ENVIRONMENT PLAN APPENDICES

GEOGRAPHE SUBSEA INSTALLATION & COMMISSIONING (VIC/L23)

Appendices

Title	
1	Assessment of the activity against the aims of marine park management plans
2	Assessment of the activity against the aims of threatened species' management plans
3	Stakeholder consultation flyer
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7	Sound Transmission Loss Modelling (STLM) Report
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Appendix 1

Assessment of the activity against the management aims of protected area management plans

Assessment of the activity against the aims of protected area management plans	
COMMONWEALTH	
1a	South-east Commonwealth Marine Reserves Network
1b	The National Light Pollution Guidelines for Wildlife
SOUTH AUSTRALIA	
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VICTORIAN RESERVES (west to east)	
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1q	Bunurong-Kilcunda-Harmers Parks
1r	Cape Liptrap Coastal Park
1s	Wilsons Promontory (three marine) Parks

Assessment of the activity against the stated management strategies and actions of the South-east Commonwealth Marine Reserves Network Management Plan 2013-2023 (DNP, 2013)

The table below provides an assessment of the routine and non-routine operations against the IUCN objectives outlined in the Australian IUCN Reserve Management Principles for Commonwealth Marine Protected Areas (Environment Australia, 2002).

Zonation of each relevant AMP based on IUCN categories

	IUCN Ia	IUCN Ib	IUCN II	IUCN III	IUCN IV	IUCN V	IUCN VI
Apollo	-	-	-	-	-	-	
Beagle	-	-	-	-	-	-	

Note: Only Category IUCN II and VI AMPs are relevant to the activity. As such, only the Category IUCN VI management principles are assessed.

Category	IUCN 1994 category description	IUCN 1994 primary objective	Australian IUCN reserve management principles (Schedule 8 of the EPBC Regulations 2000)	Predicted consequences from routine activities or a worst-case hydrocarbon spill
IUCN VI *Managed Resource Protected Area*: Protected Area managed mainly for the sustainable use of natural ecosystems	Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.	To protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.	The reserve or zone should be managed mainly for the sustainable use of natural ecosystems based on the following principles:	Routine discharges from the CSV will not impact on the AMPs. The AMPs may only be impacted in the event of a Level 3 hydrocarbon spill. Response strategies outlined in the OPEP aim to protect the AMPs from the risks of hydrocarbons. An assessment of the risk of a hydrocarbon spill on sensitivities in the region is presented in the EP.
			The biological diversity and other natural values of the reserve or zone should be protected and maintained in the long term.	
			Management practices should be applied to ensure ecologically sustainable use of the reserve or zone.	Routine discharges from the CSV will not impact on the management practices of the AMPs.
			Management of the reserve or zone should contribute to regional and national development to the extent that this is consistent with these principles.	Routine discharges from the CSV will have no influence on management of the zones within the AMP.

The table on the following page provides an assessment of the activity against the stated management strategies and actions of the South-east Commonwealth Marine Reserves Network Management Plan 2013-2023.

Management Strategy	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Improve knowledge and understanding of the conservation values of the Marine Reserves Network and of the pressures on those values		
As part of a national-scale program for Commonwealth marine reserves, develop and implement a South-east Commonwealth Marine Reserves Network Research and Monitoring strategy that contribute to increased understanding of the values of the reserves and provides for ongoing reporting of their condition	No impacts.	No impacts.
Develop and implement a framework for the long-term scientific monitoring of changes in key conservation values protected by the Commonwealth marine reserves and on the pressures on those values.	No impacts.	No impacts.
Adopt standards and protocols for managing biophysical and ecological data collected within Commonwealth Marine Reserves.	No impacts.	No impacts.
Collaborate, including through developing partnerships, with national research facilities, science and academic institutions and, as appropriate, marine reserve users, to deliver on strategic information needs and to inform research programs and government and industry investment in marine research.	No impacts.	No impacts.
Minimise impacts of activities through effective assessment of proposals, decision-making and management of reserve-specific issues		
Establish in consultation with relevant stakeholders, efficient, effective and transparent processes for assessment, decision-making and authorisation of activities, and implement within the marine reserves network.	No impacts.	No impacts.
When the interests of a person or group are likely to be affected by a decision under this Management Plan, the Director will: a) as far as practicable consult them in a timely and appropriate way; b) provide an opportunity to comment on the proposed decision and associated actions; c) take any comments into account; d) give reasonable notice before decisions are taken or implemented (except in cases of emergency); and e) provide reasons for decisions.	No impacts.	No impacts.
Comply with Division 14.3 of the EPBC Regulations in relation to reconsideration of decisions about permits.	No impacts.	No impacts.
Reconsider a decision about a class approval when requested by a person whose interests are affected by the decision. A request for reconsideration must be made and considered in the same manner as provided by Divison14.3 of the EPBC Regulations. Subject to the Administrative Appeals Tribunal Act 1975, a person who has requested a reconsideration may apply to the Administrative Appeals Tribunal for review of the reconsideration.	No impacts.	No impact.

Management Strategy	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Consider further use of class approvals where there is a sound case for effectively assessing and efficiently approving users that carry out a class of activities in a uniform way.	No impacts.	No impact.
Identify reserve specific issues and develop, implement and evaluate management responses where appropriate.	No impacts.	No impact.
Protect the conservation values of the Marine Reserves Network through management of environmental incidents		
Establish systems for timely reporting of, and assisting with responses to, environmental incidents.	No impacts.	No impacts.
Collaborate with responsible agencies and assist with responding to environmental incidents that threaten the values of the marine reserves network.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Maintain effective liaison and partnerships with relevant environmental incident response agencies and organisations.	No impacts.	No impact.
Identify and assess potential incidents that may threaten conservation values of the Reserves and implement if feasible approaches to reduce the likelihood or consequence of such incidents.	No impacts.	No impact.
Facilitate compliance with this Management Plan through education and enforcement		
Implement reliable methods for monitoring compliance with this Plan.	No impacts.	No impact.
Develop, maintain and disseminate appropriate information to assist users of the marine reserves network to comply with the provisions of this Plan.	No impacts.	No impact.
Consult with users of the network to identify opportunities to improve the effectiveness and efficiency of compliance measures.	No impacts.	No impact.
Implement a risk-based annual compliance plan.	No impacts.	No impact.
Establish a reporting system that supports users and visitors of the marine reserves network to report suspected non-compliant activity.	No impacts.	No impact.
Build effective working partnerships and agreements with Commonwealth and state government agencies for the delivery of compliance services.	No impacts.	No impact.
Investigate and monitor suspected non-compliant activity and, where appropriate, take enforcement action.	No impacts.	No impact.

Management Strategy	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Support initiatives and programs which promote best practice standards that guide use, and minimise impacts on the marine environment	No impacts.	No impact.
Promote community understanding of, and stakeholder participation in, the management of the Marine Reserves Network		
Develop and implement a communication and education plan that increases community understanding of the importance of the marine reserves network and meets reserve-specific needs for communication about the values protected and management arrangements and requirements.	No impacts.	No impact.
Maintain effective working relationships with user groups to facilitate the exchange of knowledge, understanding and participation in the management of the marine reserves network.	No impacts.	No impact.
Within the first 12 months of the Plan's operation, establish consultative structures (e.g., committees) to guide and participate in the management of the marine reserves network.	No impacts.	No impact.
Support involvement of Indigenous people in management of Commonwealth Marine Reserves		
Drawing on the significant body of knowledge built as part of sea country planning and similar initiatives across Australia, and in consultation with relevant representative organisations, consolidate and communicate information about cultural values protected in the South-east Commonwealth Marine Reserves Network.	No impacts.	No impact.
Identify, and where feasible support, opportunities for Indigenous people to engage in the management of sea country in Commonwealth marine reserves, for example through the delivery of critical management services, such as monitoring surveillance, compliance and research.	No impacts.	No impact.
Build effective partnerships with Indigenous communities and organisations that have an interest in the marine reserves network.	No impacts.	No impact.
Comply with the requirements of the Native Title Act 1993.	No impacts.	No impact.
Evaluate and report on the effectiveness of this Management Plan through monitoring and review		
Within the first twelve months of the Plan's operation, design and initiate a program to measure and monitor progress on Actions and outcomes.	No impacts.	No impact.
Report annually on the South-east Commonwealth Marine Reserves Network in the Director of National Parks annual report.	No impacts.	No impact.
Evaluate and report on the implementation of the Management Plan before its expiry. The report will consider: a. An assessment of the existing measures to protect the South-east Commonwealth Marine Reserves Network; b. Progress of the strategies and actions towards achieving the stated outcomes; c. options for improving management of the marine reserves network.	No impacts.	No impact.

Assessment of the activity against the stated management actions of National Light Pollution Guidelines (DoEE, 2020)

The table on the following pages provide an assessment of the activity against the stated management actions of the Guidelines.

Note: impacts to turtles are not assessed because there are only vagrant individuals and no nesting beaches present in the Otway region. Similarly, impacts to shorebirds are not assessed given that the nearest part of the activity area is located over 45 km from the nearest shoreline.

Management Actions	Achievable?	Assessment of the activity against stated management actions
Implement management actions during the breeding season.	Yes	Achievable management actions are identified throughout this table.
Maintain a dark zone between the rookery and the light sources.	Yes	The nearest potential rookery location is 47 km away on the Otway coast. As such, there is a large dark zone between the rookery and the activity area.
Turn off lights during fledgling season.	N/A	The activity is conducted 24-hours a day and light is necessary for personnel safety. Most seabirds in the region are migratory with breeding occurring internationally, so fledglings are not an important consideration in this area.
Use curfews to manage lighting.	N/A	The activity is conducted 24-hours a day and deck lighting is necessary for personnel safety. Lighting maintained in accordance with legislation and for human safety overrides environmental considerations.
Aim lights downwards and direct them away from nesting areas.	Yes	Where practicable, lights will be directed towards working areas for the safety of personnel. The nearest potential rookery location is 47 km away on the Otway coast.
Use flashing/intermittent lights instead of fixed beam.	No	The activity is conducted 24-hours a day and deck lighting is necessary for personnel safety. Vessel lighting is installed and maintained in accordance with the *Navigation Act* 2012. Lighting for human safety overrides environmental considerations.
Use motion sensors to turn lights on only when needed.	No	The activity is conducted 24-hours a day and lighting of all areas is necessary for personnel safety. Lighting for human safety overrides environmental considerations.
Prevent indoor lighting reaching outdoor environment.	Yes	Blinds will be lowered on portholes and windows at night where this does not interfere with safe work practices.
Manage artificial light on jetties, wharves, marinas, etc.	N/A	Not applicable to this activity.
Reduce unnecessary outdoor, deck lighting on all vessels and permanent and floating oil and gas installations in known seabird foraging areas at sea.	No	The activity is conducted 24-hours a day and deck lighting is necessary for personnel safety. Lighting for human safety overrides environmental considerations.

Management Actions	Achievable?	Assessment of the activity against stated management actions
Night fishing should only occur with minimum deck lighting.	N/A	Not applicable - fishing is not permitted from the CSV.
Avoid shining light directly onto fishing gear in the water.	N/A	Not applicable - fishing is not permitted from the CSV.
Ensure lighting enables recording of any incidental catch, including by electronic monitoring systems.	N/A	Not applicable - fishing is not permitted from the CSV.
Avoid shining light directly onto longlines and/or illuminating baits in the water.	N/A	Not applicable - fishing is not permitted from the CSV.
Vessels working in seabird foraging areas during breeding season should implement a seabird management plan to prevent seabird landings on the ship, manage birds appropriately and report the interaction.	N/A	The CSV is equipped with lighting required under legislation to identify itself to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew. Most seabirds in the region are migratory with breeding occurring internationally, with no breeding areas (i.e., islands) within 45 km of the activty area.
Use luminaires with spectral content appropriate for the species present.	No	The CSV is equipped with lighting required under legislation to identify itself to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew. Most seabirds in the region are migratory with breeding occurring internationally, with no breeding areas (i.e., islands) within 45 km of the activity area.
Avoid high intensity light of any colour.	No	
Shield gas flares and locate inland and away from seabird rookeries.	N/A	Not applicable – no flaring undertaken during this activity.
Minimise flaring on offshore oil and gas production facilities.	N/A	Not applicable – no flaring undertaken during this activity.
In facilities requiring intermittent night-time inspections, turn on lights only during the time operators are moving around the facility.	N/A	The CSV is equipped with lighting required under legislation to identify itself to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew.
Ensure industrial site/plant operators use head torches.	No	The activity is conducted 24-hours a day and lighting of all areas is necessary for personnel safety. As such, the use of head torches is not necessary.
Supplement facility perimeter security lighting with computer monitored infrared detection systems.	N/A	Not applicable to this activity.
Tourism operations around seabird colonies should manage torch usage so birds are not disturbed.	N/A	Not applicable to this activity.

Management Actions	Achievable?	Assessment of the activity against stated management actions
Design and implement a rescue program for grounded birds.	No	Due to the distance between the activity area and seabird rookeries, grounding of birds is unlikely to occur and thus a rescue program is not necessary.

Assessment of the activity against the stated goals of the Belfast Coastal Reserve Management Plan (Parks Victoria, 2018)

The table on the following pages provide an assessment of routine and non-routine operations against the management goals of the park.

Management Goals	Assessment of impacts of routine activities against management goals	Assessment of impacts of Level 2 or 3 hydrocarbon spill against management goals
Geological features and functioning dune systems are maintained and protected from avoidable damage.	No impact.	No impact.
The cultural landscape of Belfast Coastal Reserve is recognised and landscape features and values, including Traditional Owner and local community connections, are recognised, respected, protected and celebrated.	No impact.	No impact.
Historic heritage and connections are recognised and understanding of heritage values and places is enhanced.	No impact.	No impact.
Contemporary Traditional Owner and local community connections are recognised as an integral part of heritage management.	No impact.	No impact.
Partnerships with Traditional Owners protects and conserves Aboriginal features, places and objects of cultural significance.	No impact.	No impact.
Eastern Maar cultural traditions and knowledge is practiced and shared at the Reserve.	No impact.	No impact.
The condition of Coastal Dune Scrub and Swamp Scrub/Aquatic Herbland Mosaic communities and wetlands is maintained and enhanced to support dependent flora and fauna species.	No impact.	No impact.
The impact of predation is reduced to maintain and increase native fauna populations.	No impact.	No impact.
The impact of visitors and uses at key locations is reduced to allow for an increase in the extent and richness of vulnerable fauna, and the occupation of most of their potential habitat.	No impact.	No impact.
The diversity and productivity of the marine habitats is maintained and impacts from new pests and other threats are reduced.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impact.

Management Goals	Assessment of impacts of routine activities against management goals	Assessment of impacts of Level 2 or 3 hydrocarbon spill against management goals
Water levels in the Lower Merri are managed to maintain resilience and aquatic values in the wetlands and estuary.	No impact.	No impact.
The risk of bushfire into and from the Reserve is minimised and ecologically appropriate fire regimes are maintained to enhance Reserve ecosystems.	No impact.	No impact.
Management activities build resilience of coastal systems, ecosystems, species and dependent species to climate change risks and minimise impacts on Reserve facilities.	No impact.	No impact.

Assessment of activity against the stated aims of the Discovery Bay Parks Management Plan (Parks Victoria, 2006)

The table on the following page provides an assessment of routine and non-routine operations against the management aims of the park.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Geological and landform features		
Protect significant and sensitive geological and geomorphological features and land-forming processes.	No impact.	No impact.
Minimise impacts of visitors and other activities on the significant geological and geomorphological features.	No impact.	No impact.
Improve understanding of the nature, origin and dynamics of the landform and geological features of the planning area.	No impact.	No impact.
Interpret geological and geomorphological features of the planning area.	No impact.	No impact.
4.2 Rivers and Wetlands		
Maintain and manage the wetlands for natural and cultural values conservation and appreciation.	No impact.	No impact.
Maintain access to the deeper lakes for approved recreation and to assist in minimising visitor impacts.	No impact.	No impact.
4.3 Vegetation		
Manage ecosystems to ensure the preservation and protection of indigenous flora, particularly threatened communities and species.	No impact.	No impact.

Management Aims	**Assessment of impacts of routine activities against management aims**	**Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives**
In the short-term, conserve native plant communities in their present condition as far as practicable, and conserve biodiversity.	No impact.	No impact.
Improve knowledge of vegetation community dynamics and the ecology of threatened plant species.	No impact.	No impact.
Adopt, in the longer term, improved vegetation management practices to achieve outcomes identified in vegetation studies.	No impact.	No impact.
Respect Indigenous peoples' tradition and practices related to indigenous flora.	No impact.	No impact.
4.4 Fauna		
Protect native fauna from unnecessary disturbance by visitors and management activities.	No impact.	
Maintain or enhance fauna habitat diversity and integrity.	No impact.	No impact.
Increase knowledge of the distribution and management requirements of rare or threatened species.	No impact.	No impact.
Respect Indigenous tradition and practices related to endemic fauna.	No impact.	No impact.
4.5 Landscape		
Protect and preserve the landscape values of the planning area, particularly the places of special significance to the Gournditch-Mara and areas of high scenic quality and viewer interest.	No impact.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Minimise visual impacts on the natural landscape of the planning area, especially from major viewing points.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Rehabilitate, remove or ameliorate undesirable visual intrusions in the planning area.	No impact.	No impact.
Ensure that impacts of developments within the planning area on views from within and outside the area are adequately mitigated.	No impact.	No impact.
4.6 Fire Management		
Protect human life, property and planning area values from injury by fire.	No impact.	No impact.
Manage fire and undertake fire protection works as appropriate for the protection of life, property and planning area values, and the conservation of natural values.	No impact.	No impact.
4.7 Pest Plants and Animals		
Control, and where possible eradicate, pest plants and animals in the parks.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impact.
Minimise the introduction and spread of new pest plant infestations and pathogens.		No impact.
Minimise the impact of control programs on native flora and fauna.	No impact.	No impact.
Restore native vegetation to areas previously infested by introduced plants.	No impact.	No impact.
4.8 Soil Conservation		
Stabilise selected coastal headland areas to protect cultural values, particularly middens.	No impact.	No impact.
Allow natural dune movement processes to continue without management intervention, except where clearly identified assets are threatened.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Manage visitor and management activities to prevent erosion, especially in sensitive or significant areas.	No impact.	No impact.
Restore erosion damage directly attributable to recent visitor use or where cultural or environmental values are threatened.	No impact.	No impact.
Educate visitors, users and neighbours to respect the natural and cultural values of the dune environment and its assets.	No impact.	No impact.
5.1 Indigenous Heritage		
Protect Aboriginal cultural heritage from damage by natural processes and inappropriate human activities.	No impact.	No impact.
Encourage research of Aboriginal heritage, including tradition and practices, relating to the planning area.	No impact.	No impact.
5.2 Post-settlement Cultural Heritage		
Protect archaeological and cultural places and relics from damaging natural processes and inappropriate recreational and other activities.	No impact.	No impact.
Ensure that post-settlement historical perspectives are included in the planning and implementation of programs.	No impact.	No impact.
6.1 Information, Interpretation and Education		
Provide appropriate pre-visit motivational and tour-planning information to visitors.	No impact.	No impact.
Orientate visitors to the planning area and its features.	No impact.	No impact.
Facilitate visitors' enjoyment, appreciation and understanding of the planning area by influencing their behaviour.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Enhance the community's knowledge of the values of the planning area and its contributions to employment and the State's economy, and promote a positive image of the planning area.	No impact.	No impact.
Inform visitors of appropriate behaviour during their visit to the planning area.	No impact.	No impact.
6.2 Vehicle Access		
Maintain existing public access in the planning area to standards appropriate to the use and protection of particular sites.	No impact.	No impact.
Identify opportunities for reducing vehicular impacts on the planning area.	No impact.	No impact.
Facilitate responsible four-wheel-drive vehicle use in appropriate areas.	No impact.	No impact.
Protect park values from illegal off-road driving including sensitive dune areas.	No impact.	No impact.
Ensure that appropriate materials are used for road construction and maintenance.	No impact.	No impact.
6.3 Day Visitor Activities		
Provide day visitor facilities that enhance visitors' enjoyment of the planning area while protecting park values.	No impact.	No impact.
Provide and maintain safe visitor facilities of an adequate standard for visitors.	No impact.	No impact.
6.4 Walking		
Provide for a variety of walking experiences, including long-distance walking experiences for independent and guided walkers.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Maintain tracks to standards appropriate to their settings while minimising the impacts on park values.	No impact.	No impact.
6.5 Fishing		
Provide ongoing, sustainable opportunities for recreational fishing and bait collection.	No impact.	No impact.
Work in partnership with angling clubs and interest groups to maintain appropriate access to fishing locations, while minimising impacts on the planning area's values and minimising the risks to visitors.	No impact.	No impact.
6.6 Camping		
Maintain and improve existing opportunities for vehicle-based camping.	No impact.	No impact.
Maintain remote campsites in sections of the Great South West Walk in the planning area.	No impact.	No impact.
6.7 Water-based recreation activities		
Provide appropriate opportunities for a range of water based recreational activities, including motorised activities.	No impact.	No impact.
Minimise impacts of water-based recreational activities on park conservation values.	No impact.	No impact.
Minimise risks and loss of amenity for visitors and neighbours from motorised uses of the planning area.	No impact.	No impact.
6.8 Horse riding		
Provide ongoing, sustainable opportunities for commercial and recreational horse riding activities, consistent with protecting natural and cultural values, and avoiding conflicts with other park	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
visitors.		
6.9 Dogs		
Continue to permit dogs on leashes in designated beach areas.	No impact.	No impact.
Minimise conflict between dogs and visitors.	No impact.	No impact.
Minimise impacts from dogs and dog walking on natural and cultural values, particularly shore-nesting birds.	No impact.	No impact.
6.10 Commercial tourism services		
Provide opportunities for, and encourage the provision of commercial tourism services and events that achieve outcomes consistent with the aims for the planning area and contribute to tourism opportunities.	No impact.	No impact.
6.11 Public safety		
Inform visitors and staff of risks to their safety.	No impact.	No impact.
Promote and observe safe practices, and co-operate with emergency services.	No impact.	No impact.
Avoid, and identify and minimise or remove, risks associated with developments, access and use.	No impact.	No impact.

Assessment of activity against the stated aims of the Port Campbell National Park and Bay of Islands Coastal Park Management Plan (Parks Victoria, 1998)

The table on the following page provides an assessment of routine and non-routine operations against the management aims of the park.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Geological and landform features		
Protect significant and sensitive geological and geomorphological features and land-forming processes.	No impact.	No impact.
Minimise impacts of visitors and other activities on the significant geological and geomorphological features.	No impact.	No impact.
Provide opportunities for visitors to observe and experience the features and processes of the Parks.	No impact.	No impact.
Improve understanding of the nature, origin and dynamics of the landform and geological features of the Parks.	No impact.	No impact.
4.2 Vegetation		
Conserve native plant communities in their natural condition and maintain and enhance habitat diversity while allowing natural environmental processes to continue.	No impact.	No impact.
Maintain genetic diversity.	No impact.	No impact.
Provide special protection for significant plant species and communities, and sites of botanical significance.	No impact.	No impact.
4.3 Fauna		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Protect native fauna and maintain genetic diversity.	No impact.	No impact.
Provide special protection for significant fauna.	No impact.	No impact.
Maintain fauna habitat diversity and integrity.	No impact.	No impact.
4.4 Landscape		
Minimise visual impacts on the natural landscape, especially as seen from the Great Ocean Road and other access routes and viewing points.	No impact.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Rehabilitate, remove or ameliorate undesirable visual intrusions, including inappropriate car parks.	No impact.	No impact.
4.5 Cultural Heritage		
Protect archaeological and historic sites.	No impact.	No impact.
Provide access to, and interpret, selected archaeological and historic sites, consistent with the protection of the historical values and safety of visitors.	No impact.	No impact.
Develop the tourism potential of the Glenample Homestead complex, consistent with protecting historical values and complementing the development of tourism along the Great Ocean Road.	No impact.	No impact.
4.6 Conservation Management		
Develop and apply systems that ensure change is managed to protect and enhance the natural environment.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
5.1 Fire Management		
Protect human life, property and park values from injury by fire.	No impact.	No impact.
Maintain fire regimes appropriate to the conservation of native flora and fauna.	No impact.	No impact.
Minimise the adverse effects of all fires and fire suppression methods on park values.	No impact.	No impact.
5.2 Pest Plants and Animals, and Diseases		
Control, and where possible eradicate, pest plants and animals in the parks.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impact.
Protect the Parks from other threats and diseases, in particular Cinnamon Fungus and new infestations of non-indigenous species	No impact.	No impact.
Minimise the impact of control programs on native flora and fauna.	No impact.	No impact.
Control, and where possible eradicate, non-indigenous plants and animals.	No impact.	No impact.
Restore native vegetation to areas previously infested by introduced plants.	No impact.	No impact.
5.3 Soil Conservation		
Minimise direct disturbance to soils.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Minimise damage to vegetation and maintain vegetation cover.	No impact.	No impact.
6.1 The Park Visitor		
Provide facilities and services that cater for visitors in accordance with the above overview of future management for visitors.	No impact.	No impact.
Provide a hierarchy of orientation, interpretation and tourist facilities across the Parks.	No impact.	No impact.
Monitor and investigate growing pressures on the Parks and develop strategies to contain these pressures so that natural values are protected and visitor experiences are enhanced.	No impact.	No impact.
Co-operate with other Government agencies and stakeholders in the Parks to conserve the local environment and facilitate development of the local economy.	No impact.	No impact.
6.2 Marketing		
Ensure that PCNP, BICP, Glenample Homestead and the Tourism Centre (when established at Port Campbell) are marketed as one of Victoria's key tourist destinations.	No impact.	No impact.
Provide appropriate motivational and tour planning information to visitors before they undertake their Park visit.	No impact.	No impact.
6.3 Visitor Recreation		
To orient the independent car-based traveller to the Parks in relation to park features.	No impact.	No impact.
To inform visitors of appropriate codes of behaviour before and during their Park visit.	No impact.	No impact.
Enhance visitor understanding and appreciation of the Parks through provision of interpretative information.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide varying levels of park educational information to meet a variety of visitor demands.	No impact.	No impact.
Cater to the expectations of both domestic and international independent travellers and coach visitors.	No impact.	No impact.
Establish and maintain day visitor facilities that enhance visitor enjoyment of the Parks and are consistent with protecting park values.	No impact.	No impact.
Provide facilities suitable for visitors with limited mobility.	No impact.	No impact.
Develop a world class Tourist Centre attraction highly attractive to all visitor segments, especially international tourists.	No impact.	No impact.
Ensure that the Tourist Centre augments and stimulates visitors’ experience of the Parks.	No impact.	No impact.
Given the increasing visitor pressures on park attractions, develop improved facilities to reduce environmental impacts and to enhance the visitor experience.	No impact.	No impact.
To ensure that environmental values are not compromised, introduce maximum visitor caps at key sites in the medium-and longer term, if necessary.	No impact.	No impact.
Maintain existing opportunities for camping with minimum impacts on park values.	No impact.	No impact.
Provide and maintain appropriate roads and tracks for visitor use and management purposes.	No impact.	No impact.
Increase awareness of the Parks’ identity by improving the roadside directional signage.	No impact.	No impact.
Minimise the impact of vehicle use on the Parks’ values.	No impact.	No impact.
Continue the development of the Great Ocean Walk.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide a range of opportunities for walking within the Parks.	No impact.	No impact.
Maintain an appropriate network of coast access tracks.	No impact.	No impact.
Provide opportunities for both commercial and recreational horse riding, consistent with maintaining park values.	No impact.	No impact.
Minimise environmental impacts caused by horse riding.	No impact.	No impact.
Minimise conflict between horse riders and other park users.	No impact.	No impact.
Provide opportunities for cycling while minimising environmental damage and conflicts with other recreation activities.	No impact.	No impact.
Permit dogs in the BICP consistent with protecting park values.	No impact.	No impact.
Continue to prohibit dogs in the PCNP.	No impact.	No impact.
Provide opportunities for boating in the Parks while minimising environmental impacts and conflicts with other Park visitors.	No impact.	No impact.
Provide opportunities for fishing and diving in the Parks where it is consistent with the protection of park values.	No impact.	No impact.
Provide access for swimming and surfing in the Parks consistent with protecting park values.	No impact.	No impact.
Provide an opportunity for hang gliding in the BICP while minimising environmental impact and conflict with other Park visitors.	No impact.	No impact.
Provide opportunities for commercial tourism operations, where consistent with protecting park values and improving the quality and range of recreational experiences in the Parks.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Ensure that private users are not disadvantaged, by establishing a balance between private and commercial use of the Parks.	No impact.	No impact.
Promote public safety in the use of the Parks.	No impact.	No impact.
Minimise exposure of visitors to the hazards associated with cliff failure or land subsidence.	No impact.	No impact.
Minimise the possibility of visitors becoming isolated at the cliff base as a result of rising tides or increase in wave action.	No impact.	No impact.
Ensure that natural hazards are not increased by built or other artificial structures.	No impact.	No impact.
7.1 Friends and Volunteers		
Actively encourage volunteer involvement in managing the Parks.	No impact.	No impact.
7.2 Community Awareness and Park Neighbours		
Increase public awareness of management activities undertaken in the Parks.	No impact.	No impact.
Encourage conservation and sound land management practices on private land adjoining the Parks.	No impact.	No impact.
Promote a positive image of the Parks that enhances appreciation of their contribution to the community.	No impact.	No impact.
Maintain the long-term integrity of the Parks by expanding their effective widths in strategically important areas.	No impact.	No impact.
Promote co-operation and good working relations with Park neighbours.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
7.3 Schools and other Education		
Increase use of the Parks as an educational resource for schools and other groups.	No impact.	No impact.
Increase use of the Parks’ existing facilities by educational groups.	No impact.	No impact.
8.1 Authorised Uses		
Minimise the impact of public utilities on park values.	No impact.	No impact.
Ensure appropriate use and licensing of all existing and future public utilities.	No impact.	No impact.
Ensure appropriate use and licensing of facilities occupying parts of the Parks.	No impact.	No impact.
Minimise the impacts of these occupations on park values.	No impact.	No impact.
Minimise use of the Parks for private access.	No impact.	No impact.
Minimise impacts of the proposed development of the Minerva gas field on park values.	No impact.	No impact.
Minimise the impact of other uses on park values.	No impact.	No impact.
8.2 Boundaries and Adjacent Users		
Minimise the impacts of the Great Ocean Road on the Parks.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Ensure that future realignment and relocation of the Great Ocean Road are compatible with park objectives.	No impact.	No impact.
Manage Park boundaries to protect park values.	No impact.	No impact.
Give due consideration to opportunities that arise to improve the integrity of the Parks and their boundaries through acquisition and addition of land to the Parks, and Park boundary adjustments.	No impact.	No impact.
Seek the excision of areas within or adjacent to Port Campbell Township which have little or no natural or cultural value and are for a use that is more appropriately managed under legislation other than the National Parks Act.	No impact.	No impact.
Minimise conflicts between park values and surrounding land use.	No impact.	No impact.
Co-operate with landholders adjacent to the Parks in the protection of both private property and public land from fire, pests, visual threats, erosion and other hazards.	No impact.	No impact.
Encourage, and assist as appropriate, land owners to develop and protect natural and cultural values in the vicinity of Park boundaries.	No impact.	No impact.
Minimise the noise and visual impacts of aircraft on visitors and wildlife.	No impact.	No impact.

Assessment of the activity against the stated aims of the Twelve Apostles Marine National Park and the Arches Marine Sanctuary Management Plan (Parks Victoria, 2006)

The table on the following pages provide an assessment of routine and non-routine operations against the management aims of the park.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Protect significant and fragile geological and seabed features in the park and sanctuary.	No impact.	No impact.
Minimise the impact of threatening processes derived from the catchment, estuaries and other watercourses.	No impact.	No impact.
Maintain water quality in the park and sanctuary.	No impact.	The OPEP takes into accounts risks to protected areas and prioritises actions to reduce the spread and extent of hydrocarbons.
Prevent and minimise the impact of pollution on park and sanctuary values.	No impact.	
Minimise impacts on park and sanctuary values from human-induced changes to local hydrodynamic processes.	No impact.	No impact.
Protect natural habitats, ecological communities and indigenous flora and fauna in the park and sanctuary.	No impact.	No impact.
Improve knowledge of the park and sanctuary, including habitats, indigenous species and threatening processes.	No impact.	No impact.
Protect landscape and seascape values associated with the park and sanctuary.	No impact.	No impact.
Minimise the visual impact of signs, infrastructure and management activities associated with the park and sanctuary.	No impact.	No impact.
Minimise the risk of introduction by human activity, and subsequent establishment, of marine pests in the park and sanctuary.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impact.
Establish arrangements for the detection of new incursions within the park and sanctuary in support of Victorian marine pest management arrangements.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Implement national or Victoria-wide control arrangements as they relate to the park and sanctuary.	No impact.	No impact.
Protect Indigenous places and objects from interference or damage.	No impact.	No impact.
Nurture Indigenous cultural lore and customs relating to the park and sanctuary.	No impact.	No impact.
Conserve places of cultural significance.	No impact.	No impact.
Encourage learning and understanding about the historic heritage of the park and sanctuary.	No impact.	No impact.
Promote and encourage visitors to discover, enjoy and appreciate the natural and cultural values of the park and sanctuary in a safe and appropriate manner through information, interpretation and education.	No impact.	No impact.
Encourage public support for parks and park management practices.	No impact.	No impact.
Support and manage the provision of appropriate and safe access to the park and sanctuary.	No impact.	No impact.
Provide for boating activities in the park and sanctuary consistent with management objectives.	No impact.	No impact.
Provide opportunities for diving and snorkelling that are consistent with the protection of park and sanctuary values.	No impact.	No impact.
Provide opportunities for appropriate shore-based recreation activities that are consistent with the protection of park and sanctuary values.	No impact.	No impact.
Minimise the impact of dogs and horses on the park and sanctuary.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Minimise the impact of aircraft on wildlife and visitor experiences in the park and sanctuary.	No impact.	No impact.
Encourage the provision by external providers of tourism services that accord with the provisions of the National Parks Act.	No impact.	No impact.
Promote visitor safety and awareness of safety issues and risks in the sanctuary associated with access and use.	No impact.	No impact.
Promote and observe safe practices, and cooperate with emergency response agencies.	No impact.	No impact.
Minimise the impact on park/sanctuary values of authorised uses.	No impact.	No impact.
Manage authorised uses consistent with legislation.	No impact.	No impact.
Effectively communicate the location of park and sanctuary boundaries.	No impact.	No impact.
Minimise impacts on park values from adjacent developments.	No impact.	No impact.
Increase knowledge of the relationships between the park and sanctuary and industry.	No impact.	No impact.
Increase the community's awareness and understanding of the park's and sanctuary's values, and management activities in them.	No impact.	No impact.
Build a sense of shared ownership and custodianship for the park and sanctuary among community groups and individuals.	No impact.	No impact.
Support and encourage community groups and volunteers to actively assist in the park and sanctuary management by participating and contributing their knowledge and skills.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Inform, enrich and strengthen the park and sanctuary management with the community's cultural aspirations and customs, especially relevant Indigenous cultural lore.	No impact.	No impact.
Enhance management of the park and sanctuary by collaborating with other agencies to ensure that they give appropriate consideration to park and sanctuary values in planning and implementing activities that relate to the planning area.	No impact.	No impact.

Assessment of the activity against the stated aims of the Great Otway National Park Management Plan (Parks Victoria, 2007)

The table on the following pages provides an assessment of routine and non-routine operations against the management aims of the park.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Climate change and resilience planning		
Increase park manager and community understanding of climate change, its consequences and resilience planning.	No impacts.	No impacts.
Develop and implement management strategies to build ecosystem and species resilience to climate change.	No impacts.	No impacts.
4.2 Landscape		
Protect, enhance and restore landscape values in the parks and minimise impacts of management or visitor activities on landscape values.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Encourage neighbouring developments and activities to have minimal adverse impact on landscape values.	No impacts.	No impacts.
4.3 Geological and geomorphological features		
Protect significant and fragile geological and geomorphological values.	No impacts.	No impacts.
4.4 Rivers, catchments, groundwater and coasts		
Protect, enhance and restore natural, social and resource values associated with rivers, catchments, groundwater and coasts.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil towards the shoreline.
Improve the condition of high-value streams that are not in good condition.	No impacts.	No impacts.
4.5 Vegetation		
Protect, enhance and restore indigenous flora species and communities.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Where possible, allow natural processes that shape floral biodiversity to continue with minimal interference.	No impacts.	No impacts.
Increase knowledge of flora species and communities, and threatening processes to improve management effectiveness.	No impacts.	No impacts.
4.6 Fauna		
Protect indigenous fauna and habitats from threatening processes where possible.	No impacts.	No impacts.
Where possible, allow natural processes that shape faunal biodiversity to continue with minimal interference.	No impacts.	No impacts.
Increase knowledge of fauna and threatening processes to improve management effectiveness.	No impacts.	No impacts.
4.7 Fire Management		
Protect human life, property and public assets as far as practicable from the deleterious consequences of wildlife.	No impacts.	No impacts.
Investigate, evaluate and where appropriate implement fire regimes and strategies to reduce the potential for the development of landscape scale fires and also maintain the environmental integrity of the landscape.	No impacts.	No impacts.
In partnership with other agencies and the community, undertake effective fire prevention, preparedness, response and recovery activities.	No impacts.	No impacts.
4.8 Pest Plants and Animals, and Diseases		
Eradicate or prevent the establishment of new or emerging pest plants, animals and diseases.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impacts.
Control and where possible eradicate pest plants, animals and diseases from the parks, giving priority to areas with priority species and communities or areas in good condition.	No impacts.	No impacts.
Improve the effectiveness of pest and disease management by increasing the knowledge of pest species and treatment methods through research, record-keeping and monitoring.	No impacts.	No impacts.
5.1 Aboriginal and cultural heritage		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Recognise and respect the cultural connections that Traditional Owners and other Aboriginal people have with Country within the parks.	No impacts.	No impacts.
Provide and maintain opportunities for Aboriginal cultural connections and practices within the parks.	No impacts.	No impacts.
Work together with the Traditional Owners to protect and enhance Aboriginal cultural heritage.	No impacts.	No impacts.
5.2 Historic heritage		
Protect, conserve and present places with significant historic (non-indigenous) cultural heritage values in accordance with applicable legislation, strategies and charters.	No impacts.	No impacts.
Increase visitor and local community involvement, understanding and appreciation of Otway historic heritage, including sustainable provision of access, presentation, interpretation and promotion of selected sites.	No impacts.	No impacts.
5.3 Social values		
Understand the social values of the parks, and enhance and protect places, landscapes, features and character that contribute to social values.	No impacts.	No impacts.
6.1 Tourism and recreation directions		
Provide and enhance a sustainable range of tourism and recreation opportunities and products within the parks. Contribute to the region's tourism and recreation opportunities and profile.	No impacts.	No impacts.
Provide high quality, memorable, authentic and educational experiences for visitors that capitalise on the Otways unique attributes, to generate an understanding and appreciation of park values, and meet or exceed visitor expectations.	No impacts.	No impacts.
Increase opportunities for participation of commercial and community partners in the provision of tourism and recreation experiences, particularly the Aboriginal community.	No impacts.	No impacts.
Ensure that tourism and recreation activities and infrastructure are conducted and managed in a way that respects natural settings, conservation requirements, and cultural sensitivities.	No impacts.	No impacts.
6.2 Information, interpretation and education		
Promote and encourage visitors' safe and sustainable discovery, enjoyment, understanding and appreciation of the parks natural and cultural values.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
6.3 Motor vehicle access		
Provide and maintain a sustainable network of roads for a variety of uses, including general access for recreation, tourism and transit, and access for park management activities, fire suppression and authorised resource extraction.	No impacts.	No impacts.
Provide opportunities for people to enjoy car and motorcycle touring, four-wheel driving and trail bike riding experiences within the parks, where this is sustainable and compatible with the protection of other park values.	No impacts.	No impacts.
Minimise impacts of the road network on natural, cultural and resource values of the parks.	No impacts.	No impacts.
Encourage responsible vehicle use to minimise damage to the road network and the environment, and minimise conflict between park users and with neighbours.	No impacts.	No impacts.
6.4 Visitor sites and services		
Provide a system of designated visitor sites and services for sustainable recreation, education and enjoyment of experiences in the parks, and as nodes for access to park features and recreation areas.	No impacts.	No impacts.
Minimise conflicts between parks users and impact on park values from visitor facilities.	No impacts.	No impacts.
6.5 Bushwalking		
Provide opportunities for visitors (including disabled and low mobility visitors) to enjoy a diverse range of bushwalking experiences in the parks by accessing a sustainable network of walking tracks of various lengths, standards, and degrees of challenge.	No impacts.	No impacts.
Minimise impacts of the track network and bushwalking activities on park values and on other park users, and minimise excessive safety risks. Encourage responsible bushwalking behaviour.	No impacts.	No impacts.
6.6 Camping		
Provide a sustainable range of opportunities for people to enjoy camping experiences in the parks, and utilise camping areas as a base for recreation activities.	No impacts.	No impacts.
Minimise impacts on park values and conflicts between park users from camping.		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
6.7 Cycling		
Provide opportunities for people to enjoy cycling experiences in the parks, including mountain biking and bicycle touring, where this is sustainable and compatible with the protection of other park values.	No impacts.	No impacts.
Minimise conflicts with other park users and impacts on park values from cycling activities.	No impacts.	No impacts.
6.8 Companion dogs		
Provide opportunities for people to enjoy experiences with dogs in the parks where this is sustainable and compatible with the protection of other park values.	No impacts.	No impacts.
Minimise impacts on park values and conflicts with other park users from dogs.	No impacts.	No impacts.
6.9 Horse riding		
Provide opportunities for enjoyable and diverse nature-based horse riding experiences in the parks, including trail riding and camping with horses, where this is sustainable and compatible with the protection of other park values.	No impacts.	No impacts.
Minimise impacts on park values and conflicts with other park users from horse riding activities.	No impacts.	No impacts.
6.10 Recreational fishing		
Provide high quality opportunities for recreational fishing in and adjacent to the parks, where this is sustainable and compatible with the protection of park values.	No impacts.	No impacts.
Maintain recreational fishing access while protecting environmental and cultural values.	No impacts.	No impacts.
Minimise conflicts with other park users and impacts on park values from fishing.	No impacts.	No impacts.
6.11 Recreational hunting		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide opportunities for enjoyable recreational hunting experiences in Otway Forest Park, where compatible with the protection of other park values and visitor safety.	No impacts.	No impacts.
Minimise conflicts with other parks users and impacts on park values from recreational hunting.	No impacts.	No impacts.
6.12 Fossicking and prospecting		
Provide opportunities for gemstone fossicking at Wreck Beach in Great Otway National Park, and fossicking and prospecting in all areas of Otway Forest Park.	No impacts.	No impacts.
6.13 Boating and other water sports		
Provide opportunities for enjoyable water sports including boating, swimming and surfing in and adjacent to the parks, where this is sustainable and compatible with the protection of park values.	No impacts.	No impacts.
Minimise conflicts with other park users and impacts on park values from boating, swimming and other water sports.	No impacts.	No impacts.
6.14 Recreational aircraft		
Permit opportunities for hang-gliding and paragliding activities in the parks, where this is sustainable and compatible with the protection of park values and does not significantly impact on the enjoyment of other park visitors.	No impacts.	No impacts.
Provide appropriate access by powered aircraft for scenic over-flights of the parks, where this is sustainable and compatible with the protection of park values and does not significantly impact on the enjoyment of other park visitors.	No impacts.	No impacts.
Minimise conflicts with other park users and impacts on park values from air sports and aircraft.	No impacts.	No impacts.
6.15 Events and commercial activities		
Allow and manage appropriate events and functions and minimise impacts on park values.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide for appropriate commercial businesses to operate within the parks.	No impacts.	No impacts.
Ensure commercial operators are licensed to conduct their business within the parks.	No impacts.	No impacts.
6.16 Public safety		
Promote awareness of recreation risks, responsibility for considering risks, and adherence to safe practices to park users.	No impacts.	No impacts.
Identify public safety risks and implement risk management strategies.	No impacts.	No impacts.
Plan for and respond appropriately to public safety incidents and emergencies.	No impacts.	No impacts.
7.1 Firewood harvesting		
Allow firewood harvesting for commercial and personal use from the Otway Forest Park in accordance with relevant legislation, codes of practice, procedures and prescriptions.	No impacts.	No impacts.
Minimise the impacts of harvesting firewood on the natural, cultural and recreational values of the Otway Forest Park.	No impacts.	No impacts.
7.2 Minor forest produce harvesting		
Allow minor forest produce harvesting in Otway Forest Park in alignment with relevant legislation, codes of practice, procedures and prescriptions.	No impacts.	No impacts.
Minimise the impacts of minor forest produce harvesting on the natural, cultural and recreational values of Otway Forest Park.	No impacts.	No impacts.
8.1 Public utilities infrastructure		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Manage authorised public utilities infrastructure within the parks through formal consents, leases, licences, permits and agreements in accordance with relevant legislation, and to minimise impacts on park values.	No impacts.	No impacts.
8.2 Private occupancies		
Manage authorised occupancies to allow for specified uses while minimising their impacts on park values.	No impacts.	No impacts.
Resolve unauthorised occupancies by removal or authorisation.	No impacts.	No impacts.
8.3 Cape Otway Lightstation		
Provide for the ongoing commercial operation of the Cape Otway Lightstation Tourist and Heritage precinct.	No impacts.	No impacts.
Provide for the ongoing operation of marine navigation and weather recording instruments.	No impacts.	No impacts.
8.4 Designated and Special Water Supply Catchment Areas		
Minimise impacts on water quality and yield in water supply catchment areas from fire, recreation, extraction and management activities.	No impacts.	No impacts.
Manage Designated Water Supply Catchments as closed catchments.	No impacts.	No impacts.
Protect the public health of communities that depend on water supply catchments, through minimising threats to water quality and yield within water supply catchment areas.	No impacts.	No impacts.
8.5 Grazing		
Permit low-intensity grazing in cleared areas of Otway Forest Park where it is pre-existing and consistent with conservation and recreation objectives.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Phase out grazing in Great Otway National Park.	No impacts.	No impacts.
8.6 Apiculture		
Provide for apiculture in Otway Forest Park while minimising impacts on other park values.	No impacts.	No impacts.
Do not allow apiculture in Great Otway National Park.	No impacts.	No impacts.
8.7 Commercial fishing		
Provide for existing commercial eel fishing entitlements in Great Otway National Park.	No impacts.	No impacts.
8.8 Earth resources		
Ensure that earth resources activities are conducted in accordance with the relevant legislation and that park values are adequately protected.	No impacts.	No impacts.
8.9 Occasional uses		
Allow authorised occasional uses and minimise their impacts on park values.	No impacts.	No impacts.
8.10 Park boundaries and adjacent uses		
Coordinate management activities with those of park neighbours where these are complementary to the protection of park values.	No impacts.	No impacts.
Work with park neighbours to address issues of pest plant and animal control.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide access through the parks to neighbouring properties for authorized uses such as timber carting where that access does not impact on park values.	No impacts.	No impacts.
Provide reasonable rights of access to freehold land abutting or surrounded by the Great Otway National Park and minimise the impacts on park values.	No impacts.	No impacts.
9.1 Community awareness		
Increase the community's awareness and understanding of the parks' values and management activities.	No impacts.	No impacts.
9.2 Traditional Owner partnerships		
Build collaborative relationships to engage Traditional Owners in the parks' planning and management.	No impacts.	No impacts.
Improve opportunities for Aboriginal participation in the parks' management.	No impacts.	No impacts.
9.3 Community participation		
Build a sense of shared ownership and custodianship for the parks among community groups and individuals.	No impacts.	No impacts.
Support and encourage people to actively assist in implementing the plan and managing the parks.	No impacts.	No impacts.
9.4 Agency partnerships		
Enhance park management by collaborating with other agencies to ensure they consider park values in planning and implementing activities that relate to the parks.	No impacts.	No impacts.
Contribute to cooperative programs and activities undertaken by other agencies where these complement management of the parks.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Marengo Reefs Marine Sanctuary Management Plan (Parks Victoria, 2007)

The table on the following pages provide an assessment of routine and non-routine operations against the management aims of the park.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Geological and landform features		
Protect significant and fragile geological and seabed features in the park and sanctuaries.	No impacts.	No impacts.
4.2 Catchment and water quality		
Prevent where practicable, and minimise the impact of pollution and litter on sanctuary values.	The EP contains control measures aimed to minimise the risk of pollution and litter to Victorian waters.	No impacts.
4.3 Hydrodynamics		
Minimise impacts on sanctuary values from human-induced changes to local hydrodynamics.	No impacts.	No impacts.
4.4 Habitats and communities		
Protect marine ecological communities and indigenous flora and fauna, and allow natural processes to continue.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Improve knowledge of marine ecological communities, flora and fauna and threatening processes to improve management, protection and appreciation.	No impacts.	No impacts.
4.5 Landscape and seascape		
Protect landscape and seascape values.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Minimise the visual impact of signs, infrastructure and management activities associated with the sanctuary.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.6 Marine pests		
Minimise the risk of introduction of marine pests by human activities, and their subsequent establishment in the sanctuary.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impacts.
Establish arrangements for the detection of new incursions within the planning area in support of Victorian marine pest management arrangements.		No impacts.
Implement national or Victoria-wide control arrangements as they relate to the sanctuary.		No impacts.
5.1 Indigenous cultural heritage		
Protect Indigenous places and objects from interference or damaging activities.	No impacts.	No impacts.
Support the views of the Traditional Owners in managing the sanctuary.	No impacts.	No impacts.
5.2 Maritime and other cultural heritage		
Conserve and protect places of historical significance.	No impacts.	No impacts.
Encourage learning and understanding about the historical heritage of the sanctuary.	No impacts.	No impacts.
6.1 Information, interpretation and education		
Promote and encourage visitors' discovery, enjoyment and appreciation of the park and sanctuaries' natural and cultural values in a safe and appropriate manner through information, interpretation and education.	No impacts.	No impacts.
Encourage public support for marine national parks and marine sanctuaries and management practices.	No impacts.	No impacts.
6.2 Access		
Support and manage the provision of appropriate and safe access to the sanctuary.	No impacts.	No impacts.
6.3 Recreational boating and surface water sports		
Provide for boating activities in the sanctuary consistent with management objectives.	No impacts.	No impacts.
6.4 Diving and snorkelling		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide opportunities for diving and snorkelling that are consistent with the protection of sanctuary values.	No impacts.	No impacts.
6.5 Tourism services		
Provide opportunities for and encourage provision of external tourism services while minimising impacts on natural and cultural values of the sanctuary.	No impacts.	No impacts.
6.6 Public safety		
Promote awareness of safety issues and risks, and safe practices, in use of the sanctuary.	No impacts.	No impacts.
Cooperate with emergency services.	No impacts.	No impacts.
7.1 Authorised uses		
Minimise the impact on sanctuary values of authorised uses.	No impacts.	No impacts.
Manage authorised uses in accordance with legislation.	No impacts.	No impacts.
7.2 Boundaries and adjacent uses		
Effectively communicate the location of the sanctuary boundaries.	No impacts.	No impacts.
Minimise impact on sanctuary values from adjacent developments.	No impacts.	No impacts.
8.1 Community awareness		
Increase community awareness and understanding of the sanctuary's values and management activities.	No impacts.	No impacts.
Build a common vision and sense of shared custodianship for the sanctuary in community groups and individuals.	No impacts.	No impacts.
8.2 Community participation		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Support and encourage the whole community, including community groups and volunteers to contribute their knowledge, skills and enthusiasm to the sanctuary's management.	No impacts.	No impacts.
Inform and strengthen management with cultural lore of the Traditional owners.	No impacts.	No impacts.
8.3 Agency partnerships		
Enhance sanctuary management by collaborating with other agencies to ensure appropriate consideration to sanctuary values in planning and implementing activities that relate to the sanctuary.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Sanctuary Management Plan
(Parks Victoria, 2005)

The table on the following pages provide an assessment of routine and non-routine operations against the management aims of the parks.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Geological and geomorphological features		
Protect significant and fragile geological and seabed features in the park and sanctuaries.	No impact.	No impact.
4.2 Catchment and water quality		
Minimise the impact of threatening processes derived from the catchment, estuaries and other watercourses.	No impact.	No impact.
Maintain water quality in the park and sanctuaries.	No impact.	The OPEP takes into accounts risks to protected areas and prioritises actions to reduce the spread and extent of hydrocarbons.
Prevent and minimise the impact of pollution on park and sanctuary values.	No impact.	
4.3 Hydrodynamics		
Minimise impacts on park and sanctuary values from human-induced changes to local hydrodynamics.	No impact.	No impact.
4.4 Habitats and communities		
Protect natural habitats, ecological communities and indigenous flora and fauna in the park and sanctuaries.	No impact.	The OPEP takes into accounts risks to protected areas and prioritises actions to reduce the spread and extent of hydrocarbons.
Improve knowledge of the park and sanctuaries, including habitats, indigenous species and threatening processes.	No impact.	No impact.
4.5 Landscape and seascape		
Protect landscape and seascape values.	No impact.	No impact.
Minimise the visual impact of signs, infrastructure and management activities associated with the parks and sanctuaries.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.6 Marine pests		
Minimise the risk of introduction by human activities, and subsequent establishment of, marine pests in the park and sanctuaries.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impact.
Establish arrangements for the detection of new incursions within the planning area in support of Victorian marine pest management arrangements.	No impact.	No impact.
Implement national or Victoria-wide control arrangements as they relate to the planning area.	No impact.	No impact.
5.1 Indigenous cultural heritage		
Protect Indigenous cultural values from interference or damaging activities.	No impact.	No impact.
Nurture Indigenous cultural lore relating to the park and sanctuaries.	No impact.	No impact.
5.2 Maritime and other cultural heritage		
Protect significant maritime and other cultural places, objects and places associated with the park and sanctuaries.	No impact.	No impact.
Increase awareness of the maritime and other cultural values of the park and sanctuaries.	No impact.	No impact.
6.1 Information, interpretation and education		
Promote and encourage visitors' discovery, enjoyment and appreciation of the park and sanctuaries' natural and cultural values in a safe and appropriate manner through information, interpretation and education.	No impact.	No impact.
Encourage public support for parks and park management practices.	No impact.	No impact.
Promote an awareness of Indigenous culture.	No impact.	No impact.
6.2 Access		
Support and manage the provision of appropriate and safe access to the park and sanctuaries.	No impact.	No impact.
6.3 Recreational boating and surface water sports		
Provide for boating activities in the park and sanctuaries consistent with management objectives.	No impact.	No impact.
6.4 Diving and snorkelling		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide opportunities for diving and snorkelling that are consistent with the protection of the values of the park and sanctuaries.	No impact.	No impact.
6.5 Swimming and shore-based activities		
Provide opportunities for appropriate shore-based recreation activities that are consistent with the protection of park and sanctuary values.	No impact.	No impact.
6.6 Dogs and horses		
Provide opportunities for walking dogs where compatible with the protection of natural values.	No impact.	No impact.
Minimise conflicts with other visitors and impacts on park and sanctuary values from dogs and horses.	No impact.	No impact.
6.7 Surfing		
Provide opportunities for surfing that are consistent with the protection of park and sanctuary values.	No impact.	No impact.
6.8 Hang-gliding, para-gliding and other aircraft		
Provide for landing of hang-gliders and para-gliders where safe and appropriate.	No impact.	No impact.
Minimise the disturbing effects of aircraft on park and sanctuary visitors.	No impact.	No impact.
6.9 Events		
Manage surfing and other events in accordance with the National Parks Act and regulations and minimise their impact on park and sanctuary values.	No impact.	No impact.
6.10 Tourism services		
Encourage the provision of appropriate commercial visitor services while minimising impacts on natural and cultural values.	No impact.	No impact.
6.11 Public safety		
Promote visitor safety and awareness of safety issues and risks within the park and sanctuaries associated with access and use.	No impact.	No impact.
Promote and observe safe practices, and cooperate with emergency services.	No impact.	No impact.
7.1 Authorised uses		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Manage authorised uses and permitted activities in accordance with the National Parks Act.	No impact.	No impact.
Minimise the impact of authorised uses and permitted activities on park and sanctuary values.	No impact.	No impact.
7.2 Boundaries and adjacent uses		
Effectively communicate the location of the park and sanctuary boundaries.	No impact.	No impact.
Participate in planning processes that could affect park and sanctuary values.	No impact.	No impact.
8.1 Community awareness		
Increase community awareness and understanding of park and sanctuary values and management activities.	No impact.	No impact.
Build a sense of shared ownership and custodianship for the park and sanctuaries among community groups and individuals.	No impact.	No impact.
8.2 Community participation		
Support and encourage community groups and volunteers to actively assist in the management of the park and sanctuaries.	No impact.	No impact.
Inform and strengthen management with cultural lore of the Traditional owners.	No impact.	No impact.
8.3 Agency partnerships		
Enhance park and sanctuary management by collaborating with other agencies to ensure they give appropriate consideration to park values in planning and implementing activities that relate to the park and sanctuaries.	No impact.	No impact.

Assessment of the activity against the stated aims of the Mushroom Reef Marine Sanctuary Management Plan (Parks Victoria, 2007)

The table on the following pages provide an assessment of routine and non-routine operations against the management aims of the park.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Geological and geomorphological features		
Protect the geological and geomorphological features of the sanctuary from the impacts of human activity.	No impacts.	No impacts.
Increase knowledge of the geological and geomorphological significance of the sanctuary.	No impacts.	No impacts.
4.2 Catchment and water quality		
Protect and maintain water quality within the sanctuary to ensure that sanctuary values are protected.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Minimise the impact of threatening processes from catchment-derived activities.	No impacts.	No impacts.
4.3 Hydrodynamics		
Minimise the impacts on sanctuary values from human-induced changes to local hydrodynamic processes.	No impacts.	No impacts.
Increase knowledge of the way in which local hydrodynamic processes, especially wave refraction, influence the intertidal structures within the sanctuary.	No impacts.	No impacts.
4.4 Habitats and communities		
Protect marine ecological communities and indigenous flora and fauna, and allow natural processes to continue.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Improve knowledge of marine ecological communities, flora and fauna and threatening processes to improve management, protection and appreciation.	No impacts.	No impacts.
4.5 Landscape and seascape		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Protect landscape and seascape values within the sanctuary, including the natural beauty and character.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Minimise visual impacts on the seascape and landscape of management activities and any future developments.	No impacts.	No impacts.
4.6 Marine pests		
Minimise the risk of introduction of marine pests by human activities, and their subsequent establishment in the park.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impacts.
Establish arrangements for the detection of new incursions within the sanctuary in support of Victorian marine pest management arrangements.	No impacts.	No impacts.
Implement national or Victoria-wide control arrangements as they relate to the sanctuary.	No impacts.	No impacts.
5.1 Indigenous cultural heritage		
Protect Indigenous cultural heritage from interference or damaging activities.	No impacts.	No impacts.
Support the views of the Traditional Owners in managing the sanctuary.	No impacts.	No impacts.
5.2 Maritime and other cultural heritage		
Conserve places of historic significance.	No impacts.	No impacts.
Encourage learning and understanding about historic heritage of the sanctuary.	No impacts.	No impacts.
6.1 Information, interpretation and education		
Promote and encourage visitors to discover, enjoy and appreciate the sanctuary's natural and cultural values in a safe and appropriate manner through information, interpretation and education.	No impacts.	No impacts.
Encourage public support for the sanctuary and the sanctuary's management practices.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
6.2 Access		
Facilitate access to the sanctuary while minimising the impact on natural and cultural values of the sanctuary and abutting natural areas.	No impacts.	No impacts.
6.3 Intertidal activities		
Encourage the exploration and enjoyment of intertidal platform habitats within the sanctuary while minimising impacts on natural and cultural values.	No impacts.	No impacts.
6.4 Diving and snorkelling		
Encourage snorkelling and diving activities that are for enjoyment and understanding of the sanctuary and have minimal impact on natural or cultural values.	No impacts.	No impacts.
6.5 Dog walking		
Protect natural and cultural values, and visitor enjoyment from the impacts of dogs.	No impacts.	No impacts.
6.6 Other activities		
Permit activities, including the landing of hang gliders and paragliders in the sanctuary that have minimal impact on natural or cultural values and the enjoyment of other visitors.	No impacts.	No impacts.
6.7 Tourism services		
Encourage the promotion and interpretation of the sanctuary and its values by licensed tour operators in a manner consistent with the aims for the sanctuary and visitor safety.	No impacts.	No impacts.
6.8 Public Safety		
Promote visitor safety and awareness of safety issues and risks within the sanctuary associated with access and use.	No impacts.	No impacts.
Promote and observe safe practices, and cooperate with emergency services.	No impacts.	No impacts.
7.1 Authorised uses		
Manage authorised uses in accordance with the National Parks Act and minimise their impact on sanctuary values.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
7.2 Boundaries and adjacent uses		
Minimise impacts on sanctuary values from adjacent uses and developments.	No impacts.	No impacts.
8.1 Community awareness		
Increase the community’s awareness and understanding of the sanctuary’s values and management activities.	No impacts.	No impacts.
Build a sense of shared ownership and custodianship for the sanctuary in community groups and individuals.	No impacts.	No impacts.
8.2 Community participation		
Encourage and support the whole community, particularly Traditional Owners, in undertaking projects that contribute to or complement sanctuary programs.	No impacts.	No impacts.
Inform, enrich and strengthen the sanctuary’s management with the community’s tradition, knowledge, experience, skills and enthusiasm, particularly that of the Traditional Owners.	No impacts.	No impacts.
8.3 Agency partnerships		
Enhance sanctuary management by collaborating with other agencies to ensure they give appropriate consideration to sanctuary values in planning and implementing activities that relate to the sanctuary but for which they are responsible.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Port Phillip Bay Environmental Management Plan (DELWP, 2017)

The table on the following pages provide an assessment of routine and non-routine operations against the management aims of the park.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Work with Aboriginal groups to improve understanding of Aboriginal cultural values and interests in the Bay and support connections to Country	No impacts.	No impacts.
Develop and deliver programs to inspire greater appreciation of the Bay's values	No impacts.	No impacts.
Build understanding of management responsibilities and programs for the Bay and its catchment	No impacts.	No impacts.
Build capacity and knowledge within community and industry networks	No impacts.	No impacts.
Empower the broader community to get more actively involved in caring for the Bay	No impacts.	No impacts.
Support stronger partnerships across community, industry and government to ensure aims and outcomes are aligned	No impacts.	No impacts.
Effectively maintain existing stormwater infrastructure and programs to mitigate loads to the Bay, or secure via equivalent means	No impacts.	No impacts.
Prevent increases in nutrients loads from wastewater systems and, where practicable, reduce loads of other pollutants	No impacts.	The OPEP takes into accounts risks to protected areas and prioritises actions to reduce the spread and extent of hydrocarbons.
Ensure all urban and rural land use effectively controls impacts from stormwater and runoff, and that controls are in place to manage increases in loads	No impacts.	No impacts.
Establish a baseline estimate of the volume of litter entering the Bay, and support clean up activities	No impacts.	No impacts.
Support capability and capacity building programs that target litter prevention, including reduction of microplastics	No impacts.	No impacts.
Identify and prioritise litter sources and pathways, and take actions to prevent litter entering the Bay	Control measures to mitigate marine debris are contained in the EP.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Improve understanding of links between pathogen concentrations and human health risks for swimming and consumption of shellfish	No impacts.	No impacts.
Adopt a risk-based approach to mitigate sources of pathogens found in the Bay	No impacts.	No impacts.
Improve monitoring and reporting to better detect and communicate human health risks from pathogens	No impacts.	No impacts.
Monitor indicator species and key habitats at priority locations	No impacts.	No impacts.
Improve understanding of ecological processes, threats and pressures	No impacts.	No impacts.
Improve overall extent and condition of the Bay's natural ecosystems	No impacts.	No impacts.
Prevent introduction and dispersal of marine pests	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impacts.
Monitor priority locations for early detection of marine pest introductions	No impacts.	No impacts.
Respond rapidly to new introductions of marine pests	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Bunurong Marine National Park, Bunurong Marine Park and Kilcunda-Harmers Haven Coastal Reserve Management Plan (Parks Victoria, 2006)

The table on the following pages provides an assessment of routine and non-routine operations against the management aims of the parks.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Landscape and seascape		
Preserve and protect the landscape and seascape values of the planning area, particularly the natural character and places of high scenic quality and areas of significance to the indigenous community.	No impacts.	No impacts.
Minimise the impact of developments and management activities on the planning area's landscape values.	No impacts.	No impacts.
4.2 Geological and geomorphological features		
Protect geological and geomorphological features of the planning area and minimise impacts from management activities and visitor use.	No impacts.	No impacts.
Allow natural geological and geomorphological processes to continue with minimal human interference.	No impacts.	No impacts.
Provide opportunities for appropriate research into, appreciation of, and education about the geological and geomorphological features of the planning area.	No impacts.	No impacts.
4.3 Catchment and water quality		
Ensure the integration of future planning and management between the planning area and adjacent catchment.	No impacts.	No impacts.
Maintain a high quality of water within the planning area and surrounding waters to ensure that natural biological and physical processes can occur.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Minimise impacts of threatening processes from catchment-sourced activities.	No impacts.	No impact.
4.4 Hydrodynamics		
Allow natural hydrodynamic processes to continue without human interference.	No impacts.	No impacts.
Minimise impacts on planning area values from human-induced changes to local hydrodynamic processes.	No impacts.	No impacts.
4.5 Marine habitats and communities		

Protect marine ecological communities and indigenous flora and fauna, particularly threatened species.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Increase knowledge of marine ecological communities, flora and fauna to aid management, protection and appreciation.	No impacts.	No impacts.
Increase knowledge of key threatening processes to marine ecological communities, flora and fauna, to limit impacts.	No impacts.	No impacts.
4.6 Marine pests		
Minimise the risk of introduction of marine pests by human activities, and their subsequent establishment in the planning area.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters.	No impacts.
Establish arrangements for the detection of new incursions within the planning area in support of Victorian marine pest management arrangements.	No impacts.	No impacts.
Implement national or Victoria-wide control arrangements as they relate to the planning area.	No impacts.	No impacts.
4.7 Terrestrial flora		
Maintain the floristic structure and diversity of vegetation communities, and protect them from threatening processes.	No impacts.	No impacts.
Increase knowledge of the planning area's vegetation communities and species, particularly its threatened species, to aid management, protection and appreciation.	No impacts.	No impacts.
4.8 Terrestrial fauna		
Protect and preserve indigenous fauna and faunal habitats from visitor use and management activities, and maintain genetic diversity.	No impacts.	No impacts.
Increase knowledge of the planning area's fauna species and habitats, particularly threatened species, to aid management, protection and appreciation.	No impacts.	No impacts.
4.9 Terrestrial pests		
Control, and where possible eradicate, non-indigenous plants, animals and diseases.	No impacts.	No impacts.
Minimise the potential for the introduction and spread of pest plants and animals and diseases.	No impacts.	No impacts.
Minimise the impact of control programs on native flora and fauna species.	No impacts.	No impacts.

Restore native vegetation in areas where weeds have been controlled or eradicated.	No impacts.	No impacts.
4.10 Soil conservation		
Prevent and control soil degradation, and rehabilitate areas affected by soil degradation caused by visitor and management activities.	No impacts.	No impacts.
4.11 Fire management		
Protect planning area values from the deleterious effects of wildfire or inappropriate fire regimes.	No impacts.	No impacts.
Cooperate with relevant agencies and land managers in the protection of human life, neighbouring properties and assets.	No impacts.	No impacts.
5.1 Indigenous cultural heritage		
Protect Indigenous cultural heritage, including places and objects, from interference or damaging activities.	No impacts.	No impacts.
Nurture Indigenous cultural lore relating to the planning area.	No impacts.	No impacts.
5.2 Maritime and other cultural heritage		
Conserve places and values of historic and cultural significance within the planning area.	No impacts.	No impacts.
Increase learning about and appreciation of the historic heritage of the planning area.	No impacts.	No impacts.
6.1 Information, interpretation and education		
Promote and encourage visitors' discovery, enjoyment and appreciation of the planning area's natural and cultural values in a safe and appropriate manner through information, interpretation and education.	No impacts.	No impacts.
Encourage public support for parks and management practices.	No impacts.	No impacts.
Provide opportunities to learn about and understand the cultural and spiritual significance of the planning area to the Indigenous community.	No impacts.	No impacts.
6.2 Access		
Provide and maintain appropriate access to the planning area for visitor use and management purposes.	No impacts.	No impacts.
Minimise the impact of access on natural and cultural values of the planning area.	No impacts.	No impacts.
6.3 Visitor site activities		

Establish and maintain visitor facilities that enhance visitor enjoyment and are consistent with the protection of planning area values.	No impacts.	No impacts.
6.4 Recreational boating and associated facilities		
Provide opportunities for recreational boating and appropriate surface water sports while protecting natural and cultural values.	No impacts.	No impacts.
Promote safe boating and water safety within the planning area.	No impacts.	No impacts.
6.5 Diving and snorkelling		
Provide opportunities for diving and snorkelling in the planning area while protecting natural and cultural values.	No impacts.	No impacts.
6.6 Swimming, surfing and shore-based activities		
Provide opportunities for appropriate shore-based recreation within the planning area, while minimising impacts on the natural and cultural values.	No impacts.	The OPEP takes into accounts risks to the shoreline and prioritises actions to reduce the spread and extent of oil towards the shoreline.
6.7 Dog walking		
Provide opportunities for dog walking in appropriate areas of the planning area, while protecting park and reserve values and the experience of visitors.	No impacts.	No impacts.
6.8 Horse riding		
Minimise conflicts with recreational activities, threats to visitor safety and natural values within the planning area.	No impacts.	No impacts.
6.9 Hang gliding		
Protect visitors and values in the planning area from impacts of hang gliding and paragliding within the planning area.	No impacts.	No impacts.
6.10 Recreational fishing		
Provide opportunities for sustainable recreational fishing while minimising impacts to natural and cultural values.	No impacts.	No impacts.
6.11 Tourism services		
Provide opportunities for and encourage provision of external tourism services while minimising impacts on natural and cultural values of the planning area.	No impacts.	No impacts.
6.12 Public Safety		

Promote visitor safety and awareness of safety issues and risks within the planning area associated with access and use.	No impacts.	No impacts.
Promote and observe safe practices and cooperate with emergency services.	No impacts.	No impacts.
7.1 Authorised uses		
Manage authorised uses in accordance with relevant legislation, and minimise their impact on the planning area's values.	No impacts.	No impacts.
7.2 Occasional uses		
Manage uses and permitted activities in accordance with relevant legislation, and minimise their impacts on the planning area's values.	No impacts.	No impacts.
7.3 Boundaries and adjacent uses		
Minimise impacts on planning area values from adjacent uses and developments.	No impacts.	No impacts.
Ensure the integration of management with adjoining land and waters in accordance with principles for ecologically sustainable development.	No impacts.	No impacts.
Effectively communicate the location of Marine National Park and other planning area boundaries.	No impacts.	No impacts.
8.1 Community awareness		
Build a shared sense of ownership and custodianship for the planning area among community groups and individuals.	No impacts.	No impacts.
Increase community awareness and understanding of the values and management activities of the planning area.	No impacts.	No impacts.
8.2 Community participation		
Support and encourage community groups and volunteers to assist actively in the area's management by participating and by contributing their knowledge and skills.	No impacts.	No impacts.
Encourage tertiary students to undertake volunteer work experience and research that is consistent with aims for the planning area.	No impacts.	No impacts.
Inform, enrich and strengthen the planning area's management with the community's traditions and customs, especially Traditional Owner's cultural lore.	No impacts.	No impacts.
8.3 Agency partnerships		
Enhance management by collaborating with other agencies to ensure that they give appropriate consideration to natural and cultural values in planning and implementing activities that relate to the planning area.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Cape Liptrap Coastal Park Management Plan (Parks Victoria, 2003)

The table on the following pages provide an assessment of routine and non-routine operations against the management aims of the park.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Geological and landform features		
Manage sites of geological and geomorphological significance to allow public access and interpretation.	No impact.	No impact.
4.2 Rivers and Catchments		
Maintain water quality in the park's catchments.	No impact.	No impact.
4.3 Vegetation		
Manage ecosystems to ensure the protection of indigenous flora species and vegetation communities, particularly significant species and communities.	No impact.	No impact.
Improve knowledge about the conservation of natural values with minimal disturbance to the environment.	No impact.	No impact.
4.4 Fauna		
Ensure the preservation and protection of indigenous fauna.	No impact.	No impact.
Manage park ecosystems to provide for the long-term protection and preservation of significant communities, habitats and species.	No impact.	No impact.
Improve knowledge about the conservation of fauna and their habitat requirements.	No impact.	No impact.
4.5 Landscape		
Minimise the visual intrusions on natural landscape within the park, especially from major viewing points.	No impact.	No impact.
Where possible, remove or shield undesirable visual intrusions.	No impact.	No impact.
4.6 Fire Management		
Protect life, property and park values from damage by fire.	No impact.	No impact.
Suppress wildfires in a manner appropriate to seasonal conditions, with the objective of minimising impacts on park values.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Sustain the vigour, diversity and successional development of the park's plant and animal communities by ecological burning on the basis of current and future knowledge.	No impact.	No impact.
4.7 Pest plants and animals		
Eradicate or control pest plant and animal species using methods that minimise disturbance to natural systems and park values.	No impact.	No impact.
Restore native vegetation to areas where weeds have been removed.	No impact.	No impact.
4.8 Soil Conservation		
Prevent and control soil degradation caused by visitor and management activities	No impact.	No impact.
Rehabilitate sites where unnatural soil degradation has occurred.	No impact.	No impact.
Protect important economic, cultural and natural assets from soil erosion.	No impact.	No impact.
4.9 Aboriginal Cultural Heritage		
Preserve and protect features of Aboriginal cultural and archaeological significance.	No impact.	No impact.
Provide opportunities for people to learn about and understand the park's Aboriginal cultural values.	No impact.	No impact.
4.10 Post-settlement Cultural Heritage		
Preserve and protect features of cultural, archaeological and historical significance.	No impact.	No impact.
Provide opportunities for people to learn about and understand the park's historic and cultural values.	No impact.	No impact.
5.1 Information, interpretation and education		
Encourage visitors' discovery, enjoyment and appreciation of the park's natural and cultural values.	No impact.	No impact.
Orientate visitors in relation to park features.	No impact.	No impact.
Inform visitors of appropriate behaviour during their park visit.	No impact.	No impact.
Provide high-quality interpretive and educational opportunities to promote an understanding and appreciation of the park's values.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
5.2 Access		
Maintain roads and tracks to standards consistent with management aims.	No impact.	No impact.
5.3 Day Visits		
Establish and maintain day visitor facilities that enhance visitor enjoyment of the park and are consistent with protecting park values.	No impact.	No impact.
Improve visitor facilities and raise the profile of the park as a day visitor destination.	No impact.	No impact.
5.4 Camping		
Provide opportunities for a range of camping experiences while minimising impacts on park values.	No impact.	No impact.
5.5 Boating		
Support the Walkerville Foreshore Committee of Management in providing basic boat launching facilities at Walkerville North.	No impact.	No impact.
5.6 Fishing		
Provide opportunities for recreational fishing while minimising the impacts on park values.	No impact.	No impact.
5.7 Bushwalking		
Provide a variety of high-quality walking opportunities within the park, while minimising impacts on park values.	No impact.	No impact.
5.8 Horse Riding		
Provide opportunities for horse riding while minimising this activity's adverse environmental effects and conflicts with other users.	No impact.	No impact.
5.9 Cycling		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide access for cycling, and at the same time minimise the environmental impact of cycling and the conflict with other recreational activities.	No impact.	No impact.
5.10 Dogs		
Provide for dogs in certain areas of the park, consistent with protecting park values and the experience of visitors.	No impact.	No impact.
5.11 Hang-gliding and Paragliding		
Provide opportunities for hang-gliding and paragliding while minimising the impact on park values and other uses.	No impact.	No impact.
5.12 Fossicking		
Provide an opportunity for gemstone collecting in the park, while ensuring that the impact on environmental values and other visitors is minimised.	No impact.	No impact.
5.13 Commercial Services		
Provide opportunities for commercial tourism and the touring public while minimising environmental impacts and effects on other visitors.	No impact.	No impact.
5.14 Public Safety		
Promote safe visitor use of the park.	No impact.	No impact.
Ensure that park management has adequate capacity to respond to emergency situations.	No impact.	No impact.
6.1 Friends and Volunteers		
Provide opportunities for and encourage the participation of groups and volunteers in protection, conservation and maintenance projects to enhance the management of the park.	No impact.	No impact.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide opportunities for and encourage tertiary students to undertake volunteer work experience and research consistent with park management aims.	No impact.	No impact.
6.2 Community Awareness and Park Neighbours		
Increase community awareness of park management activities, including prescribed burning, pest plant and animal control and visitor management activities.	No impact.	No impact.
Encourage conservation and sound land management practices on private land adjacent to the park.	No impact.	No impact.
7.1 Authorised Uses		
Manage public utilities and authorised uses in accordance with the National Parks Act, to minimise their impacts on the parks natural and scenic values.	No impact.	No impact.
Protect water quality in the park and provide for appropriate use of water resources.	No impact.	No impact.
7.2 Boundaries and Adjacent Uses		
Accurately define park boundaries on the ground.	No impact.	No impact.
Ensure adequate planning controls for adjoining land developments are in place.	No impact.	No impact.
Co-operate with adjacent landowners to protect both private and park areas from fire, pests and other hazards.	No impact.	No impact.

