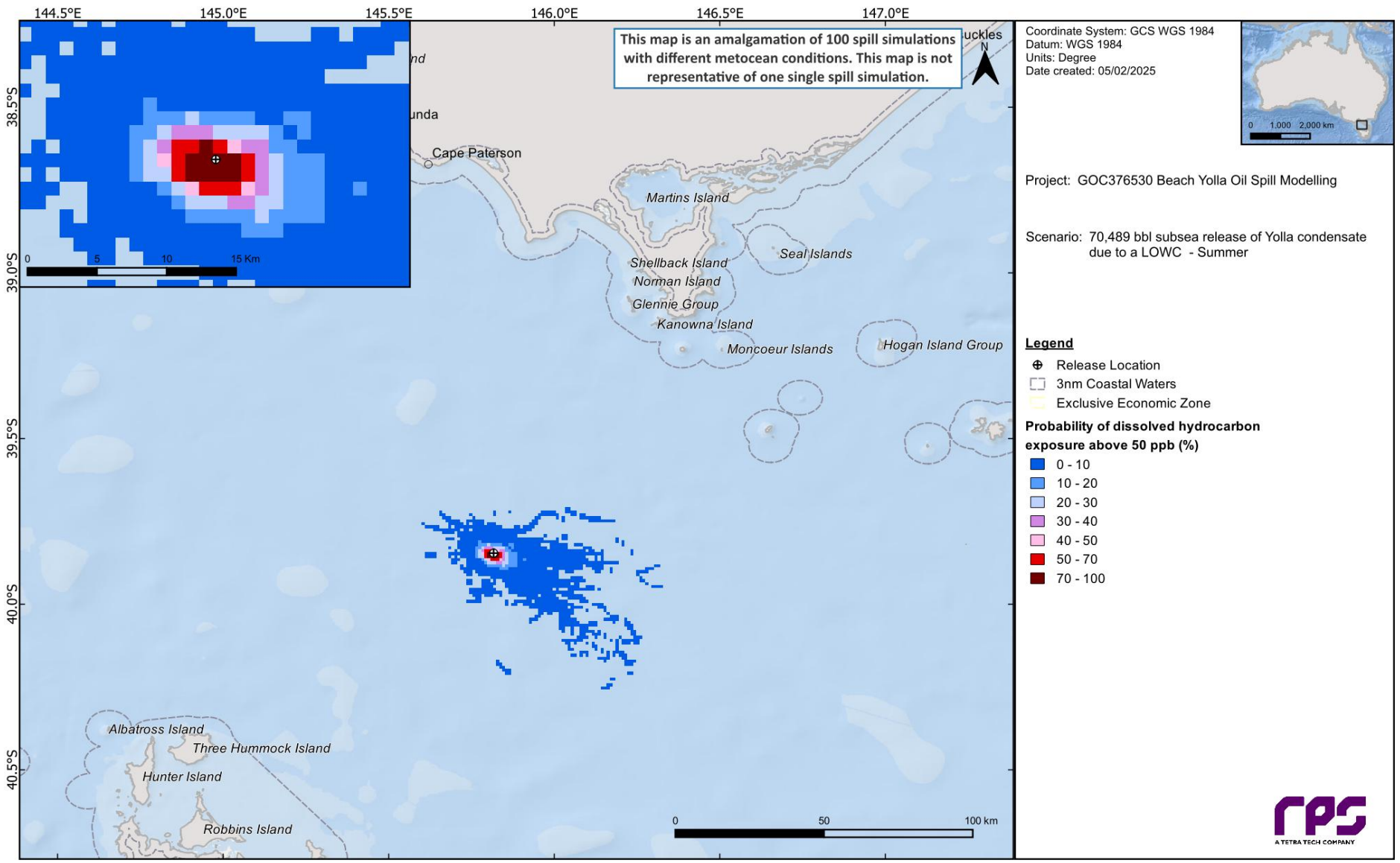


Figure 13-13 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

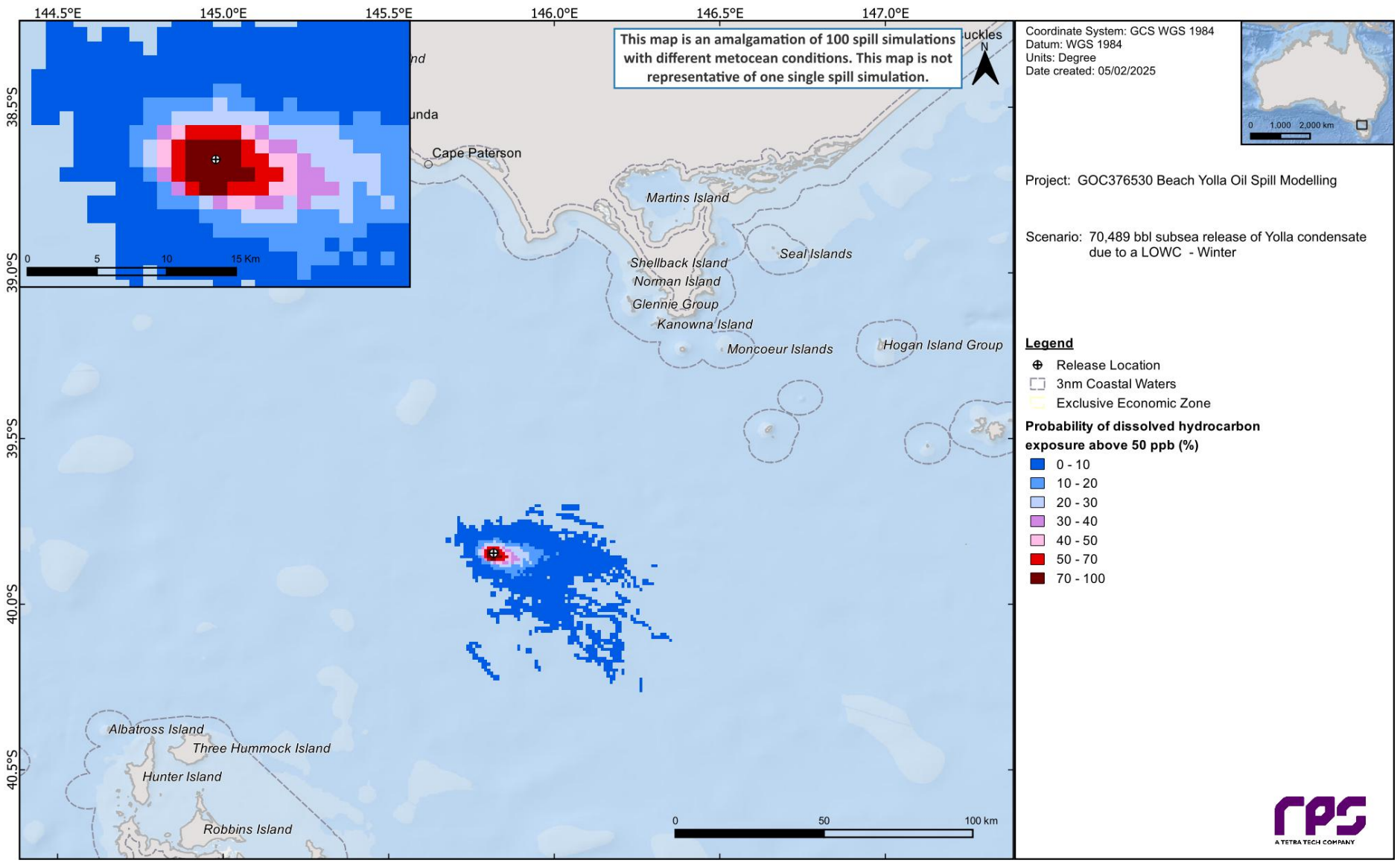


Figure 13-14 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

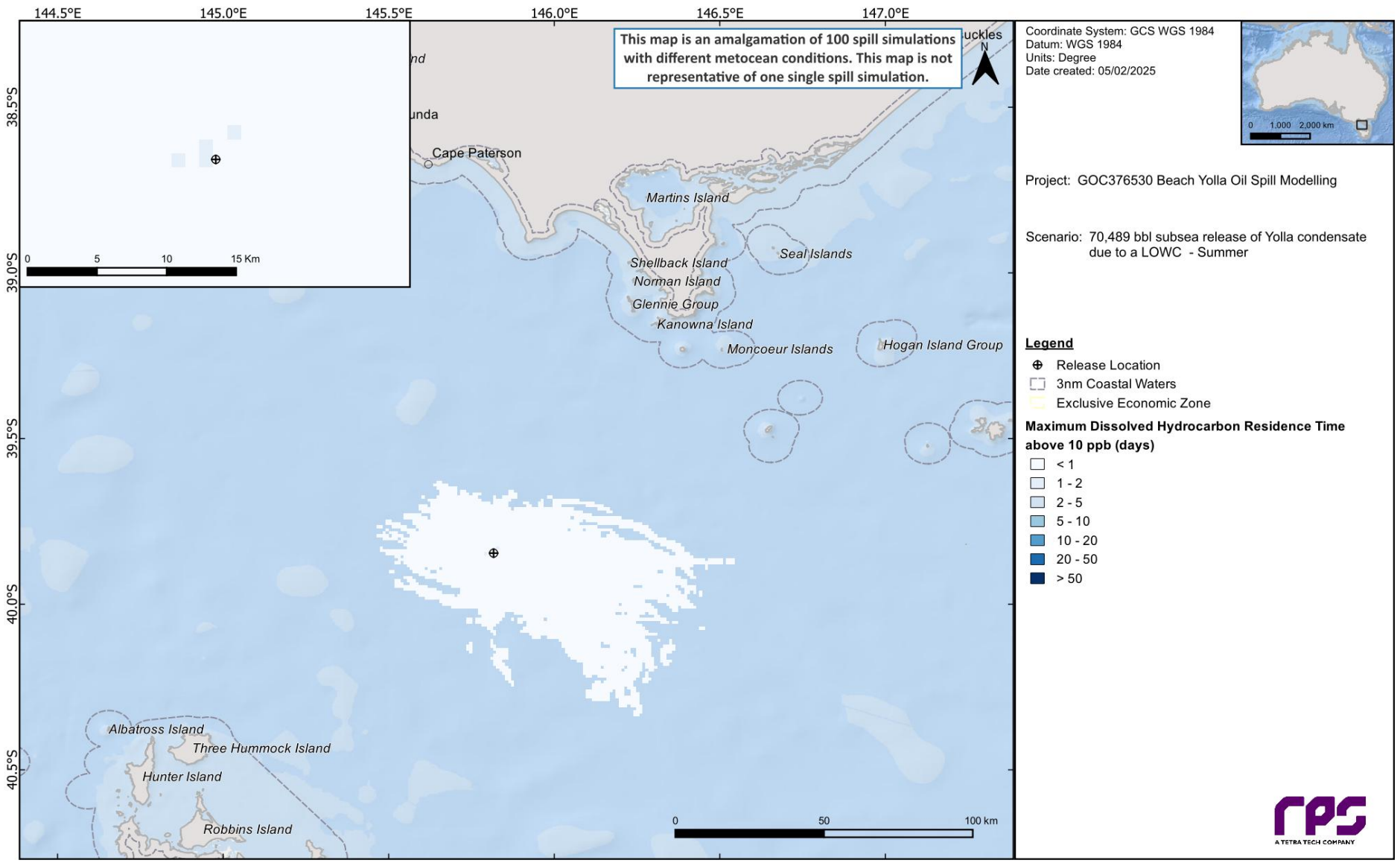


Figure 13-15 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

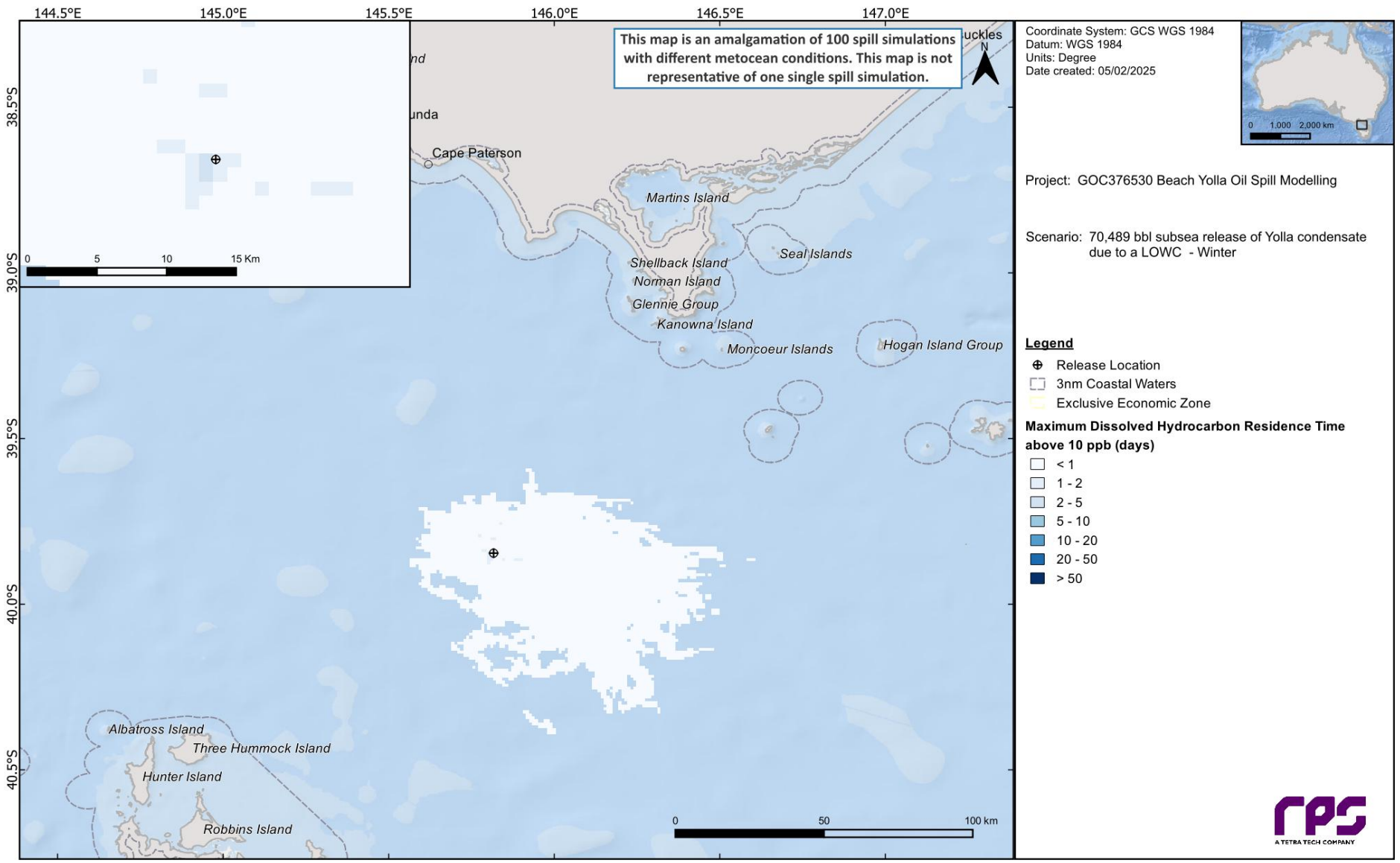


Figure 13-16 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

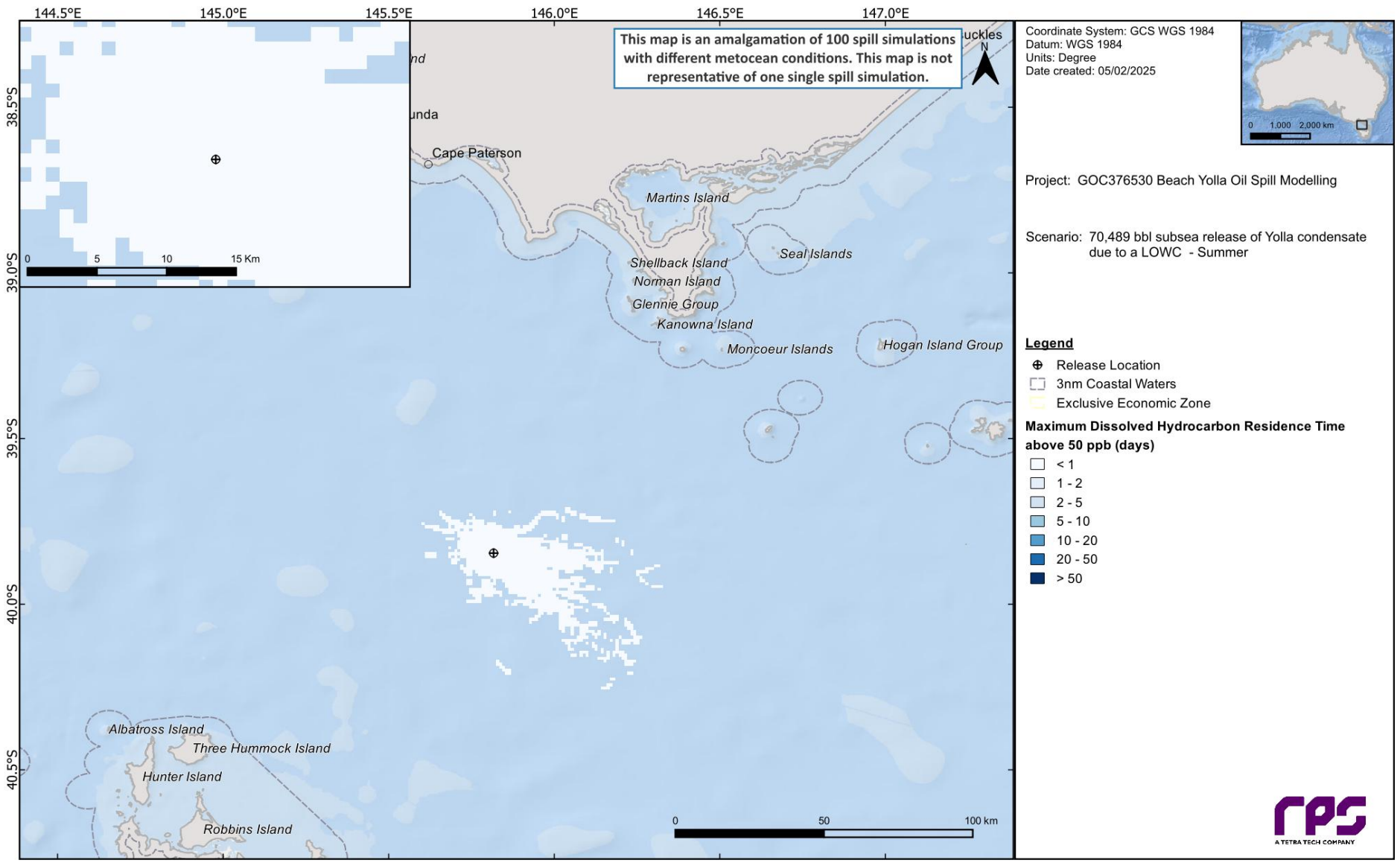


Figure 13-17 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

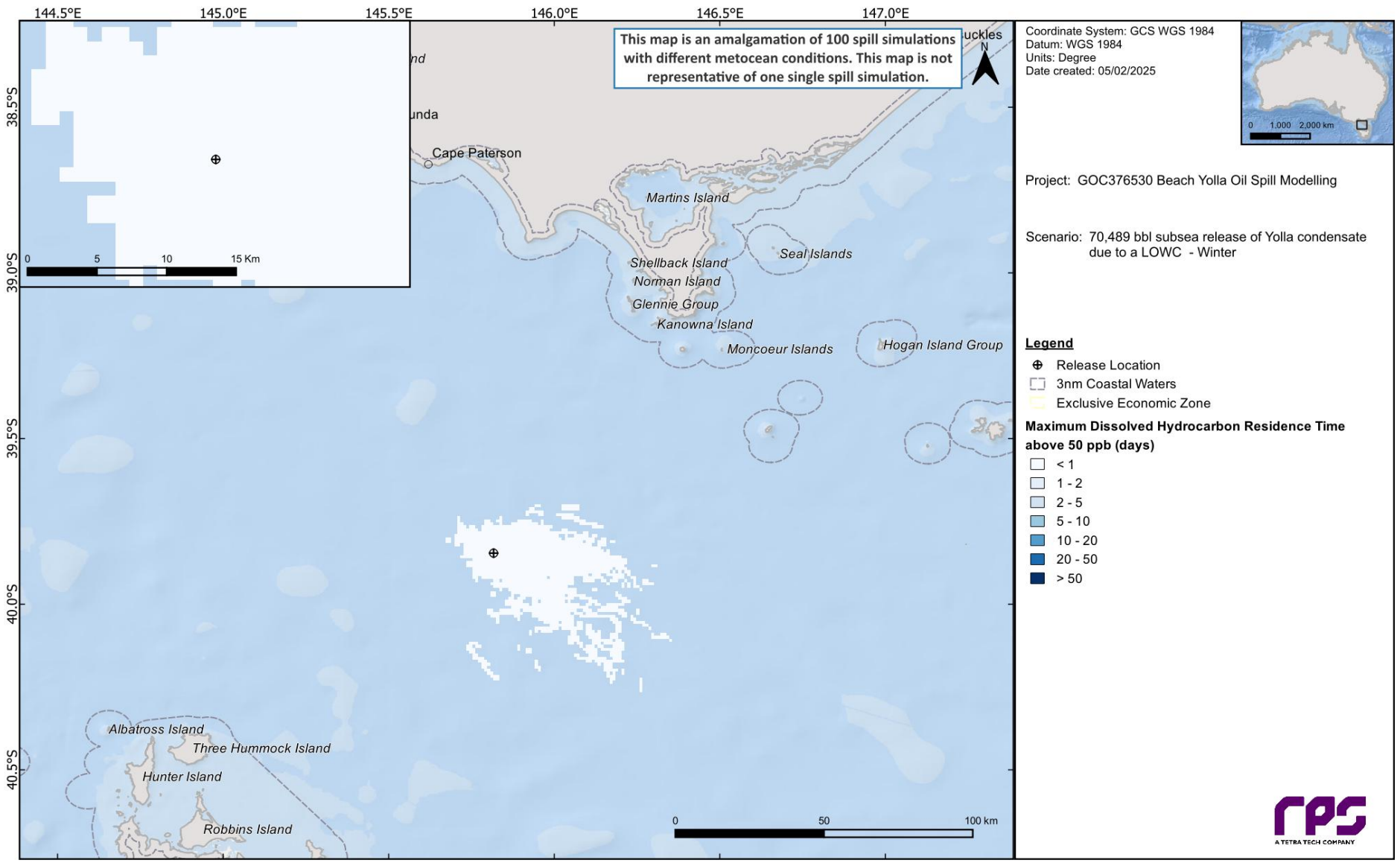


Figure 13-18 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during 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.

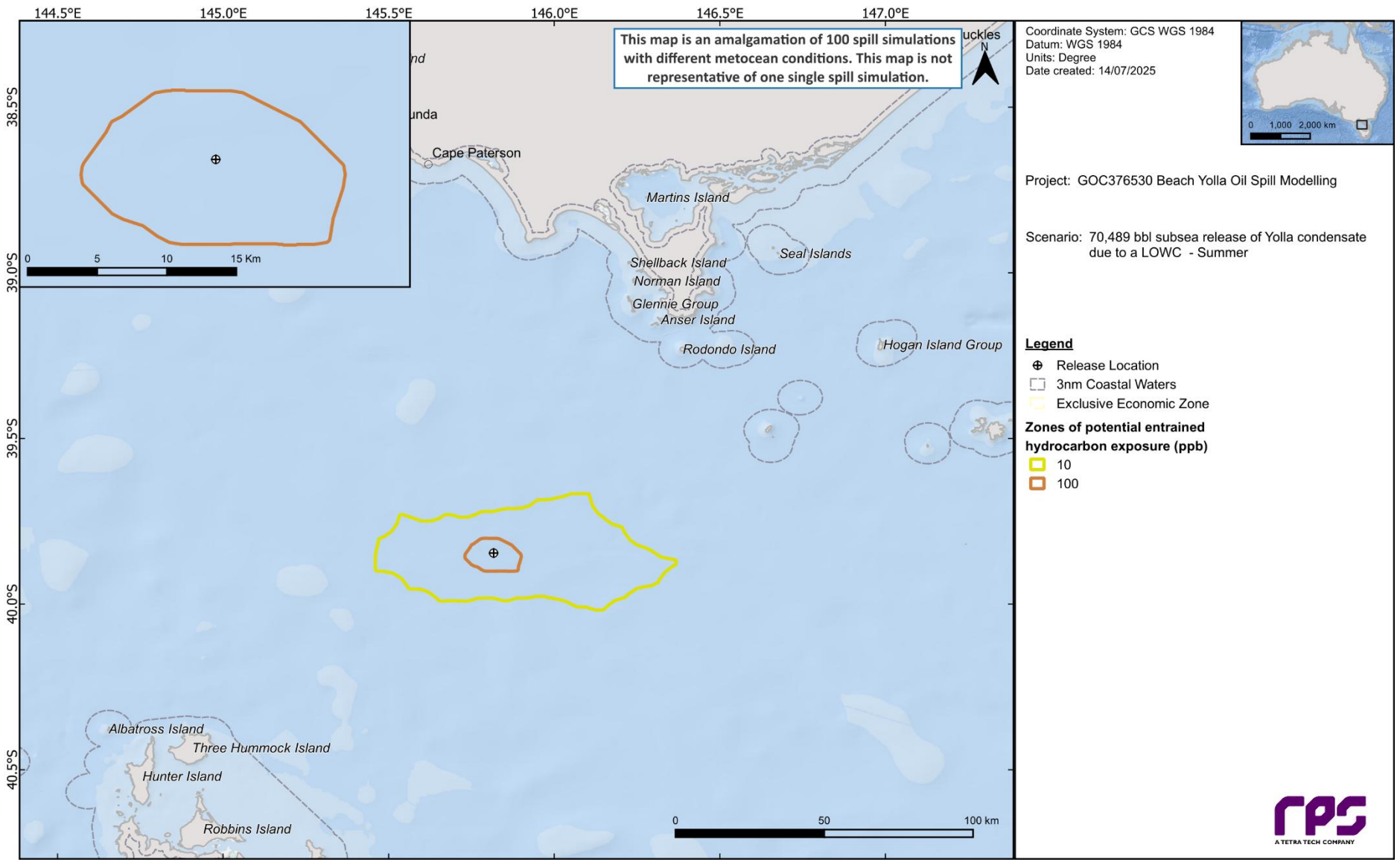


Figure 13-19 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

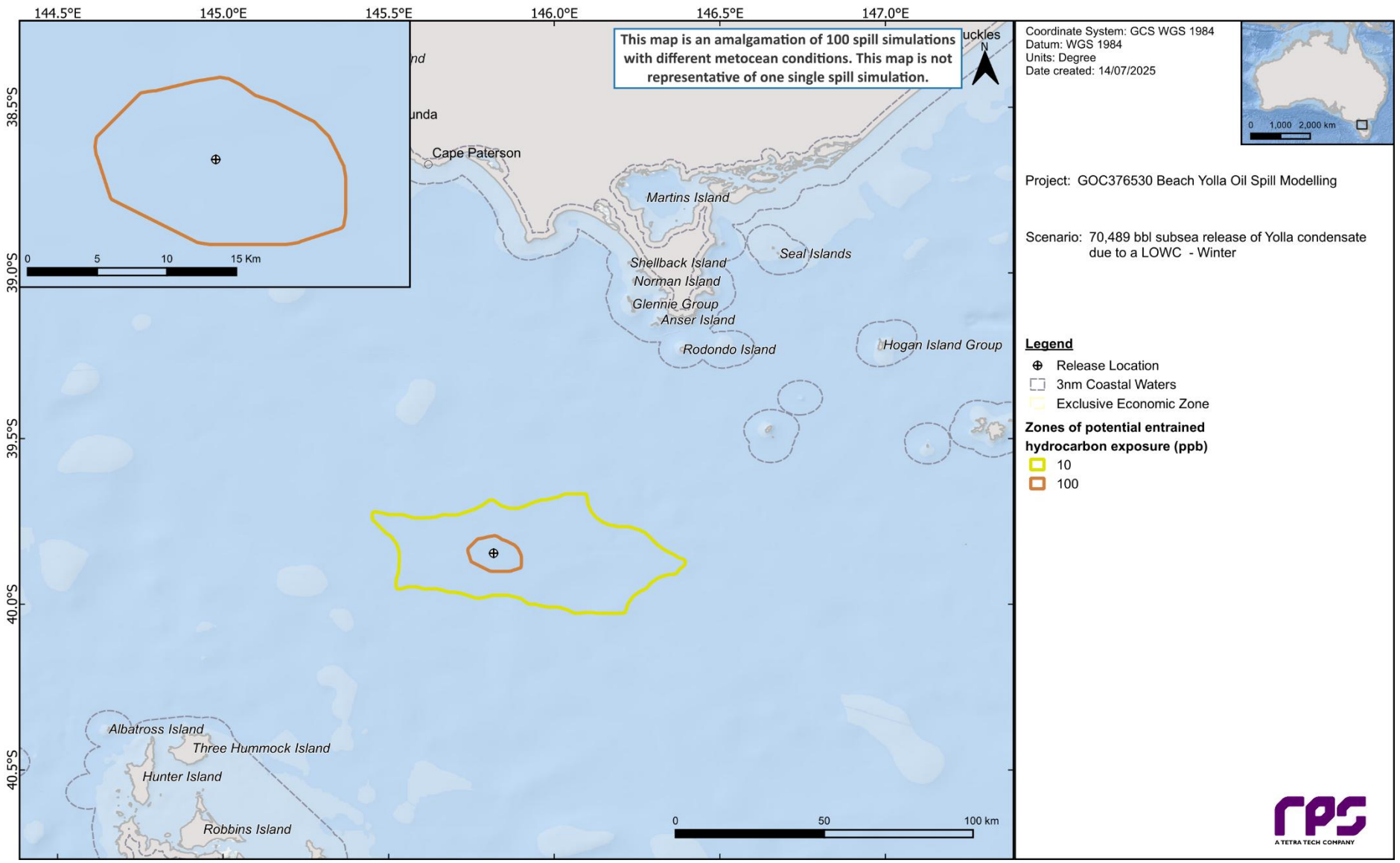


Figure 13-20 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

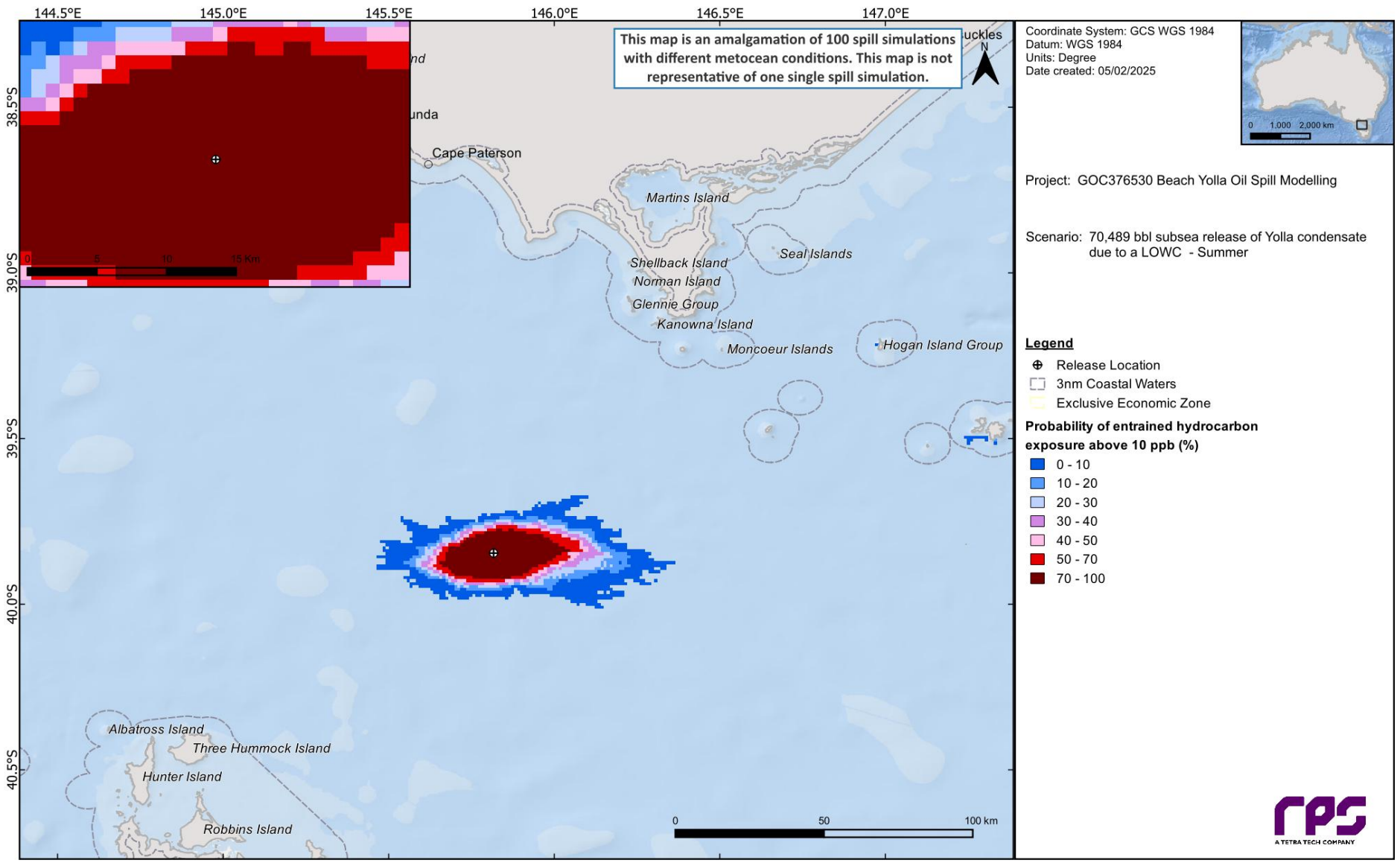


Figure 13-21 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

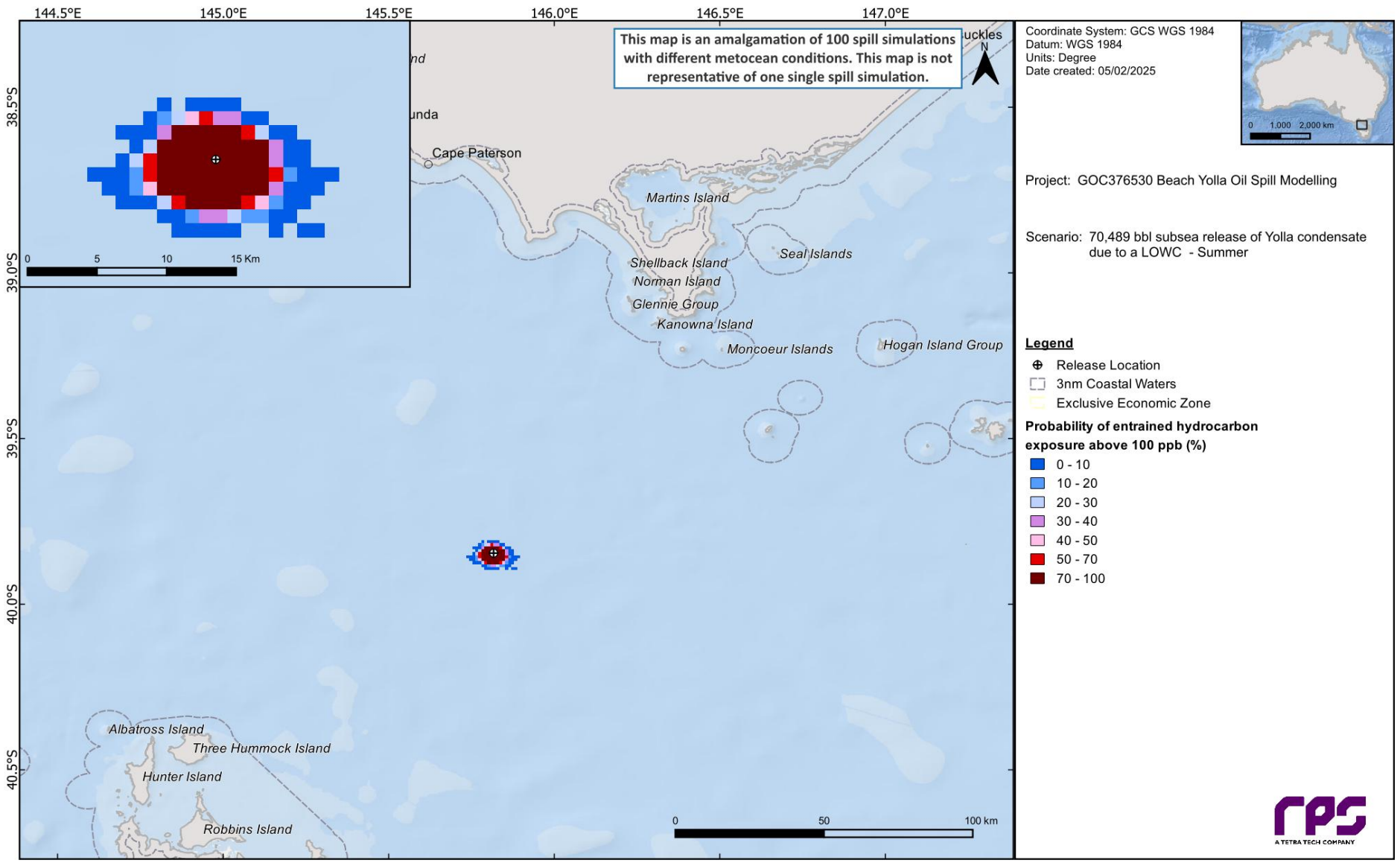


Figure 13-22 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

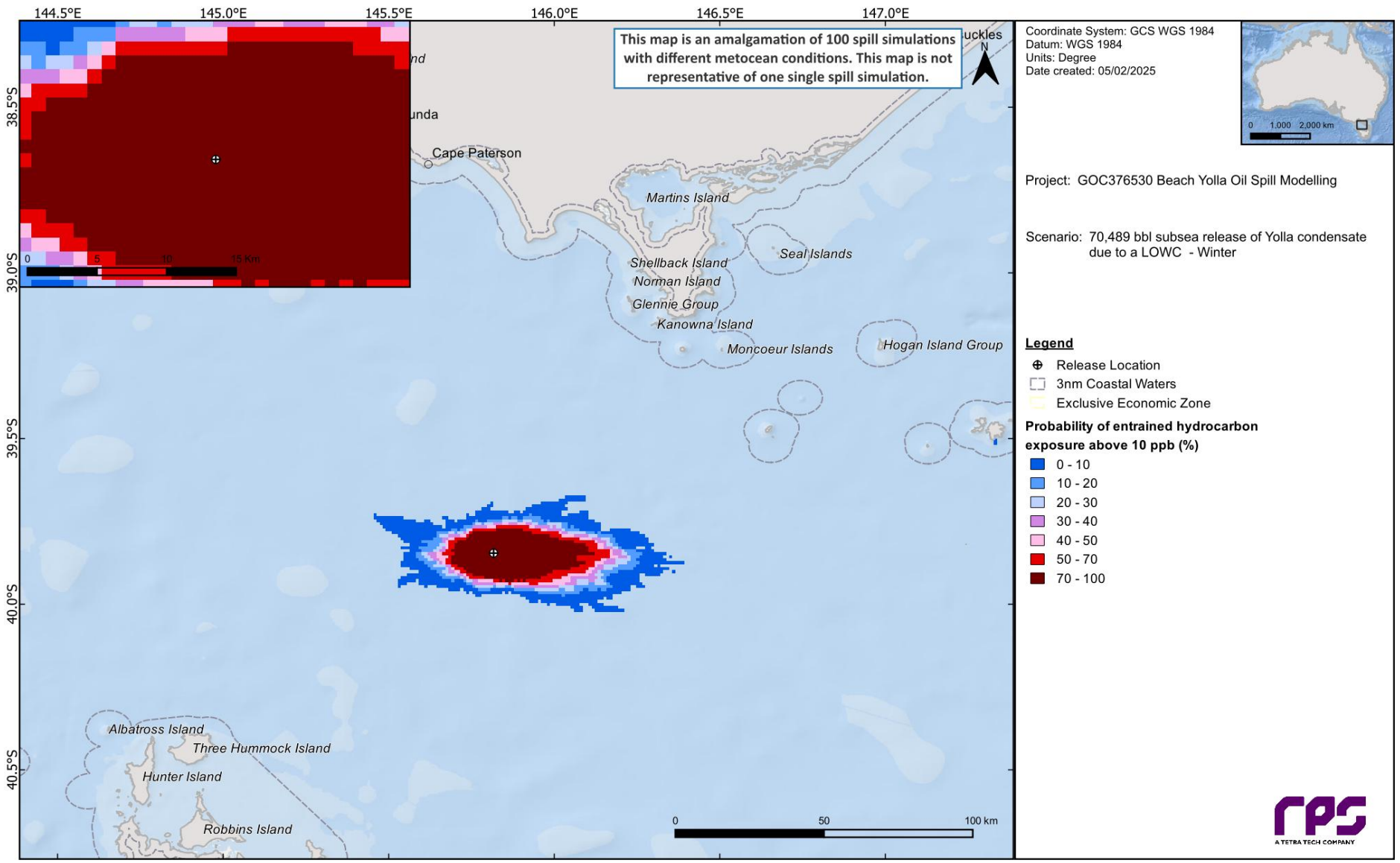


Figure 13-23 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

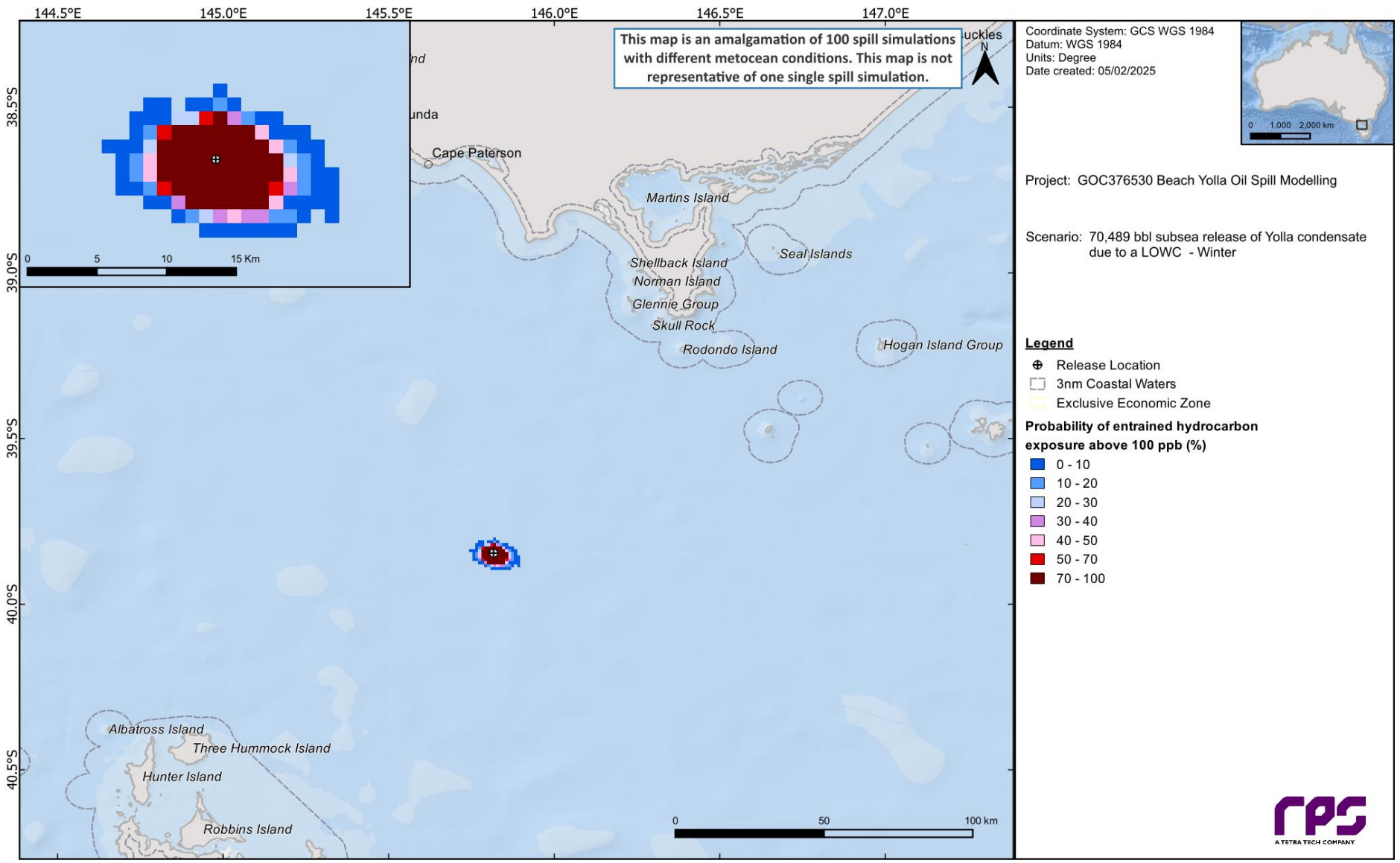


Figure 13-24 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

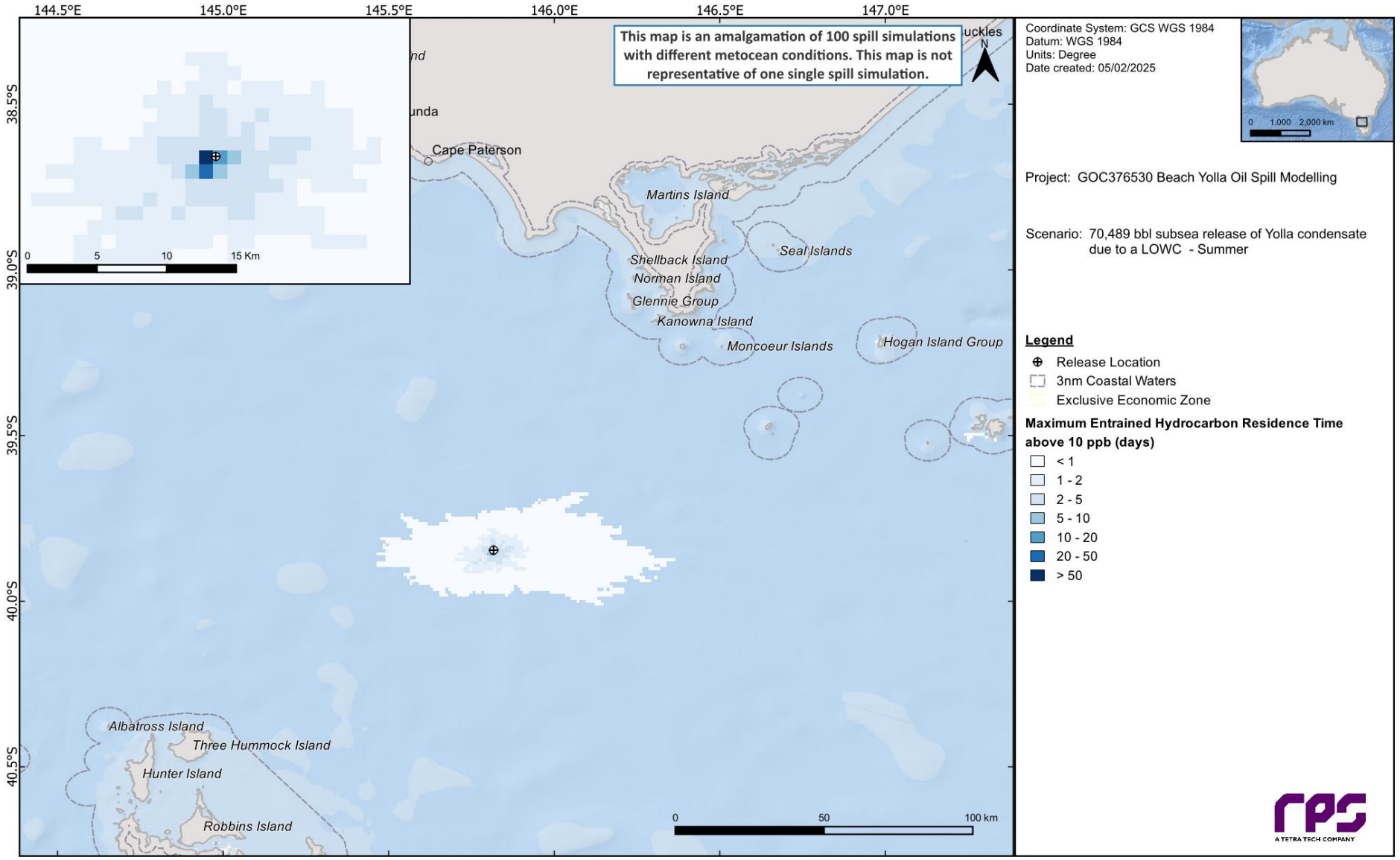


Figure 13-25 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

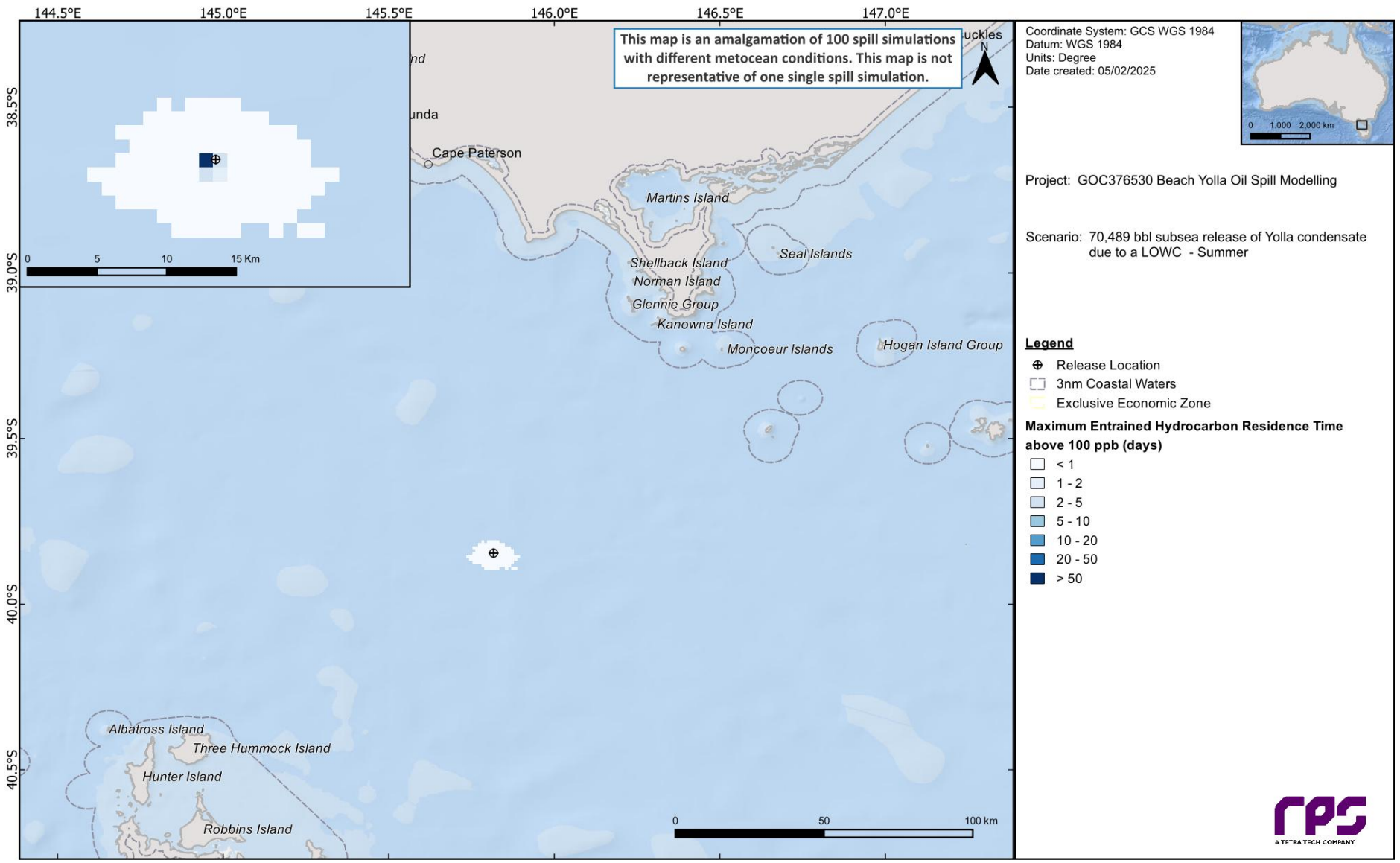


Figure 13-26 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during summer conditions.