Assessment of the activity against the stated aims of the Wilsons Promontory Marine National Park, Marine Park and Marine Reserve Management Plan (Parks Victoria, 2006).

The table on the following pages provides an assessment of routine and non-routine operations against the management aims of the parks.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
4.1 Geological and geomorphological features		
Identify geological and geomorphological features of the planning area and protect them from potentially damaging human activities	No impacts.	No impacts.
Allow natural geological and geomorphological processes to continue without human interference.	No impacts.	No impacts.
Provide opportunities for appropriate research into, appreciation of, and education about geological and geomorphological features.	No impacts.	No impacts.
4.2 Catchment and water quality		
Ensure the integration of future planning and management for the planning area and adjacent catchment.	No impacts.	No impacts.
Maintain a high quality of water within the planning area and surrounding waters to ensure that natural biological and physical processes can occur.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Minimise the impacts on water quality within the planning area from activities within the catchment.	No impacts.	
4.3 Hydrodynamics		
Allow natural hydrodynamic processes to continue without human interference.	No impacts.	No impacts.
Minimise impacts on planning area values from human-induced changes to local hydrodynamic processes.	No impacts.	No impacts.
4.4 Habitats and communities		
Protect marine ecological communities and indigenous flora and fauna, particularly threatened species.	No impacts.	The OPEP takes into accounts risks to the open ocean and prioritises actions to reduce the spread and extent of oil on the sea surface.
Increase knowledge of marine ecological communities, flora and fauna to aid management, protection and appreciation.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Increase knowledge of key threatening processes to marine ecological communities, flora and fauna, to limit impacts.	No impacts.	No impacts.
4.5 Landscape and seascape		
Preserve and protect the landscape and seascape values of the park, including the natural character, aesthetic qualities and values of significance to Indigenous communities.	No impacts.	No impacts.
Minimise the visual impact of developments and management activities, including those adjacent to the park.	No impacts.	No impacts.
4.6 Marine pests		
Minimise the risk of introduction of marine pasts by human activities, and their subsequent establishment in the planning area.	The EP contains control measures aimed to minimise the risk of introducing marine pests to Victorian waters	No impacts.
Establish arrangements for the detection of new incursions within the planning area in support of Victorian marine pest management arrangements.	No impacts.	No impacts.
Implement national or Victoria-wide control arrangements as they relate to the planning area.	No impacts.	No impacts.
5.1 Indigenous cultural heritage		
Protect Indigenous cultural heritage from interference or damaging activities.	No impacts.	No impacts.
Nurture Indigenous cultural lore relating to the planning area.	No impacts.	No impacts.
5.2 Maritime and other cultural heritage		
Conserve and protect places and values of historic significance associated with maritime exploration, commercial exploitation, coastal trading and navigation	No impacts.	No impacts.
Encourage learning and understanding about the historic heritage of the planning area, particularly as they relate to the historic theme 'Shipping along the Coast'.	No impacts.	No impacts.
6.1 Information, interpretation and education		
Promote and encourage visitors' discovery, enjoyment and appreciation of the natural and cultural values of the planning area in a safe and appropriate manner through information, education and interpretation.	No impacts.	No impacts.
Encourage public support for the planning area and management practices.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Provide opportunities to learn about and understand the cultural and spiritual significance of the planning area to the Traditional Owners.	No impacts.	No impacts.
Promote an awareness of past European cultural activities in the park.	No impacts.	No impacts.
6.2 Access		
Provide for the use and enjoyment of the planning area.	No impacts.	No impacts.
Minimise the impact of access on natural and cultural values of the planning area	No impacts.	No impacts.
6.3 Recreational boating and surface water sports		
Provide opportunities for recreational boating and appropriate surface water sports while protecting natural and cultural values	No impacts.	No impacts.
Promote safe boating and water safety within the planning area.	No impacts.	No impacts.
Provide opportunities for marine mammal observation while ensuring their long-term protection.	No impacts.	No impacts.
6.4 Diving and snorkelling		
Provide opportunities for diving and snorkelling in the planning area while protecting natural and cultural values.	No impacts.	No impacts.
6.5 Swimming and shore-based activities		
Provide for appropriate shore-based activities while protecting natural and cultural values.	No impacts.	The OPEP takes into accounts risks to the shoreline and prioritises actions to reduce the spread and extent of oil towards the shoreline.
6.6 Recreational fishing		
Provide opportunities for sustainable recreational fishing while minimising impacts on the marine park and marine reserve.	No impacts.	No impacts.
6.7 Tourism services		
Encourage the provision of appropriate tourism services to improve the quality and range of recreational experiences available to visitors.	No impacts.	No impacts.
Ensure that licensed tour operators recognise and respect the natural and cultural values of the planning area, including Indigenous cultural heritage values.	No impacts.	No impacts.

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
6.8 Aircraft		
Monitor and minimise the impact of fixed wing aircraft and helicopters on the natural values of the planning area.	No impacts.	No impacts.
6.9 Public Safety		
Promote visitor safety and awareness of safety issues and risks within the planning area associated with access and use.	No impacts.	No impacts.
Promote and observe safe practices, and cooperate with emergency services.	No impacts.	No impacts.
7.1 Authorised uses		
Manage authorised uses and permitted activities in accordance with the National Parks Act, and minimise their impact on park values.	No impacts.	No impacts.
7.2 Boundaries and adjacent uses		
Ensure the integration of management of the planning area with adjoining land and waters in accordance with principles for ecologically sustainable development.	No impacts.	No impacts.
Ensure that necessary boundaries are clearly identifiable.	No impacts.	No impacts.
Minimise confusion by simplifying land tenure in the planning area.	No impacts.	No impacts.
8.1 Community awareness		
Build a shared sense of ownership and custodianship for the planning area in community groups and individuals.	No impacts.	No impacts.
Increase the community's awareness and understanding of the planning area's values, management activities and catchment impacts.	No impacts.	No impacts.
8.2 Community participation		
Support and encourage the active participation of community groups and volunteers in protection, conservation and monitoring projects to enhance management of the planning area.	No impacts.	No impacts.
Provide opportunities for, and encourage, tertiary students to undertake volunteer work experience and research consistent with aims for the planning area.	No impacts.	No impacts.
Inform, enrich and strengthen the planning area's management with the community's tradition and customs, especially the Traditional Owner's cultural lore.	No impacts.	No impacts.
8.3 Agency partnerships		

Management Aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Enhance management of the planning area by collaborating with other agencies to ensure that they give appropriate consideration to park values in planning and implementing activities that relate to the planning area.	No impacts.	No impacts.

Appendix 2

Assessment of the activity against the management aims of threatened species' management plans

Assessment of the activity against the aims of threatened species' management plans	
BIRDS	
2a	Albatross and petrels
2b	Soft-plumaged petrel
2c	Blue petrel
2d	Gould's petrel
2e	Australian painted snipe
2f	Bar-tailed godwit
2g	Curlew sandpiper
2h	Eastern curlew
2i	Fairy prion
2j	Australian fairy tern
2k	Hooded plover
2l	Orange-bellied parrot
2m	Red knot
2n	Swift parrot
2o	Australasian bittern
MAMMALS	
2p	Blue whale
2q	Humpback whale
2r	Southern right whale
2s	Fin whale
2t	Sei whale
2u	Australian sea-lion
FISH	
2v	Australian grayling
2w	Dwarf galaxias
2x	Great white shark
REPTILES	
2y	Marine turtles

Assessment of the activity against the stated aims of the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPC, 2011)

The following table provides an assessment of routine and non-routine operations against the management aims of the plan.

Criteria to measure performance of the Plan against the objective	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Specific Objectives		
Research and monitoring of the biology, ecology and population dynamics of albatrosses and giant petrels breeding within Australian jurisdiction is sufficient to understand conservation status and to implement effective and efficient conservation measures.	No impacts.	No impacts.
Land-based threats to the survival and breeding success of albatrosses and giant petrels breeding within areas under Australian jurisdiction are quantified and reduced.	No impacts.	No impacts.
Marine-based threats to the survival and breeding success of albatrosses and giant petrels foraging in waters under Australian jurisdiction are quantified and reduced.	No impacts.	The OPEP takes into account risks to marine bird species and prioritises actions to reduce the spread and extent of oil on the sea surface.
Fishers are educated and public awareness is raised on the threats to albatrosses and giant petrels.	No impacts.	No impacts.
Substantial involvement in the promotion and development of improved and, ultimately, favourable conservation status of albatrosses and giant petrels globally in international conservation and fishing fora is maintained.	No impacts.	No impacts.
Actions to achieve specific objectives		
Research and monitoring of the biology, ecology and population dynamics of albatrosses and giant petrels breeding within Australian jurisdiction is sufficient to understand conservation status and to implement effective and efficient conservation measures.	No impacts.	No impacts.
Quantify and reduce land-based threats to the survival and breeding parameters of albatrosses and giant petrels breeding within areas under Australian jurisdiction.	No impacts.	No impacts.
Quantify and reduce marine-based threats to the survival and breeding parameters of albatrosses and giant petrels foraging in waters under Australian jurisdiction.	No impacts.	The OPEP takes into account risks to marine bird species and prioritises actions to reduce the spread and extent of oil on the sea surface.
Educate fishers and promote public awareness of the threats to albatrosses and giant-petrels.	No impacts.	No impacts.
Achieve substantial progress towards global conservation of albatrosses and giant petrels in international conservation and fishing fora.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Approved Conservation Advice for the Soft-plumaged petrel (*Pterodroma mollis*) (TSSC, 2015)

The following table provides an assessment of routine and non-routine operations against the management aims of the plan.

Stated management aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Actions		
Continue to manage Maatsuyker and Macquarie Island in such a way that human disturbance is minimised.	No impacts.	No impacts.
Continue strict quarantine management practices for Maatsuyker and Macquarie Island to reduce the risk of any invasive species (re)establishing on the islands.	No impacts.	No impacts.
Survey and Monitoring Priorities		
Continue to monitor population numbers on Maatsuyker Island.	No impacts.	No impacts.
Include monitoring for soft-plumaged petrels in monitoring programs occurring on Macquarie Island to detect any breeding occurrences.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Approved Conservation Advice for the Blue Petrel (*Halobaena caerulea*). (TSSC, 2015)

The following table provides an assessment of routine and non-routine operations against the management aims of the plan.

Stated management aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Actions		
Continue to manage Macquarie Island and its surrounds in such a way that human disturbance is minimised.	No impacts.	No impacts.
Continue strict quarantine management practices for Macquarie Island to reduce the risk of any invasive species (re)establishing on the island.	No impacts.	No impacts.
Survey and Monitoring Priorities		
Continue monitoring the species, and if decreases become evident in the population, identify potential causes and adapt management actions as required.	No impacts.	No impacts.
Include monitoring for blue petrels in monitoring programs occurring on Macquarie Island to detect any future breeding occurrences	No impacts.	No impacts.
Information and Research Priorities		
Monitor breeding population size and success on Macquarie Island offshore rock stacks.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Gould's Petrel (*Pterodroma leucoptera leucoptera)* Recovery Plan (DEC, 2006)

The following table provides an assessment of routine and non-routine operations against the management aims of the plan.

Stated objectives of the recovery plan	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
To identify and manage the threats operating at sites where the subspecies occur.	No impacts.	No impacts.
To establish and maintain a translocated second colony at Boondelbah Island.	No impacts.	No impacts.
To raise awareness of the subspecies with the local community and involve volunteers in the recovery program.	No impacts.	No impacts.
To promote research and continue monitoring that will assist with the management of the subspecies.	No impacts.	No impacts.
To co-ordinate recovery actions through a recovery team and annual reporting on Recovery Plan implementation.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the Australian painted-snipe (*Rostratula australis*) (DSEWPC, 2013)

The following table provides an assessment of routine and non-routine operations against the management aims of the conservation advice.

Regional Priority Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Habitat Loss, Disturbance and Modification		
Develop management guidelines for breeding and non-breeding habitat.	No impacts.	No impacts.
Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.	No impacts.	No impacts.
Ensure there is no disturbance in areas where the species is known to breed, excluding necessary actions to manage the conservation of the species.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises those for protection and where necessary, beach clean-up and oiled wildlife response.
Control access routes to suitably constrain public access to existing and future breeding sites on public land.	No impacts.	No impacts.
Suitably control and manage access on private land and other land tenure.	No impacts.	No impacts.
Minimise adverse impacts from land use at known sites.	No impacts.	No impacts.
Manage any changes to hydrology that may result in changes to water table levels, run-off, salinity, algal blooms, sedimentation or pollution.	No impacts.	No impacts.
Manage any disruptions to water flows.	No impacts.	No impacts.
Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate/secure inclusion in reserve tenure if possible.	No impacts.	No impacts.
Manage any other known, potential or emerging threats including inappropriate fire regimes and coastal port/infrastructure development.	No impacts.	No impacts.
Invasive Weeds		

Regional Priority Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Implement the Parkinsonia (Parkinsonia aculeata) Strategic Plan (Commonwealth of Australia, 2000) for the control of this species within the range of the Australian painted snipe.	No impacts.	No impacts.
Identify and remove weeds in wetland areas that could become a threat to the Australian painted snipe, using appropriate methods.	No impacts.	No impacts.
Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on the Australian painted snipe	No impacts.	No impacts.
Trampling, Browsing or Grazing		
Develop and implement a stock management plan for roadside verges and travelling stock routes which include swamps, marshes or wetlands.	No impacts.	No impacts.
If livestock grazing occurs in known Australian painted snips habitats, ensure land owners/managers use an appropriate management regime and density that does not detrimentally affect Australian painted snipe nesting.	No impacts.	No impacts.
If appropriate, manage total grazing pressure at important breeding sites through exclusion fencing or other barriers.	No impacts.	No impacts.
Animal Predation or Competition		
Implement the national threat abatement plans for the European red fox (DEWHA, 2008a) and feral cats (DEWHA, 2008b) to control the adverse impacts of foxes (*Vulpes vulpes*) and cats (*Felis catus*) in the species' range.	No impacts.	No impacts.
Continue baiting to control population numbers of feral animals.	No impacts.	No impacts.
Fire		
Develop and implement a suitable fire management strategy for the habitat of the Australian painted snipe.	No impacts.	No impacts.
Conservation Information		
Raise awareness of the Australian painted snipe within the local community and the importance of reporting observations to BirdLife Australia, using fact sheets and/or brochures.	No impacts.	No impacts.
Advertise and encourage use of Australian painted snipe survey techniques and survey forms (Birds Australia, 2012).	No impacts.	No impacts.

Regional Priority Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Organise field days with industry and interest groups to raise awareness and share information on the species. These groups may include natural resource management groups, catchment management authorities, Indigenous groups, conservation organisations, local and state governments, and private landholders.	No impacts.	No impacts.
Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.	No impacts.	No impacts.
Raise awareness of banded individuals (see BirdLife Australia, 2012) to increase the likelihood of re-sighting and reporting.	No impacts.	No impacts.
Facilitate the exchange of information between interested parties, including sightings, research and management approaches.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the Bar-tailed Godwit (western Alaskan) (*Limosa lapponica baueri*) (DoE, 2016)

The following table provides an assessment of routine and non-routine operations against the management aims of this conservation advice.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Actions		
Work with governments along the East Asian – Australasian Flyway to prevent destruction of key breeding and migratory staging sites.	No impacts.	No impacts.
Support initiatives to improve habitat management at key sites.	No impacts.	No impacts.
Advocate for the creation and restoration of foraging and roosting sites.	No impacts.	No impacts.
Manage important sites to identify, control and reduce the spread of invasive species.	The EP puts in place control measures to reduce the risk of biofouling and introduction of invasive marine species.	No impacts.
Protect important habitat in Australia.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises those for protection and where necessary, beach clean-up and oiled wildlife response.
Maintain and improve protection of roosting and feeding sites in Australia.	No impacts.	
Incorporate requirements for bar-tailed godwit (western Alaskan) into coastal planning and management.	No impacts.	
Manage disturbance at important sites which are subject to anthropogenic disturbance when bar-tailed godwit (western Alaskan) are present – e.g. discourage or prohibit vehicle access, horse riding and dogs on beaches, implement temporary site closures.	No impacts.	
Survey and Monitoring Priorities		
Enhance existing migratory shorebird population monitoring programmes, particularly to improve coverage across northern Australia.	No impacts.	No impacts.
Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.	No impacts.	No impacts.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Information and Research Priorities		
Undertake work to more precisely assess bar-tailed godwit (western Alaskan) life history, population size, distribution and ecological requirements particularly across northern Australia.	No impacts.	No impacts.
Improve knowledge about dependence of bar-tailed godwit (western Alaskan) on key migratory staging sites, and non-breeding sites to the in south-east Asia.	No impacts.	No impacts.
Improve knowledge about threatening processes including the impacts of disturbance and hunting.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the Curlew sandpiper (*Calidris ferruginea*) (DoE, 2016)

The following table provides an assessment of routine and non-routine operations against the management aims of this conservation advice.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
International Objectives		
Achieve a stable or increasing population.	No impacts.	No impacts.
Maintain and enhance important habitat.	No impacts.	No impacts.
Disturbance at key roosting and feeding sites reduced.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
Australian Objectives		
Achieve a stable or increasing population.	No impacts.	No impacts.
Maintain and enhance important habitat.	No impacts.	No impacts.
Disturbance at key roosting and feeding sites reduced.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
Raise awareness of curlew sandpiper within the local community.	No impacts.	No impacts.
Conservation and Management Actions		
Work with governments along the East Asian – Australasian Flyway to prevent destruction of key migratory staging sites.	No impacts.	No impacts.
Support initiatives to protect and manage key staging sites of curlew sandpiper.	No impacts.	No impacts.
Manage important sites to identify, control and reduce the spread of invasive species.	No impacts.	No impacts.
Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.	No impacts.	No impacts.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Maintain and improve protection of roosting and feeding sites in Australia.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
Incorporate requirements for curlew sandpiper into coastal planning and management.	No impacts.	
Manage disturbance at important sites when curlew sandpipers are present – e.g. discourage or prohibit vehicle access, horse riding and dogs on beaches, implement temporary beach closures.	No impacts.	
Monitoring Priorities		
Enhance existing migratory shorebird population monitoring programmes, particularly to improve coverage across northern Australia.	No impacts.	No impacts.
Information and Research Priorities		
More precisely assess curlew sandpiper population size, distribution and ecological requirements particularly across northern Australia.	No impacts.	No impacts.
Improve knowledge about dependence of curlew sandpiper on key migratory staging sites, and wintering sites to the north of Australia.	No impacts.	No impacts.
Improve knowledge about threatening processes including the impacts of disturbance.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the Eastern curlew (*Numenius madagascariensis*) (DoE, 2015)

The following table provides an assessment of routine and non-routine operations against the primary conservation objectives of the advice.

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
International Objectives		
Achieve a stable or increasing population.	No impacts.	No impacts.
Maintain and enhance important habitat.	No impacts.	No impacts.
Reduce disturbance at key roosting and feeding sites.	No impacts.	No impacts.
Australian Objectives		
Achieve a stable or increasing population.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
Maintain and enhance important habitat.	No impacts.	
Reduce disturbance at key roosting and feeding sites.	No impacts.	
Raise awareness of eastern curlew within the local community.	No impacts.	No impacts.
Conservation and Management Actions		
Work with governments along the East Asian – Australasian Flyway to prevent destruction of key migratory staging sites.	No impacts.	No impacts.
Develop and implement an International Single Species Action Plan for eastern curlew with all range states.	No impacts.	No impacts.
Support initiatives to improve habitat management at key sites.	No impacts.	No impacts.
Maintain and improve protection of roosting and feeding sites in Australia.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
Incorporate requirements for eastern curlews into coastal planning and management.	No impacts.	No impacts.
Manage important sites to identify, control and reduce the spread of invasive species.	No impacts.	No impacts.

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Manage disturbance at important sites when eastern curlews are present – e.g. discourage or prohibit vehicle access, horse riding and dogs on beaches, implement temporary site closures.	No impacts.	No impacts.
Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.	No impacts.	No impacts.
Monitoring Priorities		
Enhance existing migratory shorebird population monitoring programmes, particularly to improve coverage across northern Australia	No impacts.	No impacts.
Information and Research Priorities		
More precisely assess eastern curlew life history, population size, distribution and ecological requirements particularly across northern Australia.	No impacts.	No impacts.
Improve knowledge about dependence of eastern curlew on key migratory staging sites, and wintering sites to the north of Australia.	No impacts.	No impacts.
Improve knowledge about threatening processes including the impacts of disturbance and hunting.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the southern fairy prion (*Pachyptila tutur subantarctica*) (TSSC, 2015)

The following table provides an assessment of routine and non-routine operations against the management aims of this conservation advice.

Conservations Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Actions		
Continue to manage Macquarie Island and its surrounds in such a way that human disturbance is minimised.	No impacts.	No impacts.
Continue strict quarantine management practices for Macquarie Island and surrounding rock stacks to reduce the risk of any invasive species (re)establishing on the island.	No impacts.	No impacts.
Survey and Monitoring Priorities		
Continue to monitor the species, and if decreases become evident in the population, identify potential causes and adapt management actions as required.	No impacts.	No impacts.
Information and Research Priorities		
Continue to monitor breeding population size and success on Macquarie Island offshore rock stacks, including Bishop and Clerk Islands.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the Australian fairy tern (*Sternula nereis nereis*) (DSEWPC, 2011)

The following table provides an assessment of routine and non-routine operations against the management aims of the conservation advice.

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Regional Priority Actions		
Habitat Loss, Disturbance and Modification		
Monitor the progress of recovery (using a variety of methods such as survey and banding programs, video surveillance of breeding colonies and maintaining a central breeding and sightings database), including the effectiveness of management actions and the need to adapt them if necessary.	No impacts.	No impacts.
Identify populations of high conservation priority.	No impacts.	No impacts.
Manage any changes to hydrology that may result in changes to tide levels, increase salinity or pollution.	No impacts.	No impacts.
Manage any disruptions to water flows in wetland areas such as the Coorong in South Australia.	No impacts.	No impacts.
Introduce recreational codes of conduct and license commercial tourism operations utilising the subspecies' habitat.	No impacts.	No impacts.
Animal Predation or Competition		
Develop and implement a management plan for the control or eradication of foxes, dogs, cats and Black Rats where the species is found.	No impacts.	No impacts.
Establish programs to discourage gulls (such as Silver Gulls) competing with Fairy Terns. Examples of activities could include: education programs to raise awareness of the problems of feeding gulls and; minimising night time lighting from oil and gas rigs near the subspecies' habitat to reduce night time feeding opportunities for Silver Gulls.	No impacts.	No impacts.
Local Priority Actions		
Habitat Loss, Disturbance and Modification		
Use nest protection measures to safeguard nests from extreme weather/tides, including sandbagging and nest relocation.	No impacts.	No impacts.
Control access routes to suitably constrain public access to known sites on public and private land.	No impacts.	

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Reduce disturbance during the breeding season from human recreation such as the use of off road vehicles and predation by domestic dogs, using signage and/ or fencing where appropriate. The use of signage can restrict access to the site as well as raise awareness of the sites ecological importance.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
Ensure appropriate oil-spill contingency plans are in place for the subspecies' breeding sites which are vulnerable to oil spills, such as the breeding colonies in Victoria.	No impacts.	
Weed Control		
Remove weeds which could become a threat to the Fairy Tern, using appropriate methods outside the breeding season.	No impacts.	No impacts.
Manage sites to prevent introduction of invasive weeds, which could become a threat to the Fairy Tern, using appropriate methods.	No impacts.	No impacts.
Animal Predation		
Control introduced pests such as foxes, dogs, cats and Black Rats, using a variety of methods such as trapping and 1080 baiting.	No impacts.	No impacts.

<u>Assessment of the activity against the stated aims of the Conservation Advice for the Hooded Plover (*Thinornis rubricollis rubricollis*) (DoE, 2014)</u>

The following table provides an assessment of routine and non-routine operations against the recovery and impact avoidance guidance of this conservation advice.

Recovery and Impact avoidance guidance	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Primary Conservation Objectives		
1. Achieve stable numbers of adults in the population, and maintain a stable number of occupied and active breeding territories.	No impacts.	No impacts.
2. Improve breeding success, namely increase fledgling rates (which is a combination of improving egg and chick survival rates), via: a. reducing the destruction of nests and chicks, and the disturbance of breeding pairs, by human and human-related activities. b. reducing predation by feral animals and overabundant native predators.	No impacts.	No impacts.
3. Maintain, enhance and restore habitat, and integrate the subspecies' needs into coastal planning.	No impacts.	No impacts.
Information and Research Priorities		
1. Determine demographic trends including population size, breeding success, and status and trends in breeding populations.	No impacts.	No impacts.
2. Determine levels of nest predation and breeding success, in areas with and without predator and stock control programs.	No impacts.	No impacts.
3. Identify the causes of chick mortality, and factors which may mediate chick survival rates.	No impacts.	No impacts.
4. Identify habitat availability and risk of habitat loss due to weed invasion, rising sea levels and dune morphology changes, via: a) incorporating coastal weed mapping data into a single data set. b) utilising SmartLine for all population assessments; this maps coastal geomorphology and can indicate areas of coasts which are vulnerable to erosion and other weather/climate impacts. c) integrating coastal weed, geomorphology and hooded plover (eastern) nesting territory data, in order to provide an assessment of threats from invasive weeds and erosion.	No impacts.	No impacts.
5. For each breeding site/beach, assess the relative impacts of different threats and the likelihood of threat management measures being successful, so that beaches can be prioritised for management.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and

Recovery and Impact avoidance guidance	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
		prioritises action to control the spread and extent of hydrocarbons.
6. Monitor the breeding and abundance of hooded plovers on an ongoing basis, ensuring that survey methods and data reporting are standardised as much as possible.	No impacts.	No impacts.
7. Undertake a population viability analysis to set breeding success targets for recovery programs.	No impacts.	No impacts.
Management Actions Required		
1. Manage the use of (and access to) key beaches for recreation when plovers are breeding – e.g. discourage or prohibit vehicle access, horse riding and dogs from beaches; implement temporary beach closures; erect fencing to prevent people entering.	No impacts.	No impacts.
2. Adequately police beaches to ensure compliance with regulations, especially those relating to dog walking, and undertake a review of existing regulations to assess whether there is room for improvement.	No impacts.	No impacts.
3. Educate the public in research, monitoring, management and advocacy efforts.	No impacts.	No impacts.
4. Incorporate requirements for the hooded plover into coastal planning and management, and erosion control activities, including: a) limiting levels of urban development within the coastal zone. b) adopting evidence-based best practice. c) consulting with relevant state and local government departments, research organisations, and community organisations.	No impacts.	No impacts.
5. Construct fencing to prevent livestock entering beaches.	No impacts.	No impacts.
6. Implement predator control programs for invasive species where necessary.	No impacts.	No impacts.
7. Evaluate the efficacy of management techniques such as the use of chick shelters, predator controls, mechanisms to alter human behaviour on beaches, habitat restoration and maintenance, and identify areas for improvement.	No impacts.	No impacts.
8. Further develop methods for reducing or controlling rates of colonisation by invasive plants and rehabilitating dunes colonised by invasive plants, and establish trials to recover habitat degraded by marram grass (*Ammophila arenaria*).	No impacts.	No impacts.

Recovery and Impact avoidance guidance	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
9. Prepare oil spill response plans to ensure effective rehabilitation of oiled birds.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
10. Reduce in-shore marine debris, including educating fishers and the public to properly dispose of fishing lines.	No impacts.	No impacts.
11. As a last resort, investigate control options for native predators such as ravens, magpies, currawongs and silver gulls, if their impacts are threatening a population and human activities cannot be sufficiently reduced to mitigate their impacts.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the National Recovery Plan for the Orange-bellied Parrot (*Neophema chrysogaster*) (DELWP, 2016)

The following table provides an assessment of routine and non-routine operations against the primary conservation objectives of the plan.

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
To achieve a stable or increasing population in the wild within five years.		
Increase breeding output in the wild.	No impacts.	No impacts.
Increase survival in the wild.	No impacts.	No impacts.
Maintain wild behaviours.	No impacts.	No impacts.
To increase the capacity of the captive population, both to support future releases of captive-bred birds to the wild and to provide a secure long-term insurance population.		
Increase the size of the captive population as quickly as possible.	No impacts.	No impacts.
Manage genetics of the captive population.	No impacts.	No impacts.
Manage the wild and captive populations as a metapopulation.	No impacts.	No impacts.
To protect and enhance habitat to maintain, and support growth of, the wild population.		
Maintain the extent of habitat throughout the breeding and non-breeding range.	No impacts.	No impacts.
Increase the extent of high quality of habitat throughout the breeding and nonbreeding range.	No impacts.	No impacts.
To ensure effective adaptive implementation of the plan.		
Obtain and analyse key information required to measure and improve implementation to achieve the primary objectives.	No impacts.	No impacts.
Employ sound procedures for managing, reviewing and reporting on progress to ensure effective adaptive management.	No impacts.	No impacts.
Secure delivery partners and sufficient funding to ensure very high and high priority actions are implemented.	No impacts.	No impacts.
Foster and maintain relationships with key individuals, organisations and the broader community.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the Red Knot (*Calidris canutus*) (TSSC, 2016)

The following table provides an assessment of routine and non-routine operations against the conservation actions of the conservation advice.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Actions		
Work with governments along the East Asian – Australasian Flyway to prevent destruction of key migratory staging sites.	No impacts.	No impacts.
Protect important habitat in Australia.	No impacts.	No impacts.
Support initiatives to improve habitat management at key sites.	No impacts.	No impacts.
Maintain and improve protection of roosting and feeding sites in Australia.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
Incorporate requirements for red knot into coastal planning and management.	No impacts.	
Advocate for the creation and restoration of foraging and roosting sites in Australia.	No impacts.	No impacts.
Manage important sites to identify, control and reduce the spread of invasive species.	No impacts.	No impacts.
Manage disturbance at important sites which are subject to anthropogenic disturbance when red knot are present – e.g. discourage or prohibit vehicle access, horse riding and dogs on beaches, implement temporary site closures.	No impacts.	No impacts.
Survey and Monitoring Priorities		
Enhance existing migratory shorebird population monitoring programmes, particularly to improve coverage across northern Australia	No impacts.	No impacts.
Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.	No impacts.	No impacts.
Information and Research Priorities		

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Undertake work to more precisely assess red knot life history, population size, distribution and ecological requirements.	No impacts.	No impacts.
Improve knowledge about dependence of red knot on key migratory staging sites, and nonbreeding sites in south-east Asia.	No impacts.	No impacts.
Improve knowledge about threatening processes including the impacts of disturbance and hunting.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the Swift Parrot (*Lathamus discolor*) (TSSC, 2016)

The following table provides an assessment of routine and non-routine operations against the conservation objectives of the conservation advice.

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Priorities		
Review and update management prescriptions for swift parrots for use in the Forest Practices System and Local Government land use planning and approvals processes across the breeding and non-breeding range of swift parrots.	No impacts.	No impacts.
Revise and update forestry prescriptions to reflect the most recent habitat information available in Victoria and New South Wales.	No impacts.	No impacts.
Develop and implement strategies to reduce predation from sugar gliders when circumstances require.	No impacts.	No impacts.
Consider installing nesting boxes suitable for swift parrots in areas of low sugar glider predation to enhance swift parrot breeding success	No impacts.	No impacts.
Continue to raise public awareness of the risks of collisions and how these can be minimised, targeting known high risk areas such as the greater Hobart, Melbourne and Western Sydney areas, and the central coast region of New South Wales (Wyong, Gosford, Lake Macquarie and Penrith Local Government areas).	No impacts.	No impacts.
Encourage and support the protection, conservation management and restoration of swift parrot nesting and foraging habitat through agreements with landowners, incentive programs and community projects.	No impacts.	No impacts.
Develop and implement a Disease Risk Assessment for swift parrots.	No impacts.	No impacts.
Survey and Monitoring Priorities		
Develop an effective population monitoring program.	No impacts.	No impacts.
Undertake monitoring of breeding locations on an annual basis to develop a better understanding of breeding success; the extent and number of important breeding areas; and the relative importance of non-aggregated breeding behaviour.	No impacts.	No impacts.
Establish a process for the coordination of volunteer surveys throughout breeding habitats to complement the existing mainland monitoring program.	No impacts.	No impacts.
Maintain coordination of the existing long-term volunteer monitoring throughout mainland habitats.	No impacts.	No impacts.

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Information and Research Priorities		
Prioritise conservation actions across the species range.	No impacts.	No impacts.
Identify and map movement patterns and foraging and nesting habitat throughout the breeding range.	No impacts.	No impacts.
Establish habitat phenology data collection in existing research and monitoring studies, analyse findings and incorporate into the recovery program.	No impacts.	No impacts.
Establish and maintain a database for all reported injuries and deaths.	No impacts.	No impacts.
Monitor the incidence of competition from aggressive honeyeaters, as well as introduced birds and invertebrates, for nesting and foraging resources.	No impacts.	No impacts.
Undertake research on breeding success, survival and mortality, as well as genetic structure, to provide insight into currently unknown population regulation parameters.	No impacts.	No impacts.
Update the PVA using data obtained from the above research to provide a greater understanding of the dynamics and long-term viability of the population.	No impacts.	No impacts.
Investigate the potential impact of climate change on the swift parrot and its habitat.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Approved Conservation Advice for the Australasian Bittern (*Botaurus poiciloptilus*) (TSSC, 2019)

The following table provides an assessment of routine and non-routine operations against the management aims of the plan.

Stated management aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Priorities		
Collate all recent location data to establish a list of priority sites for monitoring and for protection and management. Such a list should be updated as new sites are created or found and as knowledge is improved.	No impacts.	No impacts.
Work with key water managers (e.g., Australian, state and local government, water corporations, irrigators) to ensure adequate water flows into known Australasian Bittern habitat, both natural and artificial (e.g., rice paddies, urban ponds etc).	No impacts.	No impacts.
Ensure environmental water allocations are targeted to sustain Australasian bittern habitat and known populations.	No impacts.	No impacts.
Prevent further vegetation clearance in wetlands, ponds and associated marshy areas known to support Australasian Bitterns	No impacts.	No impacts.
Where appropriate, develop new wetlands with suitable habitats for Australasian Bitterns.	No impacts.	No impacts.
Where possible, create suitable habitats for Australasian Bitterns in existing wetlands.	No impacts.	No impacts.
Where appropriate, develop incentives for rice growers to manage crops with a sufficient period of inundation to facilitate successful breeding before harvest.	No impacts.	No impacts.
Consideration given to strategic land purchases to aid in the protection and better management of Australasian Bittern habitat.	No impacts.	No impacts.
Monitor and manage agricultural and urban runoff into wetlands known to support Australasian Bitterns in order to maintain water quality.	No impacts.	No impacts.
Fence wetlands to exclude grazing animals.	No impacts.	No impacts.
Develop and implement a management strategy for wetlands where Australasian Bitterns occur, with a focus on ensuring appropriate diversity and density of reeds and rushes. Management strategy may include measures such as controlled burns, slashing when the wetland is dry and/or flooding to limit reed re-growth. Management strategy should be informed by research targeted at better understanding optimal habitat conditions.	No impacts.	No impacts.

Stated management aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Ensure adequate water volume and quality at urban and peri-urban wetlands where Australasian Bitterns have been detected.	No impacts.	No impacts.
Investigate opportunities to encourage state and local government and private landholders to undertake conservation of wetlands on their properties for the benefit of Australasian Bitterns.	No impacts.	No impacts.
Survey and Monitoring Priorities		
Agree on standard monitoring protocols that can be applied across the Australasian Bitterns' range.	No impacts.	No impacts.
Undertake regular and systematic monitoring at identified priority sites on an annual basis.	No impacts.	No impacts.
Using information from monitoring program, identify population trends across the Australasian Bitterns' range.	No impacts.	No impacts.
Investigate the use of predictive modelling to improve estimates of the number of mature individuals and to predict population trends and distribution	No impacts.	No impacts.
Information and Research Priorities		
Research to determine critical habitat values being targeted by Australasian Bitterns, with differentiation of needs during different parts of the breeding cycle. Factors such as water quality, salinity, vegetation composition and fire history should be investigated.	No impacts.	No impacts.
Determine prey availability in Australasian Bitterns habitat and identify methods for improving prey availability in order to improve the species breeding success.	No impacts.	No impacts.
Undertake genetic analyses to determine Australasian Bittern population structure. If population structuring occurs, this information should be used to inform management strategies.	No impacts.	No impacts.
Assess the relative importance for Australasian Bitterns occupancy and breeding success of: - introduced predators, - mortality associated with fixed structures, such as fence lines and towers, - grazing by introduced herbivores, - fire regimes.	No impacts.	No impacts.
Ensure processes to allow outcomes of research to influence ongoing management and monitoring programs, and to influence the development of new actions where required.	No impacts.	No impacts.
Stakeholder Engagement and Governance		

Stated management aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Develop broad promotional material to raise awareness about the Australasian Bittern, its status and the importance of protecting vegetated freshwater wetlands, and share this material with conservation groups and the general public.	No impacts.	No impacts.
Develop targeted fact sheets for landholders to increase awareness of the Australasian Bittern, including advice regarding improved wetland management for the species, and provide an avenue for reporting sightings.	No impacts.	No impacts.
Engage with private landholders, agricultural producers and public land managers responsible for land on which Australasian Bittern populations occur, and encourage them to contribute to the implementation of conservation management actions.	No impacts.	No impacts.
Promote the important ecosystem functions of wetlands, and their aesthetic and recreational values, to increase the interest of conservation groups and general public in their protection and restoration.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Management Plan for the Blue Whale (*Balaenoptera musculus*) 2015-2025 (DSEWPC, 2011)

The following table provides an assessment of routine and non-routine operations against the conservation objectives of the plan.

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Interim Recovery Objectives		
The conservation status of blue whale populations is assessed using cost effective and robust methodology.	No impacts.	No impacts.
The spatial and temporal distribution, identification of biologically important areas, and population structure of blue whales in Australian waters is described.	No impacts.	No impacts.
Current levels of legal and management protection for blue whales are maintained or improved and an appropriate adaptive management regime is in place.	No impacts.	No impacts.
Anthropogenic threats are demonstrably minimised.	No impacts.	No impacts.
Assess and Address Threats		
Maintain and improve existing legal and management protection.	No impacts.	No impacts.
Assess and addressing anthropogenic noise.	Mitigation measures are presented in Chapter 7 of the EP.	No impacts.
Understand impacts of climate variability and change.	No impacts.	No impacts.
Minimise vessel collisions.	Vessel collision guidelines are implemented.	Vessel collision guidelines will be implemented.
Enable and Measure Recovery		
Measure and monitor population recovery.	No impacts.	No impacts.
Investigate population structure.	No impacts.	No impacts.
Describe spatial and temporal distribution and define biologically important habitat.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Advice for the Humpback Whale (*Megaptera novaeangliae*) (TSSC, 2015)

The following table provides an assessment of routine and non-routine operations against the conservation and management actions of the conservation advice.

Conservation and Management Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Maintain and improve existing legal and management protection		
Continue or improve existing legislative management actions under the EPBC Act, including the Australian Whale Sanctuary provisions.	No impacts.	No impacts.
Australia should maintain its position on promoting high levels of protection for humpback whales in all relevant international agreements including the IWC, Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Convention on the Conservation of Migratory Species of Wild Animals (CMS), fisheries related agreements, and the Antarctic Treaty Consultative Meetings (ATCM).	No impacts.	No impacts.
Understanding impacts of climate variability and change		
Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.	No impacts.	No impacts.
Assessing and addressing anthropogenic noise; shipping, industrial and seismic surveys		
All seismic surveys must be undertaken consistently with the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. Should a survey be undertaken in or near a calving, resting, foraging area, or a confined migratory pathway then Part B. Additional Management Procedures must also be applied.	No impacts.	No impacts.
For actions involving acoustic impacts (example pile driving, explosives) on humpback whale calving, resting, feeding areas, or confined migratory pathways site specific acoustic modelling should be undertaken (including cumulative noise impacts).	No impacts.	No impacts.
Should acoustic impacts on humpback calving, resting, foraging areas, or confined migratory pathways be identified a noise management plan should be developed.	No impacts.	No impacts.
Addressing infrastructure and coastal development impacts		
Environmental assessment processes must ensure that existing information about coastal habitat requirements of humpback whales, environmental suitability of coastal locations, historic high use and emerging areas are taken into consideration.	No impacts.	No impacts.

Conservation and Management Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Environmental assessment and approval processes must ensure that the impacts of coastal development on humpback whales are addressed and minimised. Mitigation and management measures for the construction stage and the ongoing operational impacts are to be included in any plans of management. Significant residual impacts must be offset.	No impacts.	No impacts.
Reducing commercial fishing entanglements		
Commonwealth and state governments with the pot and set net fishing industries to develop and implement codes of conduct to minimise interactions between commercial fishers and humpback whales.	No impacts.	No impacts.
Investigate alternative fishing techniques and technologies to reduce the risk of entanglement.	No impacts.	No impacts.
Minimising vessel collisions		
Develop a national vessel strike strategy that investigates the risk of vessel strikes on humpback whales and also identifies potential mitigation measures to reduce the risk of collision.	No impacts.	No impacts.
Maximise the likelihood that all vessel strike incidents are reported in the National Ship Strike Database. All cetaceans are protected in Commonwealth waters and, the EPBC Act requires that all collisions with whales in Commonwealth waters are reported. Vessel collisions can be submitted to the National Ship Strike Database at https://data.marinemammals.gov.au/report/shipstrike	No impacts.	No impacts.
Ensure the risk of vessel strike on humpback whales is considered when assessing actions that increase vessel traffic in areas where humpback whales occur and, if required appropriate mitigation measures are implemented to reduce the risk of vessel strike.	No impacts.	No impacts.
Enhance education programs to inform vessel operators of best practice behaviours and regulations for interacting with humpback whales.	No impacts.	No impacts.
Measuring and monitoring population recovery		
Continue long-term monitoring of east and west coast populations at appropriate multi-annual intervals to quantify rates of population increase, abundance, migratory interchange and population structure	No impacts.	No impacts.
Information and research priorities		
Assess impacts of increasing anthropogenic threats and undertake a risk assessment to determine the increased exposure of these expanding populations to entanglement, ship strike and acoustic noise.	No impacts.	No impacts.

Conservation and Management Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Expand genetic analyses to better define population structure and extent of interchange between subpopulations. In particular the genetic structure of the east coast population and interchange with Pacific humpback whale populations.	No impacts.	No impacts.
Assess the impact of whale watching on humpback whales detailing the benefits and negatives of human interactions and the potential for cumulative impacts on the species as they migrate along the coast.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Conservation Management Plan for the Southern Right Whale (*Eubalaena australis*) 2011-2021 (DSEWPC, 2012)

The following table provides an assessment of routine and non-routine operations against the primary conservation objectives of the plan.

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Interim Recovery Objectives		
Demonstrate that the number of southern right whales occurring off south-west Australia (nominally south-west Australian population) is increasing at or near the maximum biological rate.	No impacts.	No impacts.
Demonstrate that the number of southern right whales occurring off south-east Australia (nominally south-east Australian population) is showing signs of increase.	No impacts.	No impacts.
The nature and degree of difference between the south-eastern and south-western Australian populations of southern right whales is clearly understood.	No impacts.	No impacts.
Current levels of legal and management protection for southern right whales are maintained or improved and an appropriate adaptive management regime is in place.	No impacts.	No impacts.
Anthropogenic threats are demonstrably minimised.	No impacts.	No impacts.
Assess and Address Threats		
Maintain and improve existing legal and management protection.	No impacts.	No impacts.
Assess and address anthropogenic noise (shipping, industrial and seismic).	Mitigation measures are presented in Chapter 7 of the EP.	No impacts.
Reduce commercial fishing entanglements.	No impacts.	No impacts.
Impacts of climate variability and change.	No impacts.	No impacts.
Address vessel collisions.	Vessel collision guidelines are implemented.	Vessel collision guidelines will be implemented.
Address infrastructure and coastal development impacts.	No impacts.	No impacts.
Measure Recovery		

Primary Conservation Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Measure and monitor population recovery	No impacts.	No impacts.
Investigate the two-population model	No impacts.	No impacts.
Understand offshore distribution and migration	No impacts.	No impacts.
Characterise behaviour and movements	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Approved Conservation Advice for the Fin Whale (*Balaenoptera physalus*) (TSSC, 2015)

The following table provides an assessment of routine and non-routine operations against the management aims of the plan.

Stated management aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Actions		
Continue or improve existing legislative management actions under the Environment Protection and Biodiversity Act 1999, including the Australian Whale Sanctuary provisions.	No impacts.	No impacts.
Australia should maintain its position on promoting high levels of protection for Fin whales in all relevant international agreements including the International Whaling Commission (IWC), Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Convention on the Conservation of Migratory Species of Wild Animals (CMS), fisheries related agreements, and the Antarctic Treaty Consultative Meetings (ATCM).	No impacts.	No impacts.
Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.	No impacts.	No impacts.
Once the spatial and temporal distribution (including biologically important areas) of fin whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.	Mitigation measures are presented in Chapter 7 of the EP.	No impacts.
If required, additional management measures should be developed and implemented to ensure the ongoing recovery of Fin whales.	Mitigation measures are presented in Chapter 7 of the EP.	No impacts.
Develop a national vessel strike strategy that investigates the risk of vessel strikes on Fin Whales and also identifies potential mitigation measures.	No impacts.	No impacts.
Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	Vessel collision guidelines are implemented.	Vessel collision guidelines are implemented.
Information and Research Priorities		
Determine population abundance, trends and population structure for Fin whales, and establish a long-term monitoring program in Australian waters.	No impacts.	No impacts.
Describe the spatial and temporal distribution of Fin Whales and further define biologically important areas (feeding and breeding), and migratory routes within Australian and Antarctic waters.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Approved Conservation Advice for the Sei Whale (*Balaenoptera borealis*) (TSSC, 2015)

The following table provides an assessment of routine and non-routine operations against the management aims of the plan.

Management aims	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Conservation and Management Actions		
Continue or improve existing legislative management actions under the Environment Protection and Biodiversity Act 1999, including the Australian Whale Sanctuary provisions.	No impacts.	No impacts.
Australia should maintain its position on promoting high levels of protection for sei whales in all relevant international agreements including the International Whaling Commission (IWC), Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Convention on the Conservation of Migratory Species of Wild Animals (CMS), fisheries related agreements, and the Antarctic Treaty Consultative Meetings (ATCM).	No impacts.	No impacts.
Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.	No impacts.	No impacts.
Once the spatial and temporal distribution (including biologically important areas) of sei whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.	Mitigation measures are presented in Chapter 7 of the EP.	No impacts.
If required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.	Mitigation measures are presented in Chapter 7 of the EP.	No impacts.
Develop a national vessel strike strategy that investigates the risk of vessel strikes on Sei Whales and also identifies potential mitigation measures.	No impacts.	No impacts.
Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	Vessel collision guidelines are implemented.	Vessel collision guidelines are implemented.
Information and Research Priorities		
Determine population abundance, trends and population structure for sei whales, and establish a long-term monitoring program in Australian waters.	No impacts.	No impacts.
Describe the spatial and temporal distribution of Sei Whales and further define biologically important areas (feeding and breeding), and migratory routes within Australian and Antarctic waters.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Recovery Plan for the Australian Sea-lion (*Neophoca cinerea*) (TSSC, 2016)

The following table provides an assessment of routine and non-routine operations against the conservation actions of the conservation advice.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Implement appropriate management measures (monitoring, management response, compliance and review), such that incidental bycatch in the gillnet sector of the following commercial fisheries does not threaten any colony or sub-population of Australian sea lion: • The Gillnet, Hook and Trap sector of the SESSF. • The South Australian Marine Scalefish Fishery. • The West Coast Demersal Gillnet and Demersal Longline (interim) Managed Fishery. • The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery.	No impacts.	No impacts.
Implement appropriate management measures (monitoring, management response, compliance and review) in the South Australian Rock Lobster Fishery and Western Australian Rock Lobster Fishery such that incidental bycatch does not threaten any colony or sub-population of Australian sea lion.	No impacts.	No impacts.
Implement management controls in other fisheries (commercial, recreational and Indigenous) that have impacts on Australian sea lions by: • Identifying any impacting fisheries. • Implementing mitigation strategies for impacts on Australian sea lions in those fisheries where necessary.	No impacts.	No impacts.
Monitor the cumulative impact of fisheries on Australian sea lions including: • bycatch • prey depletion • restriction in habitat availability • entanglement in active (not discarded) fishing gear.	No impacts.	No impacts.
Identify the sources of marine debris having an impact on Australian sea lion populations	No impacts.	No impacts.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Assess the impacts of marine debris on Australian sea lion populations	The EP contains control measures aimed to minimise the risk of pollution and litter to waters.	No impacts.
Develop and implement measures to mitigate the impacts of marine debris on Australian sea lion populations, noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life.		No impacts.
Investigate the nature, extent and consequence of interactions between Australian sea lions and aquaculture activities and mitigate any impacts (e.g. restrictions in habitat availability).	No impacts.	No impacts.
Improve the understanding of—and where necessary mitigate—the threat posed to Australian sea lion populations by illegal killings, vessel strike, pollution and oil spills. Actions to include: • Develop protocols for collection of biological samples and ensure that a portion of each sample (including those already collected) is centrally archived. • Collect data on direct killings and confirmed vessel strikes. • Implement jurisdictional oil spill response strategies as required.	No impacts.	The OPEP takes into account beaches of importance to coastal bird species and prioritises action to control the spread and extent of hydrocarbons.
Improve understanding of the threat and importance of health related factors to Australian sea lion populations by: • developing protocols for collection of biological samples and ensuring that a portion of each sample (including those already collected) is centrally archived • undertaking research to better understand pup mortality due to disease and the variance between seasons and colonies • undertaking research on the effect of providing a broad spectrum treatment to kill parasites and whether this affects pup mortality • analysing the impacts of the bioaccumulation of toxins on the health of Australian sea lions.	No impacts.	No impacts.
Develop and implement measures to mitigate the impact of any significant factors affecting the health of Australian sea lion populations.	No impacts.	No impacts.
Monitor and mitigate cumulative impacts of human interactions on Australian sea lion colonies.	No impacts.	No impacts.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Develop and provide information for tourists and tourism operators to promote an understanding of Australian sea lion conservation issues and to emphasise the importance of minimising disturbance of Australian sea lion colonies during visits.	No impacts.	No impacts.
Develop and apply a quantitative framework to assess the population status and potential recovery of the Australian sea lion across its range. • Ensure sufficient and effective abundance and distribution monitoring is in place to adequately understand population size and trends at representative sites across the range of the Australian sea lion, including at the fringes of the species' range.	No impacts.	No impacts.
Assess and facilitate the continuation of population demographic surveys at Seal Bay in South Australia.	No impacts.	No impacts.
Improve the information base on behavioural ecology, trophic interactions and foraging ecology — particularly in areas important to the survival of the species — and at scales relevant to human activities that can be managed. Actions include: • improve knowledge of foraging range at a colony level to help determine the spatial overlap with commercial fisheries • better determine the key ecological characteristics of preferred foraging sites • determine the drivers for variance in pup production and mortality across seasons (including apparent seasonal cycles) • undertake dive and tracking studies in Western Australia to help determine specific foraging patterns and requirements.	No impacts.	No impacts.
Improve the information base on population structures of the Australian sea lion. This should include finer scale structuring, utilising genetic techniques and morphological studies, where data of such scale might improve practical management options. Actions include: • opportunistically undertaking further research on population structure. Using genetic techniques on current and opportunistically gathered biological material to determine the extent of male and female dispersal • using genetic and morphological data to determine any sub-speciation of Australian sea lion populations throughout their range.	No impacts.	No impacts.

Conservation Actions	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Improve understanding of juvenile dispersal and foraging behaviours by: • undertaking research on juvenile (2–4 year olds) dispersal and foraging patterns • assessing dive depths of juveniles, with a focus on assessing the need to include Australian sea lion exclusion spikes on pots in deep water (> 20 m).	No impacts.	No impacts.
Assess the indirect impacts of fishing on Australian sea lion populations by conducting research. Research should include: • determining the impact of fishing on prey species of Australian sea lions • assessing the impact of fishing gear on preferred habitat of Australian sea lions.	No impacts.	No impacts.
Provide advice, education and support to fishers, community members, local governments and regional natural resource management organisations by measures including: • ensuring that the Recovery Plan for the Australian Sea Lion is publicly available in electronic format • ensuring online information regarding the recovery plan is relevant and up-to-date • promoting the recovery plan to target groups, such as commercial and recreational fishers and tour group operators • conducting presentations and workshops, where appropriate • involving community groups and tour operators in research and monitoring programs, where practical.	No impacts.	No impacts.
Consult relevant Indigenous organisations within the species' range regarding the implementation of the Recovery Plan for the Australian Sea Lion.	No impacts.	No impacts.

Assessment of the activity against the stated management actions of the National Recovery Plan for the Australian Grayling (*Prototroctes maraena*) (TSSC, 2015)

The following table provides an assessment of routine and non-routine operations against the conservation actions of the plan.

Management Action	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Identify important populations of Australian grayling.	No impacts.	No impacts.
Protect and restore habitat for Australian grayling.	No impacts.	No impacts.
Investigate important life history attributes and acquire targeted information for management.	No impacts.	No impacts.
Investigate and manage threats to populations and habitats.	No impacts.	No impacts.
Increase awareness of Australian grayling conservation with resource managers and the public.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the National Recovery Plan for the Dwarf Galaxias (*Galaxiella pusilla*) (DSE, 2010)

The following table provides an assessment of routine and non-routine operations against the management aims of the plan.

Primary conservation objectives of the National Recovery Plan	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Determine the distribution and abundance of the Dwarf Galaxias.	No impacts.	No impacts.
Determine the genetic and taxonomic status of Dwarf Galaxias populations.	No impacts.	No impacts.
Determine Dwarf Galaxias habitat characteristics and requirements.	No impacts.	No impacts.
Identify and manage potentially threatening processes impacting on Dwarf galaxias conservation.	No impacts.	No impacts.
Protect key populations across the range of the Dwarf galaxias.	No impacts.	No impacts.
Determine population trends at key sights.	No impacts.	No impacts.
Investigate key aspects of biology and ecology of the Dwarf galaxias.	No impacts.	No impacts.
Establish a captive breeding population of Dwarf galaxias.	No impacts.	No impacts.
Establish new populations of Dwarf galaxias.	No impacts.	No impacts.
Increase awareness and involvement.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the National Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPC, 2013)

The following table provides an assessment of routine and non-routine operations against the primary conservation objectives of the plan.

Conservation and Management Objectives	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Develop and apply quantitative measures to assess population trends and any recovery of the white shark in Australian waters and monitor population trends.	No impacts.	No impacts.
Quantify and minimise the impact of commercial fishing, including aquaculture, on the white shark through incidental (illegal and/or accidental) take, throughout its range in Australian waters.	No impacts.	No impacts.
Quantify and minimise the impact of recreational fishing on the white shark through incidental (illegal and/or accidental) take, throughout its range in Australian waters.	No impacts.	No impacts.
Where practicable, minimise the impact of shark control activities on the white shark.	No impacts.	No impacts.
Investigate and manage (and where necessary reduce) the impact of tourism on the white shark.	No impacts.	No impacts.
Quantify and minimise the impact of international trade in white shark products through implementation of CITES provisions.	No impacts.	No impacts.
Continue to identify and protect habitat critical to the survival of the white shark and minimise the impact of threatening processes within these areas.	No impacts.	No impacts.
Continue to develop and implement relevant research programs to support the conservation of the white shark.	No impacts.	No impacts.
Promote community education and awareness in relation to white shark conservation and management.	No impacts.	No impacts.
Encourage the development of regional partnerships to enhance the conservation and management of the white shark across national and international jurisdictions.	No impacts.	No impacts.

Assessment of the activity against the stated aims of the Recovery Plan for Marine Turtles in Australia (DoEE, 2017).

The following table provides an assessment of routine and non-routine operations against the management targets of the plan.

Conservation management targets	Assessment of impacts of routine activities against management aims	Assessment of impacts of Level 2 or 3 hydrocarbon spill against objectives
Domestic and international legislation and other agreements that support the recovery of Australian marine turtles are maintained, and, where possible, strengthened.	No impacts.	No impacts.
Robust scientific information is available and used to support decision making.	No impacts.	No impacts.
The sustainable management of marine turtles by Aboriginal and Torres Strait Islander communities and ranger groups to maintain long-term cultural, spiritual and economic associations with marine turtles is supported.	No impacts.	No impacts.
The capacity of programs throughout northern Australia to conduct effective monitoring, management and research of marine turtles at nesting beaches and feeding grounds is maintained and increased.	No impacts.	No impacts.
Robust and adaptive management regimes that lead to a reduction in anthropogenic threats to marine turtles and their habitats are in place.	No impacts.	No impacts.
Threat mitigation strategies are supported by high quality information.	No impacts.	No impacts.
Effective monitoring programs are implemented and maintained at index beaches and foraging areas for each of the six species.	No impacts.	No impacts.
Measures of success identified for each stock are achieved within the life of the plan.	No impacts.	No impacts.

Appendix 3

Stakeholder consultation flyer

Otway Offshore Project
2021 – 2023 Summary

beach

Beach Energy is continuing development of the Otway offshore basin natural gas reserves to ensure ongoing production at the Otway Gas Plant, which supplies natural gas to Victoria.

Key Activities

- Seabed assessments to determine the suitability of the seabed for drilling and infrastructure
- Inspections and modifications to existing seabed infrastructure to prepare for the new wells
- Drilling of offshore exploration, appraisal and production wells, 8 wells planned, further wells proposed
- Tie-ins to connect new production wells to the existing platform and pipeline
- Discontinuing some wells in the Geographe and Thylacine field, and any unsuccessful wells
- Establishing Petroleum Safety Zones (PSZ) for new wells and infrastructure

Completed Seabed Assessments

- Assessed seabed and subsea for anchoring and rig placement for drilling new wells
- Inspected existing infrastructure and surveyed well and flowline locations

October 2019 to February 2020

Further Seabed Assessments

- Assessment of seabed and subsea within T/30P permit
- 75km from Port Campbell
- Approximately 4 weeks
- Timming to be confirmed

February to June 2021

Drilling and Infrastructure

- 8 wells to be drilled
- Seabed infrastructure to tie-in wells
- 32 to 80 km from Port Campbell
- 18 to 24 month campaign

Starting mid-February 2021

Regulatory Approvals

Activities must be undertaken in accordance with existing approvals under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* and new approvals under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act)*. Each new separate activity such as seabed assessments or drilling programs must be undertaken in accordance with Environment Plans (EP) accepted by the *National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).*

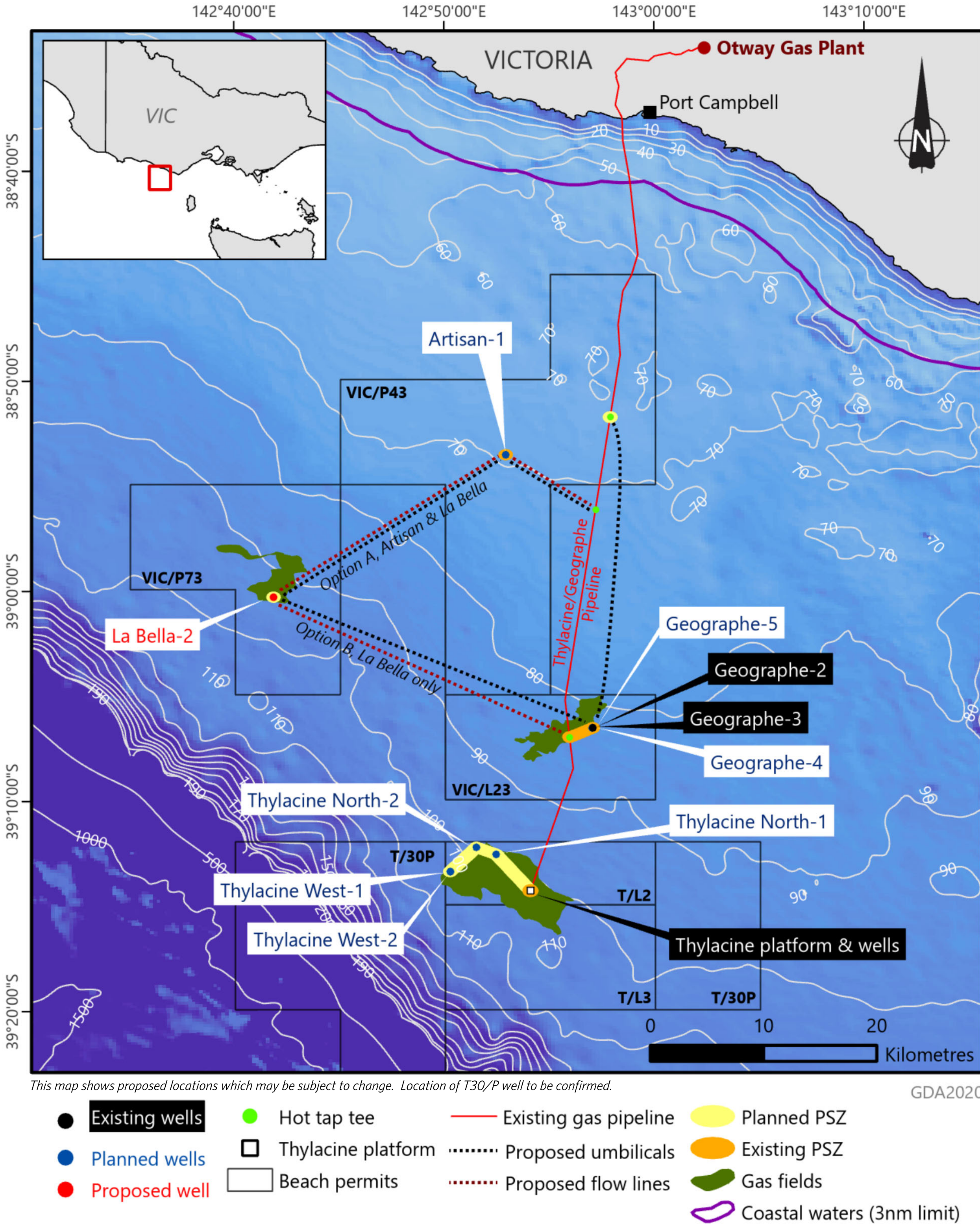
Current Otway Offshore Project

- Otway Gas Development was approved under the EPBC Act, ref no. 2002/621
- Includes Otway Gas Plant, Thylacine offshore platform, current Thylacine and Geographe fields and producing wells
- Further Thylacine and Geographe wells to be drilled after drilling Environment Plan is accepted by NOPSEMA

New Offshore Project Proposal

- An Offshore Project Proposal (OPP) is being developed by Beach for new fields and will be submitted to NOPSEMA for approval
- OPP will cover Artisan and La Bella gas fields and associated infrastructure
- Once OPP is approved, Environment Plans must be developed for separate activities

Planned and Proposed Locations



Contact us

1800 797 011

community@beachenergy.com.au

beachenergy.com.au

Appendix 4

Stakeholder communications

(provided to NOPSEMA separately as sensitive information under Regulation 9(8) of the OPGGS(E))

Appendix 5

EPBC Act Protected Matters Search Tool (PMST) results

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

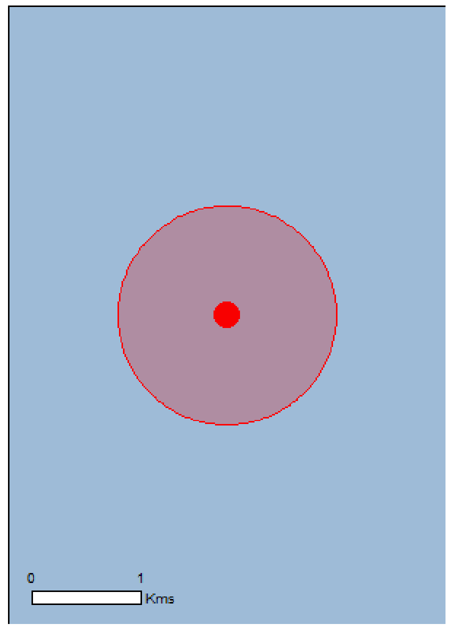
Activity Area

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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

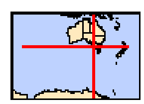
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 12/01/21 12:25:32



Coordinates

Buffer: 1.0Km



Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	36

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may 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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat 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
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may 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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known 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
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may 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

Name	Threatened	Type of Presence
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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within 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
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
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
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 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

Name	Threatened	Type of Presence
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
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
Mammals		
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 may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
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	Foraging, feeding or related behaviour known

Name	Status	Type of Presence
		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 Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
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]	Vulnerable	Species or species habitat likely 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 truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

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

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-39.10285 142.95659

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.

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

EPBC Act Protected Matters Report

Spill EMBA

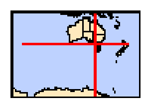
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 14/01/21 12:07:39

Coordinates
Buffer: 0.0Km



Summary

Matters of National Environmental 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:	2
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	74
Listed Migratory Species:	56

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 http://www.environment.gov.au/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 Land:	2
Commonwealth Heritage Places:	None
Listed Marine Species:	97
Whales and Other Cetaceans:	30
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	2

Extra Information

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

State and Territory Reserves:	9
Regional Forest Agreements:	2
Invasive Species:	45
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	1

Details

Matters of National Environmental Significance

National Heritage Properties [Resource Information]

Name	State	Status
Historic		
Point Nepean Defence Sites and Quarantine Station Area	VIC	Listed place
Quarantine Station and Surrounds	VIC	Within listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Corner inlet	Within 10km of Ramsar
Glenelg estuary and discovery bay wetlands	Within 10km of Ramsar
Port phillip bay (western shoreline) and bellarine peninsula	Within 10km of Ramsar
Western port	Within 10km of Ramsar

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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

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.

Name	Status	Type of Presence
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	Community may occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community may occur within area
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	Community may occur within area
Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (Eucalyptus ovata / E. brookeriana)	Critically Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia		
Regent Honeyeater [82338]	Critically Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
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
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
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat 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
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus cucullatus Hooded Plover (eastern), Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Crustaceans		
Euastacus bispinosus Glenelg Spiny Freshwater Crayfish, Pricklyback [81552]	Endangered	Species or species habitat may occur within area
Fish		
Galaxiella pusilla Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Prototroctes maraena		
Australian Grayling [26179]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Litoria raniformis		
Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
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 known to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon obesulus obesulus		
Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus		
Broad-toothed Rat (mainland), Tooarrana [87617]	Vulnerable	Species or species habitat may occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Miniopterus orianae bassanii		
Southern Bent-wing Bat [87645]	Critically Endangered	Species or species habitat likely to occur within area
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area
Potorous tridactylus tridactylus		
Long-nosed Potoroo (SE Mainland) [66645]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys novaehollandiae		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pseudomys shortridgei		
Heath Mouse, Dayang, Heath Rat [77]	Endangered	Species or species habitat may occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Plants		

Name	Status	Type of Presence
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area
Caladenia hastata Melblom's Spider-orchid [16118]	Endangered	Species or species habitat likely to occur within area
Caladenia orientalis Eastern Spider Orchid [83410]	Endangered	Species or species habitat may occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat may occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat likely to occur within area
Ixodia achillaeoides subsp. arenicola Sand Ixodia, Ixodia [21474]	Vulnerable	Species or species habitat likely to occur within area
Lachnagrostis adamsonii Adamson's Blown-grass, Adamson's Blowngrass [76211]	Endangered	Species or species habitat may occur within area
Pimelea spinescens subsp. spinescens Plains Rice-flower, Spiny Rice-flower, Prickly Pimelea [21980]	Critically Endangered	Species or species habitat may occur within area
Prasophyllum frenchii Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid [9704]	Endangered	Species or species habitat likely to occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat likely to occur within area
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
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat known to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour 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

Name	Threatened	Type of Presence
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
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known 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 likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		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
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land - Defence - TRAINING CENTRE (Norris Barracks) - Portsea

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known 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 gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		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
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pelecanoides urinatrix Common Diving-Petrel [1018]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat known to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Puffinus tenuirostris Short-tailed Shearwater [1029]		Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche sp. nov. Pacific Albatross [66511]	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 rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within 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

Name	Threatened	Type of Presence
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
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
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
Mammals		
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]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area

Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed		Species or species

Name	Status	Type of Presence
Whale, Layard's Beaked Whale [25556]		habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may 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
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Apollo	Multiple Use Zone (IUCN VI)
Beagle	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Anser Island	VIC
Cape Nelson	VIC
Discovery Bay Coastal Park	VIC
Lady Julia Percy Island W.R.	VIC
Phillip Island Nature Park	VIC
Point Nepean	VIC
Rodondo Island	TAS
Wilsons Promontory	VIC
Wilsons Promontory Islands	VIC

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Gippsland RFA	Victoria
West Victoria RFA	Victoria

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		

Name	Status	Type of Presence
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Turdus philomelos Song Thrush [597]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area

Name	Status	Type of Presence
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Western Port	VIC

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Bonney Coast Upwelling	South-east

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

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

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-37.636247 139.854841,-38.009409 140.492048,-38.078626 140.63487,-38.104565 140.810652,-38.11321 141.041365,-38.190964 141.217146,-38.251382 141.316023,-38.303129 141.348982,-38.415121 141.348982,-38.406513 141.436872,-38.432336 141.590681,-38.397903 141.733503,-38.346224 141.788435,-38.372068 141.986189,-38.423729 142.205915,-38.380681 142.337751,-38.423729 142.502546,-38.501151 142.634382,-38.569901 142.766218,-38.638585 142.90904,-38.647166 143.007917,-38.732919 143.15074,-38.784321 143.205671,-38.784321 143.337507,-38.818569 143.425398,-38.895565 143.535261,-38.792884 143.700056,-38.68148 143.908796,-38.509748 144.073591,-38.32037 144.425154,-38.268635 144.699812,-38.346224 144.677839,-38.483953 144.85362,-38.52694 144.919538,-38.440941 145.161238,-38.52694 145.106306,-38.561311 145.139265,-38.544128 145.282087,-38.595665 145.479841,-38.647166 145.545759,-38.69863 145.589704,-38.707204 145.710554,-38.715777 145.809431,-38.844243 145.886335,-38.929759 145.908308,-38.878462 146.182966,-39.006636 146.25987,-39.109008 146.314802,-39.177173 146.391706,-39.117532 146.633406,-39.262287 146.413679,-39.304806 145.677595,-39.423719 144.633894,-39.398255 144.040632,-39.296304 142.985945,-38.929759 141.667585,-38.655746 140.810652,-38.173692 140.140486,-37.827402 139.788923,-37.644946 139.755964,-37.636247 139.854841,-37.636247 139.854841

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-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.

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

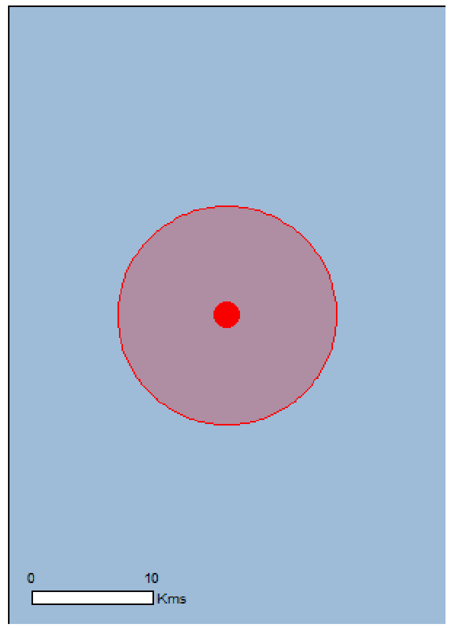
Noise behaviour EMBA

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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

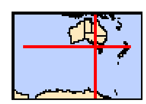
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 06/05/21 10:56:33



Coordinates

Buffer: 9.0Km



Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	36

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may 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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat 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
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may 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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known 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
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may 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

Name	Threatened	Type of Presence
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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within 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
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
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
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 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

Name	Threatened	Type of Presence
Solegnathus robustus		
Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
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
Mammals		
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 may occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
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	Foraging, feeding or related behaviour known

Name	Status	Type of Presence
		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 Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
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]	Vulnerable	Species or species habitat likely 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 truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

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

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-39.10272 142.95666

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.

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

Geographe Light EMBA

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.

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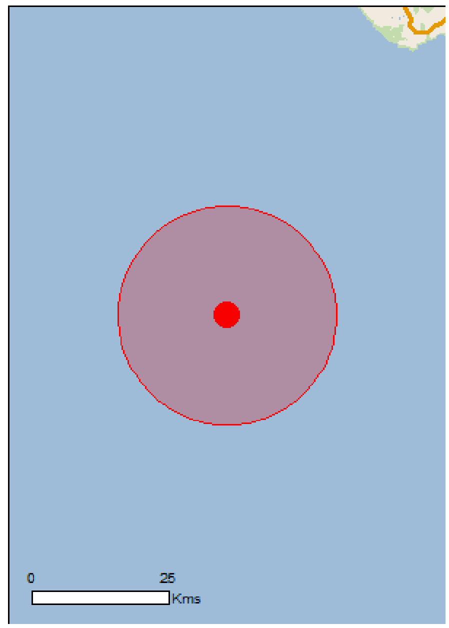
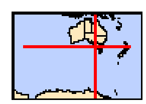


Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental Significance

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Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	37

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	26
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may 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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat 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
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may 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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known 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
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour 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

Name	Threatened	Type of Presence
Thalassarche sp. nov. Pacific Albatross [66511]	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
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
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
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
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 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

Name	Threatened	Type of Presence
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
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
Mammals		
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 may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
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

Name	Status	Type of Presence
		to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area

Name	Status	Type of Presence
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

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

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-39.10833 142.95139

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.

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

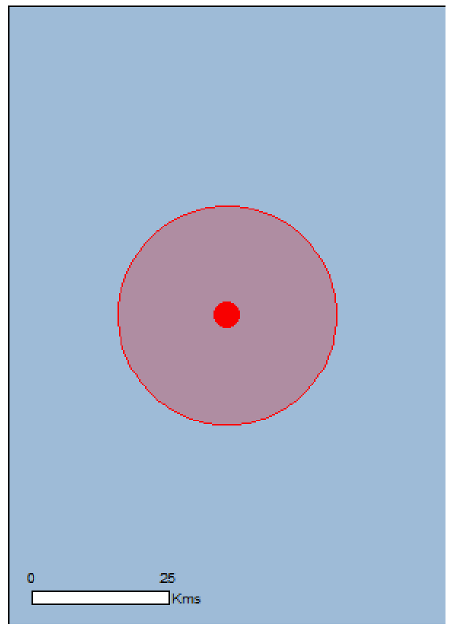
TN-1 Light EMBA

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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

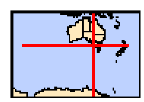
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 24/03/21 10:46:37



Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	38

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	1

Details

Matters of National Environmental Significance

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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may 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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat 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
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
[Megaptera novaeangliae](#) Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may 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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		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	Foraging, feeding or related behaviour known 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
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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 likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour 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

Name	Threatened	Type of Presence
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	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
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
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
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
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 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

Name	Threatened	Type of Presence
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
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
Mammals		
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 may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area

Name	Status	Type of Presence
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
West Tasmania Canyons	South-east

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

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

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-39.20833 142.875

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.

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

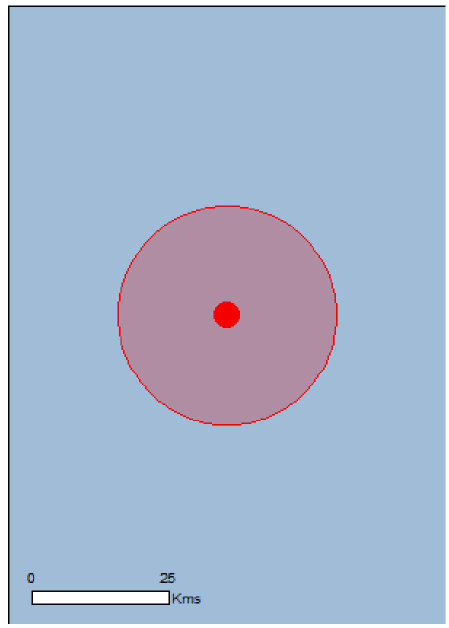
THY-Platform Light EMBA

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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

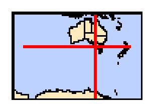
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 25/03/21 13:02:43



Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	38

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	1

Details

Matters of National Environmental Significance

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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may 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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat 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
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
[Megaptera novaeangliae](#) Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Sharks		
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Ardenna carneipes](#) Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
[Ardenna grisea](#) Sooty Shearwater [82651]		Species or species habitat may 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
[Macronectes giganteus](#) Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
[Macronectes halli](#) Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
[Phoebetria fusca](#) Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
[Thalassarche bulleri](#) Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Thalassarche cauta](#) Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		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	Foraging, feeding or related behaviour known 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
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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 likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour 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

Name	Threatened	Type of Presence
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	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
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
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
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
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 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

Name	Threatened	Type of Presence
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
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
Mammals		
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 may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area

Name	Status	Type of Presence
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
West Tasmania Canyons	South-east

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

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

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-39.23667 142.90222

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.

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Appendix 6

Otway Basin Environmental Survey

Intended for
Fugro Australia Pty Ltd

Document type
Report

Date
March 2020

ENVIRONMENTAL SURVEY
OTWAY BASIN

Bright ideas. Sustainable change.

ENVIRONMENTAL SURVEY
OTWAY BASIN

Project name	**Beach Energy Otway Basin Survey**
Project no.	**318000803**
Recipient	**Chris Henderson**
Document type	**Report**
Version	**Rev B**
Date	**17/03/2020**
Prepared by	**Emily Jones**
Checked by	**Dan McClary**
Approved by	**John Miragliotta**
Description	**Results of the environmental survey at Otway Basin for Beach Energy**

Ramboll
41 St Georges Terrace
Perth, WA 6000
Australia

T +61 8 9225 5199
F +61 2 9954 8150
https://ramboll.com

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1. INTRODUCTION

1.1 Background

This report presents the results of the environmental survey of offshore gas fields in Otway Basin for Beach Energy. Beach Energy is planning further development of the Otway offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The offshore Otway Basin gas exploration and development program may include drilling up to nine wells using a contracted semi-submersible drill rig, over a 12- to 18-month period. Additional seabed infrastructure would also be installed to tie-in new wells after the drilling phase.

As part of this plan, Fugro Australia Marine Pty Ltd (Fugro) carried out offshore geophysical and geotechnical surveys and Ramboll Australia Pty Ltd (Ramboll) were contracted by Fugro to carry out the environmental survey. These activities were in Commonwealth waters approximately 32 to 80 km from Port Campbell and in water depths ranging from 70 to 104 m.

1.2 Objective

The objective of the seabed site assessments was to determine suitable locations for anchoring and rig placement for drilling operations and the installation of infrastructure to connect new production wells to the existing platform or pipeline. Several different investigation techniques were used to examine and describe the seabed, as well as identify possible hazards from man-made, natural and geological features.

1.3 Report Scope

The scope of the environmental survey carried out in Otway Basin included investigations of:

- Water quality;
- Sediment quality;
- Benthic infauna; and
- Benthic epifauna.

Water quality assessments included laboratory analyses for:

- Suspended solids
- Nutrients
- Chlorophyll *a*
- Metals/metalloids
- Hydrocarbons

Sediment quality assessments included laboratory analyses for:

- Sediment particle size
- Total organic carbon
- Nutrients
- Metals/metalloids

Infauna were microscopically examined to determine taxonomic identification to Family level and morpho-species, and abundance was recorded. The composition and percent cover of epifauna was determined from seabed photographs.

2. SURVEY LOCATIONS

These investigations were based around five survey areas including:

- Thylacine;
- Artisan;
- La Bella;
- Geographe; and
- Hercules.

Other survey areas included two Hot Tap sites identified as HTX and HTY, and five routes selected for cone penetration tests (CPT) as part of the geotechnical survey plan identified as ARGE (Artisan to Geographe), ARHTX (Artisan to HTX), ARHTY (artisan to HTY), ARLB (Artisan to La Bella) and LBGE (La Bella to Geographe).

The collection of water and sediment/infauna samples for environmental assessment was cancelled by the client for the La Bella, Geographe and Hercules survey areas. Therefore, the collection of water and sediment/infauna samples for environmental assessment occurred only at the Thylacine and Artisan survey areas. Seabed photographs were taken as planned for all survey areas and routes. It is also noted that all survey areas were largely composed of outcropping rock with or without patches of uncemented sediments. Sampling of uncemented sediments was only possible with the grab sampler (as opposed to other devices) and of limited recovery because of the limited thickness of the surficial uncemented sediments.

The survey extent within Otway Basin, including these survey areas, hot taps and survey routes, is shown Figure 1. Environmental sampling sites were located in proximity to the proposed drilling rig mooring locations. The proposed anchor points for the drilling rig are listed in Table 1. The depth at each proposed mooring location was measure at the intersection of the anchor lines (Table 1). Sampling locations are listed in Section 3 for the relevant sampling methods.

Table 1 Location of proposed anchor points (GDA94 UTM 54 S) and water depth for drilling rig sites.

Survey Area	Anchor Point	Depth at Intersection (m LAT)	Easting	Northing
Thylacine	Thylacine 1	99	661398	5657534
	Thylacine 2		662879	5658389
	Thylacine 3		662361	5659286
	Thylacine 4		660880	5658431
	Thylacine 5	104	658235	5656067
	Thylacine 6		659717	5656923
	Thylacine 7		659198	5657820
	Thylacine 8		657717	5656965
Artisan	Artisan 1	70	662783	5692700
	Artisan 2		664261	5693554
	Artisan 3		663741	5694456
	Artisan 4		662262	5693602
Geographe	Geographe 1	83	668221	5668522
	Geographe 2		669699	5669374
	Geographe 3		669179	5670278
	Geographe 4		667700	5669424
La Bella	La Bella 1	93	647914	5681579
	La Bella 2		645915	5681579
	La Bella 3		647319	5682496
	La Bella 4		646437	5680702
Hercules	Hercules 1	73	664065	5688642
	Hercules 2		662065	5688638
	Hercules 3		663547	5689516
	Hercules 4		662596	5687757

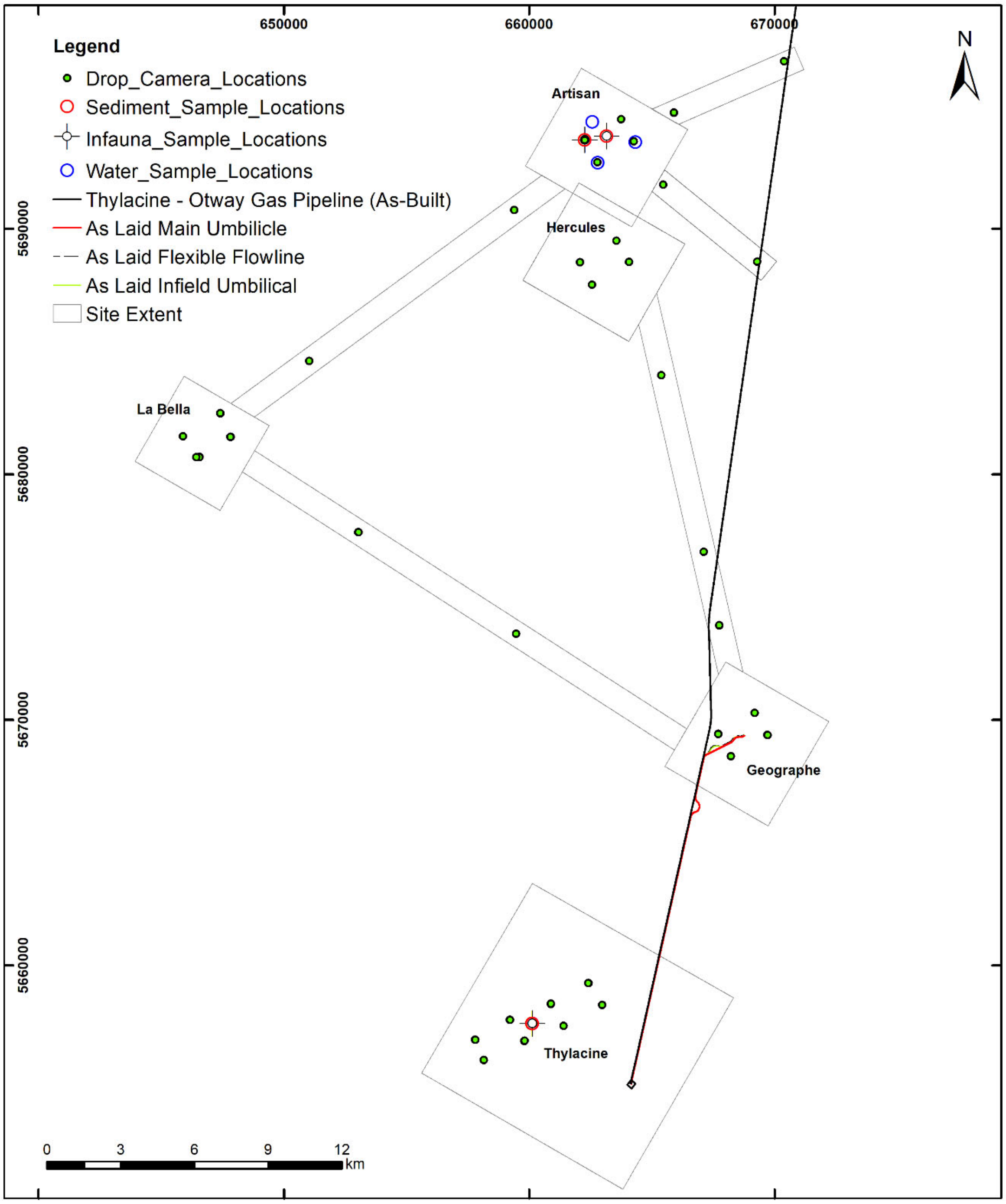


Figure 1 Locations of environmental survey site extents in Otway Basin. Provided by Fugro, April 2020.

3. METHOD

3.1 Survey Operations

The environmental survey was undertaken during several deployments from November 2019 to January 2020. The survey was carried out from the 60 m offshore supply ship *VOS SHINE*. The vessel mobilised from Portland, Victoria.

3.2 Water Quality

3.2.1 Sample Collection

Water quality samples were collected using a 2.2 L Van Dorn Beta water sampler. This sampler was used to obtain water samples from selected water depths. The sampler consisted of an open-ended, clear plastic cylinder with a rubber cap attached at each end. Before deployment, the end caps were held open, under tension, by triggers on the side of the cylinder. The sampler was attached to a rope and lowered by hand over the side of the vessel to the desired depth. A messenger weight attached to the rope was then released to trigger the end caps to close as the messenger contacted the sampler, sealing the water sample inside the cylinder. The sampler was then raised to the surface where the water sample was processed and stored for laboratory analysis.

On retrieval at the surface, the water sampler was inspected against the following sample acceptability criteria:

1. The sample bottle was full; and
2. Both end caps are fully closed; and
3. There was no obvious contamination (e.g. grease or paint chips on, or inside, the sampler).

Any sample that did not comply with these criteria was discarded and another sample was collected at the same site. All samples were recorded on the Environmental Sampling Log (Appendix 1) as per 135846-V01-01-PLA-001 Infauna Lab Testing & Reporting Plan.

Water samples were collected at two of the survey areas – at Artisan and Thylacine on 22 November 2019. Three replicate water samples were collected at each of the survey areas. The locations for water sample collection are listed in Table 2 and shown in Figure 2. Note that there is only one sampling site indicated for the Thylacine field as all samples were collected in close proximity (Figure 2 left). The process described above was carried out at each site and water samples were collected from a depth equal to half of the total water depth at that site.

Table 2 Location (GDA94 UTM 54 S) and depth of water sample collection sites.

Survey Area	Location	Replicate Sample Name	Easting	Northing	Water Depth (m)	Sample Depth (m)	Met Acceptability Criteria
Thylacine	1	1	660119	5657621	104	52	Yes
	1	2	660121	5657619	104	52	Yes
	1	3	660122	5657619	105	52.5	Yes
Artisan	1	1	662936	5692724	66	33	No
	1	2	662782	5692683	66	33	Yes
	2	1	664317	5693523	66	33	Yes
	5	1	662563	5694337	66	33	Yes

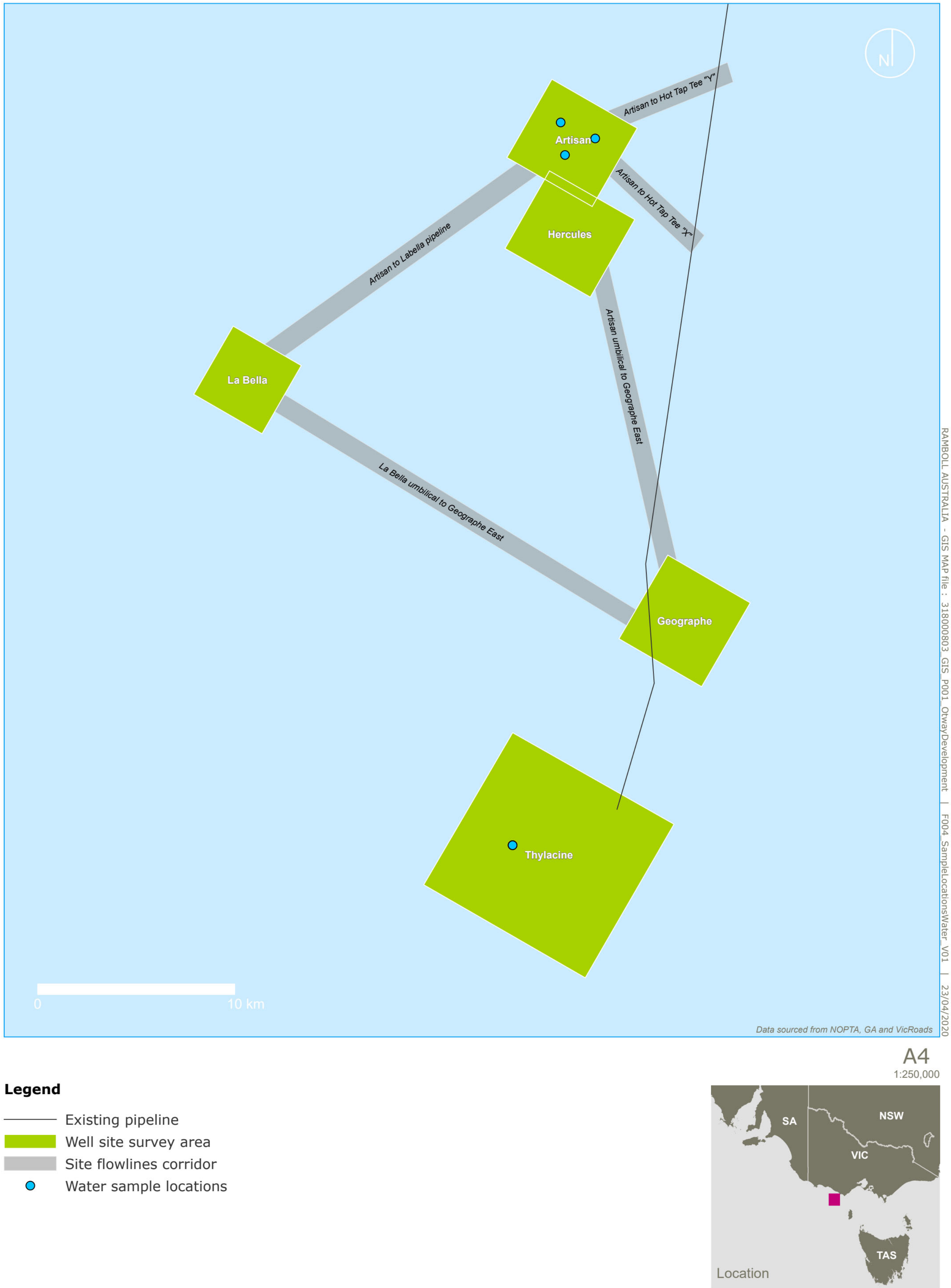


FIGURE 2 | Water sampling locations for Thylacine and Artisan survey areas.

3.2.2 Sample Processing and Analysis

Once a sample was confirmed to be acceptable for analysis, the subsamples were extracted from the water sampler and stored in pre-labelled sample jars provided by the analytical laboratory, Eurofins. The analytical laboratory was NATA accredited and accredited for compliance with ISO/IEC 17025 – Testing.

The water samples were subsampled as follows:
- 1 x 500 mL plastic bottle with no preservative
- 1 x 200 mL glass bottle with no preservative
- 1 x 60 mL plastic bottle with sulphuric acid
- 1 x 60 mL plastic bottle with nitric acid
- 2 x 40 mL glass vials with hydrogen chloride

All samples were stored in a cool, dark location prior to transfer to the laboratory.

One litre of the remaining water sample was then processed for chlorophyll analysis. A simple filtering system was set up which included a Büchner funnel with a rubber seal placed in the mouth of a conical flask and a rubber hose and vacuum hand pump attached to the side arm of the flask. Filter paper (11 µm particle retention at 98% efficiency) was used placed in the funnel and the 1L subsample was suctioned through the filtering system. The filter paper was carefully removed from the funnel using forceps, wrapped in aluminium foil, stored in a labelled sealable plastic bag and frozen prior to transfer to the laboratory.

The following measurements were then taken using a YSI EcoSense handheld meter from the remaining water sample:
- pH
- Dissolved oxygen (DO)
- Oxidation-reduction potential (ORP)
- Temperature (˚C)

Sample information was recorded on the Environmental Sample Log (Appendix 1). All sample collection and processing equipment was then rinsed in sterile demineralised water before the next sample was collected.

All water quality subsamples were recorded on the Ramboll Chain of Custody (COC) form. These subsamples were then transferred to the laboratory on the vessel's return to shore. The water quality samples were delivered to the Eurofins laboratory in Melbourne on 26 November 2019.

The water samples were analysed for the presence and concentration of these analytes:
- Total suspended solids (TSS);
- Nutrients including total nitrogen (N), total Kjeldahl nitrogen (TKN), nitrogen oxides (NOx), nitrate (NO^{-}_{3}), ammonia (NH_3), total phosphorus (TP), and total reactive phosphorus (TRP);
- Chlorophyll *a*;
- Metals/metalloids including arsenic (As), cadmium (Cd), cobolt (Co), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), and zinc (Zn); and
- Hydrocarbons including total recoverable hydrogens (TRH), benzene, toluene, ethylbenzene and xylene compounds (BTEX), and polycyclic aromatic hydrocarbons (PAH).

The analytical methods for these analytes are included in the laboratory reports in Appendix 2.

3.3 Sediment Quality

3.3.1 Sample Collection

Seabed sediment samples were collected using a Double Van Veen grab sampler. The Double Van Veen grab is designed for sampling the top layer of consolidated sediment consisting of silt and/or sand. The capacity of each grab bucket is ~12 L. The double grab allows for comparable sampling where samples for sediment and biological analysis are required from the same location.

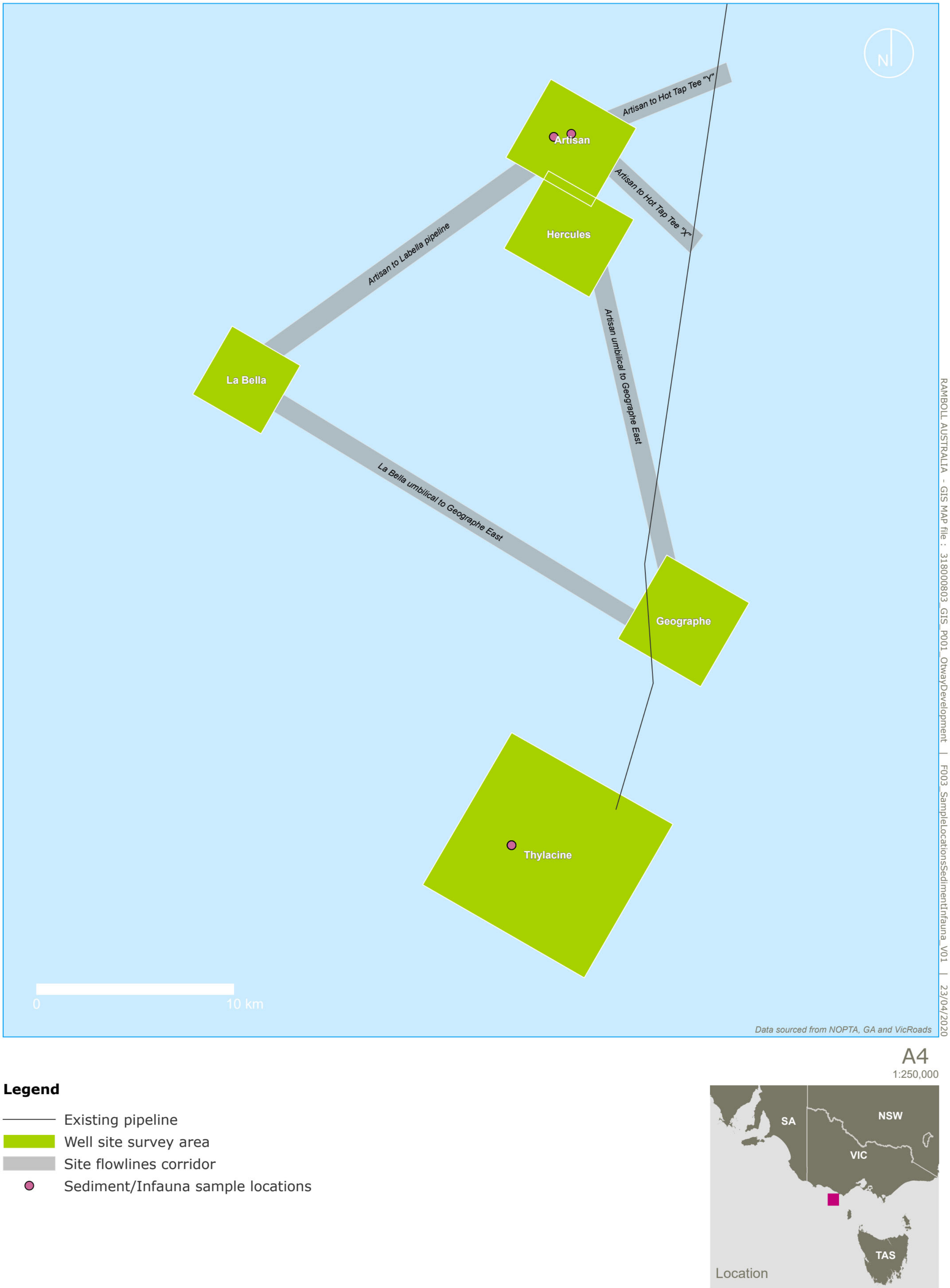
Prior to deployment, the jaws of both grabs were opened and fixed into position using a tension-based catch. The grab sampler was then winched over the stern of the vessel and lowered at a slow, steady rate to prevent the catch from being released too early. When the jaws made contact with the bottom, the release of tension caused the catch to be tripped, allowing the jaws to quickly close to capture the surface sediment. The quantity and quality of the sample was related to the compactness of the sediment whereby the grab sampler returned less sample content from more compacted sediments.

On retrieval at the surface, the grab sampler was inspected against the following sample acceptability criteria:

1. The jaws of the grab are closed; and
2. The surface of the sediment sample covers at least 70% of the grab; and
3. The surface of the sediment sample is undisturbed; and
4. There is no evidence of the sample being washed out; and
5. The sample is at least 20cm deep.

Samples that did not comply with these criteria were typically discarded and another sample was collected at the same site. However, some exceptions to these criteria were allowed on agreement with the client in order to obtain samples for analysis, given the difficulty of obtaining grab samples from the hard seabed substrate. Such instances are noted in the description of results in Section 4. At some sample locations a composite sample was made from several grab drops (up to three drops) to provide enough material for one sample. In these instances, the samples did not achieve a depth of 20 cm. The first sample replicate collected from the Thylacine survey area (Thylacine_1_1) was 15 cm deep and therefore did not meet the acceptance criteria; however, given the difficulty in obtaining suitable samples (owing to the hard seabed), this sample was retained for analysis as all other criteria were met and it was considered to be a useful sample by the field personnel. All samples were recorded on the Environmental Sampling Log (Appendix 1) as per 135846-V01-01-PLA-001 Infauna Lab Testing & Reporting Plan.

Sediment samples were collected at two of the survey areas – at Artisan and Thylacine on 22 November 2019. Three replicate sediment samples were to be collected at each of the survey areas, however, this was not always possible because of the compacted substrate. The resulting samples included four replicate samples from Thylacine and two replicate samples from Artisan. The locations for successful sediment sample collection are listed in Table 3 and shown in Figure 3. Note that there is only one sampling site indicated for the Thylacine field as all samples were collected in close proximity (Figure 3 left). Grab sample positions were provided by Fugro from the marine survey using Ultra Short Base Line positioning systems.



Legend

- Existing pipeline
- Well site survey area
- Site flowlines corridor
- Sediment/Infauna sample locations

FIGURE 3 | Grab sample locations for sediment and infauna for Thylacine and Artisan survey areas.

Table 3 Location (GDA94 UTM 54 S) and depth of sediment sample collection sites.

Survey Area	Location	Sample Replicate Name	Easting	Northing	Water Depth (m)	Met Acceptability Criteria
Thylacine	1	0	660119	5657621	104	Sample was 15 cm deep, therefore not within acceptance criteria but considered suitable by field personnel. Incorrectly recorded in lab report as Location 2.
	1	1	660121	5657619	104	Yes
	1	2	660122	5657619	105	Yes
	1	3	660120	5657622	104	Yes
Artisan	1	1	663155	5693762	72	This sample was a composite of replicate samples 1, 3, 4 and 6 taken at the same location. Listed as Artisan_GS_A in lab report.
	1	2	663155	5693762	72	No
	1	3	663155	5693762	72	Composite as above.
	1	4	663155	5693762	72	Composite as above.
	1	5	663155	5693762	72	No
	1	6	663155	5693762	72	Composite as above.
	3	1	662264	5693604	75	No
	3	2	662264	5693604	72	No
	3	3	662265	5693604	73	Yes. Listed as Artisan_GS3 in lab report.
	3	4	662265	5693605	74	No sediment sample, infauna sample only.

3.3.2 Sample Processing and Analysis

Once a sample was confirmed to be acceptable for analysis, the sample was photographed, visual observations were recorded, and subsamples were extracted from the sample and stored in pre-labelled sample jars provided by the analytical laboratory.

All sediment grab samples were photographed with a sample identity plate. Notes of the uniformity of the surface, Munsell colour and odour were then recorded. The redox (reduction–oxidation reaction) potential depth (RPD) was measured using a YSI EcoSense handheld meter and probe. Redox potential is a measure of the tendency of a chemical species to acquire electrons from or lose electrons to an electrode and thereby be reduced or oxidised, respectively. Redox potential is measured in millivolts (mV). The redox potential of the sample was measured from the surface and at 10 mm increments to a depth of up to 110 mm, or until resistance was encountered when inserting the probe. The probe was rinsed in fresh water between each sample. Sample information was recorded on the Environmental Sample Log (Appendix 1).

Sediment was then extracted from one grab bucket for sediment quality sampling (with the contents of the other grab bucket being used for infauna sampling). Subsamples were collected by releasing the sample into a collection bin below the sampler. The entire sample was homogenised using a plastic scoop.

Two subsamples were stored in pre-labelled 250 mL glass sample jars for the analysis of contaminants and particle size distribution. All samples were stored in a cool, dark location prior to transfer to the laboratory. All sample collection and processing equipment was then rinsed in fresh water before the next sample was collected.

All sediment quality subsamples were recorded on the Ramboll COC form. These subsamples were then transferred to the laboratory on the vessel's return to shore. The sediment quality samples were delivered to the Eurofins laboratory in Melbourne on 26 November 2019.

The sediment samples were analysed for the presence and concentration of these analytes:

- Sediment particle size as clay-size fraction, silt and sand;
- Total organic carbon (TOC);
- Nutrients including nitrate and nitrite, TKN, total nitrogen, phosphorus, and silicon;
- Metals/metalloids including cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), tin (Sn), and zinc (Zn).
- Hydrocarbons including Total Petroleum Hydrocarbons (TPH) , total polycyclic aromatic hydrocarbons (PAH) and BTEX (benzene, toluene, ethylbenzene and xylenes, PCBs.

The analytical methods for these analytes are included in the laboratory reports in Appendix 3.

3.4 Infauna Ecology

3.4.1 Sample Collection

Seabed sediment samples for infauna were collected using a Double Van Veen grab sampler, as described in Section 3.2.1 and at the locations presented in Table 4 and Figure 3. The critiera for accepting grab samples for infauna analysis were as described in Section 3.2.1. All samples were recorded on the Environmental Sampling Log (Appendix 1) as per 135846-V01-01-PLA-001 Infauna Lab Testing & Reporting Plan.

3.4.2 Sample Processing and Analysis

Once a sample was confirmed to be acceptable for analysis, the sample was photographed with a sample identity plate. Sediment was then extracted from one grab bucket for infauna sampling (with the contents of the other grab bucket being used for sediment quality sampling). The entire sample was released into a collection bin below the sampler and then transferred to a sample washing system where the sample was placed in a perforated bin to be mixed and rinsed with seawater. The liquified sample was then passed through a series of sieves of 1mm mesh size (top) and 500 µm mesh size (bottom). The remaining infauna and debris were then rinsed into a labelled container and preserved in ethanol at a dilution factor of 2:1 to sample volume. Where a full grab sample was collected, the contents were subsampled to a 6L sample volume to limit the time required for infauna sample processing in the laboratory.

All samples were stored in a chemical locker and were recorded on the Ramboll COC form. These samples were then transferred to the taxonomic analyst on the vessel's return to shore. The laboratory in Gladstone, Queensland received the infauna samples in December 2019.

Infauna organisms present in the samples were identified and counted to Family morpho-species or genus level where possible. Descriptive statistics (e.g., species richness, organism abundance, diversity indices) were used to summarise the seabed biota present. This information is assessed and discussed in the context of the known communities present in the wider Otway Basin, noting the presence of any habitats/species of relevance to the EPBC Act. Multivariate measures were not used in the assessment because of the small dataset and paucity of organisms found in the samples.

Table 4 Location (GDA94 UTM 54 S) and depth of infauna sample collection sites.

Survey Area	Location	Sample Replicate Name	Easting	Northing	Water Depth (m)	Met Acceptability Criteria
Thylacine	1*	0	660119	5657621	104	Sample was 15 cm deep, therefore not within acceptance criteria but considered suitable by field personnel. Incorrectly recorded in lab report as Location 2.
	1	1	660121	5657619	104	Yes
	1	2	660122	5657619	105	Yes
	1	3	660120	5657622	104	Yes
Artisan	1	1	663155	5693762	72	No
	1	2	663155	5693762	72	No
	1	3	663155	5693762	72	No
	1	4	663155	5693762	72	Yes
	1	5	663155	5693762	72	No
	1	6	663155	5693762	72	No
	3	1	662264	5693604	75	No
	3	2	662264	5693604	72	No
	3	3	662265	5693604	73	Yes
	3	4	662265	5693605	74	Sample was 7 cm deep, therefore not within acceptance criteria but considered suitable by field personnel.

3.5 Epibenthic Ecology

3.5.1 Sample Collection

The composition and percent coverage of epifauna was assessed from photographs of the seafloor taken with the Fugro drop camera system. The drop camera system was fitted with a 14.7 megapixel (MP) Canon PowerShot G10 digital camera and a low latency, live video recorder. The system was equipped with twin lasers aimed within the camera field of view to enable calibration of the image size. The lasers were calibrated to a distance of 15 cm. The camera housing was an aluminium enclosure for use in water depths up to 300 m. A mini beacon was attached to the drop camera to accurately track locations during deployment.

The drop camera was deployed via a winch over the stern of the vessel. All data was transferred directly to the surface unit and saved into a dedicated Fugro server. A real-time video feed to the surface enabled preliminary observations of benthic fauna and substrate type to be made during operation.

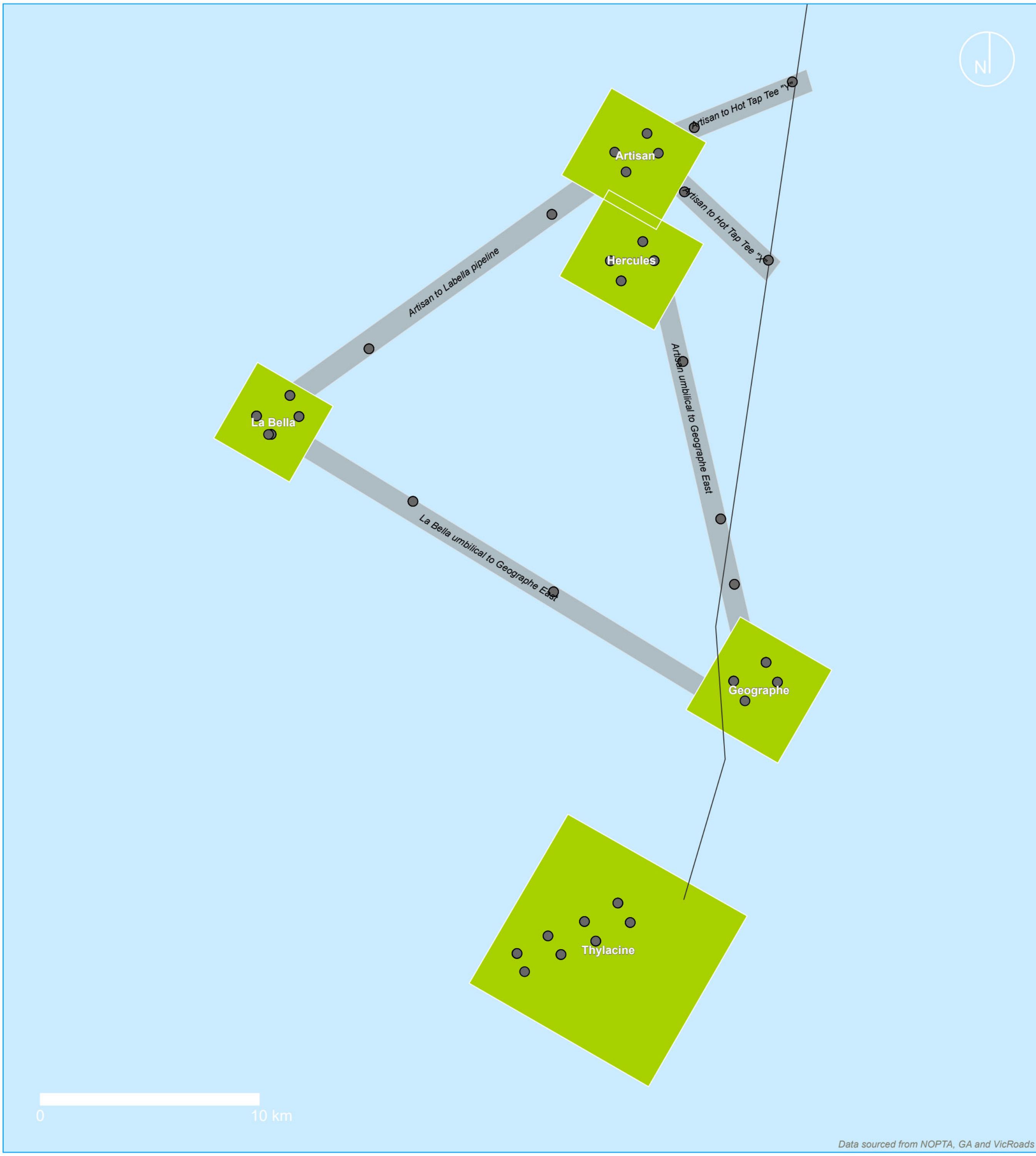
At each sampling site the camera was lowered and then to three locations approximately 1-2 m apart to obtain a collection of representative samples. At least five photographs were taken at each location to provide a selection of photographs for analysis. Drop camera sites are listed in Appendix 4. Drop camera photographs were taken at all anchor points, hot tap sites and along CPT routes as shown in Figure 4. The average area of seabed in each photograph was 0.5 m^2.

3.5.2 Sample Processing and Analysis

All seafloor photographs were examined to determine their suitability for analysis, with photographs being excluded for the assessment based on the following reasons:

- Poor resolution or blurred image;
- Sediment blow out obscuring the image;
- More than a quarter of the image was in shadow or had poor lighting;
- Images were overlapping (in which case the best quality image was chosen); or
- Images were taken at oblique angles.

For each photograph, the percent coverage of epifauna was estimated and individual, mobile organisms were counted. Photographs were examined to provide a qualitative description of the epifauna communities. Sediment type and percent coverage was also estimated for each photograph.



RAMBOLL AUSTRALIA - GIS MAP file : 318000803_GIS_P001_OtwayDevelopment | F002_DropCameraLocations_V01 | 23/04/2020

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Legend

- Existing pipeline
- Well site survey area
- Site flowlines corridor
- Drop camera locations

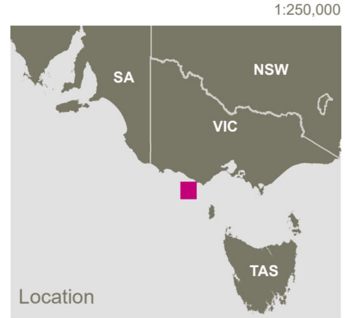

FIGURE 4 | Drop camera locations for all survey areas.

4. RESULTS

4.1 Water Quality

Measurements made *insitu* for water samples collected from the Thylacine and Artisan survey areas are presented in Table 5. Dissolved oxygen (DO) and pH were assessed against the default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). Trigger values are used to assess risk of adverse effects due to nutrients, biodegradable organic matter and pH in various ecosystem types.

Dissolved oxygen was between the lower and upper limits of 90 and 110% saturation for marine waters in all samples. Likewise, pH was between the lower and upper limits of 8.0 and 8.4 for all samples. The range of ORP measurements indicated a well oxygenated, ecologically healthy environment.

Table 5 Measurements made *insitu* for water samples at Thylacine and Artisan survey areas.

Sample Name	pH	DO (% saturation)	ORP (mV)
Thylacine_1_1	8.19	94.3	215.0
Thylacine_1_2	8.24	95.2	211.4
Thylacine_1_3	8.33	95.2	98.1
Artisan_1_2	8.16	94.0	172.7
Artisan_2_1	8.08	93.1	211.4
Artisan_5_1	8.34	93.8	164.5

The results of laboratory analyses for water samples from the Thylacine and Artisan survey areas are presented in Tables 6 to 11.

The analytes were compared to the relevant ANZECC (2000) – the default trigger values for physical and chemical stressors for nutrient analytes and the trigger values for toxicants at alternative levels of protection for all other analytes.

The concentration of ammonia, nitrite and reactive phosphorus was at or below LOR for all samples. Only one sample contained a concentration of nitrate-nitrite, NO^{-}_{3}, TKN and TN above the LOR. This was replicate Thylacine_1_3; however, none of the measurements exceeded ANZECC trigger values. Concentrations of TP were recorded in all samples, but all measurements were well below ANZECC trigger values. TSS was typically within the range expected for unmodified[1] marine ecosystems.

The concentrations of Cd, Cr, Co, Pb, Hg, and Ni were at or below LOR in all samples. The concentration of Cu was below, at or very close to the LOR for all samples.

The concentration of Zn against ANZECC protection level (or trigger values) is shown in Figure 5. All concentrations were below the 90% protection level but concentrations variously exceeded 95 or 99% protection levels. This result is consistent with a slightly disturbed marine system which is described in (ANZECC 2000) as an ecosystem in which biodiversity may have been affected to a

[1] Unmodified is a descriptive term used in reference to the quality of the environment and is used in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000). Effectively unmodified ecosystems, typically (but not always) occur in remote and/or inaccessible locations. While there are no aquatic ecosystems in Australia that are entirely without some human influence, the ecological integrity of unmodified ecosystems is regarded as intact.

small degree by human activity. Therefore, this result is likely reflective of the human activities occurring within and around the study area and the levels of environmental Zn are with a reasonable level of species protection for such an environment.

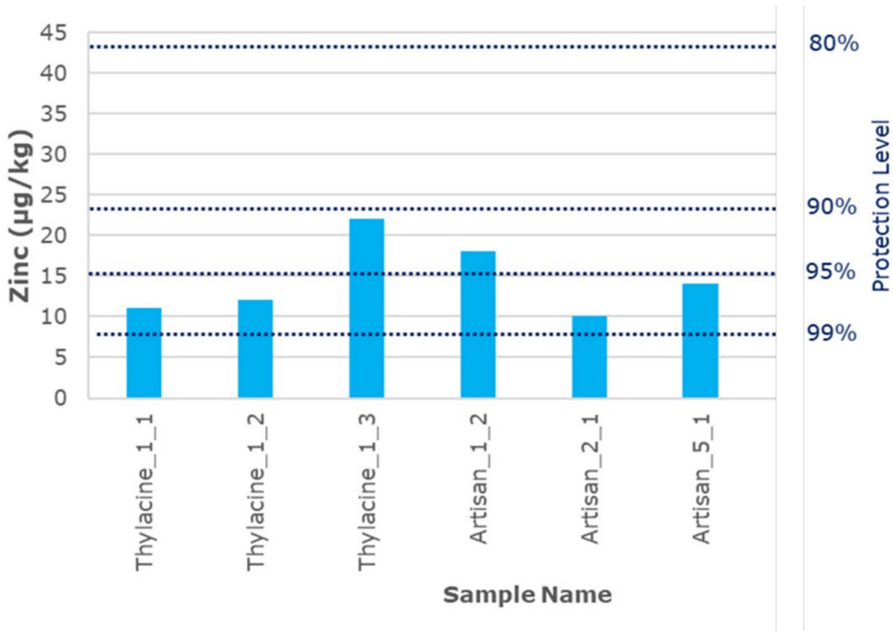

Figure 5 Concentration of Zn in water samples from Thylacine and Artisan survey areas.

BTEXs and PAHs were below the detection limit in all water samples. Very low traces of TRHs were detected in the Thylacine_1_2 water sample but were at levels of no concern. TRHs were below detection limits in all other samples. The level of chlorophyll *a* in filtered samples was below the detection level.

Table 6 Nutrients in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L								
	NH_3	Nitrate-Nitrite	NO^-_3	Nitrite	TP	RP	TKN	TN	TSS
Thylacine_1_1	< 0.01	< 0.05	0.03	< 0.02	0.03	< 0.01	< 0.2	< 0.2	3.4
Thylacine_1_2	< 0.01	< 0.05	0.02	< 0.02	0.02	< 0.01	< 0.2	< 0.2	9.7
Thylacine_1_3	< 0.01	0.10	0.10	< 0.02	0.02	< 0.01	2.4	2.5	2.4
Artisan_1_2	< 0.01	< 0.05	< 0.02	< 0.02	0.02	< 0.01	< 0.2	< 0.2	5.9
Artisan_2_1	< 0.01	< 0.05	< 0.02	< 0.02	0.01	0.01	< 0.2	< 0.2	4.6
Artisan_5_1	< 0.01	< 0.05	< 0.02	< 0.02	0.01	< 0.01	< 0.2	< 0.2	5.2

Table 7 Metals and metalloids in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L								
	Ar	Cd	Cr	Co	Cu	Pb	Hg	Ni	Zn
Thylacine_1_1	0.001	< 0.0002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.0001	< 0.001	0.011
Thylacine_1_2	0.004	< 0.0002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.0001	< 0.001	0.012
Thylacine_1_3	0.002	< 0.0002	< 0.001	< 0.001	0.002	< 0.001	< 0.0001	0.001	0.022
Artisan_1_2	0.003	< 0.0002	< 0.001	< 0.001	0.001	< 0.001	< 0.0001	< 0.001	0.018
Artisan_2_1	0.005	< 0.0002	< 0.001	< 0.001	0.001	< 0.001	< 0.0001	< 0.001	0.01
Artisan_5_1	0.010	< 0.0002	< 0.001	< 0.001	0.001	< 0.001	< 0.0001	< 0.001	0.014

Table 8 Polycyclic Aromatic Hydrocarbons (PAH) in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L					
	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b&j)fluoranthene
Thylacine_1_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thylacine_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thylacine_1_3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_2_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_5_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Sample Name	mg/L					
	Benzo(g.h.i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a.h)anthracene	Fluoranthene	Fluorene
Thylacine_1_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thylacine_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thylacine_1_3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_2_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_5_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Sample Name	mg/L					p-Terphenyl-d14 (%)	2-Fluorobiphenyl (%)
	Indeno(1.2.3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH		
Thylacine_1_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	134	111
Thylacine_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	145	107
Thylacine_1_3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	138	109
Artisan_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	93	109
Artisan_2_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	102	114
Artisan_5_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	101	117

Table 9 Total Recoverable Hydrocarbons (1999 NEPM Fractions) in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L				
	TRH C10-C14	TRH C10-C36 (Total)	TRH C15-C28	TRH C29-C36	TRH C6-C9
Thylacine_1_1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02
Thylacine_1_2	0.05	0.15	0.1	< 0.1	< 0.02
Thylacine_1_3	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02
Artisan_1_2	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02
Artisan_2_1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02
Artisan_5_1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02

Table 10 Total Recoverable Hydrocarbons (2013 NEPM Fractions) in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L							
	Naphthalene	TRH >C10-C16	TRH >C10-C16 less Naphthalene (F2)	TRH >C10-C40 (total)*	TRH >C16-C34	TRH >C34-C40	TRH C6-C10	TRH C6-C10 less BTEX (F1)
Thylacine_1_1	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02
Thylacine_1_2	< 0.01	0.07	0.07	0.17	0.1	< 0.1	< 0.02	< 0.02
Thylacine_1_3	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02
Artisan_1_2	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02
Artisan_2_1	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02
Artisan_5_1	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02

Table 11 BTEX in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L						4-Bromofluoro-benzene (%)
	Benzene	Ethylbenzene	m&p-Xylenes	o-Xylene	Toluene	Xylenes - Total	
Thylacine_1_1	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	106
Thylacine_1_2	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	94
Thylacine_1_3	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	107
Artisan_1_2	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	94
Artisan_2_1	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	102
Artisan_5_1	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	100

4.2 Sediment Quality

The particle size distribution of marine sediments in each sample is shown in Figure 6 with data recorded in Appendix 3. The particle size is <2 µm for the clay-size fraction, 2-20 µm for the silt fraction and 20-2000 µm for the sand fraction. Note that the sample for Artisan 1_1 was a composite of up to three drops of the grab sampler. The sediment within all samples and, therefore at both survey areas, was predominantly sand with a range of 95-97% as a proportion of each sample. There was very little silt and a maximum of 4.7% for the clay-size fraction. There were no discernible trends based on the location of sample collection. The Munsell colour of all samples as 10YR 8/4.

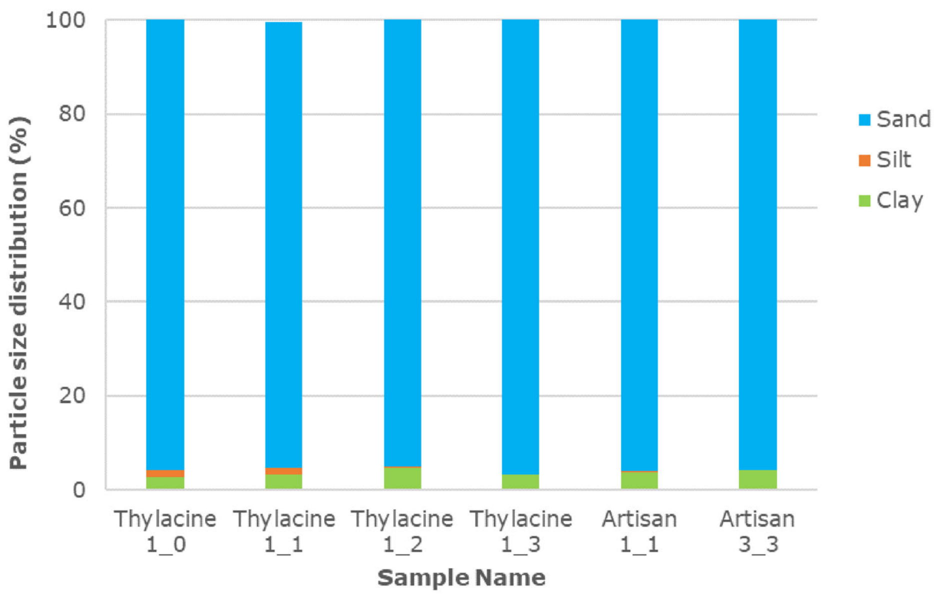

Figure 6 Particle size distribution (%) in sediment samples collected at Thylacine and Artisan survey areas.

The ORP (oxidation-reduction potential) or redox potential of sediments within the samples was measured and the results are presented in Table 12. Note that the measurement probe was inserted into the sediment until resistance prevented further insertion. Given that the substrate was predominantly sand, the probe was typically only inserted to 1-2 cm and no more than 3 cm into the sediment sample. The anoxic layer with low ORP was not detected in any of the sediments analysed and the range of measurements indicated that these sediments maintain a well oxygenated, unmodifed environment.

Table 12 Measurement of oxidation reduction potential in sediment samples at Thylacine and Artisan survey areas.

Sample Name	ORP Measurement Depth (mV)		
	1 cm	2 cm	3 cm
Thylacine_1_0	211	211	No further penetration
Thylacine_1_1	252.7	No further penetration	-
Thylacine_1_2	242.7	No further penetration	-
Thylacine_1_3	225.5	223	216.7
Artisan_1_1	Composite sample; measurement not possible		
Artisan_3_3	242.1	217.3	No further penetration

The results of nutrient analyses are shown in Table 13, Figure 7 and Figure 8. Nitrate-nitrite was not detected in any samples. There was a notable degree of variability in the samples collected in the Thylacine field, however the small number of samples means that a trend or pattern is not discernible. TOC and detectable nitrogen concentrations were slightly higher in the Artisan samples compared to the Thylacine samples. Generally, the concentrations of nutrients in the marine sediments were to be expected for this environment and type of sediment.

Table 13 Nutrients in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg					Total Organic Carbon (%)
	Phosphorus	Silicon	Nitrate-Nitrite	Total Kjeldahl Nitrogen	Total Nitrogen	
Thylacine_1_0	750	850	< 5	230	230	1.3
Thylacine_1_1	620	1000	< 5	190	190	0.9
Thylacine_1_2	400	950	< 5	130	130	0.5
Thylacine_1_3	< 200	460	< 5	180	180	< 0.1
Average (± S.D.)	467.5 (± 284)	815 (± 245)	NA	183 (± 41)	183 (± 41)	1.0 (± 0.5)
Artisan_1_1	620	570	< 5	310	310	1.6
Artisan_3_3	530	810	< 5	270	270	2.4
Average (± S.D.)	575 (± 64)	690 (± 170)	NA	290 (± 28)	290 (± 28)	2.0 (± 1.0)

Level of Reporting (LOR): phosphorus 200 mg/kg; silicon 5 mg/kg; nitrate-nitrite 5 mg/kg; TKN 10 mg/kg; TN 10 mg/kg; TOC 0.1%.
S.D. = standard deviation. Note that average (± S.D.) calculations are made with half LOR where the sample result was < LOR.

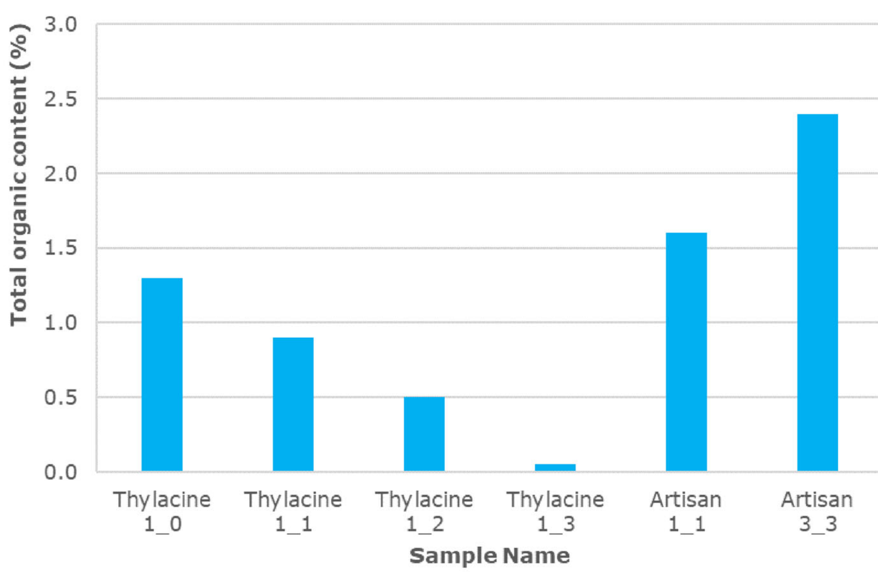

Figure 7 Total organic content (%) in sediment samples collected at Thylacine and Artisan survey areas.

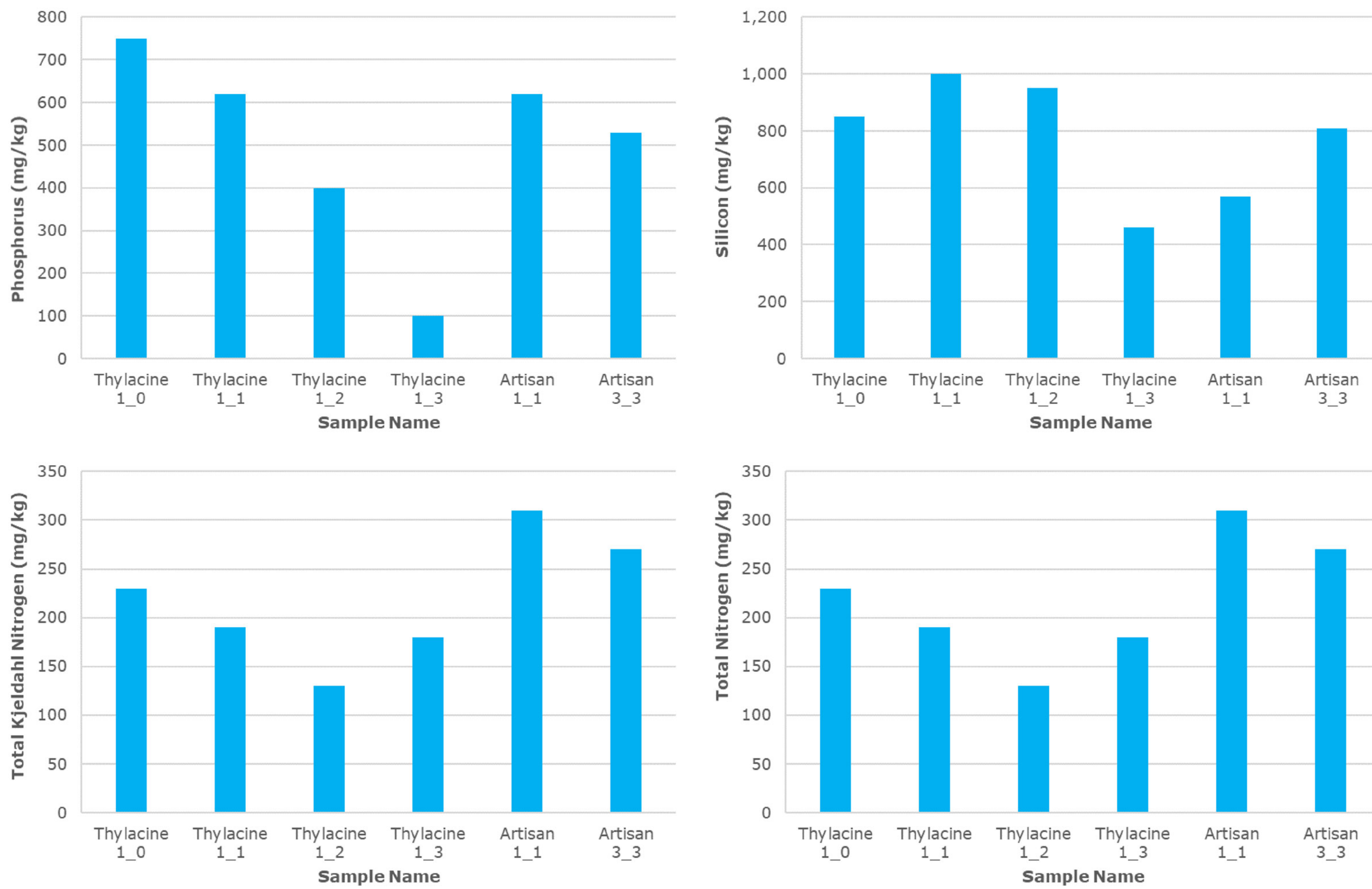

Figure 8 Nutrient concentrations (mg/kg) in sediment samples collected at Thylacine and Artisan survey areas, including phosphorus (top left), silicon (top right), total Kjeldahl nitrogen (bottom left) and total nitrogen (bottom right).

Table 14 presents the results of the analysis for metal compounds in the sediment samples. Of the inorganic compounds tested, Cd, Cu, Pb, Hg, Ni and Sn were below the detection limits (LOR) in all sediment samples. The concentration of Cr in sediments was low, and well below the Interim Sediment Quality Guidelines (ISQG) low trigger value of 80 mg/kg from the recommended sediment quality guidelines set out in ANZECC (2000). The concentration of Cr was slightly higher in the samples from Artisan than those from Thylacine. Zn was detected in two of the six samples (one sample from each field) and was well below the ISQC-Low trigger value of 200 mg/kg.

Table 14 Metals in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg							
	Cd	**Cr**	**Cu**	**Pb**	**Hg**	**Ni**	**Sn**	**Zn**
Thylacine_1_0	< 0.4	6.2	< 5	< 5	< 0.1	< 5	< 10	7.2
Thylacine_1_1	< 0.4	6.6	< 5	< 5	< 0.1	< 5	< 10	< 5
Thylacine_1_2	< 0.4	6.4	< 5	< 5	< 0.1	< 5	< 10	< 5
Thylacine_1_3	< 0.4	< 5.0	< 5	< 5	< 0.1	< 5	< 10	< 5
Artisan_1_1	< 0.4	11	< 5	< 5	< 0.1	< 5	< 10	9.4
Artisan_3_3	< 0.4	8.1	< 5	< 5	< 0.1	< 5	< 10	< 5

Level of Reporting (LOR): Cd 0.4 mg/kg; Cr 5 mg/kg; Cu 5 mg/kg; Pb 5 mg/kg; Hg 0.1 mg/kg; Ni 5 mg/kg; Sn 10 mg/kg; Zn 5 mg/kg.

The results of laboratory analyses for hydrocarbons in sediment samples from the Thylacine and Artisan survey areas are presented in Tables 15 to 19. BTEXs, PAHs, PCBs and TRHs were either below the LOR or at levels of no concern.

Table 15 Polycyclic Aromatic Hydrocarbons (PAH) in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg						
	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(a)pyrene TEQ (lower bound)	Benzo(a)pyrene TEQ (medium bound)
Thylacine_1_0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Thylacine_1_1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Thylacine_1_2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Thylacine_1_3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Artisan_1_1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Artisan_3_3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6

Sample Name	mg/kg						
	Benzo(a)pyrene TEQ (upper bound)	Benzo(b&j) fluoranthene	Benzo(g.h.i) perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a.h)anthracene	Fluoranthene
Thylacine_1_0	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Thylacine_1_1	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Thylacine_1_2	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Thylacine_1_3	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Artisan_1_1	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Artisan_3_3	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Sample Name	mg/kg						p-Terphenyl-d14 (%)	2-Fluorobiphenyl (%)
	Fluorene	Indeno(1.2.3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH*		
Thylacine_1_0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	83	79
Thylacine_1_1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	121	92
Thylacine_1_2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	137	87
Thylacine_1_3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	118	97
Artisan_1_1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	59	60
Artisan_3_3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	147	58

Table 16 Total Recoverable Hydrocarbons (1999 NEPM Fractions) in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg				
	TRH C10-C14	TRH C10-C36 (Total)	TRH C15-C28	TRH C29-C36	TRH C6-C9
Thylacine_1_0	< 20	< 50	< 50	< 50	< 20
Thylacine_1_1	< 20	< 50	< 50	< 50	< 20
Thylacine_1_2	< 20	< 50	< 50	< 50	< 20
Thylacine_1_3	< 20	< 50	< 50	< 50	< 20
Artisan_1_1	< 20	< 50	< 50	< 50	< 20
Artisan_3_3	< 20	< 50	< 50	< 50	< 20

Table 17 Total Recoverable Hydrocarbons (2013 NEPM Fractions) in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg							
	Naphthalene	TRH >C10-C16	TRH >C10-C16 less Naphthalene (F2)	TRH >C10-C40 (total)*	TRH >C16-C34	TRH >C34-C40	TRH C6-C10	TRH C6-C10 less BTEX (F1)
Thylacine_1_0	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Thylacine_1_1	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Thylacine_1_2	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Thylacine_1_3	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Artisan_1_1	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Artisan_3_3	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20

Table 18 BTEX in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg						4-Bromofluoro-benzene (%)
	Benzene	Ethylbenzene	m&p-Xylenes	o-Xylene	Toluene	Xylenes - Total	
Thylacine_1_0	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	55
Thylacine_1_1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	104
Thylacine_1_2	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	110
Thylacine_1_3	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	106
Artisan_1_1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	62
Artisan_3_3	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	106

Table 19 Polychlorinated Biphenyls in sediment samples at Thylacine and Artisan survey areas

Sample Name	mg/kg								Dibutylchlorendate (%)	Tetrachloro-m-xylene (%)
	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260	Total PCB*		
Thylacine_1_0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	105	86
Thylacine_1_1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	132	77
Thylacine_1_2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	139	80
Thylacine_1_3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	78	77
Artisan_1_1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	73	64
Artisan_3_3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	115	54

4.3 Infauna Ecology

The benthic infauna recorded from the grab samples are presented in Table 20. The benthic infauna identified and counted from samples collected at the Thylacine and Artisan sites were relatively depauperate in both abundance and diversity. A total of 22 morpho-species were identified, from a total of 45 organisms collected from the grab samples. The samples Thylacine_1_1 and Artisan_1_4 had the greatest infauna abundance with nine organisms in each sample (Figure 9). The samples Artisan_1_4 and Artisan_3_4 had the greatest diversity with eight morpho-species) (Figure 10), most of which were polychaete worms or crustaceans (Figure 11).

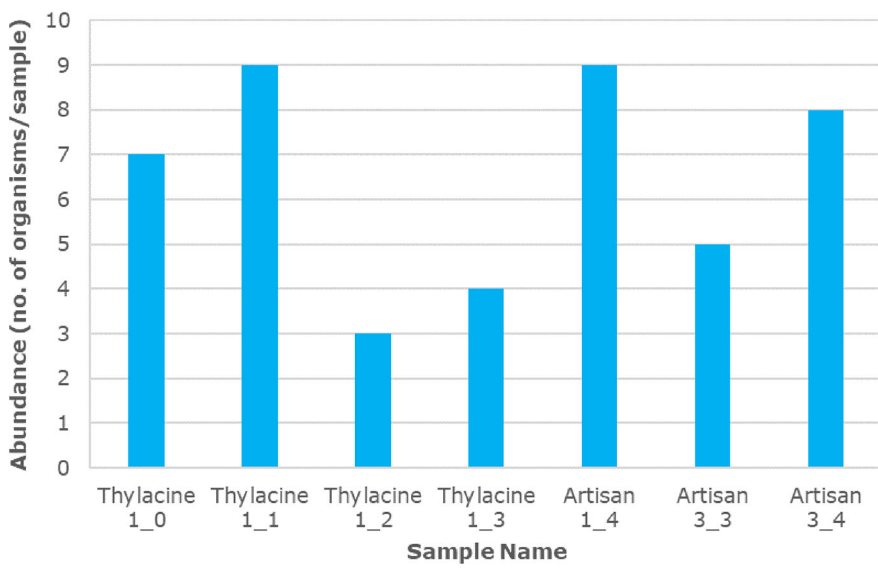

Figure 9 Abundance of benthic infauna in grab samples at Thylacine and Artisan survey areas.

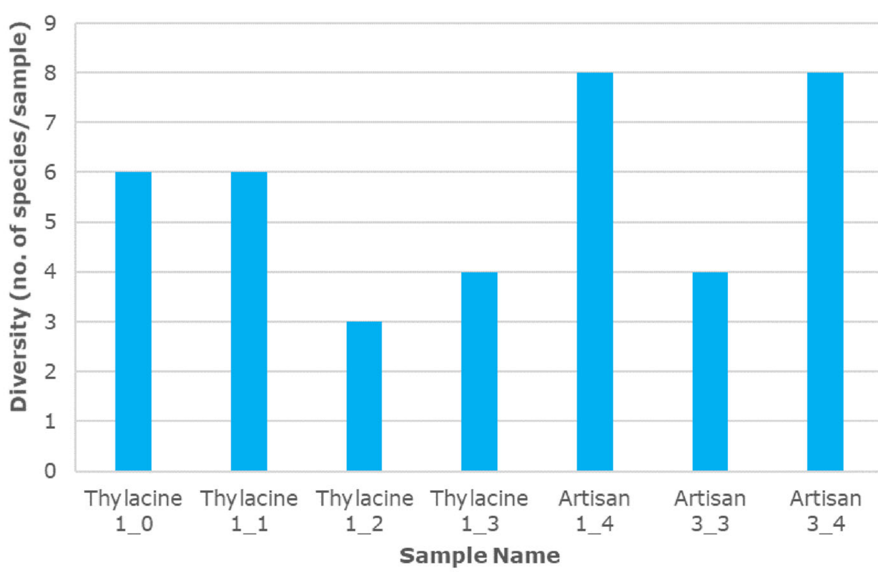

Figure 10 Diversity of benthic infauna in grab samples at Thylacine and Artisan survey areas.

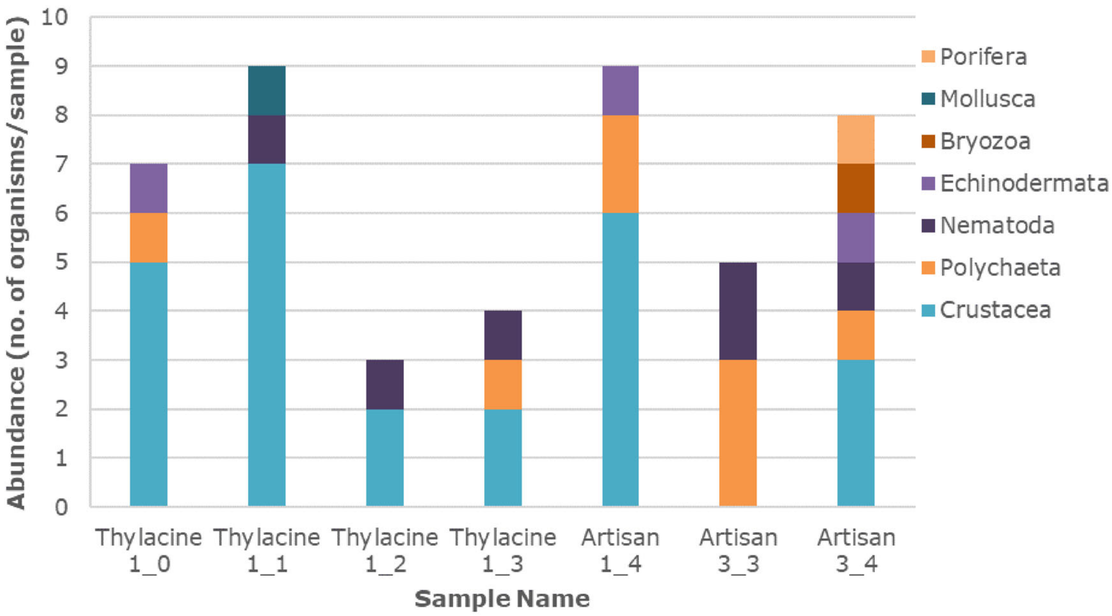

Figure 11 Abundance of benthic infauna by taxonomic group in grab samples at Thylacine and Artisan survey areas.

These results are reflective of the sedimentary environment at the Thylacine and Artisan survey areas, as described in Section 4.2. All sites were dominated by sand, which typically have a lower abundance and diversity of infauna given that this abrasive type of substrate tends to be more easily subjected to hydrodynamic conditions that move the sediment more dynamically than muddy substrates. The consequence of this is a physical environment that is not favourable for filter feeding and burrowing infauna species to inhabit. The observed species typically have a higher tolerance for dynamic environments.

There were no discernible spatial trends in the distribution of sediment particle size. Likewise, there were no clear trends in the abundance, diversity or composition of benthic infauna.

Table 20 Benthic infauna present in sediment samples collected at Thylacine and Artisan survey areas.

Phylum	Class/ Order	Family	Morpho-species	Thylacine				Artisan		
				1_0	1_1	1_2	1_3	1_4	3_3	3_4
Annelida	Polychaeta	Glyceridae	Glyceridae sp.	1			1	1	1	
		Goniadidae	Goniadidae sp.							1
		Pisionidae	Pisionidae sp.					1		
		Spionidae	Spionidae sp.						1	
		Syllidae	Syllidae sp.						1	
Crustacea	Amphipoda	Ampeliscidae	Ampeliscidae sp.		2	1				
		Ischyroceridae	Ischyroceridae sp.					1		1
		Lysianassidae	Lysianassidae sp.	2						
		Oedicerotidae	Oedicerotidae sp.		2					
		Phoxocephalidae	Phoxocephalidae sp.	1			1			
		Platyischnopidae	Platyischnopidae sp.	1		1				1
		Podoceridae	Podoceridae sp.					1		
Crustacea	Caridea	Pasiphaeidae	Pasiphaeidae sp.					1		
	Copepoda	Copepoda	Copepoda sp.					1		
	Cumacea	Bodotriidae	Bodotriidae sp.				1	2		
	Ostracoda	Ostracoda	Ostracoda sp.	1	2					
	Tanaidacea	Tanidae	Tanidae sp.		1					1
Echinodermata	Ophiuroidea	Ophiuroidea	Ophiuroidea sp.	1				1		1
Ectoprocta	Bryozoa	Bryozoa	Branching-sp.2							1
Mollusca	Gastropoda	Rissoidae	Rissoidae sp.		1					
Nematoda	Nematoda	Nematoda	Nematoda		1	1	1		2	1
Porifera	Porifera	Porifera	Solitary-Fan							1

4.4 Epibenthic Ecology

A total of 821 photographs were taken of the seafloor with the survey areas in Otway Basin. A total of 442 photographs used in this assessment (Appendix 5), with the remaining images excluded for the reasons as listed in Section 3.5.2. An average of 56 photographs were taken per survey area, 17 photographs per Hot Tap location and 15 photographs per umbilical route. Table 21 provides a summary of the number of photograph replicate samples used for the visual assessment, average (± standard deviation) for percent cover of epifauna, and total abundance of individual (and often mobile) epifauna organisms. Two example images from each survey area, Hot Tap and umbilical route are included in Appendix 6.

Figure 12 shows the average (± S.D.) percent cover of epifauna at each of the drop camera locations. Percent cover ranged from 0 to 80% of the sample photograph for all samples but on average the percent cover was typically no more than 37% cover. The seabed at Hot Tap X had the greatest average coverage of epibiota while the lowest coverage of epibiota was recorded along the CPT route between Artisan and Hot Tap Y (ARHTY) (Figure 12). Artisan and Hercules survey areas had a slighted greater coverage of epifauna, while the CPT routes between survey areas and Hot Tap Y had the least coverage of epifauna.

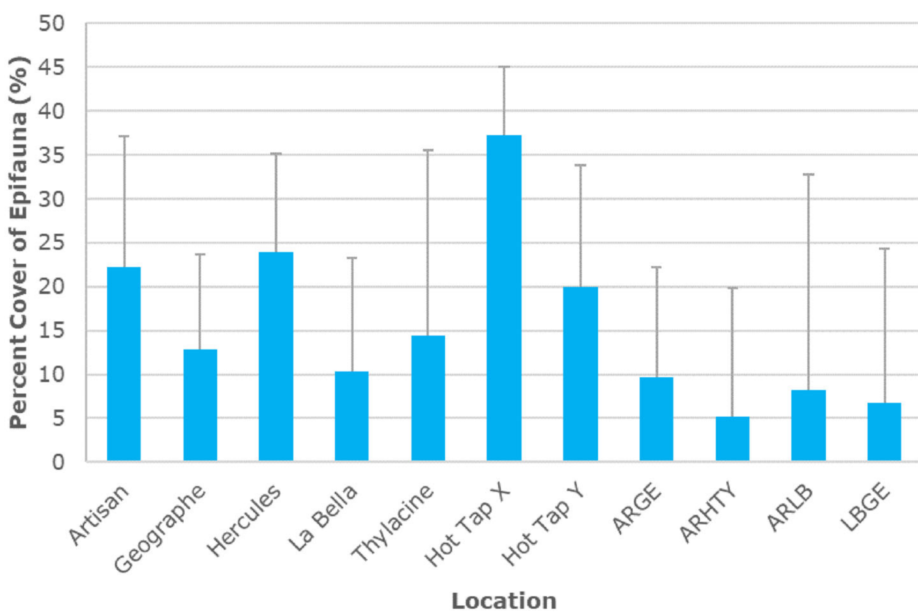

Figure 12 Percent cover of epifauna at drop camera location in Otway Basin.

Figure 13 provides information of the percent cover of epifauna at each drop camera site within these locations and shows the high variability of smaller-scale variability between drop camera sites. For example, the coverage of epifauna at most Thylacine drop camera sites was no more than 16% while at Thylacine 1 the percent cover was up 43% on average.

Of the individual epibenthic organisms, Gastropoda sp. 2 (a cone shell) and crionids (featherstars) were the most abundant (Table 21). Figure 14 shows an example of the seabed at Thylacine 1 (TH1) with a high percent cover of epifauna and a relatively high abundance of crinoids. Further examples are included in Appendix 6.