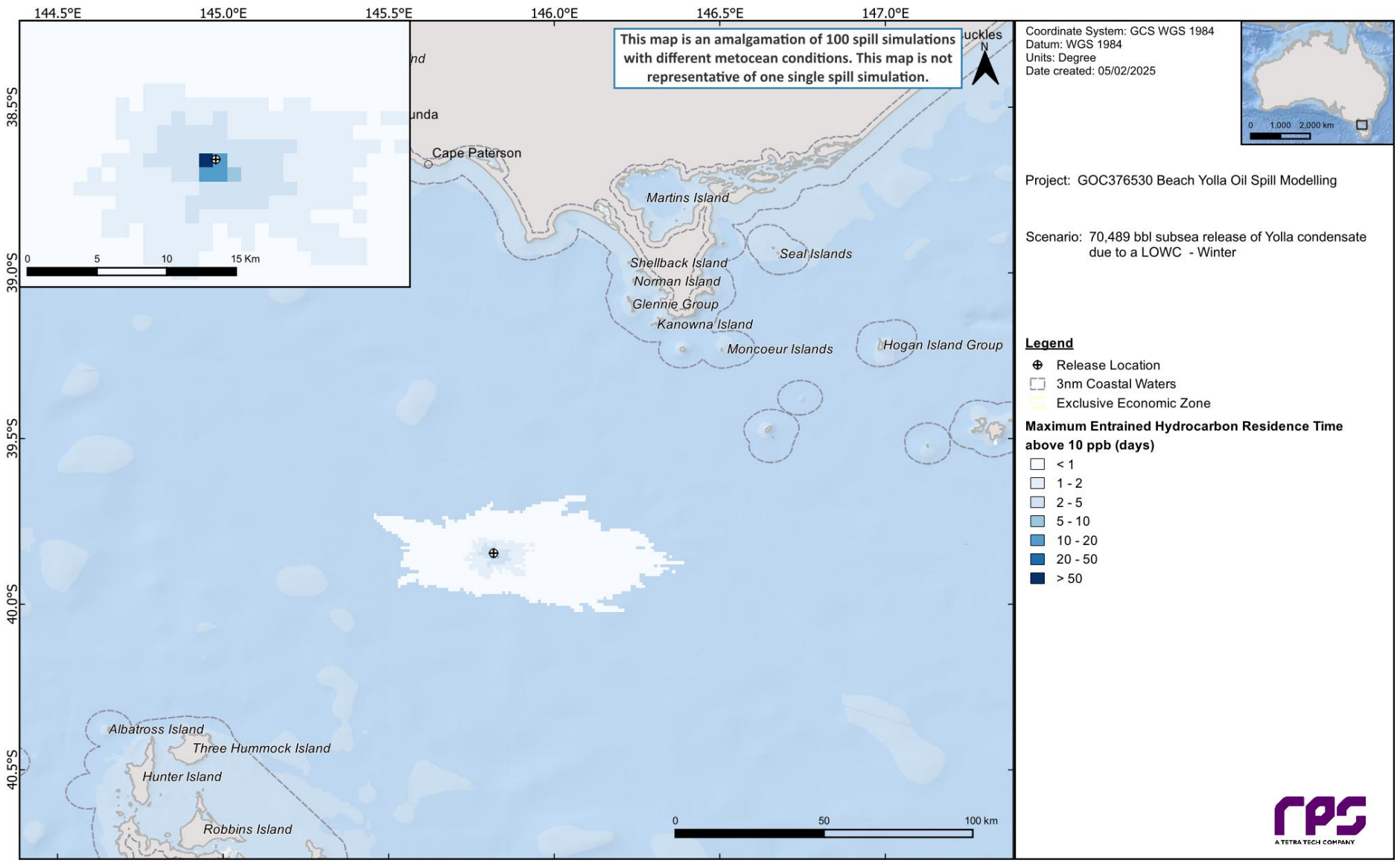


Figure 13-27 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during winter conditions.

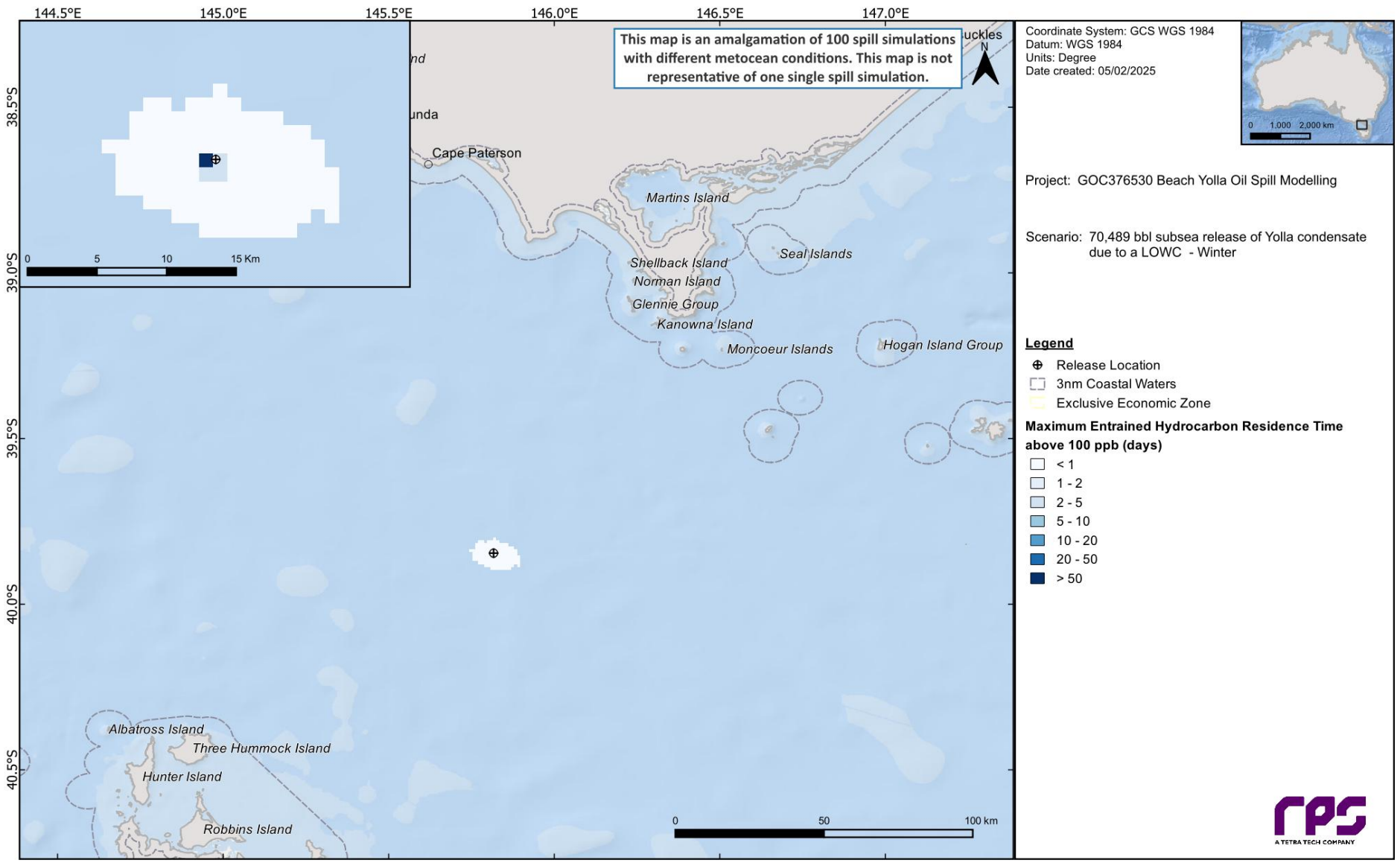


Figure 13-28 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 70,489 bbl subsea release of condensate over 86 days from a loss of well control at the Yolla Well Head. The results were calculated from 100 spill simulations during 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.

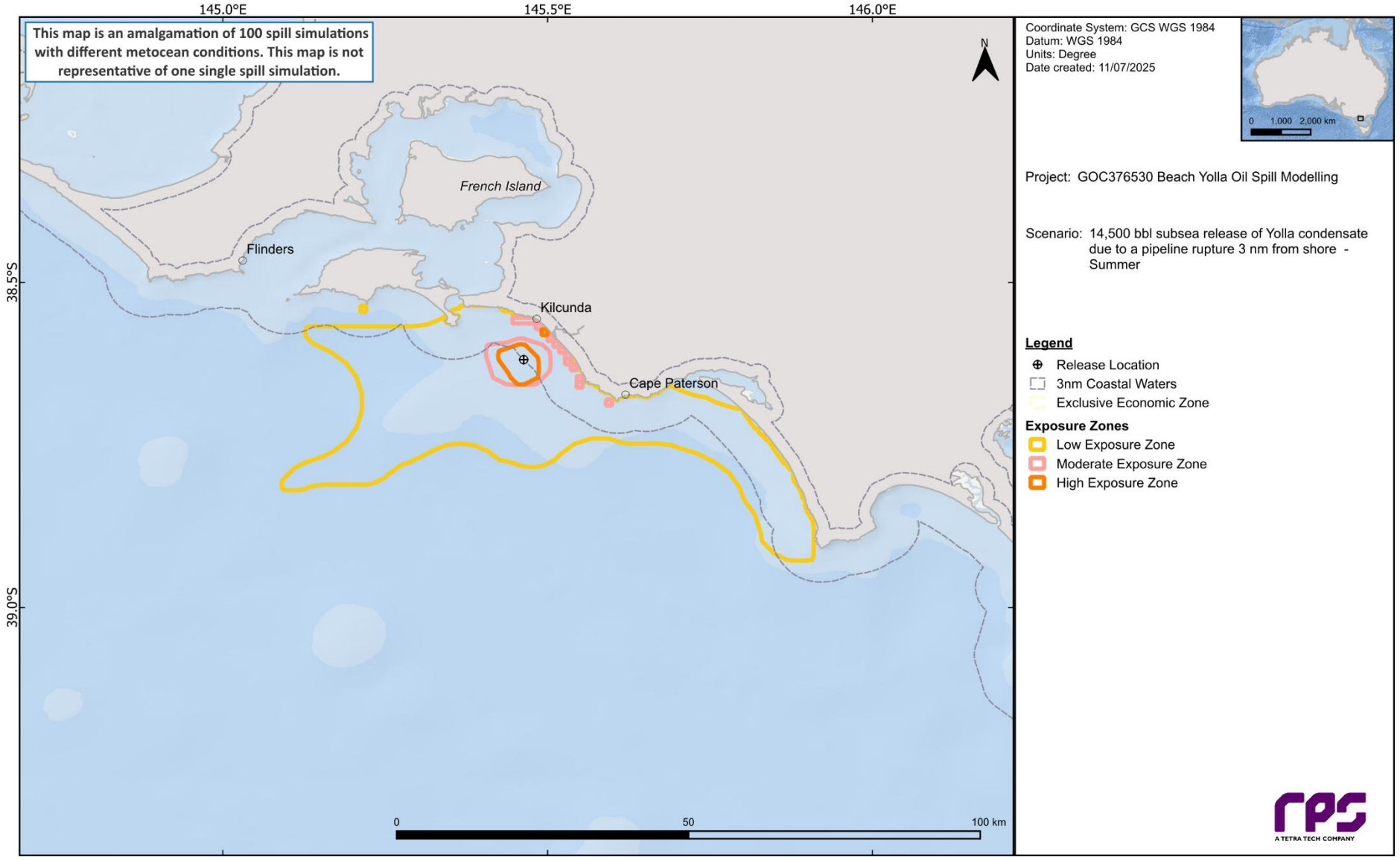


Figure 14-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore during summer conditions.

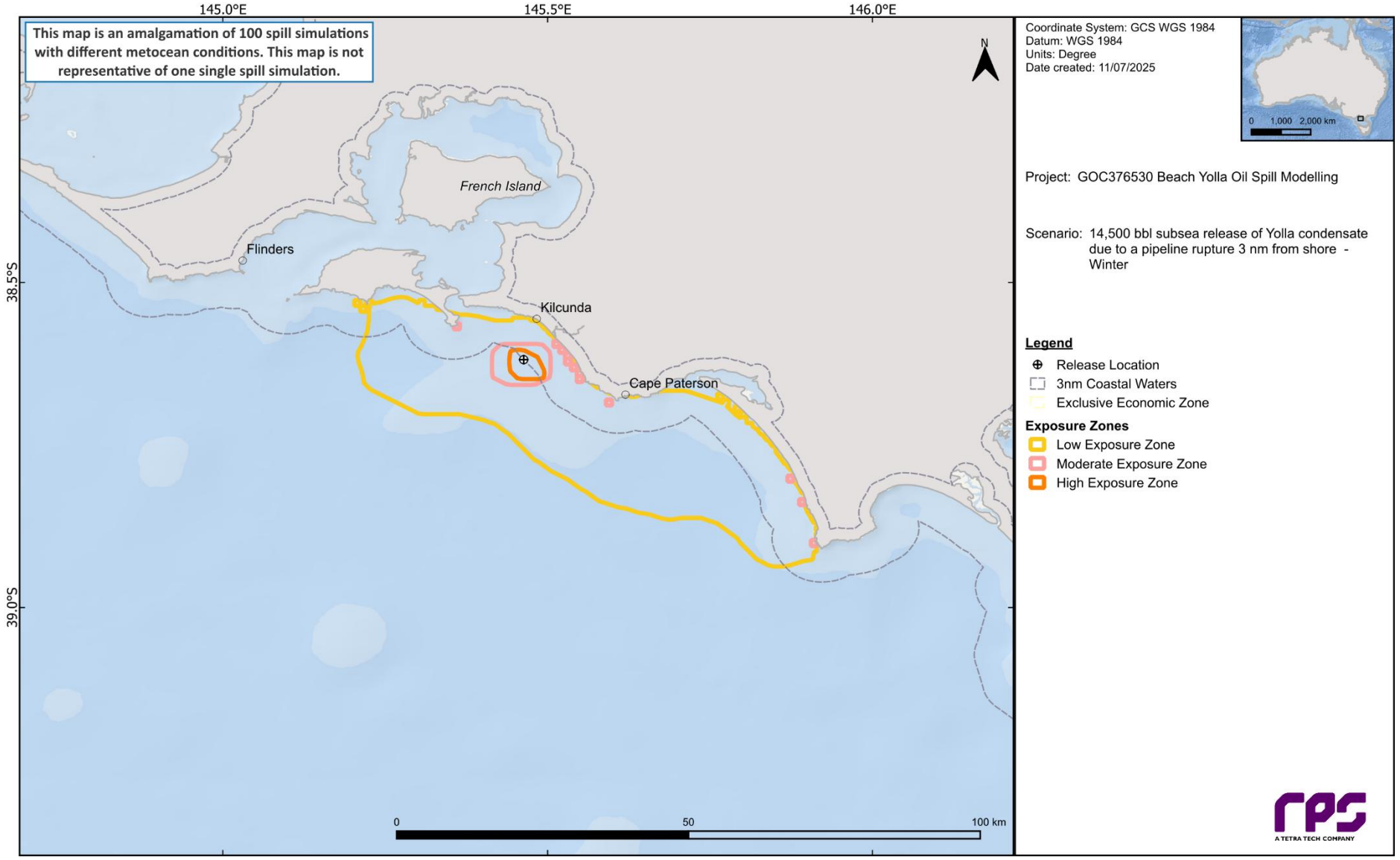


Figure 14-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore during winter conditions.

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.

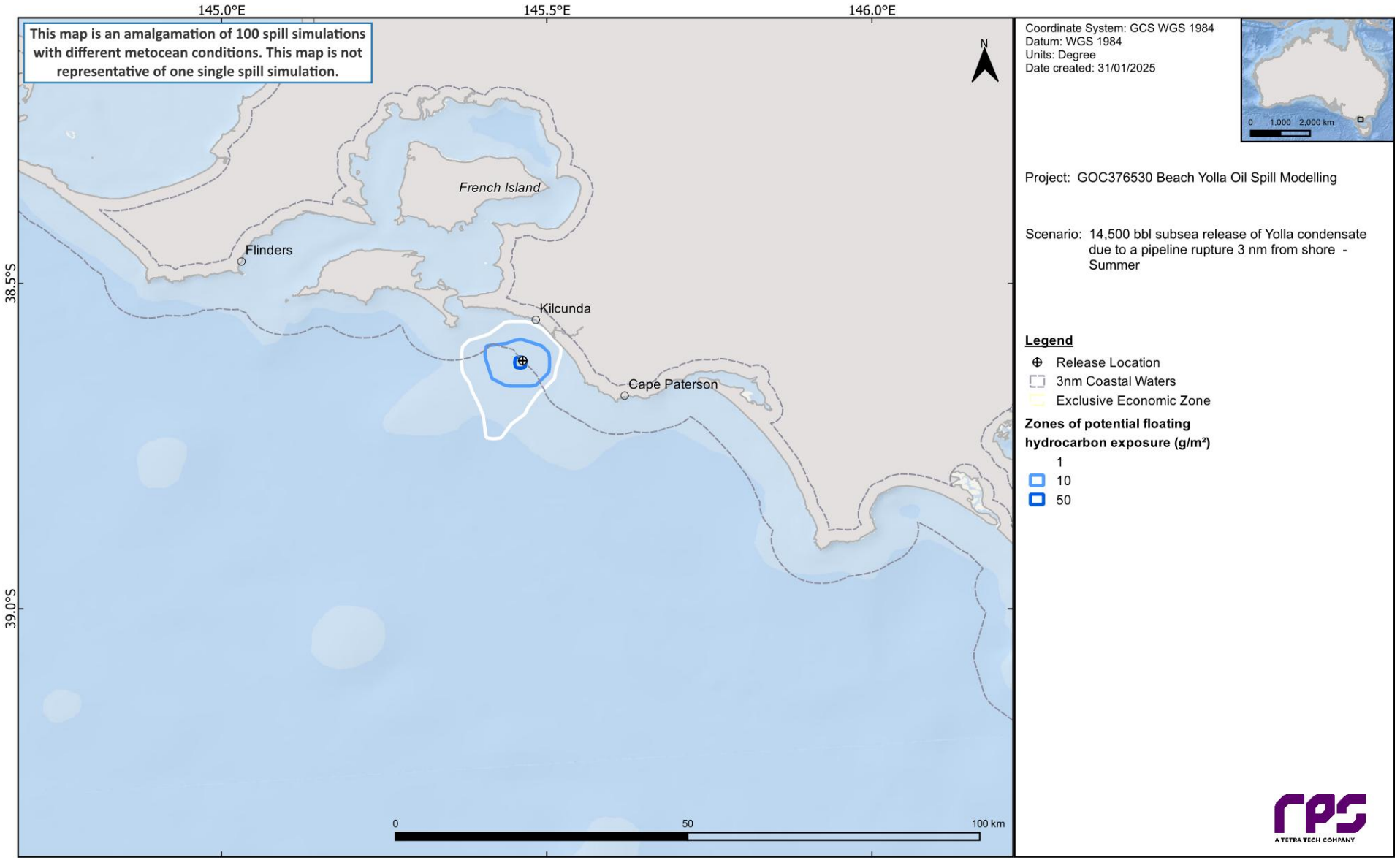


Figure 14-3 Zones of potential floating oil exposure in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

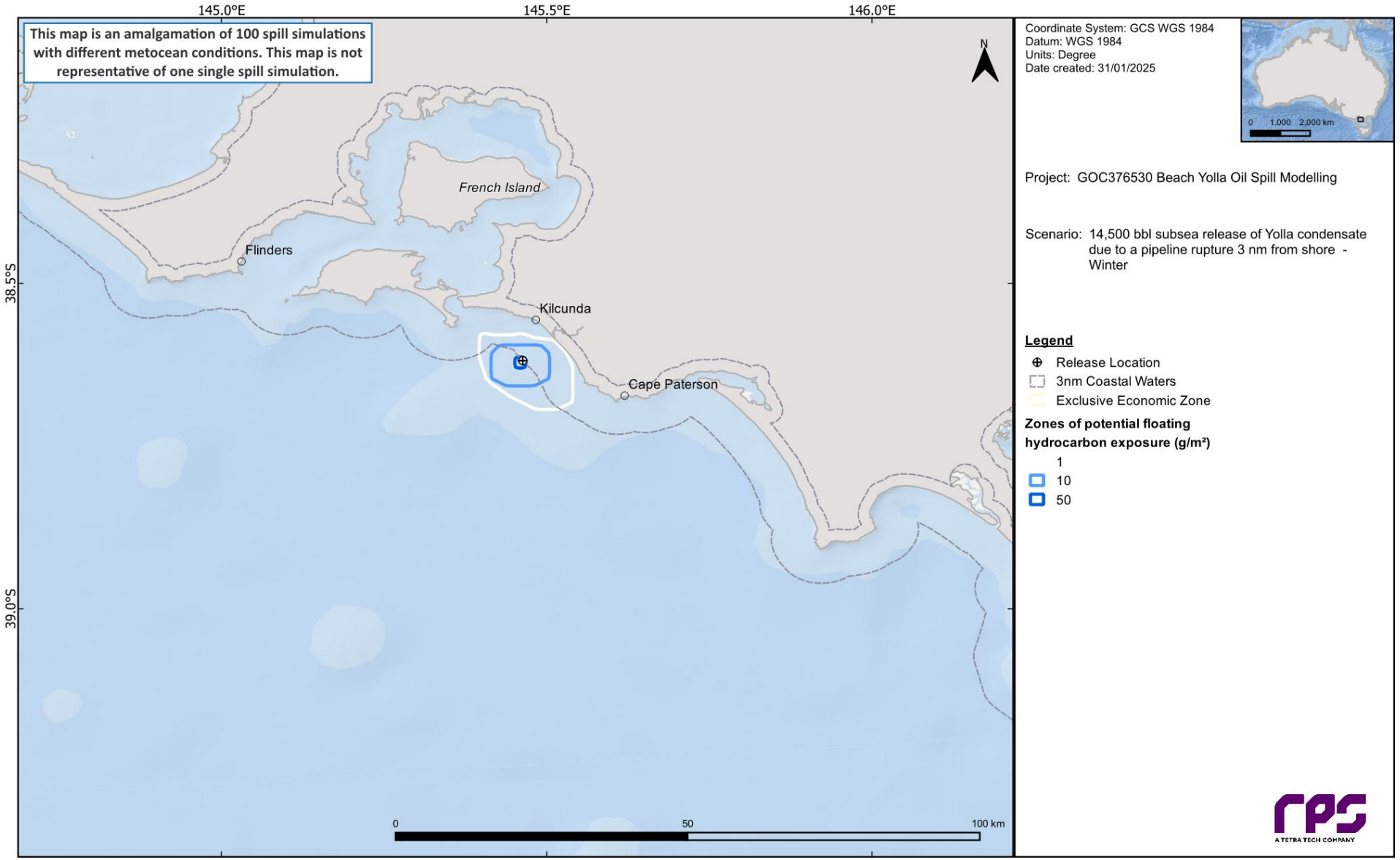


Figure 14-4 Zones of potential floating oil exposure in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

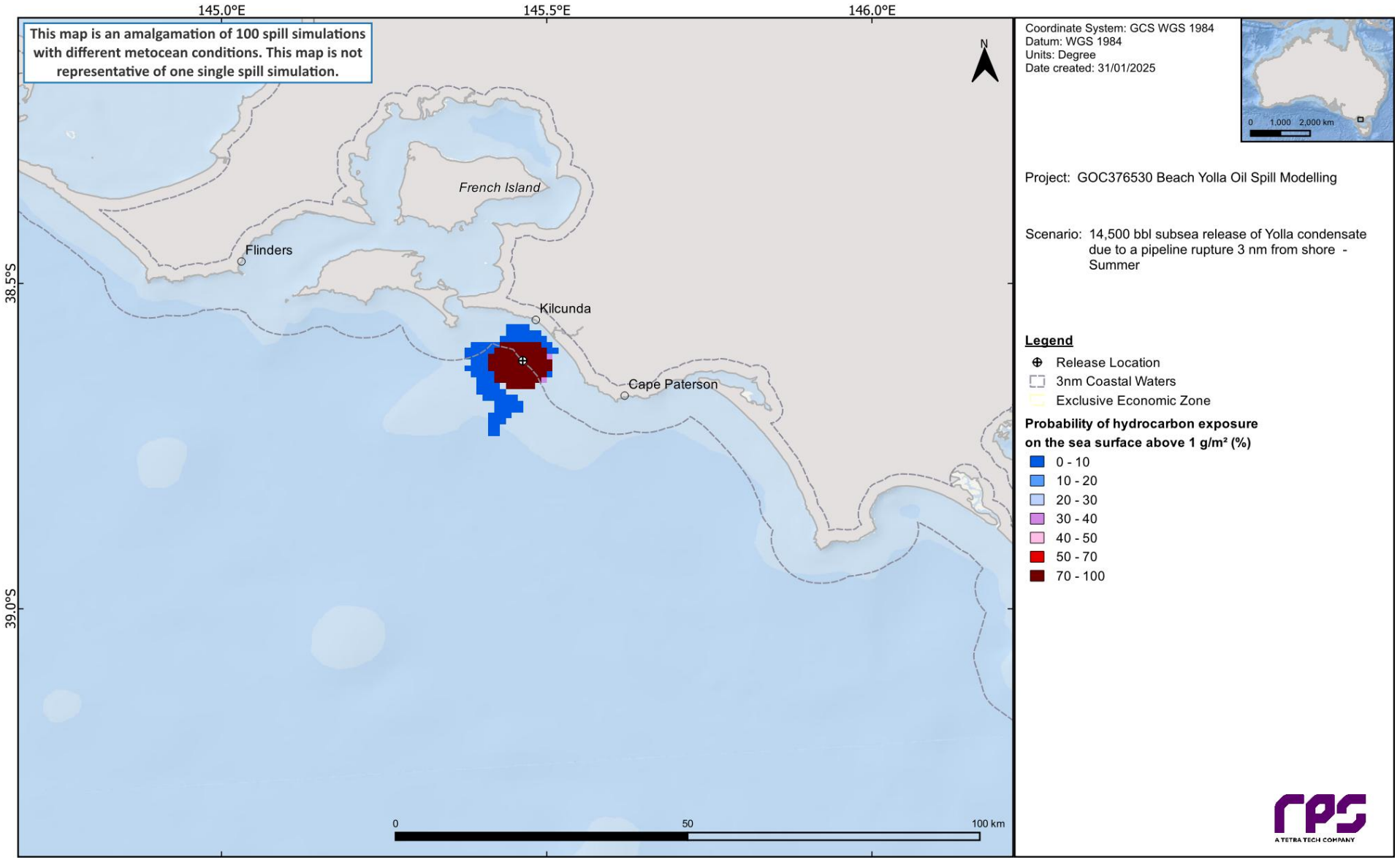


Figure 14-5 Probability of floating oil exposure above 1 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

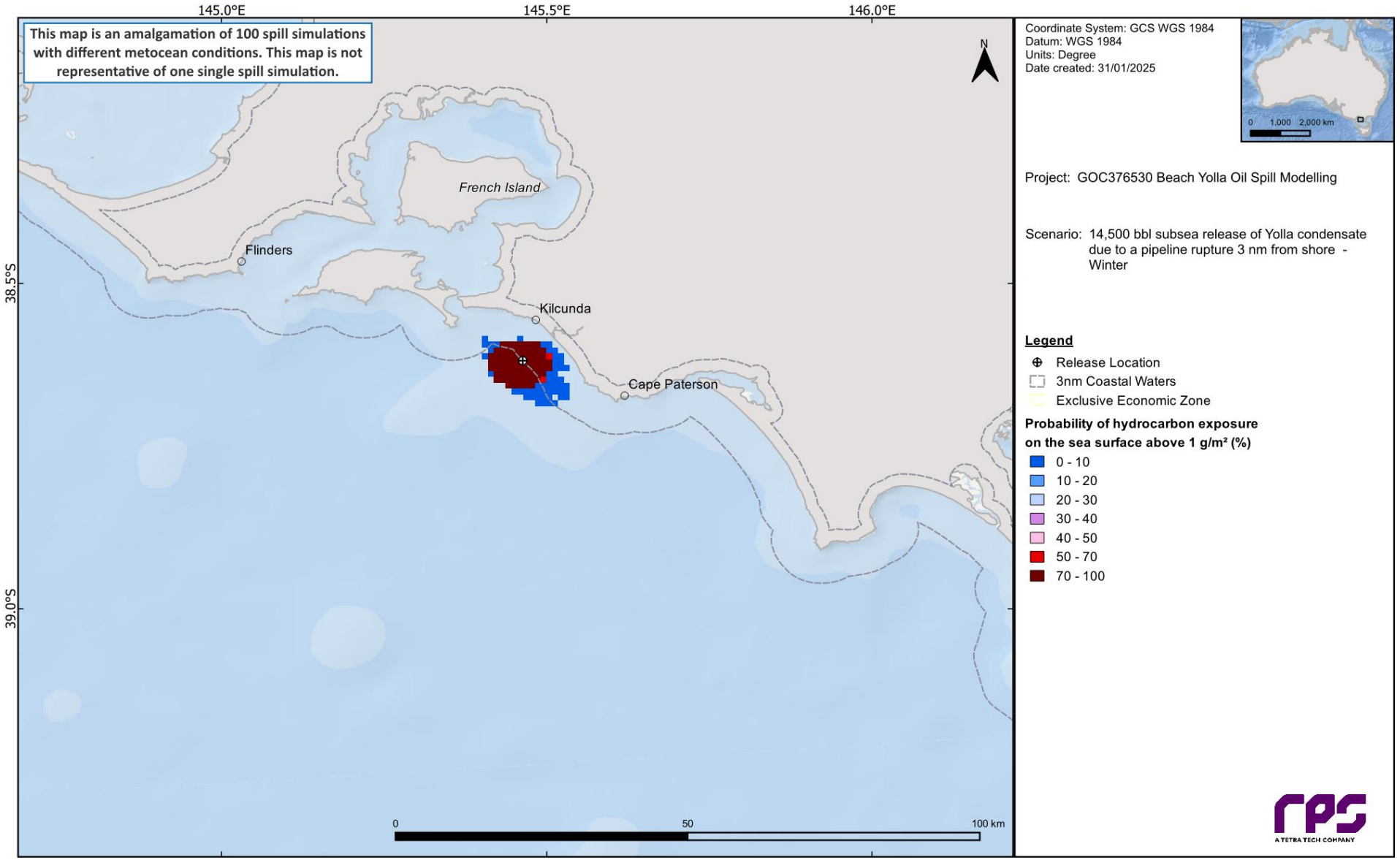


Figure 14-6 Probability of floating oil exposure above 1 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

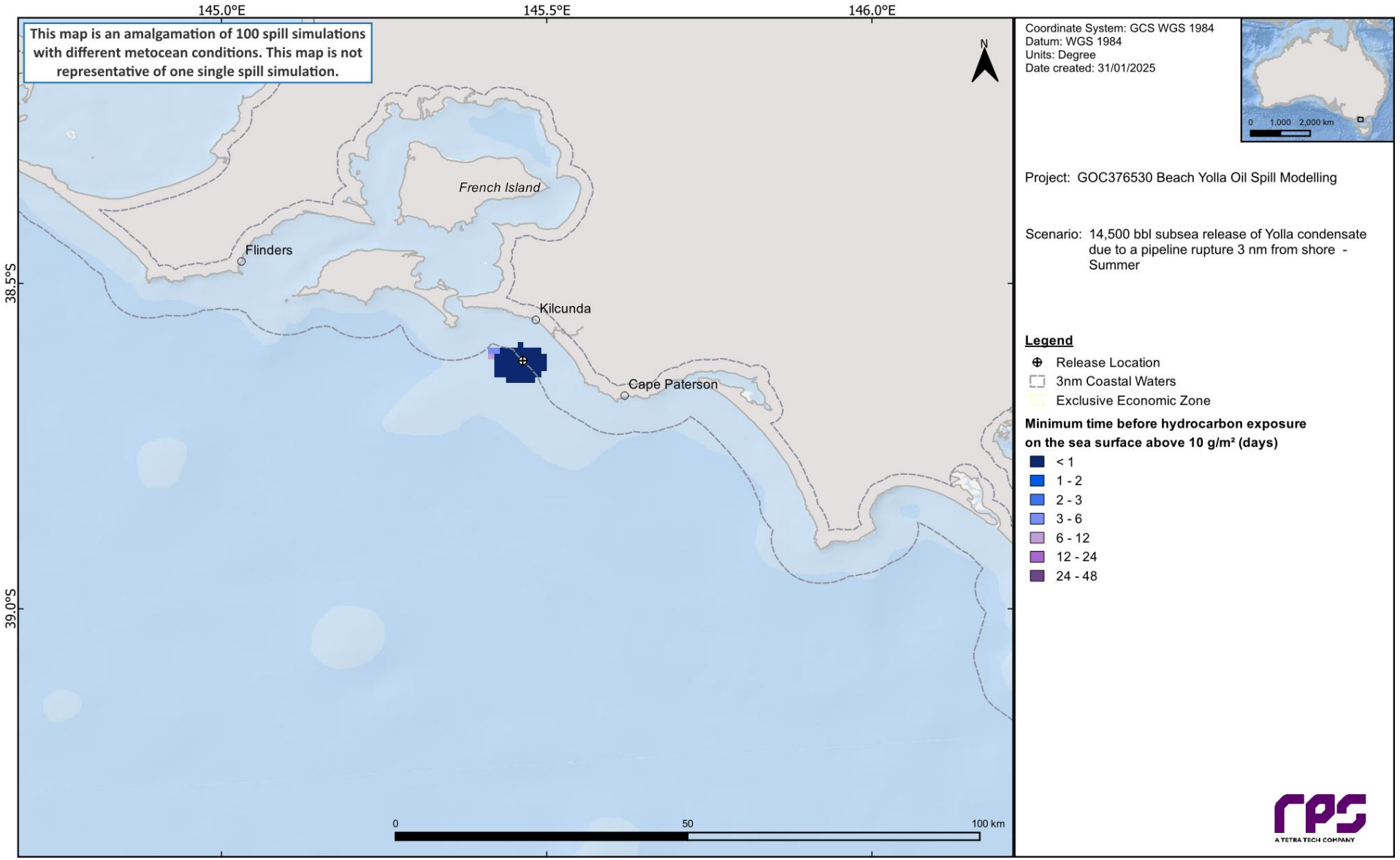


Figure 14-7 Probability of floating oil exposure above 10 g/m², in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

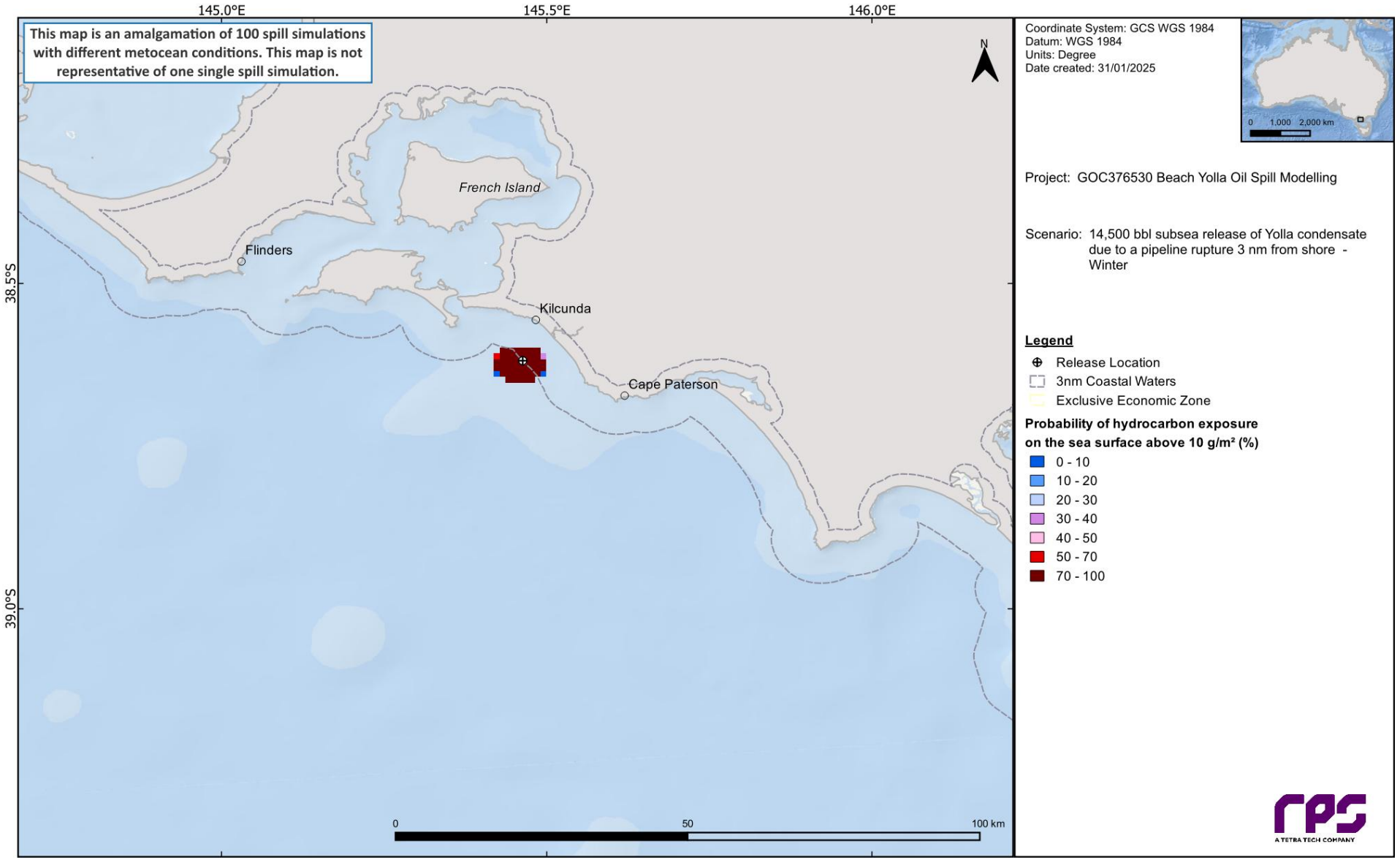


Figure 14-8 Probability of floating oil exposure above 10 g/m², in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