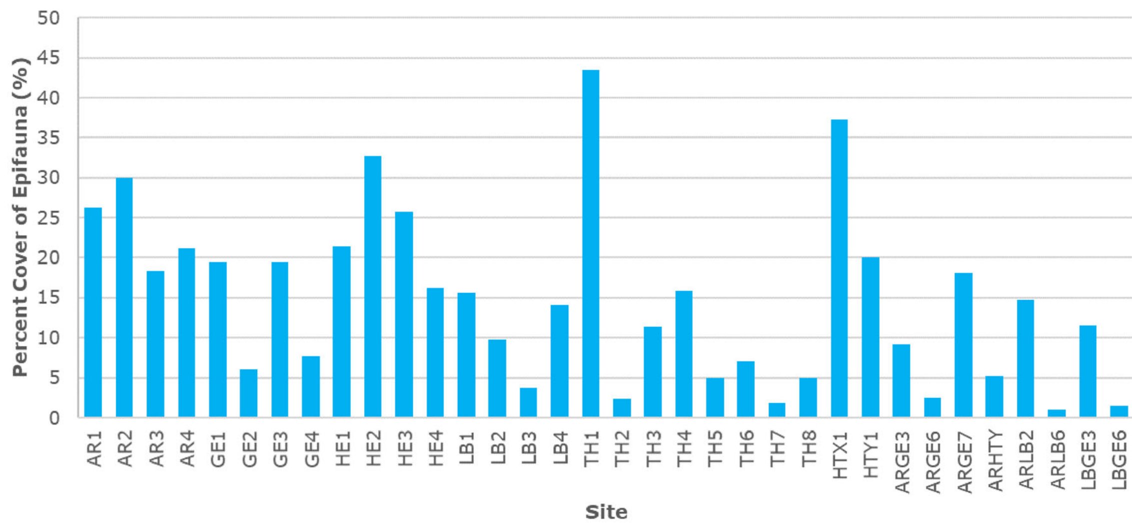

Figure 13 Percent cover of epifauna at drop camera sites in Otway Basin.

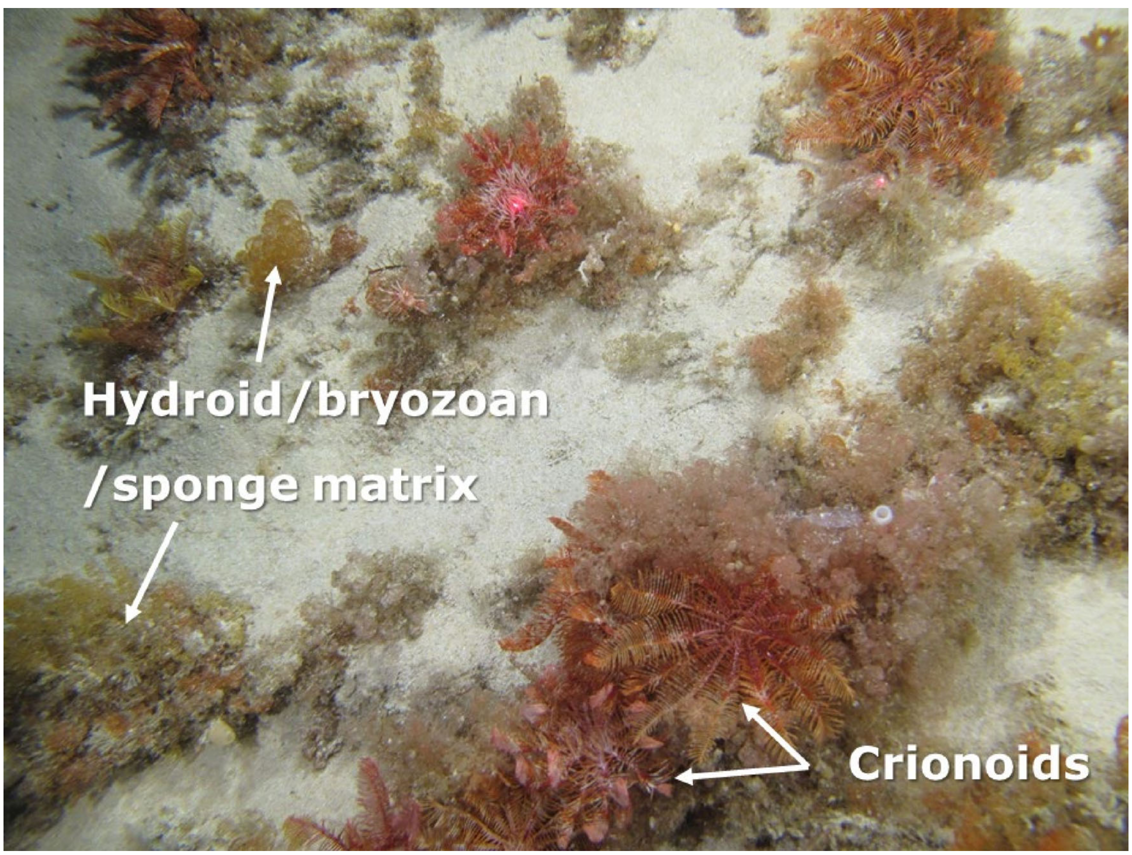

Figure 14 Example of the typical seabed epifauna with high percent cover at Thylacine 1 (TH1).

Table 21 Percent cover and total abundance of epibiota at drop camera sites.

Location	*n*	Percent cover of epifauna (%)		Total abundance of individual organisms								
				Crinoidea	Gastropoda spp.					Nudibranchia	Polychaeta	Teleostei
		Average	S.D.		Sp. 1	Sp. 2	Sp. 3	Sp. 4	Sp. 5			
AR1	4	26	15			4						
AR2	4	30	11			1						
AR3	9	18	11			1						
AR4	13	21	13			14						
GE1	9	19	21		2	2						
GE2	9	6	8		1							
GE3	9	19	14			1						
GE4	11	8	13			1						
HE1	14	21	15					2				
HE2	15	33	24		1	1		1				
HE3	14	26	18	1		2	1					
HE4	16	16	12		1							
LB1	9	16	10			1						
LB2	18	10	10									
LB3	15	4	2			4						
LB4	17	14	15			2		1				
TH1	16	43	14	40						1		
TH2	15	2	3		1	1						
TH3	21	11	7	8		7			2			
TH4	18	16	8	24								

Location	*n*	Percent cover of epifauna (%)		Total abundance of individual organisms								
				Crinoidea	Gastropoda spp.					Nudibranchia	Polychaeta	Teleostei
		Average	S.D.		Sp. 1	Sp. 2	Sp. 3	Sp. 4	Sp. 5			
TH5	1	5	-									
TH6	5	7	4									
TH7	8	2	3			1						
TH8	11	5	2			1						
HTX1	9	37	14		2	1		1				
HTY1	18	20	8			7		1	1			
ARGE3	12	9	8			6	1				1	
ARGE6	20	3	3			1						1
ARGE7	18	18	10			3		1				1
ARHTY	21	5	11	1	1	1				1		1
ARLB2	17	15	9			5	1					
ARLB6	15	1	2			7		1				
LBGE3	16	12	17			4						
LBGE6	14	1	2			1		1				

A composite, qualitative sample of epifauna from the Artisan field as examined and identified by the Benthic Australia invertebrate laboratory, with the results presented in Table 22. This epifauna was collected from grab samples at Artisan 1. This analysis shows that much of the epifauna is comprised of branching bryozoans, feather-like gorgonian cnidarians and sponges. This complex of encrusting/branching fauna provides refuge for macrofauna such as amphipods, isopods, polychaete worms and molluscs.

Table 22 Epifauna present in grab samples collected at the Artisan field.

Phylum	Class/ Order	Family	Morpho-species	Artisan_1_Epifauna
Annelida	Polychaeta	Amphinomidae	Hermodice spp.	1
		Eunicidae	Eunice spp.	1
		Phyllodocidae	Phyllodocidae sp.	1
		Syllidae	Syllidae sp.	2
		Terebellidae	Terebellidae sp.	1
Cnidaria	Alcyonacea	Alcyonacea	Gorgonian-Feather sp.	1
Crustacea	Amphipoda	Dexaminidae	Dexaminidae sp.	10
		Eusiridae	Eusiridae sp.	2
		Ischyroceridae	Ischyroceridae sp.	2
		Maeridae	Maeridae sp.1	3
			Maeridae sp.2	3
		Stegocephalidae	Stegocephalidae sp.	2
Crustacea	Isopoda	Valvifera	Valvifera sp.	1
Echinodermata	Ophiuroidea	Ophiuroidea	Ophiuroidea sp.	4
Ectoprocta	Bryozoa	Bryozoa	Branching-sp.1	7
			Branching-sp.2	2
Mollusca	Bivalvia	Glycymerididae	Glycymerididae sp.	1
	Gastropoda	c.f.Olividae	c.f.Olividae sp.	1
Porifera	Porifera	Porifera	Conglomerate-Branching sp.	3
			Conglomerate-Bulbous sp.1	4
			Conglomerate-Bulbous sp.2	2
			Solitary-Fan	4

5. DISCUSSION

The survey was conducted over in the Otway Basin covering five survey areas, two hot taps and five routes between those locations. The survey areas were located in offshore Commonwealth waters at 32 to 80 km from Port Campbell. Water depth ranged from 70 to 104 m.

The water quality at the Thylacine and Artisan survey areas indicated an undisturbed mid-depth environment, based on the six samples collected during the survey. There were low or undetectable levels of nutrients, metals/metalloids, BTEXs, PAHs and TRHs in the seawater samples. Metal and metalloids measurements were generally below ANZECC trigger values and within the range expected for unmodified, marine waters. The range of ORP measurements indicated a well oxygenated, ecologically healthy environment.

The sandy substrates described for Thylacine and Artisan survey areas are consistent with the reported description for the area of unconsolidated seabed sediments made up of carbonate sands (Barton et al., 2012; Murray-Wallace and Woodroffe, 2014). The sediment quality results were also consistent with Jones and Davies (1983) who described the grain size distribution as sand and gravel covering the entire shelf except for areas of silty sand in central Bass Strait and other locations more remote from the survey area. The authors noted a regional trend of 'reverse grading' whereby sediment tended to become coarser with distance from shore. Fine sand was reported to be the predominant sediment type along the inner shelf of Victoria and off much of Tasmania, grading seawards into medium-grain sand, and locally into coarse sand at the edge of the shelf (Jones and Davies, 1983). While the gravel fraction was not assessed, it is likely that some gravel occurs within the sediment as shown by some larger shell fragments observed in seabed photographs. Sediments had a high ORP and low or undetectable levels of toxicants indicating an unmodified seabed environment.

The Otway Basin is part of the Southeast Marine Bioregion which extends from the far south coast of New South Wales to Kangaroo Island (Commonwealth of Australia, 2015). Significant variation in seafloor features and water depth contribute to the high level of species diversity in the Region and the shelf habitats are reported to support a diverse range of species from a broad range of taxonomic groups (Commonwealth of Australia, 2015). However, there is no readily-available literature describing the seabed fauna of Otway Basin, meaning it is not possible to make a comparison of infauna and epifauna communities detected to prior studies. Most descriptions of the ecological values of the Basin or the Bioregion are at a broad scale and focus of key features such as cetaceans, birds, fisheries and macroalgae habitats (Commonwealth of Australia, 2015).

Based on the assessment of epifauna using seabed photographs, the general impression of the seafloor is of a unmodifed marine environment that supports a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians and sponges). This complex was highly patchy, covering 0.25 m^2 on average but could be found in patches of at least 0.4 m^2.

A microscopic examination of a qualitative sample of this epibiota indicated that this complex of fauna provide microhabitat for a range of macrofauna such as amphipods, isopods, polychaete worms and molluscs. Such epifaunal habitats are known to provide refuge and other resources for benthic species (Jones, 2006). By comparison, there was a low abundance and diversity of infauna living within the sediment which reflects the coarse nature of the substrate. This type of substrate is highly mobile making it difficult for filter feeders and soft bodies invertebrates to survive and establish significant populations.

In summary, the epibiota on the seabed in the vicinity of the Thylacine and Artisan survey areas is representative of what is expected at depths around 70-100 m. The infauna was of relatively low abundance and diversity as expected for coarse sand substrates. No species or ecological communities listed as threatened under the Environmental Protection and Biodiversity Conservation Act 1999 (the EPBC Act) were observed.

6. REFERENCES

Barton, J.; Pope, A.; Howe S. (2012) Marine Natural Values Study Vol 2: Marine Protected Areas of the Otway Bioregion. Parks Victoria Technical series No. 75. Parks Victoria, Melbourne.

Commonwealth of Australia (2015) South-east marine region profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region. 87 p. https://www.environment.gov.au/system/files/resources/7a110303-f9c7-44e4-b337-00cb2e4b9fbf/files/south-east-marine-region-profile.pdf [Accessed February 2020].

Jones, E.J. (2006) Bryozoan thickets on Otago shelf, New Zealand: a quantitative assessment of the epibenthos using underwater photography. MSc thesis. University of Otago, Dunedin, New Zealand. 213 p.

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APPENDIX 1
ENVIRONMENTAL SAMPLE LOGS

SAMPLE MANAGEMENT ROUTINES

Project Code: 318000803	**Project Name: Otway Offshore Development**	
Vessel: Vos Shine **Location: Artisan and Thylacine, Otway Basin**	**Sampling Team: Irene Middleton** **Sampling Gear: Van Dorn 2.4L and Van Veen Double benthic grab sampler**	**Date: 22/11/2019**

☑	**All samples are stored on board as required for the analysis**	
☒	**Once ashore samples are transported by air with the sampling team to Perth**	**Not required, samples sent directly from port to lab.**
☑	**All Chain of Costody (COC) forms are copied and saved to cloud storage prior to sample dispatch**	
☑	**Samples for contaminants analyses (metals, metalloids, hydrocarbons) are shipped by courier to EUROFINS in Melbourne with COC documentation**	
☑	**Samples for infaunal analysis are shipped via courier to Benthic Australia, Gladstone, QLD with COC documentation**	
☑	**Image data is saved in its entireity to two separate storage drives, each transported by a different team member to Ramboll's office (holding a relevant COC)**	**Only one team member transported storage drives as only one enviro team member on board at one time. Additional image data sent to Ramboll by Fugro via sercure file transfer.**
☑	**Image data is saved in its entireity to Ramboll's secure servers once back in the office (noted on COC when complete)**	

Comments:

SAMPLING LOG

Project Code: 318000803		Project Name: Otway Offshore Development	
Vessel: VOS Shine	Sampling Team: Irene Middleton	Sky/Wind: 20 knots	Date: 22/11/2019
Location: Artisan	Sampling Gear: Van Dorn 2.4L water sampler	Sea State: 2 m swell	Shift: 04:00-20:00

Site No.	Local Time	Sample No.	Replicate No.	Image ID	Sample Acceptable?	pH	ORP (mV)	Temperature (°C)	Dissolved oxygen (%/ppb)	Conductivity (uS/cm)	Visual Contamination
AR 2	6:21	2	1	N/A	YES, Sampler A	8.08	172.1	13.6	93.1/7.78	497679	None
AR 1a	6:49	1	1	N/A	NO, sample rejected	-	-	-	-	-	-
AR 1b	7:11	1	2	N/A	YES, Sampler A	8.16	172.7	13.9	93.8/7.89	50112	None
AR 5	7:26	1	1	N/A	YES, Sampler A	8.34	164.5	13.4	93.8/7.89	50502	None

Comments: Sampler B was contaminated by a greasy hand print so all samples came from Sampler A. Blank samples were collected from Sampler A (labelled Blank A) and Sampler B (labelled Blank B).

SAMPLING LOG

Project Code: 318000803 | **Project Name: Otway Offshore Development**

Vessel: VOS Shine | **Sampling Team: Irene Middleton** | **Sky/Wind: 20 knots** | **Date: 22/11/2019**

Location: Artisan | **Sampling Gear: Van Veen Double benthic grab sampler** | **Sea State: 2 m swell** | **Shift: 04:00-20:00**

Site No.	Local Time	Sample No.	Replicate No.	Image ID	Sample Acceptable?	Munsell Colour	ORP (mV)	Texture / Surface or Vertical Structure	Odour (describe)	Visual Contamination	Organic Fragments /Bioturbation /other Fauna
AR_GS-1	8:36	1	1	1-5	NO, not enough material	7.5YR 8/4	-	Sand and epibenthos/sponges	None	None	Sponges, bryozoans, ascidians
AR_GS-1	9:12	1	2	-	NO, grab not triggered	-	-	-	-	-	-
AR_GS-1	9:40	1	3	6-10	YES, small sample used for composite sample	10YR 8/4	Not able to be measured for small sample	Sand, some sponge	None	None	Sponge, coral fragments and tubeworms
AR_GS-1	10:05	1	4	11-13	YES, small sample (3 cm deep) used for composite sample	10YR 8/4	176.4 at 2 cm	Sand	None	None	No sponges, just shell
AR_GS-1	10:39	1	5	14-15	NO	-	-	Only some epifauna retained for examination	None	None	Sponges and bryozoans
AR_GS-1	10:56	1	6	16-19	YES, small sample used for composite sediment sample, no infauna sampled	10YR 8/4	176.3 at 1 cm	Sand	None	None	Bryozoans and corals
AR4_GS-3_1	12:25	3	1	-	NO, grab not triggered	-	-	-	-	-	-
AR4_GS-3_2	12:45	3	2	20-21	NO, small sample (3 cm deep) for sediment only. Infauna grab not triggered	10YR 8/4	217.3 at 2 cm	Shelly sand	None	None	-

AR4_GS-3_3	13:20	3	3	22-24	YES, good sample	10YR 8/4	241.2 at 1 cm	Shelly sand	None	None	-
AR4_GS-3_4	13:30	3	4	25-26	YES, infauna only, 7 cm deep	10YR 8/4	202.3 at 1 cm	Shell coarse hash	None	None	None

Comments: Sample quality was variable and did not always meet the acceptability criteria but allowances were made to get some material for processing.

SAMPLING LOG

Project Code: 318000803		**Project Name: Otway Offshore Development**	
Vessel: VOS Shine	**Sampling Team: Irene Middleton**	**Sky/Wind: 20 knots**	**Date: 22/11/2019**
Location: Thylacine	**Sampling Gear: Van Veen Double benthic grab sampler**	**Sea State: 2 m swell**	**Shift: 04:00-20:00**

Site No.	Local Time	Sample No.	Replicate No.	Image ID	Sample Acceptable?	Munsell Colour	ORP (mV)	Texture / Surface or Vertical Structure	Odour (describe)	Visual Contamination	Organic Fragments /Bioturbation /other Fauna
TH_GS1	17:12	1	0	27-30	YES, 15 cm deep	10YR 8/4	216.7 at 3 cm	Shelly and	None	None	Shell coarse, sand
TH_GS1_1	17:42	1	1	31-33	YES	10YR 8/4	211.0 at 2 cm	Shelly sand	None	None	Shell coarse, sand
TH_GS1_2	18:04	1	2	34-36	YES	10YR 8/4	252.7 at 1 cm	Shelly sand	None	None	Shell coarse, sand
TH_GS1_3	18:26	1	3	37-40	YES	10YR 8/4	242.7 at 1cm	Shelly sand	None	None	Shell coarse, sand

Comments:

SAMPLING LOG

Project Code: 318000803 | **Project Name: Otway Offshore Development**

Vessel: VOS Shine	**Sampling Team: Irene Middleton**	**Sky/Wind: 20 knots**	**Date: 22/11/2019**
Location: Artisan and Thylacine	**Sampling Gear: Van Dorn 2.4L water sampler**	**Sea State: 2 m swell**	**Shift: 04:00-20:00**

Site No.	Local Time	Sample No.	Replicate No.	Image ID	Sample Acceptable?	pH	ORP (mV)	Temperature (°C)	Dissolved oxygen (%/ppb)	Conductivity (uS/cm)	Visual Contamination
TH_GS1	19:13	1	1	N/A	YES, Sampler A	8.19	215	13.4	94.3/8.07	No clear/steady reading	None
TH_GS1	19:30	1	2	N/A	YES, Sampler A	8.24	211.4	13.2	95.2/8.33	No clear/steady reading	None
TH_GS1	19:40	1	3	N/A	YES, Sampler A	8.33	198.1	13.2	95.2/8.16	No clear/steady reading	None

Comments:

SAMPLING LOG _REDOX MEASUREMENTS

Project Code: 318000803 | **Project Name: Otway Offshore Development**

Recorder: Irene Middleton | **Sample Acceptable: Only acceptable samples used** | **Date: 22/11/2019** | **Time (local): 0400-2000**

				ORP Reading Depth (mm)																	
Site No.	**Sample No.**	**Replicate No.**	**Surface**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**
Artisan GS	1	4	No surface measurements as hard sand surface gave indeterminate readings	176.2	176.4	No further penetration															
Artisan GS	1	6		176.3	No further penetration																
Artisan GS 3	2	1	As above	242.1	217.3	No further penetration															
Artisan GS 3	2	2	As above	241.2	No further penetration																
Artisan GS 3	2	3	As above	202.3	No further penetration																
Thylacine GS 2	1	1	As above	225.5	223.0	216.7	No further penetration														
Thylacine GS 1	1	1	As above	211.0	211.0	No further penetration															
Thylacine GS 1	1	1	As above	252.7	No further penetration																
Thylacine GS 1	1	1	As above	242.7	No further penetration																

Comments:

APPENDIX 2
WATER QUALITY LABORATORY REPORT

eurofins | Environment Testing

NATA Accredited
Accreditation Number 1261
Site Number 1254

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.

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Attention: **Dan McClary**

Report **690395-W**
Project name OTWAY OFFSHORE EBS
Project ID 318000803
Received Date Dec 04, 2019

Client Sample ID			**THYLACINE_GS1_1**	**THYLACINE_GS1_2**	**THYLACINE_G1_3**	**ARTISON_1**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**M19-No38322**	**M19-No38323**	**M19-No38324**	**M19-No38325**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH C10-C14	0.05	mg/L	< 0.05	0.05	< 0.05	< 0.05
TRH C15-C28	0.1	mg/L	< 0.1	0.1	< 0.1	< 0.1
TRH C29-C36	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C36 (Total)	0.1	mg/L	< 0.1	0.15	< 0.1	< 0.1
BTEX						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)	1	%	106	94	107	94
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH C6-C10 less BTEX (F1)[N04]	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH >C10-C16	0.05	mg/L	< 0.05	0.07	< 0.05	< 0.05
TRH >C10-C16 less Naphthalene (F2)[N01]	0.05	mg/L	< 0.05	0.07	< 0.05	< 0.05
TRH >C16-C34	0.1	mg/L	< 0.1	0.1	< 0.1	< 0.1
TRH >C34-C40	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C10-C40 (total)*	0.1	mg/L	< 0.1	0.17	< 0.1	< 0.1
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Acenaphthylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benz(a)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(a)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(b&j)fluoranthene[N07]	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Chrysene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluorene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001

Client Sample ID			THYLACINE_GS1_1	THYLACINE_GS1_2	THYLACINE_G1_3	ARTISON_1
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			M19-No38322	M19-No38323	M19-No38324	M19-No38325
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Polycyclic Aromatic Hydrocarbons						
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Naphthalene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Phenanthrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Total PAH*	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2-Fluorobiphenyl (surr.)	1	%	111	107	109	109
p-Terphenyl-d14 (surr.)	1	%	134	145	138	93
Ammonia (as N)	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Chlorophyll a	5	ug/L	< 10	< 10	< 10	< 10
Nitrate & Nitrite (as N)	0.05	mg/L	< 0.05	< 0.05	0.10	< 0.05
Nitrate (as N)	0.02	mg/L	0.03	0.02	0.10	< 0.02
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (as P)	0.01	mg/L	0.03	0.02	0.02	0.02
Phosphorus reactive (as P)	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	< 0.2	< 0.2	2.4	< 0.2
Total Nitrogen (as N)*	0.2	mg/L	< 0.2	< 0.2	2.5	< 0.2
Total Suspended Solids Dried at 103–105°C	1	mg/L	3.4	9.7	2.4	5.9
Heavy Metals						
Arsenic	0.001	mg/L	0.001	0.004	0.002	0.003
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	< 0.001	< 0.001	0.002	0.001
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	< 0.001	< 0.001	0.001	< 0.001
Zinc	0.005	mg/L	0.011	0.012	0.022	0.018

Client Sample ID			ARTISON_2	ARTISON_5	BLANK A	BLANK B
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			M19-No38326	M19-No38327	M19-No38328	M19-No38329
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	0.03	< 0.02
TRH C10-C14	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C36 (Total)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
BTEX						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	0.001	mg/L	< 0.001	< 0.001	0.003	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)	1	%	102	100	96	92

Client Sample ID			ARTISON_2	ARTISON_5	BLANK A	BLANK B
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			M19-No38326	M19-No38327	M19-No38328	M19-No38329
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	0.03	< 0.02
TRH C6-C10 less BTEX (F1)[N04]	0.02	mg/L	< 0.02	< 0.02	0.03	< 0.02
TRH >C10-C16	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C10-C16 less Naphthalene (F2)[N01]	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C10-C40 (total)*	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Acenaphthylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benz(a)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(a)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(b&j)fluoranthene[N07]	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Chrysene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluorene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Naphthalene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Phenanthrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Total PAH*	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2-Fluorobiphenyl (surr.)	1	%	114	117	97	56
p-Terphenyl-d14 (surr.)	1	%	102	101	52	67
Ammonia (as N)	0.01	mg/L	< 0.01	< 0.01	0.03	< 0.01
Chlorophyll a	5	ug/L	< 10	< 10	-	-
Nitrate & Nitrite (as N)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (as P)	0.01	mg/L	0.01	0.01	< 0.01	< 0.01
Phosphorus reactive (as P)	0.01	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	< 0.2	< 0.2	< 0.2	< 0.2
Total Nitrogen (as N)*	0.2	mg/L	< 0.2	< 0.2	< 0.2	< 0.2
Total Suspended Solids Dried at 103–105°C	1	mg/L	4.6	5.2	< 1	3.1
Heavy Metals						
Arsenic	0.001	mg/L	0.005	0.010	0.001	0.001
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	0.001	0.001	< 0.001	0.040
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	0.005	mg/L	0.010	0.014	0.021	0.032

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 B4			
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Dec 09, 2019	7 Days
- Method: LTM-ORG-2010 TRH C6-C40			
BTEX	Melbourne	Dec 06, 2019	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Dec 06, 2019	7 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Dec 09, 2019	
- Method: LTM-ORG-2010 TRH C6-C40			
Polycyclic Aromatic Hydrocarbons	Melbourne	Dec 09, 2019	7 Days
- Method: LTM-ORG-2130 PAH and Phenols in Soil and Water			
Eurofins | mgt Suite B19E: Total N, TKN, NOx, NO2, NO3, NH3, Total P, Reactive P			
Ammonia (as N)	Melbourne	Dec 09, 2019	28 Days
- Method: LTM-INO-4200 Ammonia by Discrete Analyser			
Nitrate & Nitrite (as N)	Melbourne	Dec 09, 2019	28 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Nitrate (as N)	Melbourne	Dec 09, 2019	28 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Nitrite (as N)	Melbourne	Dec 09, 2019	2 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Phosphate total (as P)	Melbourne	Dec 09, 2019	28 Days
- Method: APHA 4500-P E. Phosphorus			
Phosphorus reactive (as P)	Melbourne	Dec 09, 2019	2 Days
- Method: APHA 4500-P			
Total Kjeldahl Nitrogen (as N)	Melbourne	Dec 09, 2019	7 Days
- Method: LTM-INO-4310 TKN in Waters & Soils by FIA			
Chlorophyll a	Melbourne	Dec 06, 2019	2 Days
- Method: LTM-INO-4340 Chlorophyll a in Waters			
Total Suspended Solids Dried at 103–105°C	Melbourne	Dec 09, 2019	7 Days
- Method: LTM-INO-4070 Analysis of Suspended Solids in Water by Gravimetry			
Heavy Metals	Sydney	Dec 11, 2019	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			

Australia

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

New Zealand

Auckland
35 O'Rorke Road
Penrose, Auckland 1061
Phone : +64 9 526 45 51
IANZ # 1327

Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690395
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 10:56 AM
Due: Dec 11, 2019
Priority: 5 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail						Arsenic	Cadmium	Chlorophyll a	Chromium	Cobalt	Copper	Lead	Mercury	Nickel	Pheophytin*	Total Suspended Solids Dried at 103–105°C	Zinc	Eurofins | mgt Suite B4	Eurofins | mgt Suite B19E: Total N, TKN, NOx, NO2, NO3, NH3, Total P, Reactive P
Melbourne Laboratory - NATA Site # 1254 & 14271								X							X	X		X	X
Sydney Laboratory - NATA Site # 18217 & 14271						X	X		X	X	X	X	X	X			X		
Brisbane Laboratory - NATA Site # 20794 & 14271																			
Perth Laboratory - NATA Site # 23736 & 14271																			
External Laboratory																			
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**														
1	THYLACINE_GS1_1	Nov 22, 2019		Water	M19-No38322	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	THYLACINE_GS1_2	Nov 22, 2019		Water	M19-No38323	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	THYLACINE_G1_3	Nov 22, 2019		Water	M19-No38324	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	ARTISON_1	Nov 22, 2019		Water	M19-No38325	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	ARTISON_2	Nov 22, 2019		Water	M19-No38326	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	ARTISON_5	Nov 22, 2019		Water	M19-No38327	X	X	X	X	X	X	X	X	X		X	X	X	X
7	BLANK A	Nov 22, 2019		Water	M19-No38328	X	X	X	X	X	X	X	X	X		X	X	X	X
8	BLANK B	Nov 22, 2019		Water	M19-No38329	X	X	X	X	X	X	X	X	X		X	X	X	X

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ABN – 50 005 085 521 web : www.eurofins.com.au e.mail : EnviroSales@eurofins.com

Australia

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

New Zealand

Auckland
35 O'Rorke Road
Penrose, Auckland 1061
Phone : +64 9 526 45 51
IANZ # 1327

Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

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Address: Suite 3, Level 2, 200 Adelaide Terrace
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Eurofins Analytical Services Manager : Robert Johnston

Sample Detail	Arsenic	Cadmium	Chlorophyll a	Chromium	Cobalt	Copper	Lead	Mercury	Nickel	Pheophytin*	Total Suspended Solids Dried at 103–105°C	Zinc	Eurofins | mgt Suite B4	Eurofins | mgt Suite B19E: Total N, TKN, NOx, NO2, NO3, NH3, Total P, Reactive P
Melbourne Laboratory - NATA Site # 1254 & 14271			X							X	X		X	X
Sydney Laboratory - NATA Site # 18217 & 14271	X	X		X	X	X	X	X	X			X		
Brisbane Laboratory - NATA Site # 20794 & 14271														
Perth Laboratory - NATA Site # 23736 & 14271														
Test Counts	8	8	8	8	8	8	8	8	8	5	8	8	8	8

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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.

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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							
Ammonia (as N)	mg/L	< 0.01			0.01	Pass	
Nitrate & Nitrite (as N)	mg/L	< 0.05			0.05	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Phosphate total (as P)	mg/L	< 0.01			0.01	Pass	
Phosphorus reactive (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							
Arsenic	mg/L	< 0.001			0.001	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Chromium	mg/L	< 0.001			0.001	Pass	
Cobalt	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Lead	mg/L	< 0.001			0.001	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Zinc	mg/L	< 0.005			0.005	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	94			70-130	Pass	
TRH C10-C14	%	115			70-130	Pass	
LCS - % Recovery							
BTEX							
Benzene	%	92			70-130	Pass	
Toluene	%	79			70-130	Pass	
Ethylbenzene	%	83			70-130	Pass	
m&p-Xylenes	%	76			70-130	Pass	
Xylenes - Total	%	78			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	%	77			70-130	Pass	
TRH C6-C10	%	94			70-130	Pass	
TRH >C10-C16	%	107			70-130	Pass	
LCS - % Recovery							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	%	87			70-130	Pass	
Acenaphthylene	%	85			70-130	Pass	
Anthracene	%	72			70-130	Pass	
Benz(a)anthracene	%	99			70-130	Pass	
Benzo(a)pyrene	%	72			70-130	Pass	
Benzo(b&j)fluoranthene	%	72			70-130	Pass	
Benzo(g.h.i)perylene	%	75			70-130	Pass	
Benzo(k)fluoranthene	%	98			70-130	Pass	
Chrysene	%	99			70-130	Pass	
Dibenz(a.h)anthracene	%	80			70-130	Pass	
Fluoranthene	%	85			70-130	Pass	
Fluorene	%	100			70-130	Pass	
Indeno(1.2.3-cd)pyrene	%	98			70-130	Pass	
Naphthalene	%	86			70-130	Pass	
Phenanthrene	%	95			70-130	Pass	
Pyrene	%	86			70-130	Pass	
LCS - % Recovery							
Ammonia (as N)	%	100			70-130	Pass	
Nitrate & Nitrite (as N)	%	101			70-130	Pass	
Nitrate (as N)	%	101			70-130	Pass	
Nitrite (as N)	%	106			70-130	Pass	
Phosphate total (as P)	%	95			70-130	Pass	
Phosphorus reactive (as P)	%	95			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	%	84			70-130	Pass	
Total Suspended Solids Dried at 103–105°C	%	98			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Arsenic	%	90			70-130	Pass	
Cadmium	%	92			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Chromium			%	98			70-130	Pass	
Cobalt			%	100			70-130	Pass	
Copper			%	100			70-130	Pass	
Lead			%	101			70-130	Pass	
Mercury			%	96			70-130	Pass	
Nickel			%	99			70-130	Pass	
Zinc			%	98			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-De05914	NCP	%	111			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
TRH >C10-C16	M19-De05914	NCP	%	104			70-130	Pass	
Spike - % Recovery									
				Result 1					
Ammonia (as N)	M19-De03315	NCP	%	97			70-130	Pass	
Nitrate & Nitrite (as N)	M19-De03315	NCP	%	97			70-130	Pass	
Nitrate (as N)	M19-De03315	NCP	%	97			70-130	Pass	
Nitrite (as N)	B19-De03253	NCP	%	106			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	N19-De04634	NCP	%	91			70-130	Pass	
Spike - % Recovery									
Polycyclic Aromatic Hydrocarbons				Result 1					
Acenaphthene	M19-No38324	CP	%	84			70-130	Pass	
Acenaphthylene	M19-No38324	CP	%	85			70-130	Pass	
Anthracene	M19-No38324	CP	%	74			70-130	Pass	
Benz(a)anthracene	M19-No38324	CP	%	72			70-130	Pass	
Benzo(a)pyrene	M19-No38324	CP	%	82			70-130	Pass	
Benzo(b&j)fluoranthene	M19-No38324	CP	%	79			70-130	Pass	
Benzo(g.h.i)perylene	M19-No38324	CP	%	89			70-130	Pass	
Benzo(k)fluoranthene	M19-No38324	CP	%	113			70-130	Pass	
Chrysene	M19-No38324	CP	%	106			70-130	Pass	
Dibenz(a.h)anthracene	M19-No38324	CP	%	83			70-130	Pass	
Fluoranthene	M19-No38324	CP	%	89			70-130	Pass	
Fluorene	M19-No38324	CP	%	101			70-130	Pass	
Indeno(1.2.3-cd)pyrene	M19-No38324	CP	%	82			70-130	Pass	
Naphthalene	M19-No38324	CP	%	81			70-130	Pass	
Phenanthrene	M19-No38324	CP	%	93			70-130	Pass	
Pyrene	M19-No38324	CP	%	94			70-130	Pass	
Spike - % Recovery									
				Result 1					
Phosphate total (as P)	M19-No38324	CP	%	92			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	M19-No38329	CP	%	95			70-130	Pass	
Cadmium	M19-No38329	CP	%	94			70-130	Pass	
Chromium	M19-No38329	CP	%	87			70-130	Pass	
Cobalt	M19-No38329	CP	%	88			70-130	Pass	
Copper	M19-No38329	CP	%	84			70-130	Pass	
Lead	M19-No38329	CP	%	90			70-130	Pass	
Mercury	M19-No38329	CP	%	80			70-130	Pass	
Nickel	M19-No38329	CP	%	85			70-130	Pass	
Zinc	M19-No38329	CP	%	88			70-130	Pass	

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Environment Testing

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	B19-De02116	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
TRH C10-C14	M19-De05913	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH C15-C28	M19-De05913	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C29-C36	M19-De05913	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
BTEX				Result 1	Result 2	RPD			
Benzene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Toluene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Ethylbenzene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
m&p-Xylenes	B19-De02116	NCP	mg/L	< 0.002	< 0.002	<1	30%	Pass	
o-Xylene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Xylenes - Total	B19-De02116	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
Naphthalene	B19-De02116	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
TRH C6-C10	B19-De02116	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
TRH >C10-C16	M19-De05913	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH >C16-C34	M19-De05913	NCP	mg/L	< 0.1		<1	30%	Pass	
TRH >C34-C40	M19-De05913	NCP	mg/L	< 0.1		<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Ammonia (as N)	B19-De03253	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Chlorophyll a	M19-De06051	NCP	ug/L	28	34	21	30%	Pass	
Nitrate & Nitrite (as N)	B19-De03253	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Nitrate (as N)	B19-De03253	NCP	mg/L	0.04	0.05	34	30%	Fail	Q15
Nitrite (as N)	B19-De03253	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Phosphate total (as P)	M19-De05566	NCP	mg/L	0.91	0.88	4.0	30%	Pass	
Total Kjeldahl Nitrogen (as N)	M19-De03633	NCP	mg/L	79	77	2.8	30%	Pass	
Total Suspended Solids Dried at 103–105°C	M19-De06128	NCP	mg/L	230	230	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M19-No38322	CP	mg/L	0.001	0.001	2.0	30%	Pass	
Cadmium	M19-No38322	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Lead	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Mercury	M19-No38322	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Nickel	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Zinc	M19-No38322	CP	mg/L	0.011	0.012	9.0	30%	Pass	
Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Acenaphthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Acenaphthylene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benz(a)anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(a)pyrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(b&j)fluoranthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(g.h.i)perylene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(k)fluoranthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chrysene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibenz(a.h)anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	

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Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Fluoranthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Fluorene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Indeno(1.2.3-cd)pyrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Naphthalene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Phenanthrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Pyrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	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
Q15	The RPD reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Robert Johnston	Analytical Services Manager
Gabriele Cordero	Senior Analyst-Metal (NSW)
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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Environment Testing

Certificate of Analysis

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

NATA Accredited
Accreditation Number 1261
Site Number 1254

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: **Dan McClary**

Report **690387-A**
Project name OTWAY OFFSHORE EBS
Project ID 318000803
Received Date Dec 04, 2019

Client Sample ID			**ARTISON-1**	**ARTISON-5**	**ARTISON-2**	**THYLACINE GS1_3**
Sample Matrix			**Filter paper**	**Filter paper**	**Filter paper**	**Filter paper**
Eurofins Sample No.			**M19-No38257**	**M19-No38258**	**M19-No38259**	**M19-No38260**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Chlorophyll a	10	ug/L	< 10	< 10	< 10	< 10

Client Sample ID			**THYLACINE GS1_1**	**THYLACINE GS1_2**
Sample Matrix			**Filter paper**	**Filter paper**
Eurofins Sample No.			**M19-No38261**	**M19-No38262**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit		
Chlorophyll a	10	ug/L	< 10	< 10

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
Chlorophyll a	Melbourne	Nov 27, 2019	2 Days

- Method:

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
External Laboratory																					
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																
1	THYLACINE_GS1_3_MET1	Nov 22, 2019		Soil	M19-No38233	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
2	THYLACINE_GS1_3_MET2	Nov 22, 2019		Soil	M19-No38234	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
3	THYLACINE_GS1_3_PSD1	Nov 22, 2019		Soil	M19-No38235	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
4	THYLACINE_GS1_MET2	Nov 22, 2019		Soil	M19-No38236	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
5	THYLACINE_GS-1_MET1	Nov 22, 2019		Soil	M19-No38237	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
6	THYLACINE_	Nov 22, 2019		Soil	M19-No38238	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

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Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS-1_PSD1																				
7	THYLACINE_GS1-2_PSD1	Nov 22, 2019		Soil	M19-No38239	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
8	THYLACINE_GS1-2_MET1	Nov 22, 2019		Soil	M19-No38240	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
9	THYLACINE_GS1-2_MET2	Nov 22, 2019		Soil	M19-No38241	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
10	THYLACINE_GS2_PSD1	Nov 22, 2019		Soil	M19-No38242	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
11	THYLACINE_GS2_MET1	Nov 22, 2019		Soil	M19-No38243	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
12	THYLACINE_GS2_MET2	Nov 22, 2019		Soil	M19-No38244	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
13	ARTISON-	Nov 22, 2019		Soil	M19-No38245	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

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Sample Detail					% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271								X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																				
Brisbane Laboratory - NATA Site # 20794					X	X	X													
Perth Laboratory - NATA Site # 23736																				
	GS_A_PAR 4																			
14	ARTISON-GS_A_PAR 3	Nov 22, 2019		Soil	M19-No38246	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
15	ARTISON-GSA_MET1	Nov 22, 2019		Soil	M19-No38247	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
16	ARTISON-GSA_PAR1	Nov 22, 2019		Soil	M19-No38248	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
17	ARTISON-GSA_MET2	Nov 22, 2019		Soil	M19-No38249	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
18	ARTISON-GSA_PAR2	Nov 22, 2019		Soil	M19-No38250	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
19	ARTISON-GS3_PAR1	Nov 22, 2019		Soil	M19-No38251	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
20	ARTISON-	Nov 22, 2019		Soil	M19-No38252	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

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Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
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Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS3_MET1																				
21	ARTISON-GS3_PAR 4	Nov 22, 2019		Soil	M19-No38253	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
22	ARTISON-GS3_PAR 2	Nov 22, 2019		Soil	M19-No38254	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
23	ARTISON-GS3_MET 2	Nov 22, 2019		Soil	M19-No38255	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
24	ARTISON-GS3_PAR 3	Nov 22, 2019		Soil	M19-No38256	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
25	ARTISON-1	Nov 22, 2019		Filter paper	M19-No38257					X											
26	ARTISON-5	Nov 22, 2019		Filter paper	M19-No38258					X											
27	ARTISON-2	Nov 22, 2019		Filter paper	M19-No38259					X											
28	THYLACINE GS1_3	Nov 22, 2019		Filter paper	M19-No38260					X											

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

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Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
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Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace	**Report #:**	690387	**Due:**	Dec 5, 2019
	East Perth	**Phone:**	08 9225 5199	**Priority:**	7 Day
	WA 6004	**Fax:**		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
29	THYLACINE GS1_1	Nov 22, 2019		Filter paper	M19-No38261					X											
30	THYLACINE GS1_2	Nov 22, 2019		Filter paper	M19-No38262					X											
Test Counts						24	24	24	24	6	24	24	24	24	24	24	24	24	24	24	24

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.

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

Authorised By

Robert Johnston	Analytical Services Manager
Julie Kay	Senior Analyst-Inorganic (VIC)
Scott Beddoes	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.

APPENDIX 3
SEDIMENT QUALITY LABORATORY REPORT

Certificate of Analysis

Environment Testing

NATA Accredited
Accreditation Number 1261
Site Number 1254

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.

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Attention: **Dan McClary**

Report **690387-S**
Project name OTWAY OFFSHORE EBS
Project ID 318000803
Received Date Dec 04, 2019

Client Sample ID			THYLACINE_GS1_3_MET1	THYLACINE_GS1_3_MET2	THYLACINE_GS1_3_PSD1	THYLACINE_GS1_MET2
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M19-No38233	M19-No38234	M19-No38235	M19-No38236
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
% Clay	1	%	4.7	3.1	3.3	3.7
% Sand		%	95	95	97	96
% Silt		%	< 1	1.6	< 1	< 1
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	130	71	110	160
Total Nitrogen (as N)*	10	mg/kg	130	71	110	160
Total Organic Carbon	0.1	%	0.5	1.8	2.7	4.8
Phosphorus	5	mg/kg	400	660	740	610
Silicon (Aqua regia extractable)	5	mg/kg	950	750	630	970
% Moisture	1	%	37	34	37	36
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	6.4	5.7	5.6	6.7
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	< 5	< 5	7.8	< 5

Client Sample ID			THYLACINE_GS-1_MET1	THYLACINE_GS-1_PSD1	THYLACINE_GS1-2_PSD1	THYLACINE_GS1-2_MET1
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M19-No38237	M19-No38238	M19-No38239	M19-No38240
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
% Clay	1	%	2.8	1.7	4.4	3.1
% Sand		%	96	98	96	95
% Silt		%	1.4	< 1	< 1	1.5
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	230	210	310	190
Total Nitrogen (as N)*	10	mg/kg	230	210	310	190
Total Organic Carbon	0.1	%	1.3	0.4	1.9	0.9

Client Sample ID			THYLACINE_GS-1_MET1	THYLACINE_GS-1_PSD1	THYLACINE_GS1-2_PSD1	THYLACINE_GS1-2_MET1
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M19-No38237	M19-No38238	M19-No38239	M19-No38240
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Phosphorus	5	mg/kg	750	870	550	620
Silicon (Aqua regia extractable)	5	mg/kg	850	940	890	1000
% Moisture	1	%	34	35	37	38
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	6.2	5.7	5.2	6.6
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	7.2	< 5	< 5	< 5

Client Sample ID			THYLACINE_GS1-2_MET2	THYLACINE_GS2_PSD1	THYLACINE_GS2_MET1	THYLACINE_GS2_MET2
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M19-No38241	M19-No38242	M19-No38243	M19-No38244
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
% Clay	1	%	3.9	2.5	3.3	2.9
% Sand		%	96	98	97	97
% Silt		%	< 1	< 1	< 1	< 1
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	260	290	180	220
Total Nitrogen (as N)*	10	mg/kg	260	290	180	220
Total Organic Carbon	0.1	%	1.4	1.7	< 0.1	0.5
Phosphorus	5	mg/kg	630	830	< 200	500
Silicon (Aqua regia extractable)	5	mg/kg	980	700	460	600
% Moisture	1	%	38	39	35	38
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	5.1	5.7	< 5	6.3
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	< 5	< 5	< 5	< 5

Client Sample ID			ARTISON-GS_A_PAR 4	ARTISON-GS_A_PAR 3	ARTISON-GSA_MET1	ARTISON-GSA_PAR1
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M19-No38245	M19-No38246	M19-No38247	M19-No38248
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
% Clay	1	%	< 1	< 1	3.6	3.1
% Sand		%	100	97	96	95
% Silt		%	< 1	2.9	< 1	1.5
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	340	370	310	250
Total Nitrogen (as N)*	10	mg/kg	340	370	310	250
Total Organic Carbon	0.1	%	< 0.1	< 0.1	1.6	0.4
Phosphorus	5	mg/kg	< 200	860	620	440
Silicon (Aqua regia extractable)	5	mg/kg	490	630	570	580
% Moisture	1	%	34	34	37	29
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	8.0	7.4	11	6.9
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	5.2	9.0	9.4	< 5

Client Sample ID			ARTISON-GSA_MET2	ARTISON-GSA_PAR2	ARTISON-GS3_PAR1	ARTISON-GS3_MET1
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M19-No38249	M19-No38250	M19-No38251	M19-No38252
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
% Clay	1	%	3.7	3.0	3.9	4.1
% Sand		%	96	97	96	96
% Silt		%	< 1	< 1	< 1	< 1
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	370	340	440	270
Total Nitrogen (as N)*	10	mg/kg	370	340	440	270
Total Organic Carbon	0.1	%	< 0.1	1.1	< 0.1	2.4
Phosphorus	5	mg/kg	460	< 200	730	530
Silicon (Aqua regia extractable)	5	mg/kg	600	520	770	810
% Moisture	1	%	34	34	36	35
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	6.0	6.4	6.6	8.1
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	6.9	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	25	5.4	< 5	< 5

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Client Sample ID			ARTISON-GS3_PAR 4	ARTISON-GS3_PAR 2	ARTISON-GS3_MET 2	ARTISON-GS3_PAR 3
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M19-No38253	M19-No38254	M19-No38255	M19-No38256
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
% Clay	1	%	4.8	3.5	3.6	4.0
% Sand		%	95	95	96	96
% Silt		%	< 1	1.8	< 1	< 1
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	310	270	150	310
Total Nitrogen (as N)*	10	mg/kg	310	270	150	310
Total Organic Carbon	0.1	%	0.6	4.9	1.6	1.8
Phosphorus	5	mg/kg	570	400	390	480
Silicon (Aqua regia extractable)	5	mg/kg	830	520	650	640
% Moisture	1	%	36	35	34	34
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	9.0	8.1	9.5	8.0
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	< 5	< 5	< 5	< 5

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
% Clay	Brisbane	Dec 13, 2019	0 Days
- Method: LTM-GEN-7040			
% Sand	Brisbane	Dec 09, 2019	0 Days
- Method: LTM-GEN-7040			
% Silt	Brisbane	Dec 09, 2019	0 Days
- Method: LTM-GEN-7040			
Total Organic Carbon	Melbourne	Dec 16, 2019	28 Days
- Method: LTM-INO-4060 Total Organic Carbon in water and soil			
Silicon (Aqua regia extractable)	Melbourne	Dec 06, 2019	180 Days
- Method: LTM-MET-3010 Alkali Metals Sulfur Silicon and Phosphorus by ICP-AES			
Heavy Metals	Melbourne	Dec 06, 2019	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Total Nitrogen Set (as N)			
Nitrate & Nitrite (as N)	Melbourne	Dec 06, 2019	28 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Total Kjeldahl Nitrogen (as N)	Melbourne	Dec 06, 2019	28 Days
- Method: LTM-INO-4310 TKN in Waters & Soils by FIA			
Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P			
Phosphorus	Melbourne	Dec 06, 2019	180 Days
- Method: LTM-MET-3010 Alkali Metals Sulfur Silicon and Phosphorus by ICP-AES			
% Moisture	Melbourne	Nov 27, 2019	14 Days
- Method: LTM-GEN-7080 Moisture			

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
External Laboratory																					
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																
1	THYLACINE_GS1_3_MET1	Nov 22, 2019		Soil	M19-No38233	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
2	THYLACINE_GS1_3_MET2	Nov 22, 2019		Soil	M19-No38234	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
3	THYLACINE_GS1_3_PSD1	Nov 22, 2019		Soil	M19-No38235	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
4	THYLACINE_GS1_MET2	Nov 22, 2019		Soil	M19-No38236	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
5	THYLACINE_GS-1_MET1	Nov 22, 2019		Soil	M19-No38237	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
6	THYLACINE_	Nov 22, 2019		Soil	M19-No38238	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

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ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS-1_PSD1																				
7	THYLACINE_GS1-2_PSD1	Nov 22, 2019		Soil	M19-No38239	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
8	THYLACINE_GS1-2_MET1	Nov 22, 2019		Soil	M19-No38240	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
9	THYLACINE_GS1-2_MET2	Nov 22, 2019		Soil	M19-No38241	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
10	THYLACINE_GS2_PSD1	Nov 22, 2019		Soil	M19-No38242	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
11	THYLACINE_GS2_MET1	Nov 22, 2019		Soil	M19-No38243	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
12	THYLACINE_GS2_MET2	Nov 22, 2019		Soil	M19-No38244	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
13	ARTISON-	Nov 22, 2019		Soil	M19-No38245	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
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Brisbane
1/21 Smallwood Place
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NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace	**Report #:**	690387	**Due:**	Dec 5, 2019
	East Perth	**Phone:**	08 9225 5199	**Priority:**	7 Day
	WA 6004	**Fax:**		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS_A_PAR 4																				
14	ARTISON-GS_A_PAR 3	Nov 22, 2019		Soil	M19-No38246	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
15	ARTISON-GSA_MET1	Nov 22, 2019		Soil	M19-No38247	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
16	ARTISON-GSA_PAR1	Nov 22, 2019		Soil	M19-No38248	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
17	ARTISON-GSA_MET2	Nov 22, 2019		Soil	M19-No38249	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
18	ARTISON-GSA_PAR2	Nov 22, 2019		Soil	M19-No38250	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
19	ARTISON-GS3_PAR1	Nov 22, 2019		Soil	M19-No38251	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
20	ARTISON-	Nov 22, 2019		Soil	M19-No38252	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
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Eurofins Analytical Services Manager : Swati Shahaney

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Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS3_MET1																				
21	ARTISON-GS3_PAR 4	Nov 22, 2019		Soil	M19-No38253	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
22	ARTISON-GS3_PAR 2	Nov 22, 2019		Soil	M19-No38254	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
23	ARTISON-GS3_MET 2	Nov 22, 2019		Soil	M19-No38255	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
24	ARTISON-GS3_PAR 3	Nov 22, 2019		Soil	M19-No38256	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
25	ARTISON-1	Nov 22, 2019		Filter paper	M19-No38257					X											
26	ARTISON-5	Nov 22, 2019		Filter paper	M19-No38258					X											
27	ARTISON-2	Nov 22, 2019		Filter paper	M19-No38259					X											
28	THYLACINE GS1_3	Nov 22, 2019		Filter paper	M19-No38260					X											

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WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
29	THYLACINE GS1_1	Nov 22, 2019		Filter paper	M19-No38261					X											
30	THYLACINE GS1_2	Nov 22, 2019		Filter paper	M19-No38262					X											
Test Counts						24	24	24	24	6	24	24	24	24	24	24	24	24	24	24	24

Environment Testing

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.

Environment Testing

Quality Control Results

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
% Clay			%	< 1			1	Pass	
Nitrate & Nitrite (as N)			mg/kg	< 5			5	Pass	
Total Kjeldahl Nitrogen (as N)			mg/kg	< 10			10	Pass	
Total Organic Carbon			%	< 0.1			0.1	Pass	
Method Blank									
Heavy Metals									
Cadmium			mg/kg	< 0.4			0.4	Pass	
Chromium			mg/kg	< 5			5	Pass	
Copper			mg/kg	< 5			5	Pass	
Lead			mg/kg	< 5			5	Pass	
Mercury			mg/kg	< 0.1			0.1	Pass	
Nickel			mg/kg	< 5			5	Pass	
Tin			mg/kg	< 10			10	Pass	
Zinc			mg/kg	< 5			5	Pass	
LCS - % Recovery									
% Clay			%	93			70-130	Pass	
Total Organic Carbon			%	107			70-130	Pass	
LCS - % Recovery									
Heavy Metals									
Cadmium			%	101			80-120	Pass	
Chromium			%	117			80-120	Pass	
Copper			%	118			80-120	Pass	
Lead			%	114			80-120	Pass	
Mercury			%	112			75-125	Pass	
Nickel			%	114			80-120	Pass	
Tin			%	112			80-120	Pass	
Zinc			%	116			80-120	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
Heavy Metals				Result 1					
Cadmium	M19-No38239	CP	%	94			75-125	Pass	
Chromium	M19-No38239	CP	%	83			75-125	Pass	
Copper	M19-No38239	CP	%	84			75-125	Pass	
Lead	M19-No38239	CP	%	87			75-125	Pass	
Mercury	M19-No38239	CP	%	101			70-130	Pass	
Nickel	M19-No38239	CP	%	85			75-125	Pass	
Tin	M19-No38239	CP	%	87			75-125	Pass	
Zinc	M19-No38239	CP	%	83			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	M19-De07683	NCP	%	3.0	3.0	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Clay	M19-Oc40940	NCP	%	5.0	6.3	22	30%	Pass	
% Sand	M19-Oc40940	NCP	%	91	90	1.0	30%	Pass	
% Silt	M19-Oc40940	NCP	%	3.8	3.8	<1	30%	Pass	
Nitrate & Nitrite (as N)	M19-No38234	CP	mg/kg	< 5	< 5	<1	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38238	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38238	CP	mg/kg	5.7	5.8	1.0	30%	Pass	
Copper	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38238	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38238	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38239	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38239	CP	mg/kg	5.2	5.5	6.0	30%	Pass	
Copper	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38239	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38239	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38248	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38248	CP	mg/kg	6.9	6.8	1.0	30%	Pass	
Copper	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38248	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38248	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38248	CP	mg/kg	< 5	6.3	54	30%	Fail	Q15
Duplicate									
				Result 1	Result 2	RPD			
Total Organic Carbon	M19-No38249	CP	%	< 0.1	< 0.1	<1	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
Q15	The RPD reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Robert Johnston	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)
Jonathon Angell	Senior Analyst-Inorganic (QLD)
Julie Kay	Senior Analyst-Inorganic (VIC)
Scott Beddoes	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.

Certificate of Analysis

Environment Testing

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

NATA Accredited
Accreditation Number 1261
Site Number 1254

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: **Serena Orr**

Report **700321-S**
Project name OTWAY OFFSHORE EBS
Project ID 318000803
Received Date Feb 05, 2020

Client Sample ID			**THYLACINE_GS1_3_MET1**	**THYLACINE_GS1_3_MET2**	**THYLACINE_GS1_MET2**	**THYLACINE_GS-1_MET1**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05003**	**M20-Fe05004**	**M20-Fe05005**	**M20-Fe05006**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	< 20	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	< 50	< 50	< 50	< 50
TRH C29-C36	50	mg/kg	< 50	< 50	< 50	< 50
TRH C10-C36 (Total)	50	mg/kg	< 50	< 50	< 50	< 50
BTEX						
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	106	86	112	104
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C34-C40	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C10-C40 (total)*	100	mg/kg	< 100	< 100	< 100	< 100
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.2	1.2	1.2
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5

Environment Testing

Client Sample ID			THYLACINE_GS1_3_MET1	THYLACINE_GS1_3_MET2	THYLACINE_GS1_MET2	THYLACINE_GS-1_MET1
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M20-Fe05003	M20-Fe05004	M20-Fe05005	M20-Fe05006
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Polycyclic Aromatic Hydrocarbons						
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH*	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
2-Fluorobiphenyl (surr.)	1	%	97	54	83	92
p-Terphenyl-d14 (surr.)	1	%	118	81	103	121
Polychlorinated Biphenyls						
Aroclor-1016	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1221	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1232	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1242	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1248	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1254	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1260	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Total PCB*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Dibutylchlorendate (surr.)	1	%	78	99	78	132
Tetrachloro-m-xylene (surr.)	1	%	77	51	55	77
% Moisture	1	%	33	35	36	32

Client Sample ID			THYLACINE_GS1-2_MET1	THYLACINE_GS1-2_MET2	THYLACINE_GS2_MET1	THYLACINE_GS2_MET2
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			M20-Fe05007	M20-Fe05008	M20-Fe05009	M20-Fe05010
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	< 20	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	< 50	< 50	< 50	< 50
TRH C29-C36	50	mg/kg	< 50	< 50	< 50	< 50
TRH C10-C36 (Total)	50	mg/kg	< 50	< 50	< 50	< 50
BTEX						
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	110	62	55	61

Client Sample ID			THYLACINE_GS1-2_MET1	THYLACINE_GS1-2_MET2	THYLACINE_GS2_MET1	THYLACINE_GS2_MET2
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05007**	**M20-Fe05008**	**M20-Fe05009**	**M20-Fe05010**
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C34-C40	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C10-C40 (total)*	100	mg/kg	< 100	< 100	< 100	< 100
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.2	1.2	1.2
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH*	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
2-Fluorobiphenyl (surr.)	1	%	87	75	79	91
p-Terphenyl-d14 (surr.)	1	%	137	88	83	57
Polychlorinated Biphenyls						
Aroclor-1016	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1221	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1232	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1242	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1248	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1254	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1260	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Total PCB*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Dibutylchlorendate (surr.)	1	%	139	112	105	64
Tetrachloro-m-xylene (surr.)	1	%	80	90	86	75
% Moisture	1	%	37	35	33	35

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Client Sample ID			ARTISON-GSA_MET1	ARTISON-GSA_MET2	ARTISON-GS3_MET1	ARTISON-GS3_MET 2
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05011**	**M20-Fe05012**	**M20-Fe05013**	**M20-Fe05014**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	< 20	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	< 50	< 50	< 50	< 50
TRH C29-C36	50	mg/kg	< 50	< 50	< 50	< 50
TRH C10-C36 (Total)	50	mg/kg	< 50	< 50	< 50	< 50
BTEX						
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	62	57	106	55
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C34-C40	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C10-C40 (total)*	100	mg/kg	< 100	< 100	< 100	< 100
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.2	1.2	1.2
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH*	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
2-Fluorobiphenyl (surr.)	1	%	60	77	58	67
p-Terphenyl-d14 (surr.)	1	%	59	125	147	56

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Client Sample ID			ARTISON-GSA_MET1	ARTISON-GSA_MET2	ARTISON-GS3_MET1	ARTISON-GS3_MET 2
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05011**	**M20-Fe05012**	**M20-Fe05013**	**M20-Fe05014**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Polychlorinated Biphenyls						
Aroclor-1016	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1221	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1232	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1242	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1248	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1254	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1260	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Total PCB*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Dibutylchlorendate (surr.)	1	%	73	89	115	110
Tetrachloro-m-xylene (surr.)	1	%	64	88	54	72
% Moisture	1	%	33	30	34	34

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	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Feb 05, 2020	
- Method: LTM-ORG-2010 TRH C6-C40			
BTEX	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Polycyclic Aromatic Hydrocarbons	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2130 PAH and Phenols in Soil and Water			
Polychlorinated Biphenyls	Melbourne	Feb 05, 2020	28 Days
- Method: LTM-ORG-2220 OCP & PCB in Soil and Water (USEPA 8082)			
% Moisture	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-GEN-7080 Moisture			

Australia

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

New Zealand

Auckland
35 O'Rorke Road
Penrose, Auckland 1061
Phone : +64 9 526 45 51
IANZ # 1327

Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 700321
Phone: 08 9225 5199
Fax:

Received: Feb 5, 2020 3:36 AM
Due: Feb 12, 2020
Priority: 5 Day
Contact Name: Serena Orr

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail						Polycyclic Aromatic Hydrocarbons	Polychlorinated Biphenyls	BTEX	Moisture Set	Total Recoverable Hydrocarbons
Melbourne Laboratory - NATA Site # 1254 & 14271						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	THYLACINE_GS1_3_MET1	Nov 22, 2019		Soil	M20-Fe05003	X	X	X	X	X
2	THYLACINE_GS1_3_MET2	Nov 22, 2019		Soil	M20-Fe05004	X	X	X	X	X
3	THYLACINE_GS1_MET2	Nov 22, 2019		Soil	M20-Fe05005	X	X	X	X	X
4	THYLACINE_GS-1_MET1	Nov 22, 2019		Soil	M20-Fe05006	X	X	X	X	X
5	THYLACINE_GS1-2_MET1	Nov 22, 2019		Soil	M20-Fe05007	X	X	X	X	X
6	THYLACINE_GS1-2_MET2	Nov 22, 2019		Soil	M20-Fe05008	X	X	X	X	X

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ABN – 50 005 085 521 web : www.eurofins.com.au e.mail : EnviroSales@eurofins.com

Australia

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
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Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

New Zealand

Auckland
35 O'Rorke Road
Penrose, Auckland 1061
Phone : +64 9 526 45 51
IANZ # 1327

Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**	
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	700321
		Phone:	08 9225 5199
		Fax:	
Project Name:	OTWAY OFFSHORE EBS	**Received:**	Feb 5, 2020 3:36 AM
Project ID:	318000803	**Due:**	Feb 12, 2020
		Priority:	5 Day
		Contact Name:	Serena Orr

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail						Polycyclic Aromatic Hydrocarbons	Polychlorinated Biphenyls	BTEX	Moisture Set	Total Recoverable Hydrocarbons
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X
Sydney Laboratory - NATA Site # 18217										
Brisbane Laboratory - NATA Site # 20794										
Perth Laboratory - NATA Site # 23736										
7	THYLACINE_ GS2_MET1	Nov 22, 2019		Soil	M20-Fe05009	X	X	X	X	X
8	THYLACINE_ GS2_MET2	Nov 22, 2019		Soil	M20-Fe05010	X	X	X	X	X
9	ARTISON-GSA_MET1	Nov 22, 2019		Soil	M20-Fe05011	X	X	X	X	X
10	ARTISON-GSA_MET2	Nov 22, 2019		Soil	M20-Fe05012	X	X	X	X	X
11	ARTISON-GS3_MET1	Nov 22, 2019		Soil	M20-Fe05013	X	X	X	X	X
12	ARTISON-GS3_MET 2	Nov 22, 2019		Soil	M20-Fe05014	X	X	X	X	X
Test Counts						12	12	12	12	12

Environment Testing

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/kg	< 20			20	Pass	
TRH C10-C14	mg/kg	< 20			20	Pass	
TRH C15-C28	mg/kg	< 50			50	Pass	
TRH C29-C36	mg/kg	< 50			50	Pass	
Method Blank							
BTEX							
Benzene	mg/kg	< 0.1			0.1	Pass	
Toluene	mg/kg	< 0.1			0.1	Pass	
Ethylbenzene	mg/kg	< 0.1			0.1	Pass	
m&p-Xylenes	mg/kg	< 0.2			0.2	Pass	
o-Xylene	mg/kg	< 0.1			0.1	Pass	
Xylenes - Total	mg/kg	< 0.3			0.3	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/kg	< 0.5			0.5	Pass	
TRH C6-C10	mg/kg	< 20			20	Pass	
TRH >C10-C16	mg/kg	< 50			50	Pass	
TRH >C16-C34	mg/kg	< 100			100	Pass	
TRH >C34-C40	mg/kg	< 100			100	Pass	
Method Blank							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/kg	< 0.5			0.5	Pass	
Acenaphthylene	mg/kg	< 0.5			0.5	Pass	
Anthracene	mg/kg	< 0.5			0.5	Pass	
Benz(a)anthracene	mg/kg	< 0.5			0.5	Pass	
Benzo(a)pyrene	mg/kg	< 0.5			0.5	Pass	
Benzo(b&j)fluoranthene	mg/kg	< 0.5			0.5	Pass	
Benzo(g.h.i)perylene	mg/kg	< 0.5			0.5	Pass	
Benzo(k)fluoranthene	mg/kg	< 0.5			0.5	Pass	
Chrysene	mg/kg	< 0.5			0.5	Pass	
Dibenz(a.h)anthracene	mg/kg	< 0.5			0.5	Pass	
Fluoranthene	mg/kg	< 0.5			0.5	Pass	
Fluorene	mg/kg	< 0.5			0.5	Pass	
Indeno(1.2.3-cd)pyrene	mg/kg	< 0.5			0.5	Pass	
Naphthalene	mg/kg	< 0.5			0.5	Pass	
Phenanthrene	mg/kg	< 0.5			0.5	Pass	
Pyrene	mg/kg	< 0.5			0.5	Pass	
Method Blank							
Polychlorinated Biphenyls							
Aroclor-1016	mg/kg	< 0.1			0.1	Pass	
Aroclor-1221	mg/kg	< 0.1			0.1	Pass	
Aroclor-1232	mg/kg	< 0.1			0.1	Pass	
Aroclor-1242	mg/kg	< 0.1			0.1	Pass	
Aroclor-1248	mg/kg	< 0.1			0.1	Pass	
Aroclor-1254	mg/kg	< 0.1			0.1	Pass	
Aroclor-1260	mg/kg	< 0.1			0.1	Pass	
Total PCB*	mg/kg	< 0.1			0.1	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	96			70-130	Pass	

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
TRH C10-C14			%	85			70-130	Pass	
LCS - % Recovery									
BTEX									
Benzene			%	100			70-130	Pass	
Toluene			%	98			70-130	Pass	
Ethylbenzene			%	91			70-130	Pass	
m&p-Xylenes			%	93			70-130	Pass	
Xylenes - Total			%	94			70-130	Pass	
LCS - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions									
Naphthalene			%	120			70-130	Pass	
TRH C6-C10			%	91			70-130	Pass	
TRH >C10-C16			%	81			70-130	Pass	
LCS - % Recovery									
Polycyclic Aromatic Hydrocarbons									
Acenaphthene			%	109			70-130	Pass	
Acenaphthylene			%	117			70-130	Pass	
Anthracene			%	124			70-130	Pass	
Benz(a)anthracene			%	120			70-130	Pass	
Benzo(a)pyrene			%	96			70-130	Pass	
Benzo(b&j)fluoranthene			%	108			70-130	Pass	
Benzo(g.h.i)perylene			%	90			70-130	Pass	
Benzo(k)fluoranthene			%	86			70-130	Pass	
Chrysene			%	95			70-130	Pass	
Dibenz(a.h)anthracene			%	103			70-130	Pass	
Fluoranthene			%	120			70-130	Pass	
Fluorene			%	119			70-130	Pass	
Indeno(1.2.3-cd)pyrene			%	99			70-130	Pass	
Naphthalene			%	107			70-130	Pass	
Phenanthrene			%	110			70-130	Pass	
Pyrene			%	120			70-130	Pass	
LCS - % Recovery									
Polychlorinated Biphenyls									
Aroclor-1260			%	105			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	N20-Fe00759	NCP	%	89			70-130	Pass	
TRH C10-C14	N20-Fe03039	NCP	%	79			70-130	Pass	
Spike - % Recovery									
BTEX				Result 1					
Benzene	N20-Fe00759	NCP	%	93			70-130	Pass	
Toluene	N20-Fe00759	NCP	%	93			70-130	Pass	
Ethylbenzene	N20-Fe00759	NCP	%	84			70-130	Pass	
m&p-Xylenes	N20-Fe00759	NCP	%	86			70-130	Pass	
o-Xylene	N20-Fe00759	NCP	%	91			70-130	Pass	
Xylenes - Total	N20-Fe00759	NCP	%	88			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
Naphthalene	N20-Fe00759	NCP	%	100			70-130	Pass	
TRH C6-C10	N20-Fe00759	NCP	%	87			70-130	Pass	
TRH >C10-C16	N20-Fe03039	NCP	%	77			70-130	Pass	
Spike - % Recovery									
Polycyclic Aromatic Hydrocarbons				Result 1					

Eurofins Environment Testing

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Acenaphthene	S20-Ja29582	NCP	%	87			70-130	Pass	
Acenaphthylene	S20-Ja29582	NCP	%	91			70-130	Pass	
Anthracene	S20-Ja29582	NCP	%	94			70-130	Pass	
Benz(a)anthracene	S20-Ja29582	NCP	%	87			70-130	Pass	
Benzo(a)pyrene	S20-Ja29582	NCP	%	113			70-130	Pass	
Benzo(b&j)fluoranthene	S20-Ja29582	NCP	%	102			70-130	Pass	
Benzo(g.h.i)perylene	S20-Ja29582	NCP	%	101			70-130	Pass	
Benzo(k)fluoranthene	S20-Ja29582	NCP	%	84			70-130	Pass	
Chrysene	S20-Ja29582	NCP	%	95			70-130	Pass	
Dibenz(a.h)anthracene	S20-Ja29582	NCP	%	105			70-130	Pass	
Fluoranthene	S20-Ja29582	NCP	%	90			70-130	Pass	
Fluorene	S20-Ja29582	NCP	%	95			70-130	Pass	
Indeno(1.2.3-cd)pyrene	S20-Ja29582	NCP	%	112			70-130	Pass	
Naphthalene	S20-Ja29582	NCP	%	128			70-130	Pass	
Phenanthrene	S20-Ja29582	NCP	%	85			70-130	Pass	
Pyrene	S20-Ja29582	NCP	%	86			70-130	Pass	
Spike - % Recovery									
Polychlorinated Biphenyls				Result 1					
Aroclor-1016	M20-Ja30810	NCP	%	88			70-130	Pass	
Aroclor-1260	M20-Ja30810	NCP	%	90			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Acenaphthene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Acenaphthylene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Anthracene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benz(a)anthracene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(a)pyrene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(b&j)fluoranthene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(g.h.i)perylene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(k)fluoranthene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Chrysene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Dibenz(a.h)anthracene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Fluoranthene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Fluorene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Indeno(1.2.3-cd)pyrene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Naphthalene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Phenanthrene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Pyrene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	M20-Fe05006	CP	%	32	32	<1	30%	Pass	
Duplicate									
Polychlorinated Biphenyls				Result 1	Result 2	RPD			
Aroclor-1016	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1221	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1232	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1242	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1248	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1254	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1260	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Total PCB*	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	M20-Fe05012	CP	mg/kg	< 20	< 20	<1	30%	Pass	

Duplicate									
BTEX				Result 1	Result 2	RPD			
Benzene	M20-Fe05012	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Toluene	M20-Fe05012	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Ethylbenzene	M20-Fe05012	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
m&p-Xylenes	M20-Fe05012	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
o-Xylene	M20-Fe05012	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Xylenes - Total	M20-Fe05012	CP	mg/kg	< 0.3	< 0.3	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
Naphthalene	M20-Fe05012	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
TRH C6-C10	M20-Fe05012	CP	mg/kg	< 20	< 20	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C10-C14	M20-Fe05014	CP	mg/kg	< 20	< 20	<1	30%	Pass	
TRH C15-C28	M20-Fe05014	CP	mg/kg	< 50	< 50	<1	30%	Pass	
TRH C29-C36	M20-Fe05014	CP	mg/kg	< 50	< 50	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
TRH >C10-C16	M20-Fe05014	CP	mg/kg	< 50	< 50	<1	30%	Pass	
TRH >C16-C34	M20-Fe05014	CP	mg/kg	< 100	< 100	<1	30%	Pass	
TRH >C34-C40	M20-Fe05014	CP	mg/kg	< 100	< 100	<1	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	No
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

Robert Johnston	Analytical Services Manager
Harry Bacalis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (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.