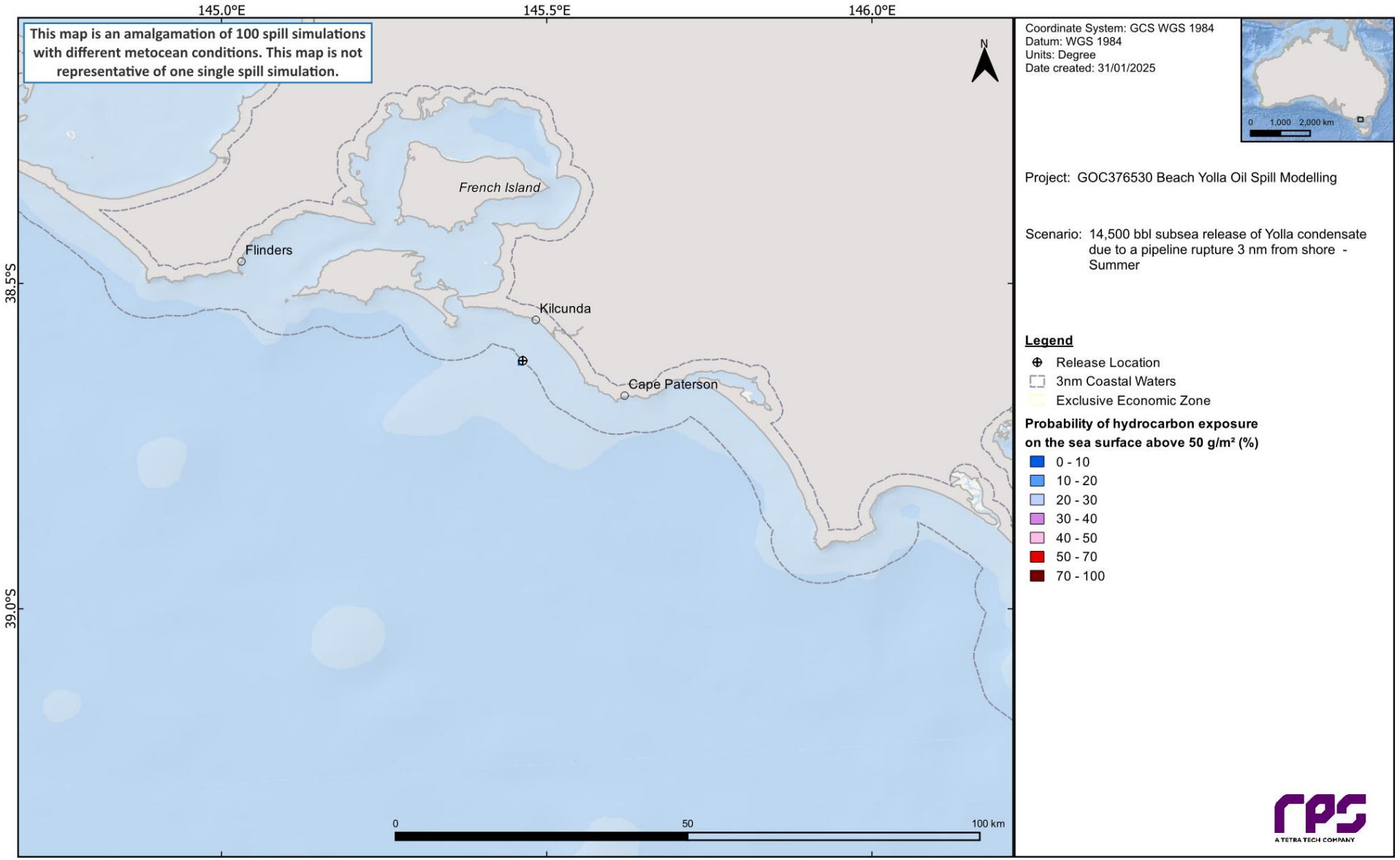


Figure 14-9 Probability of floating oil exposure above 50 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

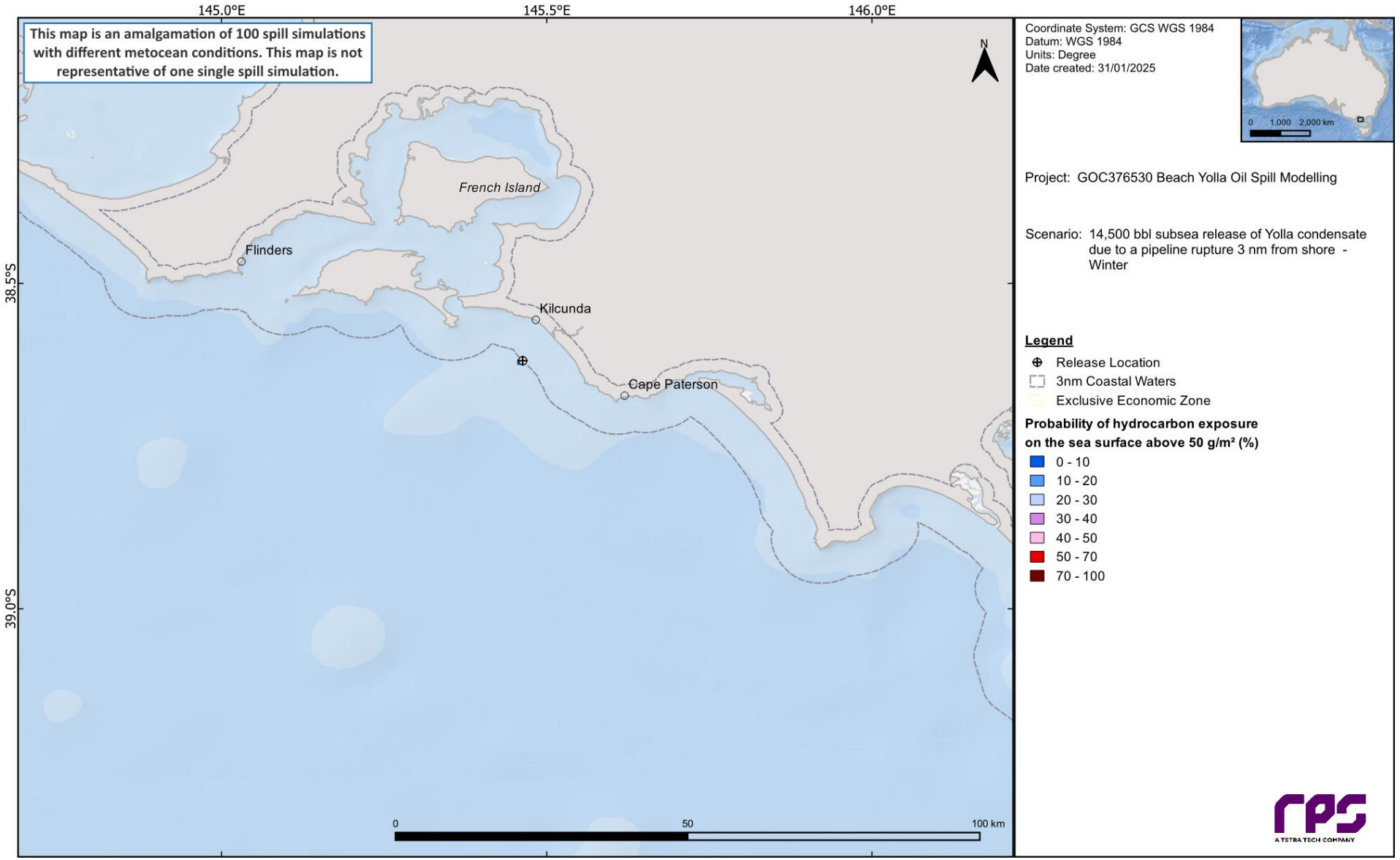


Figure 14-10 Probability of floating oil exposure above 50 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

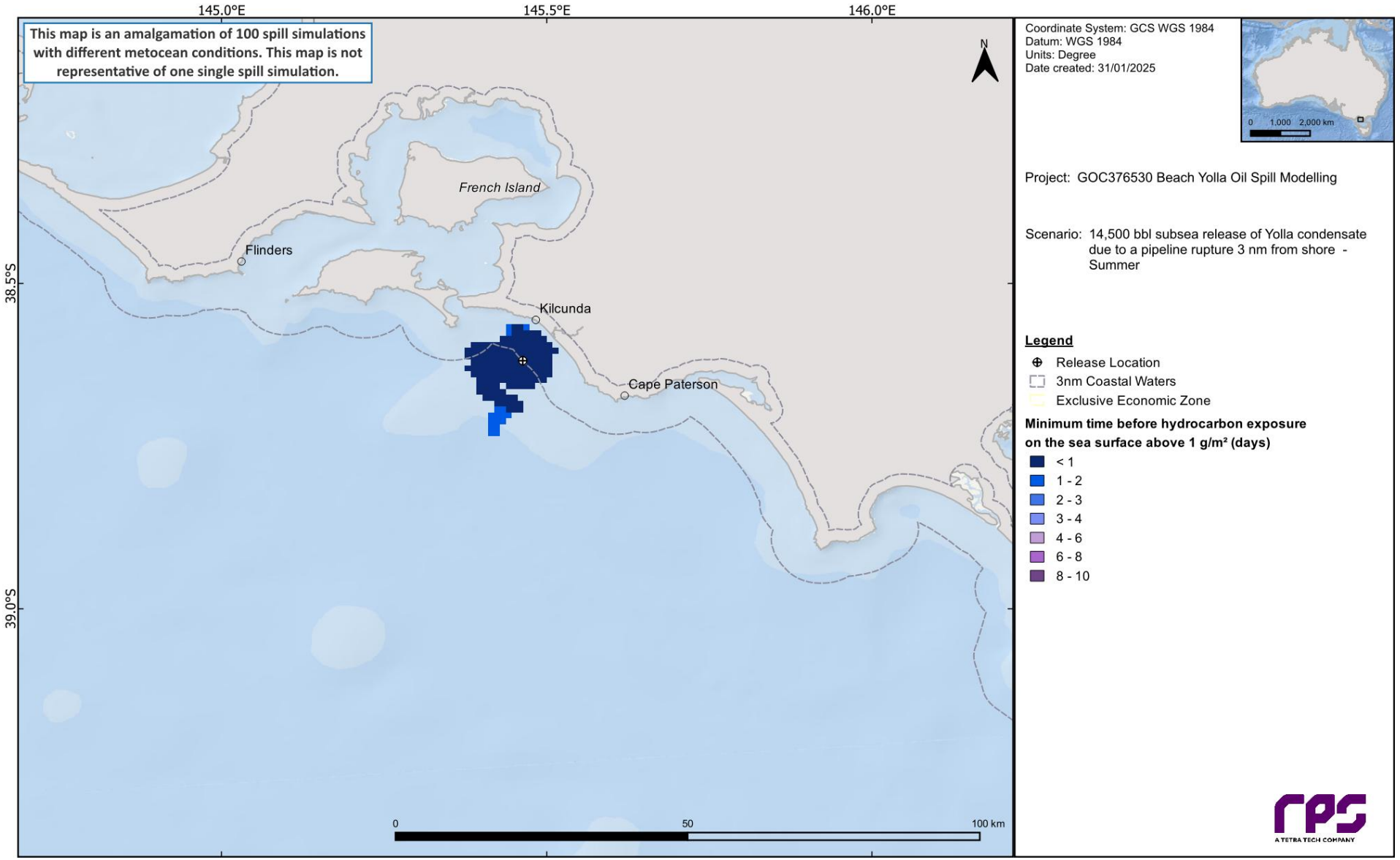


Figure 14-11 Minimum time before floating oil exposure above 1 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

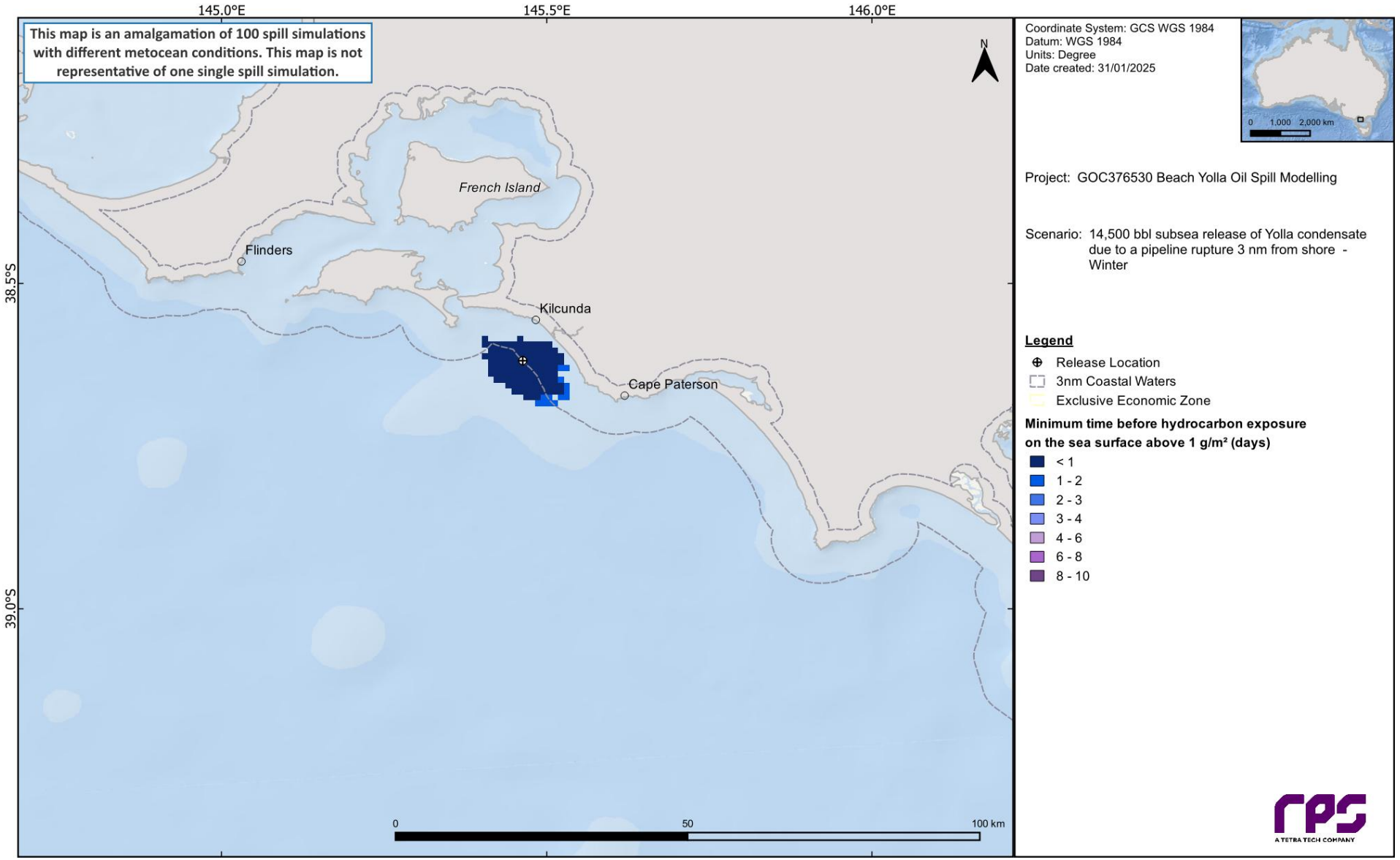


Figure 14-12 Minimum time before floating oil exposure above 1 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

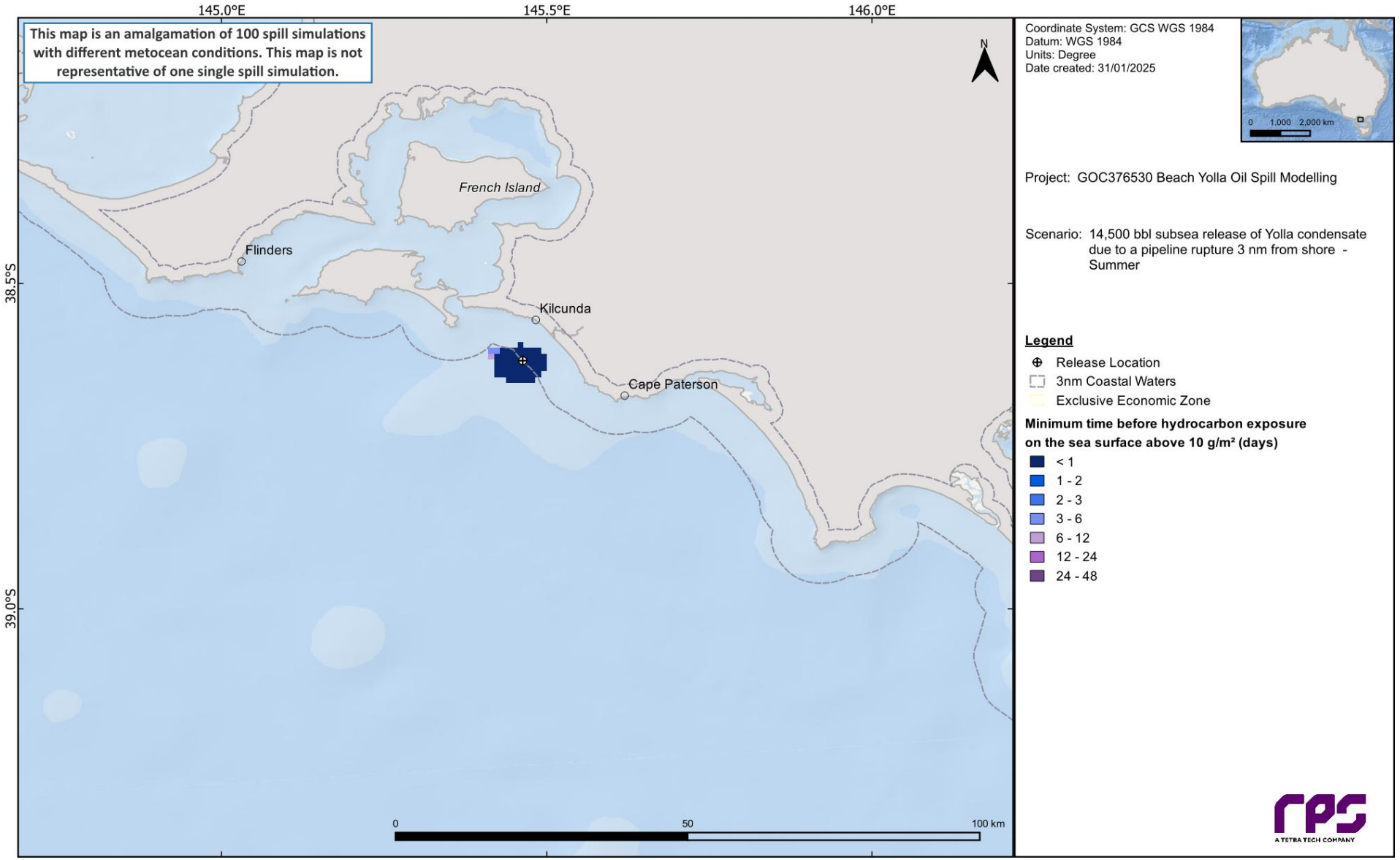


Figure 14-13 Minimum time before floating oil exposure above 10 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

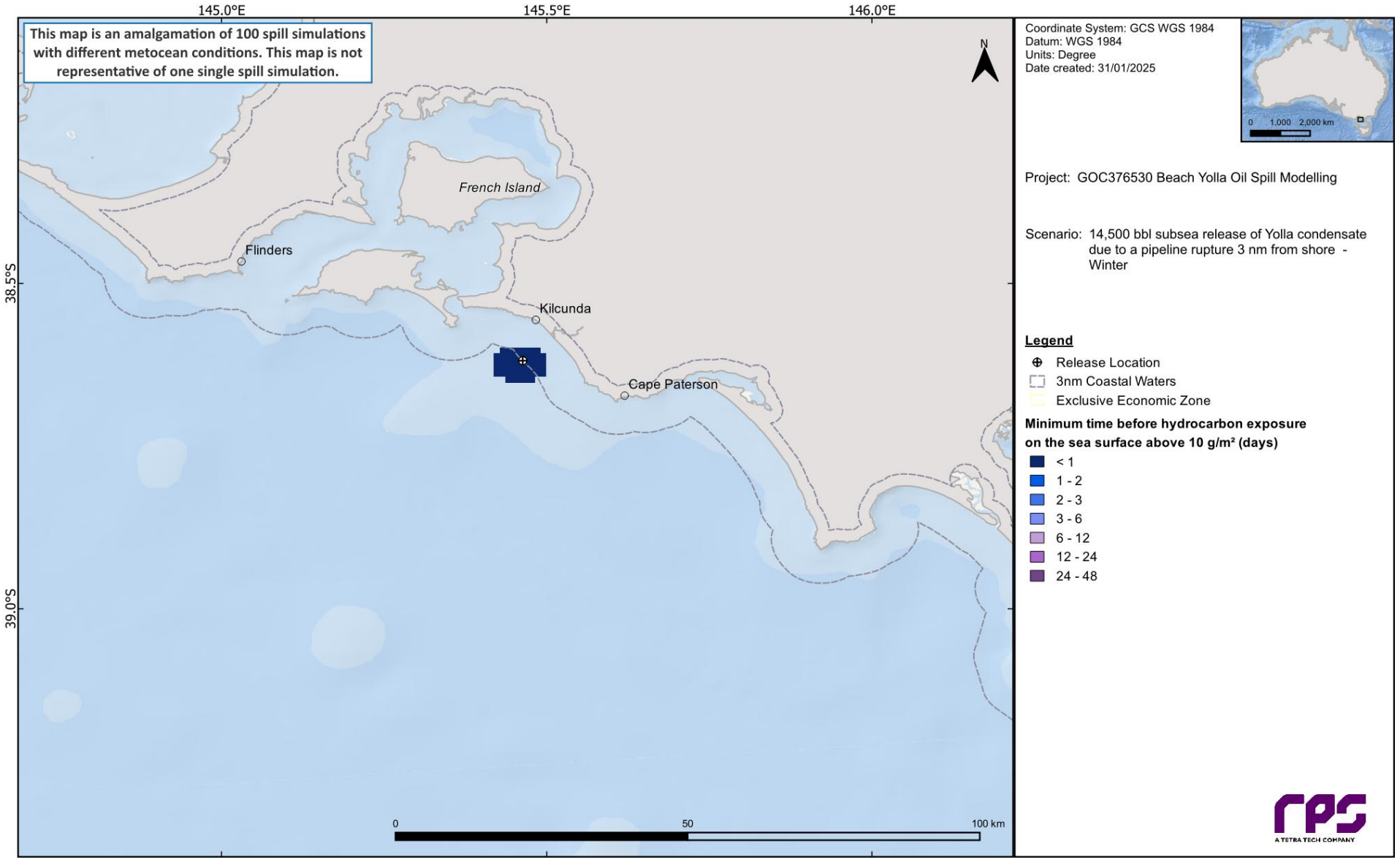


Figure 14-14 Minimum time before floating oil exposure above 10 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

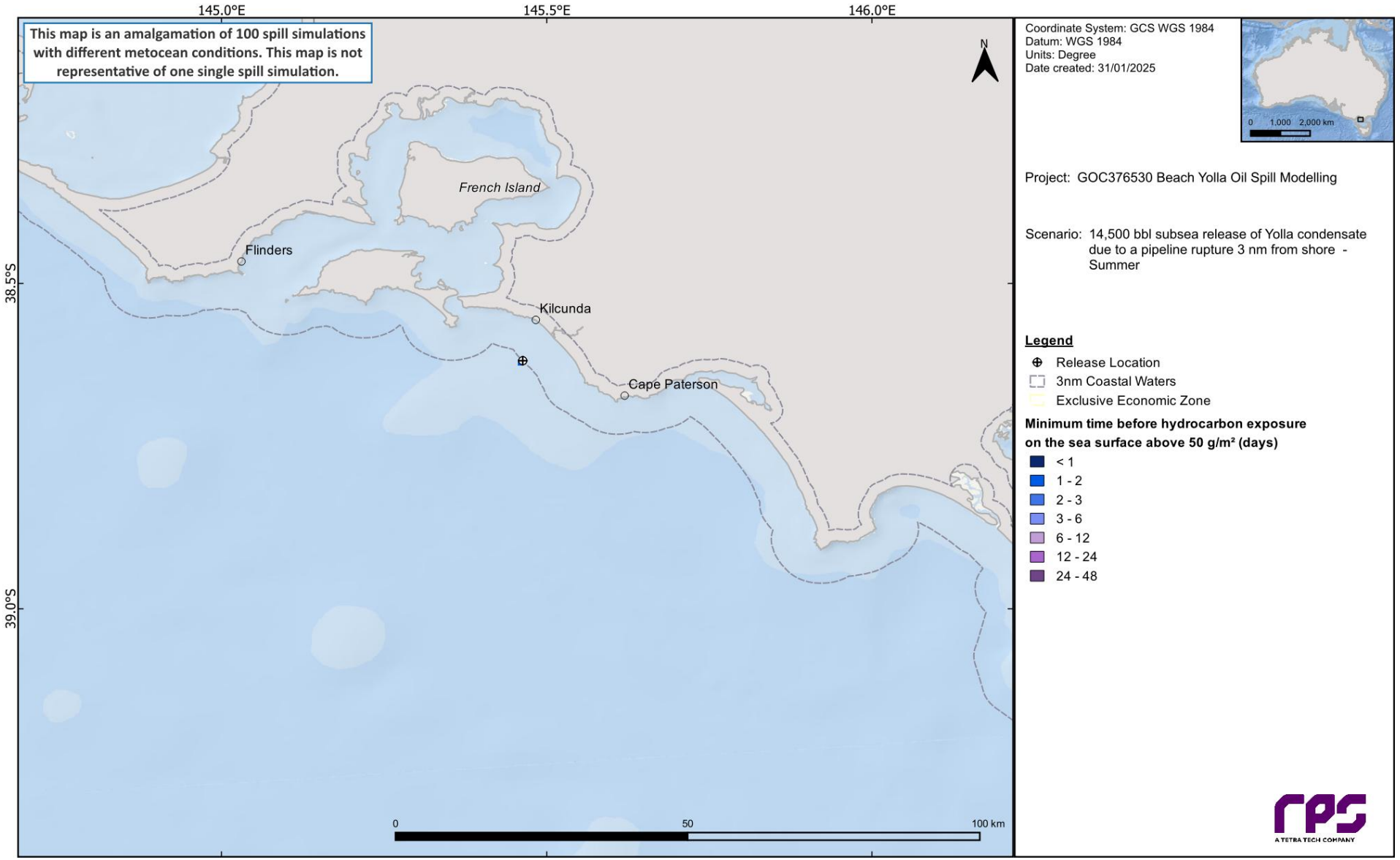


Figure 14-15 Minimum time before floating oil exposure above 50 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

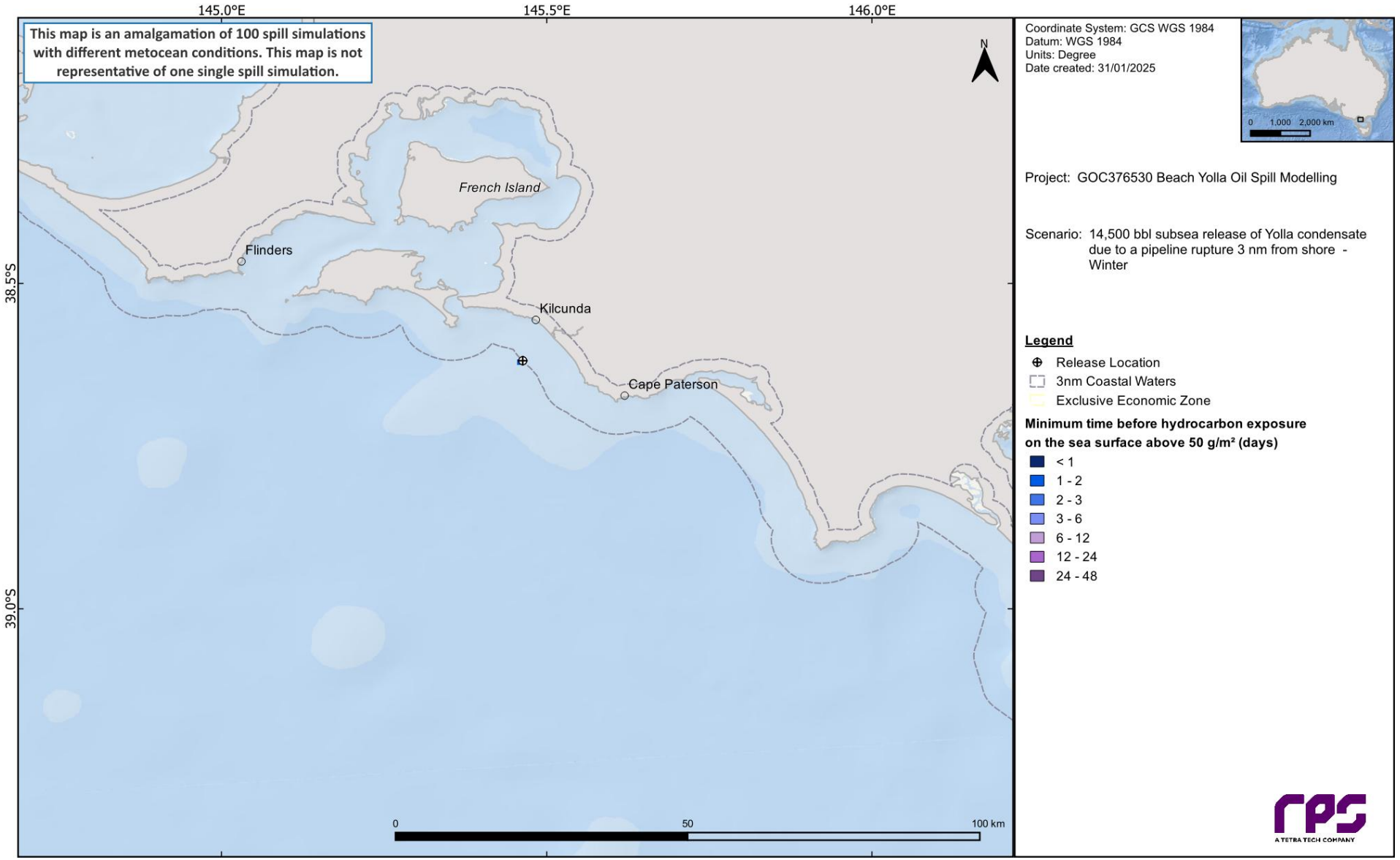


Figure 14-16 Minimum time before floating oil exposure above 50 g/m^2, in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

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	-

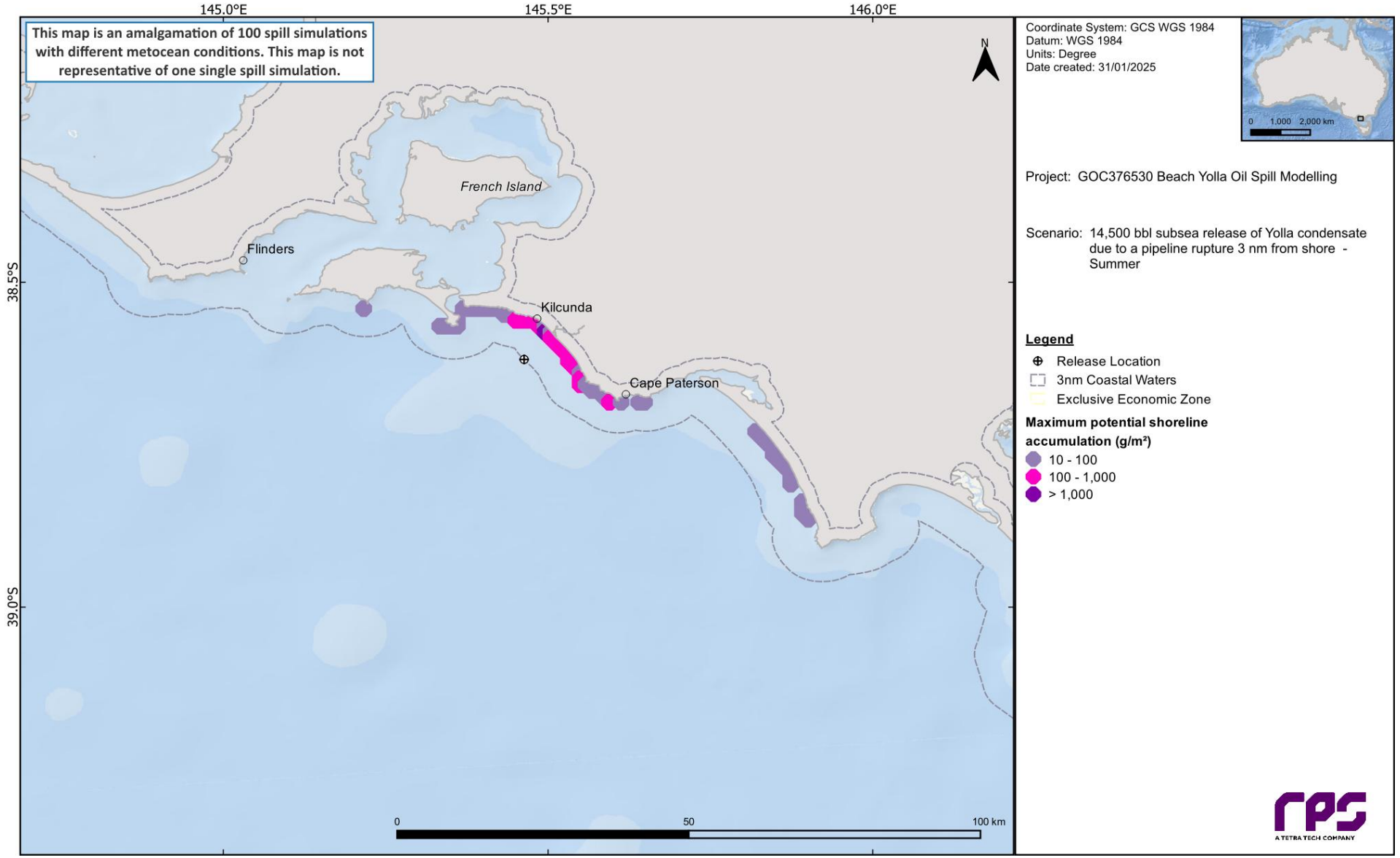


Figure 14-17 Maximum potential shoreline loading in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

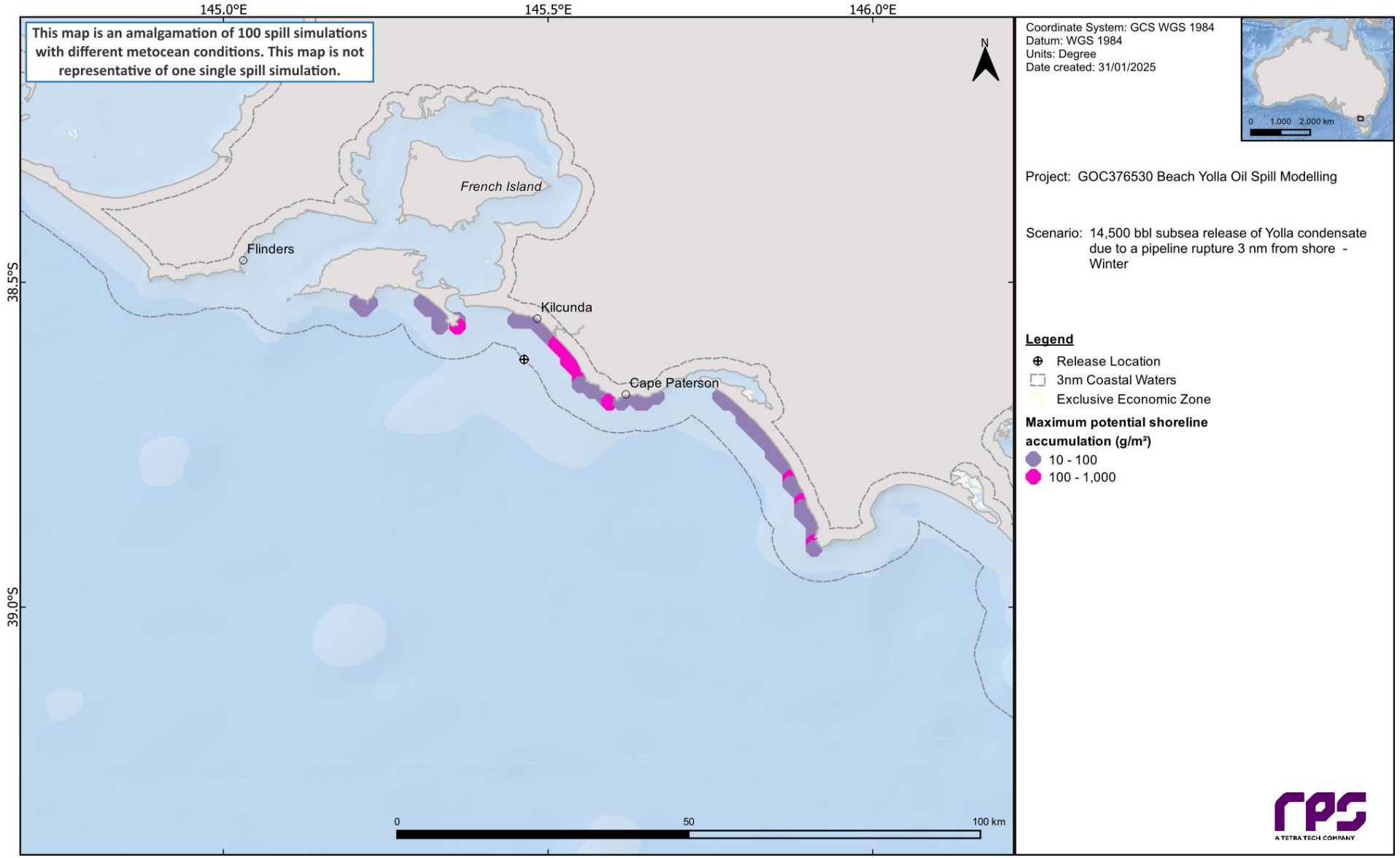


Figure 14-18 Maximum potential shoreline loading in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

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.

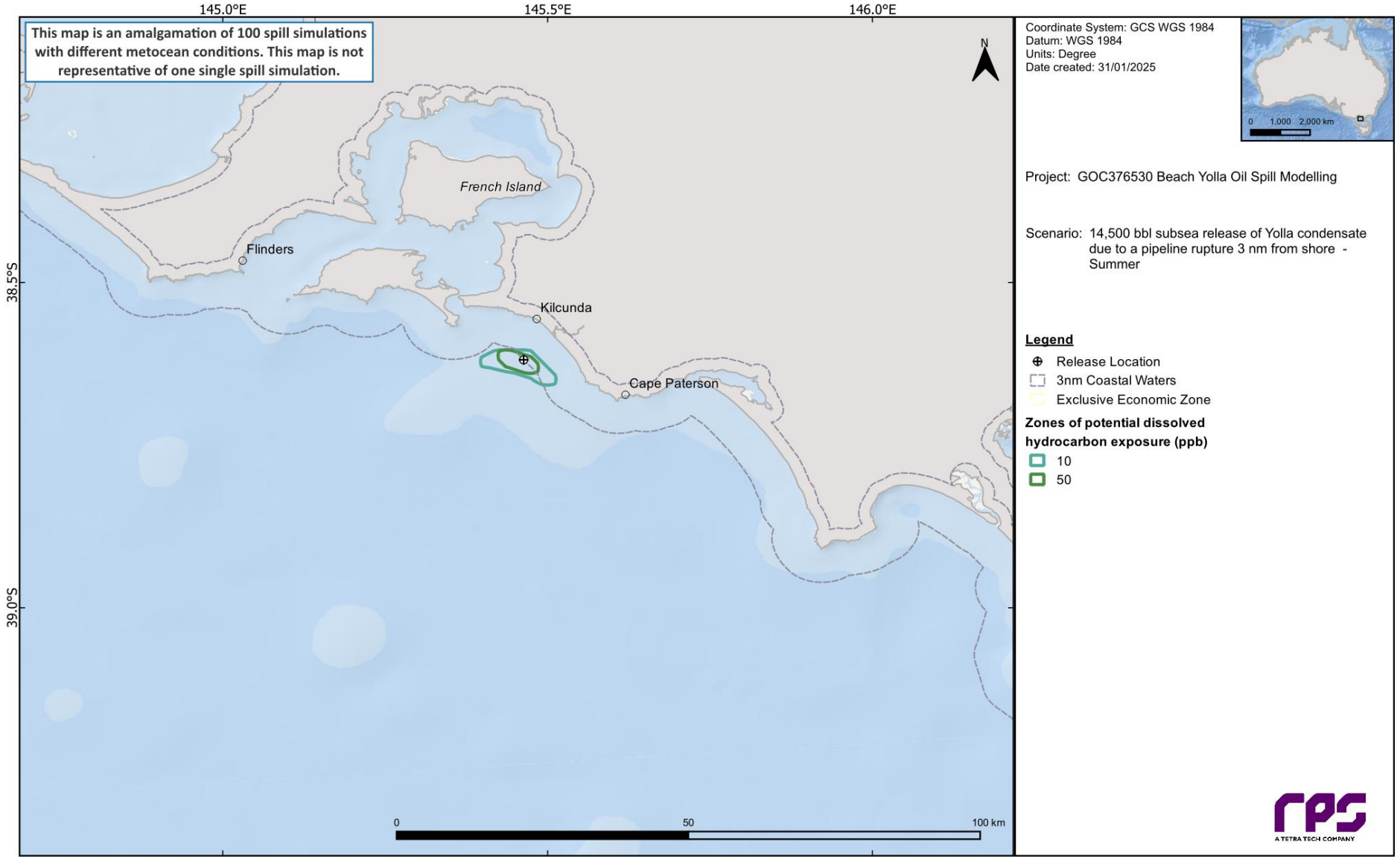


Figure 14-19 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

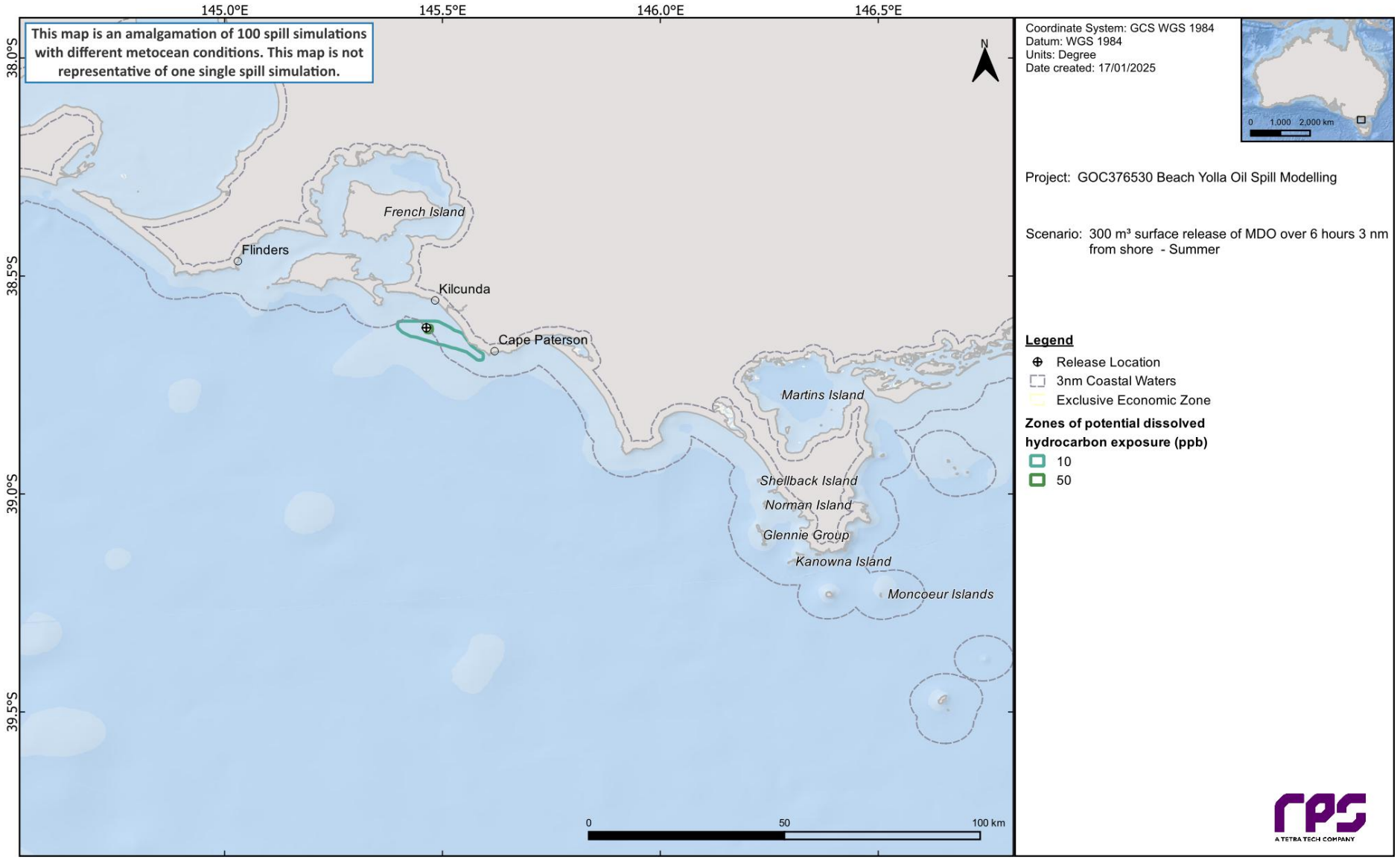


Figure 14-20 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

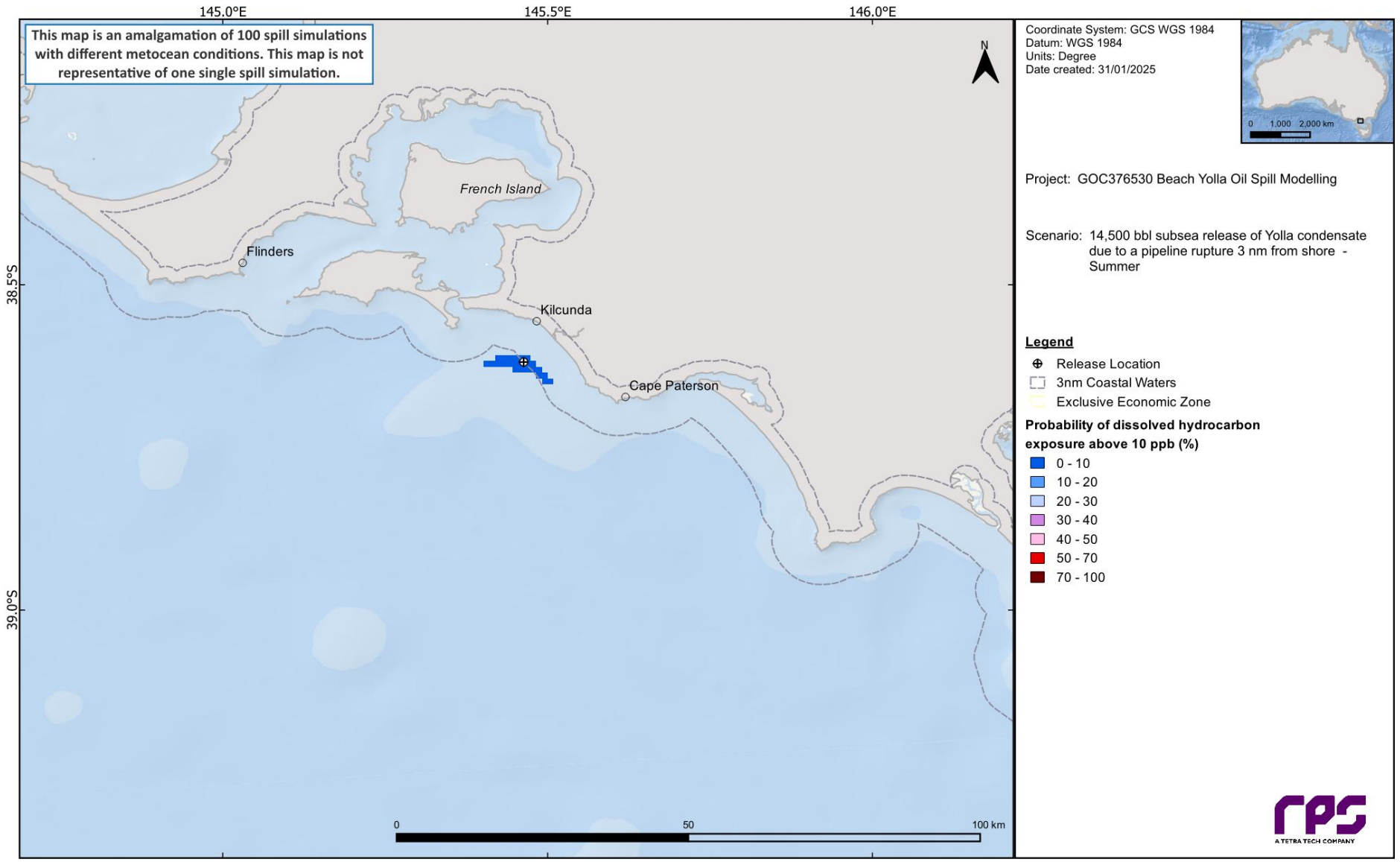


Figure 14-21 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

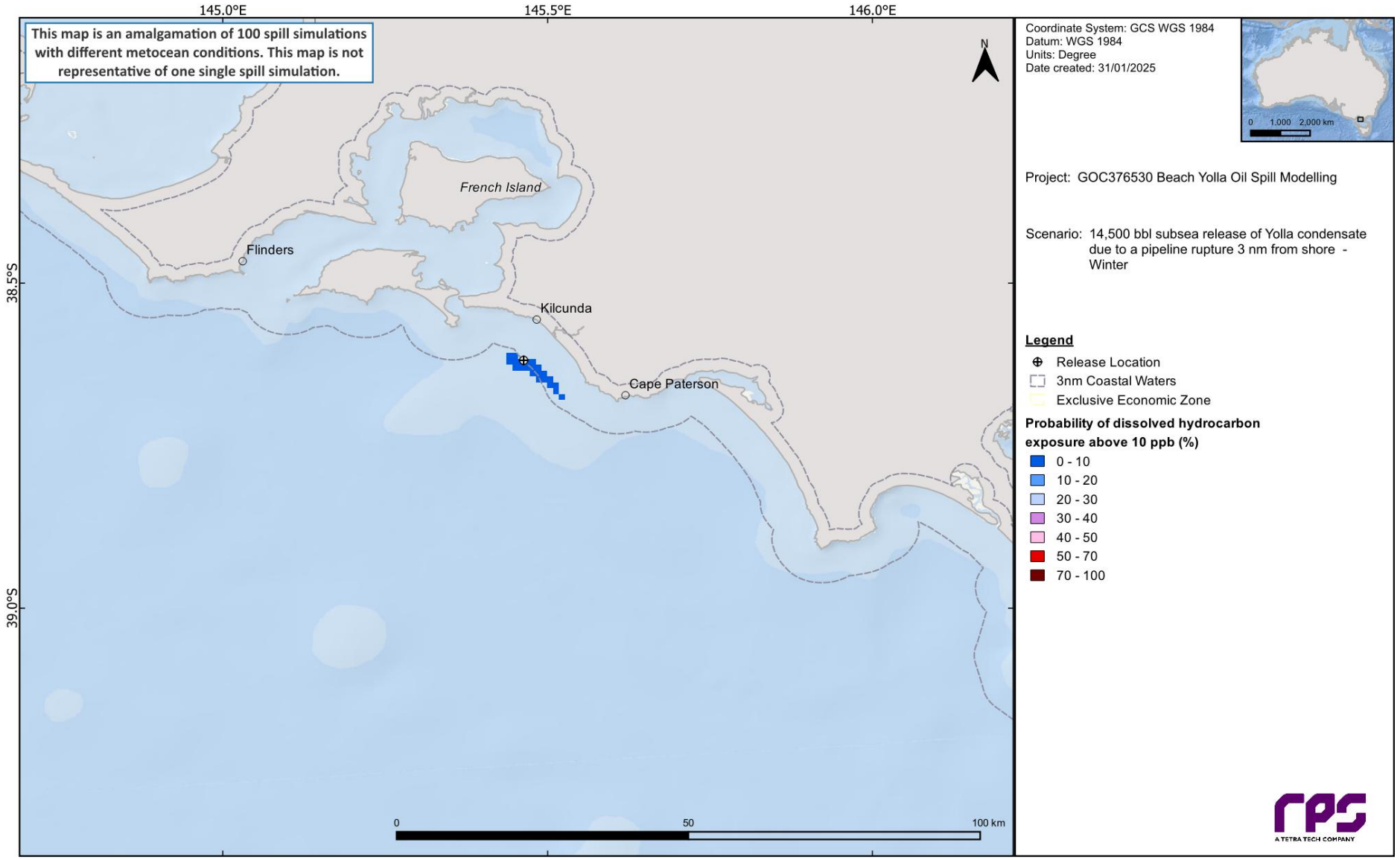


Figure 14-22 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

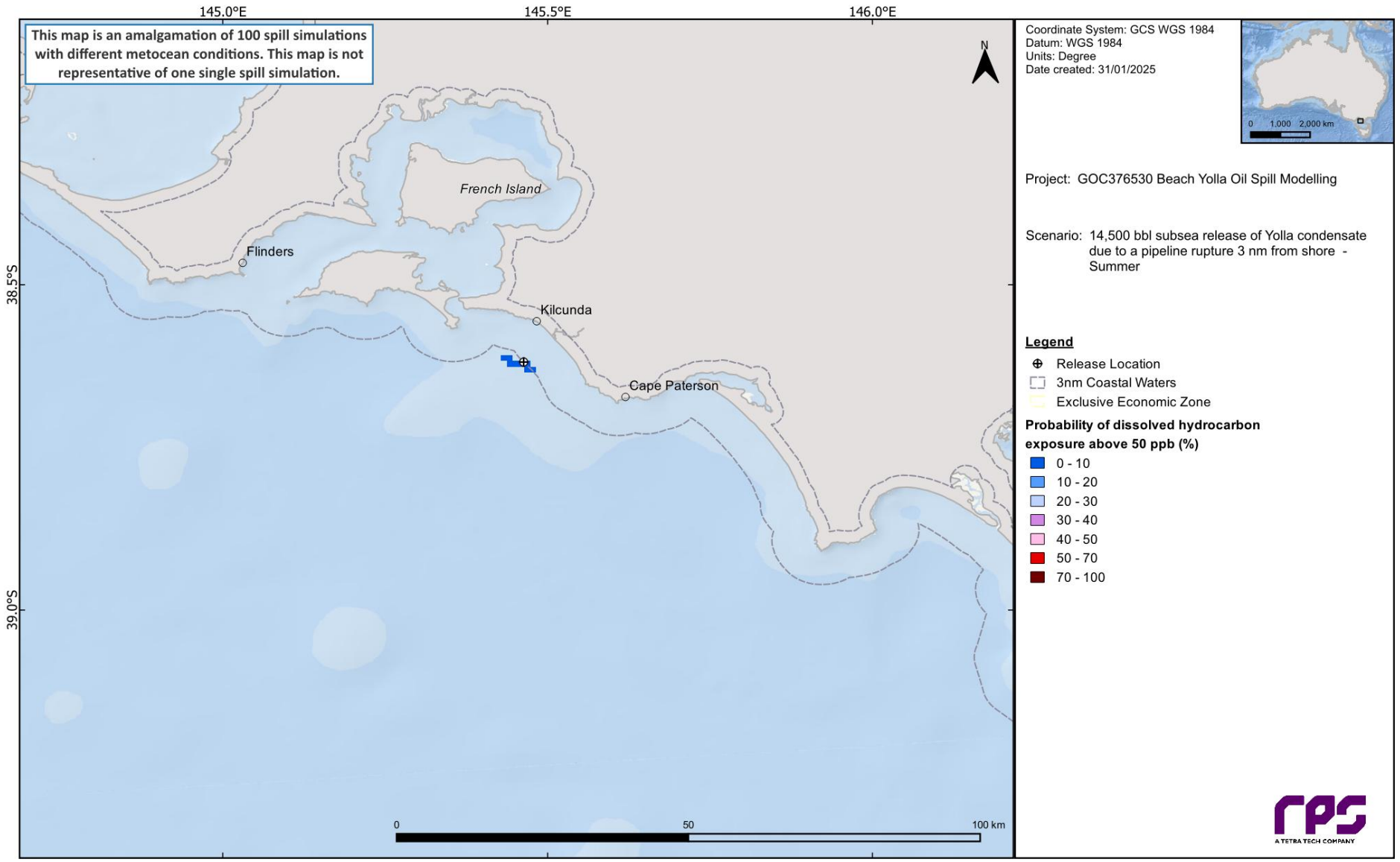


Figure 14-23 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

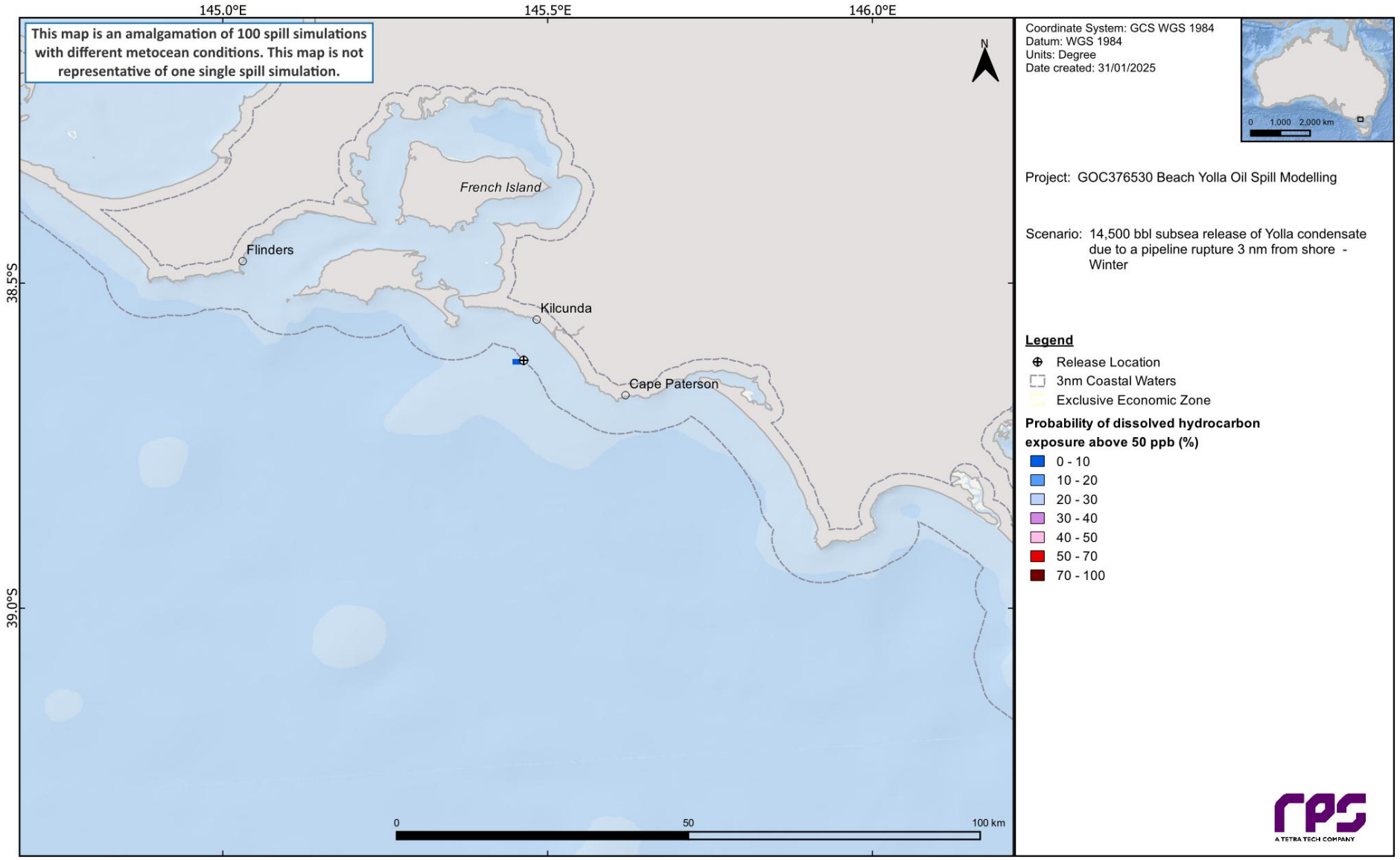


Figure 14-24 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

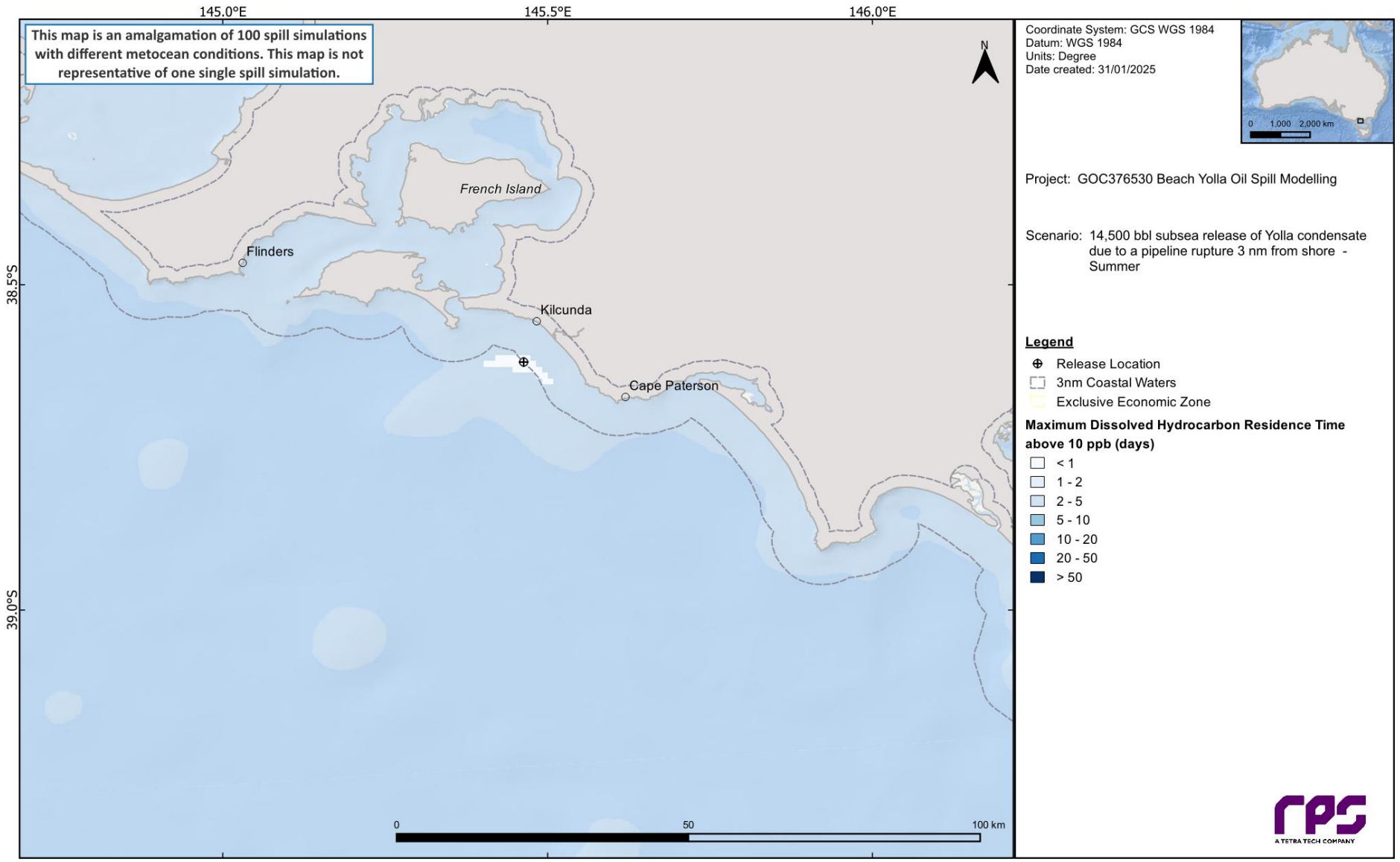


Figure 14-25 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

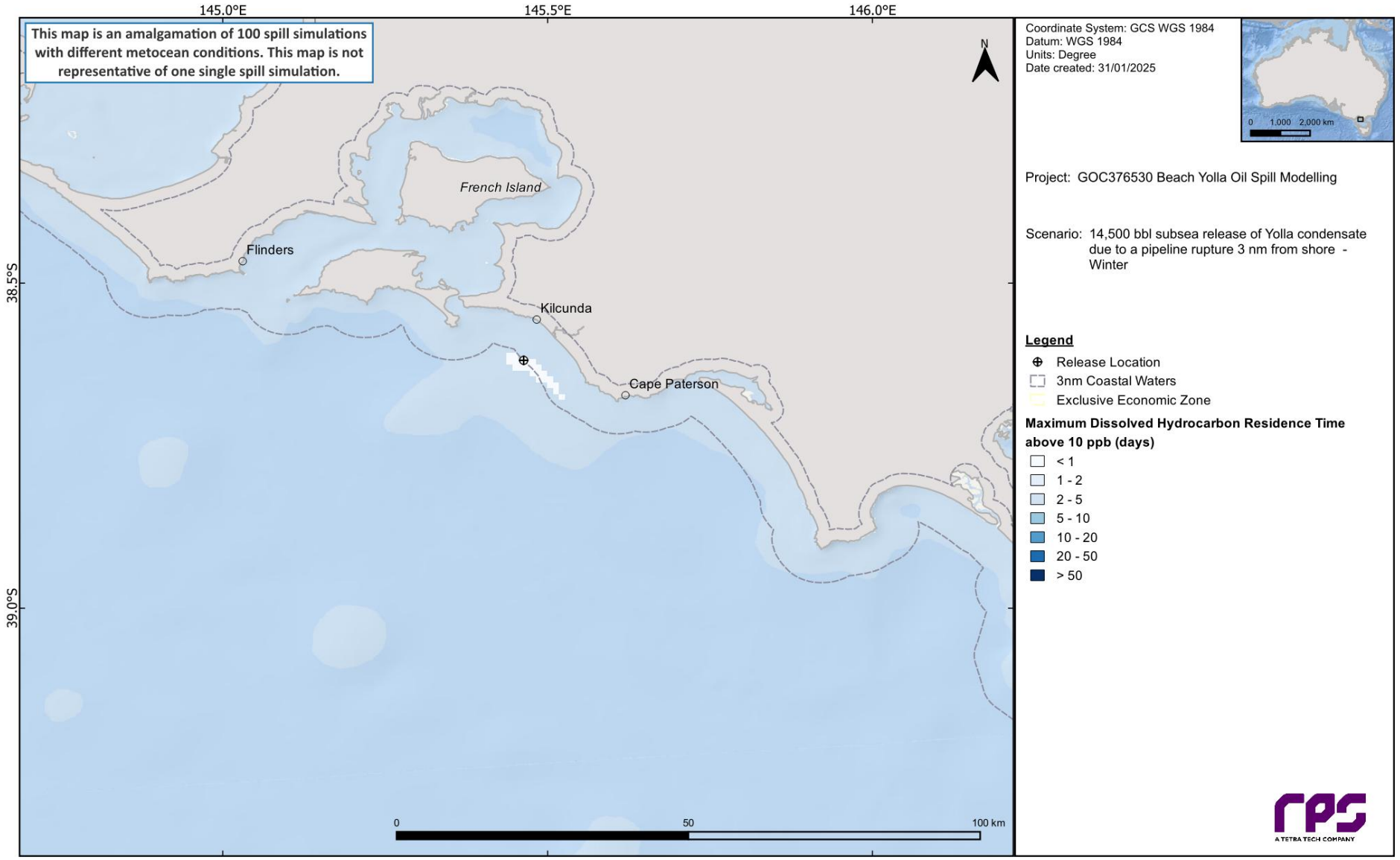


Figure 14-26 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

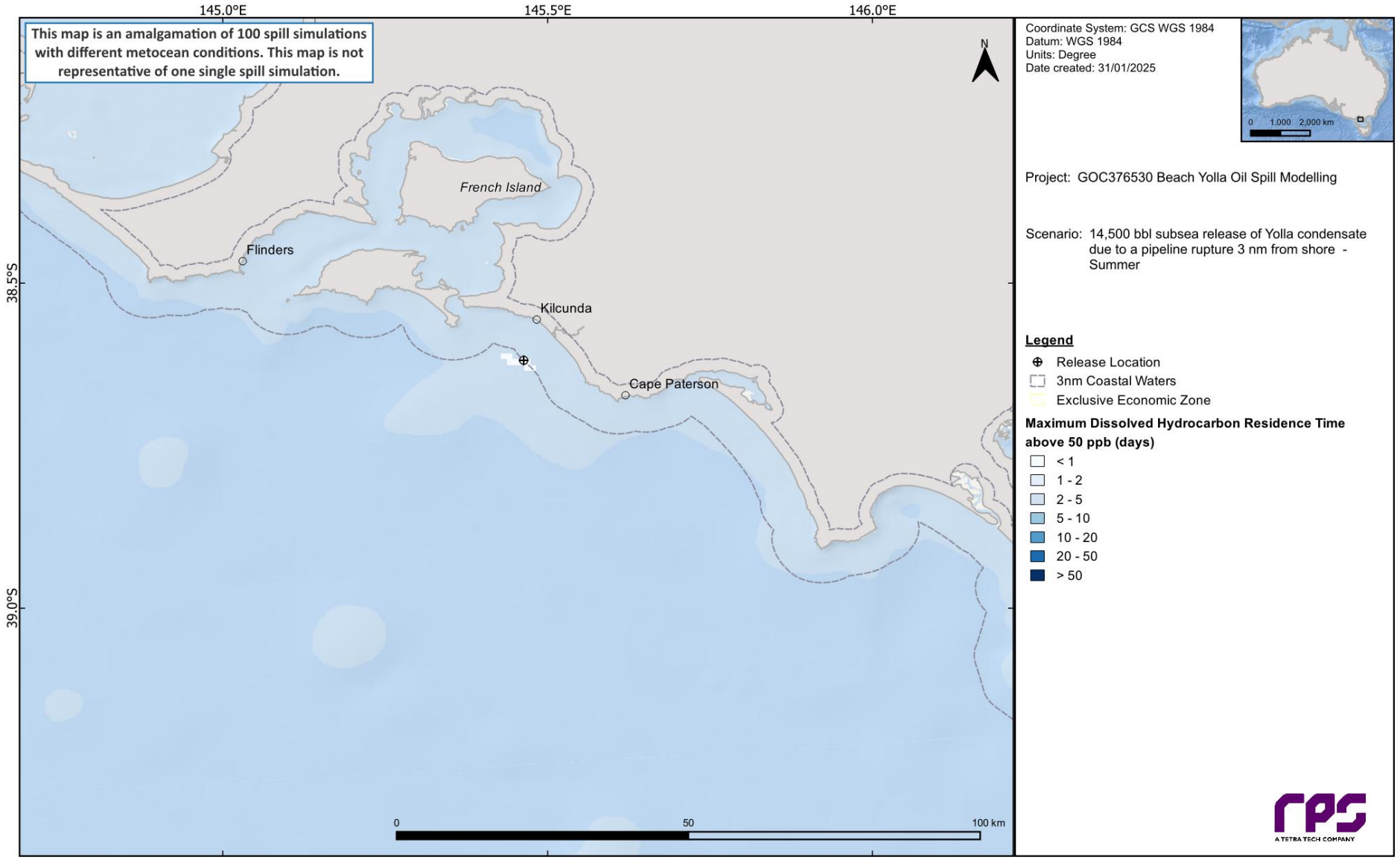


Figure 14-27 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

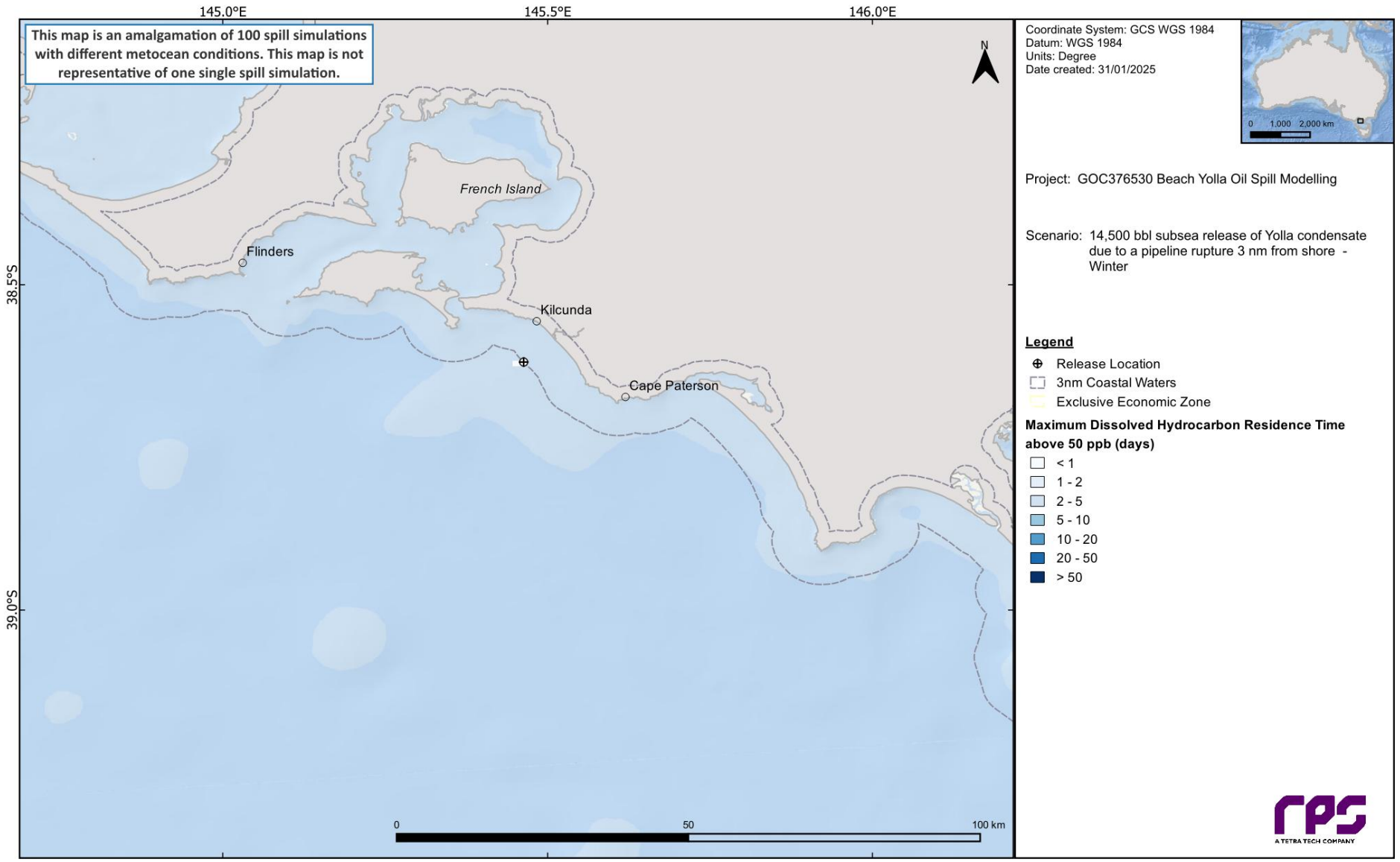


Figure 14-28 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

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.

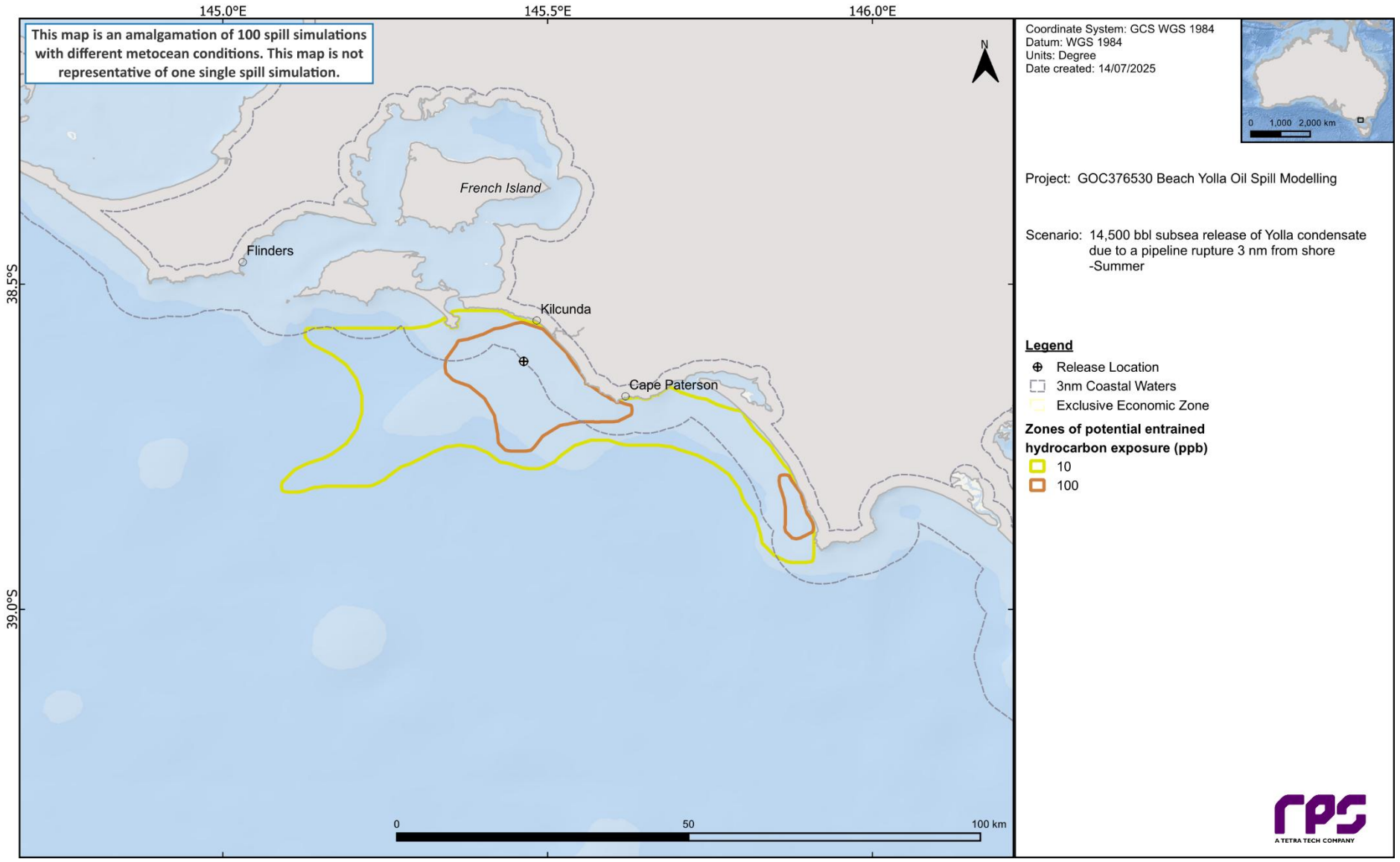


Figure 14-29 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions.

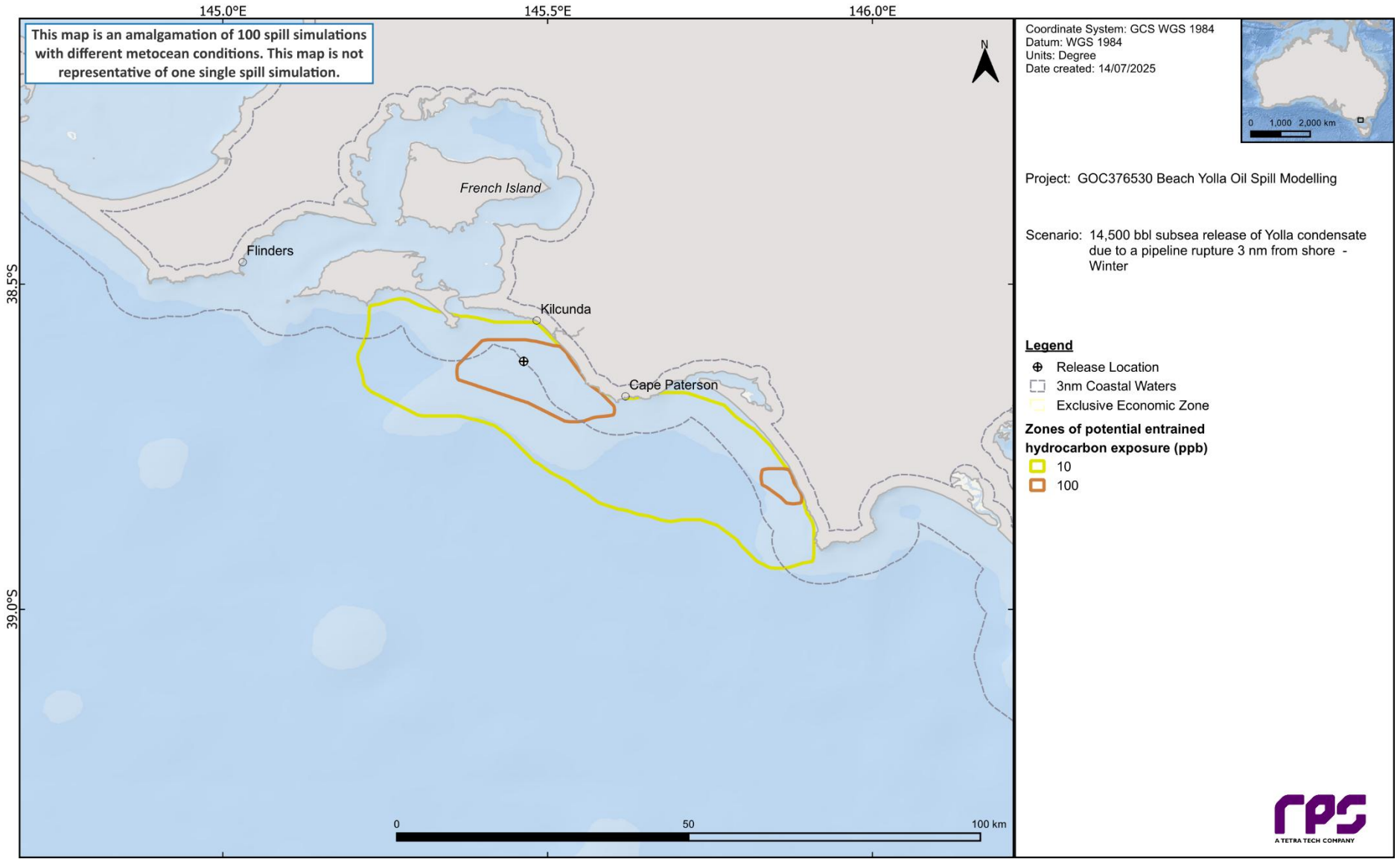


Figure 14-30 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

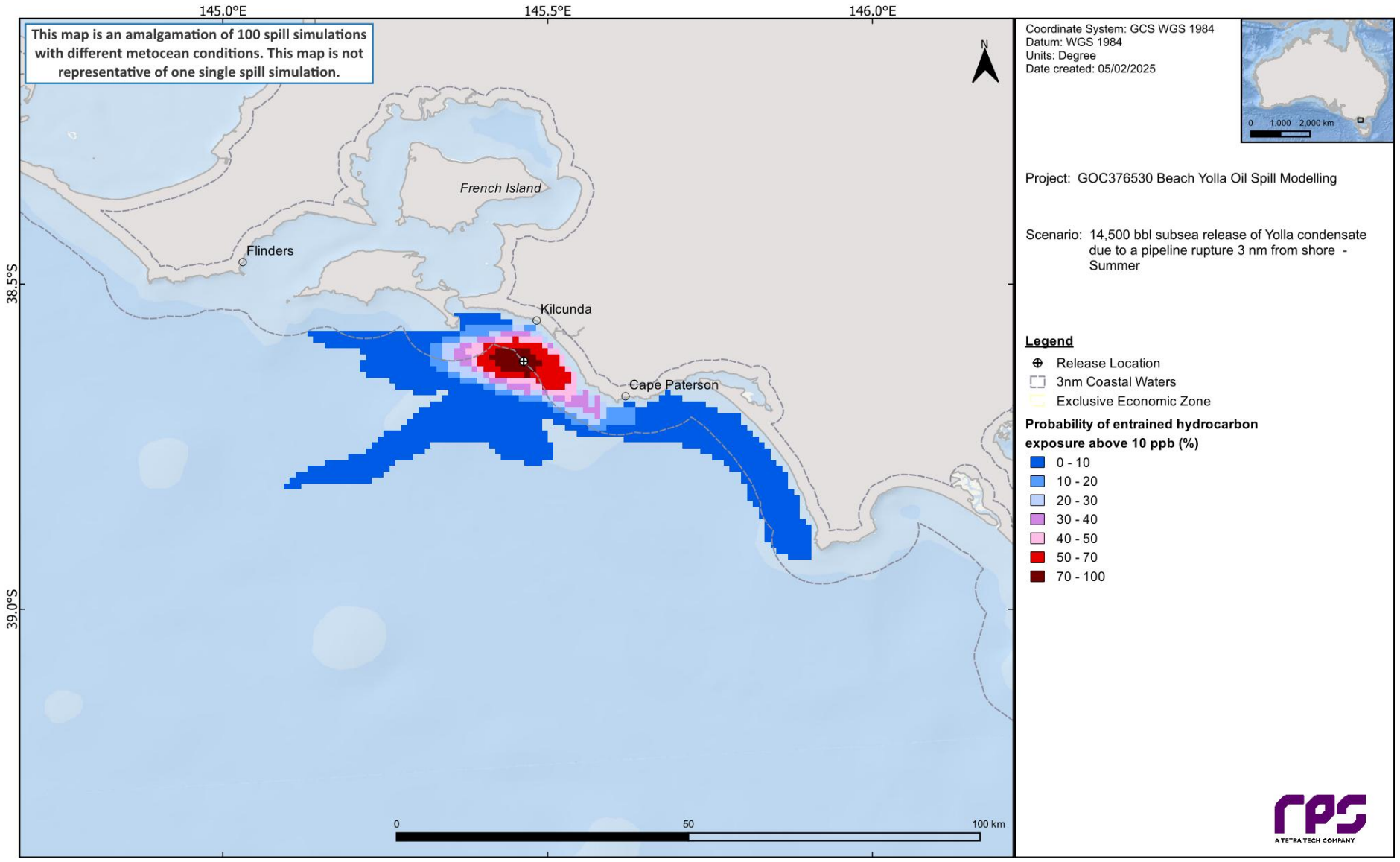


Figure 14-31 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during summer conditions.

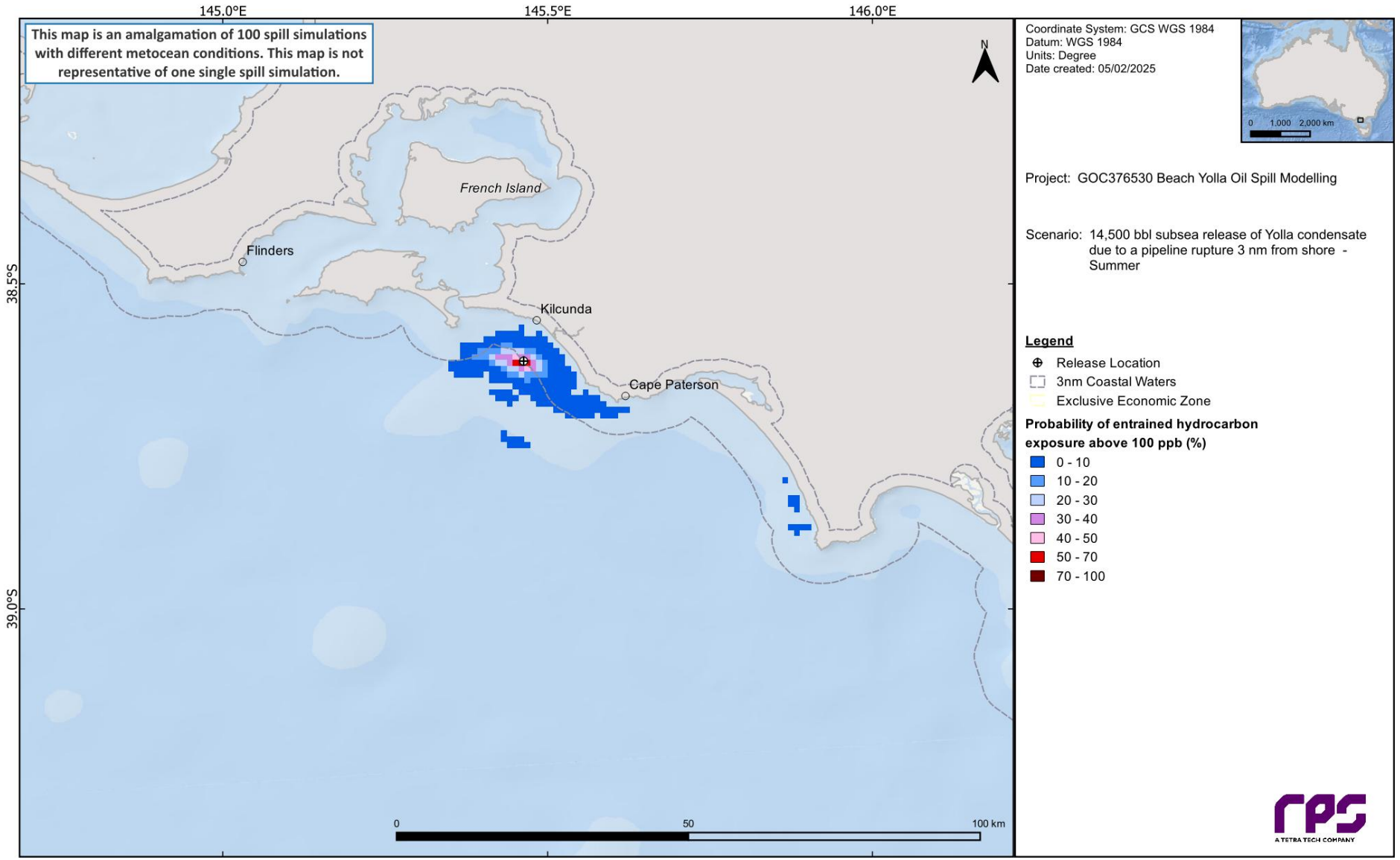


Figure 14-32 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions.

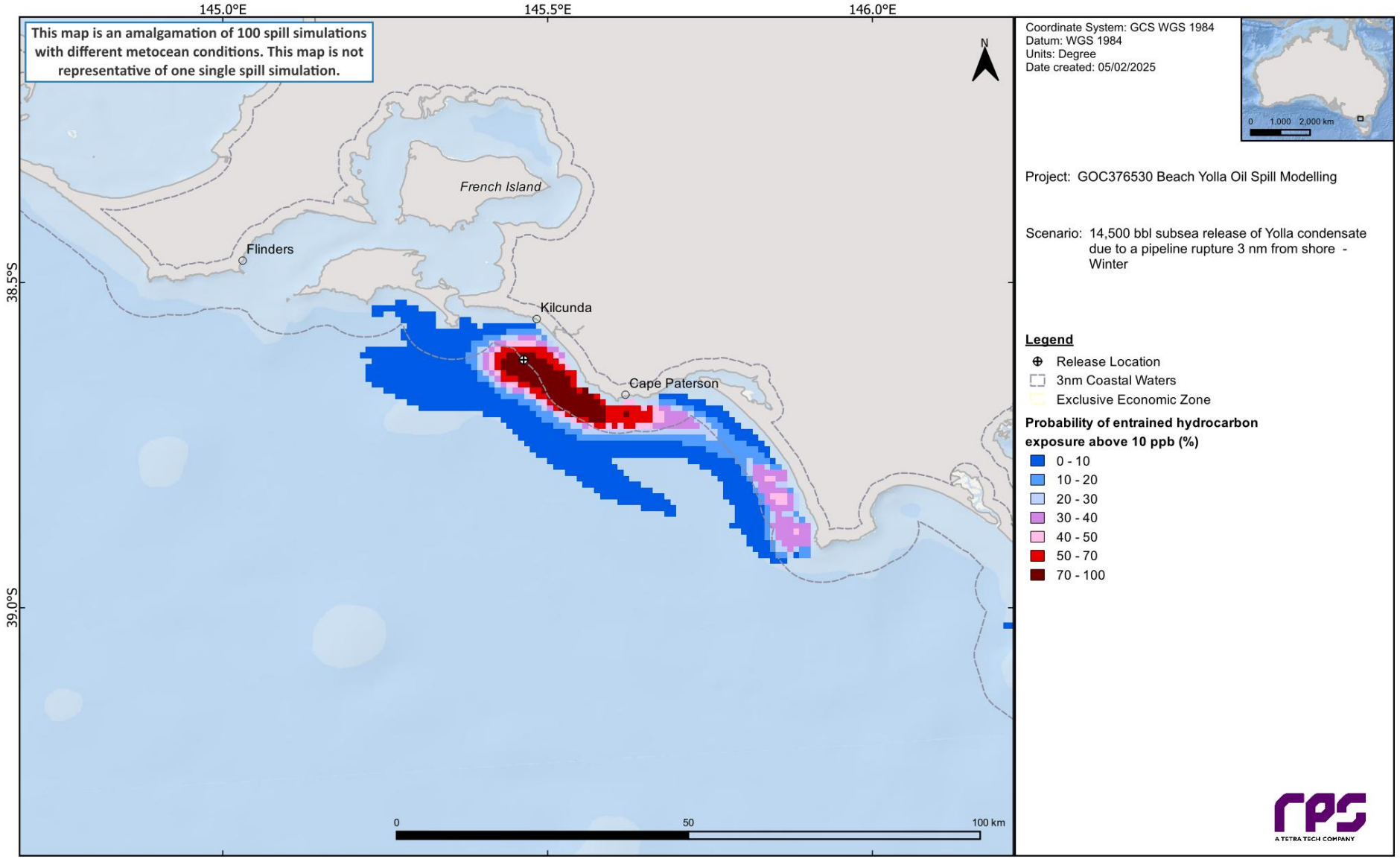


Figure 14-33 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3nm from shore. The results were calculated from 100 spill simulations during winter conditions.