APPENDIX 4
DROP CAMERA SITES (GDA94 UTM 54 S)

Date	Site	Easting	Northing	Depth (m LAT)
31/10/2019	DC_AR2	664260	5693556	69.5
	DC_AR3	663741	5694457	69.6
	DC_AR4	662262	5693605	70.8
	DC_AR1	662782	5692701	70.9
20/11/2019	DC_TH5	658145	5656139	107.1
21/11/2019	DC_TH8	657791	5656967	104.9
	DC_TH8_4m	657796	5656969	104.9
	DC_TH8_8m	657800	5656972	104.9
	DC_TH6	659801	5656919	101.9
	DC_TH6_4m	659810	5656925	101.9
	DC_TH6_8m	659810	5656923	101.9
	DC_TH7	659211	5657774	103.5
	DC_TH7_4m	659213	5657774	103.5
9/12/2019	DC_TH4	660880	5658431	98.9
	DC_TH4_2m	660880	5658428	98.9
	DC_TH4_5m	660881	5658432	98.9
	DC_TH1	661398	5657534	96.8
	DC_TH1_2m	661397	5657532	96.8
	DC_TH1_5m	661397	5657539	96.8
	DC_TH2	662970	5658384	96.9
	DC_TH2_2m	662972	5658383	96.9
	DC_TH2_5m	662975	5658387	96.9
	DC_TH3	662409	5659275	98.2
	DC_TH3_2m	662412	5659274	98.2
	DC_TH3_5m	662406	5659277	98.2
25/12/2019	DC_GE1	668217	5668519	85.6
	DC_GE2	669700	5669375	85.0
	DC_GE2_2m	669703	5669375	85.0
	DC_GE2_5m	669704	5669377	85.0
	DC_GE3	669179	5670280	82.3
	DC_GE3_2m	669180	5670279	82.3
	DC_GE3_5m	669184	5670277	82.3
	DC_GE4	667699	5669424	83.4
	DC_GE4_2m	667700	5669424	83.4
	DC_GE4_5m	667704	5669422	83.4
28/12/2019	DC_LB1	647832	5681521	92.5
	DC_LB1_2m	647831	5681519	92.5
	DC_LB1_5m	647831	5681516	92.5
	DC_LB4	646558	5680703	97.8
	DC_LB4_2m	646560	5680702	97.8

Date	Site	Easting	Northing	Depth (m LAT)
	DC_LB4_5m	646560	5680700	97.8
	DC_LB4_Extra	646438	5680699	97.8
21/01/2020	DC_LB2R	645891	5681544	93.1
	DC_LB2R_2m	645889	5681543	93.1
	DC_LB2R_5m	645891	5681541	93.1
	DC_LB3R	647415	5682484	93.6
	DC_LB3R_2m	647415	5682479	93.6
	DC_LB3R_5m	647418	5682479	93.6
	DC_HE4R	662560	5687719	74.3
	DC_HE4R_1m	662560	5687719	74.3
	DC_HE4R_3m	662557	5687717	74.3
	DC_HE2	662068	5688635	74.3
	DC_HE2_1m	662066	5688636	74.3
	DC_HE2_3m	662064	5688637	74.3
	DC_HE1	664068	5688640	73.4
	DC_HE1_1m	664068	5688643	73.4
	DC_HE1_3m	664066	5688641	73.4
	DC_HE3	663548	5689514	73.8
	DC_HE3_1m	663548	5689515	73.8
	DC_HE3_3m	663544	5689514	73.8
	DC_HTX1R	669286	5688662	72.9
	DC_HTX1R_1m	669286	5688661	72.9
	DC_HTX1R_2m	669290	5688661	72.9
22/01/2020	DC_ARHTX1R	665451	5691790	70.5
	DC_ARHTX1R_2m	665452	5691788	70.5
	DC_ARHTX1R_5m	665452	5691788	70.5
29/01/2020	DC_ARHTY1R	665896	5694722	69.3
	DC_ARHTY1R_B	665895	5694725	69.3
	DC_ARHTY1R_C	665899	5694726	69.3
	DC_HTY1R_A	670385	5696817	67.9
	DC_HTY1R_B	670382	5696816	67.9
	DC_HTY1R_C	670384	5696816	67.9
	DC_ARGE3R_A	665383	5684033	76.4
	DC_ARGE3R_B	665383	5684033	76.8
	DC_ARGE3R_C	665382	5684030	76.7
	DC_ARGE3R_D	665381	5684028	76.2
	DC_ARGE6R_A	667106	5676840	76.9
	DC_ARGE6R_B	667108	5676837	74.7
	DC_ARGE6R_C	667109	5676835	77.6
	DC_ARGE7R_A	667735	5673842	79.4

Date	Site	Easting	Northing	Depth (m LAT)
30/01/2020	DC_ARGE7R_B	667735	5673845	79.4
	DC_ARGE7R_C	667736	5673849	79.4
	DC_ARLB2R_A	659391	5690760	73.6
	DC_ARLB2R_B	659390	5690760	73.6
	DC_ARLB2R_C	659391	5690757	73.6
	DC_ARLB6R_A	651030	5684616	87.1
	DC_ARLB6R_B	651030	5684615	87.1
	DC_ARLB6R_C	651031	5684613	87.1
	DC_LBGE3R_A	653038	5677641	98.5
	DC_LBGE3R_B	653039	5677640	98.5
	DC_LBGE3R_C	653040	5677638	98.5
	DC_LBGE6R_A	659466	5673506	88.2
	DC_LBGE6R_B	659467	5673504	88.2
	DC_LBGE6R_C	659468	5673503	88.2

APPENDIX 5
SEABED PHOTOGRAPH ASSESSMENT DATA

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
ARGE	Routes_ARGE_ARGE3R_A_00001	20									
ARGE	Routes_ARGE_ARGE3R_A_00002	10							1		
ARGE	Routes_ARGE_ARGE3R_A_00005	15		5	1						
ARGE	Routes_ARGE_ARGE3R_A_00006	25									
ARGE	Routes_ARGE_ARGE3R_A_00007	5		1							
ARGE	Routes_ARGE_ARGE3R_B_00005	15									
ARGE	Routes_ARGE_ARGE3R_B_00006	5									
ARGE	Routes_ARGE_ARGE3R_B_00007	5									
ARGE	Routes_ARGE_ARGE3R_C_00001	0									
ARGE	Routes_ARGE_ARGE3R_C_00003	5									
ARGE	Routes_ARGE_ARGE3R_C_00004	0									
ARGE	Routes_ARGE_ARGE3R_C_00005	5									
ARGE	Routes_ARGE_ARGE6R_A_00001	0									
ARGE	Routes_ARGE_ARGE6R_A_00002	0									
ARGE	Routes_ARGE_ARGE6R_A_00003	5									
ARGE	Routes_ARGE_ARGE6R_A_00004	0									
ARGE	Routes_ARGE_ARGE6R_A_00005	0									
ARGE	Routes_ARGE_ARGE6R_A_00006	0									
ARGE	Routes_ARGE_ARGE6R_A_00007	5									
ARGE	Routes_ARGE_ARGE6R_B_00001	0									
ARGE	Routes_ARGE_ARGE6R_B_00002	5									
ARGE	Routes_ARGE_ARGE6R_B_00003	5									
ARGE	Routes_ARGE_ARGE6R_B_00005	5									
ARGE	Routes_ARGE_ARGE6R_B_00006	5									
ARGE	Routes_ARGE_ARGE6R_B_00007	5									
ARGE	Routes_ARGE_ARGE6R_B_00008	0									
ARGE	Routes_ARGE_ARGE6R_B_00009	5									
ARGE	Routes_ARGE_ARGE6R_C_00001	5									
ARGE	Routes_ARGE_ARGE6R_C_00002	0									
ARGE	Routes_ARGE_ARGE6R_C_00003	5									
ARGE	Routes_ARGE_ARGE6R_C_00004	0									1
ARGE	Routes_ARGE_ARGE6R_C_00005	0		1							
ARGE	Routes_ARGE_ARGE7R_A_00001	5									
ARGE	Routes_ARGE_ARGE7R_A_00002	15									
ARGE	Routes_ARGE_ARGE7R_A_00004	10									
ARGE	Routes_ARGE_ARGE7R_A_00005	25		1							
ARGE	Routes_ARGE_ARGE7R_B_00004	5									
ARGE	Routes_ARGE_ARGE7R_B_00005	10									
ARGE	Routes_ARGE_ARGE7R_B_00006	20									
ARGE	Routes_ARGE_ARGE7R_B_00007	15									
ARGE	Routes_ARGE_ARGE7R_B_00008	20									
ARGE	Routes_ARGE_ARGE7R_B_00009	20									
ARGE	Routes_ARGE_ARGE7R_B_00011	25		1							
ARGE	Routes_ARGE_ARGE7R_B_00012	15				1					

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
ARGE	Routes_ARGE_ARGE7R_B_00015	25									
ARGE	Routes_ARGE_ARGE7R_C_00001	35									
ARGE	Routes_ARGE_ARGE7R_C_00002	10									
ARGE	Routes_ARGE_ARGE7R_C_00004	35									
ARGE	Routes_ARGE_ARGE7R_C_00005	5									1
ARGE	Routes_ARGE_ARGE7R_C_00006	30		1							
ARHTY	Routes_ARHTY_ARHTYR1_A_00001	0									
ARHTY	Routes_ARHTY_ARHTYR1_A_00002	0									
ARHTY	Routes_ARHTY_ARHTYR1_A_00003	20									
ARHTY	Routes_ARHTY_ARHTYR1_A_00004	25									
ARHTY	Routes_ARHTY_ARHTYR1_A_00005	0									
ARHTY	Routes_ARHTY_ARHTYR1_A_00006	0									
ARHTY	Routes_ARHTY_ARHTYR1_A_00008	0									1
ARHTY	Routes_ARHTY_ARHTYR1_A_00009	0						1			
ARHTY	Routes_ARHTY_ARHTYR1_B_00001	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00003	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00004	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00005	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00006	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00008	0									
ARHTY	Routes_ARHTY_ARHTYR1_C_00001	40	1								
ARHTY	Routes_ARHTY_ARHTYR1_C_00002	0									
ARHTY	Routes_ARHTY_ARHTYR1_C_00004	20									
ARHTY	Routes_ARHTY_ARHTYR1_C_00006	5									
ARHTY	Routes_ARHTY_ARHTYR1_C_00007	0		1							
ARHTY	Routes_ARHTY_ARHTYR1_C_00008	0									
ARHTY	Routes_ARHTY_ARHTYR1_C_00009	0								1	
ARLB	Routes_ARLB_ARLB2R_A_00001	20									
ARLB	Routes_ARLB_ARLB2R_A_00005	20									
ARLB	Routes_ARLB_ARLB2R_A_00006	20									
ARLB	Routes_ARLB_ARLB2R_A_00007	30									
ARLB	Routes_ARLB_ARLB2R_A_00008	15		1							
ARLB	Routes_ARLB_ARLB2R_A_00009	20									
ARLB	Routes_ARLB_ARLB2R_A_00010	20									
ARLB	Routes_ARLB_ARLB2R_B_00001	5									
ARLB	Routes_ARLB_ARLB2R_B_00002	20									
ARLB	Routes_ARLB_ARLB2R_B_00003	20		2	1						
ARLB	Routes_ARLB_ARLB2R_B_00004	20									
ARLB	Routes_ARLB_ARLB2R_B_00005	20									
ARLB	Routes_ARLB_ARLB2R_C_00001	5		1							
ARLB	Routes_ARLB_ARLB2R_C_00003	5									
ARLB	Routes_ARLB_ARLB2R_C_00004	0									
ARLB	Routes_ARLB_ARLB2R_C_00005	5									
ARLB	Routes_ARLB_ARLB2R_C_00006	5		1							

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
ARLB	Routes_ARLB_ARLB6R_A_00002	0									
ARLB	Routes_ARLB_ARLB6R_A_00003	5				1					
ARLB	Routes_ARLB_ARLB6R_A_00004	0									
ARLB	Routes_ARLB_ARLB6R_A_00005	5		1							
ARLB	Routes_ARLB_ARLB6R_B_00001	0									
ARLB	Routes_ARLB_ARLB6R_B_00002	0									
ARLB	Routes_ARLB_ARLB6R_B_00004	0									
ARLB	Routes_ARLB_ARLB6R_B_00005	0									
ARLB	Routes_ARLB_ARLB6R_B_00006	0		3							
ARLB	Routes_ARLB_ARLB6R_C_00001	0									
ARLB	Routes_ARLB_ARLB6R_C_00002	0									
ARLB	Routes_ARLB_ARLB6R_C_00003	0									
ARLB	Routes_ARLB_ARLB6R_C_00004	0									
ARLB	Routes_ARLB_ARLB6R_C_00005	0		1							
ARLB	Routes_ARLB_ARLB6R_C_00007	5		2							
Artisan	Artisan_AR1_00015	30									
Artisan	Artisan_AR1_00017	5									
Artisan	Artisan_AR1_00029	40		3							
Artisan	Artisan_AR1_00035	30		1							
Artisan	Artisan_AR2_00007	35									
Artisan	Artisan_AR2_00008	15									
Artisan	Artisan_AR2_00011	40									
Artisan	Artisan_AR2_00012	30		1							
Artisan	Artisan_AR3_00004	20									
Artisan	Artisan_AR3_00006	15									
Artisan	Artisan_AR3_00008	5									
Artisan	Artisan_AR3_00015	40									
Artisan	Artisan_AR3_00017	25									
Artisan	Artisan_AR3_00018	20		1							
Artisan	Artisan_AR3_00019	10									
Artisan	Artisan_AR3_00022	5									
Artisan	Artisan_AR3_00023	25									
Artisan	Artisan_AR4_00004	30		3							
Artisan	Artisan_AR4_00005	5									
Artisan	Artisan_AR4_00007	20		2							
Artisan	Artisan_AR4_00009	10									
Artisan	Artisan_AR4_00012	45									
Artisan	Artisan_AR4_00013	30									
Artisan	Artisan_AR4_00016	10		1							
Artisan	Artisan_AR4_00017	30		1							
Artisan	Artisan_AR4_00018	20		1							
Artisan	Artisan_AR4_00019	5		1							
Artisan	Artisan_AR4_00025	15		2							
Artisan	Artisan_AR4_00031	15		3							

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Artisan	Artisan_AR4_00034	40									
Geographe	Geographe_GE1_A_00004	55									
Geographe	Geographe_GE1_A_00007	35									
Geographe	Geographe_GE1_A_00008	45		2							
Geographe	Geographe_GE1_B_00001	0									
Geographe	Geographe_GE1_B_00002	0	1								
Geographe	Geographe_GE1_B_00004	5									
Geographe	Geographe_GE1_B_00005	5									
Geographe	Geographe_GE1_C_00001	5									
Geographe	Geographe_GE1_C_00005	25	1								
Geographe	Geographe_GE2_A_00001	5									
Geographe	Geographe_GE2_A_00002	5									
Geographe	Geographe_GE2_A_00003	10	1								
Geographe	Geographe_GE2_A_00005	25									
Geographe	Geographe_GE2_B_00002	5									
Geographe	Geographe_GE2_B_00003	5									
Geographe	Geographe_GE2_C_00002	0									
Geographe	Geographe_GE2_C_00004	0									
Geographe	Geographe_GE2_C_00005	0									
Geographe	Geographe_GE3_A_00001	5									
Geographe	Geographe_GE3_A_00003	5									
Geographe	Geographe_GE3_A_00005	25									
Geographe	Geographe_GE3_B_00001	5									
Geographe	Geographe_GE3_B_00003	20									
Geographe	Geographe_GE3_B_00005	30									
Geographe	Geographe_GE3_C_00002	35									
Geographe	Geographe_GE3_C_00005	40		1							
Geographe	Geographe_GE3_C_00006	10									
Geographe	Geographe_GE4_A_00002	35									
Geographe	Geographe_GE4_A_00004	5									
Geographe	Geographe_GE4_A_00005	30									
Geographe	Geographe_GE4_A_00006	0		1							
Geographe	Geographe_GE4_B_00002	5									
Geographe	Geographe_GE4_B_00003	5									
Geographe	Geographe_GE4_B_00005	0									
Geographe	Geographe_GE4_C_00001	5									
Geographe	Geographe_GE4_C_00002	0									
Geographe	Geographe_GE4_C_00003	0									
Geographe	Geographe_GE4_C_00005	0									
Hercules	Hercules_HE1_A_00002	20									
Hercules	Hercules_HE1_A_00003	0									
Hercules	Hercules_HE1_A_00004	35									
Hercules	Hercules_HE1_A_00005	0									
Hercules	Hercules_HE1_A_00006	35									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Hercules	Hercules_HE1_B_00001	45									
Hercules	Hercules_HE1_B_00002	35									
Hercules	Hercules_HE1_B_00004	15									
Hercules	Hercules_HE1_B_00005	5									
Hercules	Hercules_HE1_C_00001	5									
Hercules	Hercules_HE1_C_00002	20									
Hercules	Hercules_HE1_C_00005	25									
Hercules	Hercules_HE1_C_00006	30				1					
Hercules	Hercules_HE1_C_00007	30				1					
Hercules	Hercules_HE2_A_00001	30				1					
Hercules	Hercules_HE2_A_00002	5									
Hercules	Hercules_HE2_A_00003	30	1								
Hercules	Hercules_HE2_A_00004	5									
Hercules	Hercules_HE2_A_00005	60									
Hercules	Hercules_HE2_A_00006	25									
Hercules	Hercules_HE2_B_00002	60									
Hercules	Hercules_HE2_B_00004	80									
Hercules	Hercules_HE2_B_00005	25		1							
Hercules	Hercules_HE2_B_00006	75									
Hercules	Hercules_HE2_C_00002	5									
Hercules	Hercules_HE2_C_00003	25									
Hercules	Hercules_HE2_C_00004	20									
Hercules	Hercules_HE2_C_00007	20									
Hercules	Hercules_HE2_C_00009	25									
Hercules	Hercules_HE3_A_00001	50									
Hercules	Hercules_HE3_A_00003	45									
Hercules	Hercules_HE3_A_00005	40		1							
Hercules	Hercules_HE3_B_00001	30									
Hercules	Hercules_HE3_B_00002	40									
Hercules	Hercules_HE3_B_00004	15									
Hercules	Hercules_HE3_B_00005	25									
Hercules	Hercules_HE3_B_00006	30		1							
Hercules	Hercules_HE3_C_00001	5									
Hercules	Hercules_HE3_C_00002	40									
Hercules	Hercules_HE3_C_00003	0						1			
Hercules	Hercules_HE3_C_00005	35			1						
Hercules	Hercules_HE3_C_00007	0									
Hercules	Hercules_HE3_C_00008	5									
Hercules	Hercules_HE4_A_00001	5									
Hercules	Hercules_HE4_A_00002	25									
Hercules	Hercules_HE4_A_00004	15									
Hercules	Hercules_HE4_A_00005	0									
Hercules	Hercules_HE4_B_00001	30									
Hercules	Hercules_HE4_B_00003	15									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Hercules	Hercules_HE4_B_00004	40									
Hercules	Hercules_HE4_B_00005	15									
Hercules	Hercules_HE4_B_00008	15									
Hercules	Hercules_HE4_B_00009	20									
Hercules	Hercules_HE4_B_00010	25									
Hercules	Hercules_HE4_C_00001	30									
Hercules	Hercules_HE4_C_00002	0									
Hercules	Hercules_HE4_C_00003	0	1								
Hercules	Hercules_HE4_C_00004	20									
Hercules	Hercules_HE4_C_00005	5									
Hot Tap X	HotTap_HTX_HTX1R_A_00006	40									
Hot Tap X	HotTap_HTX_HTX1R_B_00004	25		1							
Hot Tap X	HotTap_HTX_HTX1R_B_00005	15									
Hot Tap X	HotTap_HTX_HTX1R_B_00007	50	1								
Hot Tap X	HotTap_HTX_HTX1R_C_00002	30	1								
Hot Tap X	HotTap_HTX_HTX1R_C_00003	45									
Hot Tap X	HotTap_HTX_HTX1R_C_00005	55									
Hot Tap X	HotTap_HTX_HTX1R_C_00006	50				1					
Hot Tap X	HotTap_HTX_HTX1R_C_00007	25									
Hot Tap Y	HotTap_HTY_HTY1R_A_00001	25				1					
Hot Tap Y	HotTap_HTY_HTY1R_A_00004	20									
Hot Tap Y	HotTap_HTY_HTY1R_A_00005	25									
Hot Tap Y	HotTap_HTY_HTY1R_A_00007	40					1				
Hot Tap Y	HotTap_HTY_HTY1R_A_00009	15									
Hot Tap Y	HotTap_HTY_HTY1R_A_00010	15									
Hot Tap Y	HotTap_HTY_HTY1R_A_00013	20									
Hot Tap Y	HotTap_HTY_HTY1R_A_00014	35									
Hot Tap Y	HotTap_HTY_HTY1R_B_00001	25		1							
Hot Tap Y	HotTap_HTY_HTY1R_B_00004	20									
Hot Tap Y	HotTap_HTY_HTY1R_B_00006	10		1							
Hot Tap Y	HotTap_HTY_HTY1R_B_00008	10		5							
Hot Tap Y	HotTap_HTY_HTY1R_B_00009	15									
Hot Tap Y	HotTap_HTY_HTY1R_C_00001	25									
Hot Tap Y	HotTap_HTY_HTY1R_C_00002	15									
Hot Tap Y	HotTap_HTY_HTY1R_C_00004	15									
Hot Tap Y	HotTap_HTY_HTY1R_C_00005	20									
Hot Tap Y	HotTap_HTY_HTY1R_C_00006	10									
La Bella	LaBella_LB1_A_00001	30		1							
La Bella	LaBella_LB1_A_00004	5									
La Bella	LaBella_LB1_A_00006	30									
La Bella	LaBella_LB1_B_00008	5									
La Bella	LaBella_LB1_B_00009	5									
La Bella	LaBella_LB1_B_00013	15									
La Bella	LaBella_LB1_C_00001	15									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
La Bella	LaBella_LB1_C_00003	15									
La Bella	LaBella_LB1_C_00004	20									
La Bella	LaBella_LB2_A_00014	15									
La Bella	LaBella_LB2_A_00017	10									
La Bella	LaBella_LB2_A_00021	0									
La Bella	LaBella_LB2_A_00024	10									
La Bella	LaBella_LB2_A_00026	0									
La Bella	LaBella_LB2_A_00028	0									
La Bella	LaBella_LB2_B_00029	35									
La Bella	LaBella_LB2_B_00030	20									
La Bella	LaBella_LB2_B_00033	20									
La Bella	LaBella_LB2_B_00035	15									
La Bella	LaBella_LB2_B_00036	25									
La Bella	LaBella_LB2_B_00040	5									
La Bella	LaBella_LB2_B_00041	5									
La Bella	LaBella_LB2_C_00043	5									
La Bella	LaBella_LB2_C_00044	5									
La Bella	LaBella_LB2_C_00045	0									
La Bella	LaBella_LB2_C_00047	0									
La Bella	LaBella_LB2_C_00048	5									
La Bella	LaBella_LB3_A_00001	5									
La Bella	LaBella_LB3_A_00003	0		1							
La Bella	LaBella_LB3_A_00005	5									
La Bella	LaBella_LB3_A_00007	5									
La Bella	LaBella_LB3_A_00009	5									
La Bella	LaBella_LB3_A_00010	0									
La Bella	LaBella_LB3_B_00002	5									
La Bella	LaBella_LB3_B_00004	5		1							
La Bella	LaBella_LB3_B_00006	5		1							
La Bella	LaBella_LB3_B_00007	5									
La Bella	LaBella_LB3_B_00009	0									
La Bella	LaBella_LB3_C_00002	5		1							
La Bella	LaBella_LB3_C_00003	5									
La Bella	LaBella_LB3_C_00005	5									
La Bella	LaBella_LB3_C_00007	0									
La Bella	LaBella_LB4_A_00001	0									
La Bella	LaBella_LB4_A_00003	0				1					
La Bella	LaBella_LB4_A_00005	5									
La Bella	LaBella_LB4_B_00004	5									
La Bella	LaBella_LB4_B_00005	0									
La Bella	LaBella_LB4_C_00001	0		1							
La Bella	LaBella_LB4_C_00004	0									
La Bella	LaBella_LB4_C_00005	5									
La Bella	LaBella_LB4_C_00006	0									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
La Bella	LaBella_LB4_D_00001	35									
La Bella	LaBella_LB4_D_00002	25									
La Bella	LaBella_LB4_D_00003	30									
La Bella	LaBella_LB4_D_00004	15									
La Bella	LaBella_LB4_D_00005	20									
La Bella	LaBella_LB4_D_00006	25									
La Bella	LaBella_LB4_D_00007	35									
La Bella	LaBella_LB4_D_00008	40		1							
LBGE	Routes_LBGE_LBGE3R_A_00001	40									
LBGE	Routes_LBGE_LBGE3R_A_00002	45		2							
LBGE	Routes_LBGE_LBGE3R_A_00004	5									
LBGE	Routes_LBGE_LBGE3R_A_00005	5									
LBGE	Routes_LBGE_LBGE3R_A_00006	15									
LBGE	Routes_LBGE_LBGE3R_A_00008	45		1							
LBGE	Routes_LBGE_LBGE3R_B_00001	15									
LBGE	Routes_LBGE_LBGE3R_B_00002	5									
LBGE	Routes_LBGE_LBGE3R_B_00003	0									
LBGE	Routes_LBGE_LBGE3R_B_00004	0									
LBGE	Routes_LBGE_LBGE3R_B_00005	10		1							
LBGE	Routes_LBGE_LBGE3R_C_00001	0									
LBGE	Routes_LBGE_LBGE3R_C_00002	0									
LBGE	Routes_LBGE_LBGE3R_C_00003	0									
LBGE	Routes_LBGE_LBGE3R_C_00004	0									
LBGE	Routes_LBGE_LBGE3R_C_00005	0									
LBGE	Routes_LBGE_LBGE6R_A_00002	0									
LBGE	Routes_LBGE_LBGE6R_A_00003	5									
LBGE	Routes_LBGE_LBGE6R_A_00004	0									
LBGE	Routes_LBGE_LBGE6R_A_00005	5				1					
LBGE	Routes_LBGE_LBGE6R_A_00006	0									
LBGE	Routes_LBGE_LBGE6R_B_00001	0									
LBGE	Routes_LBGE_LBGE6R_B_00003	5		1							
LBGE	Routes_LBGE_LBGE6R_B_00004	5									
LBGE	Routes_LBGE_LBGE6R_B_00005	0									
LBGE	Routes_LBGE_LBGE6R_C_00001	0									
LBGE	Routes_LBGE_LBGE6R_C_00002	0									
LBGE	Routes_LBGE_LBGE6R_C_00003	0									
LBGE	Routes_LBGE_LBGE6R_C_00004	0									
LBGE	Routes_LBGE_LBGE6R_C_00005	0									
Thylacine	Thylacine_TH1_A_00002	65									
Thylacine	Thylacine_TH1_A_00003	55						9			
Thylacine	Thylacine_TH1_A_00006	25									
Thylacine	Thylacine_TH1_A_00007	20						2		1	
Thylacine	Thylacine_TH1_A_00008	30						6			
Thylacine	Thylacine_TH1_A_00009	30						3			

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Thylacine	Thylacine_TH1_B_00015	45						3			
Thylacine	Thylacine_TH1_B_00016	55						3			
Thylacine	Thylacine_TH1_B_00017	60						1			
Thylacine	Thylacine_TH1_B_00018	60						5			
Thylacine	Thylacine_TH1_B_00021	55						2			
Thylacine	Thylacine_TH1_B_00023	45									
Thylacine	Thylacine_TH1_C_00028	40									
Thylacine	Thylacine_TH1_C_00029	45						3			
Thylacine	Thylacine_TH1_C_00031	25						1			
Thylacine	Thylacine_TH1_C_00033	40						2			
Thylacine	Thylacine_TH2_A_00001	0									
Thylacine	Thylacine_TH2_A_00003	0									
Thylacine	Thylacine_TH2_A_00005	5									
Thylacine	Thylacine_TH2_A_00009	5									
Thylacine	Thylacine_TH2_B_00010	5									
Thylacine	Thylacine_TH2_B_00011	0									
Thylacine	Thylacine_TH2_B_00012	0									
Thylacine	Thylacine_TH2_B_00013	5	1								
Thylacine	Thylacine_TH2_B_00014	5									
Thylacine	Thylacine_TH2_C_00015	0									
Thylacine	Thylacine_TH2_C_00016	5									
Thylacine	Thylacine_TH2_C_00017	0									
Thylacine	Thylacine_TH2_C_00018	5		1							
Thylacine	Thylacine_TH2_C_00019	0									
Thylacine	Thylacine_TH2_C_00021	0									
Thylacine	Thylacine_TH3_A_00001	15		2							
Thylacine	Thylacine_TH3_A_00003	10									
Thylacine	Thylacine_TH3_A_00004	30						4			
Thylacine	Thylacine_TH3_A_00005	25									
Thylacine	Thylacine_TH3_A_00007	20		1				1			
Thylacine	Thylacine_TH3_A_00009	20		1							
Thylacine	Thylacine_TH3_A_00010	5									
Thylacine	Thylacine_TH3_A_00011	5		2							
Thylacine	Thylacine_TH3_A_00014	10		1							
Thylacine	Thylacine_TH3_B_00015	10									
Thylacine	Thylacine_TH3_B_00018	10									
Thylacine	Thylacine_TH3_B_00020	10						1			
Thylacine	Thylacine_TH3_B_00022	10									
Thylacine	Thylacine_TH3_C_00023	15						2			
Thylacine	Thylacine_TH3_C_00024	5					1				
Thylacine	Thylacine_TH3_C_00025	5									
Thylacine	Thylacine_TH3_C_00026	10					1				
Thylacine	Thylacine_TH3_C_00027	5									
Thylacine	Thylacine_TH3_C_00030	5									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Thylacine	Thylacine_TH3_C_00031	5									
Thylacine	Thylacine_TH3_C_00033	10									
Thylacine	Thylacine_TH4_A_00005	15						3			
Thylacine	Thylacine_TH4_A_00007	15						2			
Thylacine	Thylacine_TH4_A_00008	10						1			
Thylacine	Thylacine_TH4_A_00009	10						1			
Thylacine	Thylacine_TH4_A_00010	15									
Thylacine	Thylacine_TH4_A_00011	15						4			
Thylacine	Thylacine_TH4_B_00016	30						5			
Thylacine	Thylacine_TH4_B_00018	25									
Thylacine	Thylacine_TH4_B_00019	30						3			
Thylacine	Thylacine_TH4_B_00020	20						2			
Thylacine	Thylacine_TH4_B_00022	10									
Thylacine	Thylacine_TH4_C_00023	10									
Thylacine	Thylacine_TH4_C_00024	25						1			
Thylacine	Thylacine_TH4_C_00025	15									
Thylacine	Thylacine_TH4_C_00028	20						2			
Thylacine	Thylacine_TH4_C_00029	5									
Thylacine	Thylacine_TH4_C_00030	5									
Thylacine	Thylacine_TH4_C_00033	10									
Thylacine	Thylacine_TH5_00014	5									
Thylacine	Thylacine_TH6_00003	5									
Thylacine	Thylacine_TH6_00005	5									
Thylacine	Thylacine_TH6_00006	5									
Thylacine	Thylacine_TH6_00011	5									
Thylacine	Thylacine_TH6_00016	15									
Thylacine	Thylacine_TH7_00009	0									
Thylacine	Thylacine_TH7_00012(2)	5		1							
Thylacine	Thylacine_TH7_00013(2)	5									
Thylacine	Thylacine_TH7_00014(2)	5									
Thylacine	Thylacine_TH7_00015	0									
Thylacine	Thylacine_TH7_00017	0									
Thylacine	Thylacine_TH7_00018	0									
Thylacine	Thylacine_TH7_00022	0									
Thylacine	Thylacine_TH8_00009	5									
Thylacine	Thylacine_TH8_00011	5		1							
Thylacine	Thylacine_TH8_00013	5									
Thylacine	Thylacine_TH8_00015	10									
Thylacine	Thylacine_TH8_00019	5									
Thylacine	Thylacine_TH8_00021	5									
Thylacine	Thylacine_TH8_00022	5									
Thylacine	Thylacine_TH8_00025	0									
Thylacine	Thylacine_TH8_00027	5									
Thylacine	Thylacine_TH8_00028	5									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Thylacine	Thylacine_TH8_00030	5									

APPENDIX 6
EXAMPLE SEABED PHOTOGRAPHS


Artisan – AR4


Artisan – AR4


Geographe – GE2


Geographe – GE4


Hercules – HE1


Hercules – HE3


La Bella – LB2


La Bella – LB4 Extra DC


Thylacine – TH2


Thylacine – TH4


Thylacine – TH6

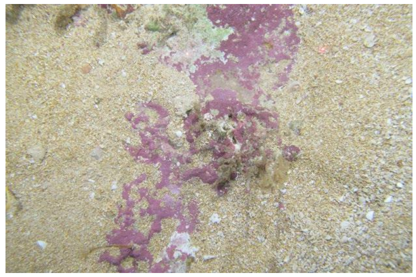

Thylacine – TH8


Hot Tap – HTX – HTX1R


Hot Tap – HTX – HTX1R


Hot Tap – HTY – HTY1R


Hot Tap – HTY – HTY1R


Routes – ARGE – ARGE3R


Routes – ARGE – ARGE6R


Routes – ARGE – ARGE7R


Routes – ARHTX – ARHTX1R


Routes – ARHTX – ARHTX1R


Routes – ARHTY – ARHTY1R


Routes – ARHTY – ARHTY1R


Routes – ARLB – ARLB2R


Routes – ARLB – ARLB6R


Routes – LBGE – LBGE3R


Routes – LBGE – LBGE6R

Appendix 7

Sound Transmission Loss Modelling
Report

Unit 1, 14 Hook Street
Capalaba, Queensland, 4157

Tel: +61 7 3823 2620
www.jasco.com

TECHNICAL ADDENDUM

DATE: 27 August 2021

FROM: Matthew Koessler, Craig McPherson (JASCO Applied Sciences (Australia) Pty Ltd)

TO: Phil Wemyss (Beach Energy)

SUBJECT: Beach Otway Project: Additional and Revised Modelling Study

1. Summary

JASCO Applied Sciences (JASCO) performed modelling study of underwater sound levels associated with the Beach Energy Otway Development, to supplement drilling and construction results previously presented in Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021).

The results have been revised due to better understanding of the propagation loss in the region gained through the validation monitoring of drilling operations at Artisan-1 McPherson et al. (2021). A significant finding of this study was lack of a thin layer of sand overlying the carbonate seabed structure near Artisan-1, which has a significant influence on propagation loss.

This monitoring project also characterised Monopole Source Levels (MSL) for project vessels (during transit and under dynamic positioning (DP)) and the *Ocean Onyx* Mobile Offshore Drilling Unit (MODU). These source levels are considered in the revised modelling.

Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), and as accumulated sound exposure levels (SEL, L_E) as appropriate for non-impulsive (continuous) noise sources. For the non-time dependent scenarios, the modelled maximum and 95th percentile distances to the marine mammal behavioural threshold based on the current interim NOAA (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources are summarised in Table 1.

For the time-dependent scenarios, the modelled maximum distances to permanent threshold shift (PTS) and temporary threshold shift (TTS) criteria for low-frequency cetaceans (NMFS 2018), which are based on SEL accumulated over a period of time are summarised in Table 2.

Table 1. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. MCR: Maximum Continuous Rating, MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, ROV: Remotely Operated Vehicle.

Applicable Scenario number	Well Area	Description	R_{max} (km)	$R_{95\%}$ (km)
A1	Thylacine North-1	MODU Drilling	1.24	1.12
A2		OSV under DP	7.1	6.5
A3		OSV Standby Transit	0.38	0.35
A4	Thylacine A	Platform Operations	0.20	0.19
A5	Thylacine North-1	MODU Drilling + OSV resupply	7.89	6.56
A7		MODU Drilling + OSV Standby Transit	1.32	1.19
1, 2, 3, 4	Thylacine A	Platform Operations + OSV resupply	7.28	6.56
5, 6		Platform Operations + OSV Standby	0.45	0.43
7, 9	Thylacine North-1	Pipelay Vessel stationary (June), operating at 20% MCR	2.71	2.57
8, 10		Pipelay Vessel stationary (November), operating at 20% MCR	2.70	2.55
11, 13	Artisan-1	Pipelay Vessel stationary (June), operating at 20% MCR	2.27	2.09
12, 14		Pipelay Vessel stationary (November), operating at 20% MCR	2.26	2.02
15	Thylacine North-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	2.98	2.76
16		Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	2.97	2.73
17	Artisan-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	2.98	2.75
18		Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	2.97	2.72

Applicable Scenario number	Well Area	Description	R_{max} (km)	$R_{95\%}$ (km)
19, 20	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + OSV resupply	7.90	6.65
21		MODU Drilling + Platform + Skid installation vessel operating at 20% MCR	4.85	4.29
23	Thylacine North-1	Pipelay Vessel stationary (June), operating at 40% MCR	4.13	3.64
24		Pipelay Vessel stationary (November), operating at 40% MCR	4.11	3.63
27	Artisan-1	Pipelay Vessel stationary (June), operating at 40% MCR	2.87	2.46
28		Pipelay Vessel stationary (November), operating at 40% MCR	2.86	2.46
31	Thylacine North-1 + Geographe-4	Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (June)	3.77	3.29
32		Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (November)	3.76	3.23
33	Artisan-1 + Geographe-4	Vessel stationary, operating at 40% MCR (Artsian-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (June)	3.76	3.24
34		Vessel stationary, operating at 40% MCR (Artsian-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (November)	3.63	3.20
35	Thylacine North-1	MODU Drilling + Platform + Skid installation vessel operating at 40% MCR	6.08	4.99

Table 2. Summary: Maximum (R_{max}) horizontal distances (in km) and ensonified area (km^2) for the frequency-weighted LF-cetacean SEL_{24h} TTS thresholds based on NMFS (2018) from the most appropriate location for considered sources per scenario. MCR: Maximum Continuous Rating, MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, ROV: Remotely Operated Vehicle.

Scenario number	Well Area	Description	R_{max} (km)	Area (km^2)
A1	Thylacine North-1	MODU Drilling	0.39	0.33
A2		OSV under DP	0.95	2.33
A3		OSV Standby Transit	–	–
A4	Thylacine A	Platform Operations	0.04	0.004
A5	Thylacine North-1	MODU Drilling + 4h OSV resupply	1.06	2.49
A6		MODU Drilling + 8h OSV resupply	1.31	4.39
A7		MODU Drilling + OSV Standby Transit	0.39	0.33
1	Thylacine A	Platform + 2h OSV resupply	0.75	1.31
2		Platform + 4h OSV resupply	0.95	2.30
3		Platform + 6h OSV resupply	1.11	3.15
4		Platform + 8h OSV resupply	1.25	4.01
5		Platform 8h + OSV Standby	0.04	0.004
6		Platform + 24h OSV Standby	0.04	0.004
7	Thylacine North-1	Pipelay Vessel stationary (June), operating at 20% MCR	0.60	1.04
8		Pipelay Vessel stationary (November), operating at 20% MCR	0.59	1.04
9		Pipelay Vessel laying pipe (June), operating at 20% MCR	1.18	13.62
10		Pipelay Vessel laying pipe (November), operating at 20% MCR	1.17	13.53
11	Artisan-1	Pipelay Vessel stationary (June), operating at 20% MCR	0.67	1.14
12		Pipelay Vessel stationary (November), operating at 20% MCR	0.67	1.12
13		Pipelay Vessel laying pipe (June), operating at 20% MCR	0.90	10.76
14		Pipelay Vessel laying pipe (November), operating at 20% MCR	0.90	10.69
15	Thylacine North-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	0.66	1.35
16		Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	0.66	1.34
17	Artisan-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	0.67	1.35
18		Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	0.67	1.33
19	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + 4h OSV resupply	0.95	2.31
20		MODU Drilling + Platform + 8h OSV resupply	1.23	4.03
21		MODU Drilling + Platform + Skid installation vessel operating at 20% MCR	0.65	1.10

Scenario number	Well Area	Description	R_{max} (km)	Area (km^2)
23	Thylacine North-1	Pipelay Vessel stationary (June), operating at 40% MCR	0.95	2.28
24		Pipelay Vessel stationary (November), operating at 40% MCR	0.94	2.23
25		Pipelay Vessel laying pipe (June), operating at 40% MCR	1.95	24.2
26		Pipelay Vessel laying pipe (November), operating at 40% MCR	1.95	24.1
27	Artisan-1	Pipelay Vessel stationary (June), operating at 40% MCR	0.88	2.02
28		Pipelay Vessel stationary (November), operating at 40% MCR	0.88	1.99
29		Pipelay Vessel laying pipe (June), operating at 40% MCR	1.40	17.1
30		Pipelay Vessel laying pipe (November), operating at 40% MCR	1.39	17.0
31	Thylacine North-1 + Geographe-4	Pipelay Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	0.95	2.39
32		Pipelay Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	0.94	2.38
33	Artisan-1 + Geographe-4	Pipelay Vessel stationary, operating at 40% MCR (Artsian-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	0.91	2.39
34		Vessel stationary, operating at 40% MCR (Pipelay Vessel -1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	0.91	2.38
35	Thylacine North-1	MODU Drilling + Platform + Skid installation vessel operating at 40% MCR	0.85	2.10

2. Introduction

JASCO Applied Sciences (JASCO) performed modelling study of underwater sound levels associated with the Beach Energy Otway Development, to supplement drilling and construction results previously presented in Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021).

The results have been revised due to better understanding of the propagation loss in the region gained through the validation monitoring of drilling operations at Artisan-1 McPherson et al. (2021) as described in Section 2.1. An overview of the modelling scenarios considered is provided in Section 2.2, with results presented in Section 4, and briefly discussed in Section 5.

For noise effect criteria and explanations on methodologies applied, refer to Koessler et al. (2020), Matthews et al. (2020), Matthews et al. (2021) and McPherson et al. (2021).

2.1. Validation Monitoring Study Summary

The monitoring study (McPherson et al. 2021) was completed in relation to the exploration drilling activities at the Artisan-1 well with the aim of completing an acoustic characterisation of the drilling and associated vessel activity within the Otway Basin. Through this characterisation, validation of the modelling predictions used in Beach Energy Otway Environment Plans (EPs) for the development drilling activities was required.

The exploration well Artisan-1, drilled by the *Ocean Onyx*, was selected for the monitoring program because the predicted distances to thresholds for effects on marine mammals, including pygmy blue whales, were farthest at this location in the modelling study used for the EP (Koessler et al. 2020), as well as because it was the first well in the Otway drilling campaign.

Four JASCO Autonomous Multichannel Acoustic Recorders (AMARs) in C-lander moorings were deployed in February and retrieved in early April. Stations 1 through 4 were deployed at distances of 0.336, 1.13, 5.11, and 25 km from the *Ocean Onyx*. The AMARs recorded continuously at 24-bit resolution and 64 kHz sample rate for the entire deployment. The three stations closest to the *Ocean Onyx* were configured with a single hydrophone, whilst the station 25 km away was configured with three hydrophones to provide directional processing of received sounds.

To assist in the characterisation of *Ocean Onyx* and attendant support vessels, the vessels conducted specific activities under dynamic positioning and followed a nominated transit track between the *Ocean Onyx* and Geelong Supply Base. No specific operational requests were made of the *Ocean Onyx* and vessels during normal drilling activities due to the complexity of operationally meeting any requests. Over the course of the monitoring program, the MODU and support vessels engaged in different operational states with different uncontrollable contributors, such as variable drilling operations, resupply and support operations, weather conditions, and merchant shipping.

A summary of the findings of the monitoring study are described in the following sections.

Source Levels

The Monopole Source Levels determined through the measurement study differed from those either estimated for use in the modelling study or those determined using proxy sources. The key differences are as follows:

- The support vessels are quieter than estimated when they are under slow transit speeds, such as 7 knots.
- The support vessels are louder than estimated when they are travelling at faster transit speeds, with 9 knots used to represent these speeds and the associated MSL.
- The support vessels are louder than estimated when holding station or moving under dynamic positioning.
- The drilling operations of the *Ocean Onyx* are both louder at some frequencies and quieter at others than those for the proxy rig the *Polar Pioneer* (Austin et al. 2018), although the results presented for the *Polar Pioneer* did not examine the changes in level with increased drilling depth (over time) as completed within this study.

Comparison of Results

The results from the measurement study could not be directly compared to the modelling presented in Koessler et al. (2020) due to the differences in actual events compared to the nominal representative scenarios developed and evaluated as part of the EP assessment process. Additionally, the measurements were obtained at a receiver located 1.2 m off the seafloor, which is not the maximum-over-depth results reported in the modelling study. The ranges obtained from the measurement study were reported in relation to the Artisan-1 well location, and thus the centre of the *Ocean Onyx*. The ranges in project related modelling studies are reported from a range of locations, including the centroids of multiple sources, thus it was not possible to report the measurement results in a similar fashion using the small number of recording locations used in this study.

Geological Environment Representation

Previous modelling studies for Beach Energy, Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021), used MONM with the assumption of a 1 m thick layer of sand overlaying the carbonate seabed structure at the Artisan-1 well location. This assumption was made due to the lack of available information, and is similar to other inshore work in the Otway Basin, such as (Duncan et al. 2012), who represented the shelf as two zones, an in-shore zone out to a water depth of about 70 m in which the sand layer has a thickness of between 4–10 m, and an off-shore zone of effectively bare calcarenite probably due to scouring by current and swell. The transition between these two zones is ill-defined due to a lack of datapoints, and lies close to the Artisan-1 location, and a balanced approach of assuming 1 m thick layer of sand overlaying the carbonate seabed structure was judged to be appropriate given available information.

The measurement study has increased the understanding of the geological environment in the region and indicates that the sand overlay is thinner (or non-existent) at shallower water depths. The different environment required the use of an alternate configuration of numerical models to represent the propagation loss.

Propagation Loss

The accuracy of the broadband calculated propagation loss for the Otway Basin continental shelf environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on carbonate seabed (calcarenite) likely to occur within the region. In general, the thinner the sand layer, the greater the overall propagation loss.

When comparing SPL data fits for Stations 1–3 in McPherson et al. (2021), the loss rate is higher than what would have been expected in this environment, considering the higher monopole source levels for the support vessel on DP derived from trial measurements. The differences are likely attributable to the potential absence of a sand veneer.

Comparisons were conducted using JASCO's Marine Operations Noise Model (MONM), a wide-angle parabolic equation model which applies the BELLHOP Gaussian beam acoustic ray-trace model at higher frequencies, and JASCO's wavenumber integration model (VSTACK) which can fully account for the elasto-acoustic properties of the sub-bottom. The agreement between the models was excellent when only a comparatively thin (1 m thick) layer of sand overlies the carbonate seabed structure. In an environment such as this, MONM could have been used without correction. However, the comparisons indicate a much higher rates of loss, as would be expected if no (or only a very thin) sand layer were present.

A better understanding of the propagation loss environment, and the revision of the representation and treatment of it through the measurement study, enabled the modelling scenarios for the activities at Artisan-1 presented in Koessler et al. (2020) to be recalculated (Section 6.3 in McPherson et al. (2021)).

2.2. Scenario Details

The scenarios considered within this assessment are detailed below and in Table 3, with the associated modelling sites provided in Table 4. An overview of the scenarios is as follows:

1. Otway Offshore Project Development Drilling Campaign, Thylacine North-1 Operations:
    a. Mobile Offshore Drilling Unit (MODU) conducting normal drilling operations
    b. MODU with Offshore Supply Vessel (OSV) in attendance, standing by and conducting resupply operations under Dynamic Positioning (DP)
2. Otway Offshore Project Operations scenarios:
    1. Operations of the Thylacine platform (at Thylacine-A)
    2. OSV vessel resupply at Thylacine platform for periods of 2, 4, 6 and 8 hrs.
    3. OSV vessel on standby at Thylacine platform for periods of 8 and 24 hrs
4. Otway Offshore Project Construction scenarios: A single nominated pipelay/construction vessel, the Skandi Singapore, was considered for these scenarios. Each scenario was considered with a sound speed profiles for the 'worst case over the year' and for the period pygmy blue whales are present in the region, between November and January:
    a. Pipelay vessel (PLV) both stationary and laying pipe at Thylacine North-1 and Artisan-1 operating at 20% of its Maximum Continuous Rating (MCR).
    b. Pipelay vessel operating a Remotely Operated Vehicle (ROV) and cutting tool at Geographe-4. The vessel at Geographe-4 was also modelled operating at 20% and 40% of its Maximum Continuous Rating (MCR).
    c. Quantitively assess the combined sound levels of drilling activities and the construction vessel(s) at the emerging SRW aggregation area at Port Campbell. This scenario considered the drilling activities at

Thylacine North-1 presented in Koessler et al. (2020) and the nominated construction vessel (Skandi Singapore) operating at Geographe-4.

5. Simultaneous assessment for drilling, operations and construction operations were considered for key scenarios:
    a. Drilling at Thylacine while doing Thylacine platform resupply
    b. Drilling at Thylacine while doing installation of Thylacine skid near Thylacine platform. The construction vessel installing the skid was modelled operating at 20% and 40% of its Maximum Continuous Rating (MCR).

Table 3. Description of modelled scenarios. MCR: Maximum Continuous Rating, MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, ROV: Remotely Operated Vehicle.

Scenario number	Well Name	Description	SSP Month	Modelled sites
A1	Thylacine North-1	MODU Drilling	June	1
A2		OSV under DP	June	2
A3		OSV Standby Transit	June	3
A4	Thylacine A	Platform Operations	June	4
A5	Thylacine North-1	MODU Drilling + 4h OSV resupply	June	1,2,3
A6		MODU Drilling + 8h OSV resupply	June	1,2,3
A7		MODU Drilling + OSV Standby Transit	June	1,3
1	Thylacine A	Platform + 2h OSV resupply	June	4,5
2		Platform + 4h OSV resupply	June	4,5
3		Platform + 6h OSV resupply	June	4,5
4		Platform + 8h OSV resupply	June	4,5
5		Platform 8h + OSV Standby	June	3,5
6		Platform + 24h OSV Standby	June	3,5
7	Thylacine North-1	Pipelay Vessel stationary, operating at 20% MCR	June	6
8		Pipelay Vessel stationary, operating at 20% MCR	November	6
9		Pipelay Vessel laying pipe, operating at 20% MCR	June	6
10		Pipelay Vessel laying pipe, operating at 20% MCR	November	6
11	Artisan-1	Pipelay Vessel stationary, operating at 20% MCR	June	7
12		Pipelay Vessel stationary, operating at 20% MCR	November	7
13		Pipelay Vessel laying pipe, operating at 20% MCR	June	7
14		Pipelay Vessel laying pipe, operating at 20% MCR	November	7
15	Thylacine North-1 + Geographe-4	Pipelay Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	June	6,8,9
16		Pipelay Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	November	6,8,9

Scenario number	Well Name	Description	SSP Month	Modelled sites
17	Artisan-1 + Geographe-4	Pipelay Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	June	7,8,9
18	Artisan-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Pipelay Vessel -1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	November	7,8,9
19	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + 4h OSV resupply	June	1,4,5
20		MODU Drilling + Platform + 8h OSV resupply	June	1,4,5
21		MODU Drilling + Platform + Skid installation vessel at 20% MCR	June	1,4,6
22	Thylacine North-1 + Geographe-4	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	June	1,2,3,8,9
23	Thylacine North-1	Pipelay Vessel stationary, operating at 40% MCR	June	6
24		Pipelay Vessel stationary, operating at 40% MCR	November	6
25		Pipelay Vessel laying pipe, operating at 40% MCR	June	6
26		Pipelay Vessel laying pipe, operating at 40% MCR	November	6
27	Artisan-1	Pipelay Vessel stationary, operating at 40% MCR	June	7
28		Pipelay Vessel stationary, operating at 40% MCR	November	7
29		Pipelay Vessel laying pipe, operating at 40% MCR	June	7
30		Pipelay Vessel laying pipe, operating at 40% MCR	November	7
31	Thylacine North-1 + Geographe-4	Pipelay Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	June	6,8,9
32		Pipelay Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	November	6,8,9
33	Artisan-1 + Geographe-4	Pipelay Vessel stationary, operating at 40% MCR (Artsian-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	June	7,8,9
34		Vessel stationary, operating at 40% MCR (Pipelay Vessel -1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	November	7,8,9

35	Thylacine North-1	MODU Drilling + Platform + Skid installation at 40% MCR	June	1,4,6
36	Thylacine North-1 + Geographe-4	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	June	1,2,3,8,9

Table 4. Location details for the modelled sites. MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle, WHP: Well Head Platform

Well	**Site**	**Source**	**Latitude (S)**	**Longitude (E)**	**MGA Zone 54 (GDA94)**		**Water depth (m)**
					X (m)	*Y* (m)	
Thylacine North-1	1	MODU	39° 12.51001'	142° 52.49601'	661882	5658411	99.1
	2	OSV	39° 12.48903'	142° 53.88508'	663882	5658408	99.1
	3	OSV standby	39° 12.50986'	142° 52.54039'	661946	5658410	99.2
Thylacine A	4	WHP	39° 14.40200'	142° 54.60100'	664838	5654848	102.4
	5	OSV	39° 14.40059'	142° 54.64574'	664902	5654849	102.3
Thylacine North-1	6	PLV	39° 12.51001'	142° 52.49601'	661882	5658411	99.1
Artisan-1	7	PLV	38° 53.45684'	142° 52.97408'	663300	5693640	71.5
Geographe-4	8	PLV	39° 6.49400'	142° 57.06700'	668700	5669400	85.0
	9	*ROV Cutting Tool*	39° 6.49400'	142° 57.06700'	668700	5669400	85.0
Thylacine North-1	10	OSV	39° 14.40200'	142° 54.60100'	664838	5654848	102.4

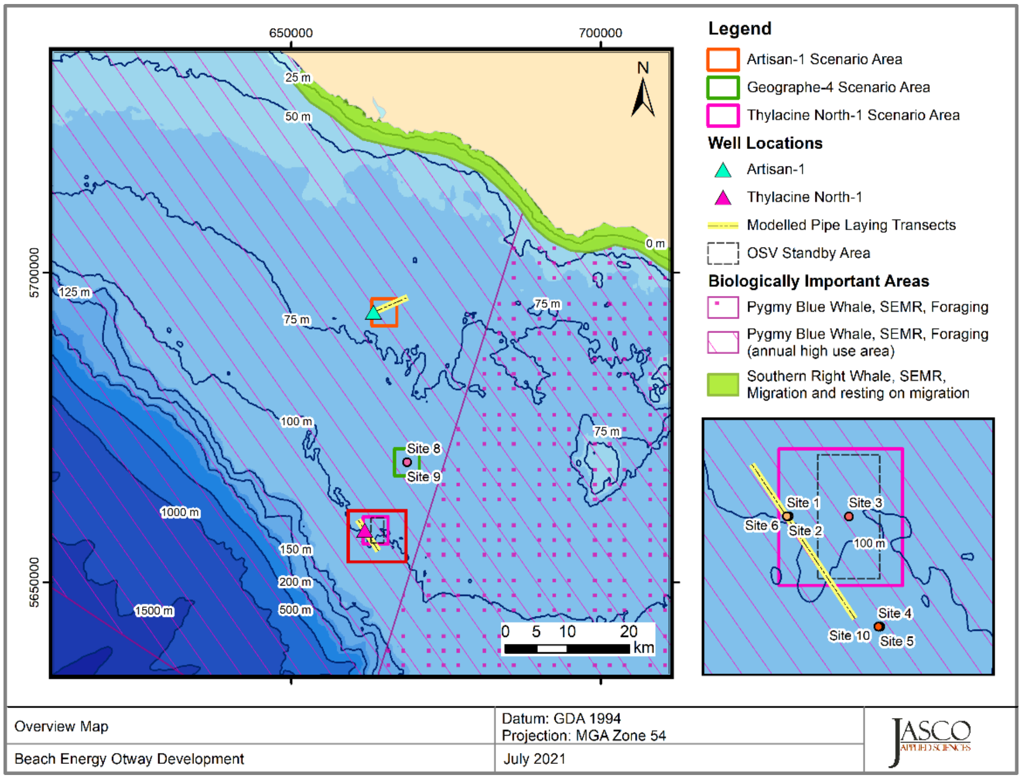


Figure 1. Overview of the modelled area (focus on Thylacine North-1 Scenario Area) and local features within the South East Marine Region (SEMR).

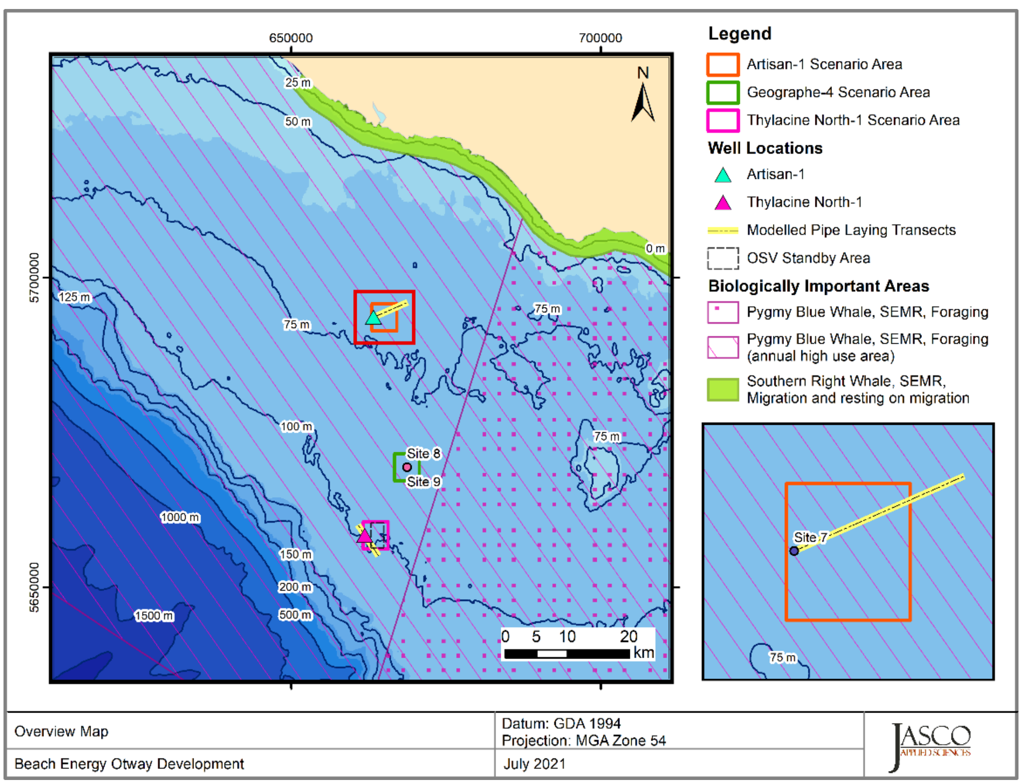


Figure 2. Overview of the modelled area (focus on Artisan-1 Scenario Area) and local features within the South East Marine Region (SEMR).

3. Methods and Parameters

A details description of the employed modelling method and input parameters can be found in refer to Koessler et al. (2020), Matthews et al. (2020), Matthews et al. (2021), Connell et al. (2021) and McPherson et al. (2021). A brief a summary of key elements used in this addendum are provided as follows.

The measured monopole source levels (MSLs) and spectra for the MODU and OSV were used here from McPherson et al. (2021):

- For the MODU drilling, mean levels from Section 5.5.1 in McPherson et al. (2021) were used.
- For scenarios where the OSV was under dynamic positioning (DP) the average spectrum from Section 5.5.2 in McPherson et al. (2021) was used.
- For scenarios where the OSV was transiting or standing by the average slow transit (7 knots) spectrum in McPherson et al. (2021) was used.

For the construction phase scenarios, estimates of the energy source levels (ESLs) for the pipelay/construction vessel were based on the specifications of the *Skandi Singapore* and an ESL derived from recordings of the TechnipFMC flexible lay and construction vessel *Deep Orient*. The specifications of proxy vessel and details on scaling can be found in Matthews et al. (2020), Matthews et al. (2021) and Connell et al. (2021).

Fixed structures such as the WHP 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).

A study involving the Endeavour Jack-up Rig, operating in Cook Inlet, was conducted by Illingworth and Rodkin (2014) during drilling activities. The results from the sound source verification indicated that sound generated from drilling or generators were below ambient sound levels. The generators used on the Endeavour are mounted on pedestals specifically to reduce sound transfer through the infrastructure, and they are enclosed in an insulated engine room, which may have reduced further underwater sound transmission to levels below those generated by the Spartan 151. The sound source verification revealed that the submersed deep-well pumps that charge the fire-suppression system and cool the generators (in a closed water system) were the most likely dominant contributor the sound field. The measurements are reported as near-source levels recorded close to the bow leg pump system (at 10 m range) (Figure 3-5 in Illingworth and Rodkin Inc. (2014). These were backpropagated using spherical spreading to determine an energy source level (ESL) spectrum. Considering the similarities between a Jack-up Rig and a static WHP the decidecade band spectrum is shown in Figure 3 was used in modelling noise emissions from the Thylacine-A platform.

Furthermore, as discussed by (McPherson et al. 2021) and discussed above in Section 2.1, significant rates of propagation loss were found when analysing the data from the measurement study. As part of the model-measurement validation an adjustment factor was applied broadband received level predictions to account for the loss associated with a cemented limestone seabed (calcarenite) (Section 6.2 in McPherson et al. (2021)). A similar adjustment, which only differed by accounting for sources in different water depths, was applied to broadband level predictions in this addendum as a very similar type of seabed environment is expected at the Thylacine scenario area

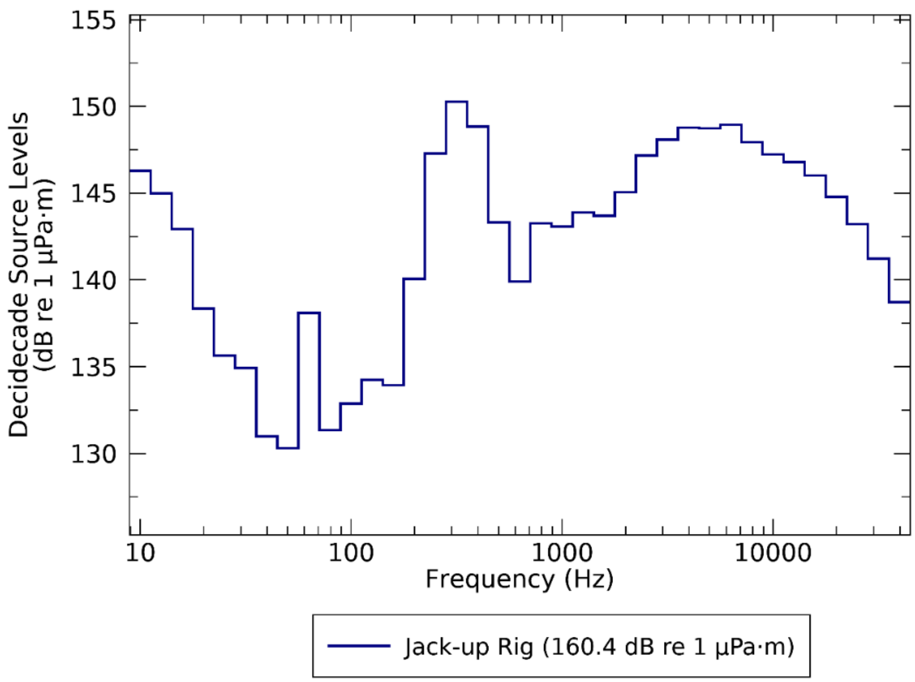


Figure 3. Energy source level (ESL) spectra (in decidecade frequency-band) for the Jack-up Rig considered as a proxy source for the Thylacine WHP.

4. Results

For the considered scenarios (described in Section 2.2), 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 distance to various sound levels. 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.

Tables 5–7 present the maximum and 95% distances (defined in Appendix B.1) to SPL isopleths. Since the SPL metric does not depend on the duration of the operation, these estimates are valid for both, stationary and non-stationary scenarios. Tables 11–16 present the distances to frequency-weighted SEL_{24h} threshold, as well as the total ensonified area for all scenarios.

The maximum-over-depth sound fields for nine scenarios (described in Section were extracted at the emerging SRW aggregation area at Port Campbell, and can be compared to the 120 dB re 1 µPa threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

4.1. Tabulated Results

Table 5. *Scenarios A1–A7:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenarioA dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, DP: Dynamic Positioning.

SPL (L_p; dB re 1 µPa)	**MODU Drilling (Scenario A1)**		**OSV under DP (Scenario A2)**		**OSV Standby Transit (Scenario A3)**		**Platform (Scenario A4)**		**MODU Drilling and OSV Resupply (Scenario A5)**		**MODU Drilling and OSV Standby (Scenario A7)**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	0.05	0.05	–	–
170[A]	–	–	–	–	–	–	–	–	0.05	0.05	–	–
160	–	–	0.08	0.08	–	–	–	–	0.11	0.10	–	–
158[B]	–	–	0.13	0.12	–	–	–	–	0.15	0.15	–	–
150	–	–	0.32	0.31	–	–	–	–	0.36	0.31	–	–
140	0.09	0.09	0.87	0.81	–	–	–	–	0.88	0.82	0.09	0.09
130	0.38	0.35	2.3	2.15	0.17	0.16	–	–	2.51	2.18	0.38	0.35
120[C]	1.24	1.12	7.10	6.50	0.38	0.35	0.20	0.19	7.89	6.56	1.32	1.19

[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 continuous noise (NOAA 2019).

Table 6. *Scenarios 1–11:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). OSV: Offshore Supply Vessel, PLV: Pipelay Vessel.

SPL (L_p; dB re 1 µPa)	Platform and OSV resupply (Scenario 1)		Platform and OSV standby (Scenario 5)		PLV stationary operating at 20% MCR, Thylacine				PLV stationary operating at 20% MCR, Artisan			
					June (Scenario 7)		November (Scenario 8)		June (Scenario 11)		November (Scenario 12)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–	–	–	–	–
160	0.08	0.08	–	–	–	–	–	–	–	–	–	–
158[B]	0.14	0.09	–	–	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
150	0.28	0.27	–	–	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
140	0.85	0.80	–	–	0.33	0.32	0.33	0.32	0.29	0.29	0.29	0.29
130	2.48	2.18	0.17	0.16	0.95	0.85	0.94	0.84	0.87	0.80	0.87	0.80
120[C]	7.31	6.56	0.45	0.43	2.71	2.57	2.70	2.55	2.27	2.09	2.26	2.02

[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 continuous noise (NOAA 2019).

Table 7. *Scenarios 15–21:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

SPL (L_p; dB re 1 µPa)	**PLV stationary operating at 20% MCR, at Thylacine and ROV Operations at Geographe-4**				**PLV stationary operating at 20% MCR, at Artisan and ROV Operations at Geographe-4**				**MODU Drilling, Platform and OSV resupply**		**MODU Drilling, Platform and Skid installation vessel at 20% MCR**	
	June (Scenario 15)		**November (Scenario 16)**		**June (Scenario 17)**		**November (Scenario 18)**		**(Scenario 19)**		**(Scenario 21)**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–	–	–	–	–
160	–	–	–	–	–	–	–	–	0.08	0.08	–	–
158[B]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.14	0.09	0.04	0.04
150	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.28	0.27	0.09	0.09
140	0.32	0.31	0.32	0.31	0.32	0.31	0.32	0.31	0.85	0.80	0.31	0.30
130	0.91	0.86	0.91	0.84	0.91	0.86	0.91	0.84	2.48	2.18	0.85	0.83
120[C]	2.98	2.76	2.97	2.73	2.98	2.75	2.97	2.72	7.90	6.65	4.85	4.29

[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 continuous noise (NOAA 2019).

Table 8. *Scenarios 23–24, 27–28:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). OSV: Offshore Supply Vessel, PLV: Pipelay Vessel.

SPL (L_p; dB re 1 µPa)	**PLV stationary operating at 40% MCR, Thylacine**				**PLV stationary operating at 40% MCR, Artisan**			
	June (Scenario 23)		**November (Scenario 24)**		**June (Scenario 27)**		**November (Scenario 28)**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–
160	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
158[B]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
150	0.17	0.17	0.17	0.17	0.16	0.15	0.16	0.15
140	0.44	0.43	0.44	0.43	0.39	0.38	0.39	0.38
130	1.26	1.18	1.27	1.17	1.12	1.10	1.12	1.09
120[C]	4.13	3.64	4.11	3.63	2.87	2.46	2.86	2.46

[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 continuous noise (NOAA 2019).

Table 9. *Scenarios 31–35:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

SPL (L_p; dB re 1 µPa)	PLV stationary operating at 40% MCR, at Thylacine and ROV Operations at Geographe-4				PLV stationary operating at 40% MCR, at Artisan and ROV Operations at Geographe-4				MODU Drilling, Platform and Skid Installation Vessel operating at 40% MCR	
	June (Scenario 31)		November (Scenario 32)		June (Scenario 33)		November (Scenario 34)		(Scenario 35)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–	–	–
160	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
158[B]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
150	0.16	0.15	0.16	0.16	0.16	0.15	0.16	0.16	0.15	0.14
140	0.46	0.41	0.46	0.4	0.46	0.41	0.46	0.40	0.42	0.38
130	1.56	1.26	1.56	1.25	1.56	1.26	1.56	1.25	1.39	1.14
120[C]	3.77	3.29	3.76	3.23	3.76	3.24	3.63	3.20	6.08	4.99

[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 continuous noise (NOAA 2019).

Table 10. Received SPL at the Port Campbell SRW receiver for relevant scenarios.

Scenario	Description	Location(s)	SPL (Lp; dB re 1 µPa) at Port Campbell SRW Receiver
22	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	Thylacine North-1 + Geographe-4	93.8
36	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	Thylacine North-1 + Geographe-4	94.1

Table 11. *Scenarios A1-A7:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km²). A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel.