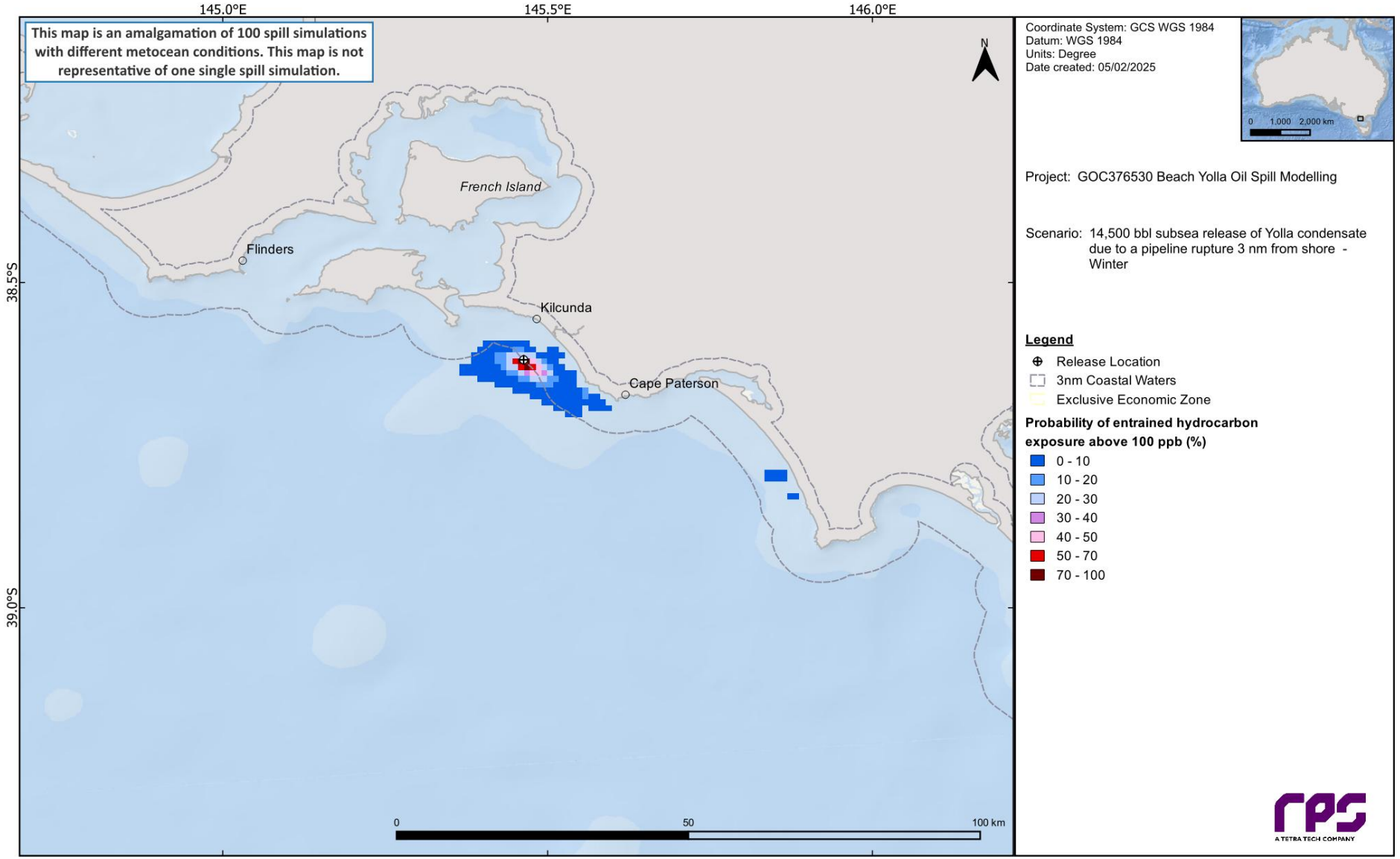


Figure 14-34 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter conditions.

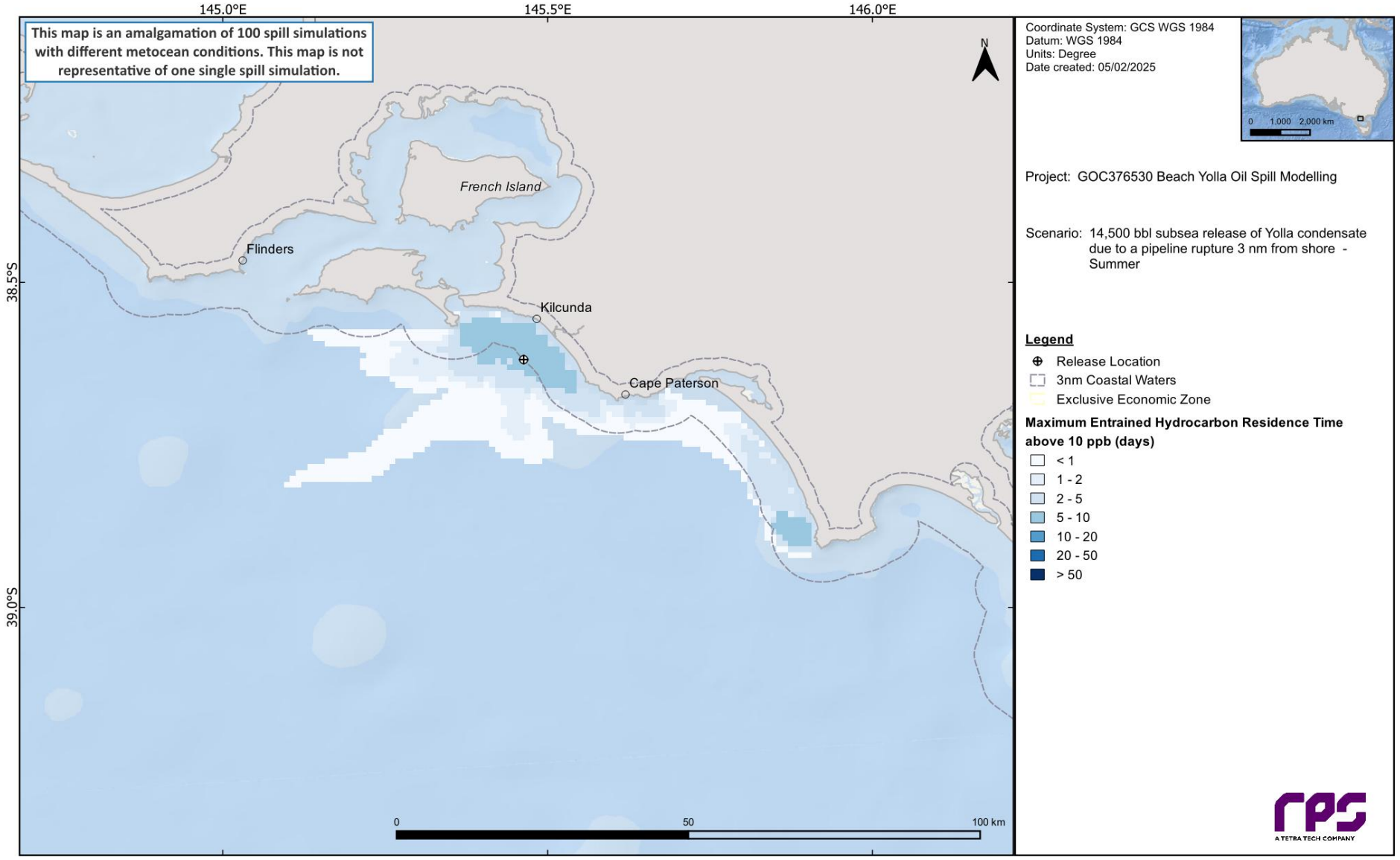


Figure 14-35 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions.

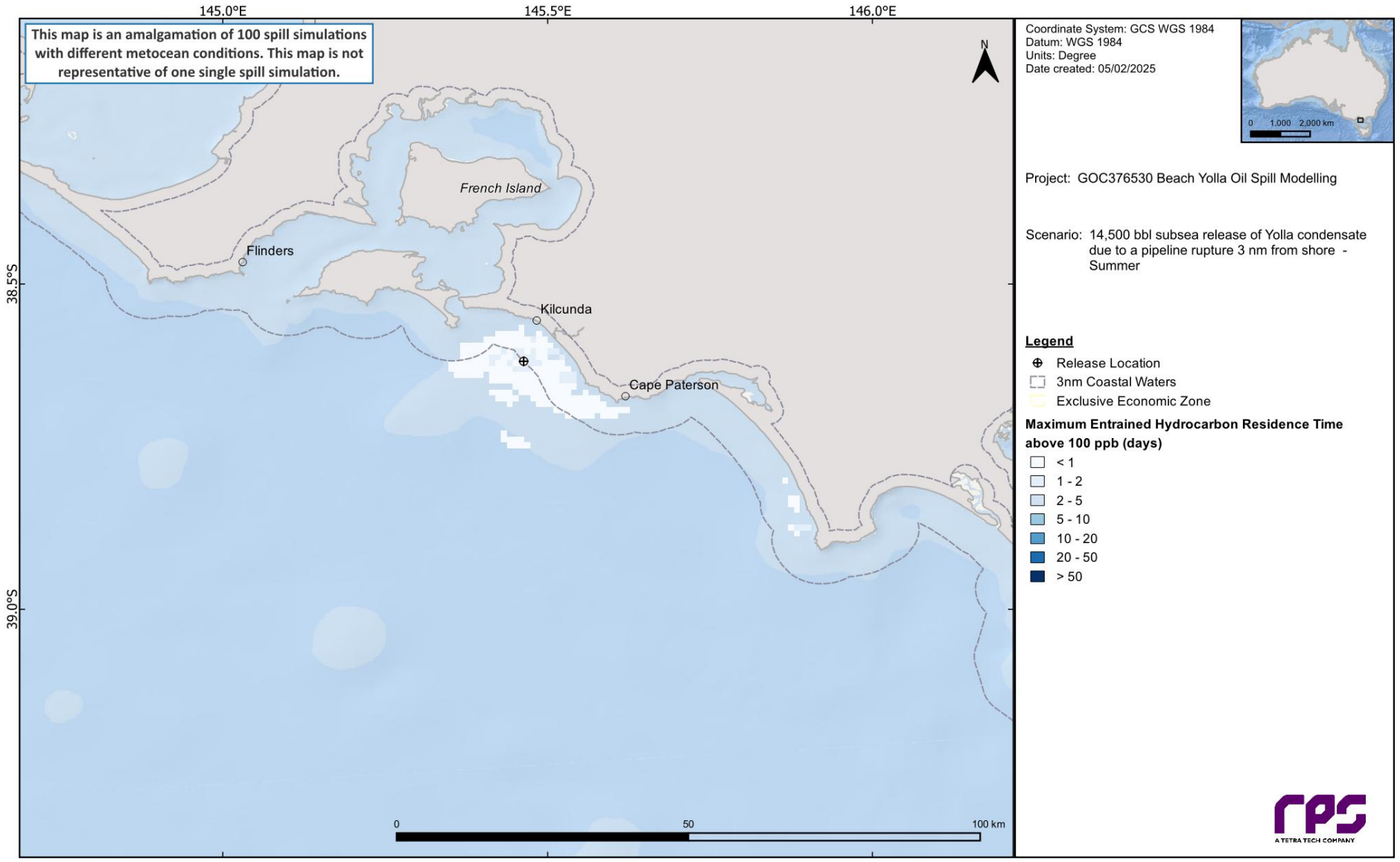


Figure 14-36 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during summer conditions.

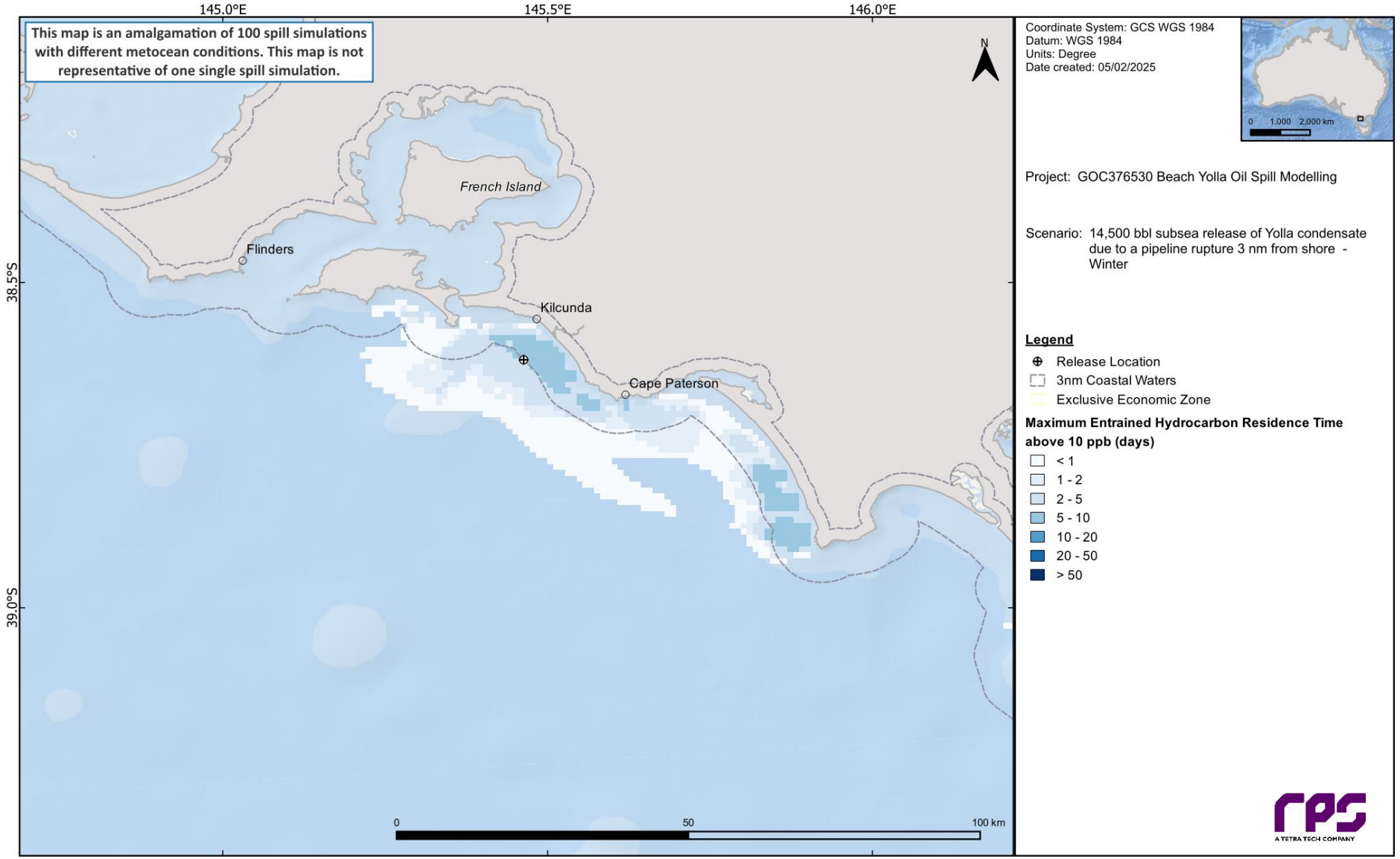


Figure 14-37 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter conditions.

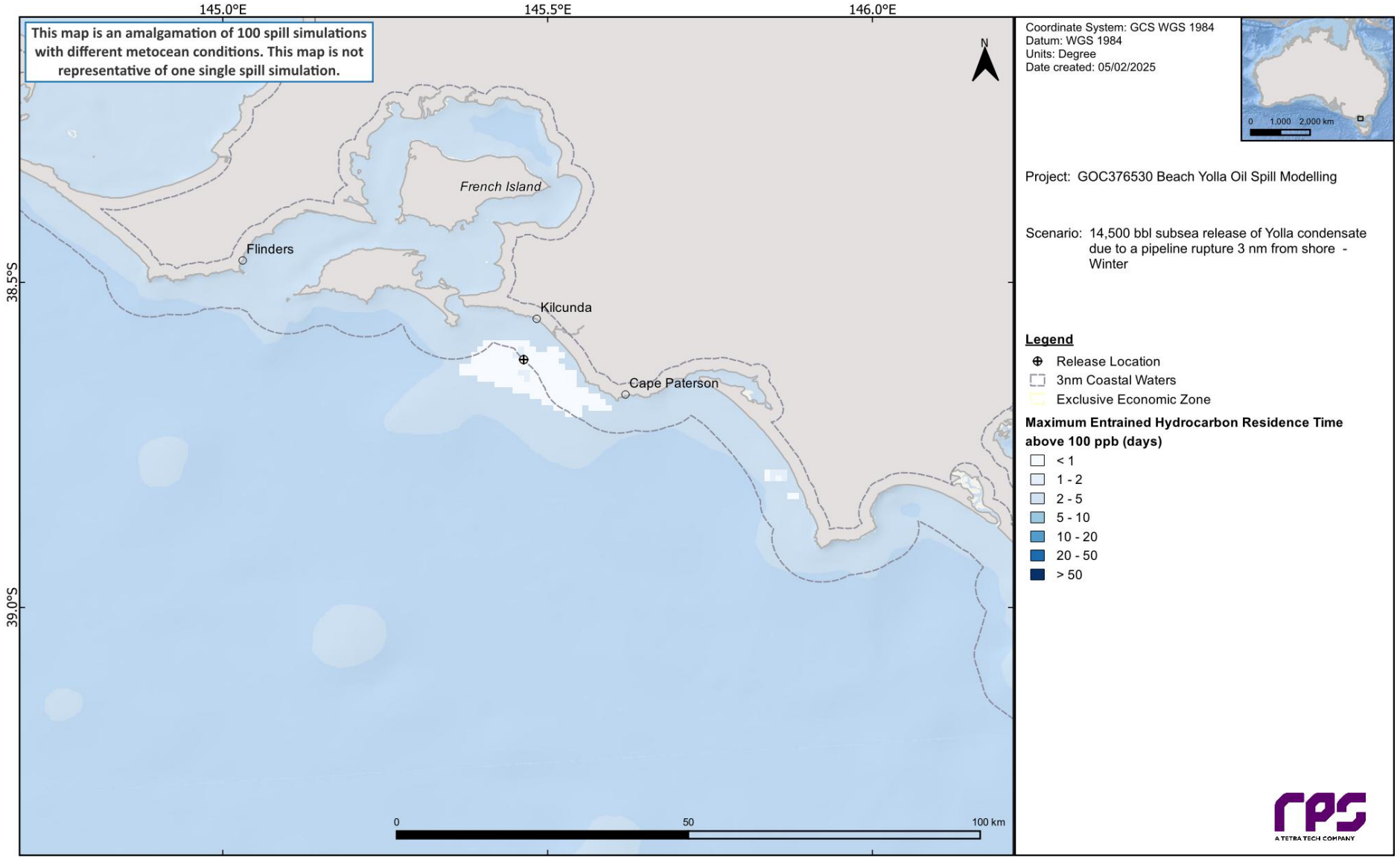


Figure 14-38 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 14,500 bbl subsea release of condensate over 36 minutes from a pipeline rupture 3 nm from shore. The results were calculated from 100 spill simulations during winter 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.

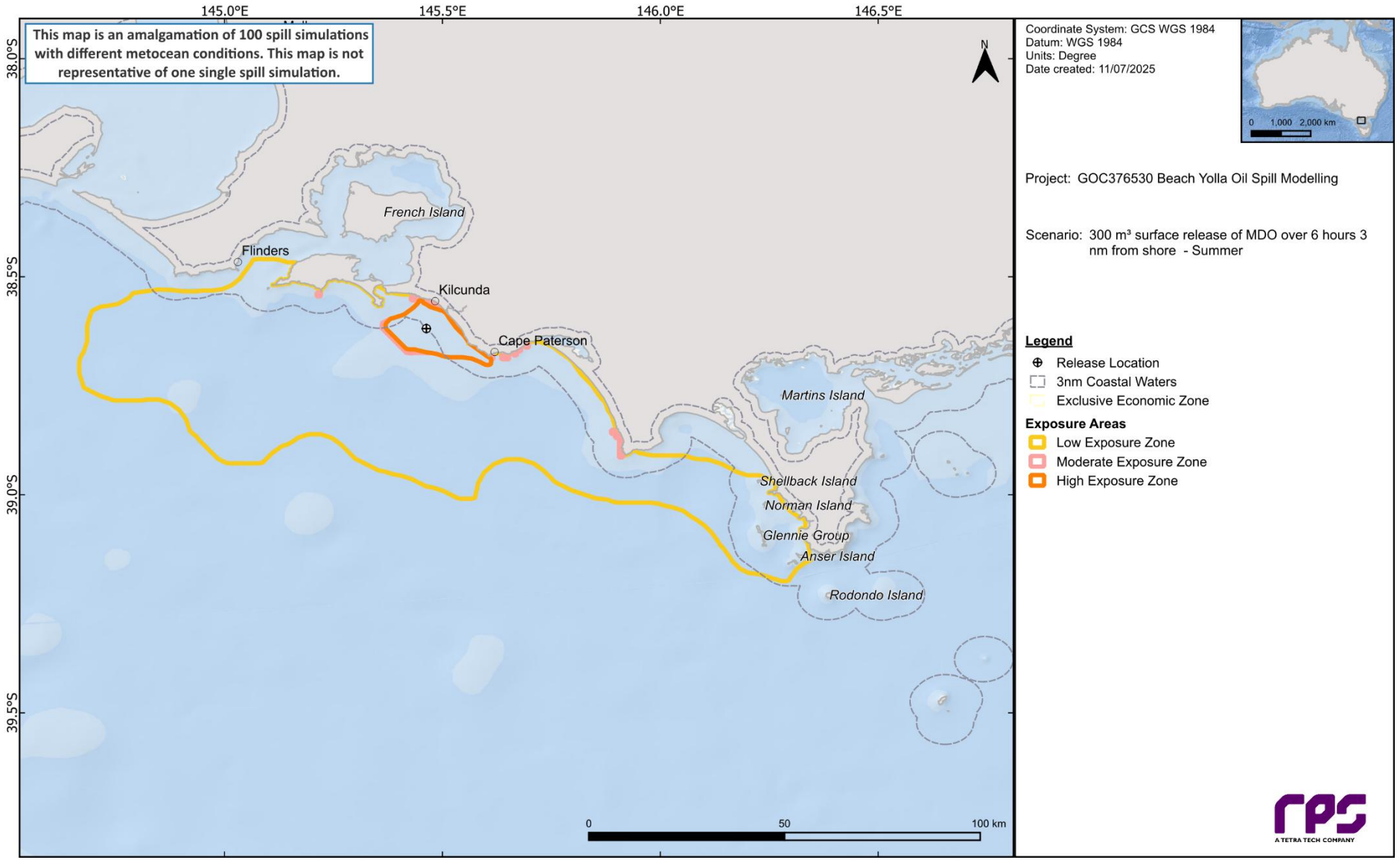


Figure 15-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore during summer conditions.

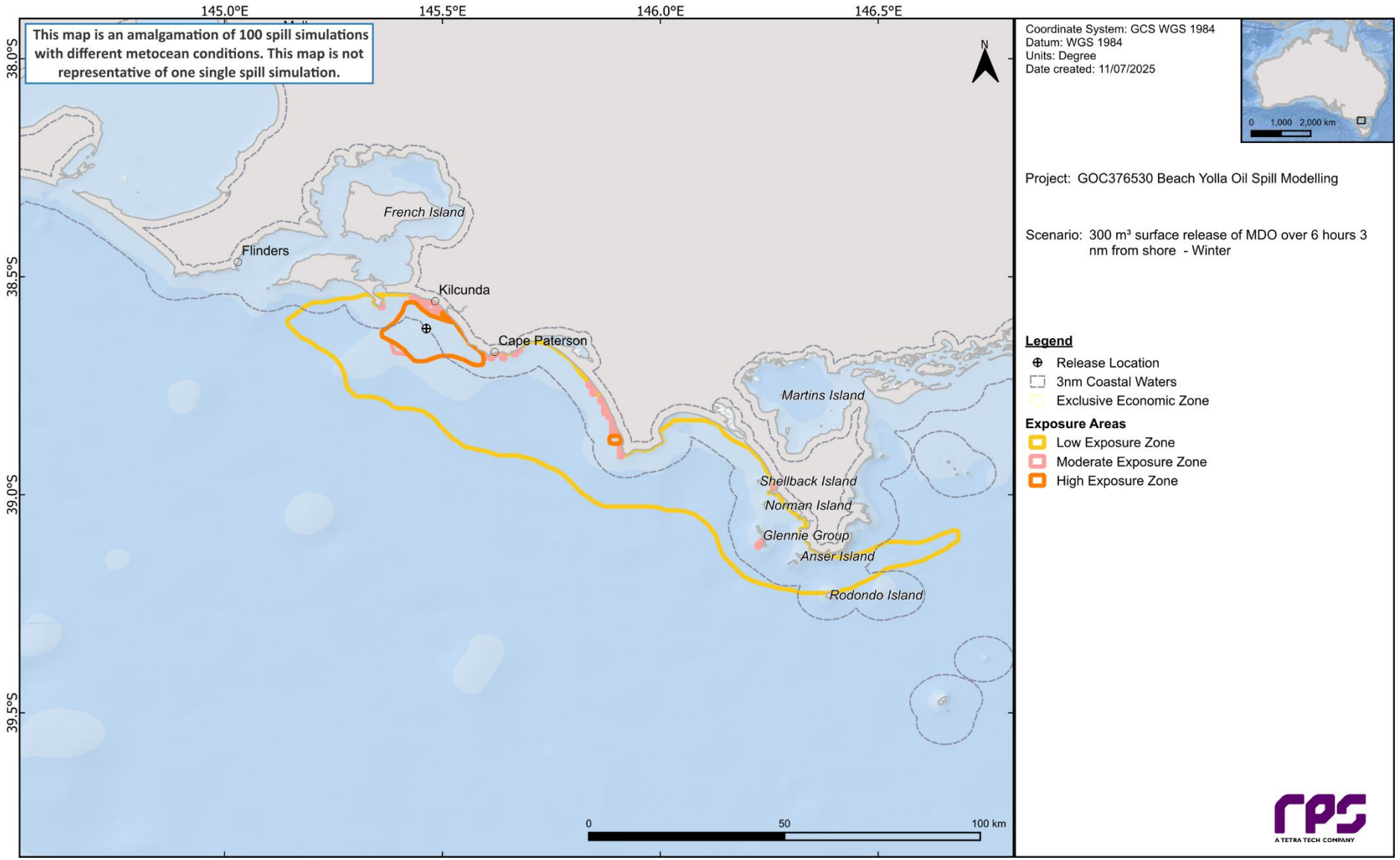


Figure 15-2 Predicted area of exposure for low thresholds produced by overlaying the results from all 100 simulations, resulting from a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore during winter conditions.

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.

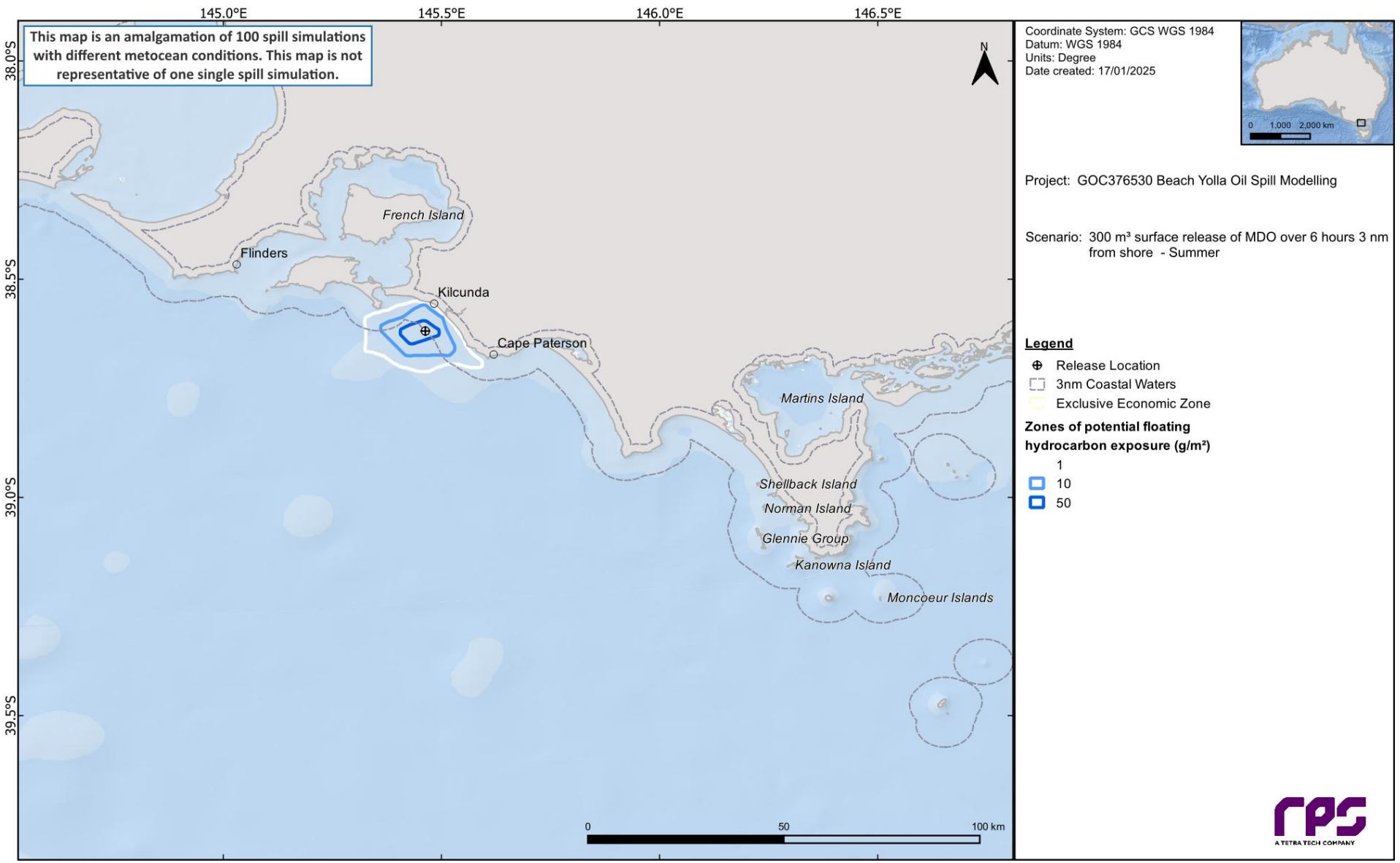


Figure 15-3 Zones of potential floating oil exposure in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

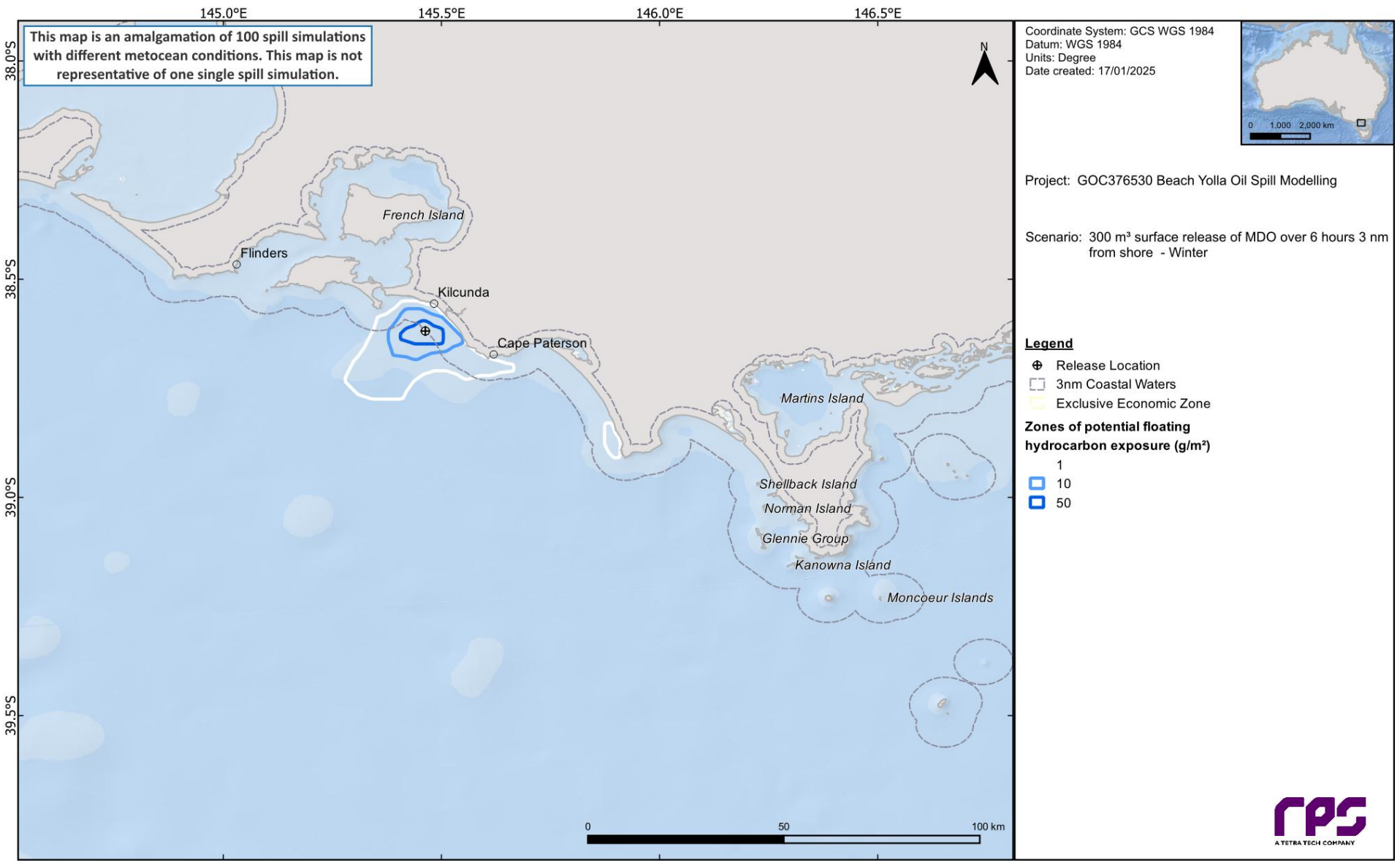


Figure 15-4 Zones of potential floating oil exposure in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

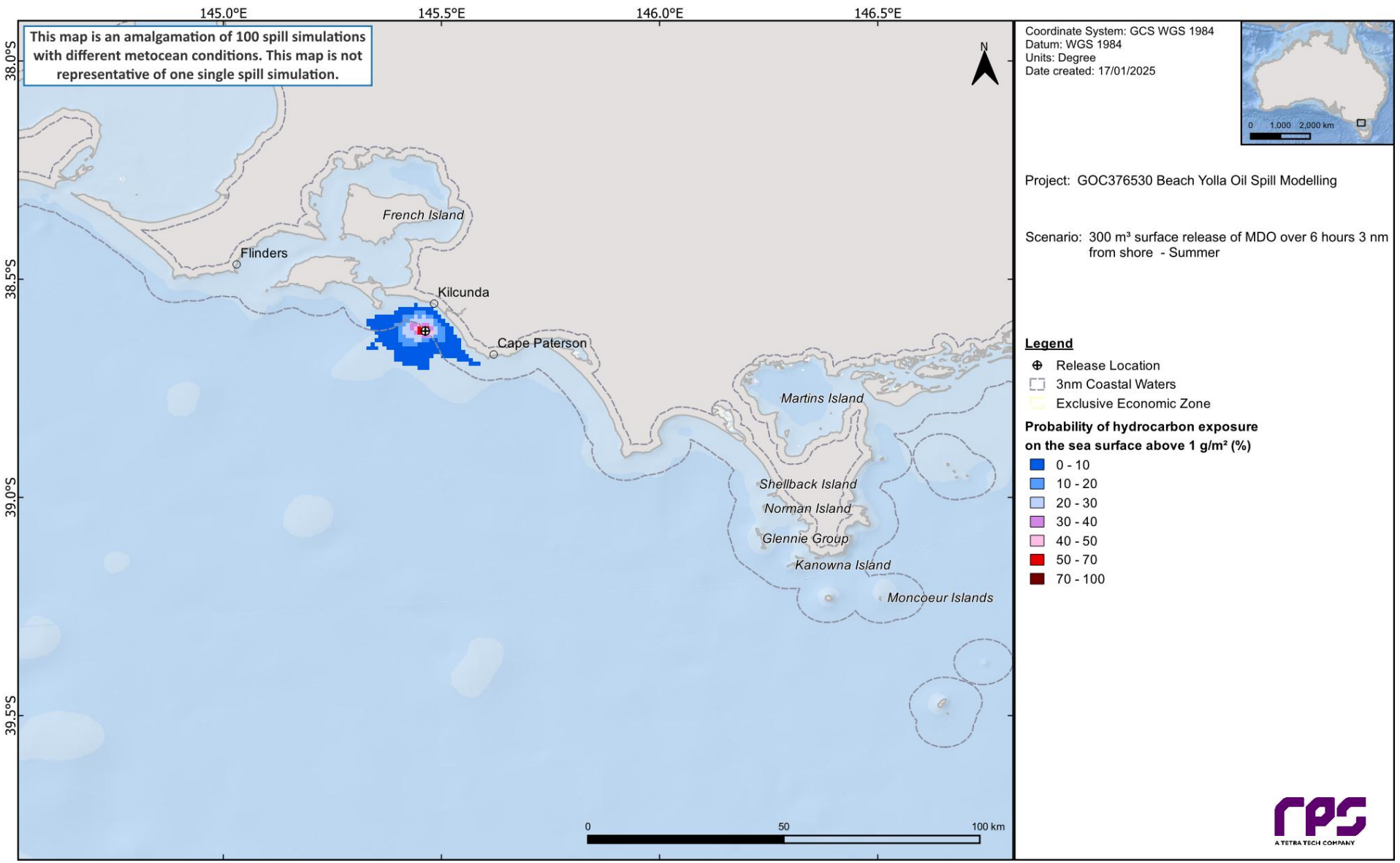


Figure 15-5 Probability of floating oil exposure above 1 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

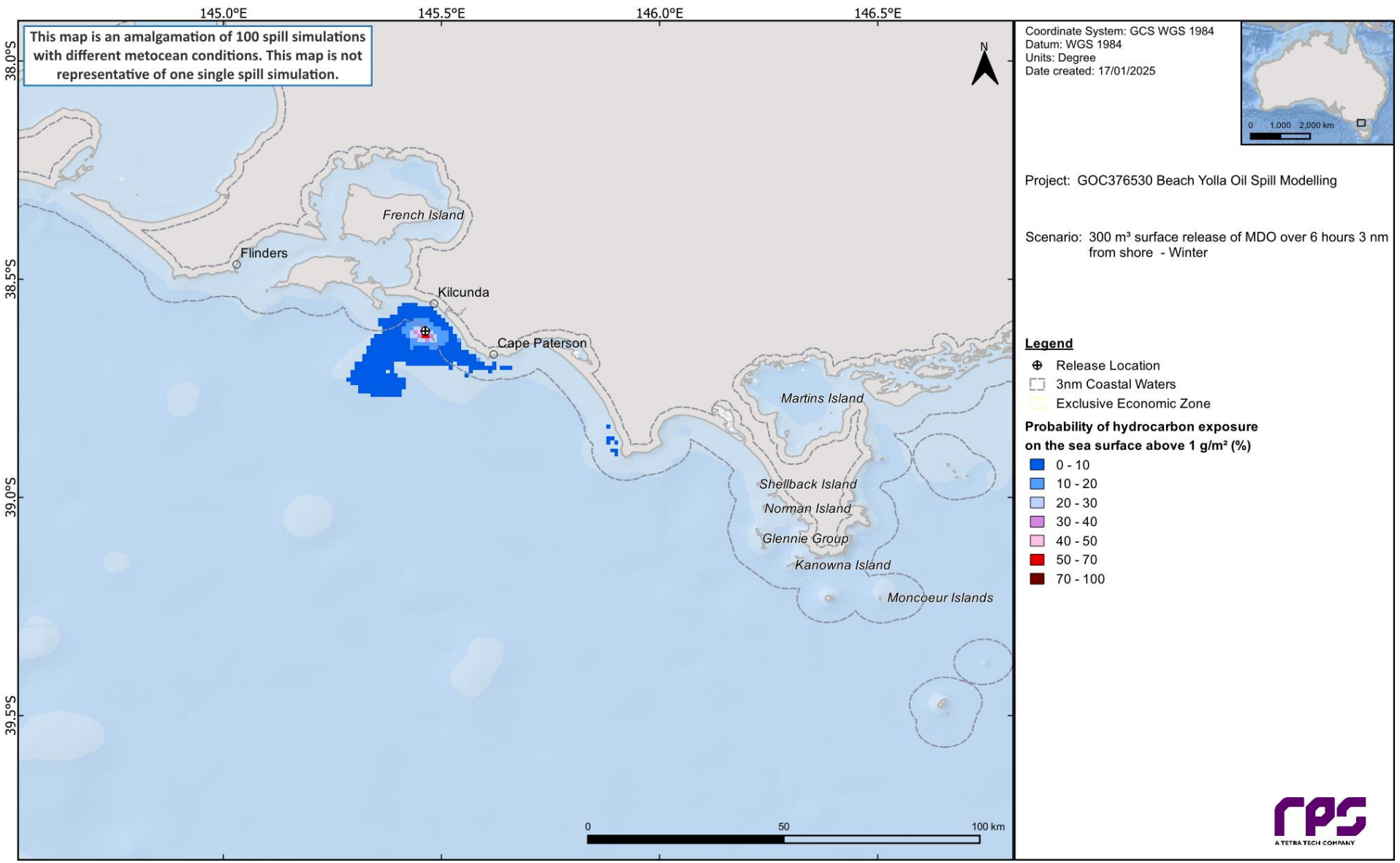


Figure 15-6 Probability of floating oil exposure above 1 g/m², in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

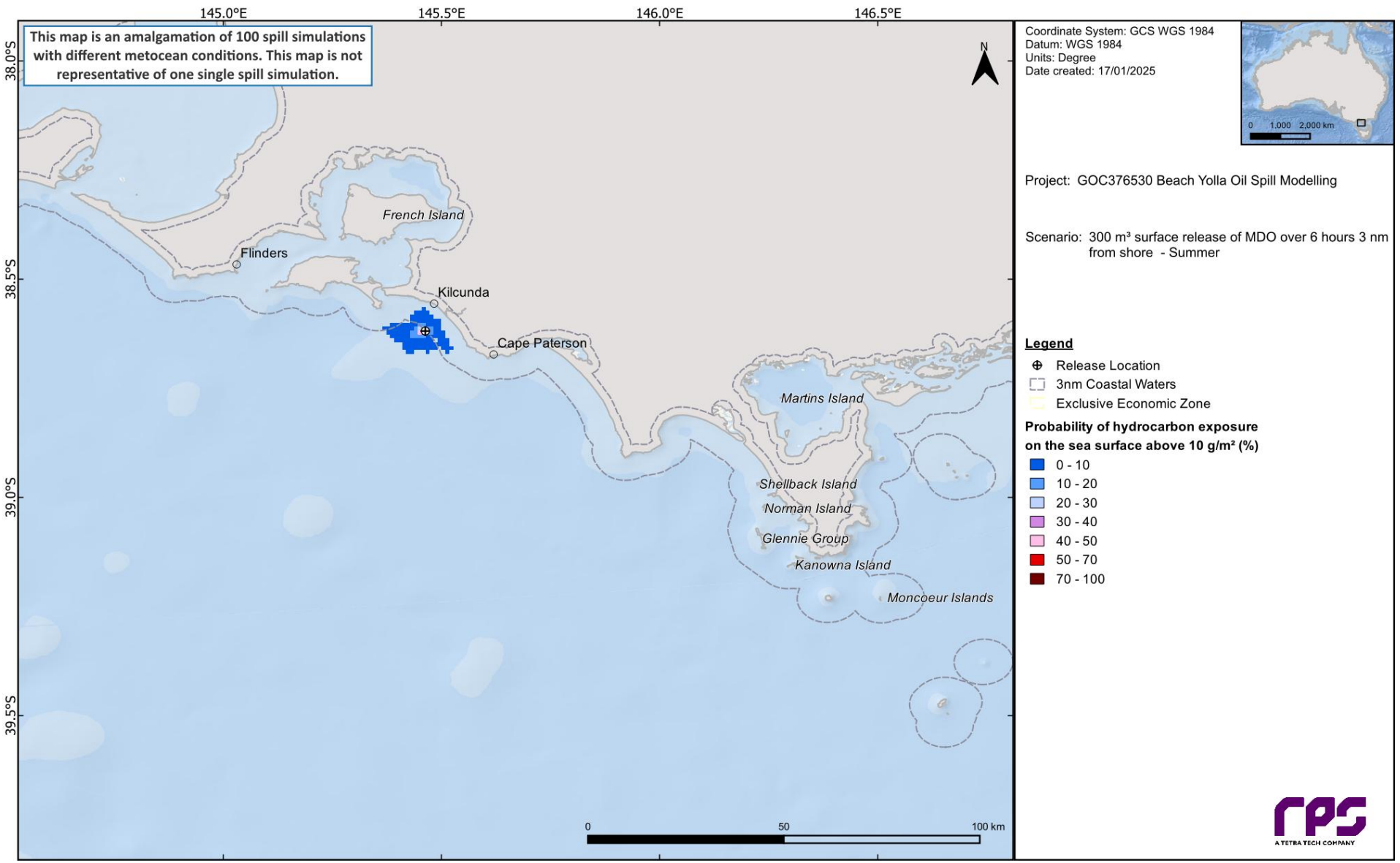


Figure 15-7 Probability of floating oil exposure above 10 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