Hearing group	**SEL_{24h} threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**MODU Drilling (Scenario A1)**		**OSV under DP (Scenario A2)**		**OSV Standby Transit (Scenario A3)**		**Platform (Scenario A4)**		**MODU Drilling and 4h OSV resupply (Scenario A5)**		**MODU Drilling and 8h OSV resupply (Scenario A6)**		**MODU Drilling and OSV Standby Transit (Scenario A7)**	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
PTS															
LF cetaceans	199	0.03	0.004	0.09	0.03	–	–	0.02	0.001	0.12	0.03	0.18	0.08	0.06	0.004
MF cetaceans	198	0.02	0.001	0.02	0.001	–	–	0.02	0.001	0.05	0.002	0.05	0.002	0.04	0.001
HF cetaceans	173	0.23	0.16	0.06	0.01	–	–	0.03	0.004	0.26	0.16	0.26	0.17	0.26	0.16
Phocid seals	201	0.02	0.001	0.03	0.003	–	–	0.02	0.001	0.05	0.004	0.07	0.01	0.04	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	0.03	0.001	0.05	0.001	–	–
Turtles	220	–	–	0.02	0.001	–	–	–	–	0.05	0.002	0.05	0.002	–	–
TTS															
LF cetaceans	179	0.39	0.33	0.95	2.33	–	–	0.04	0.004	1.06	2.49	1.31	4.39	0.39	0.33
MF cetaceans	178	0.13	0.06	0.06	0.01	–	–	0.03	0.003	0.16	0.06	0.16	0.07	0.13	0.06
HF cetaceans	153	1.12	3.22	0.47	0.69	–	–	0.30	0.28	1.16	3.71	1.16	3.99	1.12	3.22
Phocid seals	181	0.12	0.04	0.28	0.24	–	–	0.03	0.00	0.32	0.27	0.46	0.55	0.12	0.04
Otariid seals	199	0.02	0.001	0.04	0.01	–	–	0.02	0.001	0.07	0.01	0.09	0.01	0.02	0.001
Turtles	200	0.02	0.002	0.07	0.02	–	–	0.02	0.001	0.10	0.02	0.16	0.06	0.02	0.002

Table 12. *Scenarios 1–6:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), OSV: Offshore Supply Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	Platform and OSV resupply 2 h (Scenario 1)		Platform and OSV resupply 4 h (Scenario 2)		Platform and OSV resupply 6 h (Scenario 3)		Platform and OSV resupply 8 h (Scenario 4)		Platform and OSV 8h standby (Scenario 5)		Platform and OSV 24h standby (Scenario 6)	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	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													
LF cetaceans	199	0.10	0.02	0.12	0.03	0.14	0.04	0.18	0.07	0.02	0.001	0.02	0.001
MF cetaceans	198	0.05	0.001	0.05	0.001	0.05	0.002	0.05	0.002	0.02	0.001	0.02	0.001
HF cetaceans	173	0.08	0.01	0.09	0.02	0.10	0.02	0.11	0.02	0.03	0.004	0.03	0.004
Phocid seals	201	0.05	0.002	0.06	0.004	0.06	0.01	0.08	0.01	0.02	0.001	0.02	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	0.04	0.001	0.04	0.001	–	–	–	–
TTS													
LF cetaceans	179	0.75	1.31	0.95	2.30	1.11	3.15	1.25	4.01	0.04	0.004	0.04	0.004
MF cetaceans	178	0.06	0.01	0.08	0.01	0.09	0.02	0.10	0.02	0.03	0.003	0.03	0.003
HF cetaceans	153	0.45	0.60	0.52	0.79	0.60	1.05	0.63	1.17	0.30	0.28	0.30	0.28
Phocid seals	181	0.23	0.12	0.30	0.24	0.37	0.36	0.43	0.46	0.03	0.00	0.03	0.00
Otariid seals	199	0.06	0.004	0.07	0.01	0.08	0.01	0.08	0.01	0.02	0.001	0.02	0.001
Turtles	200	0.08	0.01	0.10	0.02	0.11	0.02	0.17	0.04	0.02	0.001	0.02	0.001

Table 13. *Scenarios 7–10:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary operating at 20% MCR, at Thylacine				PLV laying pipe operating at 20% MCR, at Thylacine			
		June (Scenario 7)		November (Scenario 8)		June (Scenario 9)		November (Scenario 10)	
		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									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.02	0.21	0.02	0.21
MF cetaceans	198	0.02	0.001	0.02	0.001	0.01	0.02	0.01	0.02
HF cetaceans	173	0.09	0.03	0.09	0.03	0.03	0.37	0.03	0.36
Phocid seals	201	0.02	0.001	0.02	0.001	0.01	0.14	0.01	0.14
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	0.02	0.001	0.02	0.001	–	–	–	–
TTS									
LF cetaceans	179	0.60	1.04	0.59	1.04	1.18	13.62	1.17	13.53
MF cetaceans	178	0.07	0.02	0.07	0.02	0.02	0.22	0.02	0.22
HF cetaceans	153	0.84	2.02	0.70	1.36	1.19	15.04	1.46	16.02
Phocid seals	181	0.19	0.12	0.19	0.12	0.13	1.54	0.13	1.54
Otariid seals	199	0.02	0.001	0.02	0.001	0.01	0.15	0.01	0.15
Turtles	200	0.08	0.02	0.08	0.02	0.02	0.27	0.02	0.27

Table 14. *Scenarios 11–14:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary operating at 20% MCR, at Artisan				PLV laying pipe operating at 20% MCR, at Artisan			
		June (Scenario 11)		November (Scenario 12)		June (Scenario 13)		November (Scenario 14)	
		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									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.02	0.25	0.02	0.25
MF cetaceans	198	0.01	0.001	0.01	0.001	–	–	–	–
HF cetaceans	173	0.09	0.03	0.09	0.03	0.03	0.37	0.03	0.37
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.13	0.02	0.13
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	0.01	0.001	0.01	0.001	–	–	–	–
TTS									
LF cetaceans	179	0.67	1.14	0.67	1.12	0.90	10.76	0.90	10.69
MF cetaceans	178	0.07	0.02	0.07	0.02	0.03	0.30	0.03	0.30
HF cetaceans	153	0.77	1.60	0.62	1.18	0.95	11.92	0.91	10.68
Phocid seals	181	0.19	0.11	0.19	0.11	0.12	1.36	0.12	1.36
Otariid seals	199	0.02	0.001	0.02	0.001	0.02	0.22	0.02	0.22
Turtles	200	0.07	0.02	0.07	0.02	0.03	0.29	0.03	0.29

Table 15. *Scenarios 15–18:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary operating at 20% MCR, at Thylacine and ROV Operations at Geographe-4				PLV stationary operating at 20% MCR, at Artisan and ROV Operations at Geographe-4			
		June (Scenario 15)		November (Scenario 16)		June (Scenario 17)		November (Scenario 18)	
		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									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.06	0.01	0.06	0.01
MF cetaceans	198	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
HF cetaceans	173	0.12	0.04	0.11	0.04	0.12	0.04	0.11	0.04
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
Otariid seals	219	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001
Turtles	220	0.02	0.001	0.02	0.001	0.01	0.001	0.01	0.001
TTS									
LF cetaceans	179	0.66	1.35	0.66	1.34	0.67	1.35	0.67	1.33
MF cetaceans	178	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03
HF cetaceans	153	0.87	2.37	0.83	1.93	0.87	2.37	0.83	1.93
Phocid seals	181	0.19	0.12	0.19	0.12	0.19	0.11	0.19	0.11
Otariid seals	199	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
Turtles	200	0.08	0.02	0.08	0.02	0.08	0.02	0.08	0.02

Table 16. *Scenarios 19–21:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	MODU Drilling, Platform and 4 h OSV resupply (Scenario 19)		MODU Drilling, Platform and 8 h OSV resupply (Scenario 20)		MODU Drilling, Platform and Skid Installation Vessel operating at 20% MCR (Scenario 21)	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS							
LF cetaceans	199	0.09	0.03	0.15	0.07	0.06	0.01
MF cetaceans	198	0.04	0.001	0.04	0.001	0.04	0.001
HF cetaceans	173	0.26	0.16	0.26	0.16	0.26	0.16
Phocid seals	201	0.04	0.004	0.05	0.008	0.04	0.001
Otariid seals	219	–	–	–	–	–	–
Turtles	220	–	–	0.03	0.001	0.03	0.001
TTS							
LF cetaceans	179	0.95	2.31	1.23	4.03	0.65	1.10
MF cetaceans	178	0.16	0.06	0.16	0.06	0.16	0.06
HF cetaceans	153	1.15	3.25	1.15	3.26	1.15	3.26
Phocid seals	181	0.28	0.24	0.41	0.46	0.18	0.09
Otariid seals	199	0.04	0.005	0.06	0.011	0.04	0.001
Turtles	200	0.08	0.02	0.15	0.04	0.08	0.02

Table 17. *Scenarios 23–26:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary operating at 40% MCR, at Thylacine				PLV laying pipe operating at 40% MCR, at Thylacine			
		June (Scenario 23)		November (Scenario 24)		June (Scenario 25)		November (Scenario 26)	
		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									
LF cetaceans	199	0.09	0.03	0.09	0.03	0.03	0.39	0.03	0.39
MF cetaceans	198	0.02	0.001	0.02	0.001	0.01	0.11	0.01	0.11
HF cetaceans	173	0.16	0.08	0.16	0.08	0.07	0.79	0.07	0.78
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.18	0.01	0.18
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	0.02	0.001	0.02	0.001	–	–	–	–
TTS									
LF cetaceans	179	0.95	2.28	0.94	2.23	1.95	24.2	1.95	24.1
MF cetaceans	178	0.10	0.03	0.10	0.03	0.04	0.48	0.04	0.47
HF cetaceans	153	1.17	3.44	0.94	2.47	1.75	21.8	2.08	27.0
Phocid seals	181	0.27	0.22	0.30	0.22	0.24	2.76	0.24	2.75
Otariid seals	199	0.03	0.003	0.03	0.003	0.02	0.18	0.02	0.18
Turtles	200	0.11	0.038	0.11	0.04	0.05	0.57	0.05	0.57

Table 18. *Scenarios 27–30:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary operating at 40% MCR, at Artisan				PLV laying pipe operating at 40% MCR, at Artisan			
		June (Scenario 27)		November (Scenario 28)		June (Scenario 29)		November (Scenario 30)	
		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									
LF cetaceans	199	0.09	0.03	0.09	0.03	0.04	0.39	0.03	0.39
MF cetaceans	198	0.01	0.001	0.01	0.001	0.01	0.02	0.01	0.01
HF cetaceans	173	0.14	0.06	0.14	0.06	0.07	0.75	0.06	0.74
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.25	0.02	0.25
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	–	–	–	–
TTS									
LF cetaceans	179	0.88	2.02	0.88	1.99	1.40	17.1	1.39	17.0
MF cetaceans	178	0.10	0.03	0.11	0.04	0.04	0.49	0.04	0.48
HF cetaceans	153	0.94	2.75	0.81	1.93	1.27	16.5	1.53	18.3
Phocid seals	181	0.25	0.19	0.24	0.18	0.21	2.44	0.21	2.43
Otariid seals	199	0.03	0.002	0.03	0.002	0.02	0.25	0.02	0.25
Turtles	200	0.14	0.06	0.14	0.06	0.05	0.59	0.05	0.59

Table 19. *Scenarios 31–34:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary operating at 40% MCR, at Thylacine and ROV Operations at Geographe-4				PLV stationary operating at 40% MCR, at Artisan and ROV Operations at Geographe-4				MODU Drilling, Platform and Skid Installation Vessel operating at 40% MCR (Scenario 35)	
		June (Scenario 31)		November (Scenario 32)		June (Scenario 33)		November (Scenario 34)			
		R_{max} (km)	Area (km^2)	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											
LF cetaceans	199	0.10	0.03	0.09	0.03	0.10	0.03	0.09	0.03	0.09	0.03
MF cetaceans	198	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001	0.04	0.001
HF cetaceans	173	0.16	0.08	0.16	0.08	0.15	0.08	0.15	0.08	0.26	0.16
Phocid seals	201	0.02	0.002	0.02	0.002	0.02	0.002	0.02	0.002	0.04	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	–	–
Turtles	220	0.02	0.001	0.02	0.001	–	–	–	–	0.03	0.001
TTS											
LF cetaceans	179	0.95	2.39	0.94	2.38	0.91	2.39	0.91	2.38	0.85	2.10
MF cetaceans	178	0.13	0.05	0.13	0.05	0.13	0.05	0.13	0.05	0.16	0.06
HF cetaceans	153	1.17	3.55	0.99	3.08	1.06	3.55	0.99	3.08	1.15	3.28
Phocid seals	181	0.27	0.22	0.27	0.22	0.25	0.19	0.25	0.19	0.22	0.15
Otariid seals	199	0.03	0.003	0.03	0.003	0.03	0.003	0.03	0.003	0.04	0.003
Turtles	200	0.15	0.05	0.15	0.05	0.15	0.06	0.15	0.06	0.10	0.04

4.2. Sound Field Maps

4.2.1. SPL Maps

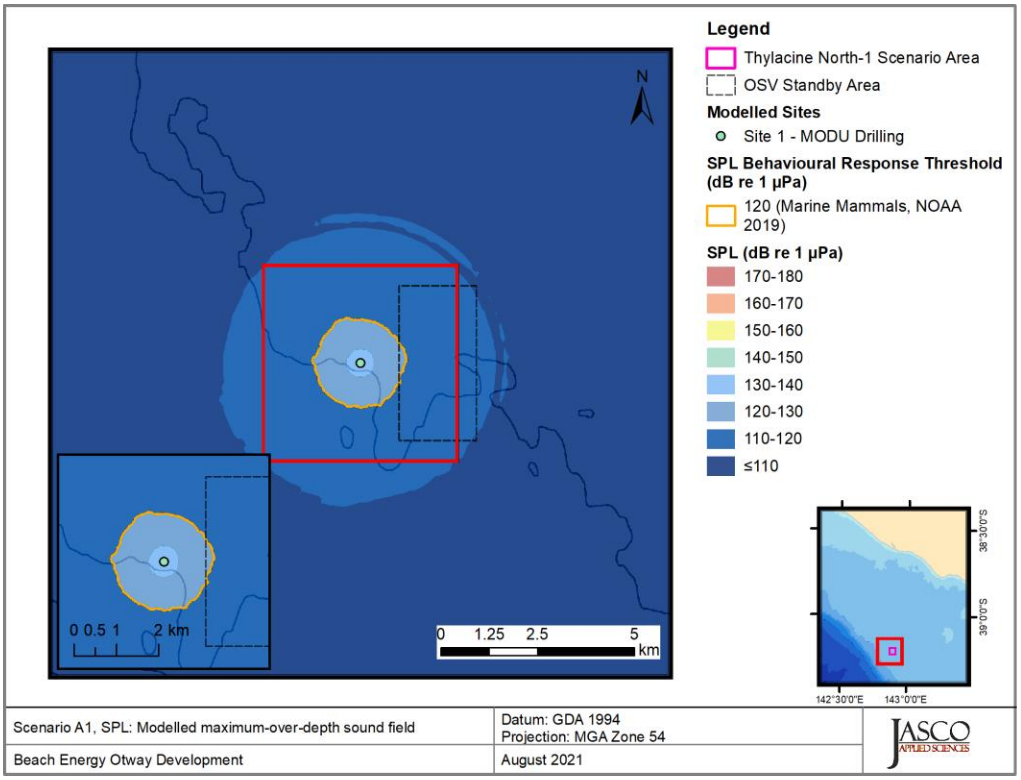


Figure 4. *Thylacine North-1, MODU Drilling (Scenario A1) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

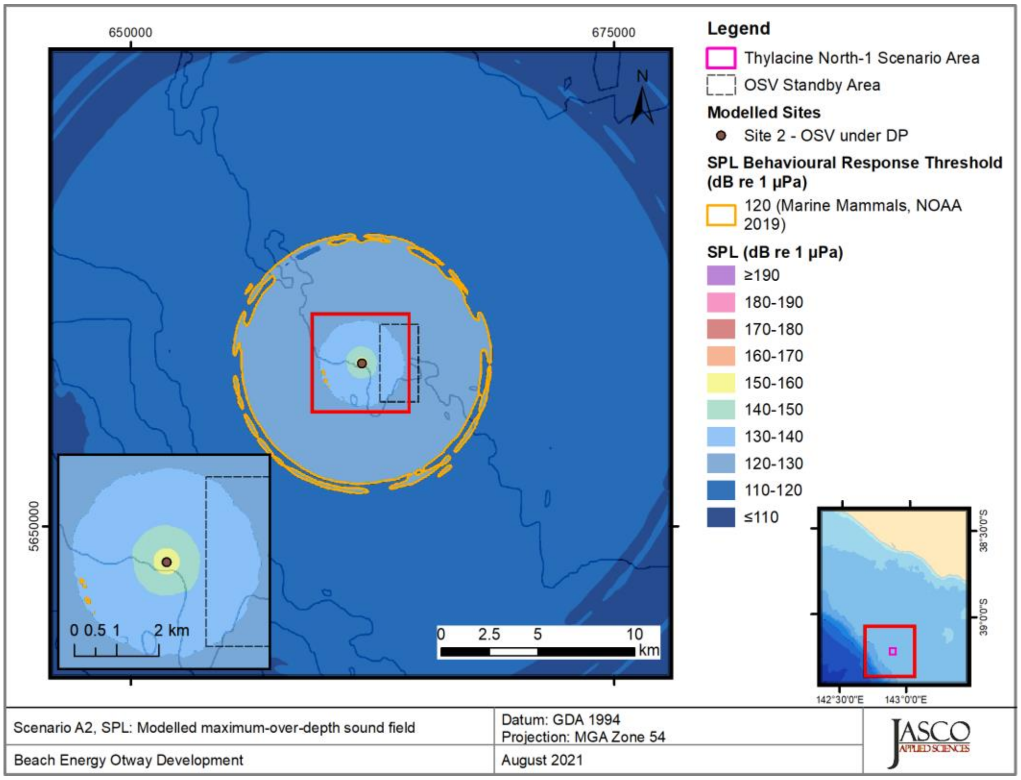


Figure 5. *Thylacine North-1, OSV on DP (Scenario A2) :* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

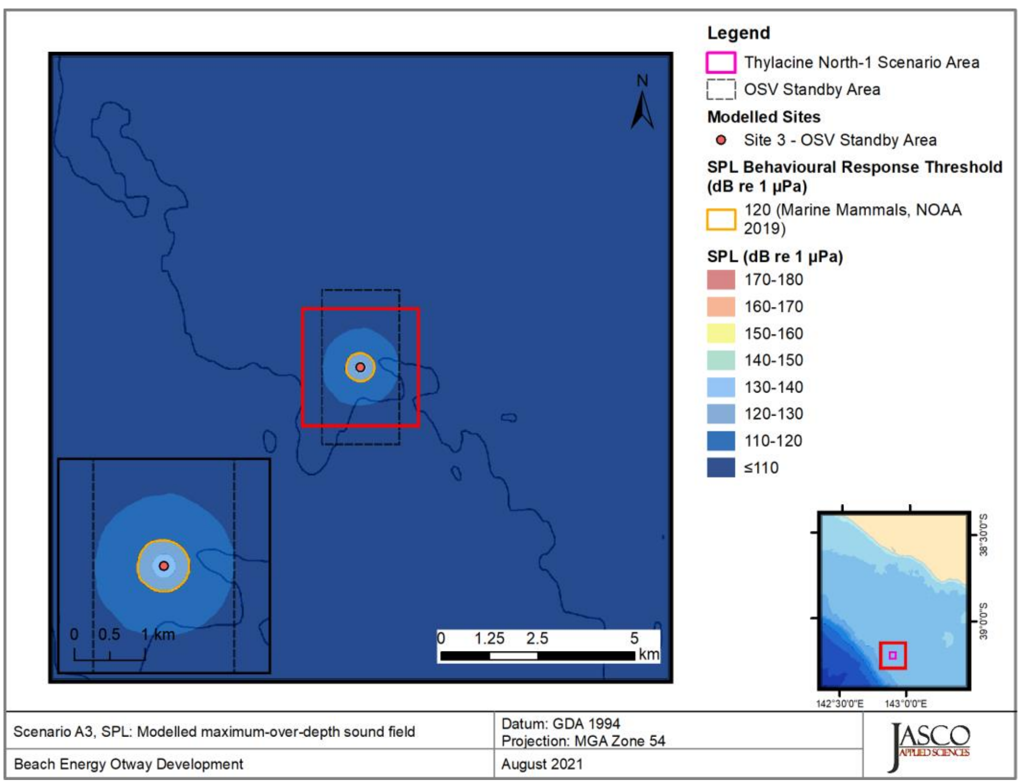


Figure 6. *Thylacine North-1, OSV Standby (Scenario A3) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

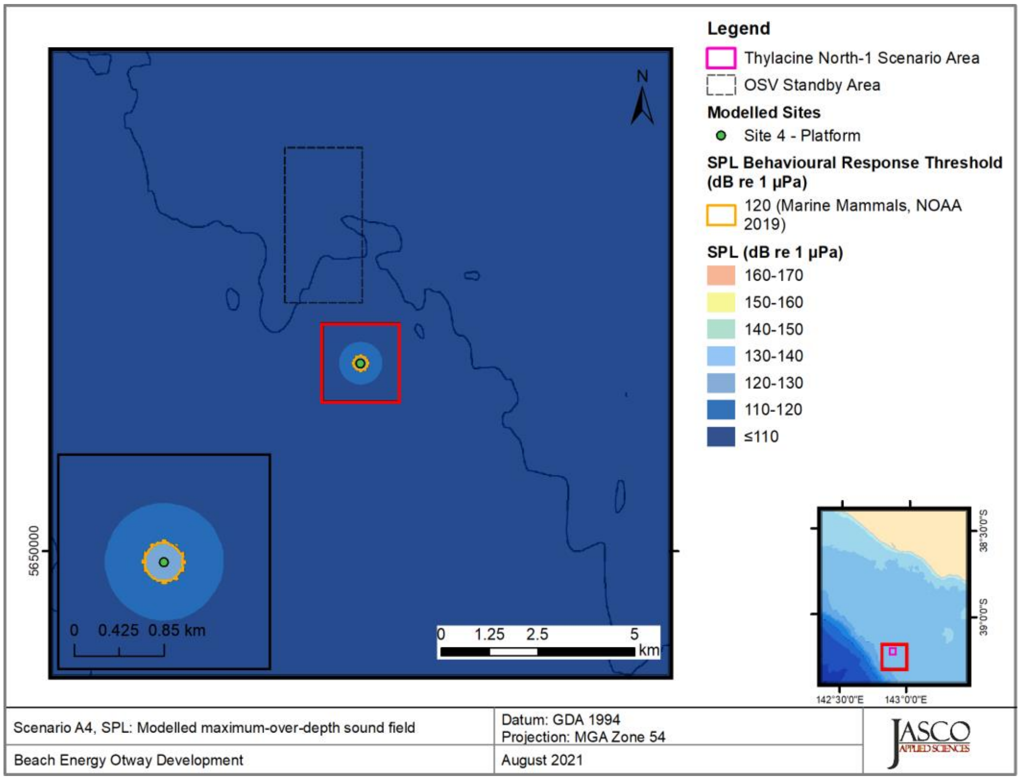


Figure 7. *Thylacine A, Platform Operations (Scenario A4) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

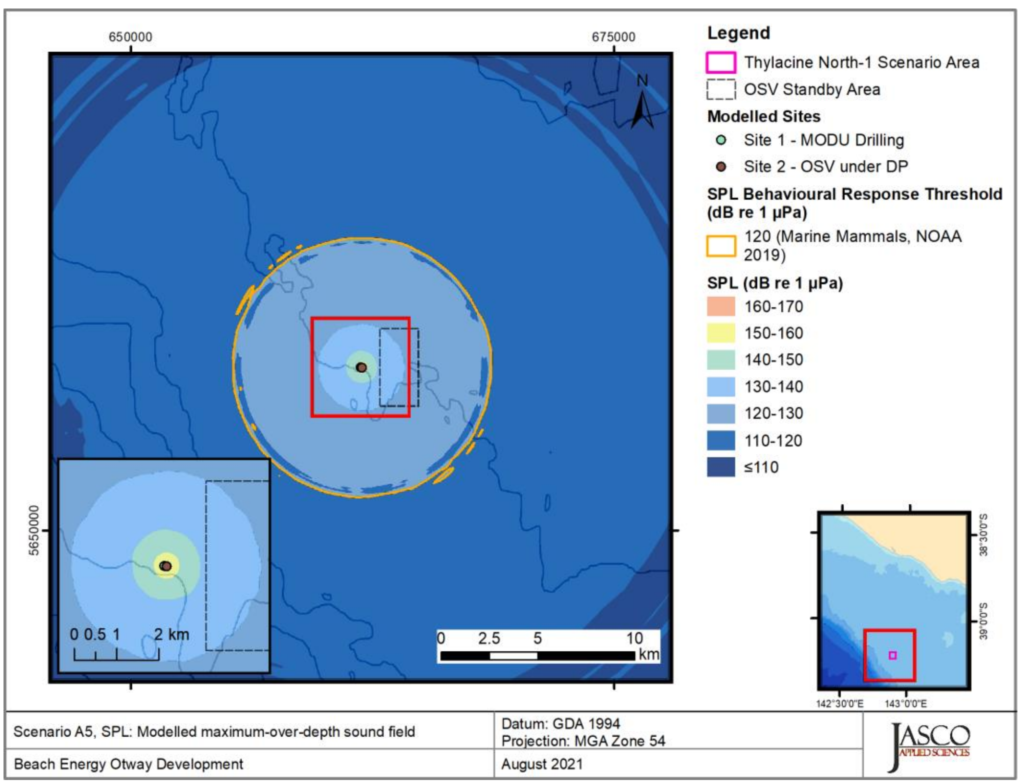


Figure 8. *Thylacine North-1, MODU Drilling and OSV Resupply (Scenario A5) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

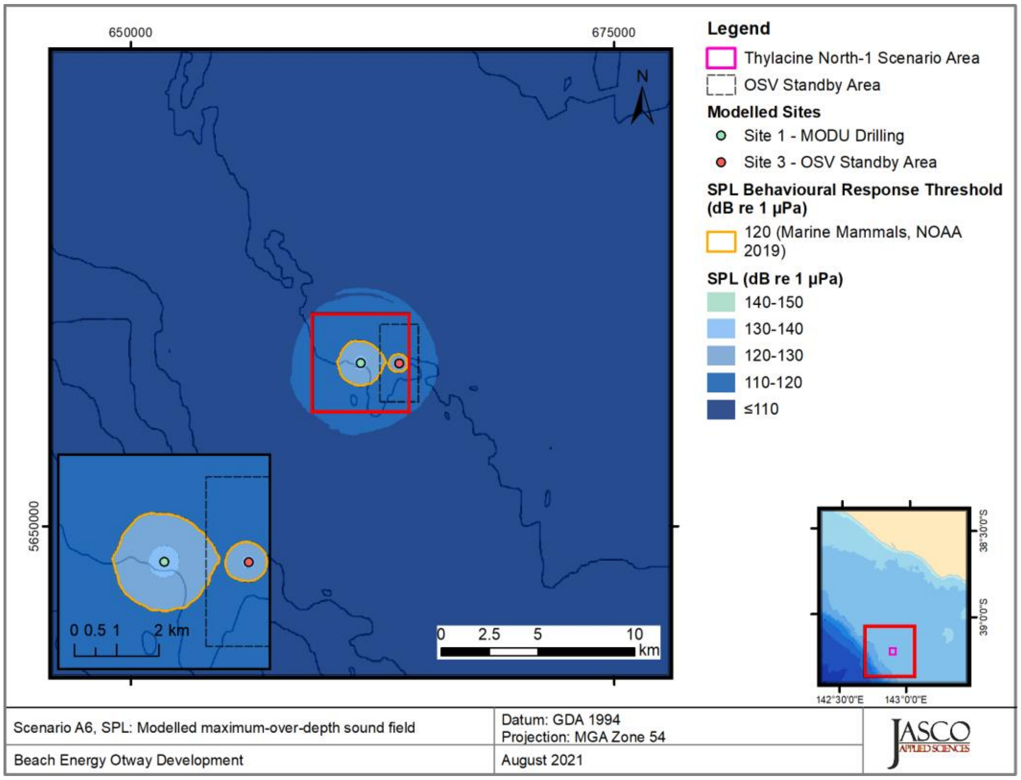


Figure 9. *Thylacine North-1, MODU Drilling and OSV Standby (Scenario A7) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

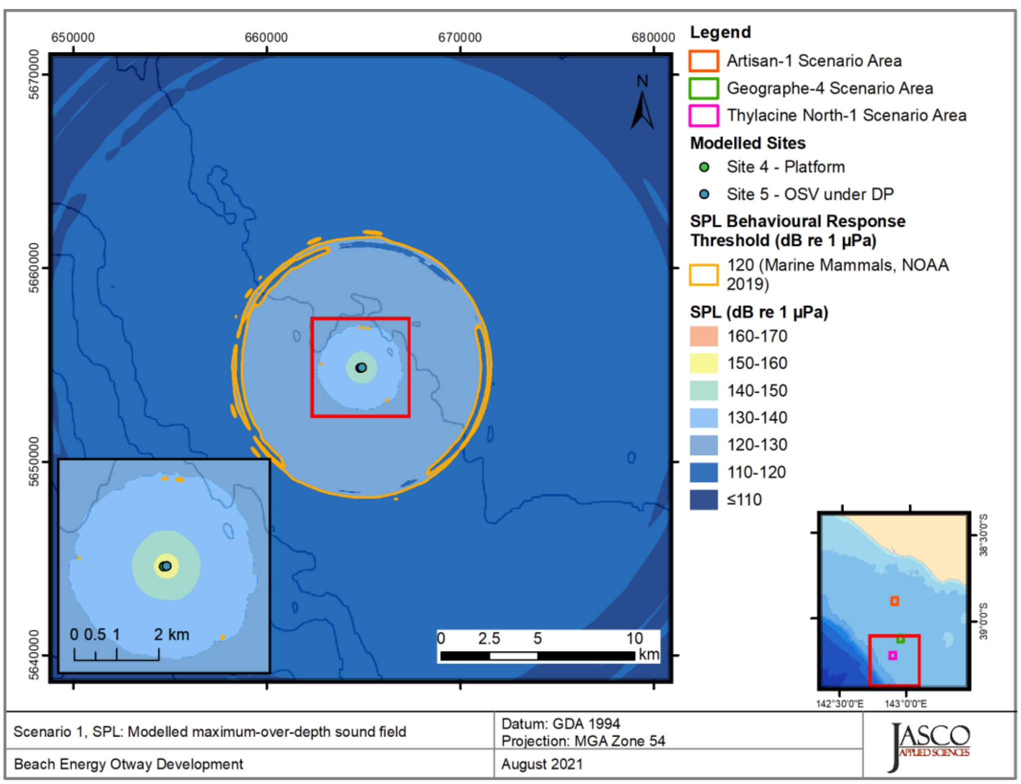


Figure 10. *Thylacine A Platform, Platform Resupply (Scenario 1) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

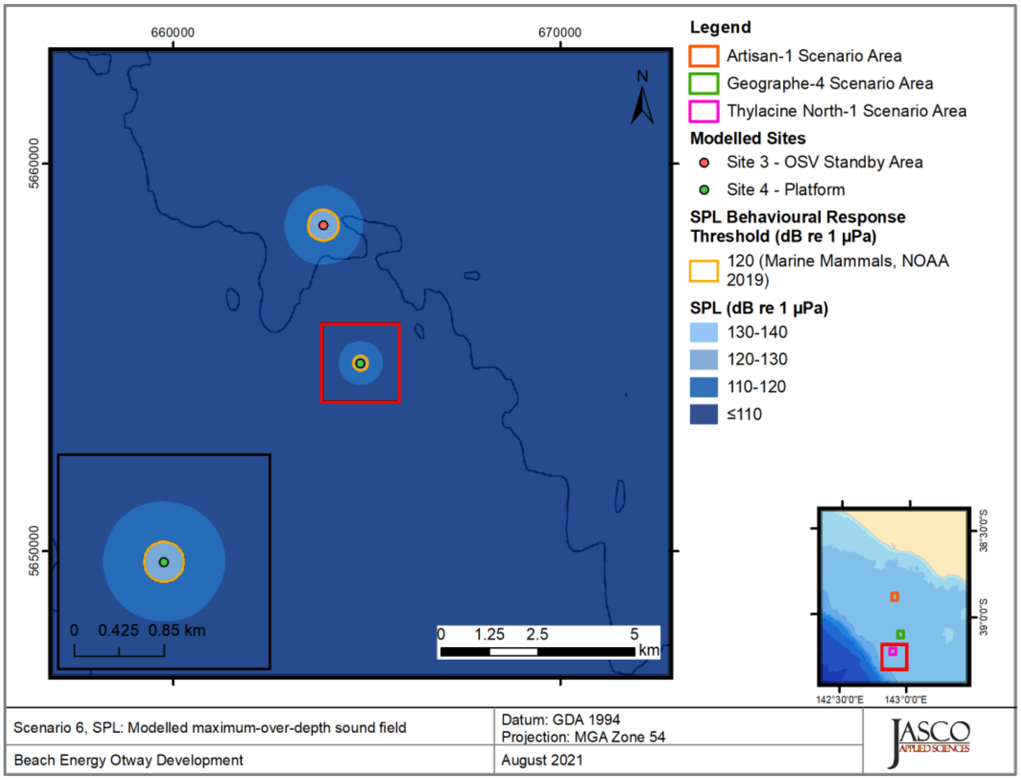


Figure 11. *Thylacine A Platform, OSV standby (Scenario 6) SPL :* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

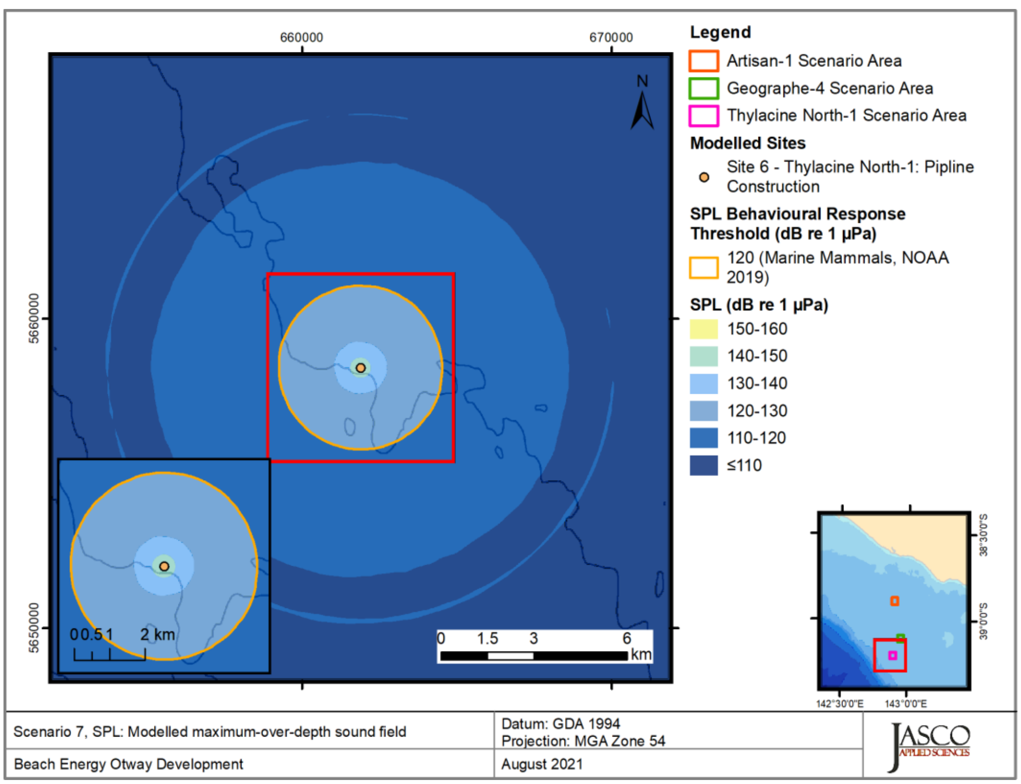


Figure 12. *Thylacine North-1, PLV stationary 20% MCR -June (Scenario 7) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

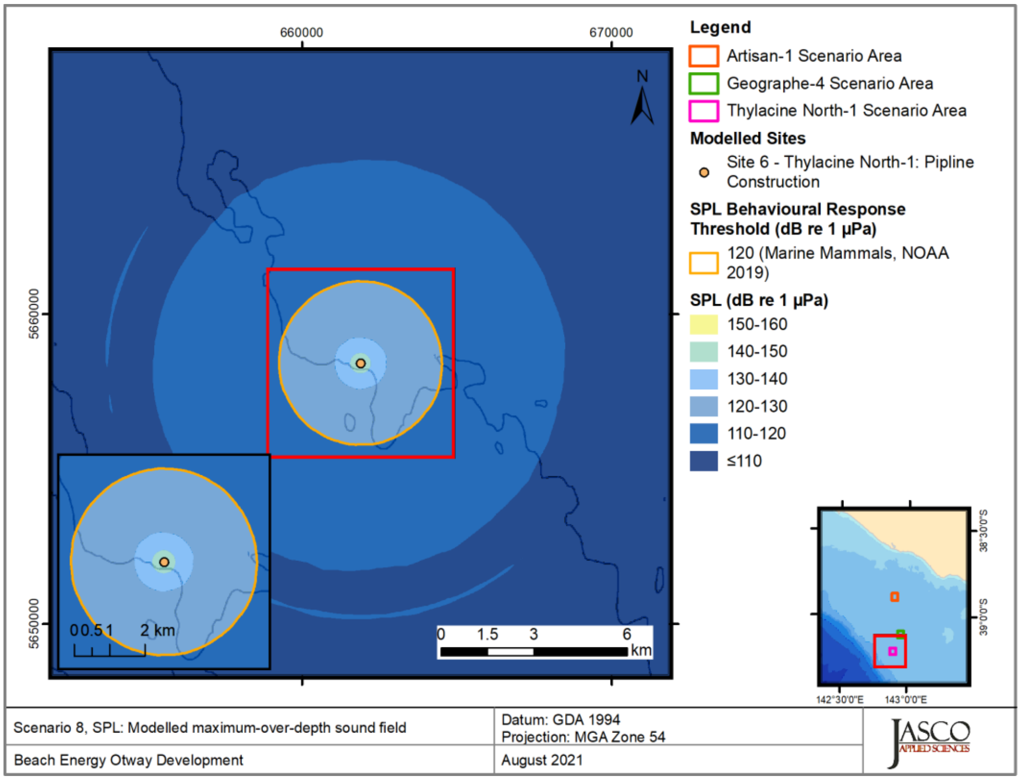


Figure 13. *Thylacine North-1, PLV stationary 20% MCR -November (Scenario 8) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

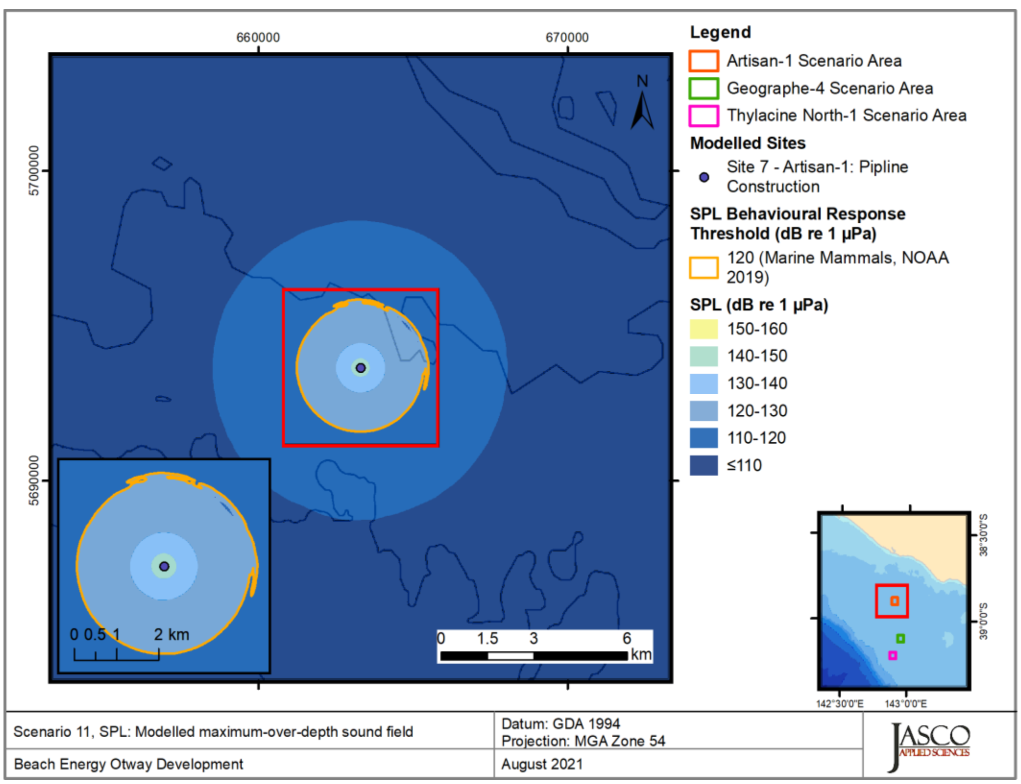


Figure 14. *Artisan-1, PLV stationary 20% MCR -June (Scenario 11) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

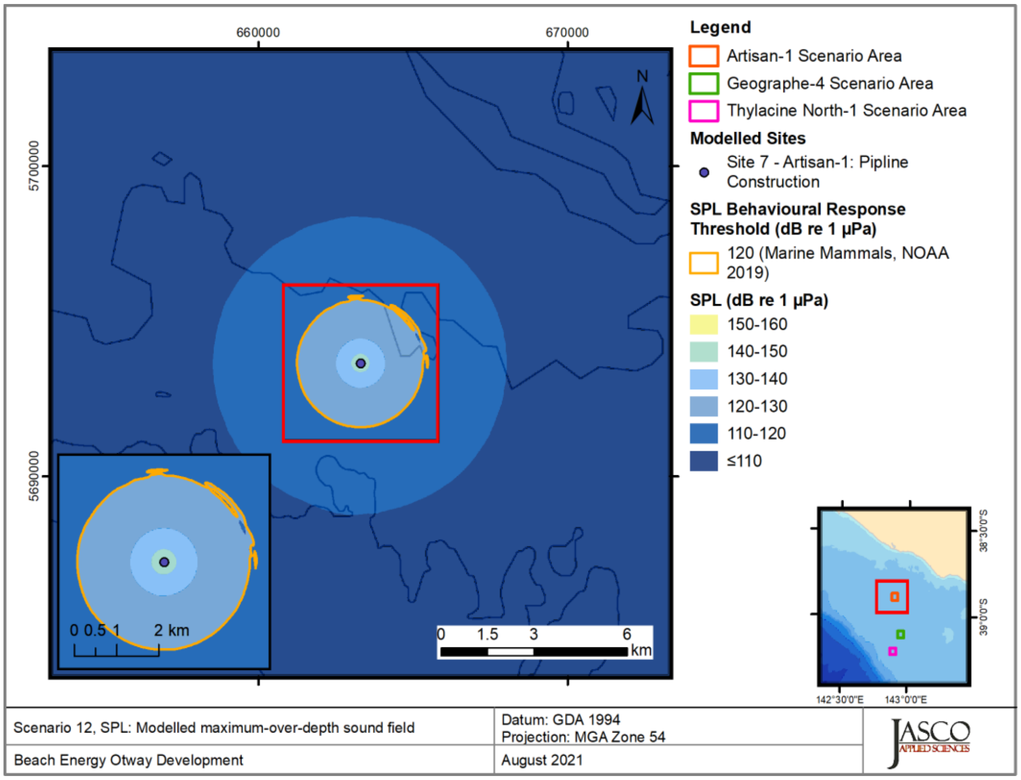


Figure 15. *Artisan-1, PLV stationary 20% MCR - November (Scenario 12) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

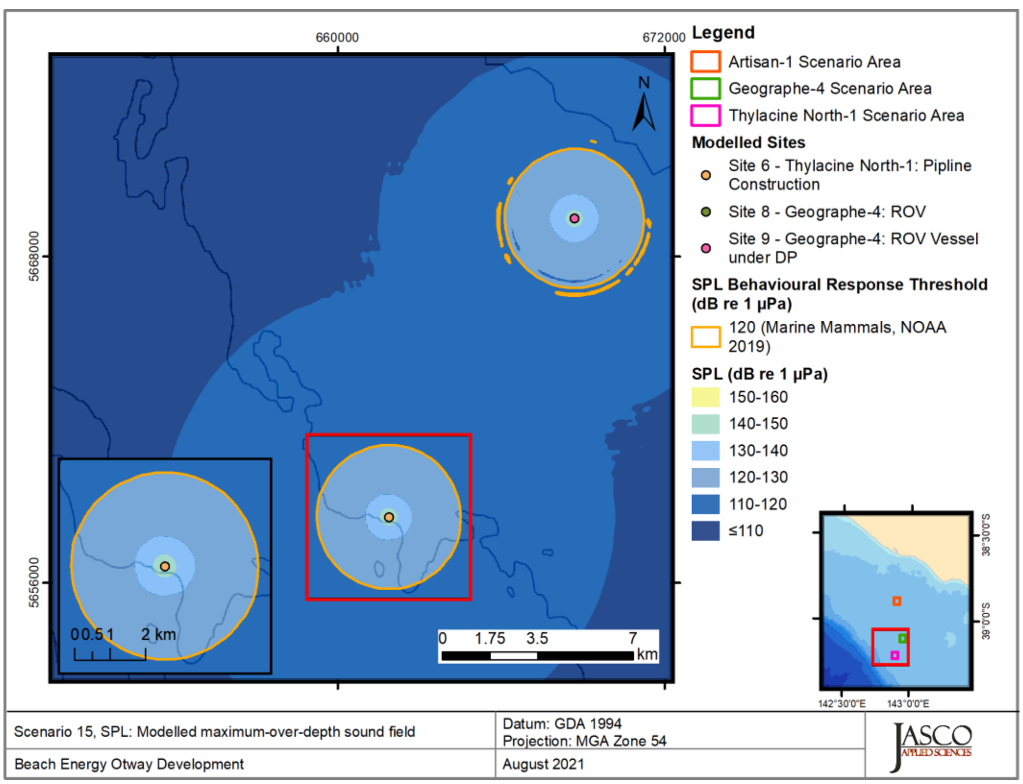


Figure 16. *Thylacine North-1, PLV stationary and ROV operations at Geographe-4 (20% MCR) - June (Scenario 15) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is s hown as an orange contour line.

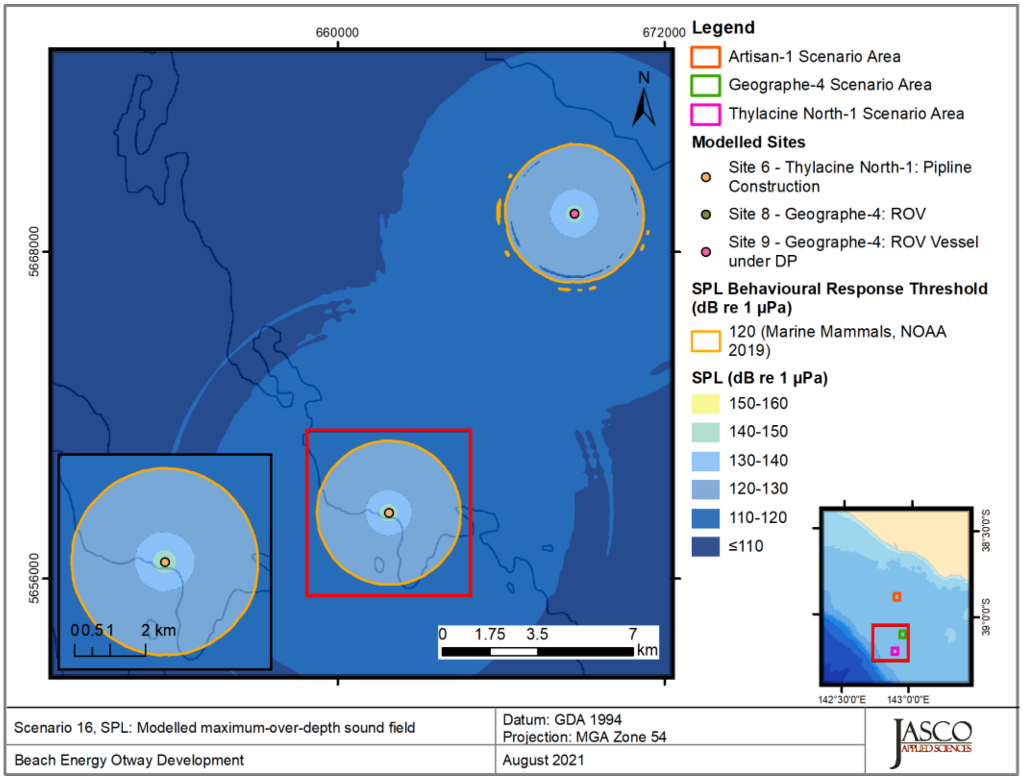


Figure 17. *Thylacine North-1, PLV stationary and ROV operations at Geographe-4 (20% MCR) – November (Scenario 16) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

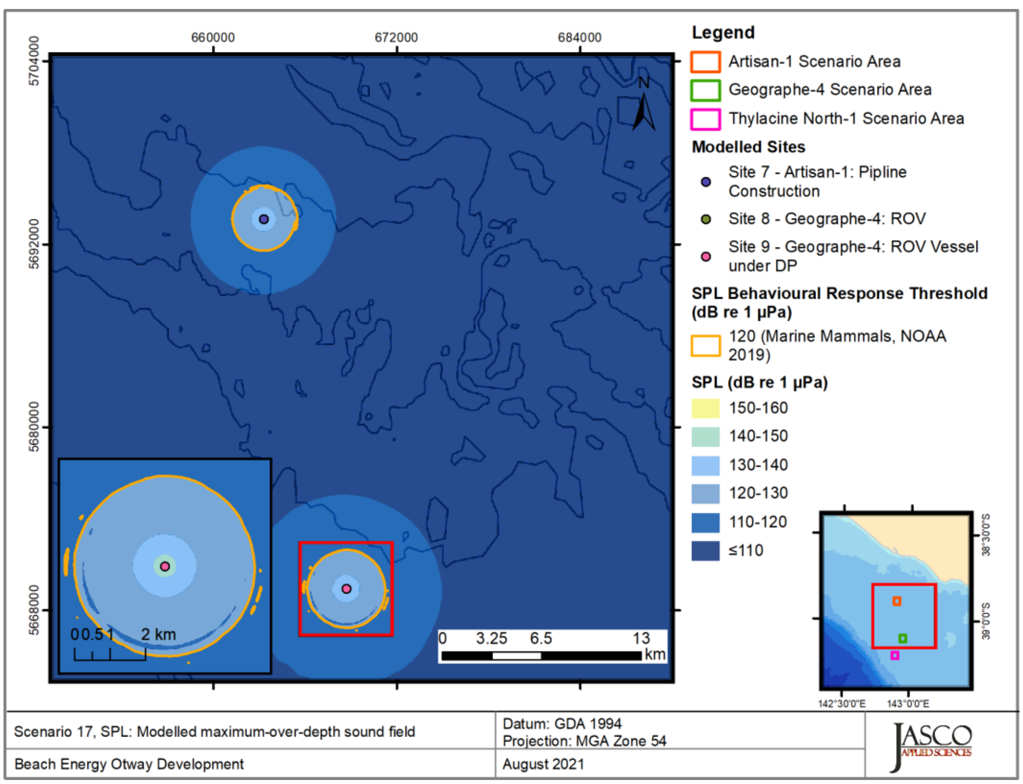


Figure 18. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 (20% MCR) – June (Scenario 17) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

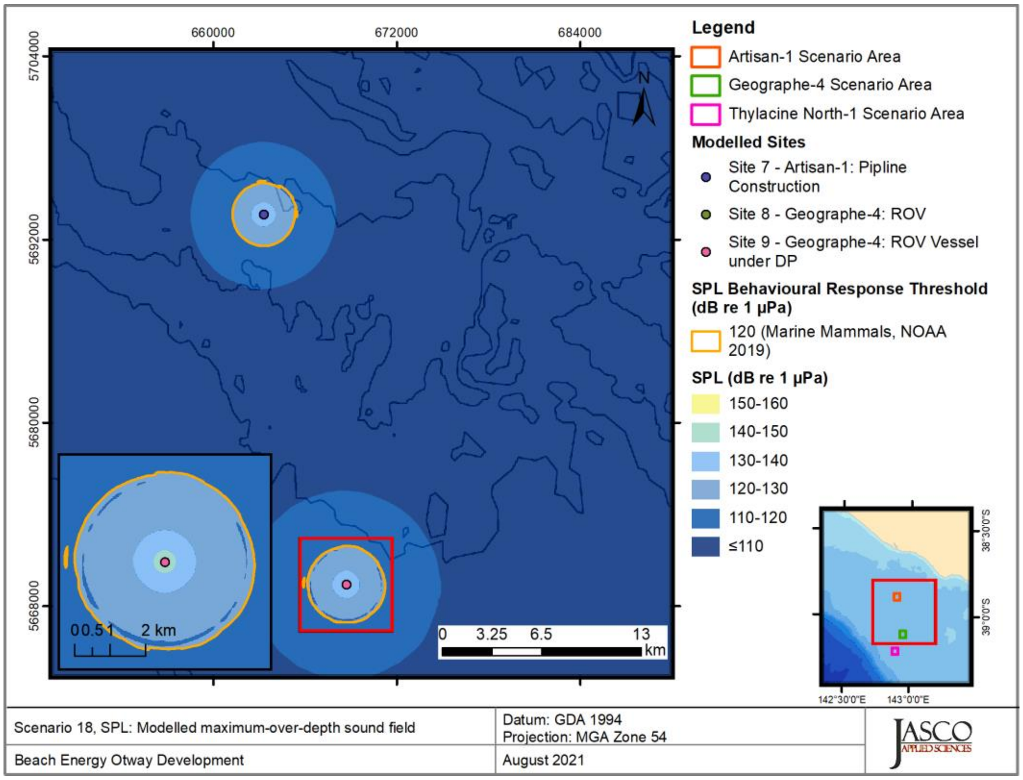


Figure 19. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 (20% MCR) – November (Scenario 18) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

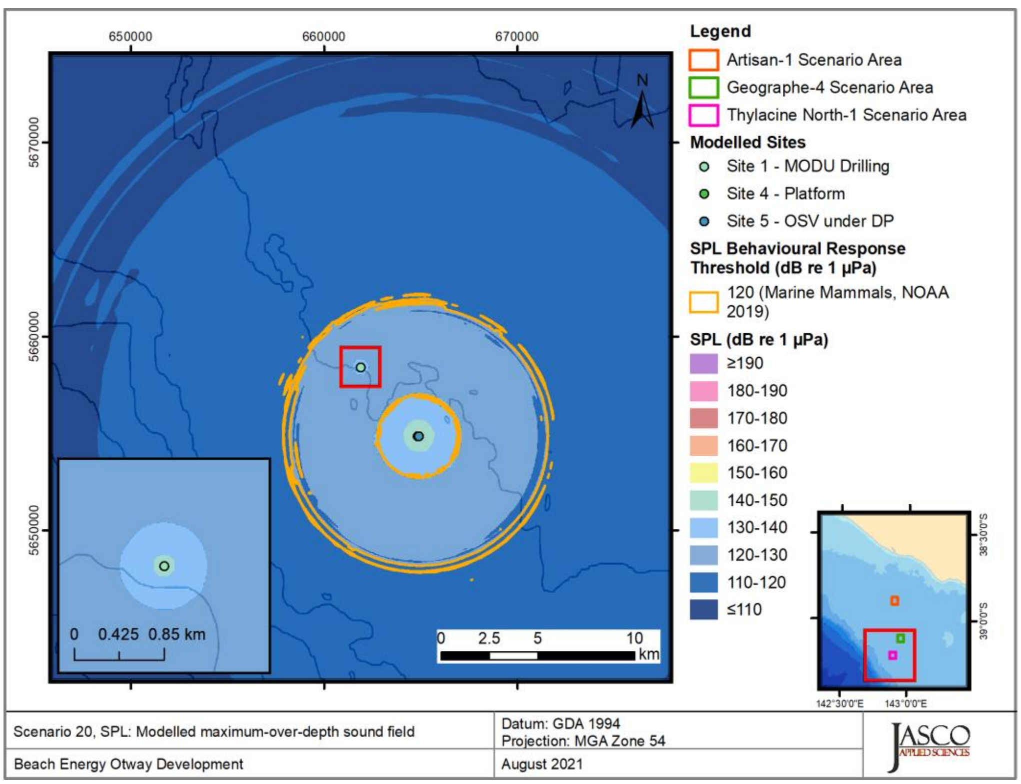


Figure 20. *Thylacine A Platform, Platform Resupply and MODU Drilling (Scenario 20) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

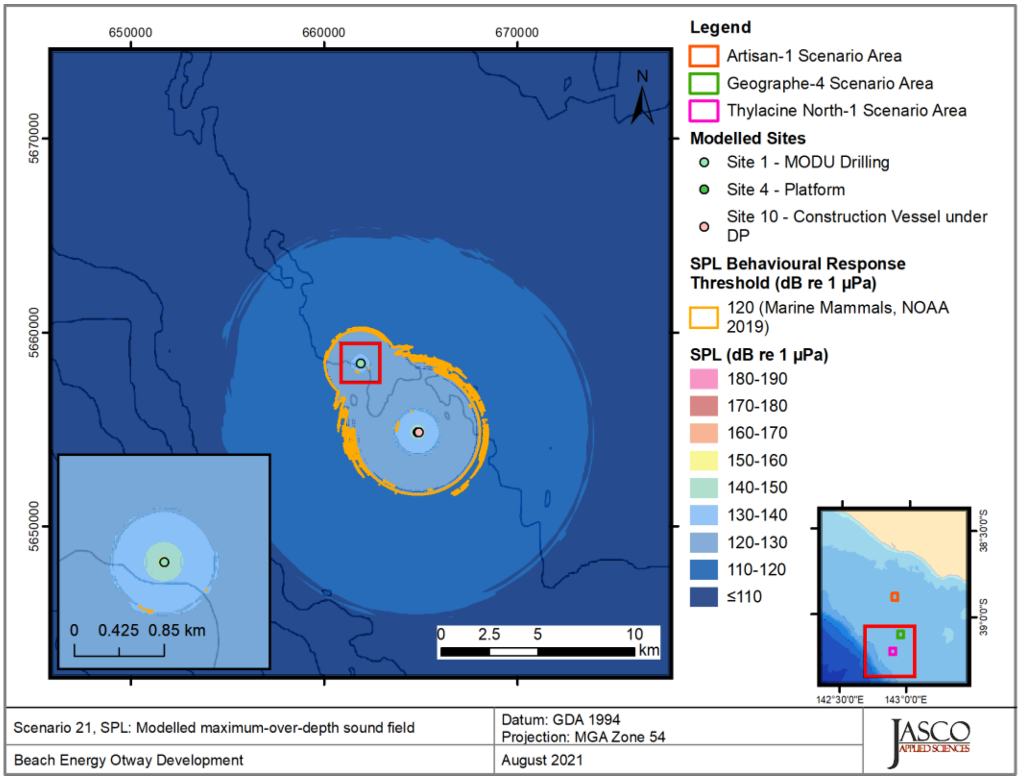


Figure 21. *Thylacine A Platform, Platform operations and skid installation* at 20% MCR *(Scenario 21) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

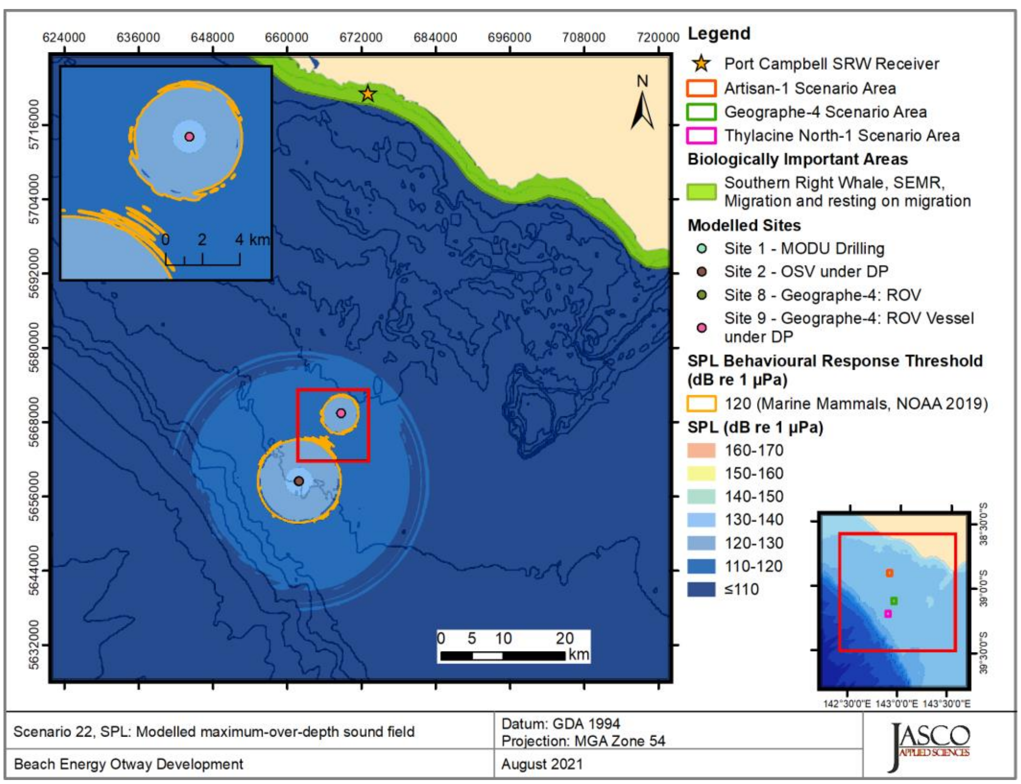


Figure 22. *Concurrent drilling operations at Thylacine North-1 and construction operations (20% MCR) at Geographe-4 (Scenario 22) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

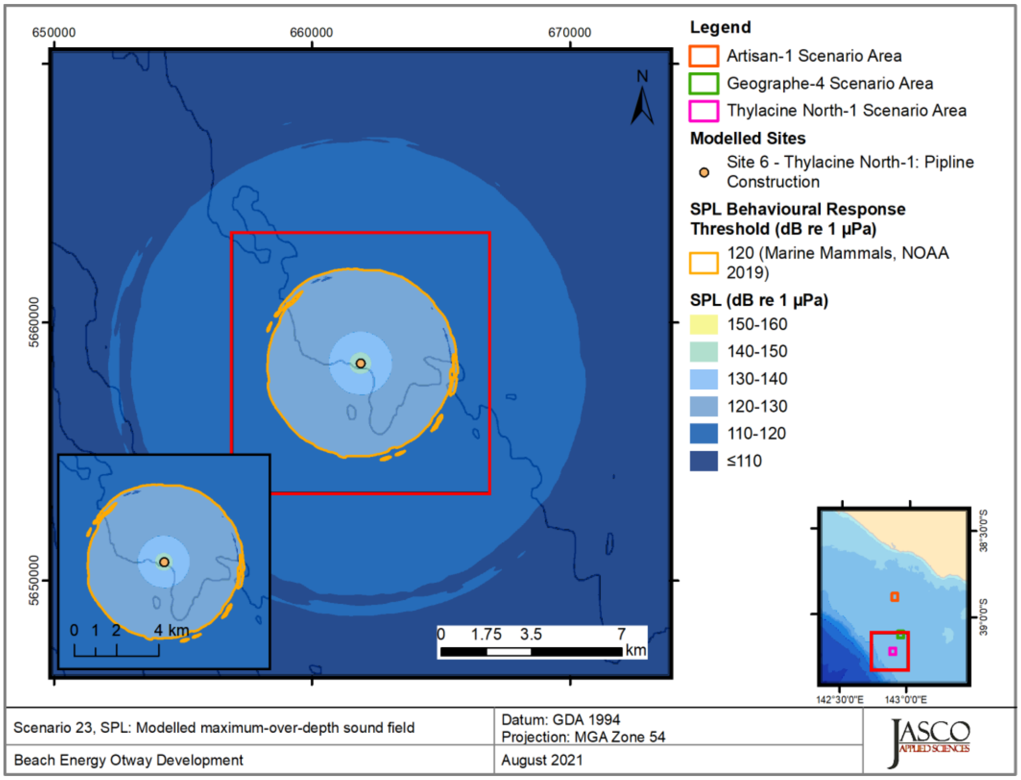


Figure 23. *Thylacine North-1, PLV stationary 40% MCR -June (Scenario 23) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

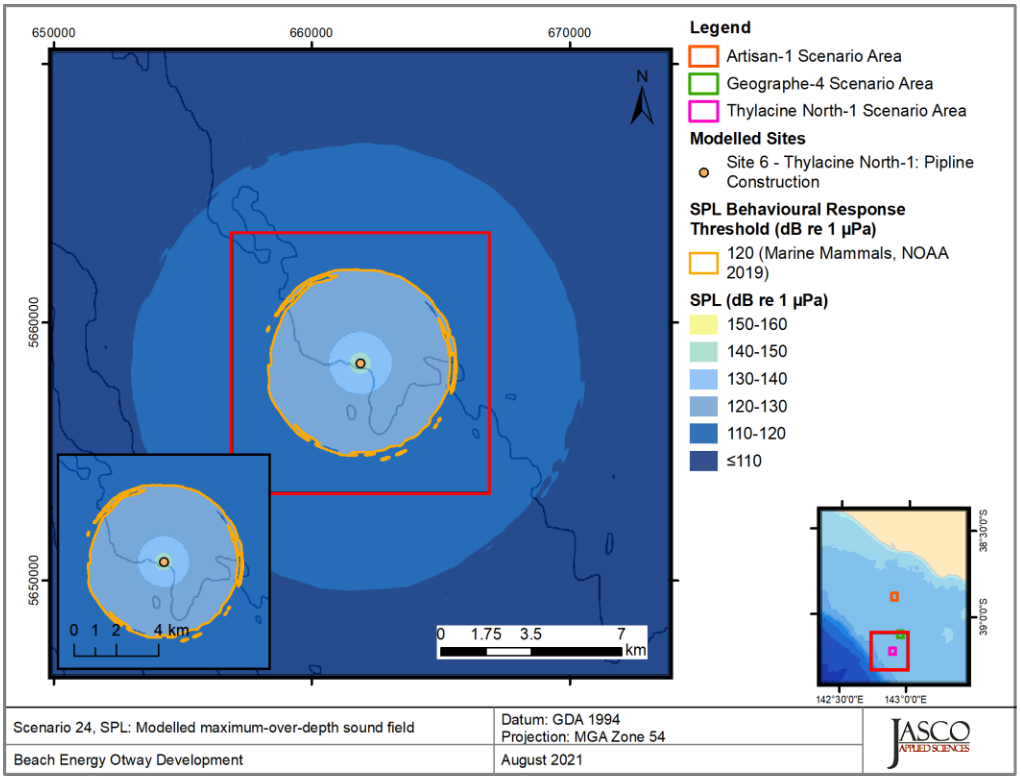


Figure 24. *Thylacine North-1, PLV stationary 40% MCR -November (Scenario 24) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

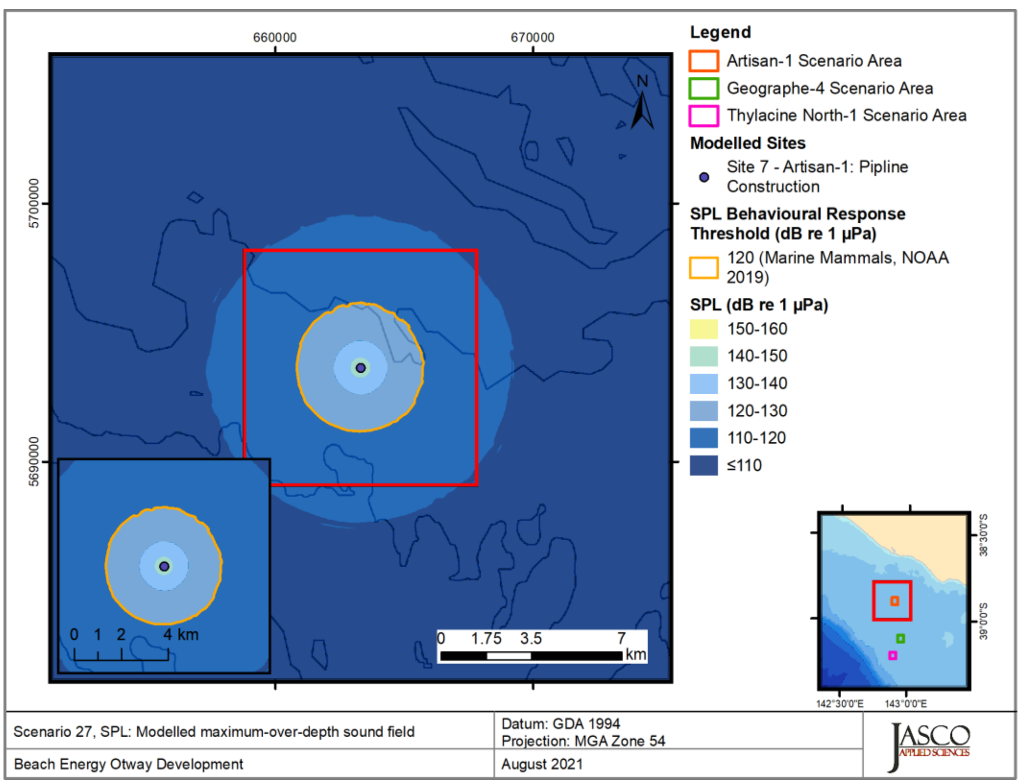


Figure 25. *Artisan-1, PLV stationary 40% MCR -June (Scenario 27) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

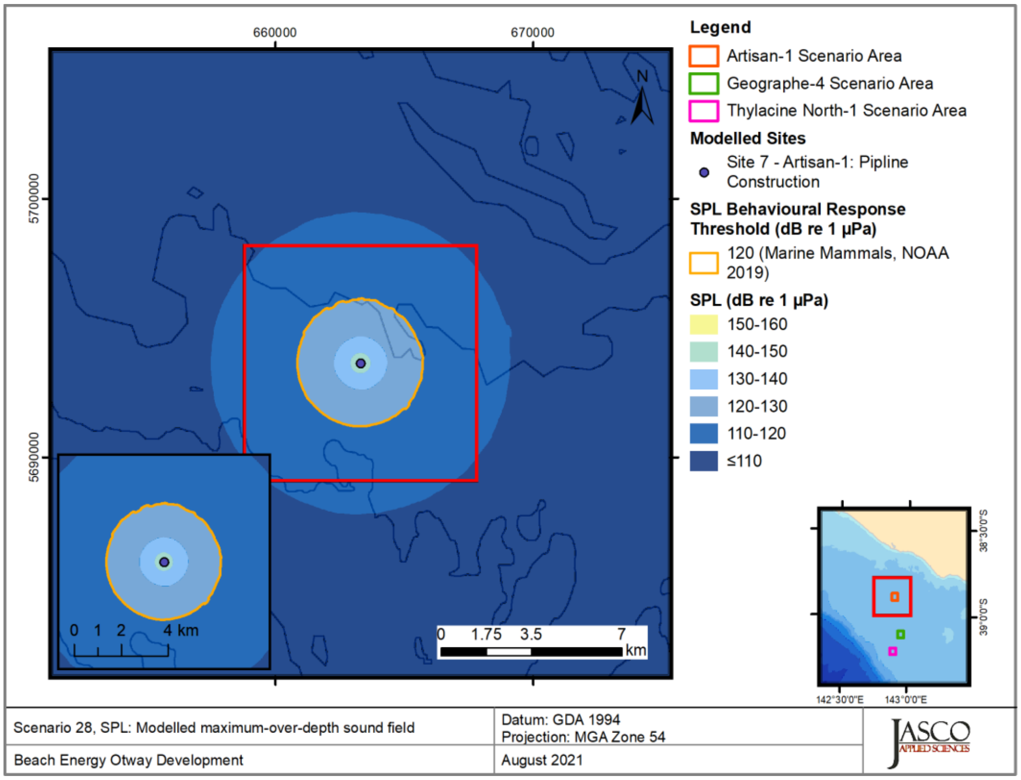


Figure 26. *Artisan-1, PLV stationary 40% MCR -November (Scenario 28) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

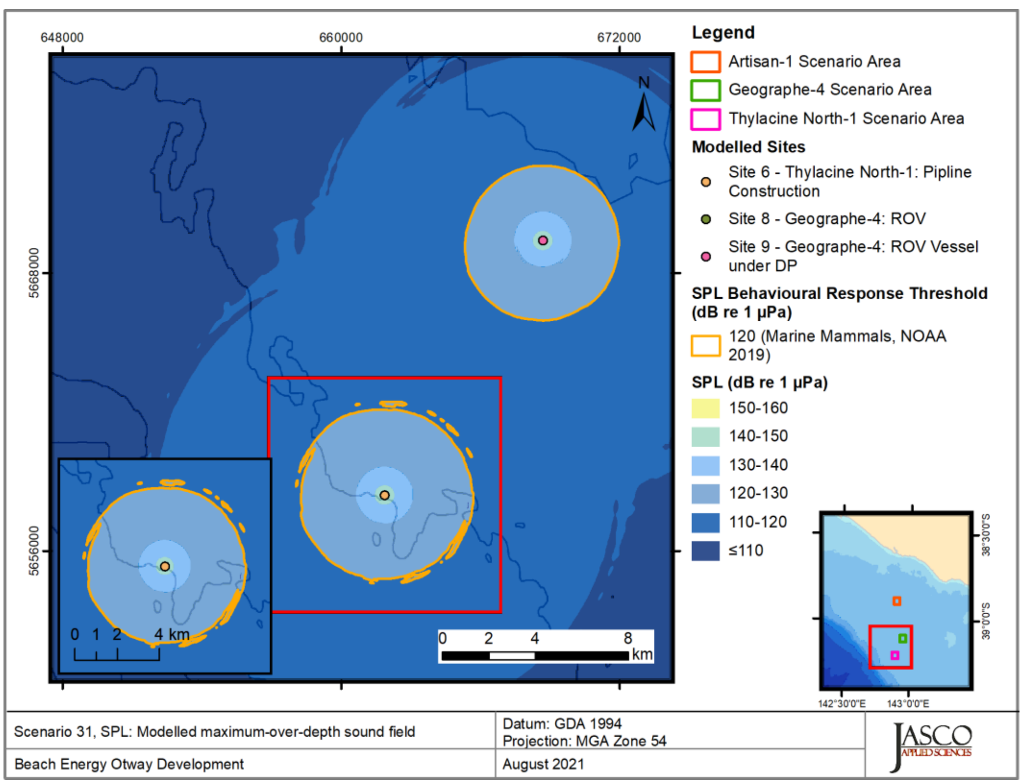


Figure 27. *Thylacine North-1, PLV stationary 40% MCR and ROV operations at Geographe-4 - June (Scenario 31) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

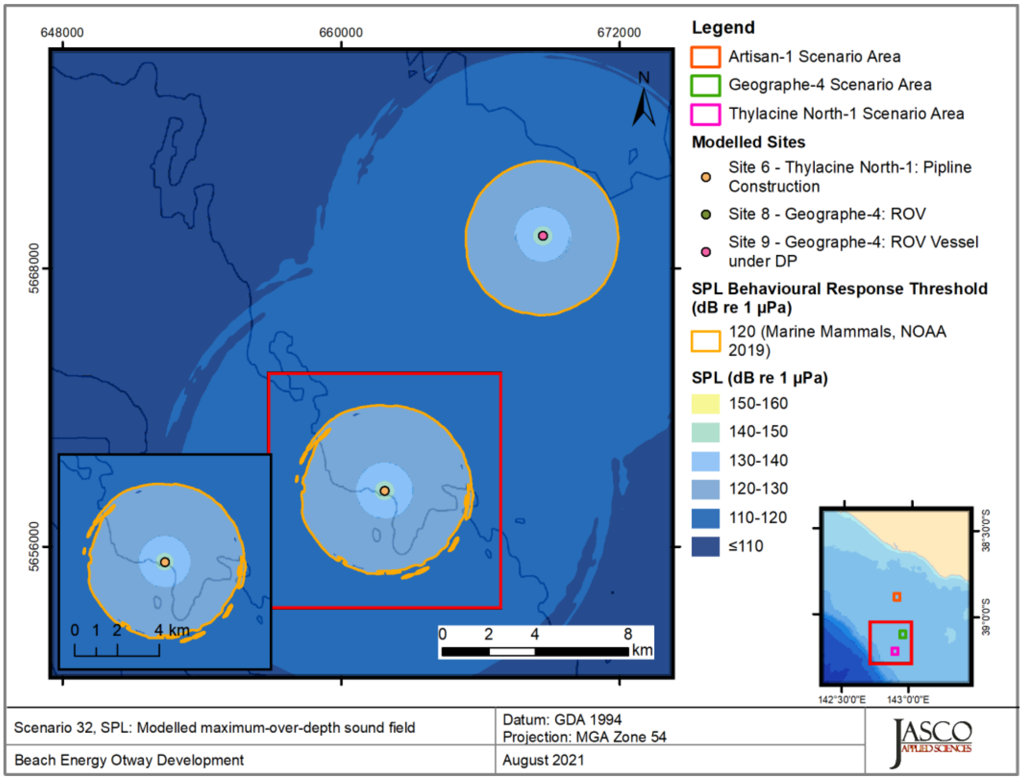


Figure 28. *Thylacine North-1, PLV stationary 40% MCR and ROV operations at Geographe-4 – November (Scenario 32) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

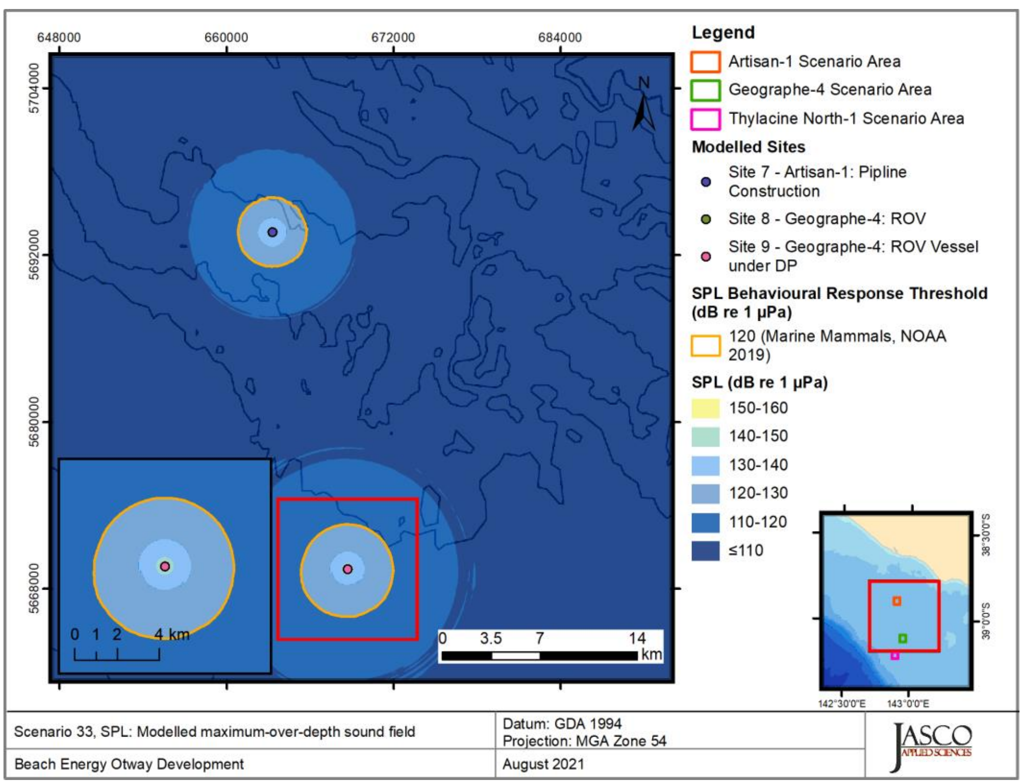


Figure 29. *Artisan-1, PLV stationary 40% MCR and ROV Operations at Geographe-4 – June (Scenario 33) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

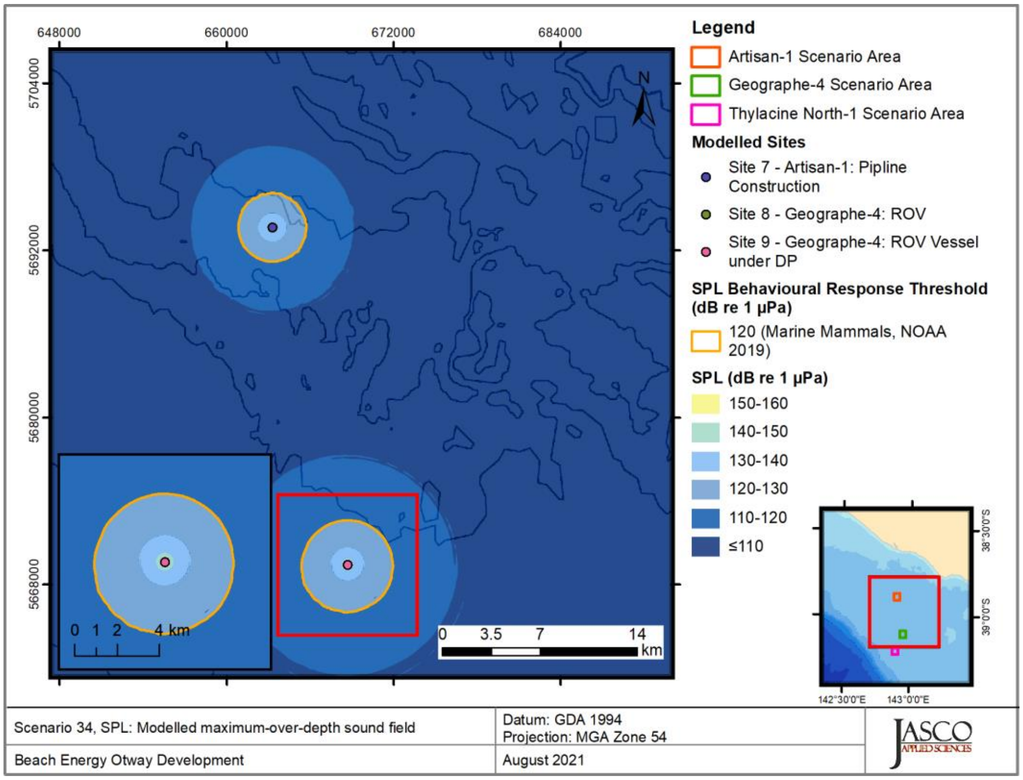


Figure 30. *Artisan-1, PLV stationary 40% MCR and ROV Operations at Geographe-4 – November (Scenario 34) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

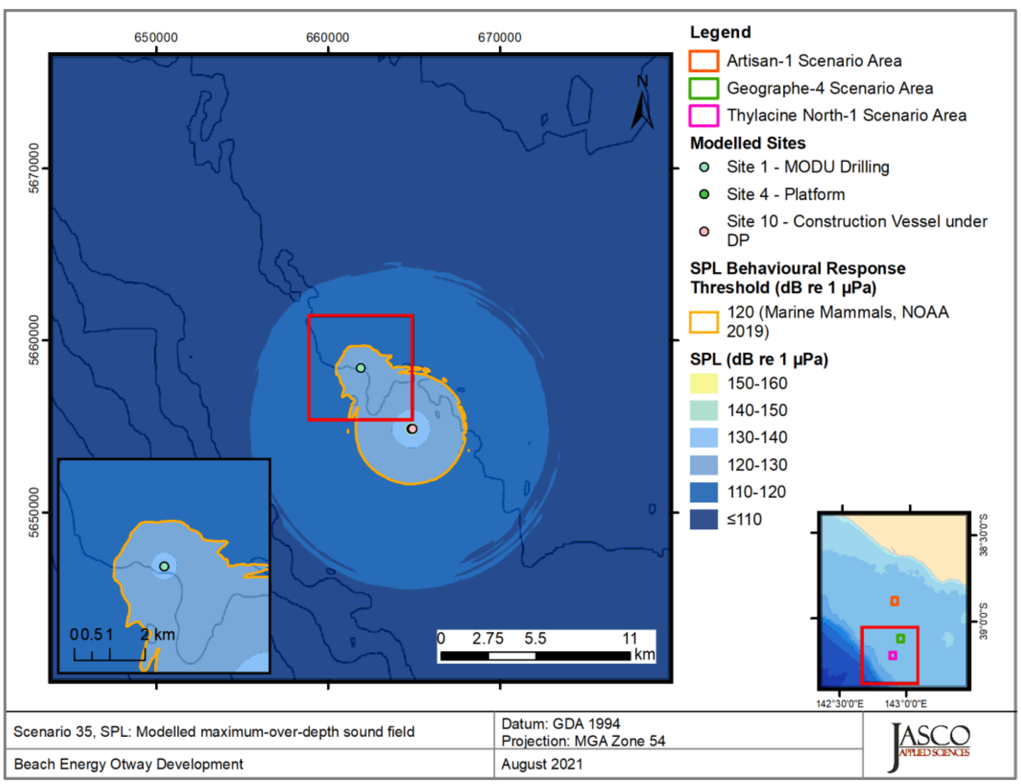


Figure 31. *Thylacine A Platform, Platform operations and skid installation at 40% MCR (Scenario 35) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

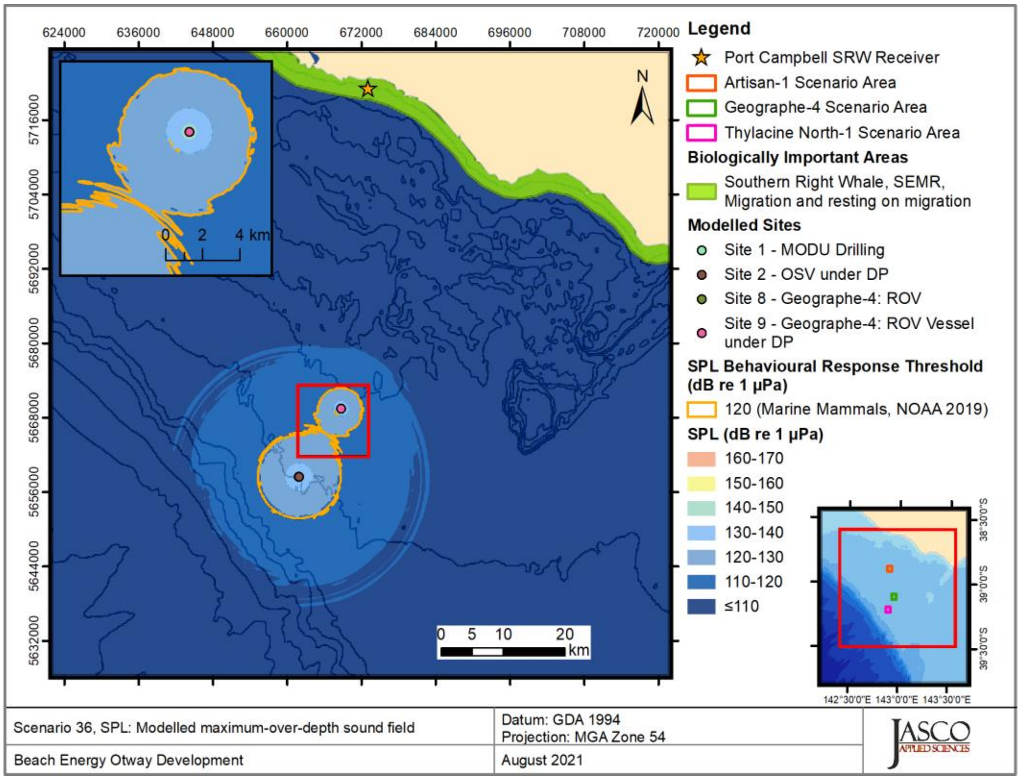


Figure 32. *Concurrent drilling operations at Thylacine North-1 and construction operations (40% MCR) at Geographe-4 (Scenario 36) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

4.2.2. Accumulated SEL_{24h} Maps

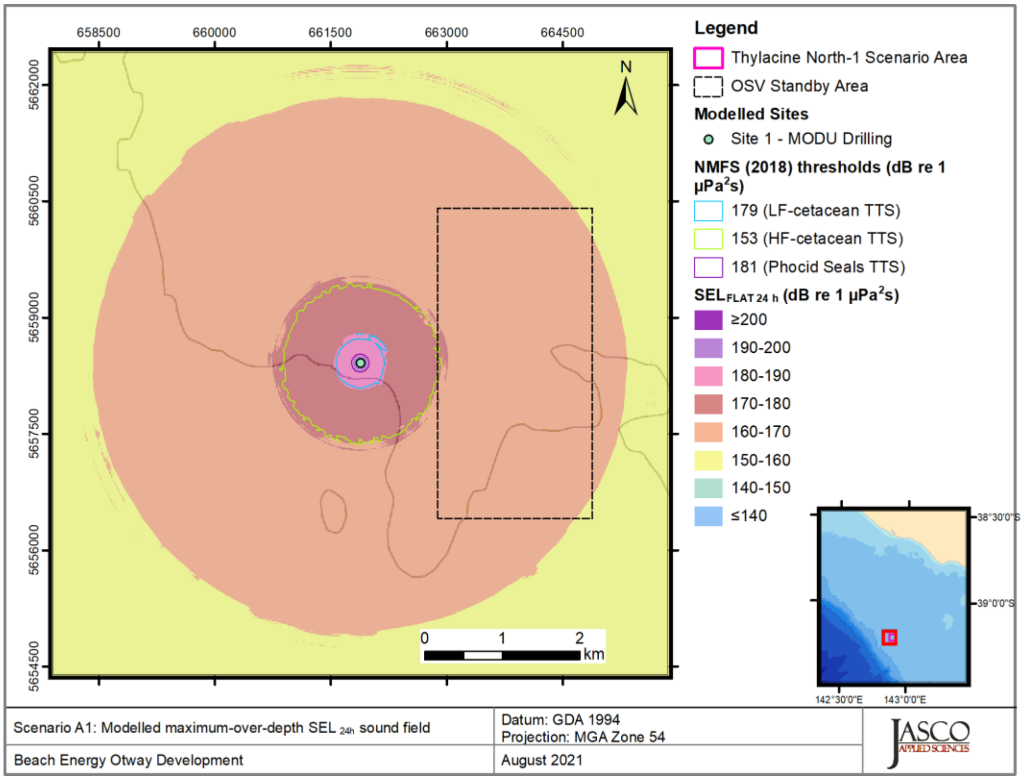


Figure 33. *Thylacine North-1, MODU Drilling (Scenario A1) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

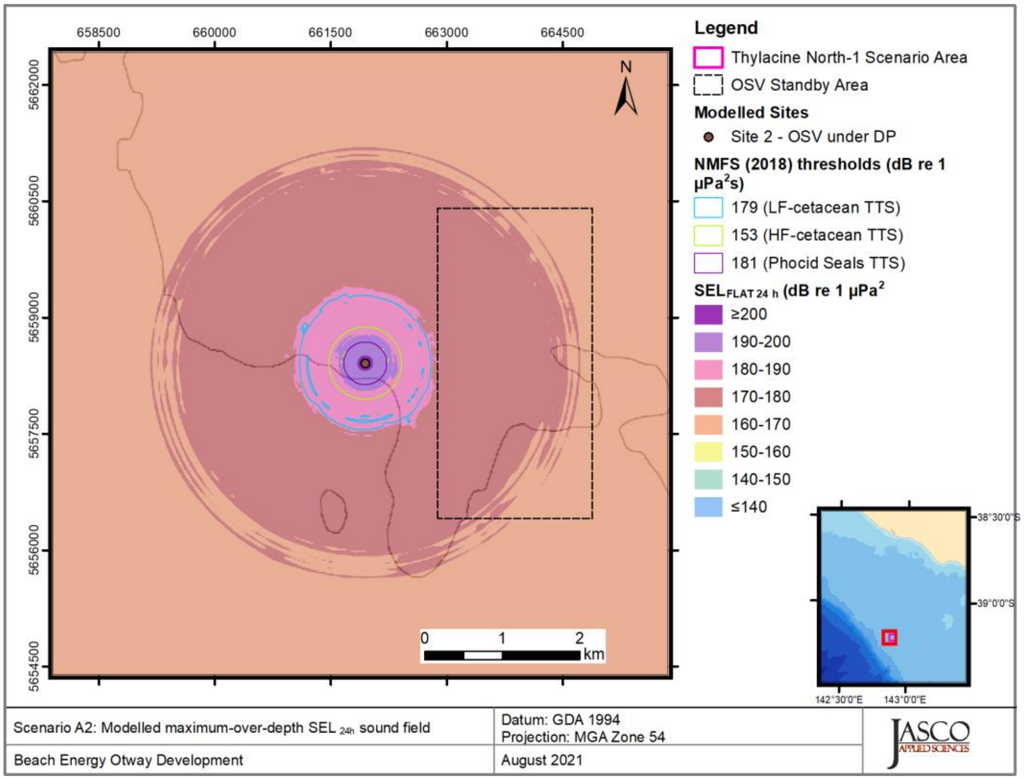


Figure 34. *Thylacine North-1, OSV on DP (4h) (Scenario A2) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

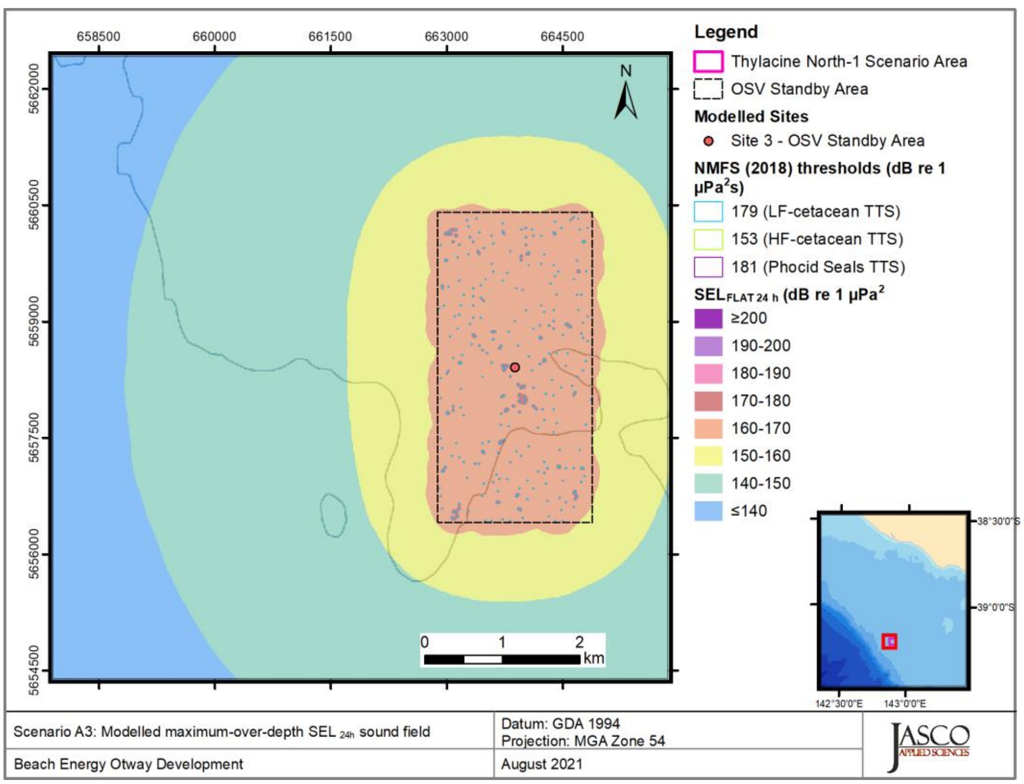


Figure 35. *Thylacine North-1, OSV Standby (Scenario A3) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

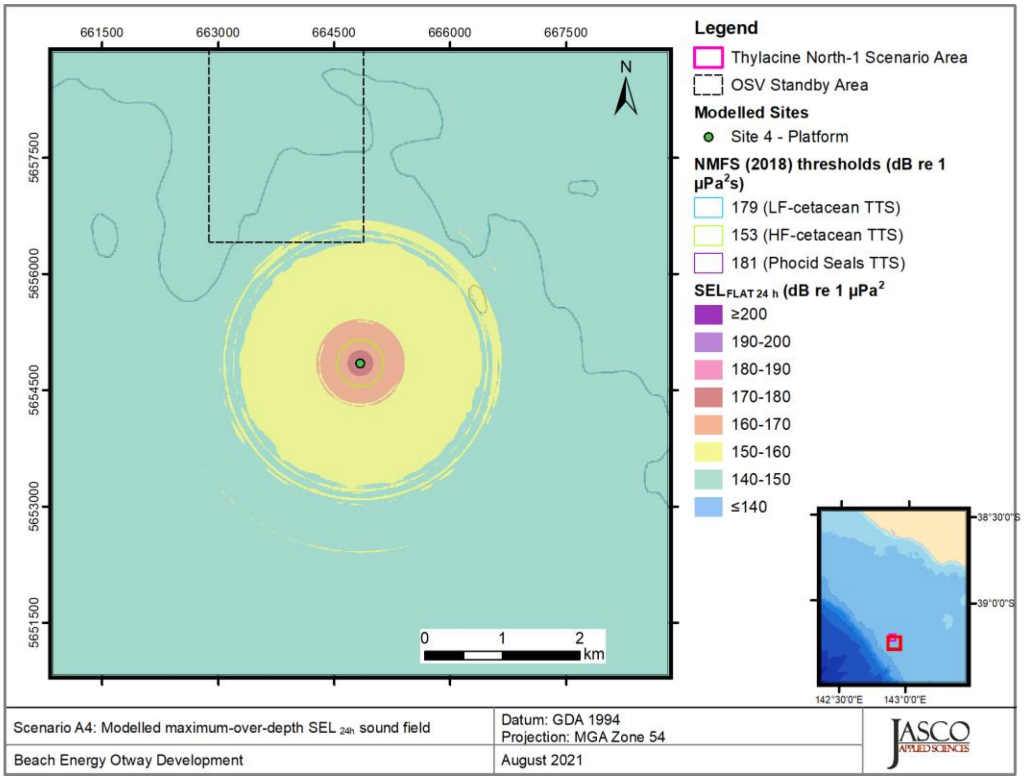


Figure 36. *Thylacine A, Platform Operations (Scenario A4) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

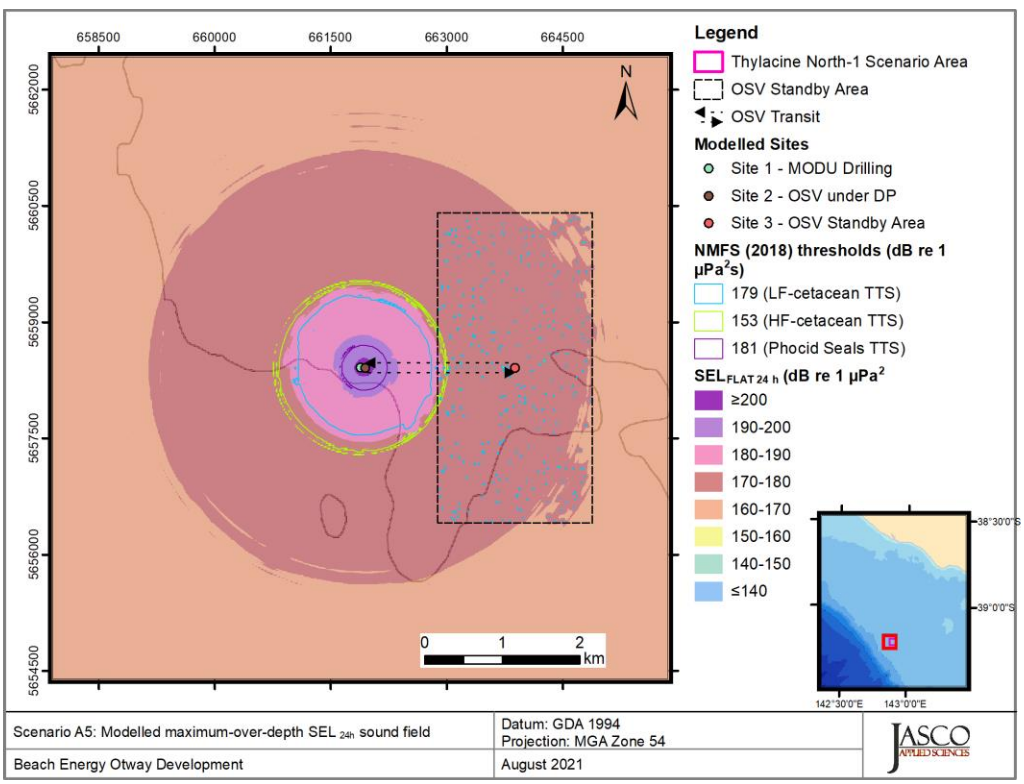


Figure 37. *Thylacine North-1, MODU 4h Resupply Operations (Scenario A5) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

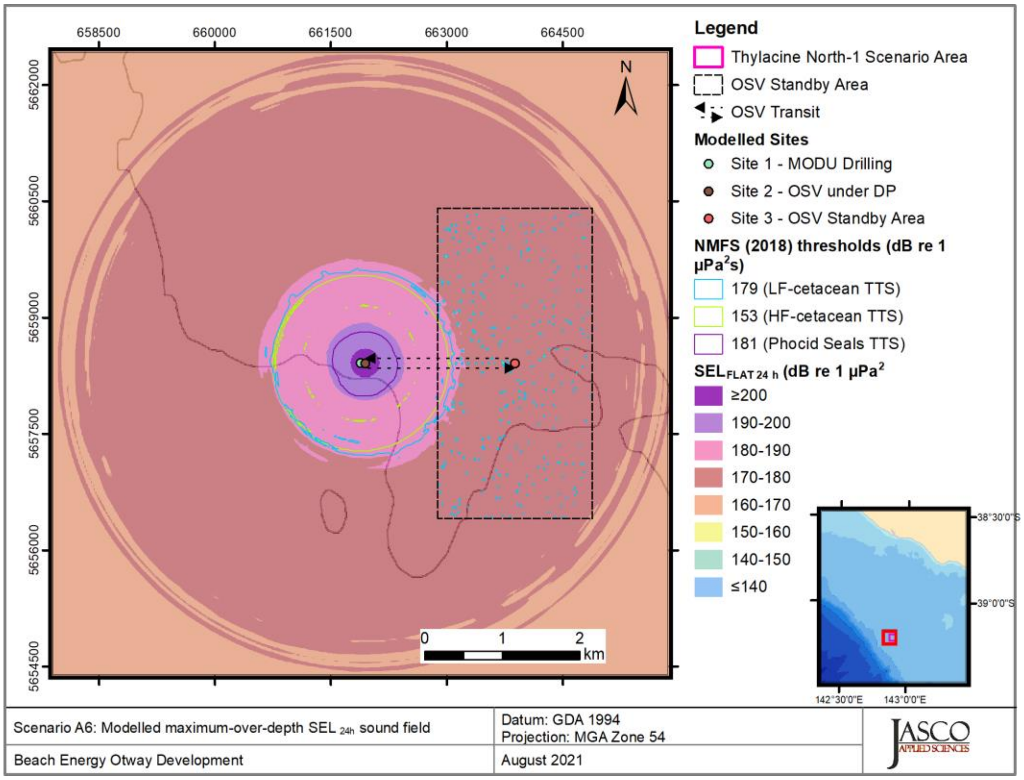


Figure 38. *Thylacine North-1, MODU 8h Resupply Operations (Scenario A6) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.*SEL24h:*

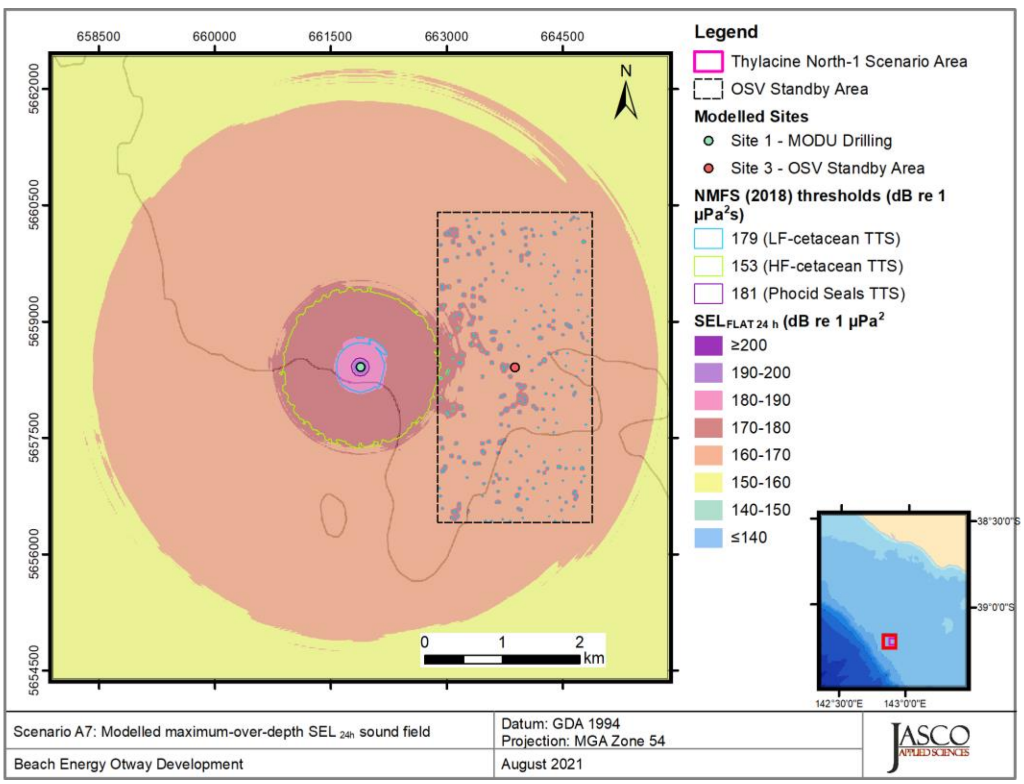


Figure 39. *Thylacine North-1, MODU Drilling and OSV standby (Scenario A7) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

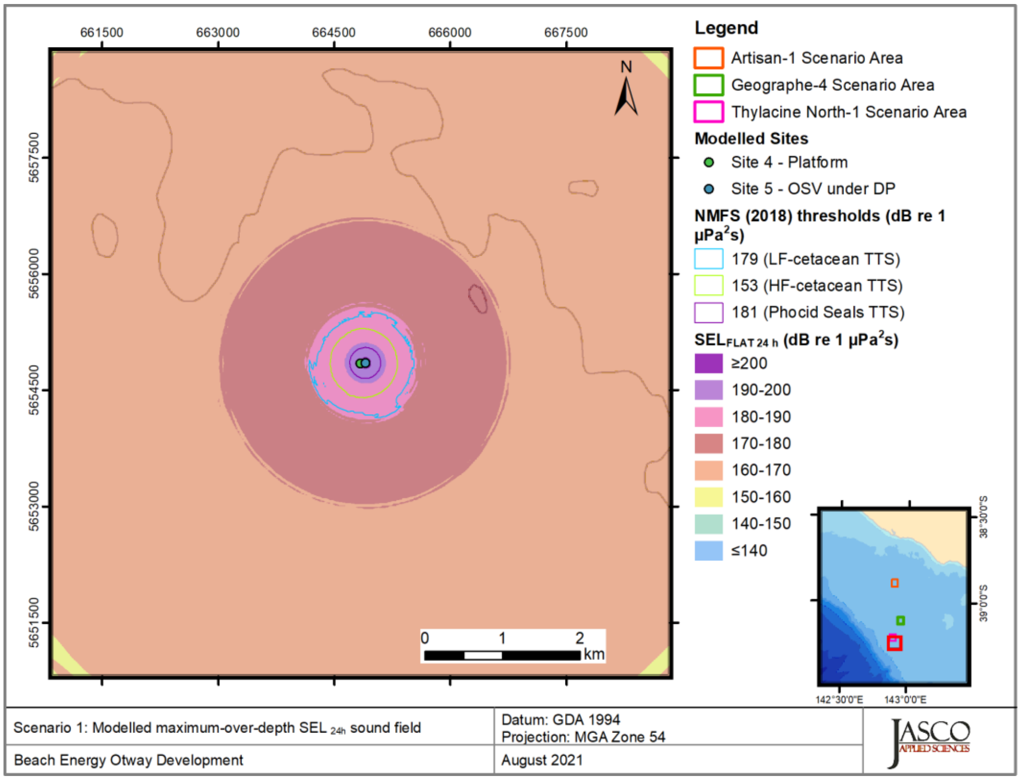


Figure 40. *Thylacine A Platform, 2 h Platform Resupply (Scenario 1) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

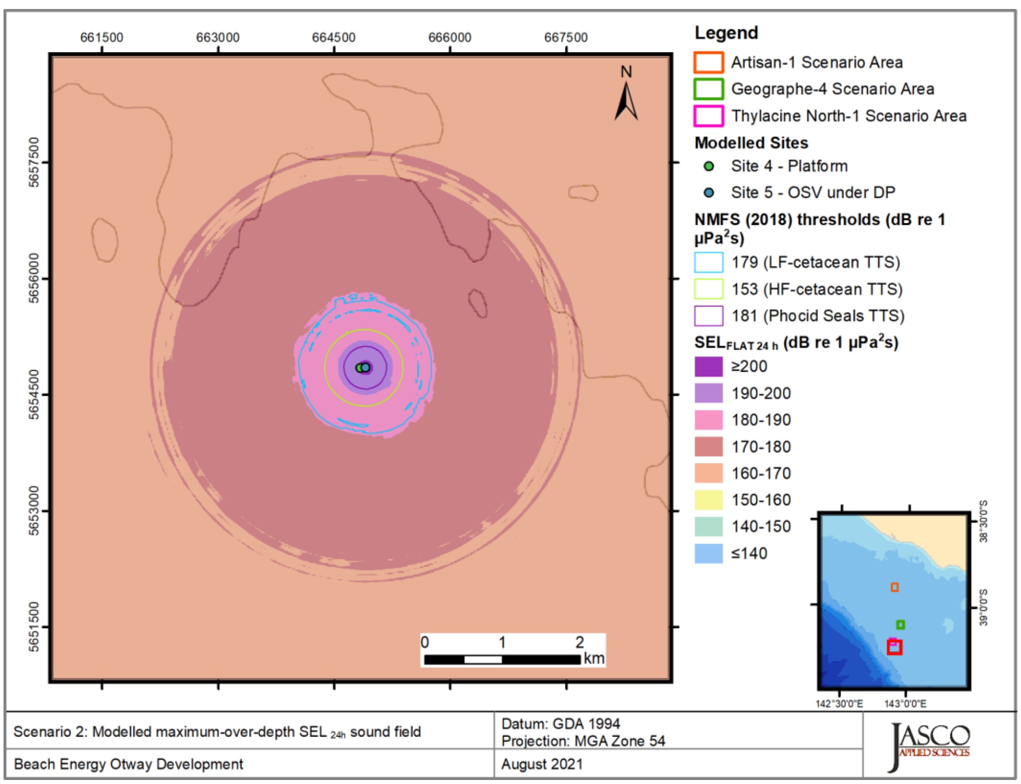


Figure 41. *Thylacine A Platform, 4 h Platform Resupply (Scenario 2) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

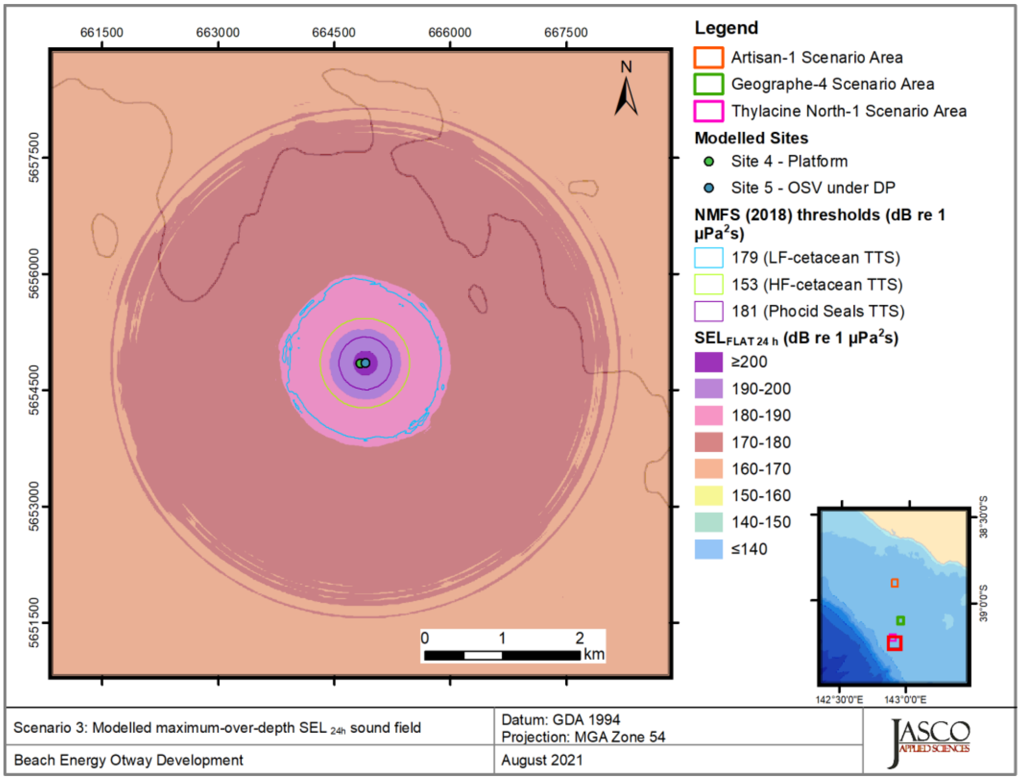


Figure 42. *Thylacine A Platform, 6 h Platform Resupply (Scenario 3) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

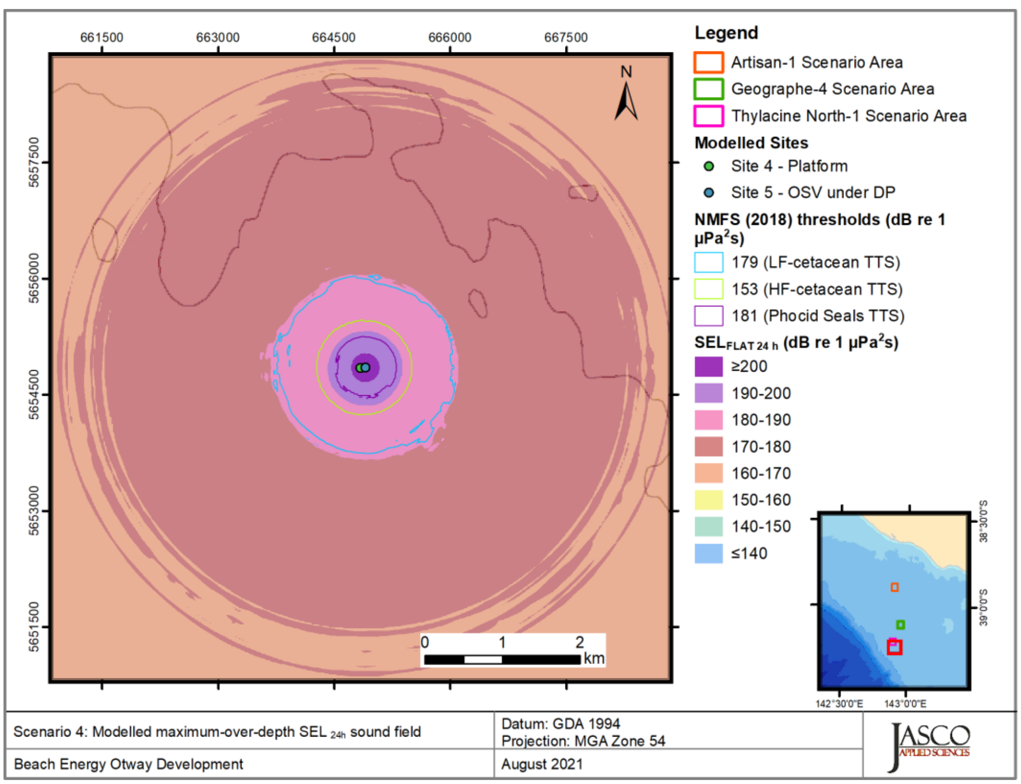


Figure 43. *Thylacine A Platform, 8 h Platform Resupply (Scenario 4) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

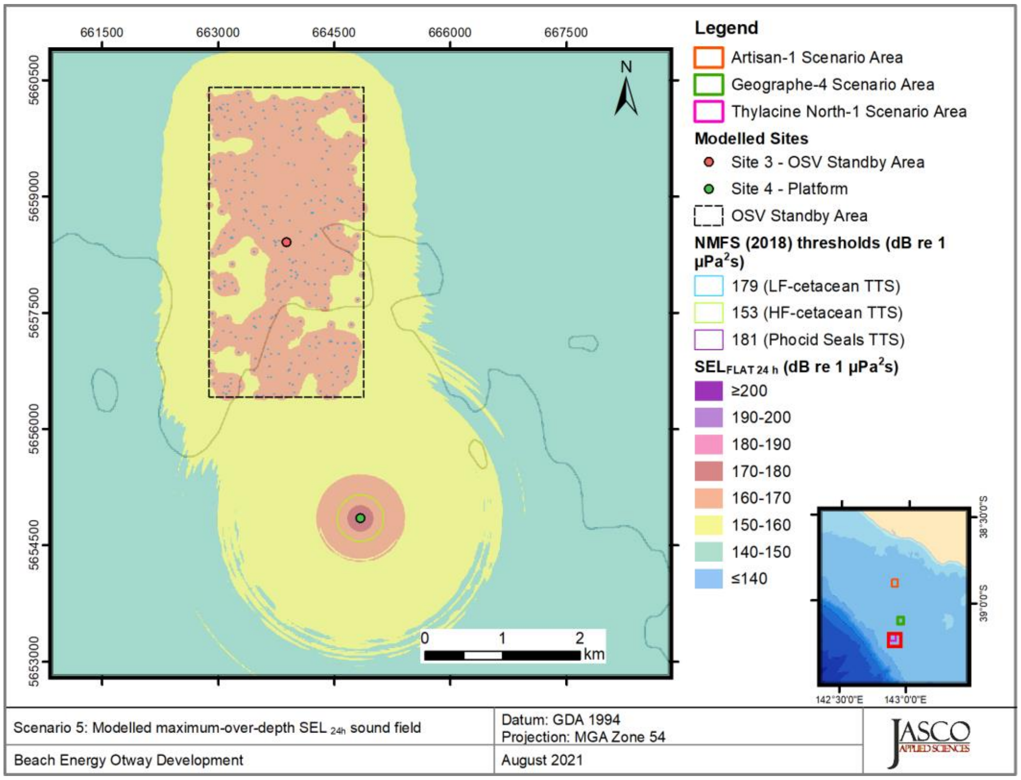


Figure 44. *Thylacine A Platform, 8h OSV standby (Scenario 5) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

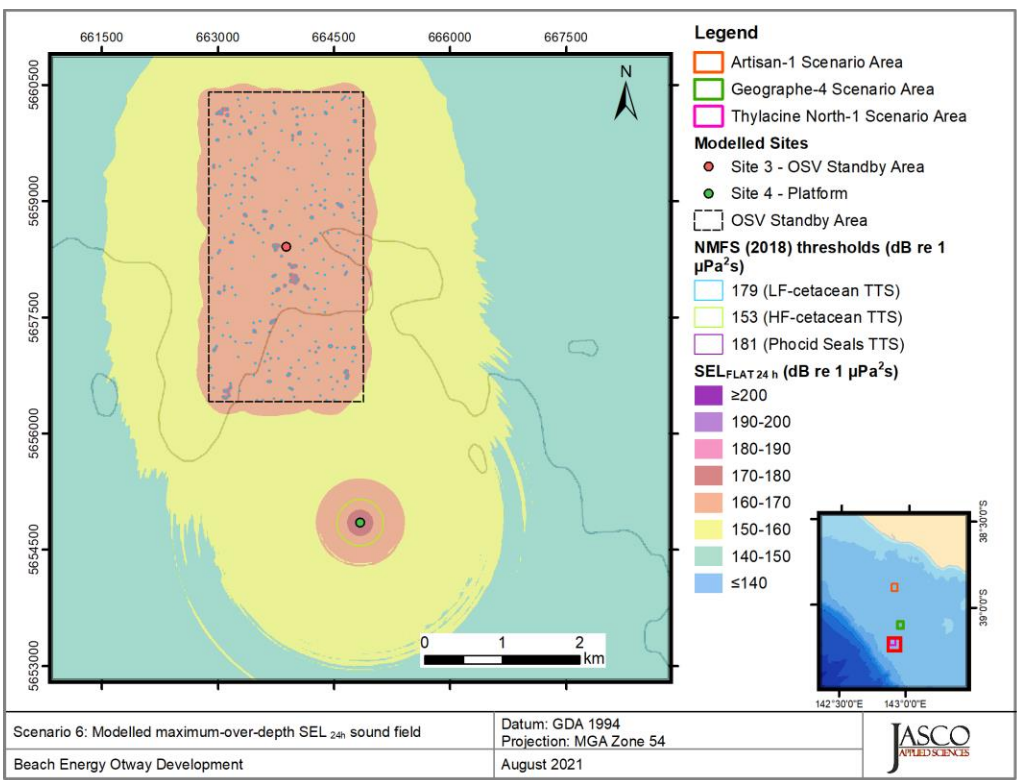


Figure 45. *Thylacine A Platform, 24h OSV standby (Scenario 6) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

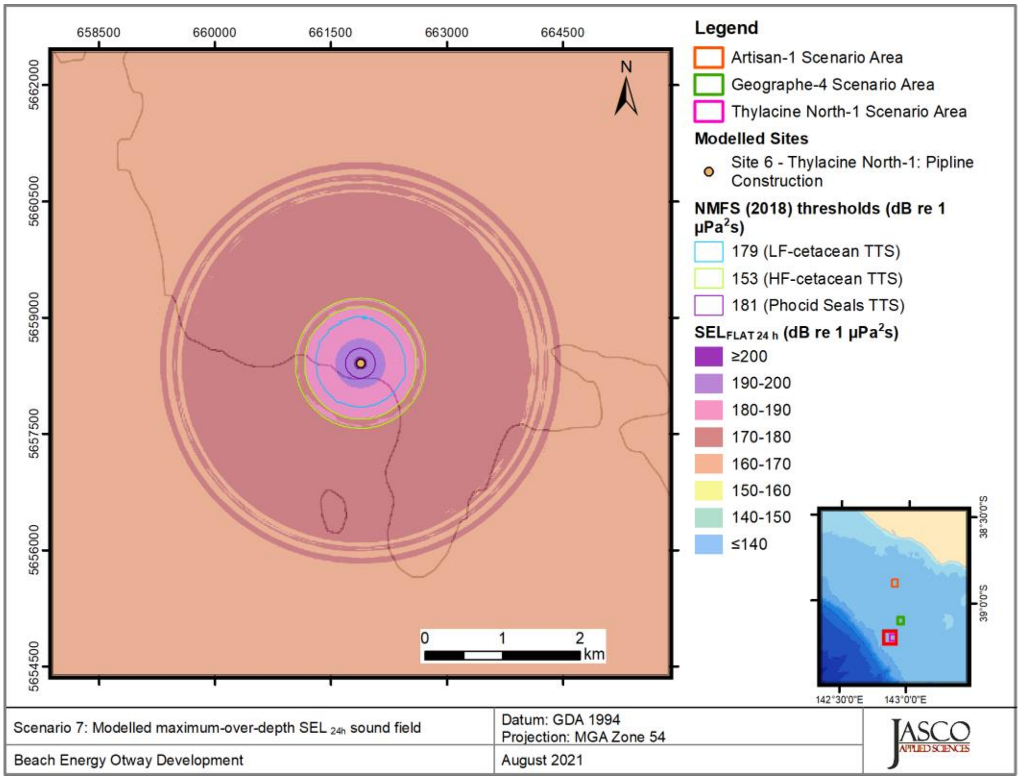


Figure 46. *Thylacine North-1, PLV stationary 20% MCR - June (Scenario 7) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

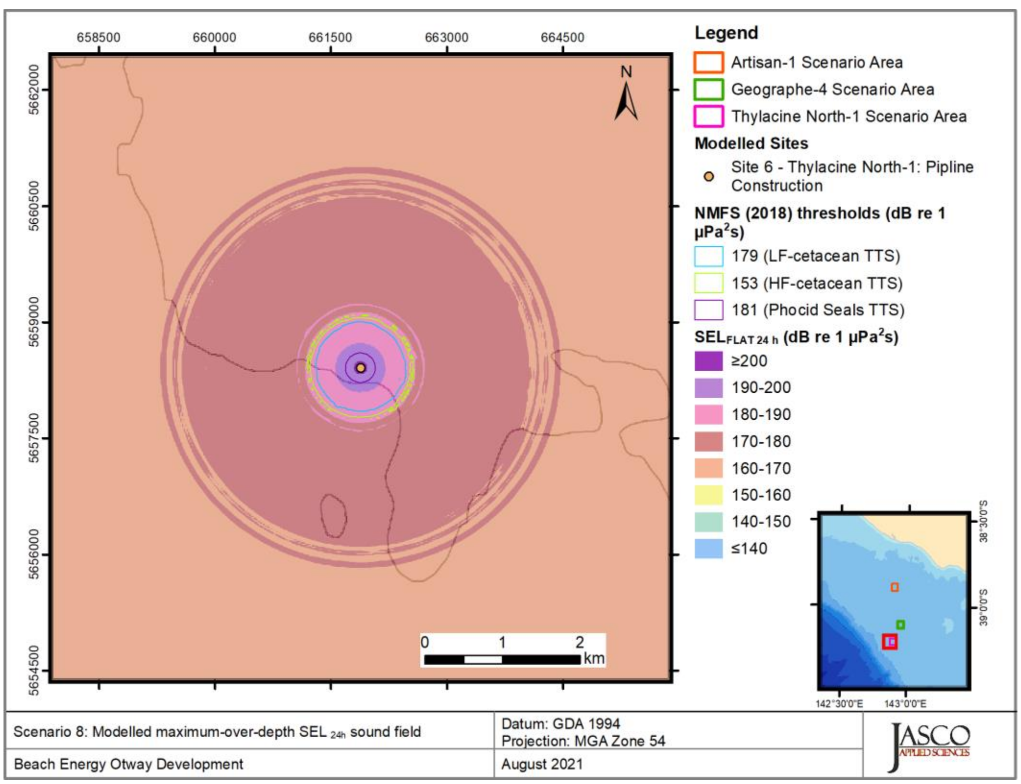


Figure 47. *Thylacine North-1, PLV stationary 20% MCR - November (Scenario 8) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

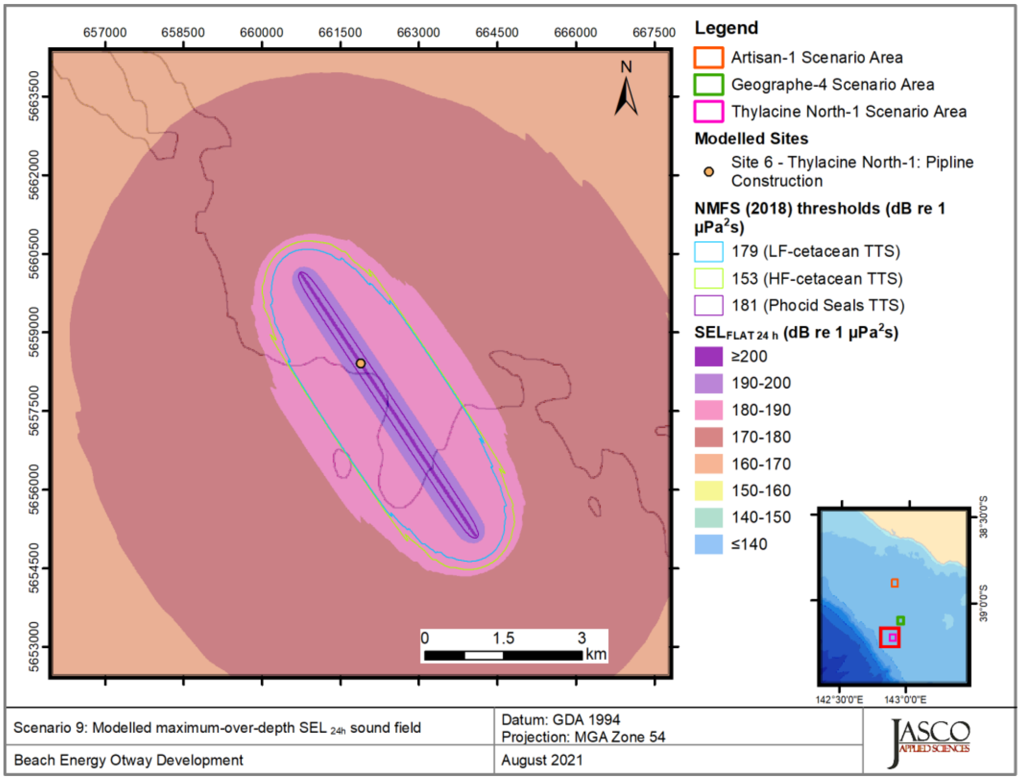


Figure 48. *Thylacine North-1, PLV pipe laying operations 20% MCR - June (Scenario 9) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

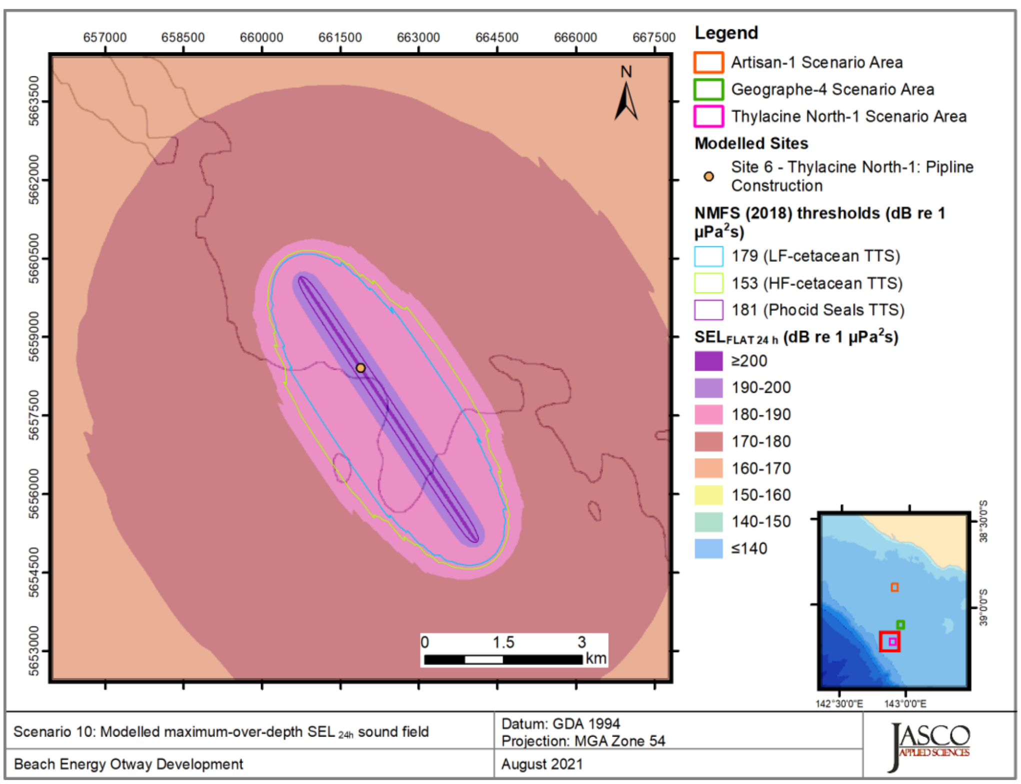


Figure 49. *Thylacine North-1, PLV pipe laying operations 20% MCR - November (Scenario 10) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

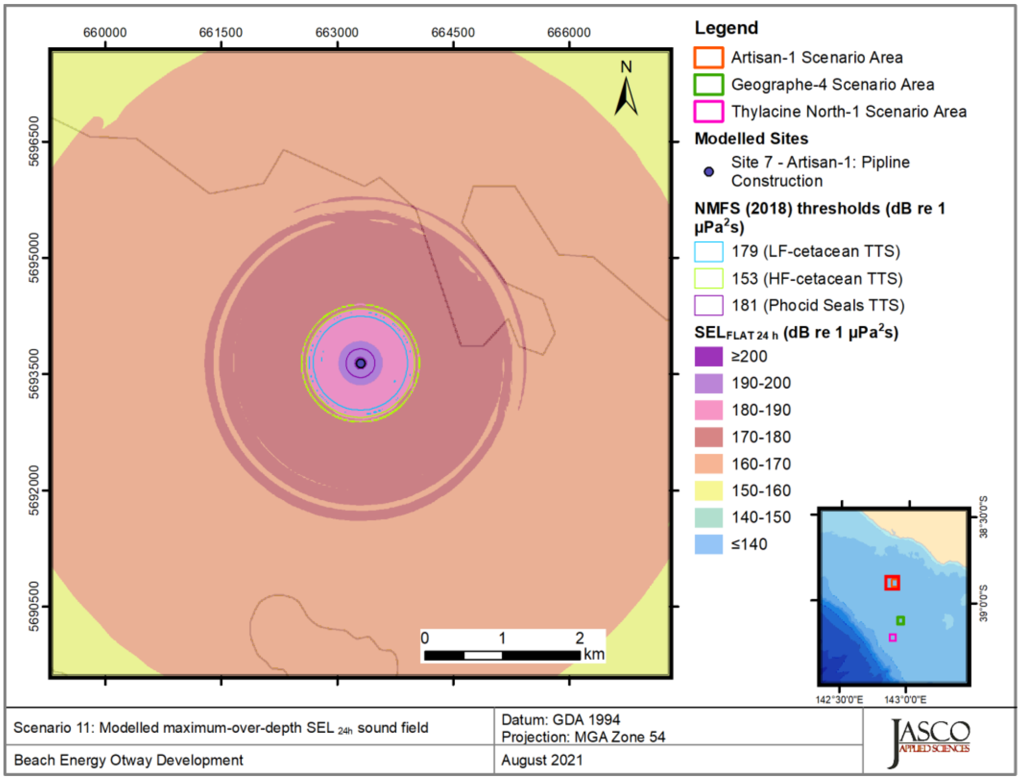


Figure 50. *Artisan-1, PLV stationary 20% MCR - June (Scenario 11) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

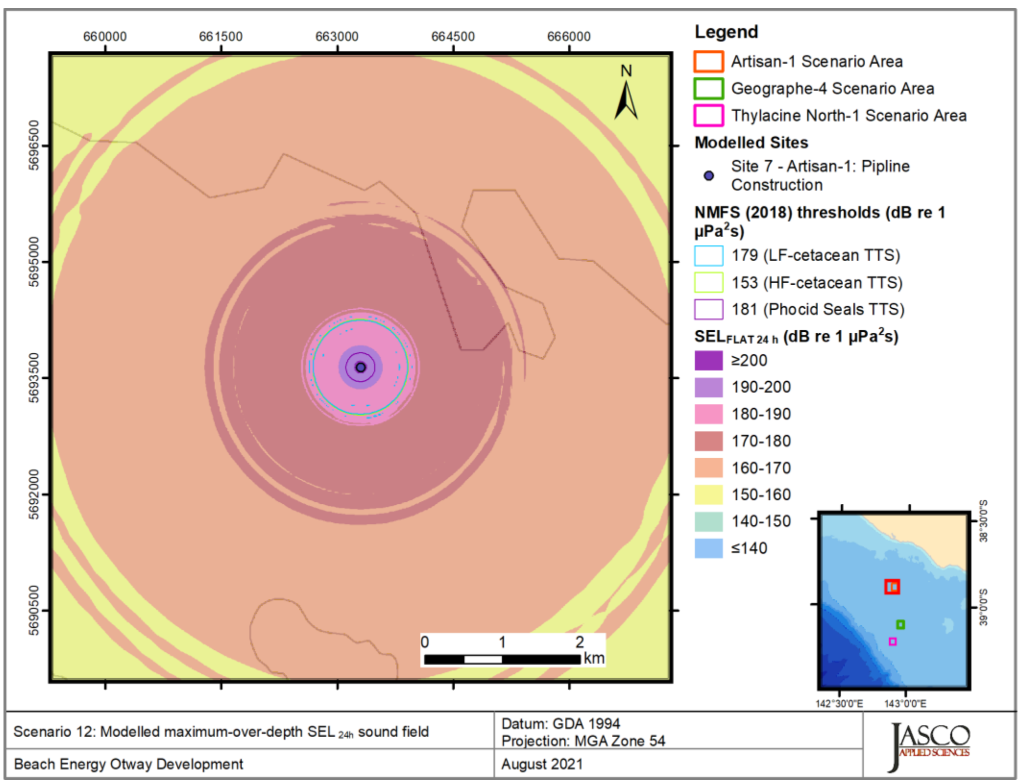


Figure 51. *Artisan-1, PLV stationary 20% MCR - November (Scenario 12) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

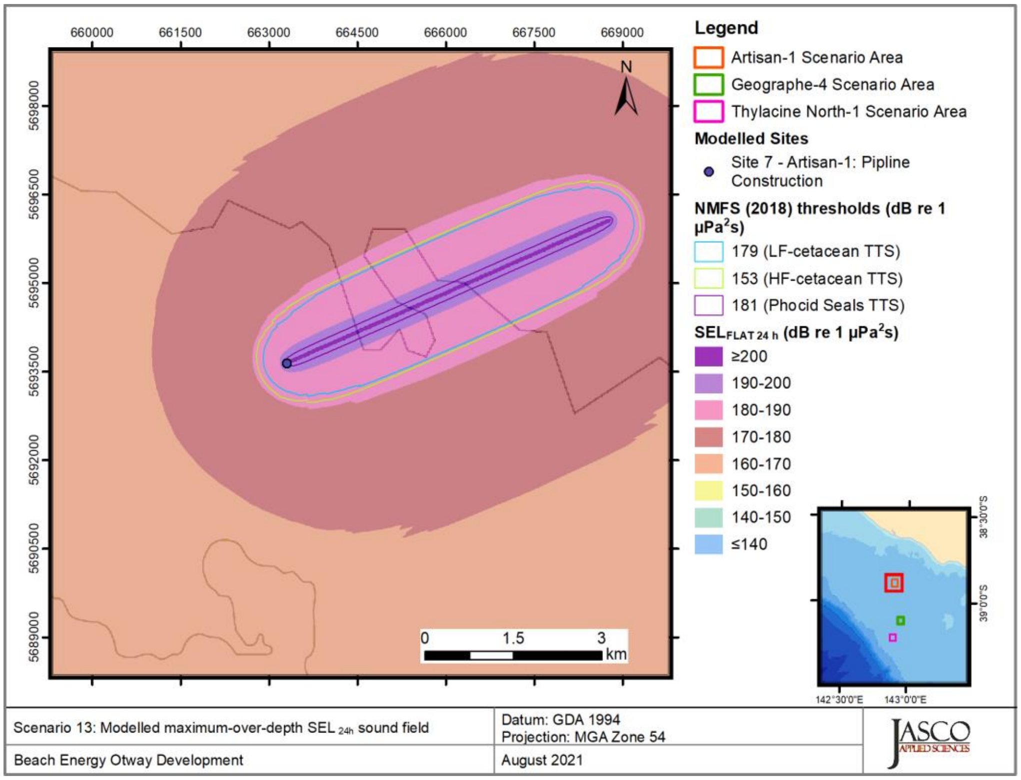


Figure 52. *Artisan-1, PLV pipe laying operations 20% MCR - June (Scenario 13)* SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

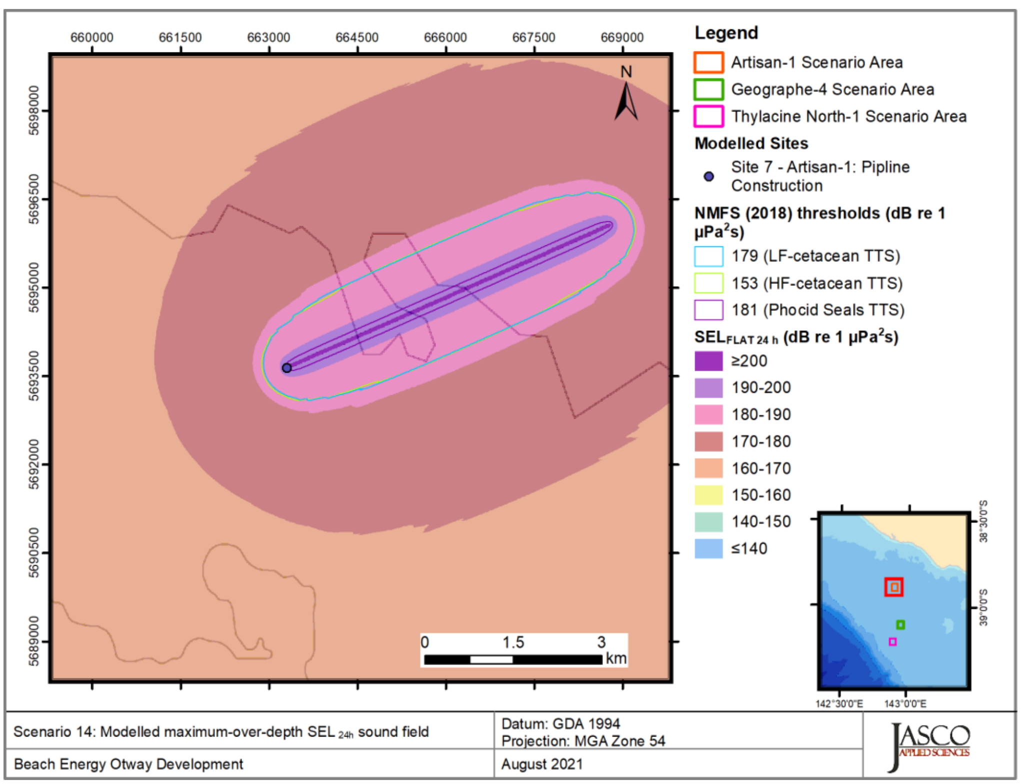


Figure 53. *Artisan-1, PLV pipe laying operations 20% MCR - November (Scenario 14)* SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

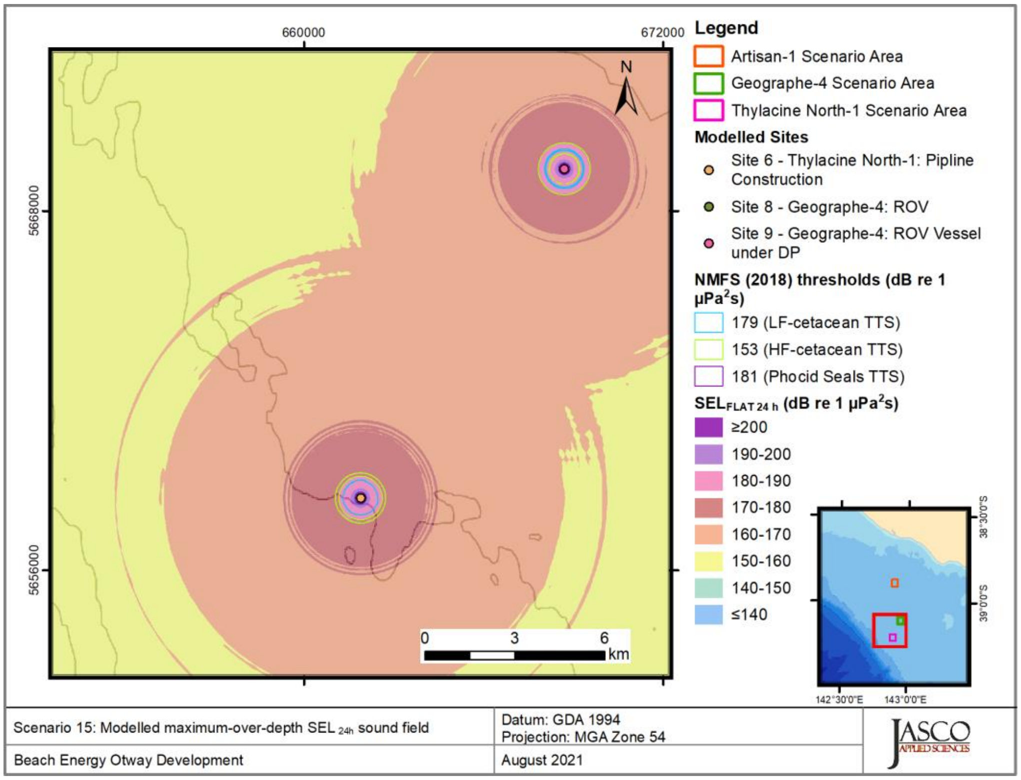


Figure 54. Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 (*20% MCR*) - June (Scenario 15) SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

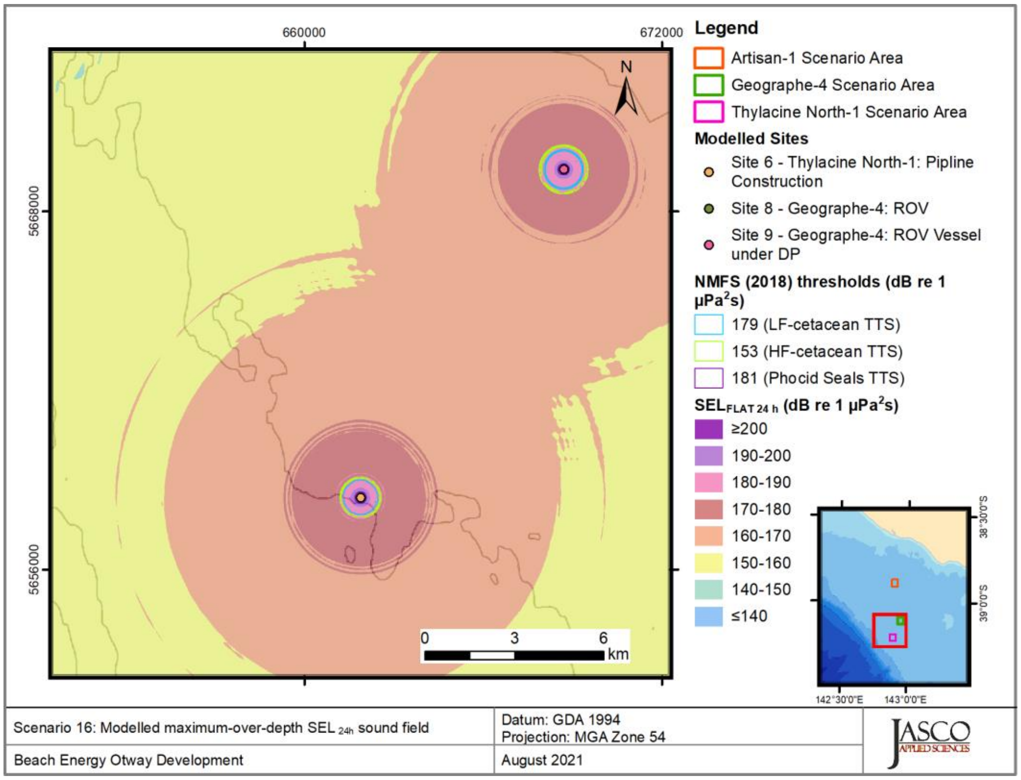


Figure 55. *Thylacine North-1, PLV stationary 20% MCR and ROV Operations at Geographe-4* (*20% MCR*) - *November (Scenario 16) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

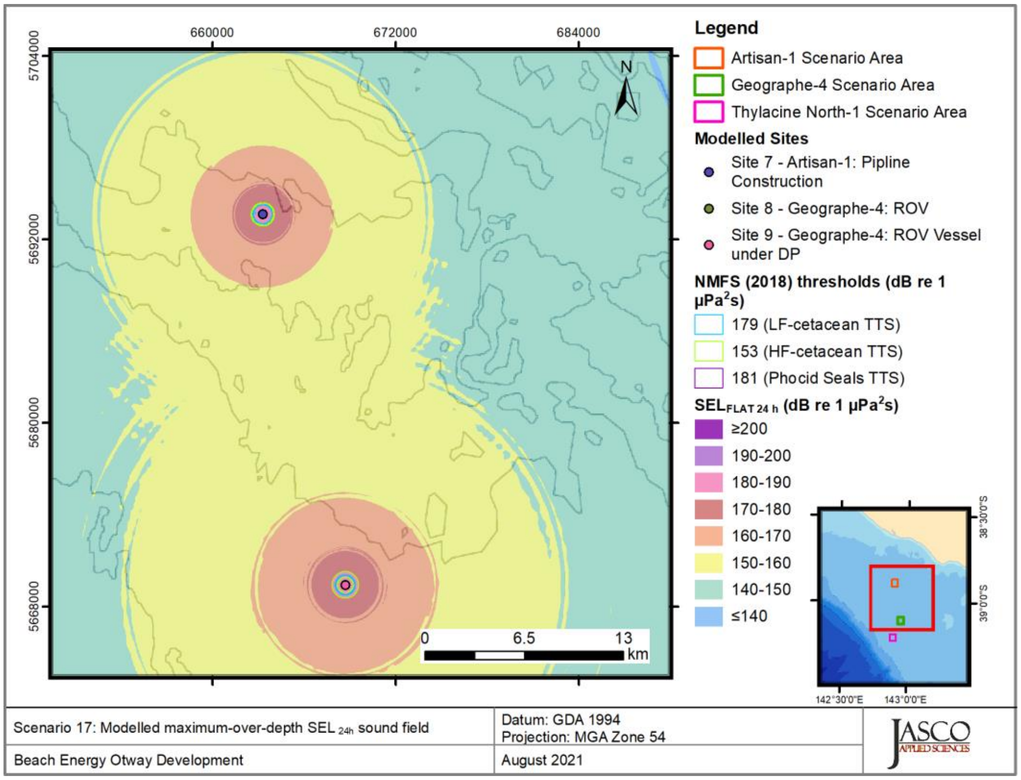


Figure 56. *Thylacine North-1, PLV stationary 20% MCR and ROV Operations at Geographe-4* (2*0% MCR*) *- June (Scenario 17) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

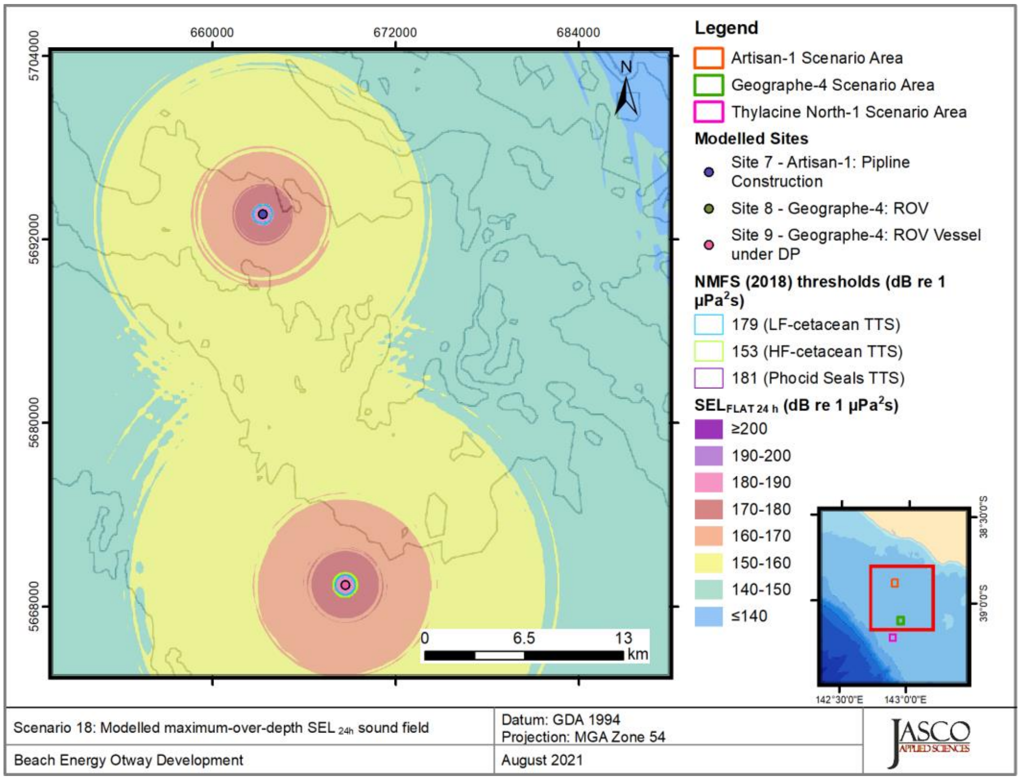


Figure 57. *Artisan-1, PLV stationary 20% MCR and ROV Operations at Geographe-4* (*20% MCR*) - *November (Scenario 18) SEL₂₄h:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

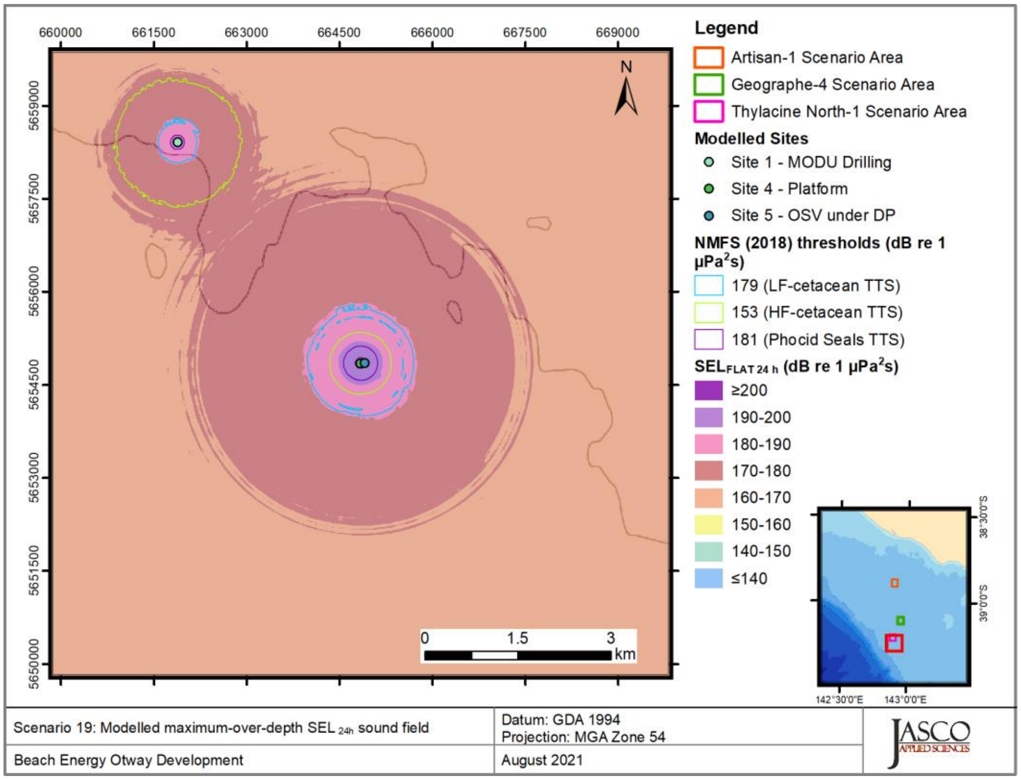


Figure 58. *Thylacine A Platform, 4h Platform Resupply and MODU Drilling (Scenario 19) SEL₂₄ₕ:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

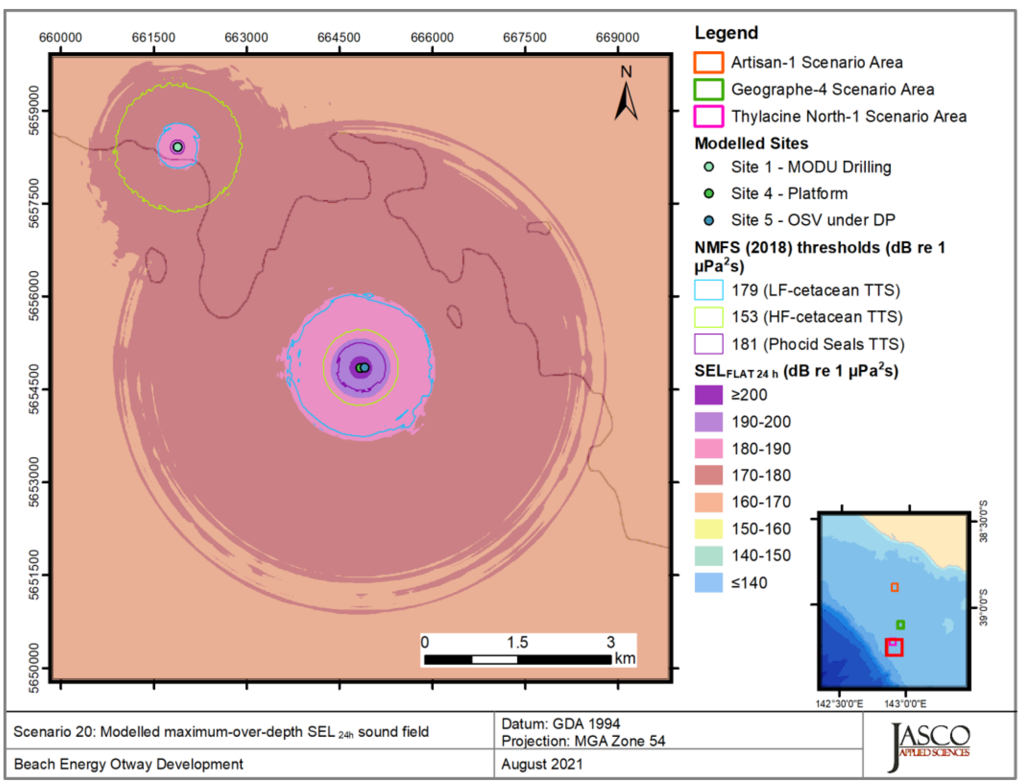


Figure 59. *Thylacine A Platform, 8h Platform Resupply and MODU Drilling (Scenario 20) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

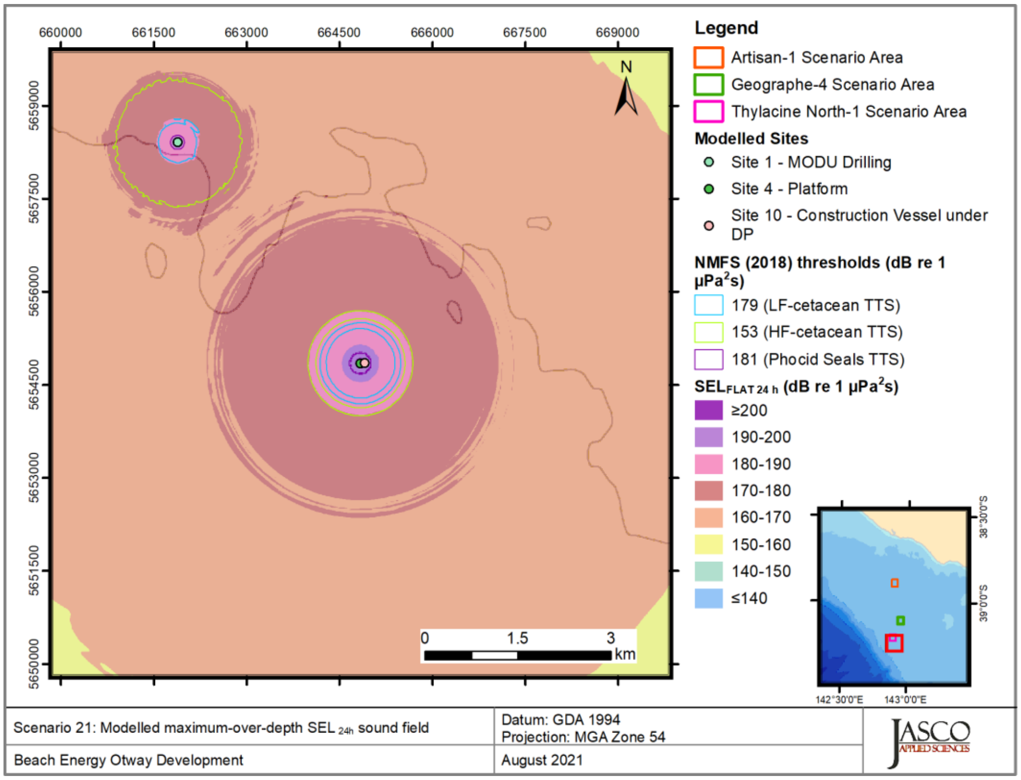


Figure 60. *Thylacine A Platform, Skid installation vessel operating at 20% MCR and MODU Drilling (Scenario 21) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