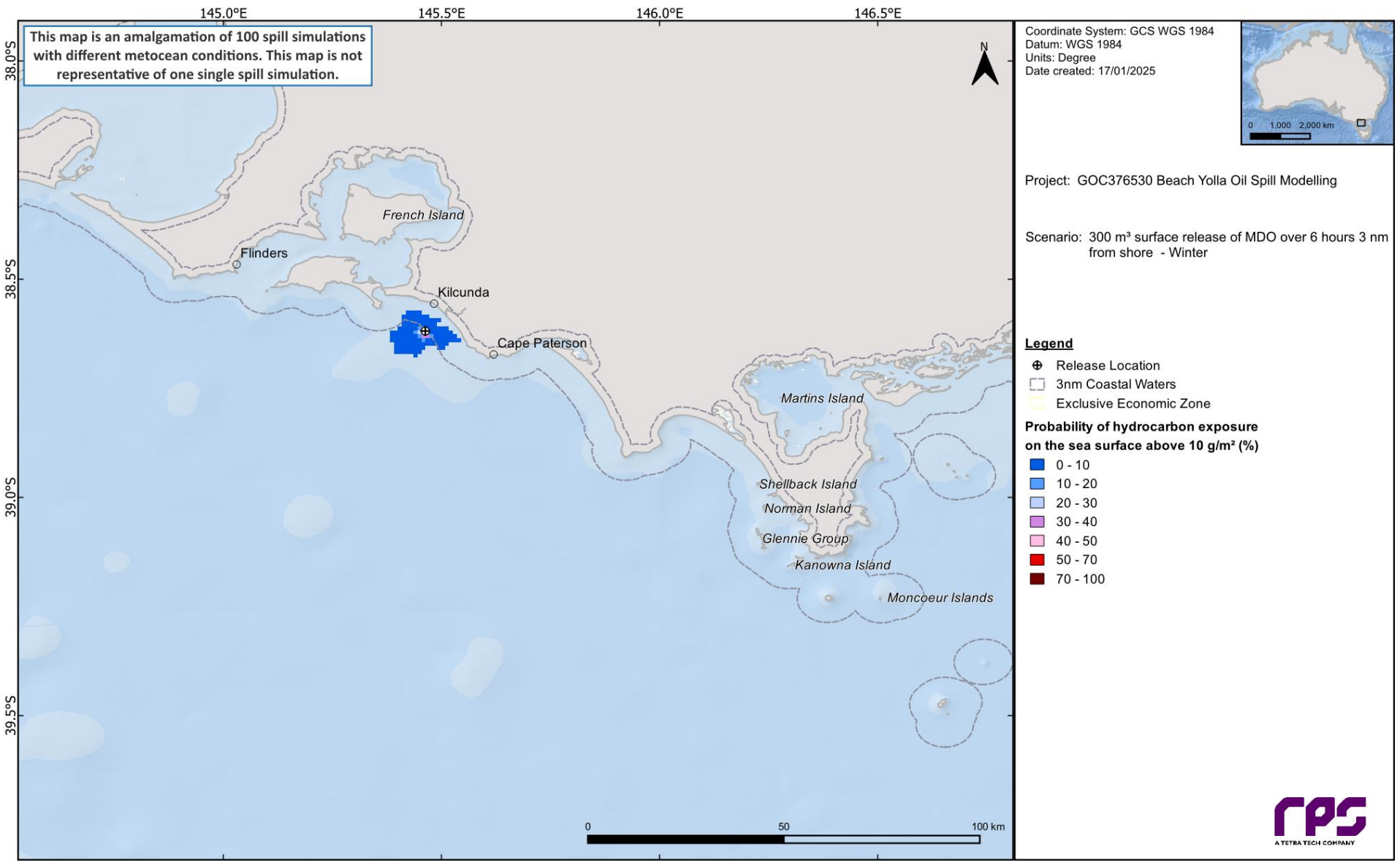


Figure 15-8 Probability of floating oil exposure above 10 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

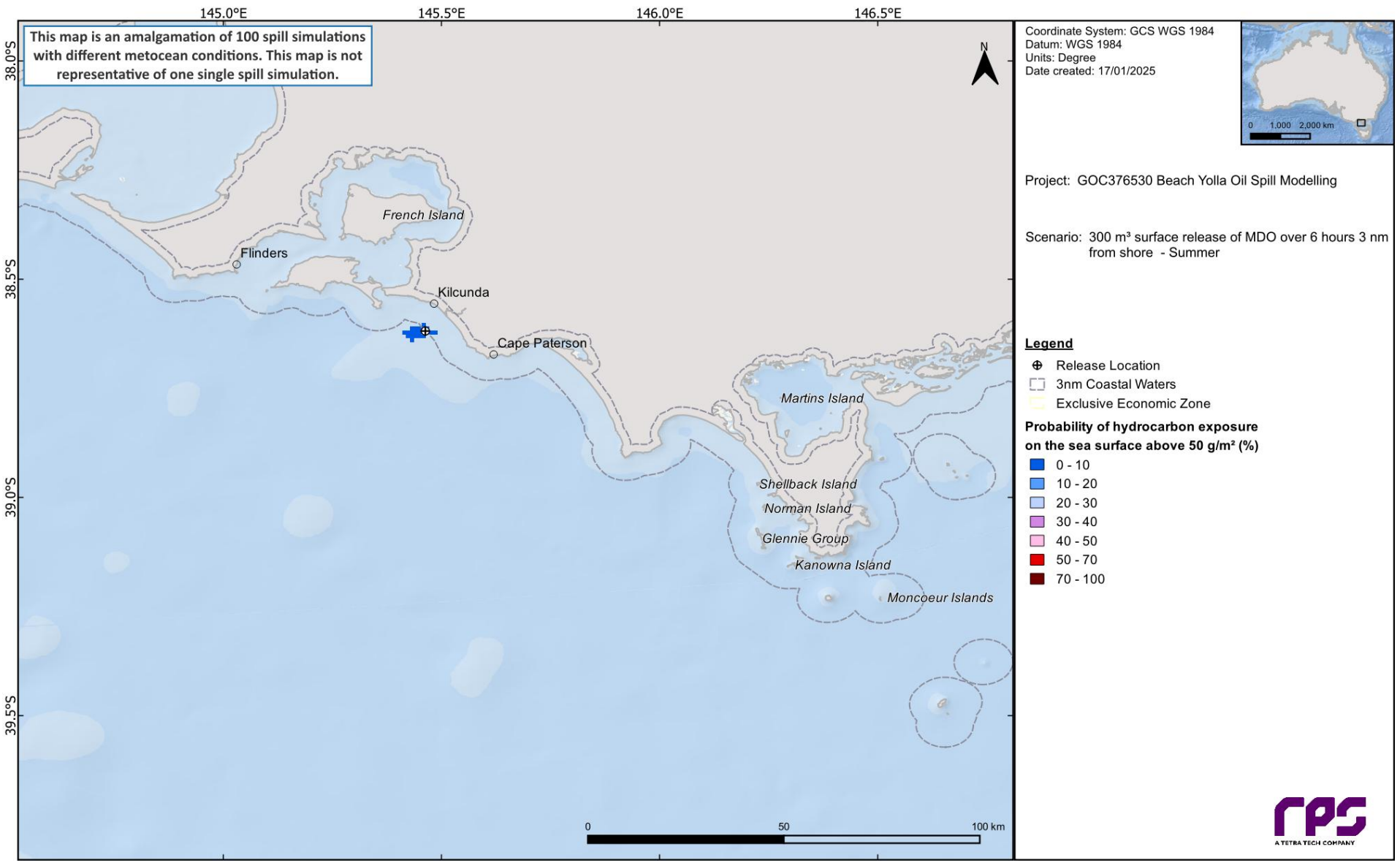


Figure 15-9 Probability of floating oil exposure above 50 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

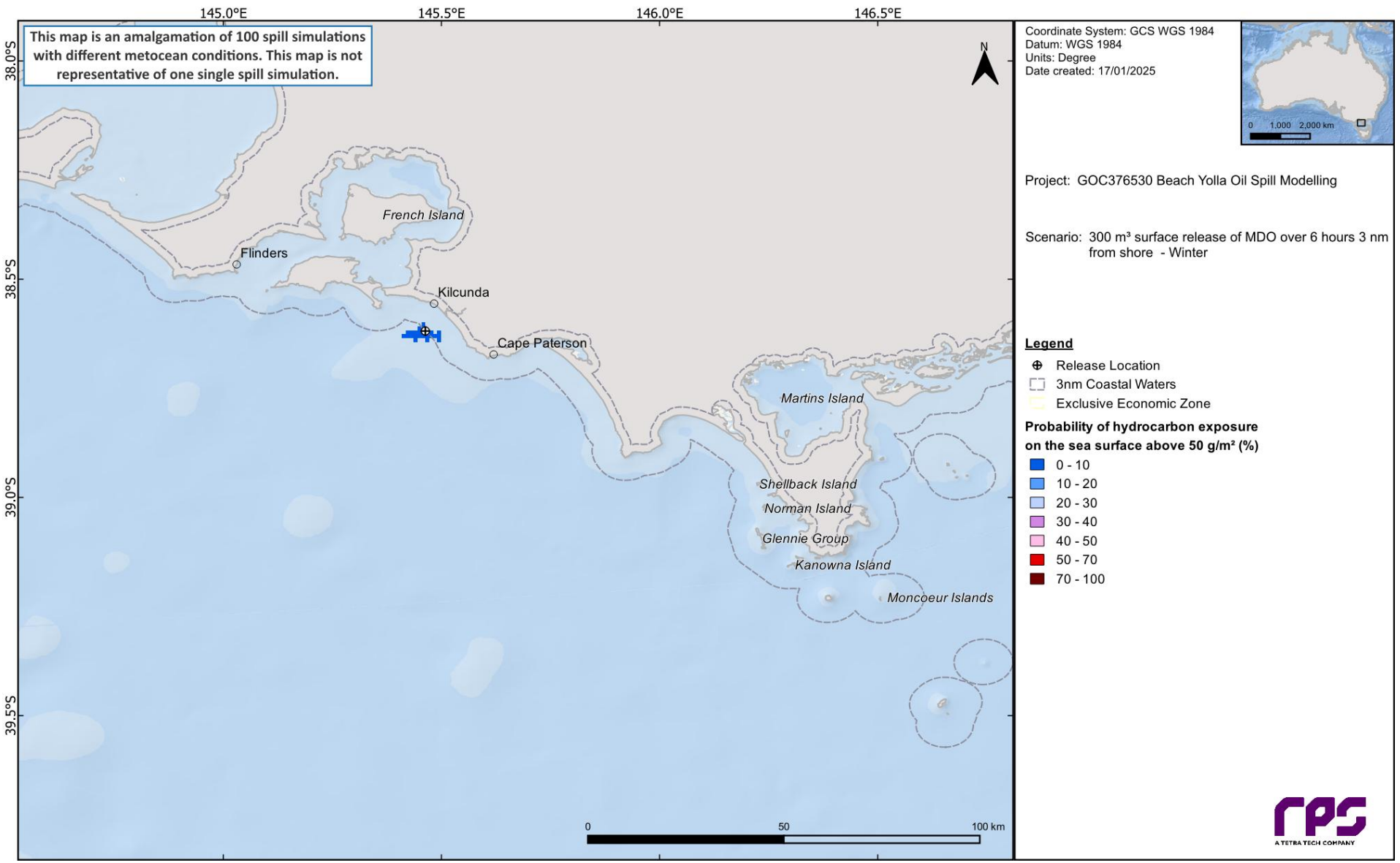


Figure 15-10 Probability of floating oil exposure above 50 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

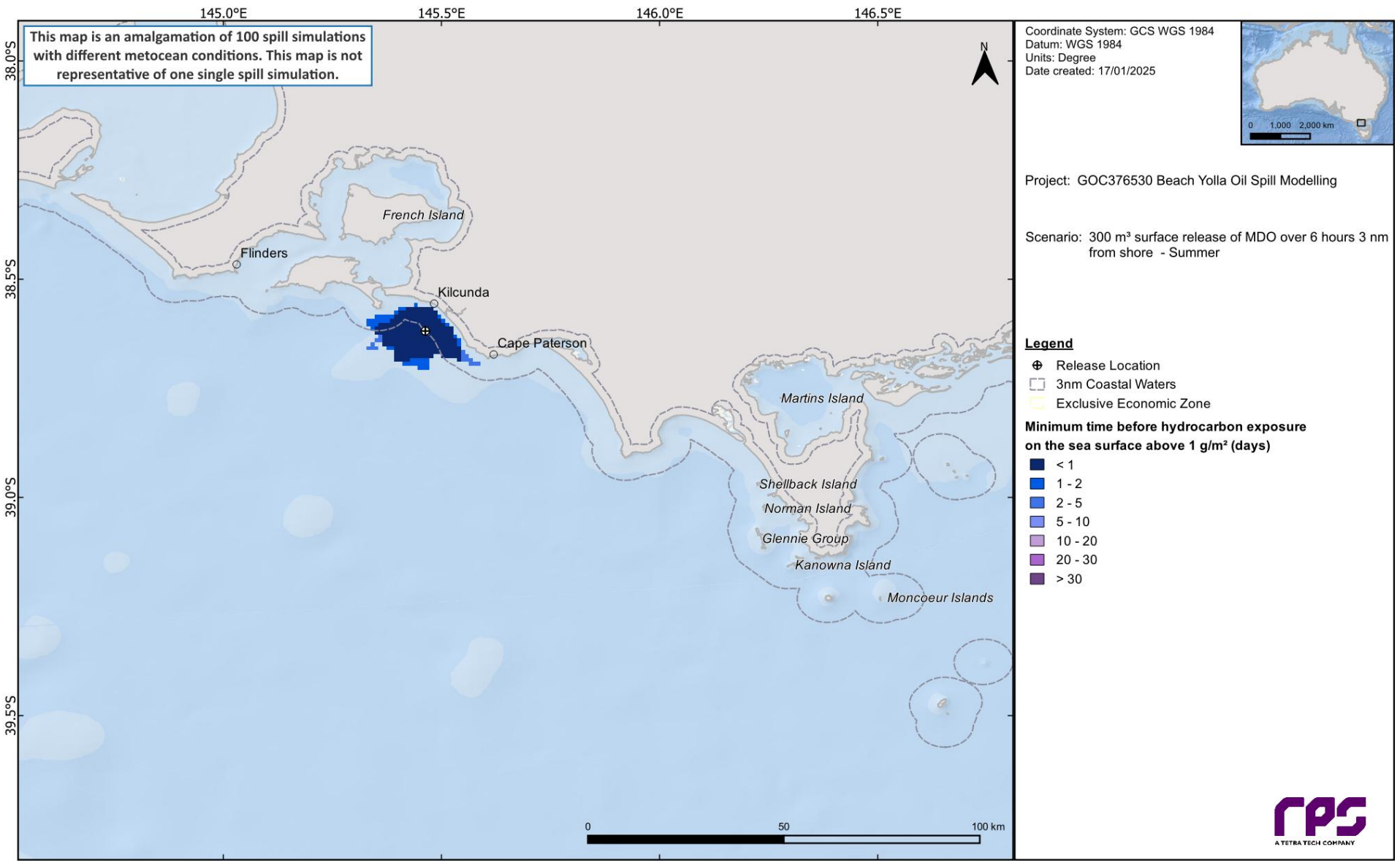


Figure 15-11 Minimum time before floating oil exposure above 1 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

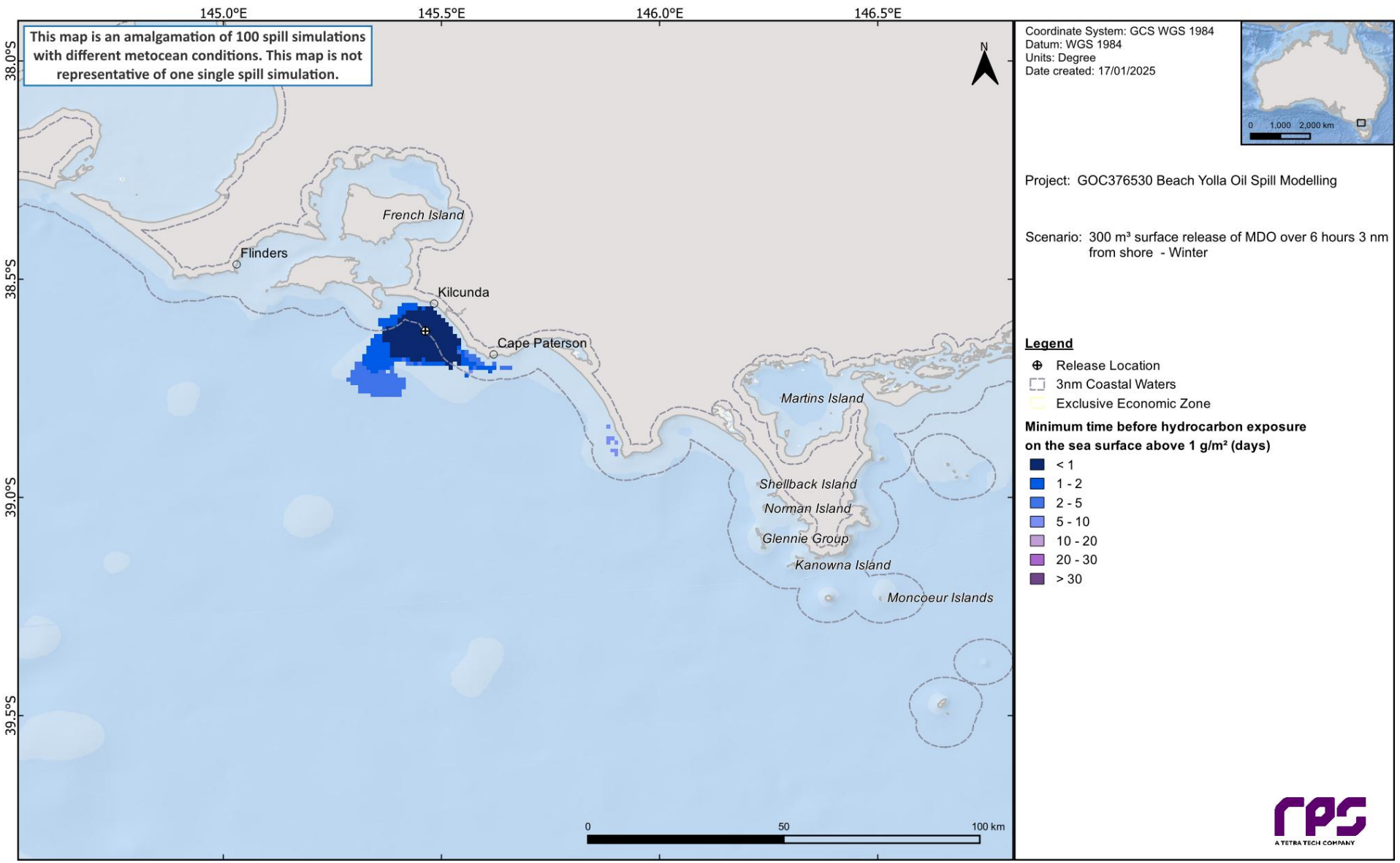


Figure 15-12 Minimum time before floating oil exposure above 1 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

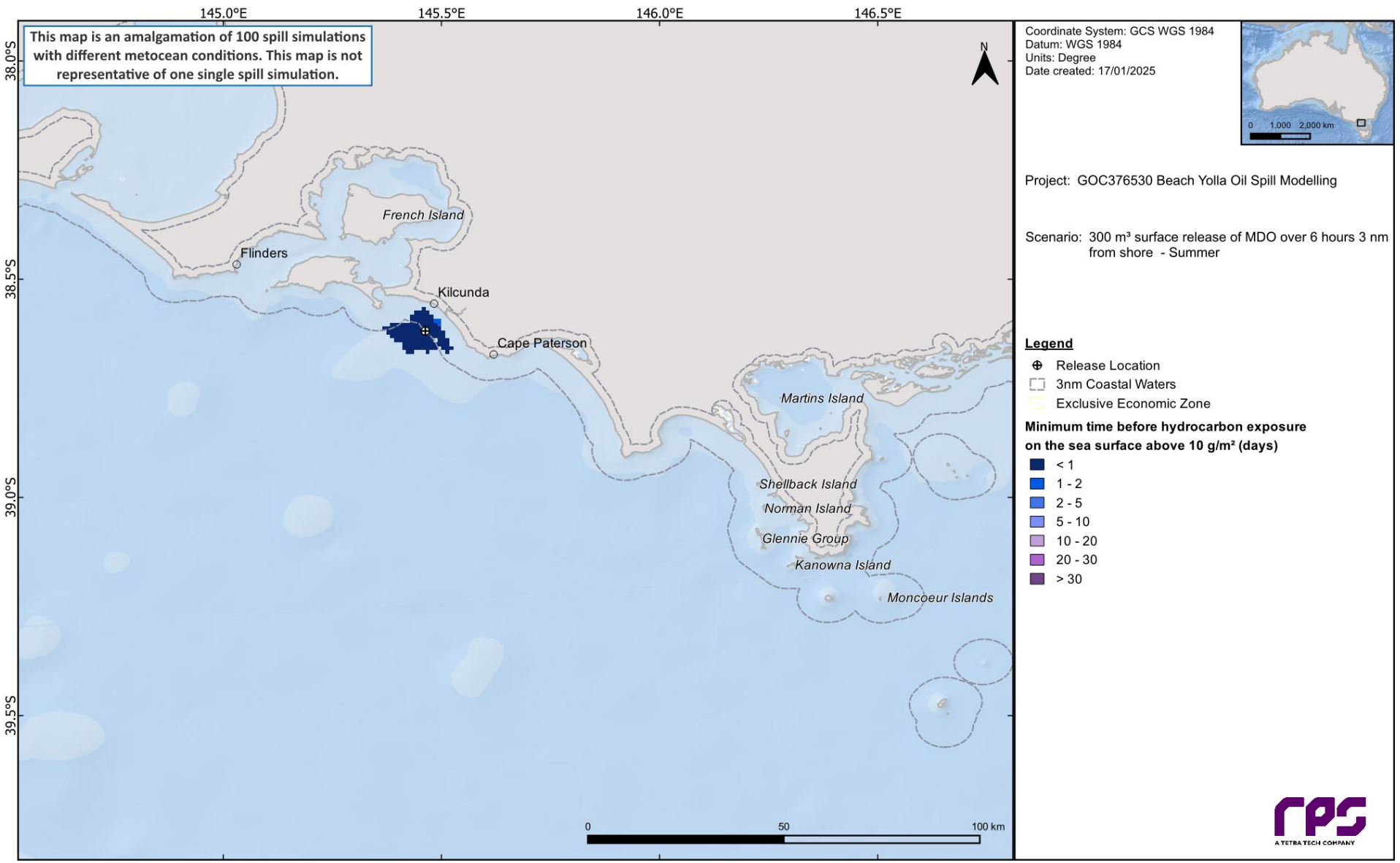


Figure 15-13 Minimum time before floating oil exposure above 10 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

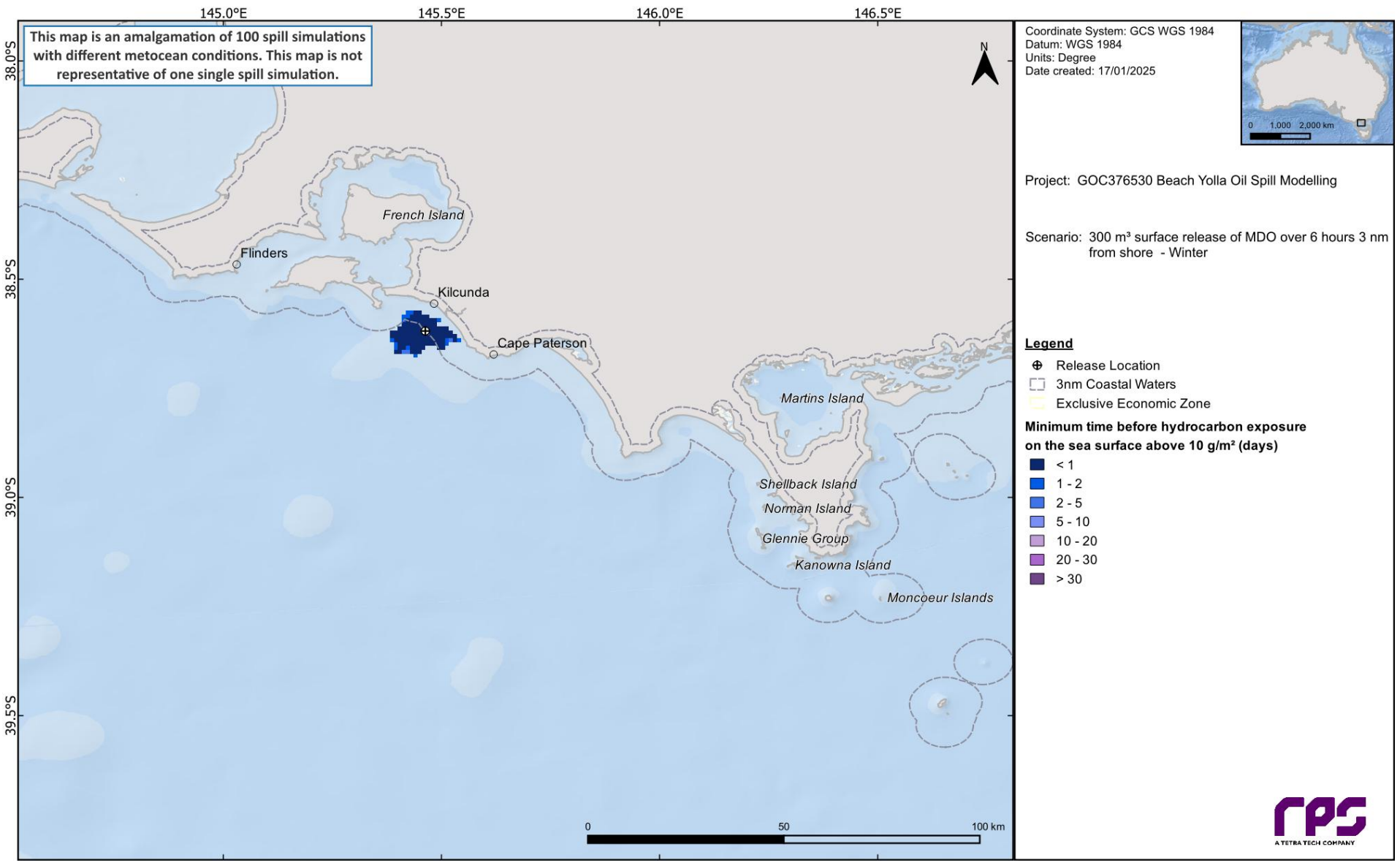


Figure 15-14 Minimum time before floating oil exposure above 10 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

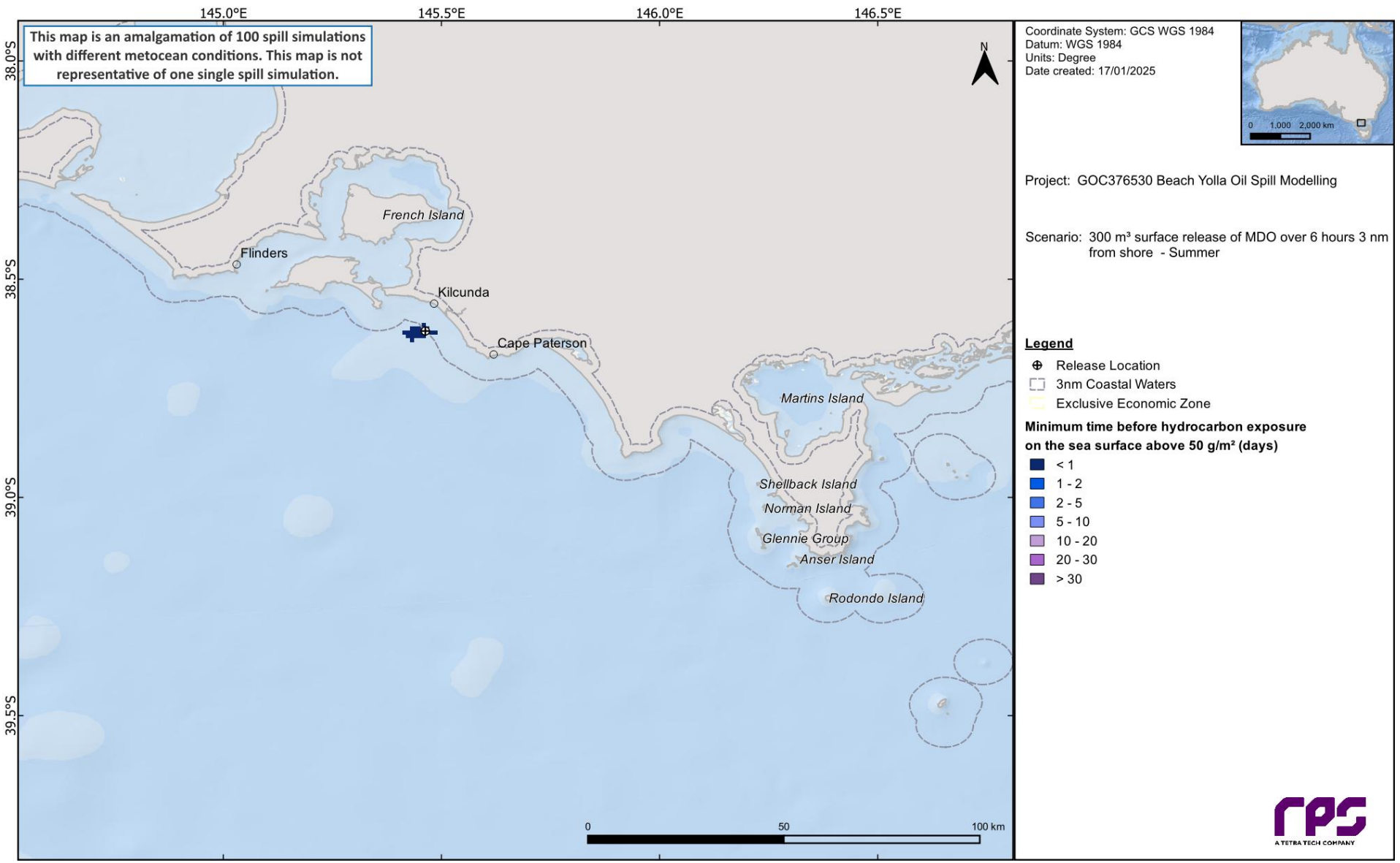


Figure 15-15 Minimum time before floating oil exposure above 50 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

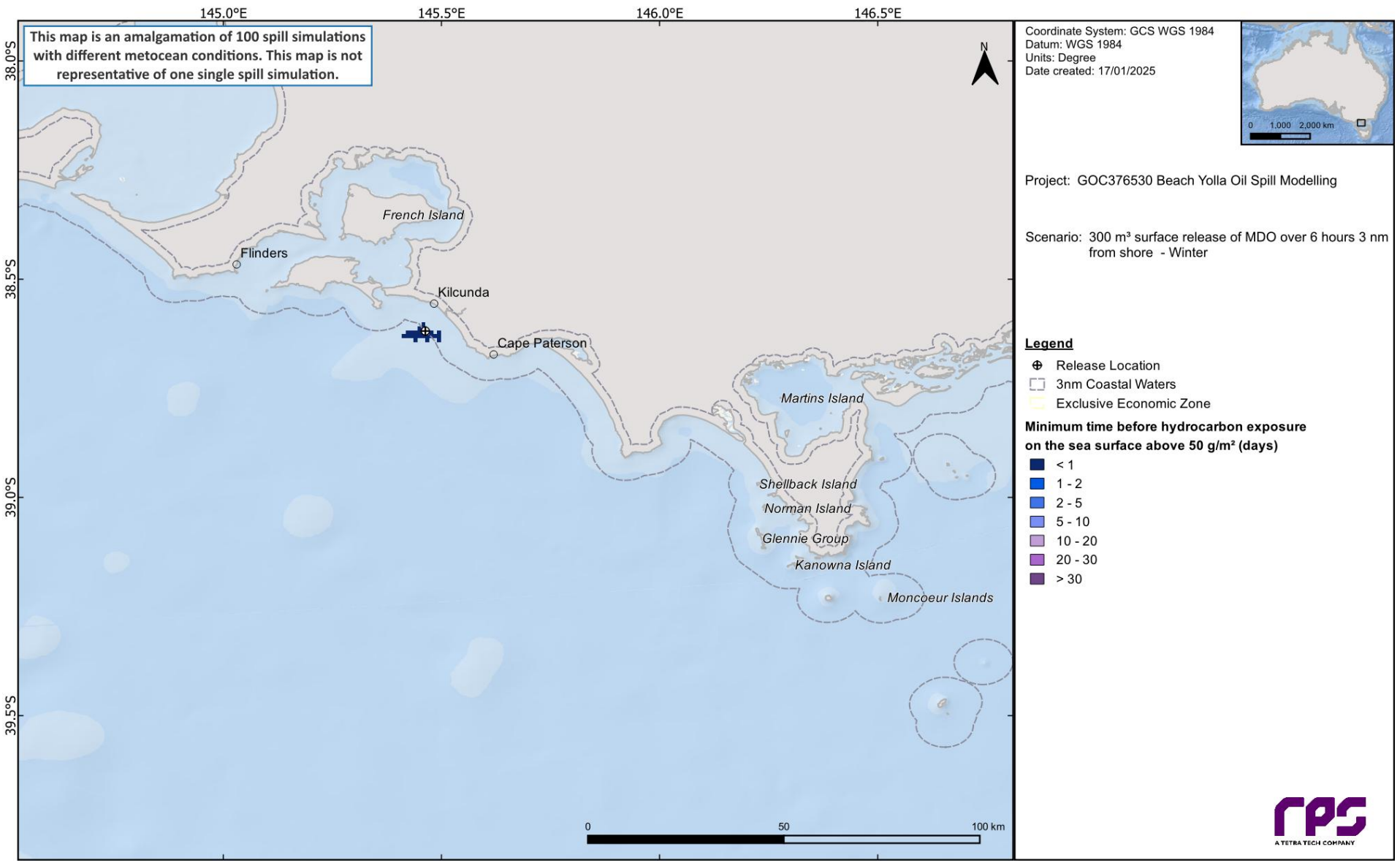


Figure 15-16 Minimum time before floating oil exposure above 50 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

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	-

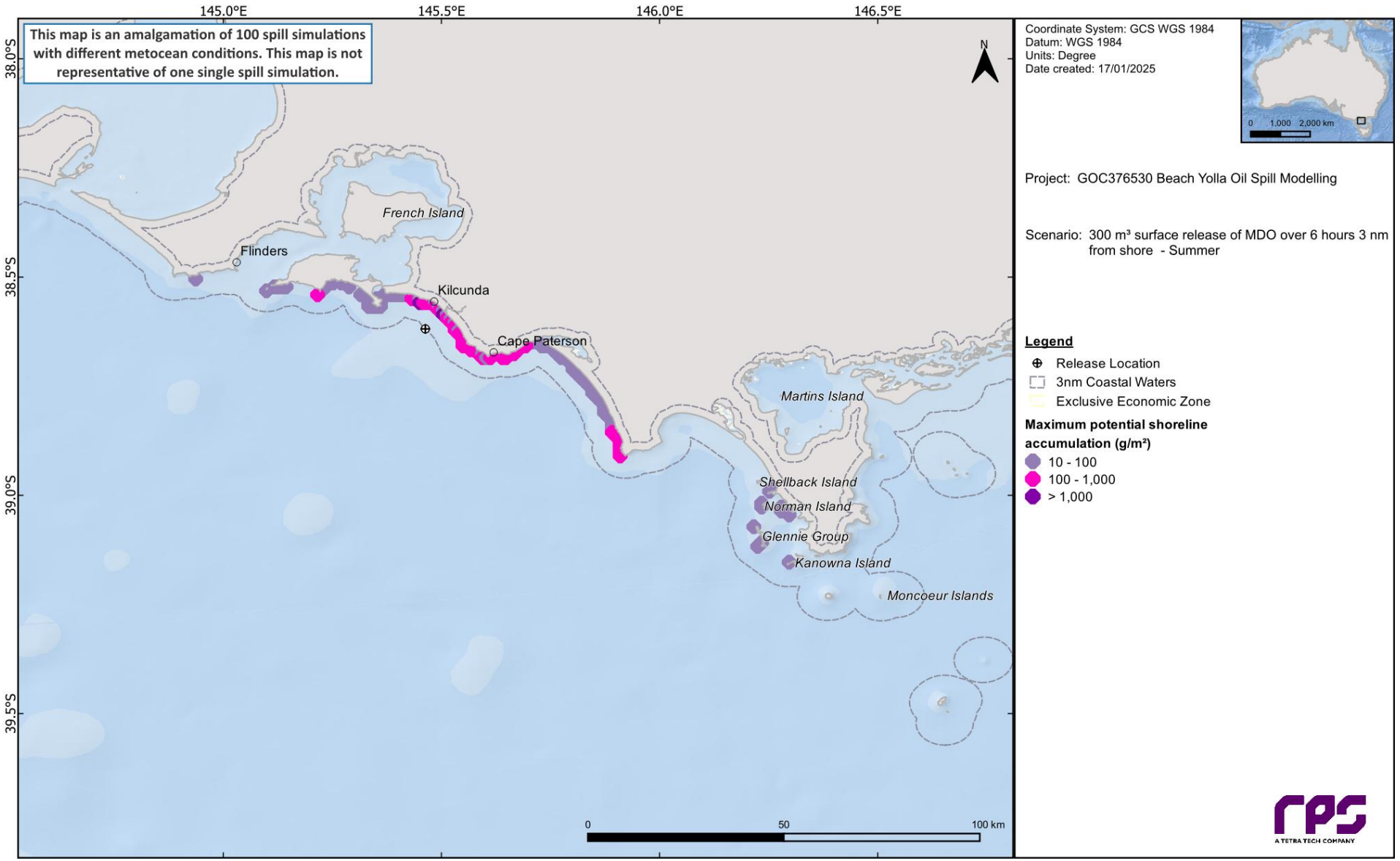


Figure 15-17 Maximum potential shoreline loading in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

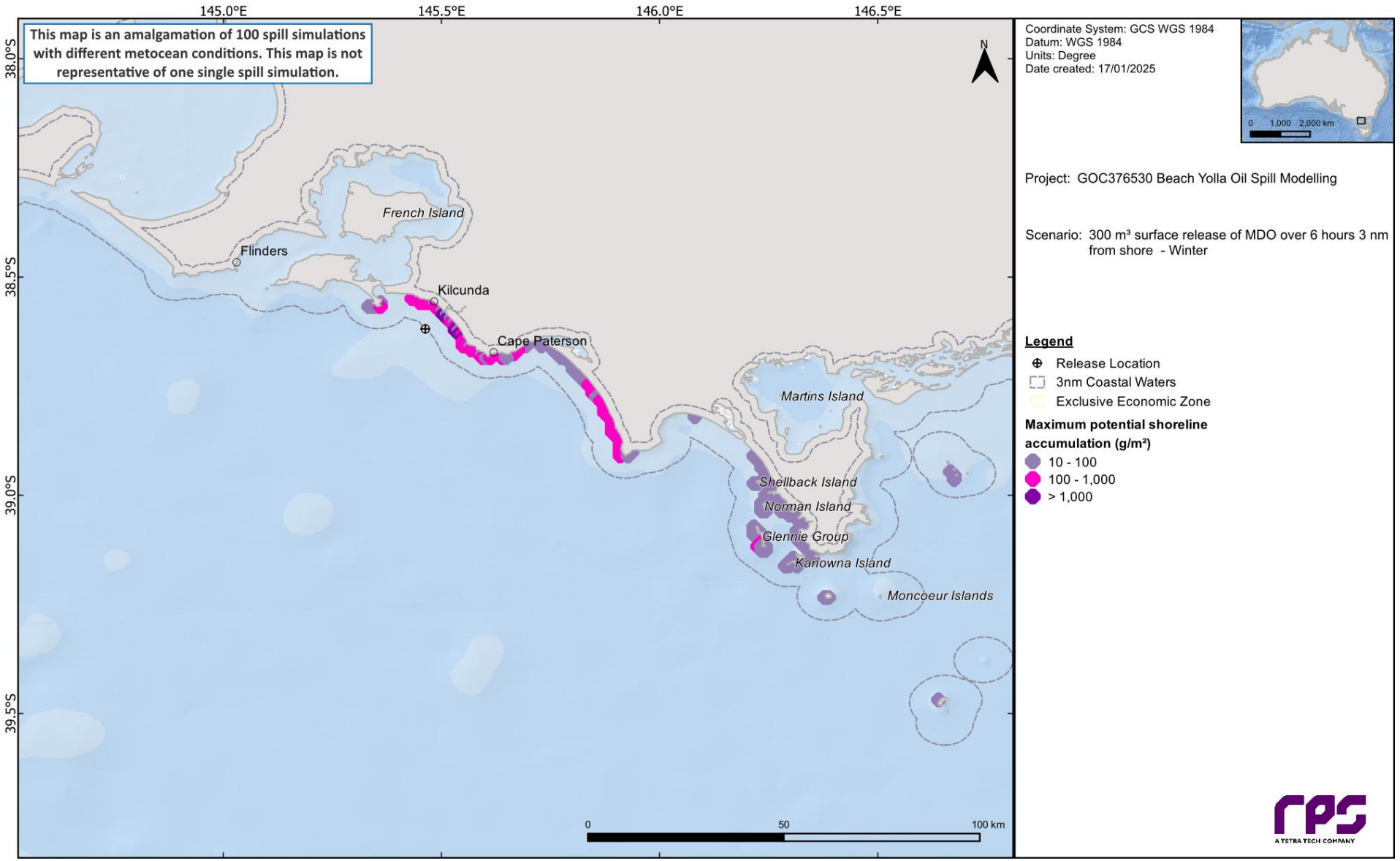


Figure 15-18 Maximum potential shoreline loading in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

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.

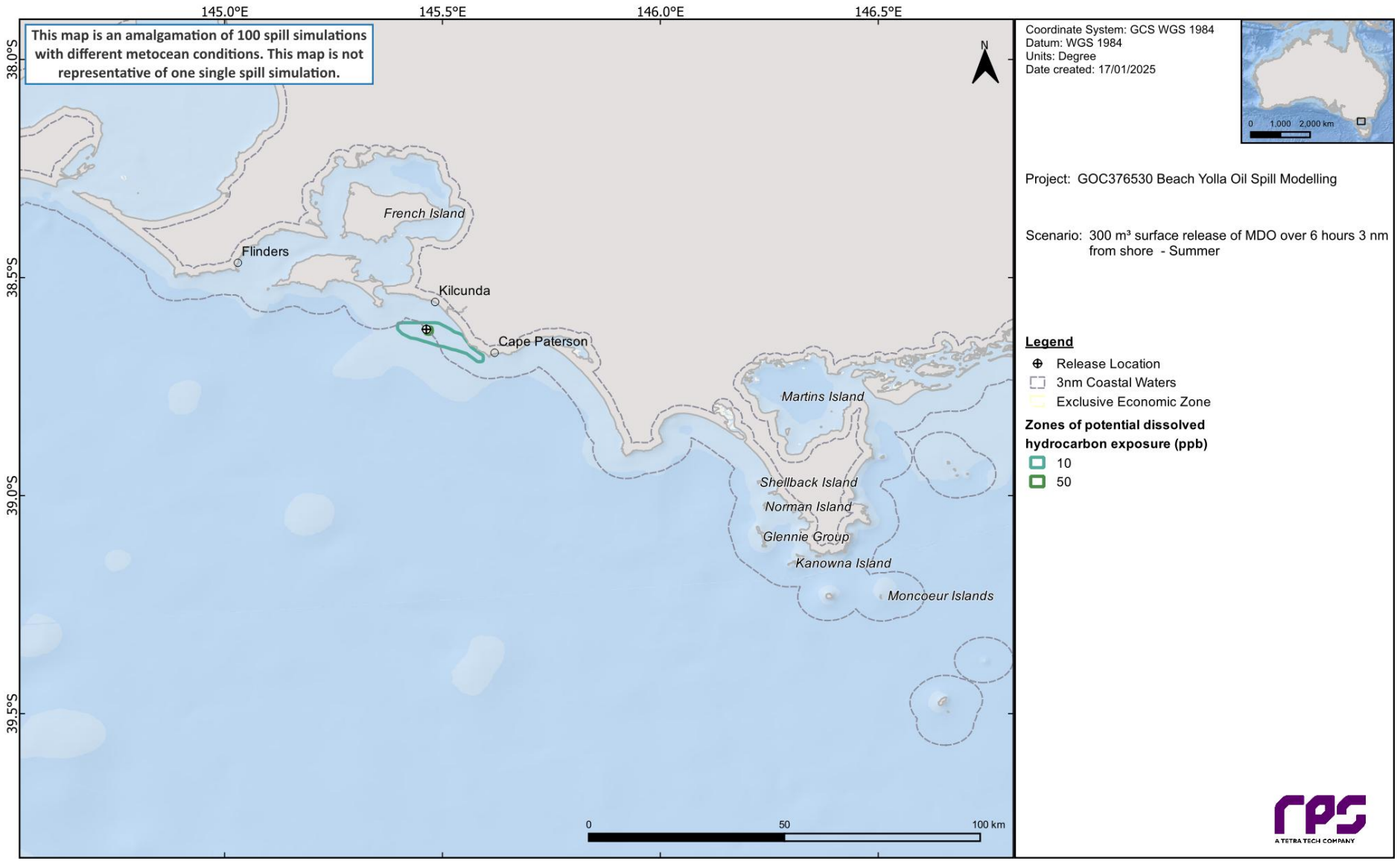


Figure 15-19 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

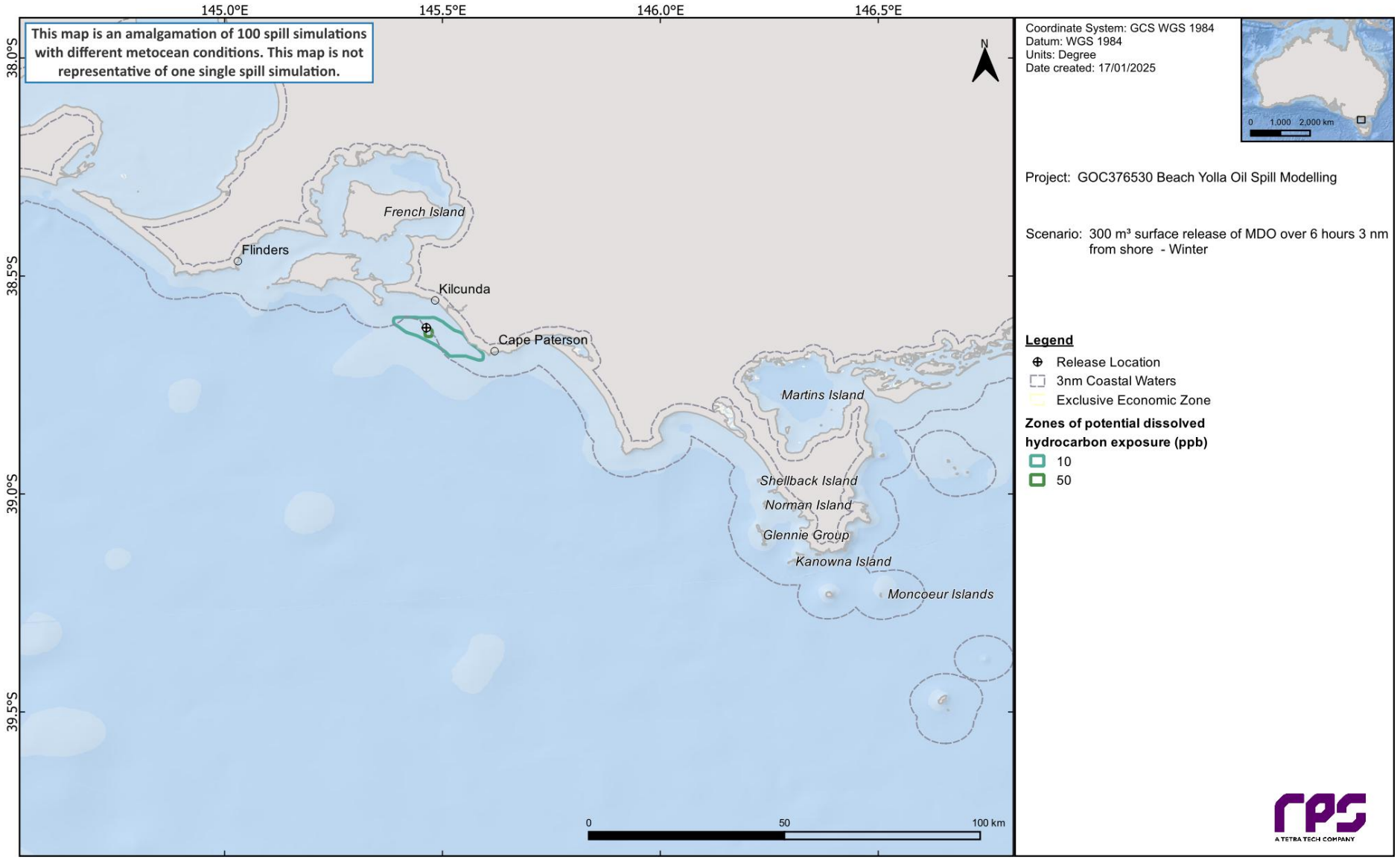


Figure 15-20 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

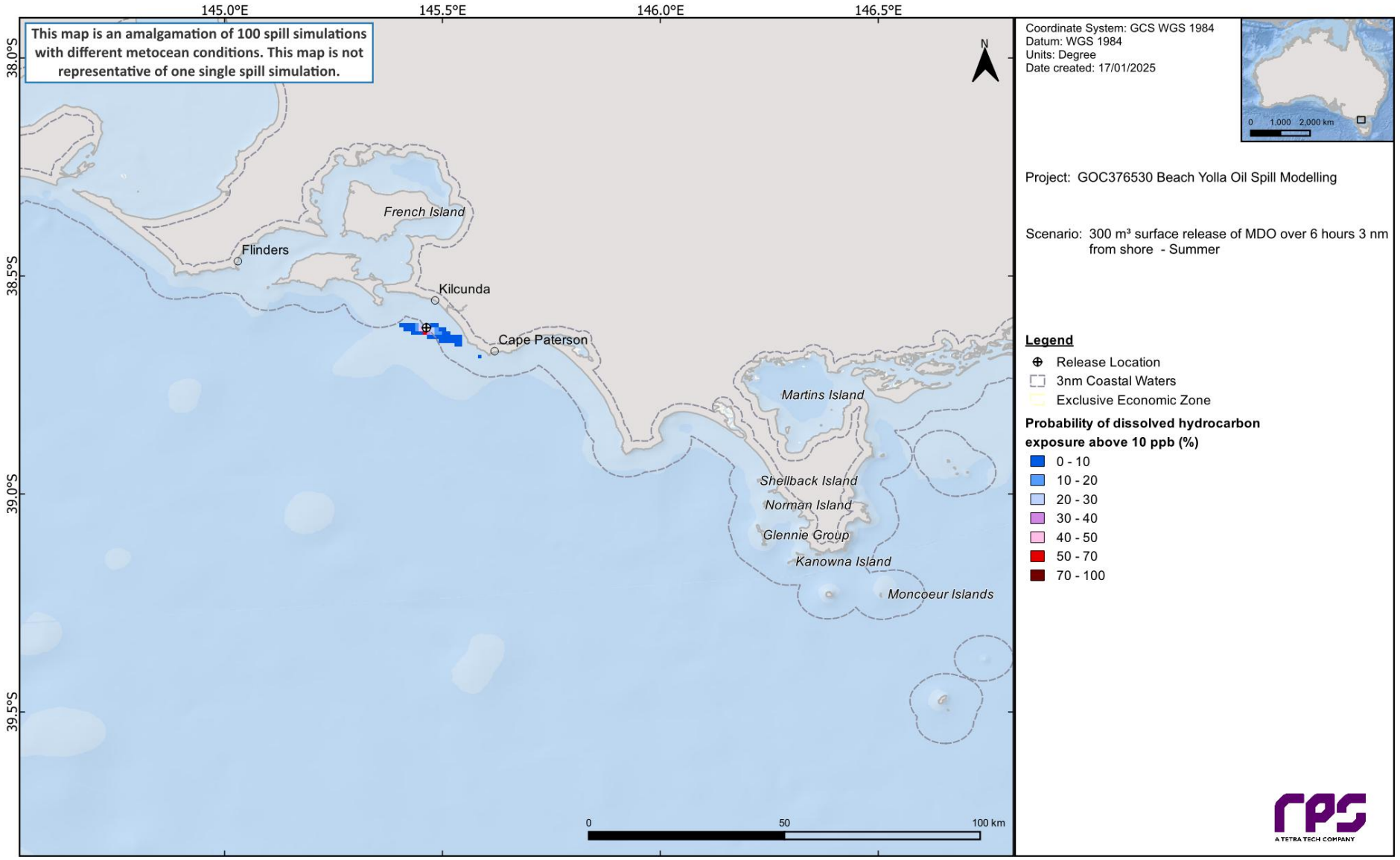


Figure 15-21 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

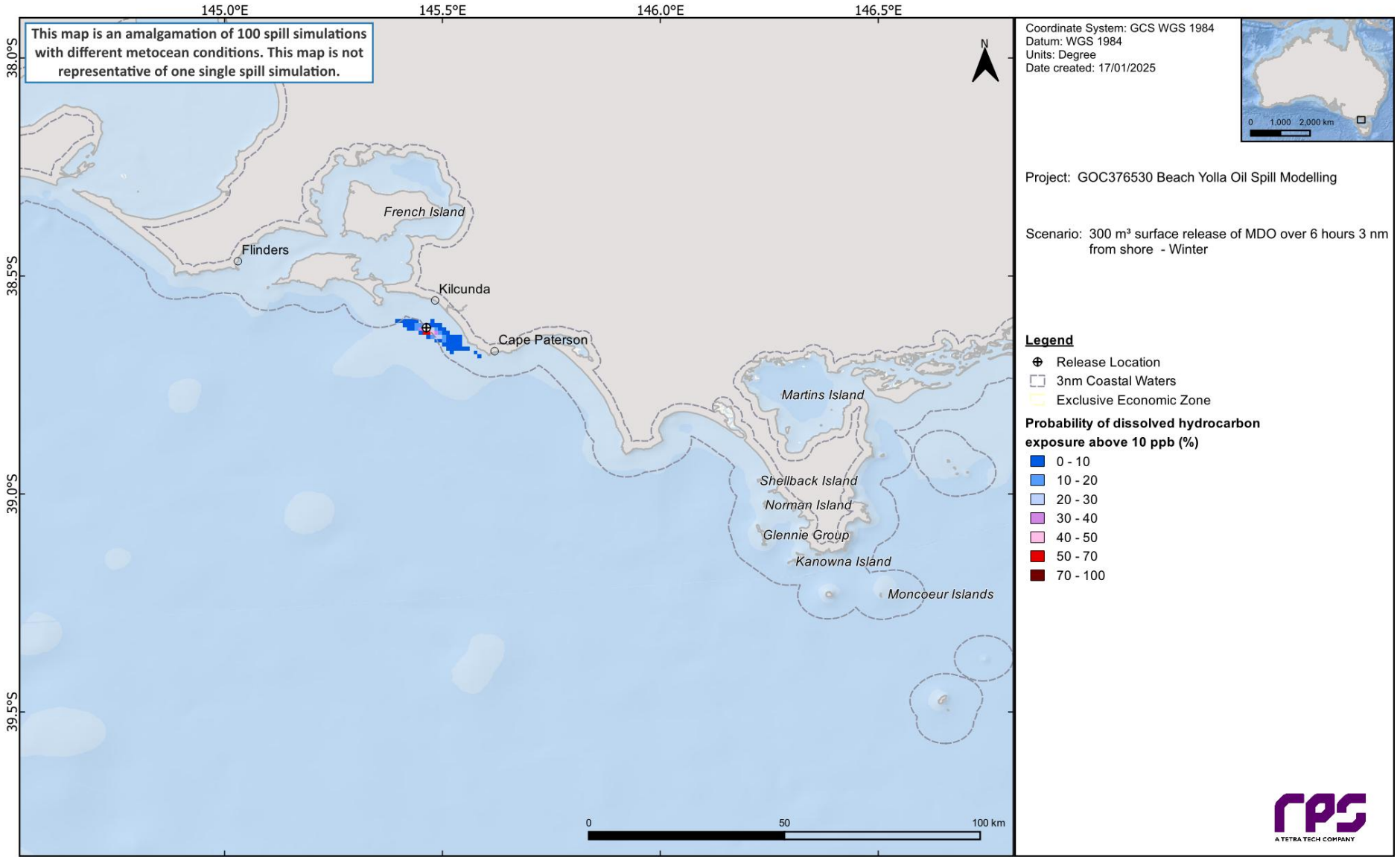


Figure 15-22 Probability of dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

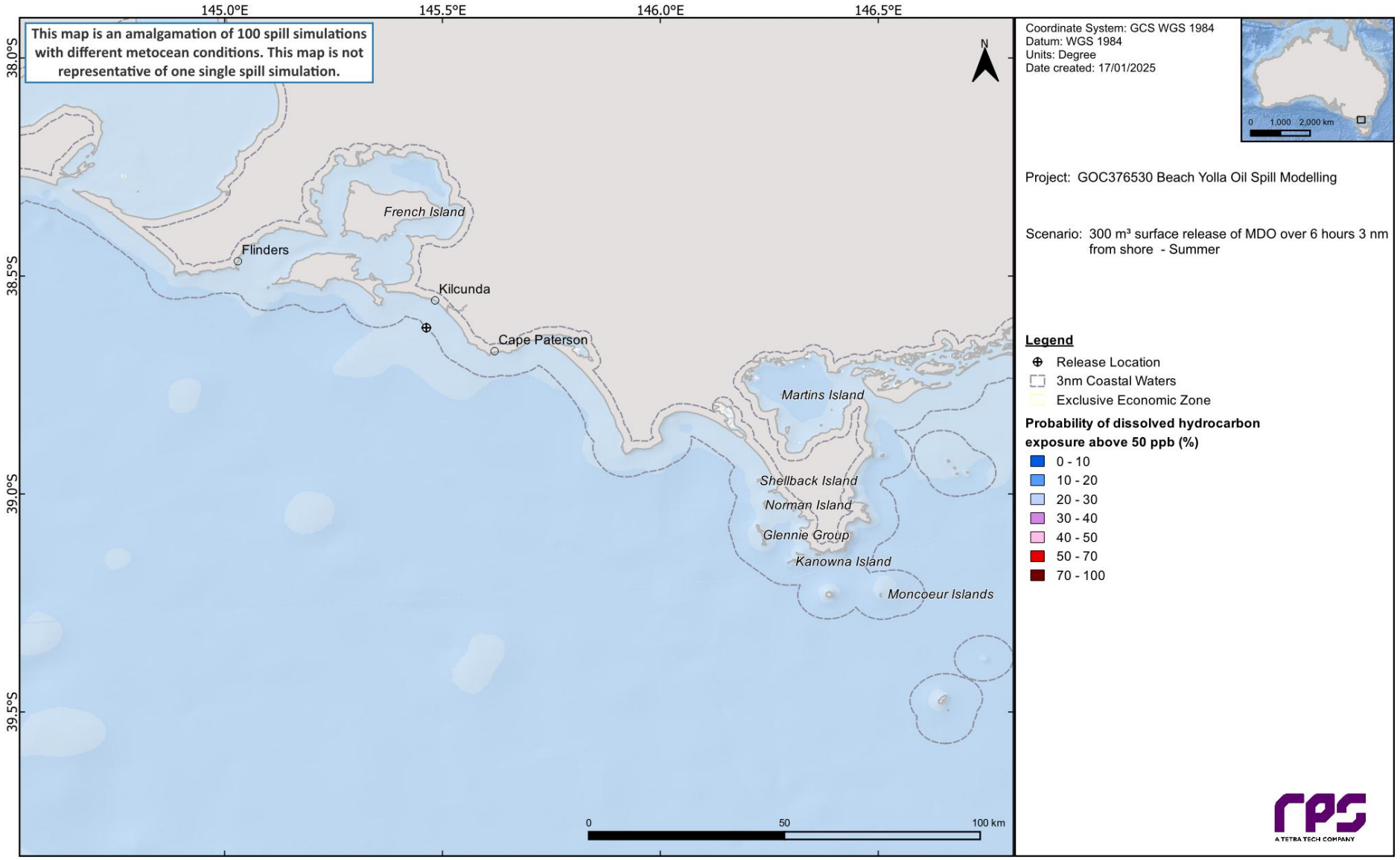


Figure 15-23 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

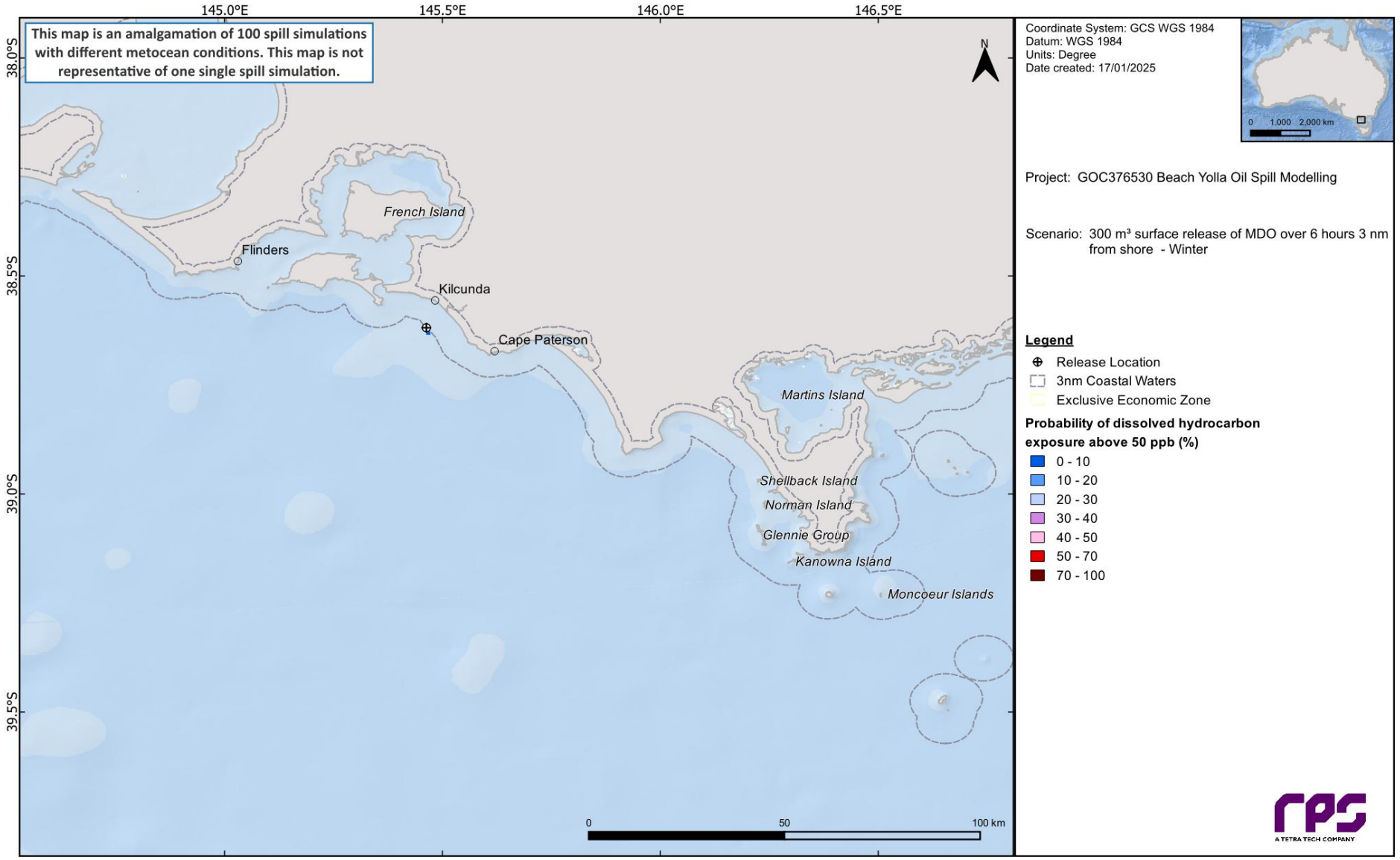


Figure 15-24 Probability of dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

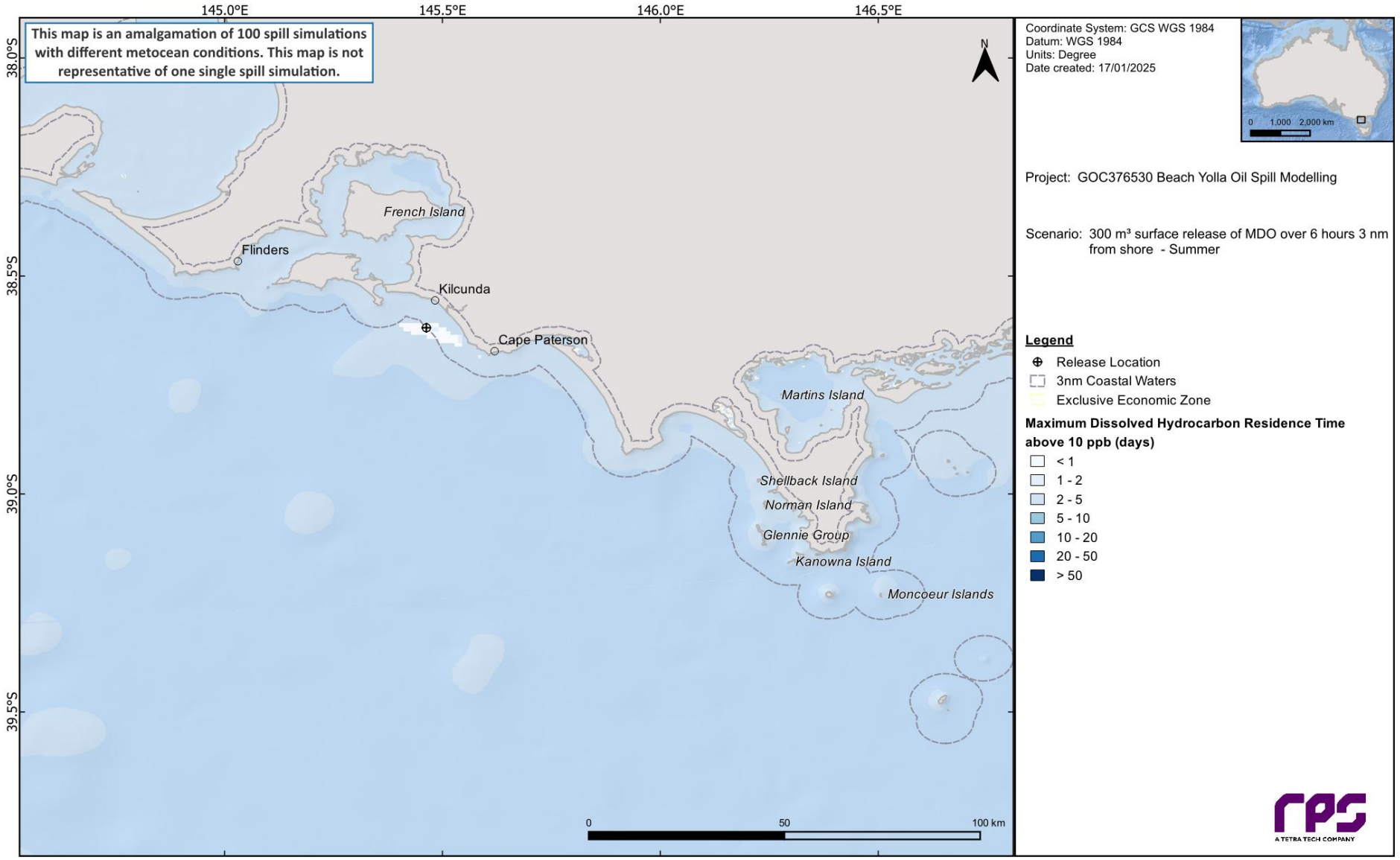


Figure 15-25 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

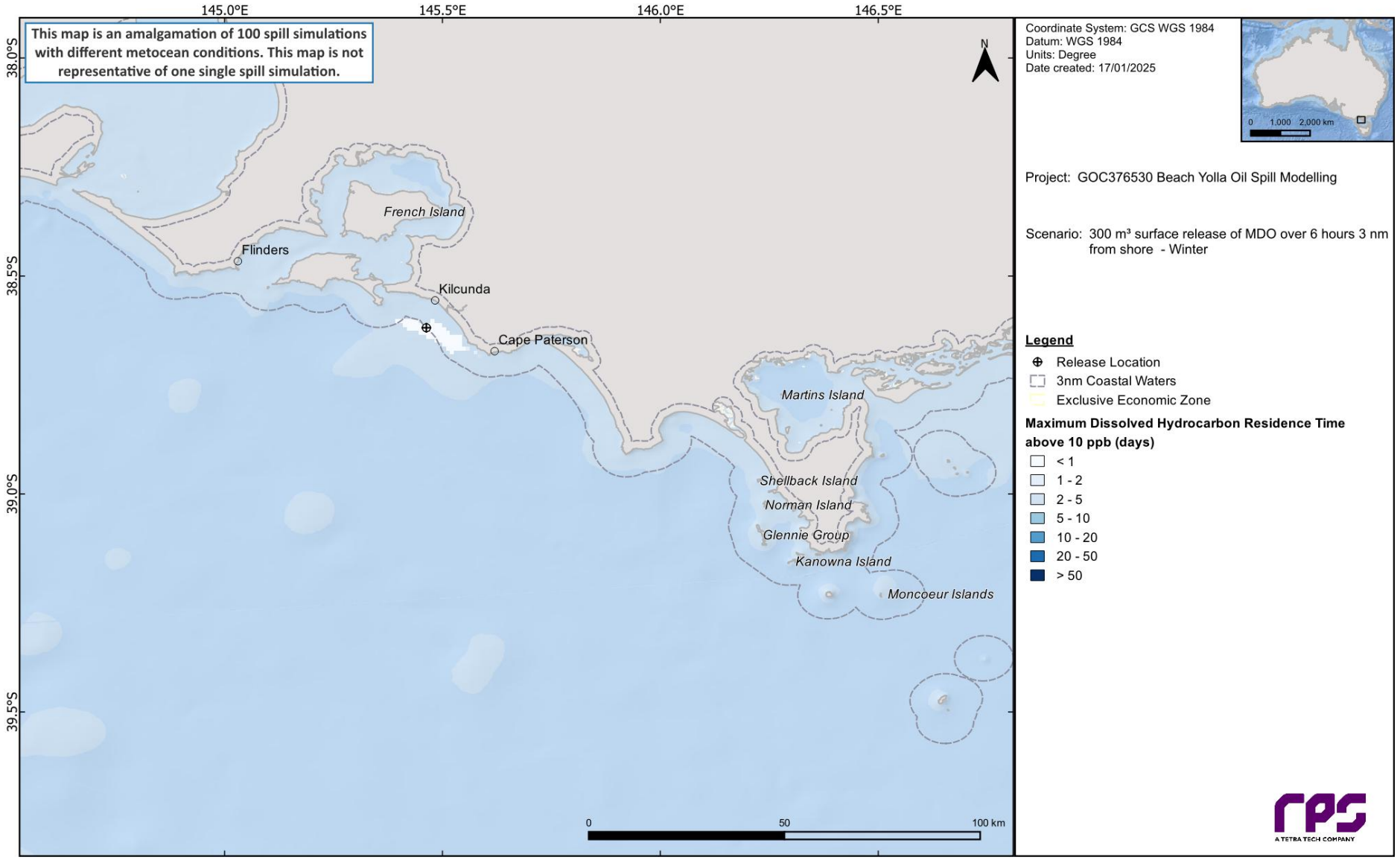


Figure 15-26 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

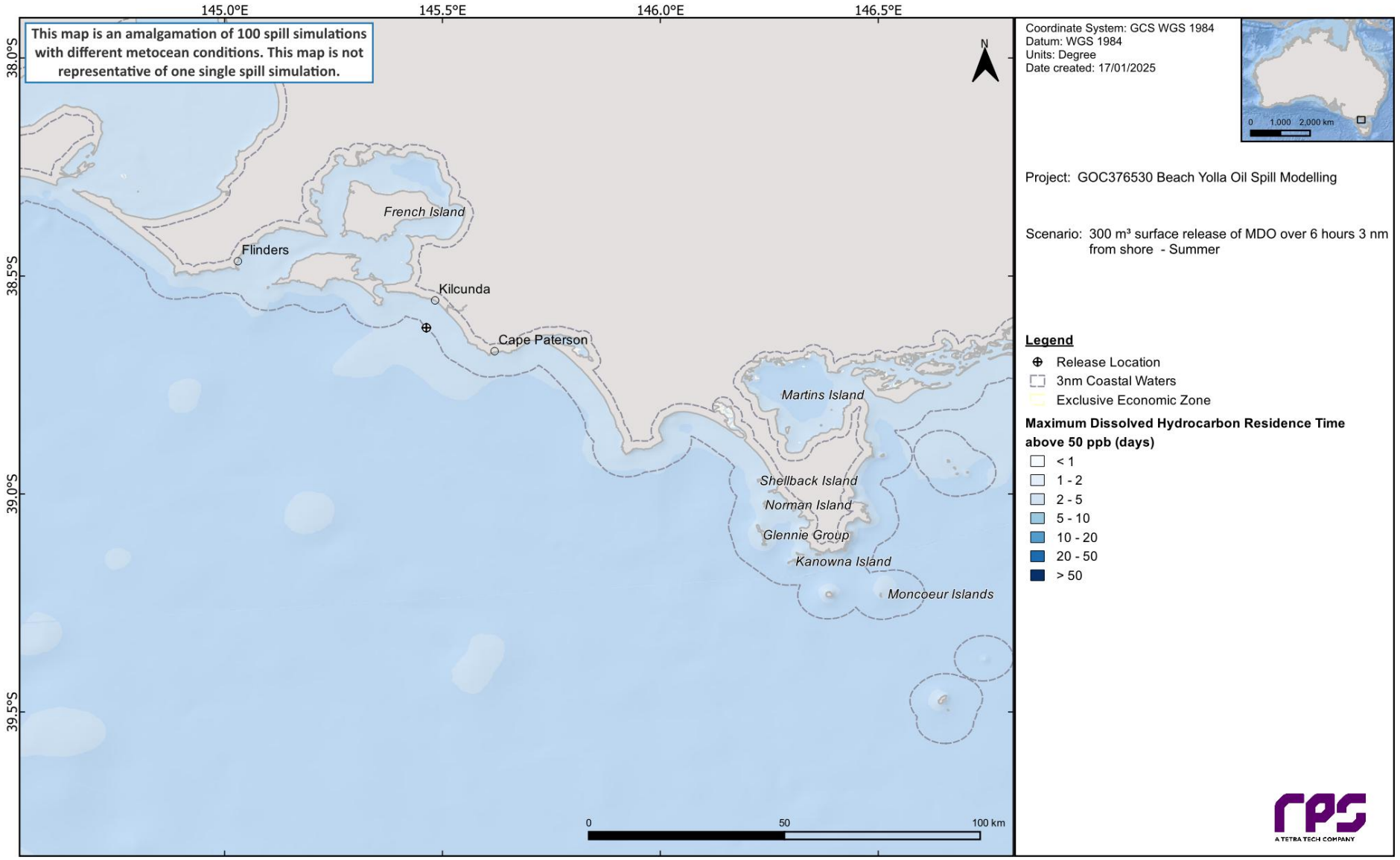


Figure 15-27 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

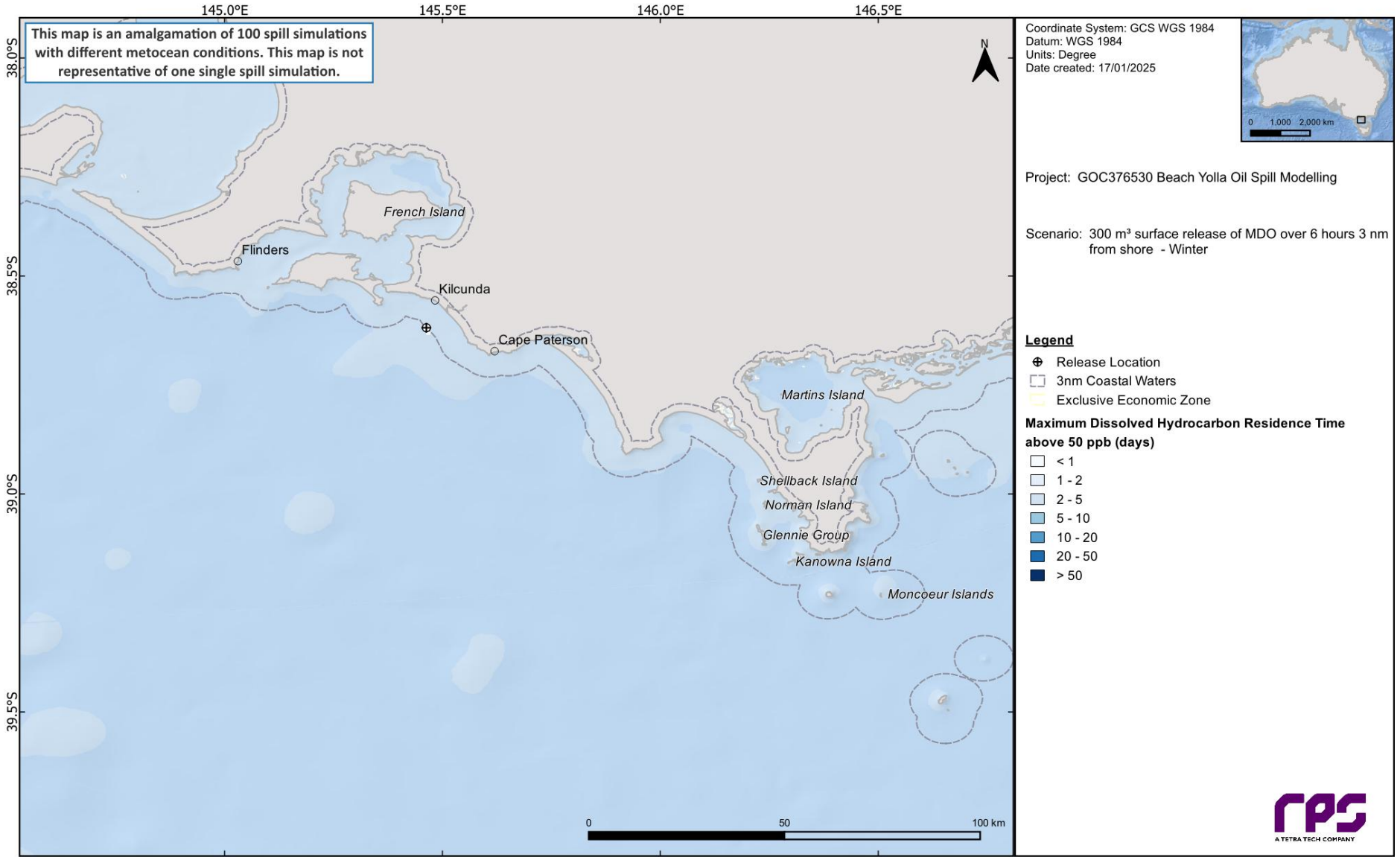


Figure 15-28 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

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.

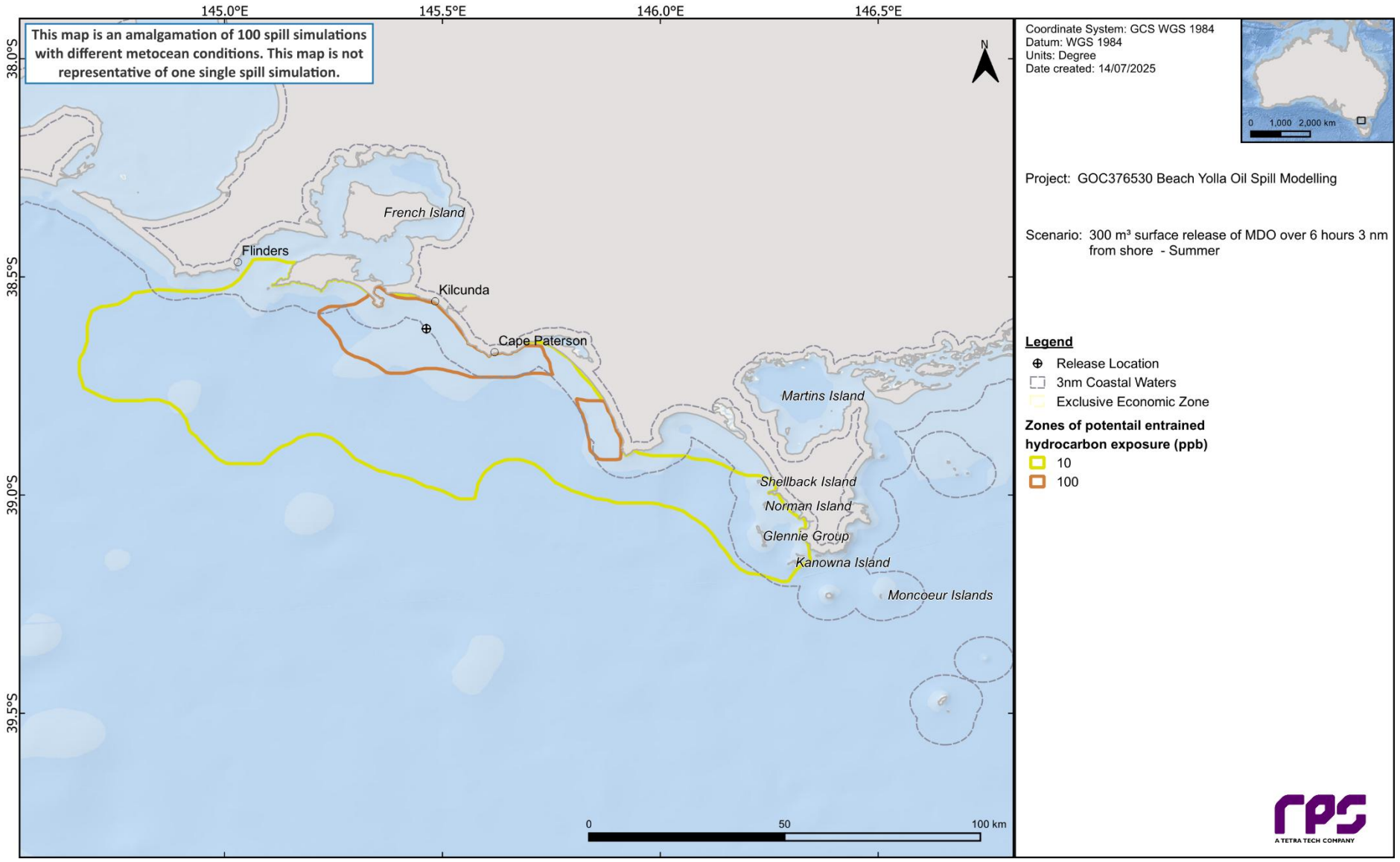


Figure 15-29 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

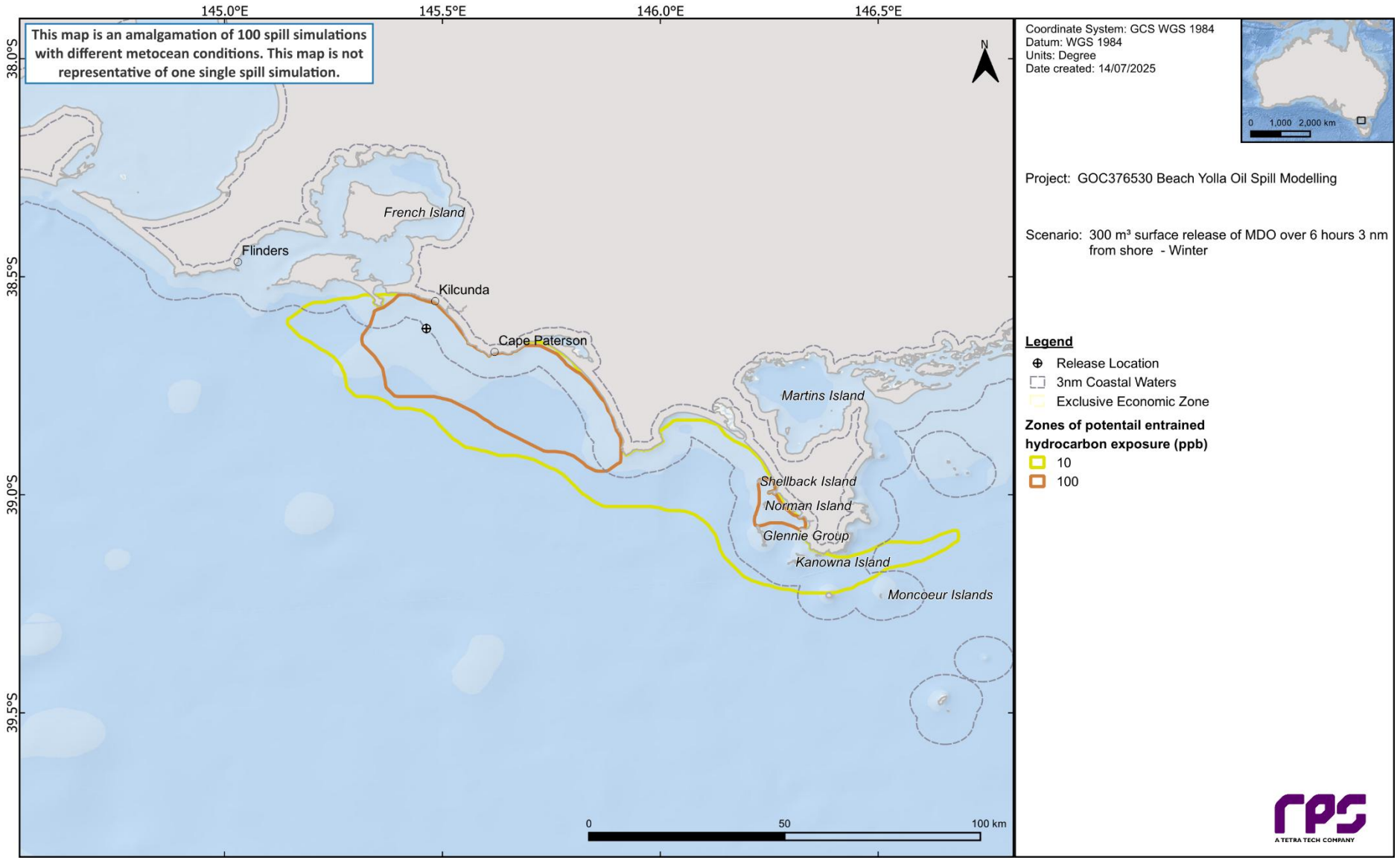


Figure 15-30 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

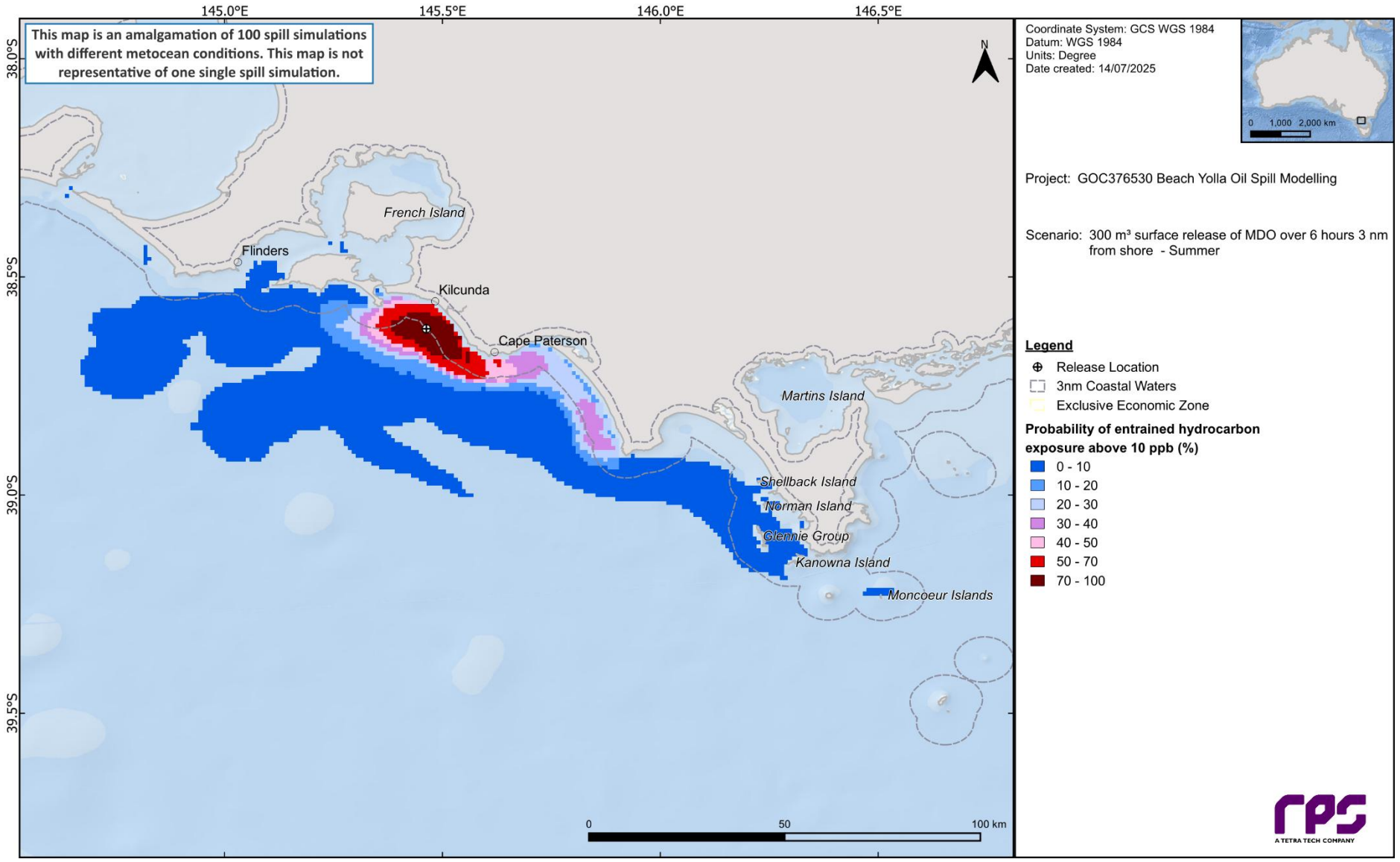


Figure 15-31 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

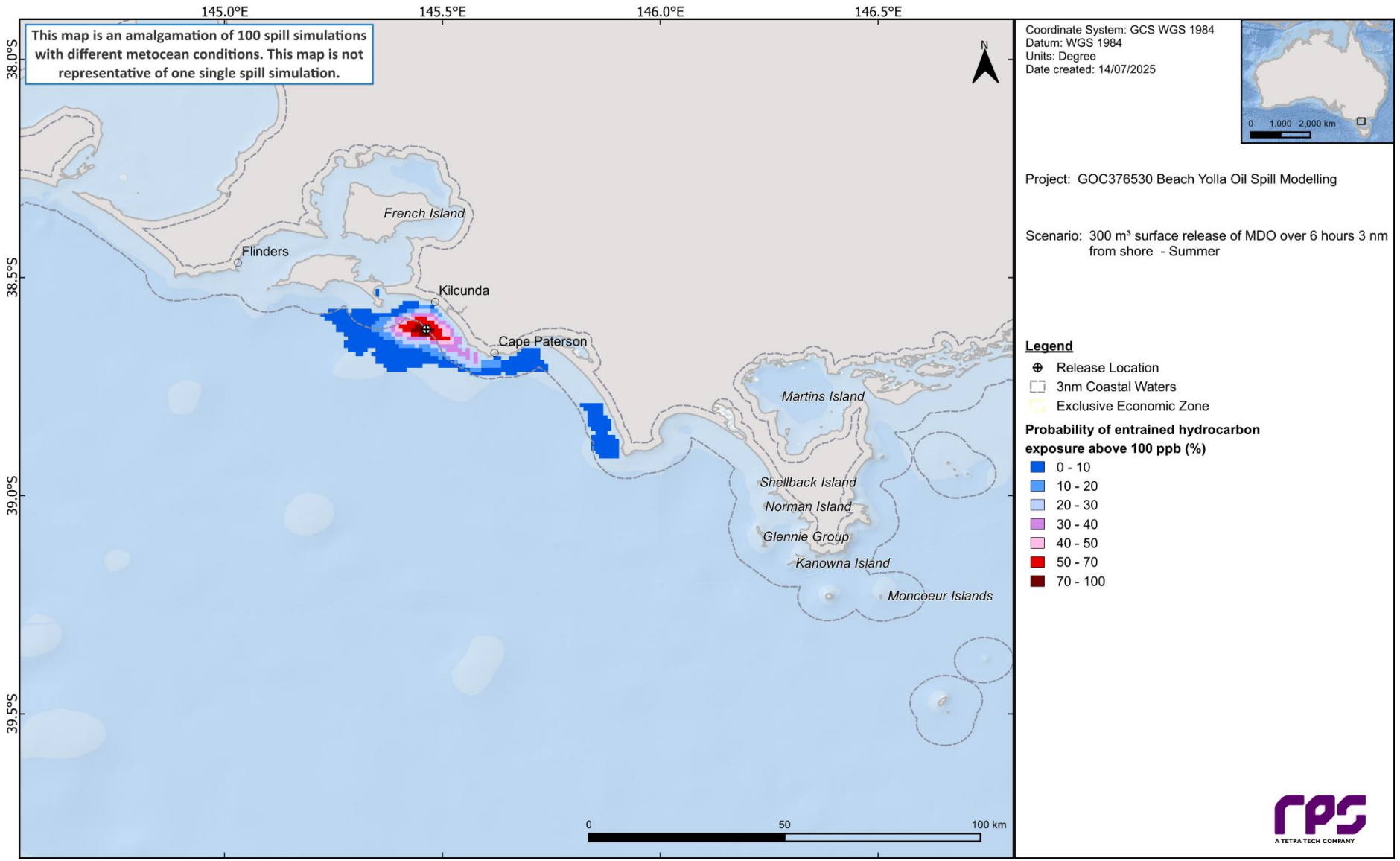


Figure 15-32 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

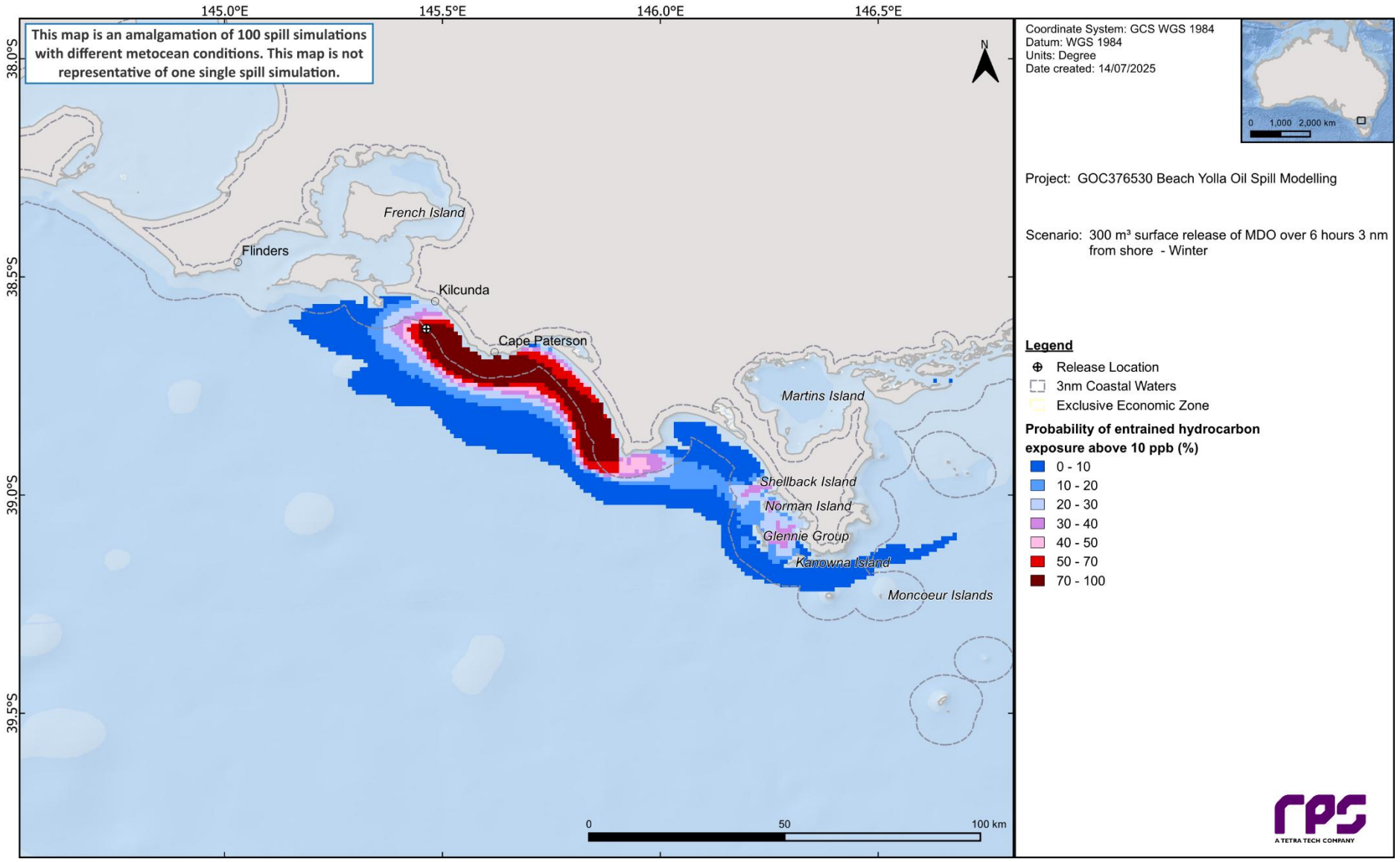


Figure 15-33 Probability of entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

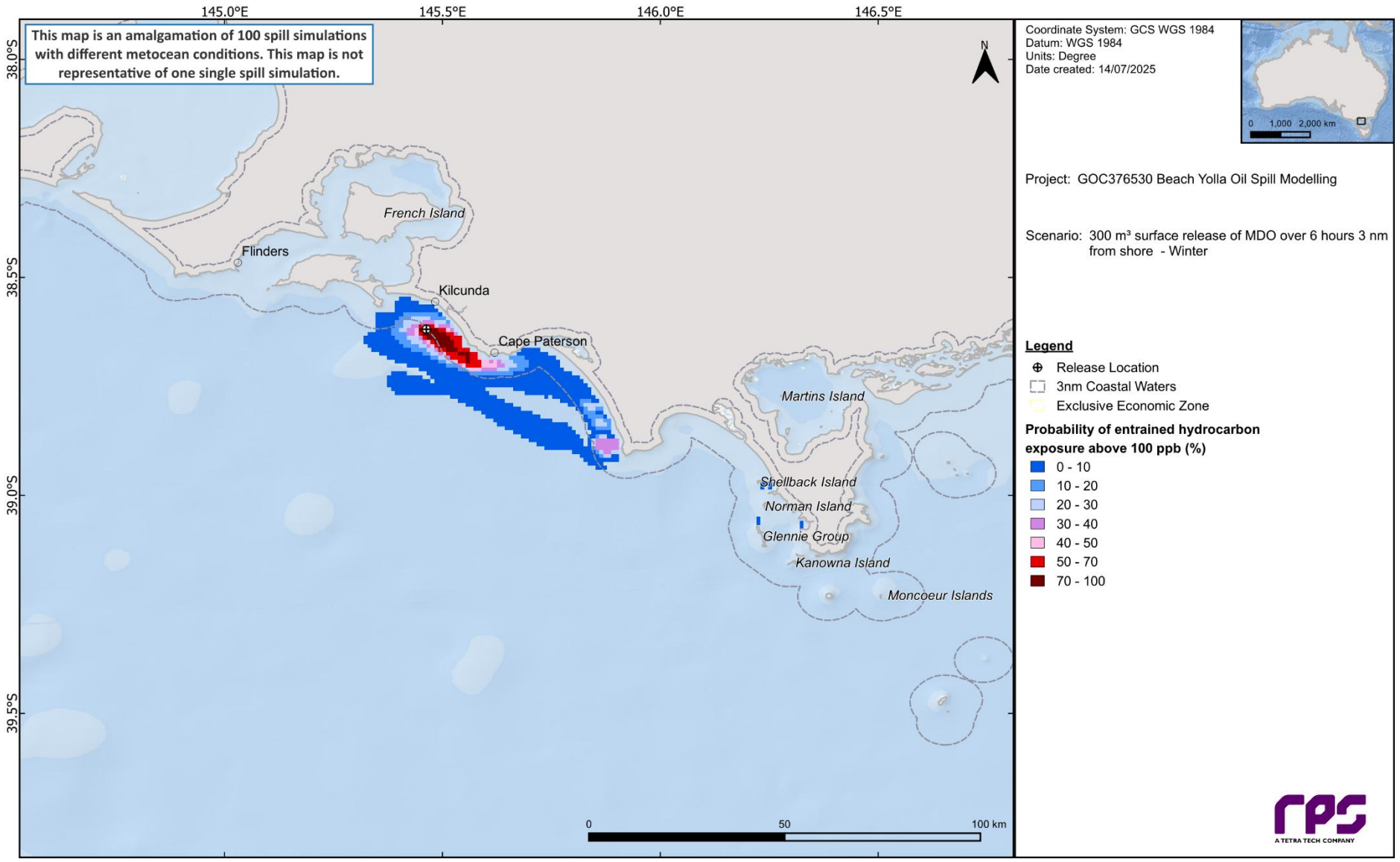


Figure 15-34 Probability of entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

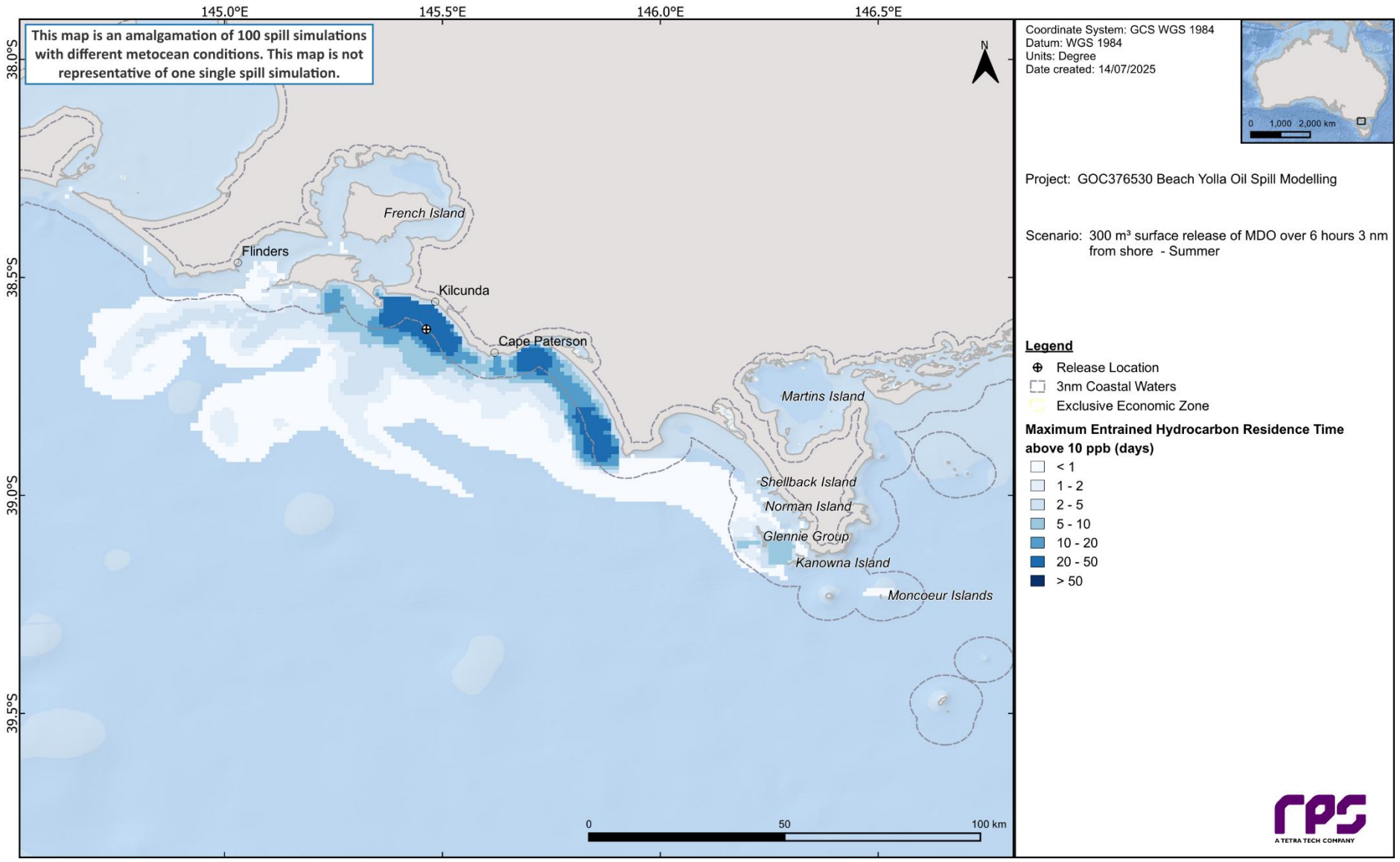


Figure 15-35 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

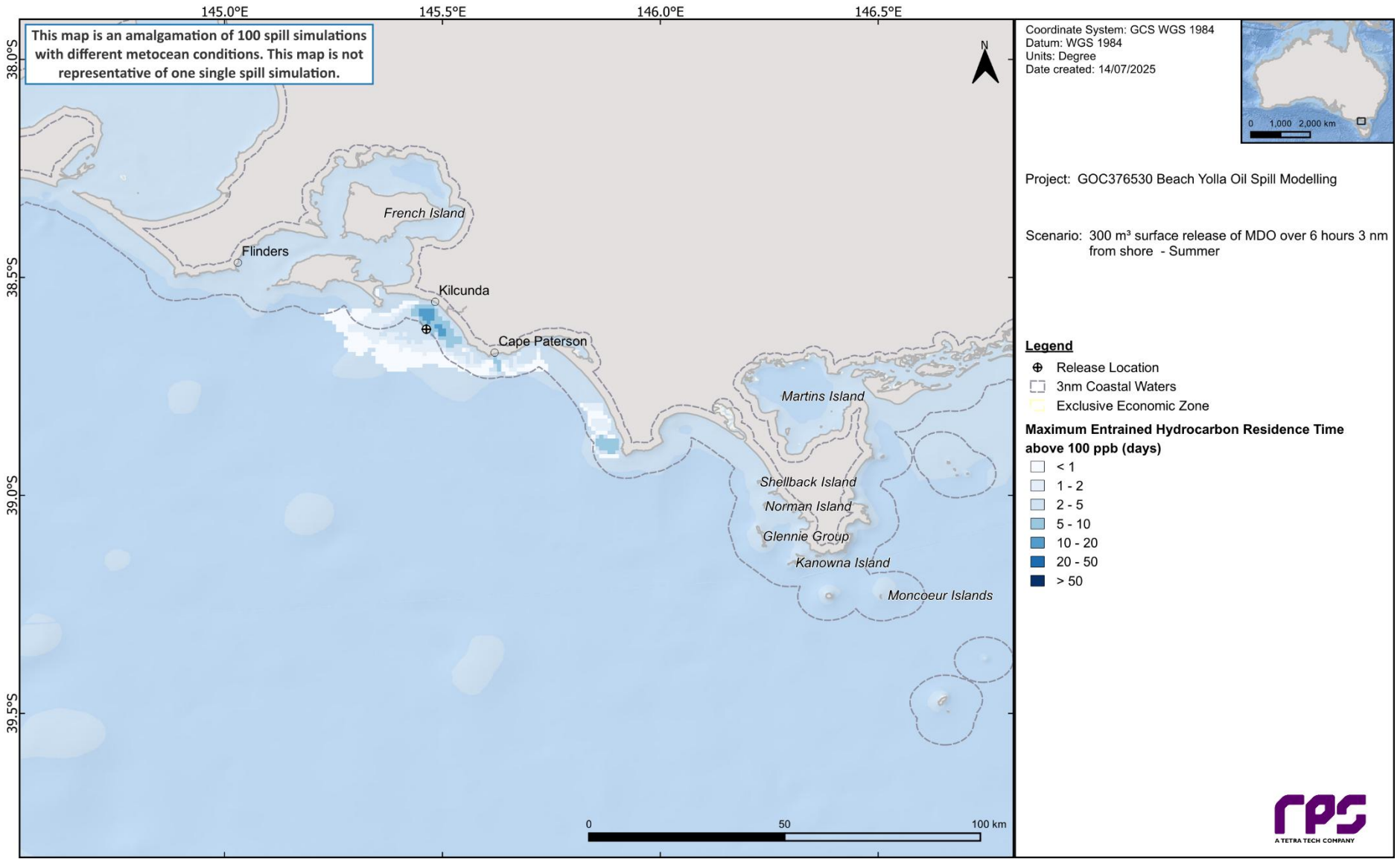


Figure 15-36 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during summer conditions.

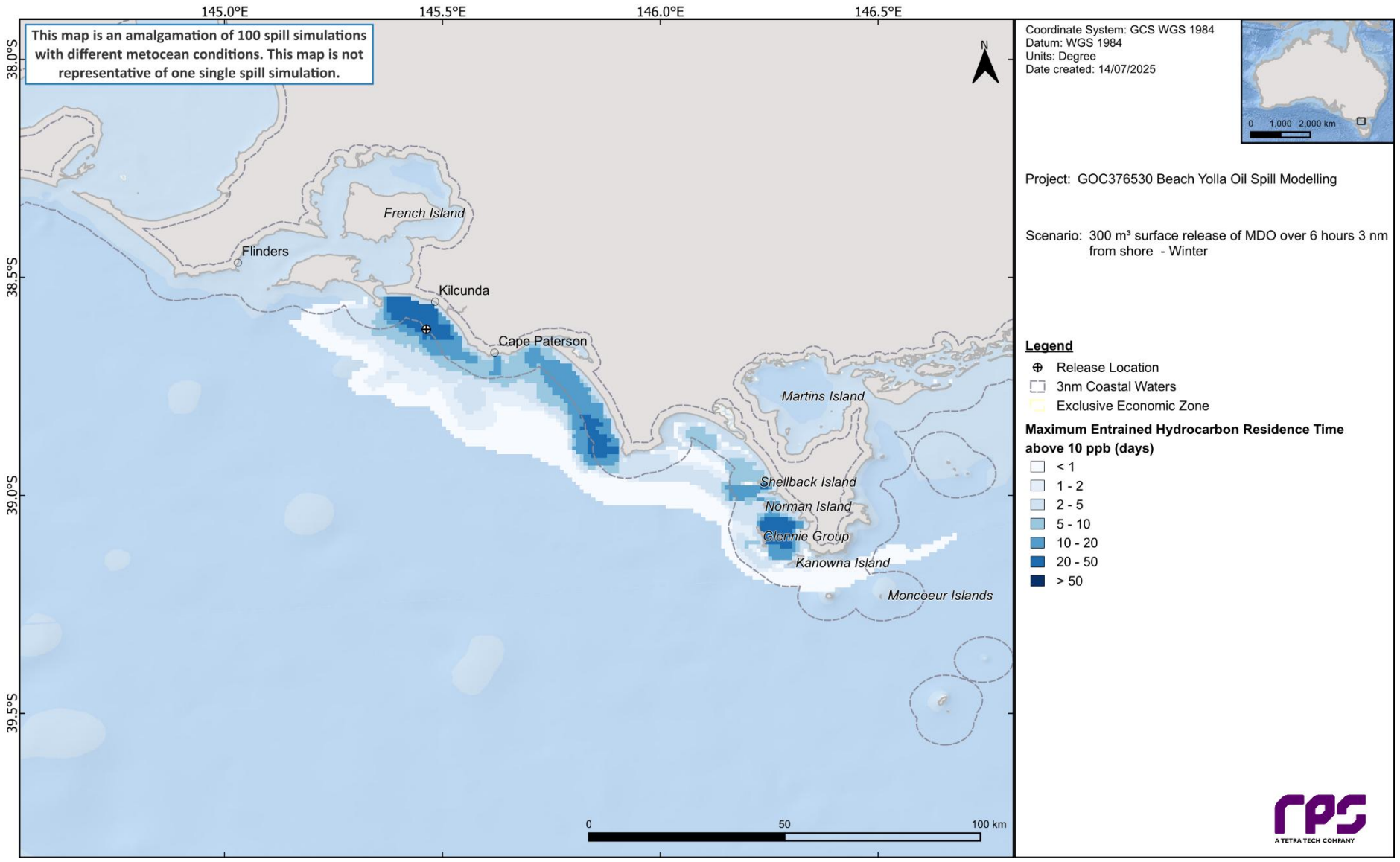


Figure 15-37 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions.

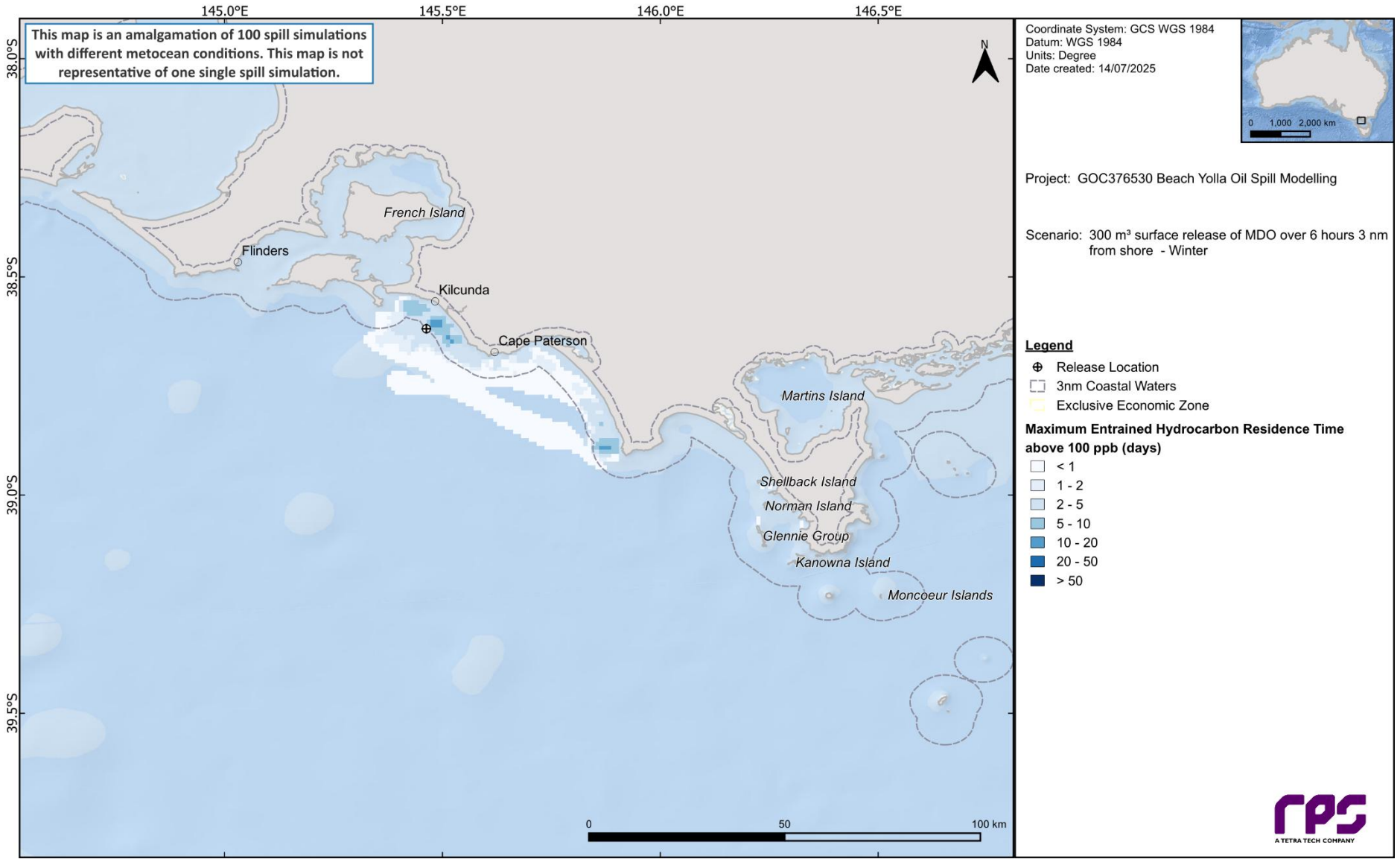


Figure 15-38 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 300 m³ surface release of MDO over 6 hours at a location 3 nm away from the shore. The results were calculated from 100 spill simulations during winter conditions

16 REFERENCES

American Society for Testing and Materials (ASTM) 2013, 'F2067-13 Standard Practice for Development and Use of Oil-Spill Trajectory Models', ASTM International, West Conshohocken (PA).

Andersen, OB 1995, 'Global ocean tides from ERS 1 and TOPEX/POSEIDON altimetry', Journal of Geophysical Research: Oceans, vol. 100, no. C12, pp. 25249–25259.

Anderson JW, Neff JM, Cox BA, Tatem HE & Hightower GM 1974, 'Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish', Marine Biology, vol. 27, no. 1, pp. 75–88.

Anderson JW, Riley R, Kiesser S & Gurtisen J 1987, 'Toxicity of dispersed and undispersed Prudhoe Bay crude oil fractions to shrimp and fish', Proceedings of the 1987 International Oil Spill Conference, American Petroleum Institute, pp. 235–240.

Applied Science Associates (ASA) 2011, OILMAP-DEEP: Blowout Plume Model Technical Manual, Applied Science Associates Inc, South Kingstown, USA.

Asia-Pacific ASA 2010, 'Montara well release monitoring study S7.2 Oil fate and effects assessment: modelling of chemical dispersant operation', Prepared for PTTEP Australasia.

Australian Maritime Safety Authority (AMSA) 2014, 'Identification of oil on water: Aerial observations and identification guide', viewed 4 June 2020, https://www.amsa.gov.au/sites/default/files/2014-01-mp-amsa22-identification-oil-on-water.pdf

Australian Maritime Safety Authority (AMSA) 2015, 'Australian Maritime Safety Authority Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities Australian Maritime Safety Authority', viewed 20 June 2017, https://www.amsa.gov.au/forms-and-publications/Publications/AMSA413_Contingency_Planning_Guidelines.pdf

Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000, 'Australian and New Zealand guidelines for fresh and marine water quality Volume 1, The guidelines (National water quality management strategy; no.4)', Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand. Brandvik, PJ, Johansen, O, Leirvik, F, Farooq, U & Daling PS 2013, 'Droplet Breakup in subsurface oil releases – Part 1: Experimental study of droplet breakup and effectiveness of dispersant injection', Marine Pollution Bulletin, vol. 73, no. 1, pp 319–326.

Becker, JJ, Sandwell, DT, Smith, WHF, Braud, J, Binder, B, Depner, J, Fabre, D, Factor, J, Ingalls, S, Kim, S-H, Ladner, R, Marks, K, Nelson, S, Pharaoh, A, Trimmer, R, Von Rosenberg, J, Wallace, G & Weatherall, P 2009, 'Global bathymetry and evaluation data at 30 arc seconds resolution: SRTM30_PLUS', Marine Geodesy, vol. 32, no. 4, pp. 355–371.

Belore, UC 2014, 'Subsea chemical dispersant research', Proceedings of the 37th AMOP Technical Seminar on Environmental Contamination and Response, Environmental Canada, Canmore, Alberta, Canada pp. 618–650.

Bejarano, AC, Gardiner, WW, Barron, MG, Word, JQ 2017, 'Relative sensitivity of Arctic species to physically and chemically dispersed oil determined from three hydrocarbon measures of aquatic toxicity', *Marine Pollution Bulletin*, vol. 122, pp. 316–322.

Blum DJ & Speece RE 1990, 'Determining chemical toxicity to aquatic species', Environmental Science & Technology, vol. 24, no. 3, pp. 284–293.

Bonn Agreement 2009, 'Bonn Agreement aerial operations handbook, 2009 - Publication of the Bonn Agreement', viewed 13 January 2015, http://www.bonnagreement.org/site/assets/files/3947/ba-aoh_revision_2_april_2012.pdf

Brandvik, PJ, Johansen, O, Farooq, U, Angell, G & Leirvik F 2014, 'Sub-surface oil releases – Experimental study of droplet distributions and different dispersant injection techniques- version 2', A scaled experimental approach using the SINTEF Tower basin. SINTEF report no: A25122. Trondheim Norway 2014. ISBN: 9788214057393

Carls, MG, Holland, L, Larsen, M, Collier, TK, Scholz, NL & Incardona, JP 2008, 'Fish embryos are damaged by dissolved PAHs, not oil particles', Aquatic Toxicology vol. 88, no. 2, pp.121–127.

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R & Bleck, R 2007, 'The HYCOM (hybrid coordinate ocean model) data assimilative system', Journal of Marine Systems, vol. 65, no. 1, pp. 60–83.

Chassignet, E, Hurlburt, H, Metzger, E, Smedstad, O, Cummings, J & Halliwell, G 2009, 'U.S. GODAE: Global Ocean Prediction with the HYbrid Coordinate Ocean Model (HYCOM)', Oceanography, vol. 22, no. 2, pp. 64–75.

Davies, AM 1977a, 'The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile', in JC Nihoul (ed), Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 1–25.

Davies, AM 1977b, 'Three-dimensional model with depth-varying eddy viscosity', in JC Nihoul (ed), Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 27–48.

French, D, Reed, M, Jayko, K, Feng, S, Rines, H, Pavignano, S, Isaji, T, Puckett, S, Keller, A, French III, FW, Gifford, D, McCue, J, Brown, G, MacDonald, E, Quirk, J, Natzke, S, Bishop, R, Welsh, M, Phillips, M & Ingram, BS 1996, 'The CERCLA Type A natural resource damage assessment model for coastal and marine environments (NRDAM/CME), Technical Documentation, Volume I - Model Description, Final Report,' Office of Environmental Policy and Compliance, U.S. Department of the Interior, Washington DC.

French, D, Schuttenberg, H & Isaji, T 1999, 'Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light', Proceedings of the 22nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Alberta, pp. 243–270.

French-McCay, DP 2002, 'Development and application of an oil toxicity and exposure model, OilToxEx', Environmental Toxicology and Chemistry, vol. 21, no. 10, pp. 2080–2094.

French-McCay, DP 2003, 'Development and application of damage assessment modelling: example assessment for the North Cape oil spill', Marine Pollution Bulletin, vol. 47, no. 9, pp. 9–12.

French-McCay, DP 2004, 'Spill impact modelling: development and validation', Environmental Toxicology and Chemistry, vol. 23, no.10, pp. 2441–2456.

French-McCay, DP 2009, 'State-of-the-art and research needs for oil spill impact assessment modelling', Proceedings of the 32nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, pp. 601–653.

French-McCay, D, Rowe, JJ, Whittier, N, Sankaranarayanan, S, & Etkin, DS 2004, 'Estimate of potential impacts and natural resource damages of oil', Journal of Hazardous Materials, vol. 107, no. 1, pp. 11–25.

French-McCay, D, Whittier, N, Dalton, C, Rowe, J, Sankaranarayanan, S & Aurand, D 2005a, 'Modeling the fates of hypothetical oil spills in Delaware, Florida, Texas, California, and Alaska waters, varying response options including use of dispersants', Proceedings of the International Oil Spill Conference 2005, American Petroleum Institute, Washington DC, paper 399.

French-McCay, D, Whittier, N, Rowe, J, Sankaranarayanan, S, Kim, H-S & Aurand, D 2005b, 'Use of probabilistic trajectory and impact modeling to assess consequences of oil spills with various response strategies,' Proceedings of the 28th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, pp. 253–271.

French-McCay, D, Reich, D, Rowe, J, Schroeder, M & Graham, E 2011, 'Oil spill modeling input to the offshore environmental cost model (OECM) for US-BOEMRE's spill risk and costs evaluations', Proceedings of the 34th Arctic and Marine Oil Spill Program (AMOP) Technical Siminar, Environment Canada, Ottawa.

French-McCay, D, Reich, D, Michel, J, Etkin, DS, Symons, L, Helton, D, & Wagner J 2012, 'Oil spill consequence analysis of potentially-polluting shipwrecks', Proceedings of the 35th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa.

French-McCay, D, Jayko, K, Li, Z, Horn, M, Kim, Y, Isaji, T, Crowley, D, Spaulding, M, Decker, L, Turner, C, Zamorski, S, Fontenault, J, Schmmkler, R & Rowe, J 2015, 'Technical Reports for Deepwater Horizon Water Column Injury Assessment: WC_TR.14: Modeling Oil Fate and Exposure Concentrations in the Deepwater Plume and Rising Oil Resulting from the Deepwater Horizon Oil Spill' RPS ASA, South Kingston, Rhode Island.

French-McCay, DP 2023, Entrained oil effects threshold applicable to oil spill modelling results – Presentation to the Australian Energy Producers (AEP) Oil Spill Preparedness and Response Working Group, 2nd November 2023, by Dr. French McCay – Director, Research and Model Development, RPS Ocean Science, South Kingstown, RI USA.

Gordon, R 1982, 'Wind driven circulation in Narragansett Bay' PhD thesis, Department of Ocean Engineering, University of Rhode Island.

Grant, DL, Clarke, PJ & Allaway, WG 1993, 'The response of grey mangrove (*Avicennia marina* (Forsk.) Vierh) seedlings to spills of crude oil,' The Journal of Experimental Marine Biological Ecology, vol. 171, no. 2, pp. 273–295.

International Tankers Owners Pollution Federation (ITOPF) 2020, 'Handbook 2020/21', International Tankers Owners Pollution Federation Ltd, UK.

Isaji, T & Spaulding, M 1984, 'A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank', Journal of Physical Oceanography, vol. 14, no. 6, pp. 1119–1126.

Isaji, T, Howlett, E, Dalton C, & Anderson, E 2001, 'Stepwise-continuous-variable-rectangular grid hydrodynamics model', Proceedings of the 24th Arctic and Marine Oil spill Program (AMOP) Technical Seminar (including 18th TSOCS and 3rd PHYTO), Environment Canada, Edmonton, pp. 597–610.

Jones, ISF 1980, 'Tidal and wind driven currents in Bass Strait', Australian Journal of Marine and Freshwater Research vol. 31, no. 2, pp. 109–117.

Koops, W, Jak, RG & van der Veen, DPC 2004, 'Use of dispersants in oil spill response to minimise environmental damage to birds and aquatic organisms', Proceedings of the Interspill 2004: Conference and Exhibition on Oil Spill Technology, Trondheim, presentation 429.

Kostianoy, AG, Ginzburg, AI, Lebedev, SA, Frankignoulle, M & Delille, B 2003, 'Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data', Oceanology, vol. 43, no. 5, pp. 632–642.

Kraly, J, Pond, RG, Walker, AH, Caplis, J, Aurand,DV, Coelho, GM, Martin, B, Sowby, M 2001, 'Ecological Risk Assessment Principles Applied to Oil Spill Response Planning', Proceedings of the 2001 International Oil Spill Conference, American Petroleum Institute, Washington, DC, pp.177–184.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, 'The World Ocean Database', Data Science Journal, vol.12, no. 0, pp. WDS229–WDS234.

Li, Z, Spaulding, M, French-McCay, D, Crowley, D & Payne JR 2017, 'Development of a unified oil droplet size distribution model with application to surface breaking waves and subsea blowout releases considering dispersant effects', Marine Pollution Bulletin, vol. 114, no. 1, pp 247–257.

Lin, Q & Mendelssohn, IA 1996, 'A comparative investigation of the effects of south Louisiana crude oil on the vegetation of fresh, brackish and Salt Marshes', Marine Pollution Bulletin, vol. 32, no. 2, pp. 202–209.

Ludicone, D, Santoleri, R, Marullo, S & Gerosa, P 1998, 'Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data', Journal of Geophysical Research, vol. 103, no. C2, pp. 2995–3011.

Malins DC & Hodgins HO 1981, 'Petroleum and marine fishes: a review of uptake, disposition, and effects', Environmental Science & Technology, vol. 15, no. 11, pp.1272–1280.

Matsumoto, K, Takanezawa, T & Ooe, M 2000, 'Ocean tide models developed by assimilating TOPEX/POSEIDON altimeter data into hydrodynamical model: A global model and a regional model around Japan', Journal of Oceanography, vol. 56, no.5, pp. 567–581.

McAuliffe CD 1987, 'Organism exposure to volatile/soluble hydrocarbons from crude oil spills – a field and laboratory comparison', Proceedings of the 1987 International Oil Spill Conference, American Petroleum Institute, pp. 275–288.

McCarty LS 1986, 'The relationship between aquatic toxicity QSARs and bioconcentration for some organic chemicals', Environmental Toxicology and Chemistry, vol. 5, no. 12, pp. 1071–1080.

McCarty LS, Dixon DG, MacKay D, Smith AD & Ozburn GW 1992a, 'Residue-based interpretation of toxicity and bioconcentration QSARs from aquatic bioassays: Neutral narcotic organics', Environmental Toxicology and Chemistry, vol. 11, no. 7, pp.917–930.

McCarty LP, Flannagan DC, Randall SA & Johnson KA 1992b, 'Acute toxicity in rats of chlorinated hydrocarbons given via the intratracheal route', Human & Experimental Toxicology, vol. 11, no. 3, pp.173–117.

McCarty LS & Mackay D 1993, 'Enhancing ecotoxicological modelling and assessment. Body residues and modes of toxic action', Environmental Science & Technology, vol. 27, no. 9, pp. 1718–1728.

McGrath JA, & Di Toro DM 2009, 'Validation of the target lipid model for toxicity assessment of residual petroleum constituents: monocyclic and polycyclic aromatic hydrocarbons', Environmental Toxicology and Chemistry, vol. 28, no. 6, pp. 1130–1148.

Middleton, JF & Bye AT 2007, 'A review of shelf-slope circulation along Australia's southern shelves: Cape Leeuwin to Portland', Progress in Oceanography vol. 75, pp. 1–41.

National Academies of Sciences, Engineering, and Medicine (NASEM) 2020, 'The Use of Dispersants in Marine Oil Spill Response', The National Academies Press, Washington, DC, USA.

National Centers for Environmental Information (NCEI) 2021, 'World Ocean Atlas' viewed 20 July 2021, https://www.ncei.noaa.gov/products/world-ocean-atlas

National Oceanic and Atmospheric Administration (NOAA) 2013, Screening level risk assessment package Gulf state, Office of National Marine Sanctuaries & Office of Response and Restoration, Washington DC.

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2018, 'At a glance: Oil spill modelling', viewed 15 November 2018, https://www.nopsema.gov.au/assets/Publications/A626200.pdf

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2019, 'Environment bulletin: Oil spill modelling', viewed 4 February 2020, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

National Research Council (NRC) 2003, 'Oil in the sea III: Inputs, fates and effects', National Research Council, The National Academic Press, Washington DC.

National Research Council (NRC) 2005, 'Oil Spill Dispersants Efficacy and Effects. Committee on Oil Spill Dispersants: Efficacy and Effects', National Research Council, The National Academies Press, Washington DC.

Neff JM & Anderson JW 1981, 'Response of marine animals to petroleum and specific petroleum hydrocarbons' United States Department of Energy, United States.

Negri, A, Brinkman, D, Jones, R 2024, 'Review of entrained oil thresholds Report prepared for Santos', Australian Institute of Marine Science: https://energyproducers.au/wp-content/uploads/2024/07/Review-Entrained-Oil-Thresholds-2024-07-22.pdf

Nirmalakhandan N & Speece RE 1988, 'Quantitative techniques for predicting the behaviour of chemicals in the ecosystem', Environmental Science & Technology, vol. 22, no. 6, pp. 606–615.

Nordtug, T., Olsen, A.J., Altin, D., Overrein, I., Storøy, W., Hansen, B.H. and De Laender, F., 2011. Oil droplets do not affect assimilation and survival probability of first feeding larvae of North-East Arctic cod. Science of the Total Environment, 412, pp.148–153.

Oil Spill Solutions 2015, 'Evaluation - The Theory of Oil Slick Appearances', viewed 6 January 2015, http://www.oilspillsolutions.org/evaluation.htm

Okubo, A, 1971 'Oceanic diffusion diagrams', *Deep Sea Research and Oceanographic Abstracts*, vol. 18, no. 8, pp. 789–802.

Owen, A 1980, 'A three-dimensional model of the Bristol Channel', Journal of Physical Oceanography, vol. 10, pp. 1290–1302.

Qiu, B & Chen, S 2010, 'Eddy-mean flow interaction in the decadally modulating Kuroshio Extension system', Deep-Sea Research II, vol. 57, no. 13, pp. 1098–1110.

Redman AD 2015, 'Role of entrained droplet oil on the bioavailability of petroleum substances in aqueous exposures', Marine Pollution Bulletin, vol. 97, no. 1–2, pp. 342–348.

Saha, S, Moorthi, S, Pan, H-L, Wu, X, Wang, J & Nadiga, S 2010, 'The NCEP Climate Forecast System Reanalysis', Bulletin of the American Meteorological Society, vol. 91, no. 8, pp. 1015–1057.

Sandery, P & Kämpf, J 2007, 'Transport timescales for identifying seasonal variation in Bass Strait, south-eastern Australia', Estuarine, Coastal and Shelf Science, vol. 74, no. 4, pp. 684-696.

Scholten, MCTh, Kaag, NHBM, Dokkum, HP van, Jak, R.G., Schobben, HPM & Slob, W 1996, Toxische effecten van olie in het aquatische milieu, TNO report TNO-MEP – R96/230, Den Helder.

Spaulding, ML, Kolluru, VS, Anderson, E & Howlett, E 1994, 'Application of three-dimensional oil spill model (WOSM/OILMAP) to hindcast the Braer Spill', Spill Science and Technology Bulletin, vol. 1, no. 1, pp. 23–35.

Spaulding, ML, Bishnoi, PR, Anderson, E & Isaji, T 2000, 'An integrated model for prediction of oil transport from a deep water blowout', Proceedings of the 23rd Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Environment Canada, Vancouver, BC, pp. 2611–2635.

Spaulding, ML, Mendelsohn, D, Crowley, D, Li, Z, and Bird A, 2015. Technical Reports for Deepwater Horizon Water Column Injury Assessment- WC_TR.13: Application of OILMAP DEEP to the Deepwater Horizon Blowout. RPS APASA, 55 Village Square Drive, South Kingstown, RE 02879.

Suprayogi, B & Murray, F 1999, 'A field experiment of the physical and chemical effects of two oils on mangroves', Environmental and Experimental Botany, vol. 42, no. 3, pp. 221–229.

Swartz RC, Schults DW, Ozretich RJ, Lamberson JO, Cole FA, Ferraro SP, Dewitt TH & Redmond MS 1995, 'ΣPAH: A Model to predict the toxicity of polynuclear aromatic hydrocarbon mixtures in field-collected sediments', Environmental Toxicology and Chemistry, vol. 14, no. 11, pp. 1977–1187.

Verhaar, HJ, Van Leeuwen, CJ & Hermens, JL 1992, 'Classifying environmental pollutants', Chemosphere, vol. 25, no. 4, pp. 471-491.

Verhaar, HJ, de Wolf, W, Dyer, S, Legierse, KC, Seinen, W & Hermens, JL 1999, 'An LC_{50} vs time model for the aquatic toxicity of reactive and receptor-mediated compounds. Consequences for bioconcentration kinetics and risk assessment', Environmental Science & Technology, vol. 33, no. 5, pp.758–763.

Willmott, CJ 1981, 'On the validation of models', Physical Geography, vol. 2, no. 2, pp.184–194.

Willmott, CJ 1982, 'Some comments on the evaluation of model performance', Bulletin of the American Meteorological Society, vol. 63, no. 11, pp.1309–1313.

Willmott CJ, Ackleson SG, Davis RE, Feddema JJ, Klink, KM, Legates, DR, O'Donnell, J & Rowe, CM 1985, 'Statistics for the evaluation of model performance', Journal of Geophysical Research, vol. I 90, no. C5, pp. 8995–9005.

Willmott, CJ & Matsuura, K 2005, 'Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance', Journal of Climate Research, vol. 30, no. 1, pp. 79–82.

Yaremchuk, M & Tangdong, Q 2004, 'Seasonal variability of the large-scale currents near the coast of the Philippines', Journal of Physical Oceanography, vol. 34, no., 4, pp. 844–855.

Zigic, S, Zapata, M, Isaji, T, King, B, & Lemckert, C 2003, 'Modelling of Moreton Bay using an ocean/coastal circulation model', Proceedings of the 16th Australasian Coastal and Ocean Engineering Conference, the 9th Australasian Port and Harbour Conference and the Annual New Zealand Coastal Society Conference, Institution of Engineers Australia, Auckland, paper 170.