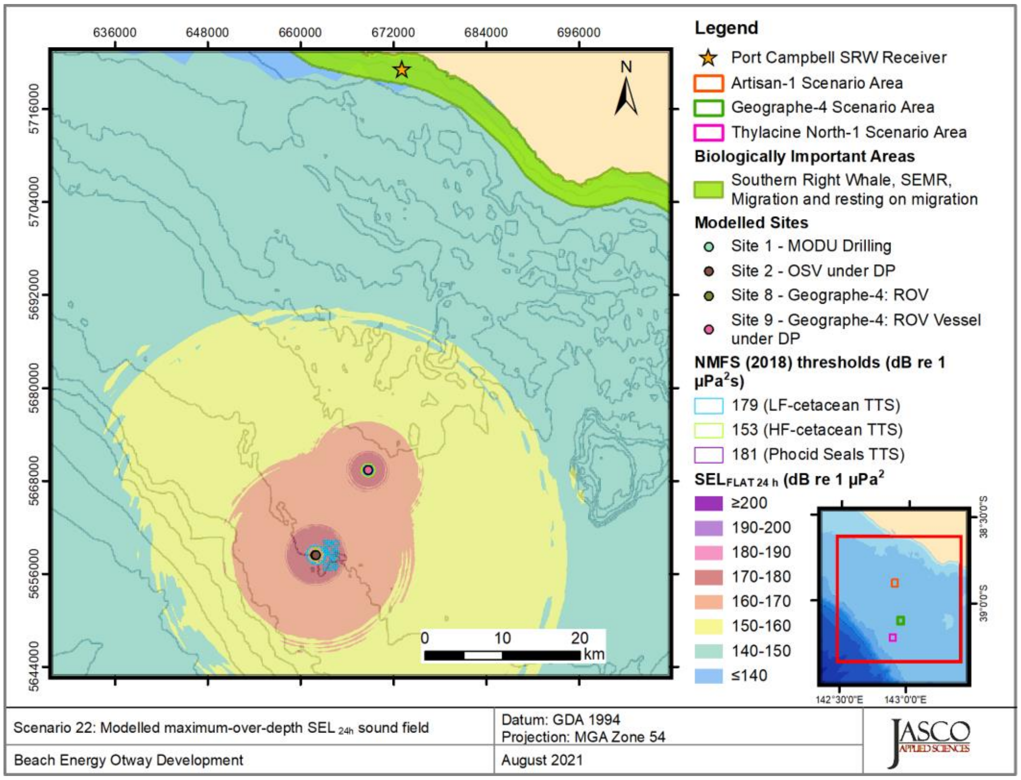


Figure 61 *Concurrent drilling operations at Thylacine North-1 and construction operations (20% MCR) at Geographe-4 (Scenario 22) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

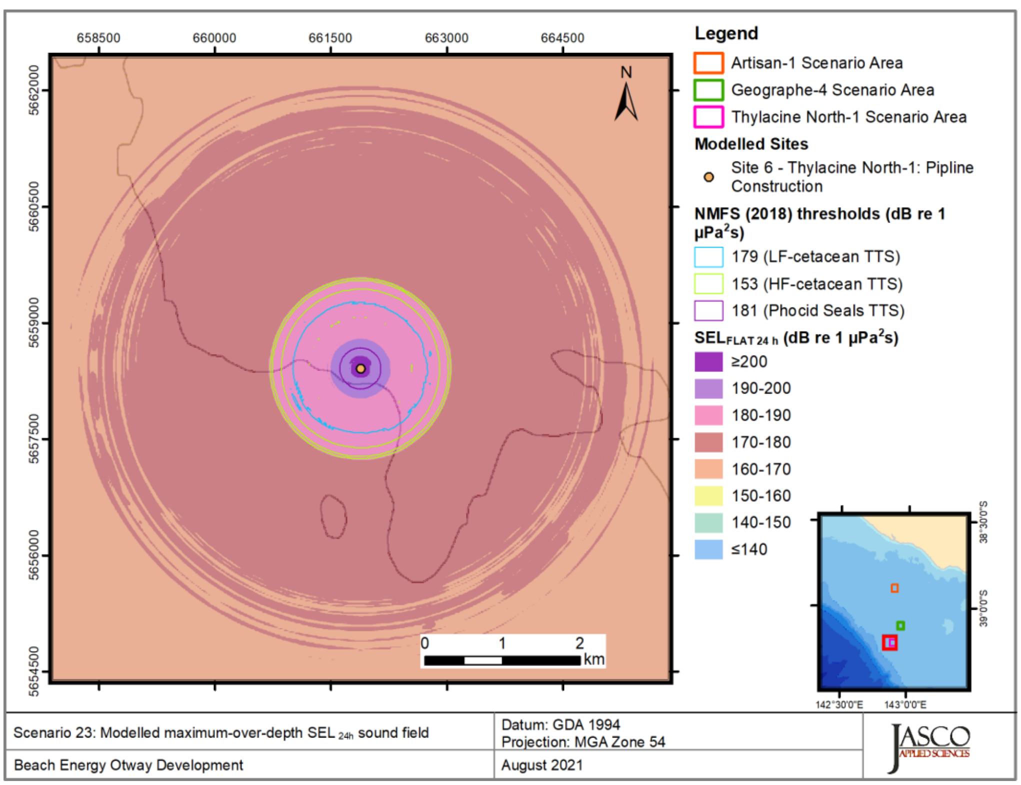


Figure 62. *Thylacine North-1, PLV stationary 40% MCR -June (Scenario 23) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

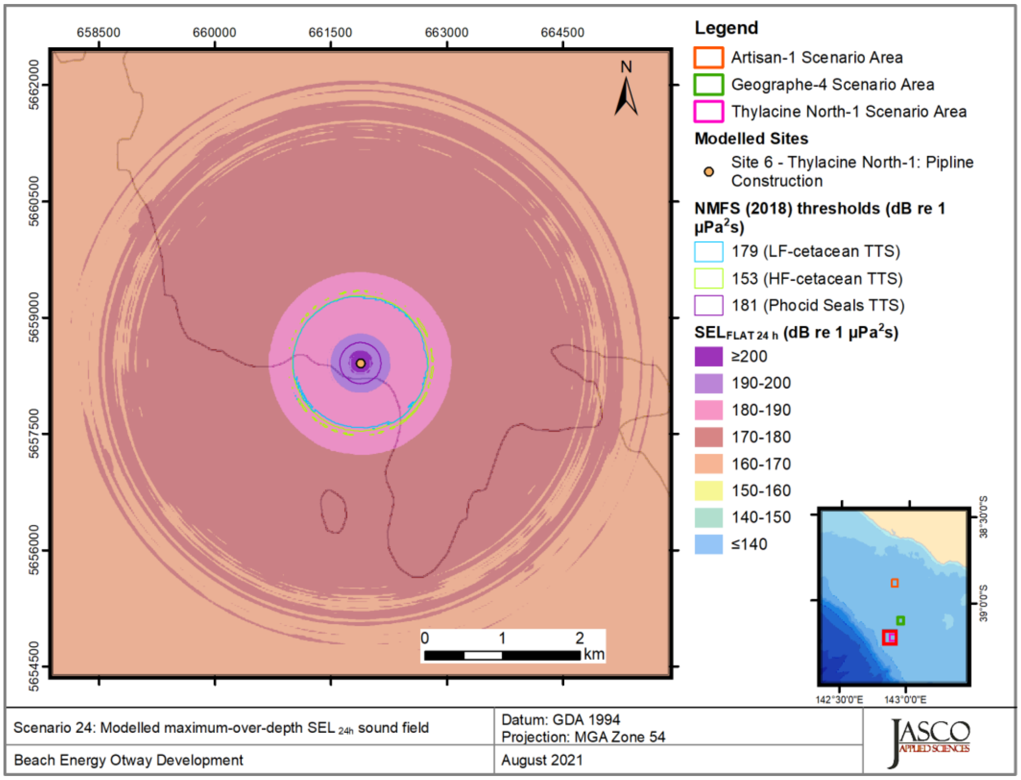


Figure 63. *Thylacine North-1, PLV stationary 40% MCR - November (Scenario 24) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

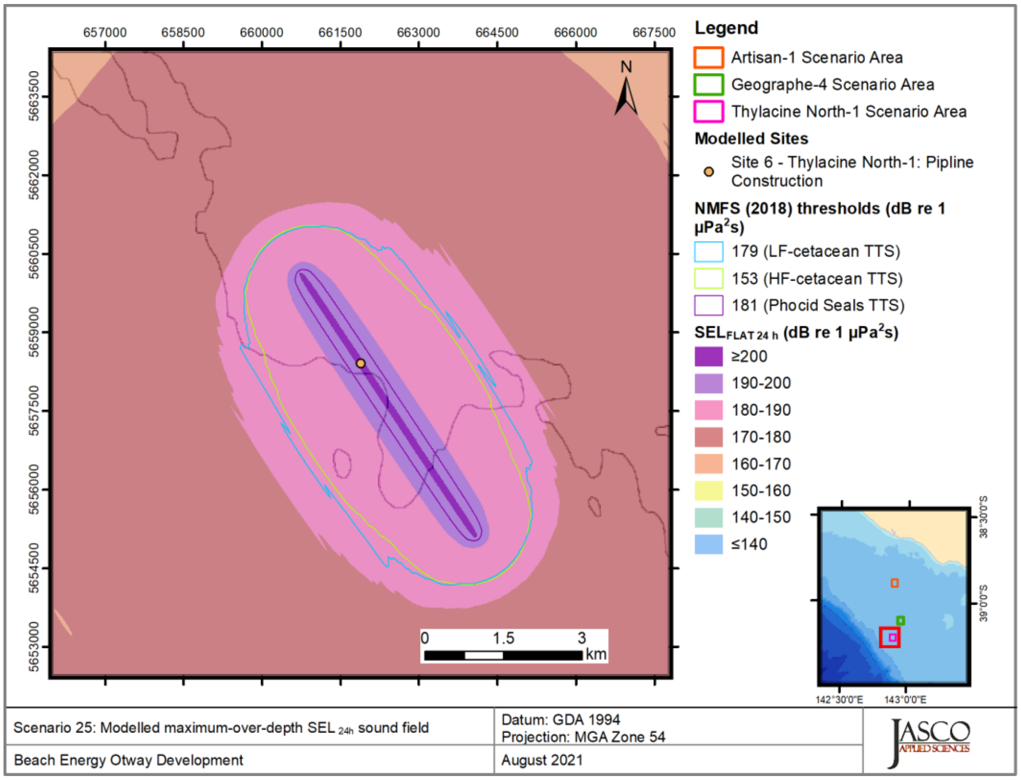


Figure 64. *Thylacine North-1, PLV pipe laying operations 40% MCR - June (Scenario 25) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

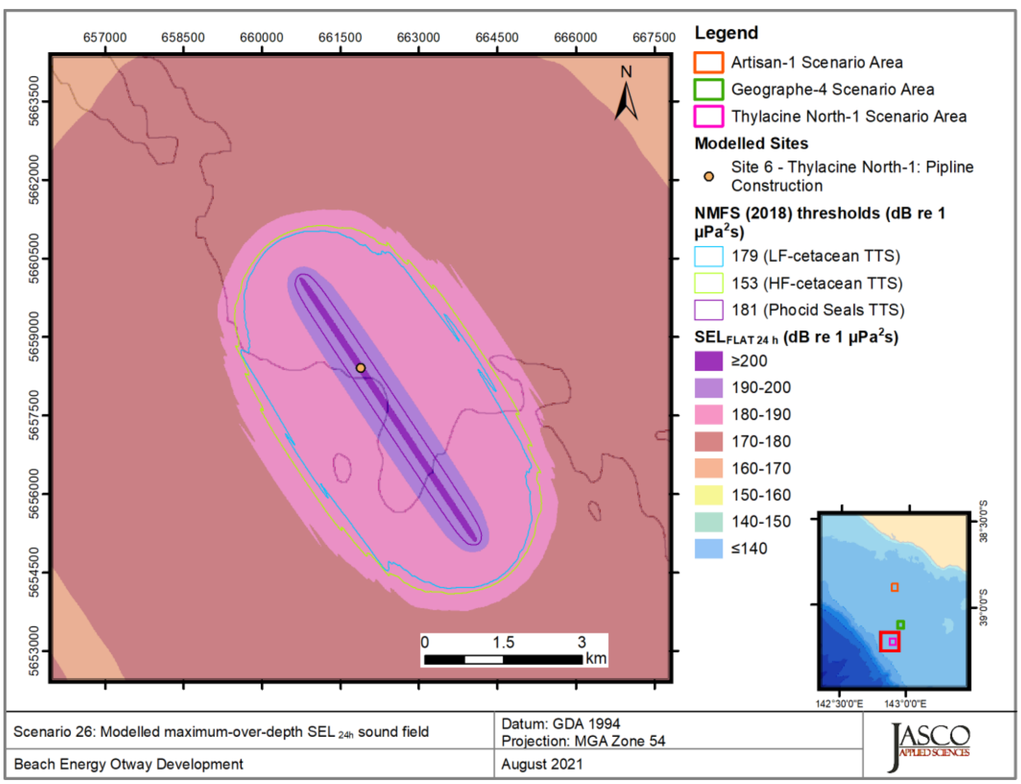


Figure 65. *Thylacine North-1, PLV pipe laying operations 40% MCR - November (Scenario 26) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

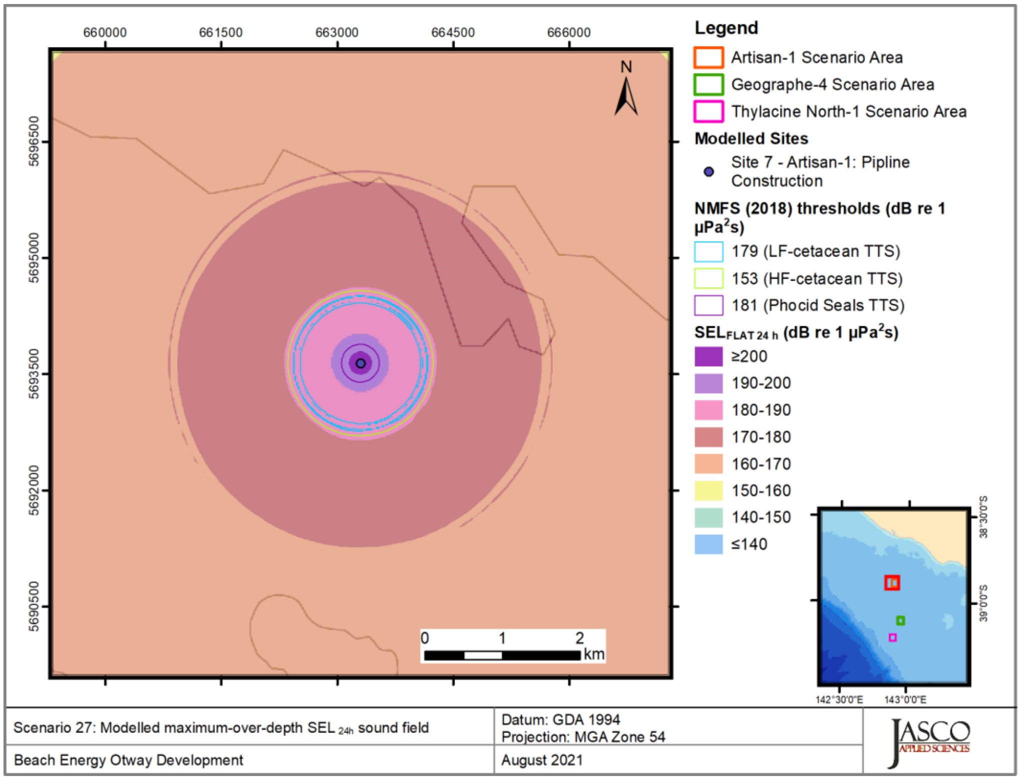


Figure 66. *Artisan-1, PLV stationary 40% MCR - June (Scenario 27) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

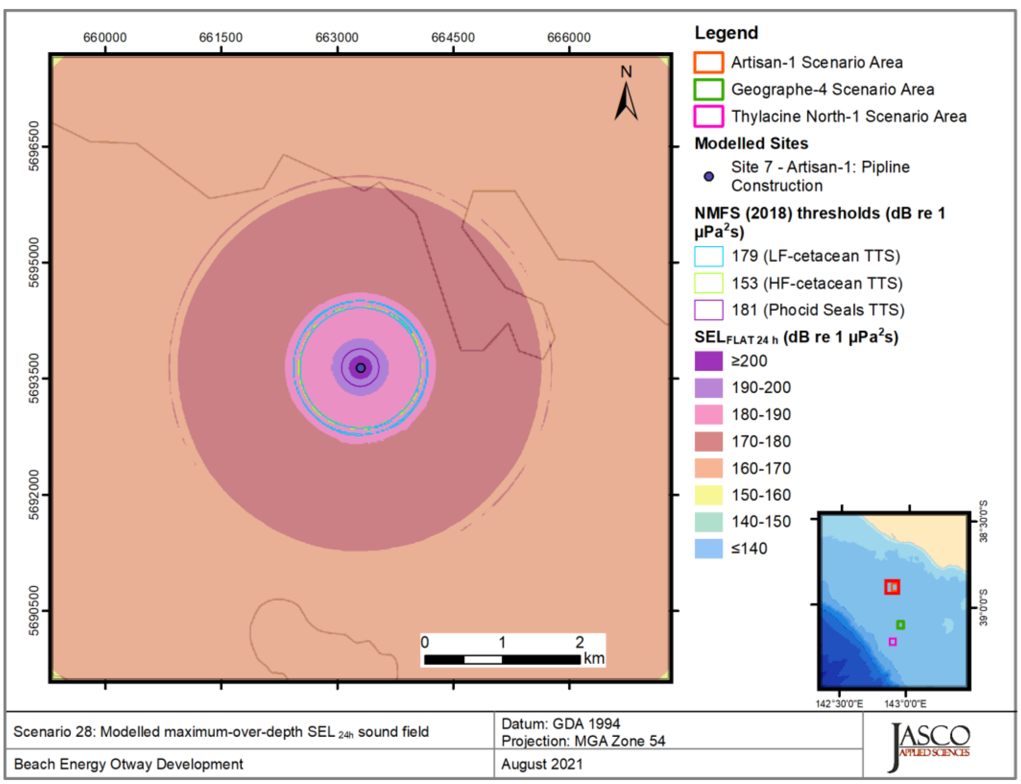


Figure 67. *Artisan-1, PLV stationary 40% MCR - November (Scenario 28) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

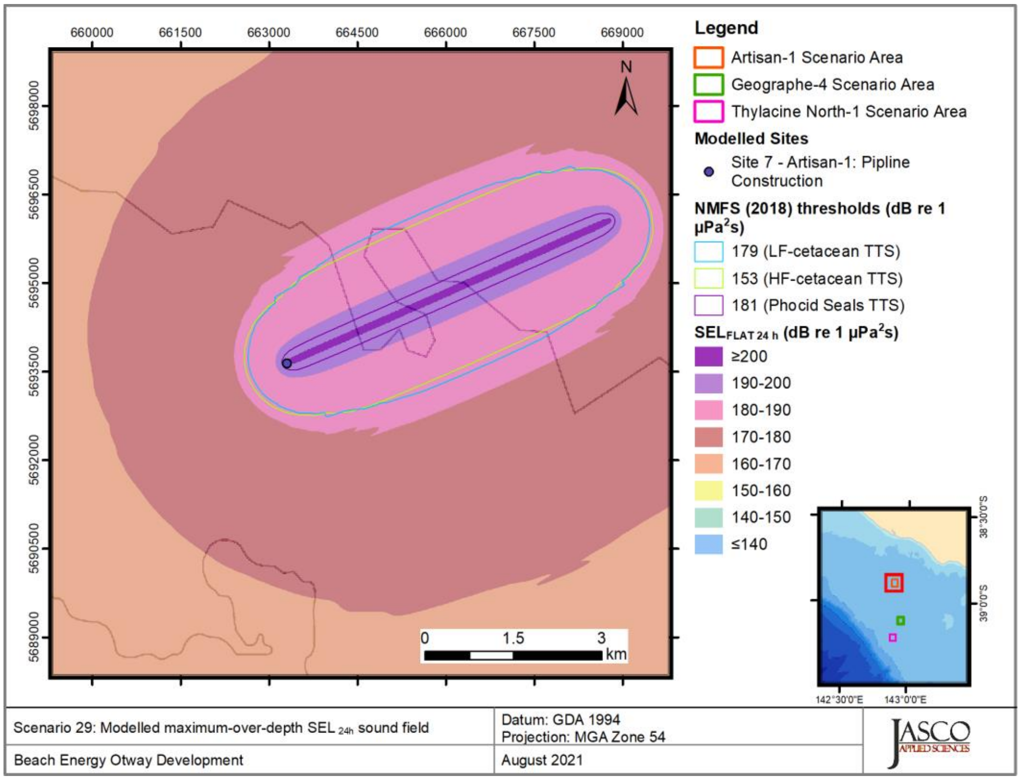


Figure 68. *Artisan-1, PLV pipe laying operations 40% MCR - June (Scenario 29)* SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

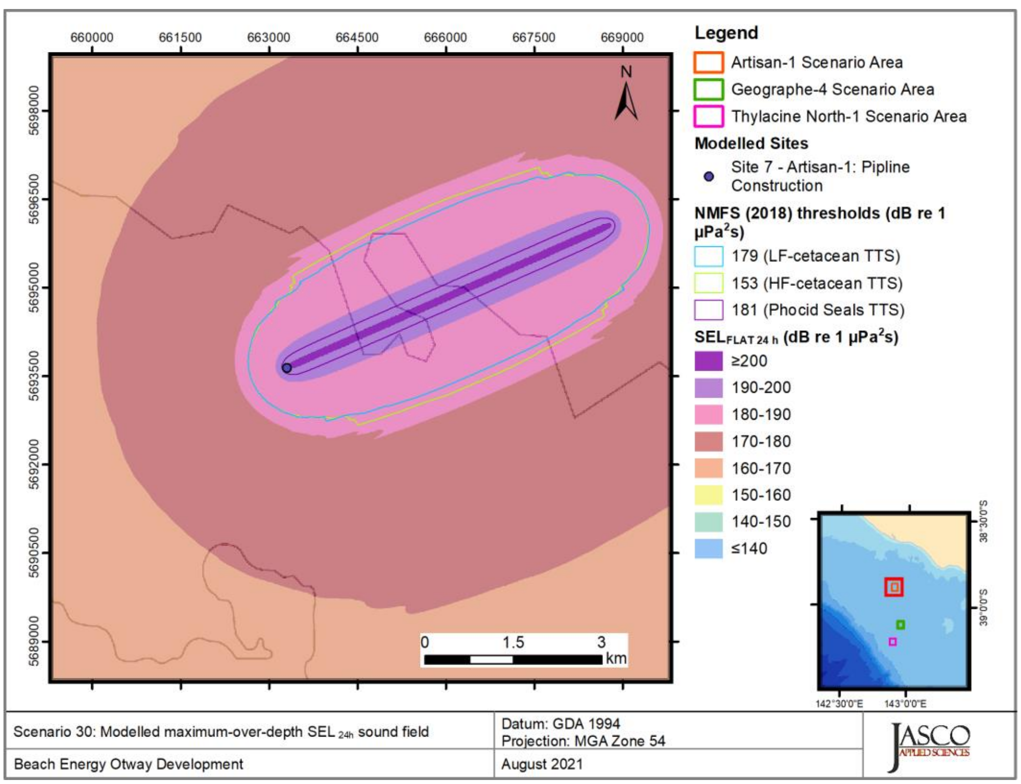


Figure 69. *Artisan-1, PLV pipe laying operations 40% MCR - November (Scenario 30)* SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

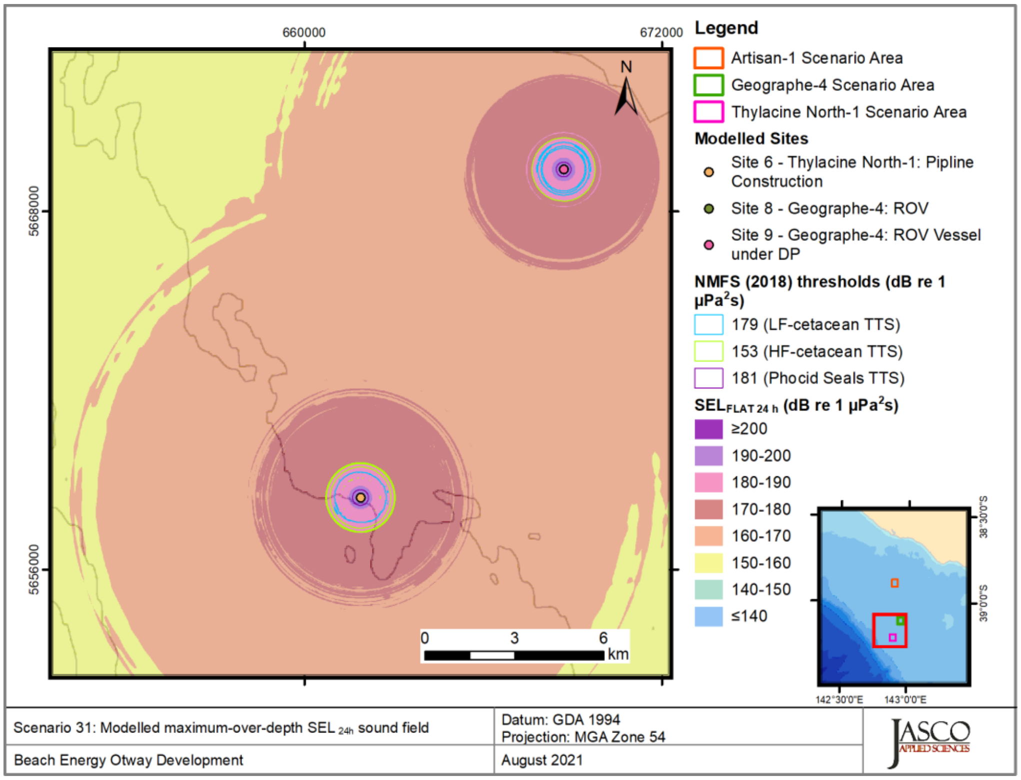


Figure 70. Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 (*40% MCR*) - June (Scenario 31) SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

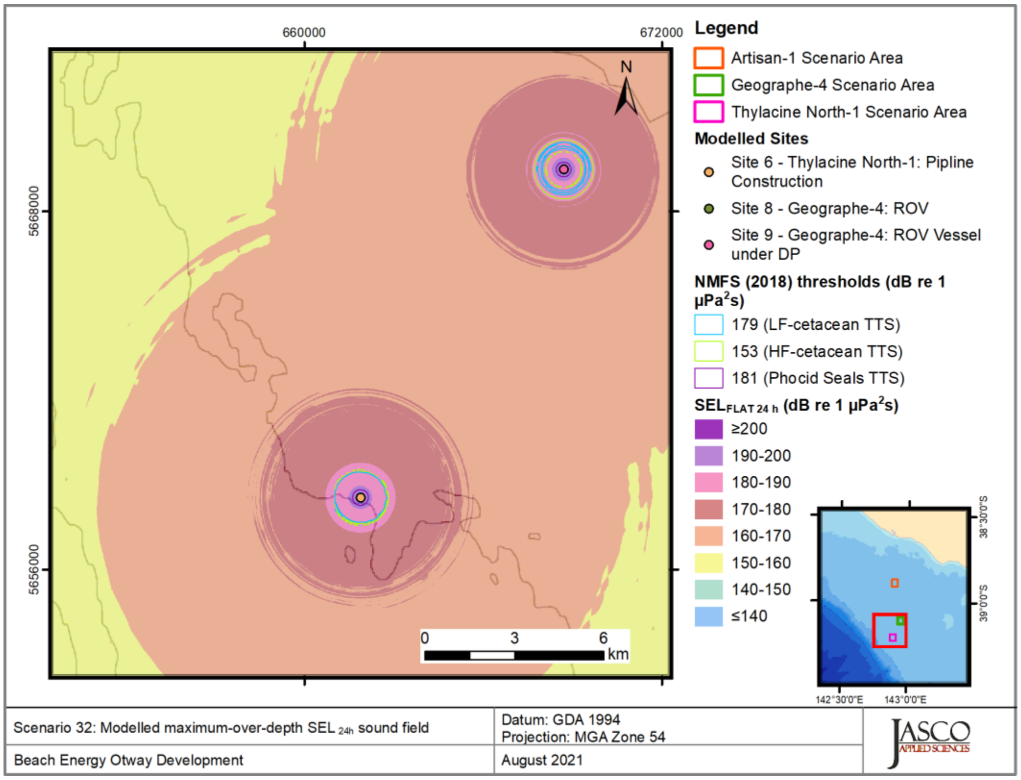


Figure 71. *Thylacine North-1, PLV stationary and ROV Operations at Geographe-4* (*40% MCR*) - *November (Scenario 32) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

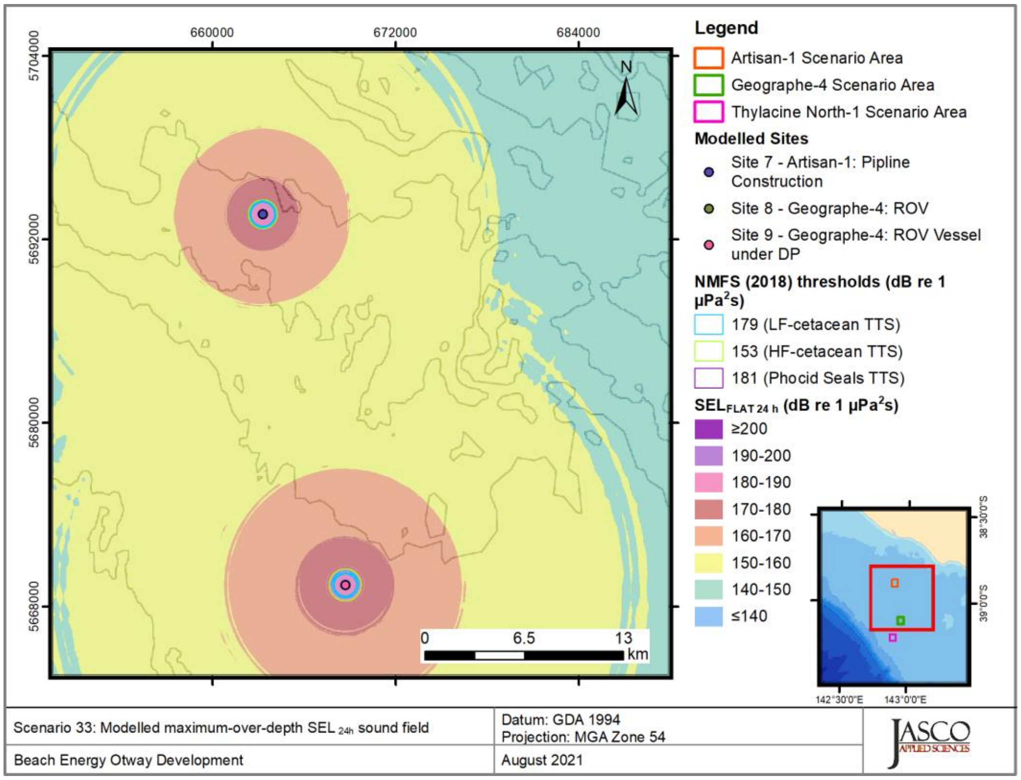


Figure 72. *Thylacine North-1, PLV stationary and ROV Operations at Geographe-4* (*40% MCR*) - *June (Scenario 33) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

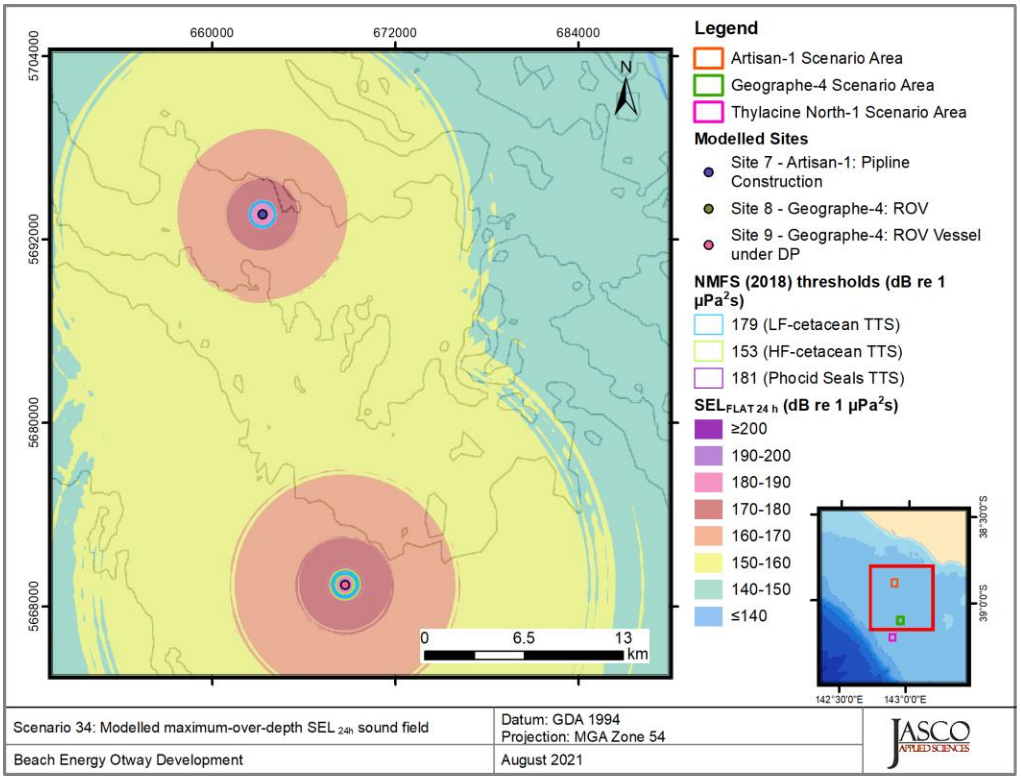


Figure 73. *Artisan-1, PLV stationary and ROV Operations at Geographe-4* (*40% MCR*) - *November (Scenario 34) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

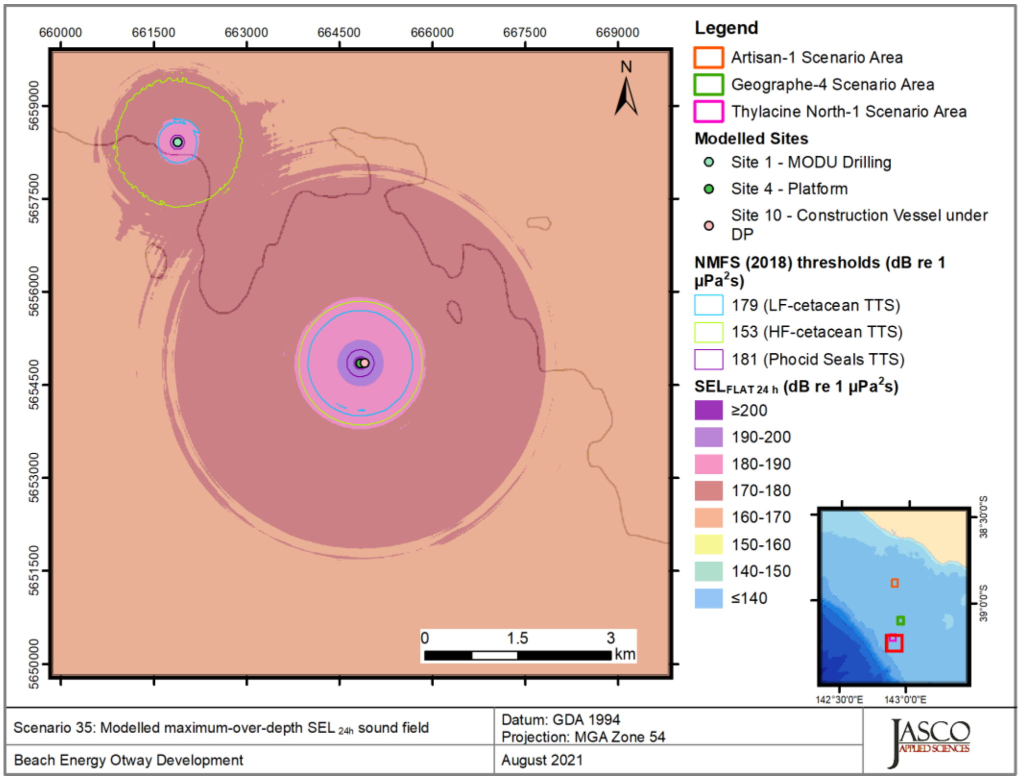


Figure 74. *Thylacine A Platform, Skid installation vessel operating at 40% MCR and MODU Drilling (Scenario 35) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

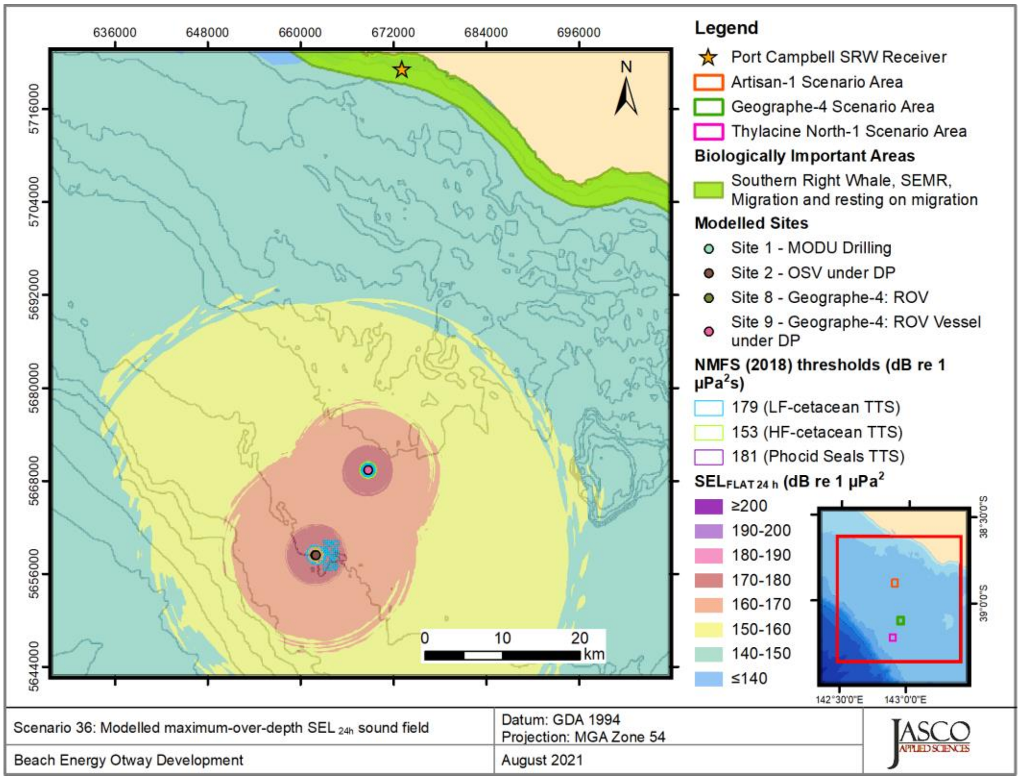


Figure 75 *Concurrent drilling operations at Thylacine North-1 and construction operations (40% MCR) at Geographe-4 (Scenario 36) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

5. Discussion

The approach applied here to model the propagation loss was based is suitable for other locations within the continental shelf portion of the Otway Basin because it is supported by measurements of very similar operational activities (McPherson et al. 2021). However, the accuracy of the modelling propagation loss within this environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on the calcarenite seabed within Otway region. In general, for these types of sources (i.e., vessels and other sources with a significant amount of energy above a few hundred Hertz) the thinner the sand layer, the greater the propagation loss. Having accurate source and site-specific information reduces the amount of uncertainty results due to model inputs uncertainty particularly when seemingly small changes in parametrisation can have reasonable significant changes in predicted results.

The distances to the effect thresholds based on modelling conducted here and supported by the results of the measurement study McPherson et al. (2021) are generally smaller when compared to those originally presented in Koessler et al. (2020). The understanding of the environment gained through the measurement study allowed for the geological environment to be represented in a site-specific fashion, and a more appropriate configuration of numerical models to represent the environmental propagation loss particularly with the layered calcarenite seabed. The application of the revised modelling approach to represent other Beach Energy activities on the continental shelf of the Otway Basin would be appropriate.

The maximum-over-depth sound field maps presented above show a few instances where threshold contours form concentric ‘rings’ around a source. These are likely the product of propagation interference patterns and the calculations method to account for the loss associated with the cemented limestone seabed (Section 6.2 in McPherson et al. (2021)). Variations in the sound field can produce local maxima and minima in loss which can results in specific levels dipping below thresholds before reaching a maximum extent. Moreover, the near constant bathymetry around most sources produces axial symmetry around a given source. Together these two factors can form the observed ‘rings’. Nevertheless, the maximum extent of these contours and associated tabulated radii are a valid prediction of the effect ranges that can be expected from the modelled operations.

The effect of different seasonality on predicted distances to the effect thresholds was minor but present. Considering the modelled Otway Offshore Project Construction scenarios, each scenario was modelled with a sound speed profiles for the ‘worst case over the year’ and for a period pygmy blue whales are present in the region, between November and January. These sound speed profiles were respectively selected as June and November. The effect thresholds applied to pygmy blue was the low-frequency cetacean SEL_{24h} thresholds based on NMFS (2018). The sound speed profile of November generally produced small distances to the low-frequency cetacean PTS and TTS threshold for the same operational activities modelled with a June SSP, see Tables 13–15. The seasonal differences were at most a few hundred metres. The receiver SPL level at the Port Campbell receiver locations presented in Table 10 are therefore expected to be lower in in November.

The SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The corresponding SEL_{24h} radii represent an unlikely worst-case scenario. More realistically, marine mammals (as well as fish and turtles) are unlikely to stay in the same location for 24 hours. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained in that location for 24 hours.

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Appendix A. Acoustic Metrics

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 impulsive noise 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 noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The sound pressure level (SPL; L_p; dB re 1 μPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to a rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2\right) \tag{A-1}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalization, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL.

The sound exposure level (SEL; L_E; $L_{E,p}$; dB re 1 μPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2\right) \tag{A-2}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, SEL can be computed by summing (in linear units) SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right) . \tag{A-3}$$

Appendix B. Methods and Parameters

This section describes the specifications of the seismic source that was used at all sites and the environmental parameters used in the propagation models.

B.1. 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-1).

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-1(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-1(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.

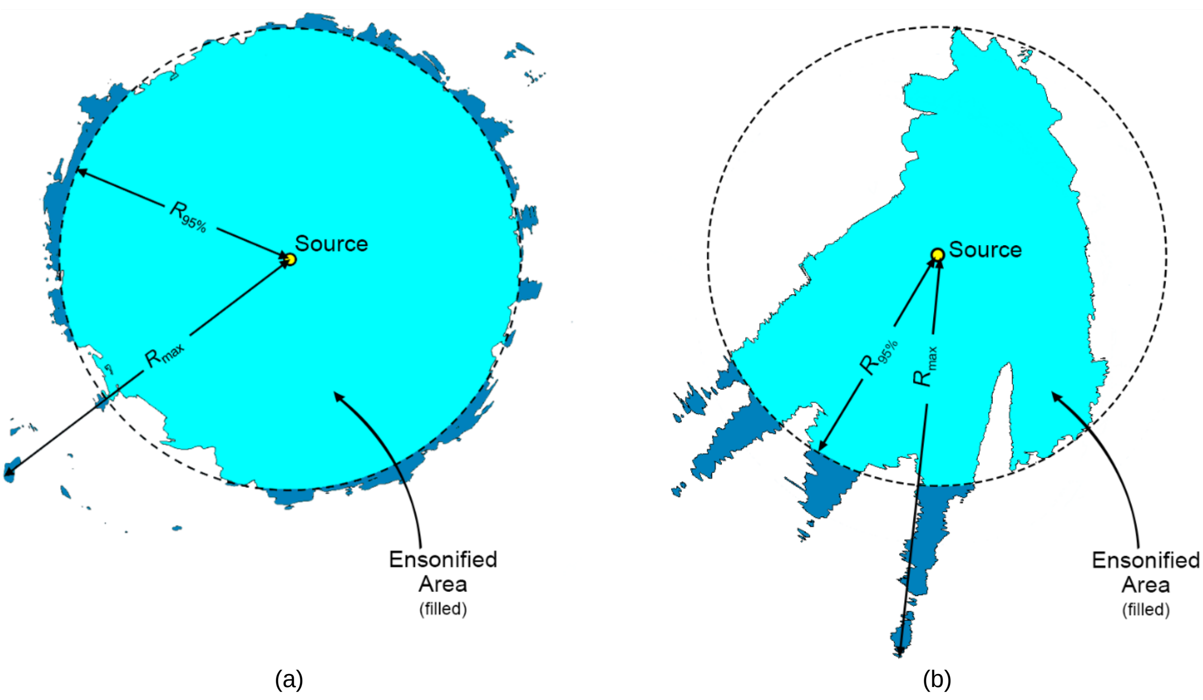

Figure B-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

B.2. Environmental Parameters

B.2.1. Bathymetry

Water depths throughout the modelled areas were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009). Bathymetry data were re-gridded onto a Map Grid of Australia (MGA) coordinate projection (Zone 54) with a regular grid spacing of 100 × 100 m.

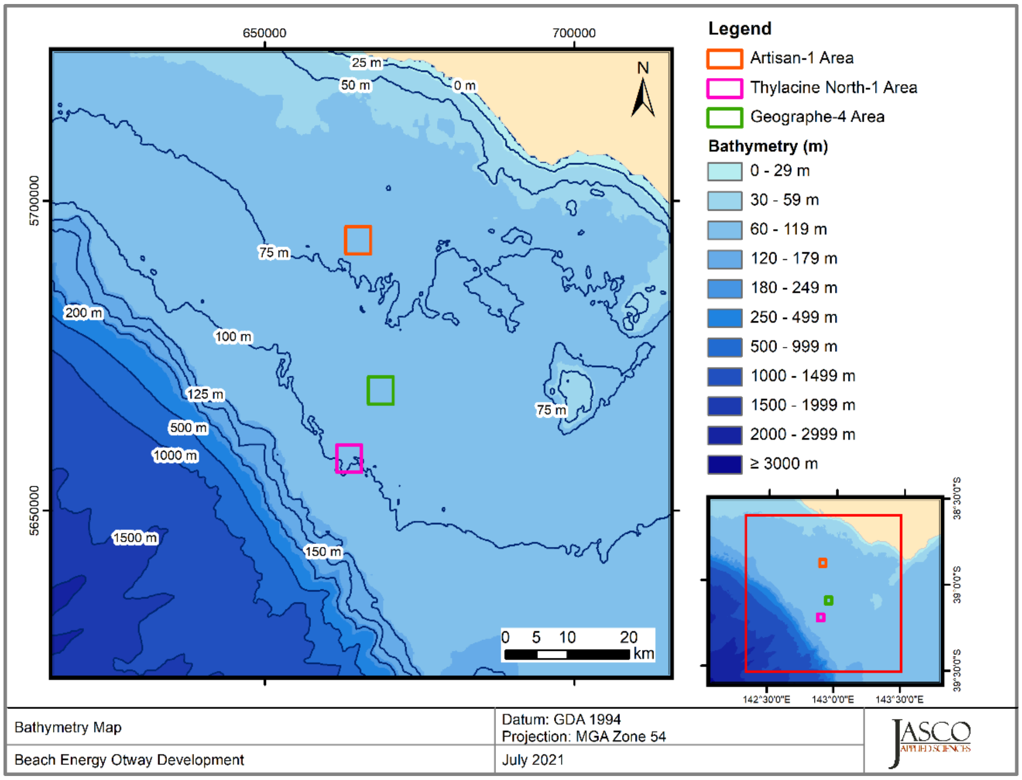

Figure B-2. Bathymetry in the modelled area.

B.2.2. 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 at distances less than 7 km around the modelled site. The June sound speed profile is expected to be most favourable to longer-range sound propagation across the entire year. As such, June was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. For the pygmy blue whale period between November and January November is expected to be most favourable to longer-range propagation in that period. Figure B-3 shows the resulting profiles, which were used as input to the sound propagation modelling.

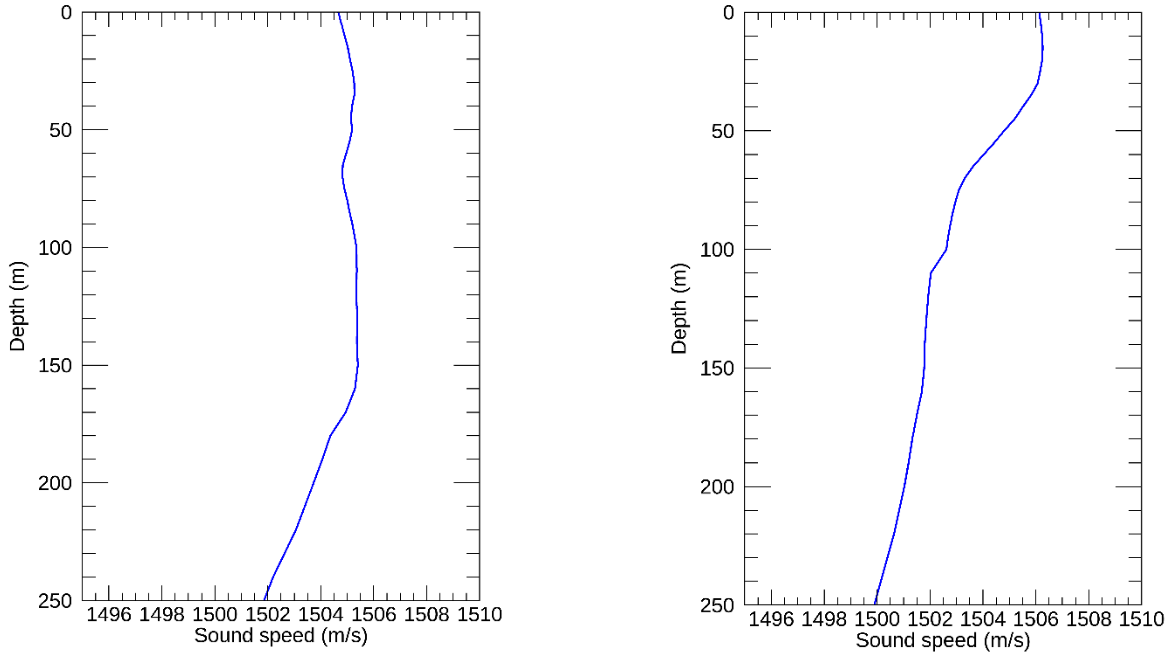

Figure B-3. The modelling sound speed profile corresponding to June (left) and November (right) Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

B.2.3. Geoacoustics

The propagation model used in this study consider a single geoacoustic profile for each development area. These profiles determine how sound is reflected from the seabed, as well as how it is transmitted, reflected and absorbed into the sediment layers. As in previous acoustic studies in the area, the modelling area was divided into two seabed types (Wood and McPherson 2018). Both areas are located on the continental shelf, however the seabed in the Thylacine North-1 and were modelled as being characterised by well-cemented carbonate caprock (calcarenite), overlying semi-cemented carbonate rock (calcarenite). This contrast in seabed environment is consistent with larger scale geological data and interpretations of the Australian continental shelf environment (James and Bone 2010). Table B-1 present the geoacoustic profile used at the modelled sites in each respective development area.

Table B-1. *Thylacine North-1*: Geoacoustic profile. Each parameter varies linearly within the stated range.

Depth below seafloor (m)	Predicted lithology	Density (g/cm^3)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–0.5	Well-cemented carbonate caprock	2.7	2600	0.50	1200	0.5
0.5–20	Increasingly cemented calcarenite	2.2	2000	0.30	900	0.27
20-40		2.3	2120	0.34	960	0.32
40-60		2.4	2240	0.38	1020	0.41
60-80		2.5	2360	0.42	1080	0.45
80–100		2.6	2480	0.46	1140	0.5
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Appendix 8

Beach Otway Development Acoustic Monitoring

Beach Otway Development Acoustic Monitoring

Characterisation, Validation, and Marine Mammals

JASCO Applied Sciences (Australia) Pty Ltd

Submitted to:

Phil Wemyss

Beach Energy Limited

Contract: BE00032123

Authors:

Craig R. McPherson

Zizheng Li

Collen C. Wilson

Katie A. Kowarski

Matthew W. Koessler

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Executive Summary

Overview

JASCO Applied Sciences (Australia), JASCO, completed a monitoring study for Beach Energy (Operations) Ltd (Beach Energy) in relation to the exploration drilling activities at the Artisan-1 well with the aim of completing an acoustic characterisation of the drilling and associated vessel activity within the Otway Basin. Through this characterisation, validation of the modelling predictions used in Beach Energy Otway Environment Plans (EPs) for the development drilling activities was required.

The exploration well Artisan-1, drilled by the *Ocean Onyx*, was selected for the monitoring program because the predicted distances to thresholds for effects on marine mammals, including pygmy blue whales, were farthest at this location in the modelling study used for the EP (Koessler et al. 2020), as well as because it was the first well in the Otway drilling campaign.

Four JASCO Autonomous Multichannel Acoustic Recorders (AMARs) in C-lander moorings were deployed in February and retrieved in early April. Stations 1 through 4 were deployed at distances of 0.336, 1.13, 5.11, and 25 km from the *Ocean Onyx*. The AMARs recorded continuously at 24-bit resolution and 64 kHz sample rate for the entire deployment. The three stations closest to the *Ocean Onyx* were configured with a single hydrophone, whilst the station 25 km away was configured with three hydrophones to provide directional processing of received sounds.

To assist in the characterisation of *Ocean Onyx* and attendant support vessels, the vessels conducted specific activities under dynamic positioning and followed a nominated transit track between the *Ocean Onyx* and Geelong Supply Base. No specific operational requests were made of the *Ocean Onyx* and vessels during normal drilling activities due to the complexity of operationally meeting any requests. Over the course of the monitoring program, the MODU and support vessels engaged in different operational states with different uncontrollable contributors, such as variable drilling operations, resupply and support operations, weather conditions, and merchant shipping.

Data Analysis

The data was analysed to determine total ocean sound levels, which presented the expansive data in a manner that documented the underwater sound conditions near Artisan-1 and allowed a comparison over time, and with external factors that affect sound levels, such as weather and human activities. The data was presented using a range of graphical and statistical representations. JASCO's ShipSound software was used to determine the source levels for the Ocean Onyx during drilling activities and the support vessels whilst under dynamic positioning and transit.

ShipSound calculates two kinds of vessel source levels from the data window: Radiated Noise Level (RNL) and Monopole Source Level (MSL). RNL is equal to the measured sound pressure level, back-propagated according to the distance between a source and the hydrophone using an empirical propagation loss approach. MSL is equal to the measured sound pressure level scaled according to a numerical acoustic propagation loss (PL) model that accounts for the effect of the local environment on sound propagation (i.e., sea-surface reflection, water column refraction and absorption, and bottom loss).

The presence of sounds produced by marine mammals were searched for using a combination of automated detector-classifiers (referred to as automated detectors) and manual review by experienced analysts. The manual review was limited to only a subset (0.5%) of acoustic data, as this was not the primary aim of the project.

Results

The analysis of data at the two stations furthest from the Ocean Onyx, 3 and 4 (5 and 25 km), found a positive correlation between wind speeds and wave heights and sound levels for frequencies over 100 Hz, with the relationship with wind speed being stronger than that for wave height. For both of these stations shipping is a strong contributor. Most days recorded a significant number of vessel detections, with the contributions at Station 4 typically between 40 and approximately 100 Hz. The station most representative of a typical ambient soundscape within the region, Station 4, had a median broadband ambient noise of 104.5 dB re 1 μPa. Dolphins and pygmy blue whales were identified in the data. The data for pygmy blue whales indicates an apparent trend in the animals early in the recording being more to the east and later in the recording being more to the west, through the directional analysis of data from Station 4, but the data were too sparse (and the analysis too limited) to confirm anything about animal movements. Extended analysis may provide more details about their presence and movements during the drilling activities.

The provided drill logs for the Artisan-1 well were reviewed to identify periods of activity defined as drilling, as this was the activity considered in the modelling study Koessler et al. (2020). Seventy ten-minute time periods were deemed suitable for use, which resulted in the MSL being calculated over three different drilling depth ranges and presented as mean and maximum levels. MSL's were calculated for support vessels during dynamic positioning trials and transit, with results summarised in Table 1.

Table 1. Project drill rig and support vessel monopole source levels (MSLs).

Vessel	Measurement	Monopole source level (dB re 1 µPa m)	
		Mean	Maximum
Ocean Onyx	Drilling 26”x42” hole from 95-172 m	175.2	180.0
	Drilling 17.5” hole from 365-621 m	169.3	171.0
	Drilling 12.25” hole up to 1851 m	162.7	170.6
Siem *Sapphire*	Dynamic Positioning Trial	193.9	194.2
	Transit at 7 kn	171.6	173.6
	Transit at 9 kn	185.0	—*
Siem *Aquamarine*	Transit at 9 kn	182.8	—*
Siem *Topaz*	Transit at 9 kn	185.2	—*

* Not reported.

Validation

The Monopole Source Levels determined through the measurement study differed from those either estimated for use in the modelling study or those determined using proxy sources. The key differences are as follows:

- The support vessels are quieter than estimated when they are under slow transit speeds, such as 7 kn.
- The support vessels are louder than estimated when they are travelling at faster transit speeds, with 9 kn used to represent these speeds and the associated MSL.
- The support vessels are louder than estimated when holding station or moving under dynamic positioning.
- The drilling operations of the *Ocean Onyx* are both louder at some frequencies and quieter at others than those for the proxy rig the *Polar Pioneer* (Austin et al. 2018), although the results presented for the *Polar Pioneer* did not examine the changes in level with increased drilling depth (over time) as completed within this study.

The results from the measurement study could not be directly compared to the modelling presented in Koessler et al. (2020) due to the differences in actual events compared to the nominal representative scenarios developed and evaluated as part of the EP assessment process. Additionally, the measurements were obtained at a receiver located 1.2 m off the seafloor, which is not the maximum-over-depth results reported in the modelling study. The ranges obtained from the measurement study are reported in relation to the Artisan-1 well location, and thus the centre of the *Ocean Onyx*. The ranges in the modelling study are reported from a range of locations, including the centroids of multiple sources, thus it is not possible to report the measurement results in a similar fashion using the small number of recording locations used in this study.

The accuracy of the broadband calculated propagation loss for the Otway Basin continental shelf environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on carbonate seabed (calcarenite) likely to occur within the region. In general, the thinner the sand layer, the greater the overall propagation loss.

When comparing SPL data fits for Stations 1–3, the loss rate is higher than what would have been expected in this environment, considering the higher monopole source levels for the support vessel on DP derived from trial measurements. The differences are likely attributable to the potential absence of a sand veneer.

Comparisons were conducted using JASCO's Marine Operations Noise Model (MONM), a wide-angle parabolic equation model which applies the BELLHOP Gaussian beam acoustic ray-trace model at higher frequencies, and JASCO's wavenumber integration model (VSTACK) which can fully account for the elasto-acoustic properties of the sub-bottom. The agreement between the models was excellent when only a comparatively thin (1 m thick) layer of sand overlies the carbonate seabed structure. In an environment such as this, MONM could have been used without correction. However, the comparisons indicate a much higher rates of loss, as would be expected if no (or only a very thin) sand layer were present.

A better understanding of the propagation loss environment, and the revision of the representation and treatment of it through the measurement study, enabled the modelling scenarios for the activities at Artisan-1 presented in Koessler et al. (2020) to be recalculated. The revised results for distances to maximum-over-depth SPL isopleths are presented in Table 2, and the revised results for distances to maximum-over-depth SEL thresholds presented in Table 3.

The understanding of the environment gained through the measurement study allowed for both the geological environment to be represented in a site-specific fashion and the use of a more appropriate configuration of numerical models to represent the propagation loss. The application of the revised modelling approach to represent other Beach Energy activities on the continental shelf of the Otway Basin would be appropriate.

Table 2. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to the marine mammal behavioural response threshold of 120 dB re 1 µPa sound pressure level (SPL) from the most appropriate location for considered sources per scenario (see table footnotes).

SPL (L_p; dB re 1 µPa)	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7)[A]		MODU and OSV standby (Scenario 8)[B]	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
120[C]	1.17	1.09	0.37	0.35	7.02	6.41	2.09	1.9

[A] Radial distance reported from the mid-point between the Mobile Offshore Drilling Unit (MODU) and the Offshore Support Vessel (OSV) on dynamic positioning (DP) in resupply operations

[B] Radial distances for isopleths/thresholds that envelope the MODU and OSV were reported from the mid-point between the MODU and the centre of the OSV standby area. Otherwise radial distances reported from the OSV in the standby area.

[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

A dash indicates the level was not reached within the limits of the modelling resolution (25 m).

Table 3. Maximum (R_{max}) horizontal distances (in km) to frequency-weighted 24 hour sound exposure level (SEL_{24h}) thresholds for permanent threshold shift (PTS) and temporary threshold shift (TTS) thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2).

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa² s)[B]	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7)[A]		MODU and OSV standby (Scenario 8)[A]	
		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									
LF cetaceans	199	–	–	–	–	–	–	–	–
MF cetaceans	198	–	–	–	–	–	–	–	–
HF cetaceans	173	0.19	0.11	–	–	0.2	0.12	0.19	0.11
Phocid seals	201	–	–	–	–	–	–	–	–
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	–	–	–	–
TTS									
LF cetaceans	179	0.31	0.31	1.01	0.35	0.95	2.78	0.31	0.66
MF cetaceans	178	0.13	0.05	–	–	0.16	0.06	0.13	0.05
HF cetaceans	153	1.07	3.44	1.01	0.18	1.09	3.86	1.06	3.64
Phocid seals	181	0.12	0.05			0.35	0.28	0.12	0.05
Otariid seals	199	–	–	–	–	–	–	–	–
Turtles	200	–	–	–	–	–	–	–	–

[A] Radial distance reported from the centre of the MODU, unless indicated otherwise.
[B] Frequency weighted.
A dash indicates the level was not reached within the limits of the modelling resolution (25 m).

1. Introduction

JASCO Applied Sciences (Australia), JASCO, completed a monitoring study for Beach Energy (Operations) Ltd (Beach Energy) in relation to the exploration drilling activities at the Artisan-1 well with the aim of completing an acoustic characterisation of the drilling and associated vessel activity within the Otway Basin. Through this characterisation, it was then required to validate the modelling predictions used in Beach Energy Otway Environment Plans (EPs) for the development drilling activities. These validation results are applicable for drilling, construction, and operational activities within the Otway Basin.

The exploration well Artisan-1 was selected for the monitoring program, because the predicted distances to thresholds for effects on marine mammals, including pygmy blue whales, were farthest at this location in the modelling study used for the EP (Koessler et al. 2020), as well as because it was the first well in the Otway drilling campaign.

This report presents an overview of the operations, environment, and measurement approaches (Section 2); general information about the marine acoustic environment (Section 3); the methods used for the data analysis, presentation, and modelling validation (Section 4); results of the monitoring program (Section 5); the validation analysis (Section 6); and a discussion of the program results and findings (Section 7).

The location of the four acoustic recording stations and the Artisan-1 well are provided in Table 4 and shown in Figure 1. One JASCO Autonomous Multichannel Acoustic Recorders (AMAR) was deployed at each recording station.

Table 4. Artisan-1 well and acoustic recording stations, including distance to Artisan-1.

Item	Latitude (S)	Longitude (E)	MGA Zone 54 (GDA94)		Water depth (m)	Distance to Artisan-1 (km)
			X (m)	*Y* (m)		
Artisan-1 (well)	38° 53.49077'	142° 52.94869'	663262.0	5693578.0	71.6	–
Station 1	38° 53.39316'	142° 53.14475'	663549.2	5693753.0	71.7	0.336
Station 2	38° 53.16585'	142° 53.61184'	664233.1	5694159.0	70.5	1.13
Station 3	38° 52.04100'	142° 55.95360'	667662.6	5696169.0	68.9	5.11
Station 4	38° 56.93456'	143° 9.71333'	687345.7	5686671.0	73.6	25.05

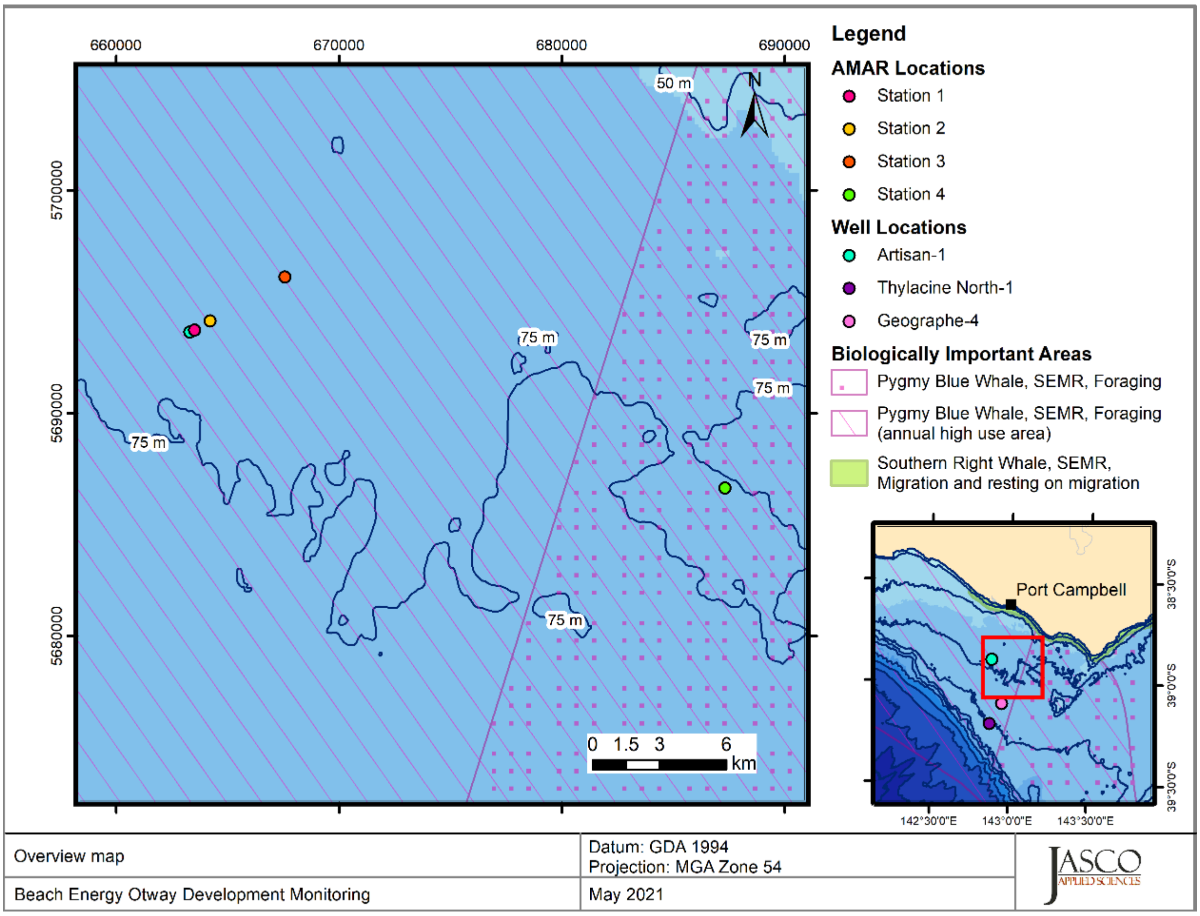

Figure 1. Otway Development Area showing location of the JASCO recorder stations.

2. Background Information

2.1. Operational Overview and Logs

The Otway Development Drilling Campaign being undertaken by Beach Energy utilises the *Ocean Onyx* Mobile Offshore Drilling Unit (MODU) (Figure 2). It is held in position via anchors and chains, as opposed to using thrusters, and has dimensions of approximately 100 m in length and width, and a draft of 22.7 m.

Figure 2. *Ocean Onyx* semi-submersible platform.

The following information was provided by Beach Energy:

- Drilling activity logs for the *Ocean Onyx,*
- Daily operational logs for the Development Drilling program,
- Daily vessel activity logs, and
- Vessel locations in ~15-minute increments from the Siem navigation systems.

The operational and activity logs used local time, which was Australian Eastern Daylight Time (AEDT), UTC+11 until 4 Apr 2021 at 3:00 am, when they changed over to Australian Eastern Standard Time (AEST), UTC+10. Therefore, AEDT is considered local time for the monitoring program. Vessel location data, including and Automated Identification System (AIS) data, as well as other ancillary environmental data and JASCO’s recorders use UTC as the time zone. Thus, to avoid potential confusion, all timestamps were converted to UTC.

The *Ocean Onyx* anchoring operation commenced on 11 Feb 2021 and completed on 12 Feb 2021 local time; therefore, 01:00 12 Feb 2021 UTC was considered the start of data with the *Ocean Onyx* moored and in location after all anchor handling was complete. The *Ocean Onyx* departed Artisan-1 on 28 Mar 2021, after commencing disconnect operations on 26 Mar 2021 local time; therefore, 00:00 25 Mar 2021 UTC was considered the end of drilling or rig operations for analysis purposes.

2.2. Vessel Traffic

Regional vessel movement information, including for the project vessels, was obtained from MarineTraffic (www.marinetraffic.com), with data supplied for the time range between 1 Feb 2021 and 5 Apr 2021 in the region. The requested area was 11,003 km^2, with the vertices shown in Table 5.

The supplied data used a one-hour timestamp for vessel locations and all data were derived from satellites, with no terrestrial reporting stations in the vicinity. Figure 3 shows the marine traffic in the project area, derived from vessels broadcasting on the Automated Identification System (AIS), with a map focused on Artisan-1 shown in Figure 4.

Table 5. MarineTraffic data request bounds.

Vertex	Latitude (S)	Longitude (E)	MGA Zone 54 (GDA94)	
			X (m)	*Y* (m)
1	38° 38.71418'	142° 15.17165'	609029.0	5721846.24
2	38° 36.92154'	143° 55.51902'	754698.76	5721846.24
3	39° 17.70699'	143° 57.20532'	754698.76	5646313.77
4	39° 19.54340'	142° 15.89490'	609029.0	5646313.77

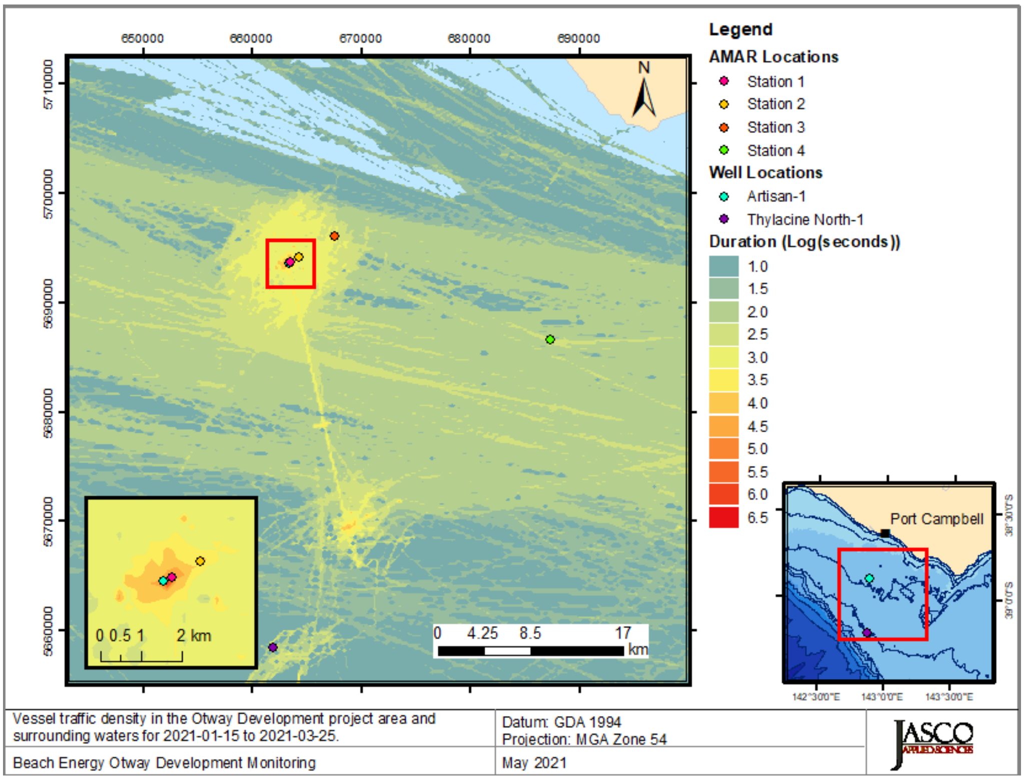

Figure 3. Vessel traffic density within the Development Drilling project area and surrounding waters for 15 Jan to 25 Mar 2021.

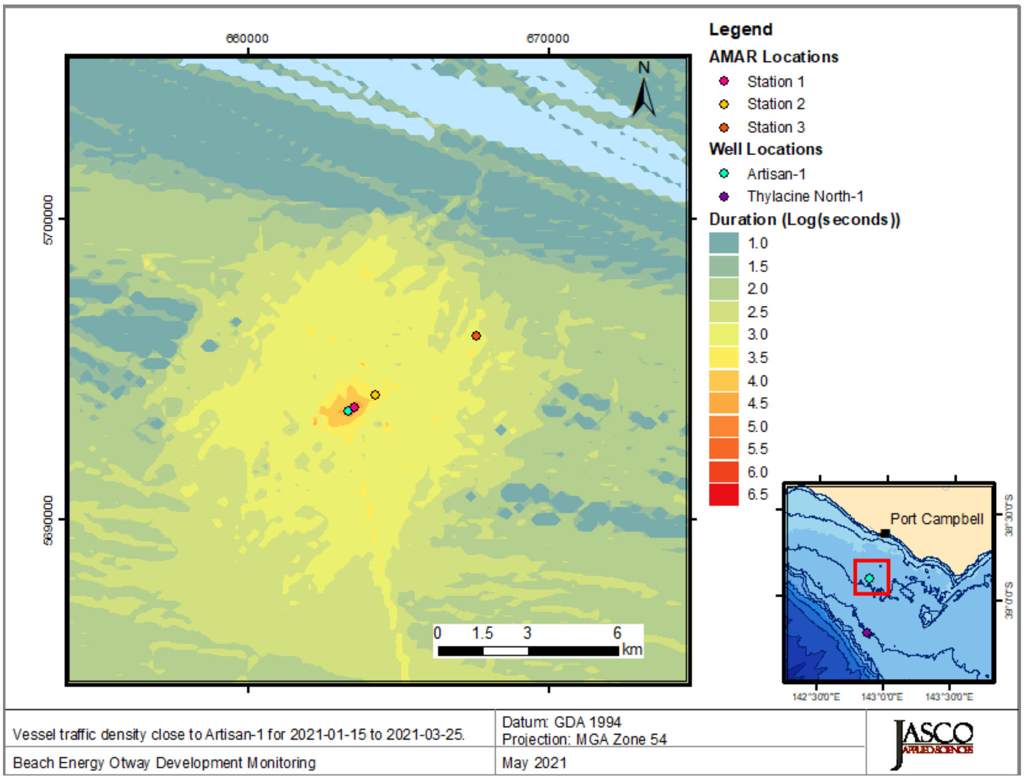

Figure 4. Vessel traffic density near Artisan-1 for 15 Jan to 25 Mar 2021.

2.3. Weather Conditions

Weather conditions at Artisan-1 were quantified through nowcast data provided by MetraWeather (Australia) for the period 00:00 on 1 Feb through until 24:00 6 Apr 2021 (UTC). The data included the following parameters:

- Significant wave height,
- Peak wave period,
- Peak wave direction,
- Significant wave height of swell >8 second period,
- Average wind speed,
- Wind direction, and
- Maximum wind gust speed.

Figure 5 shows the wave and swell weight, and Figure 6 shows the wind and gust speeds.

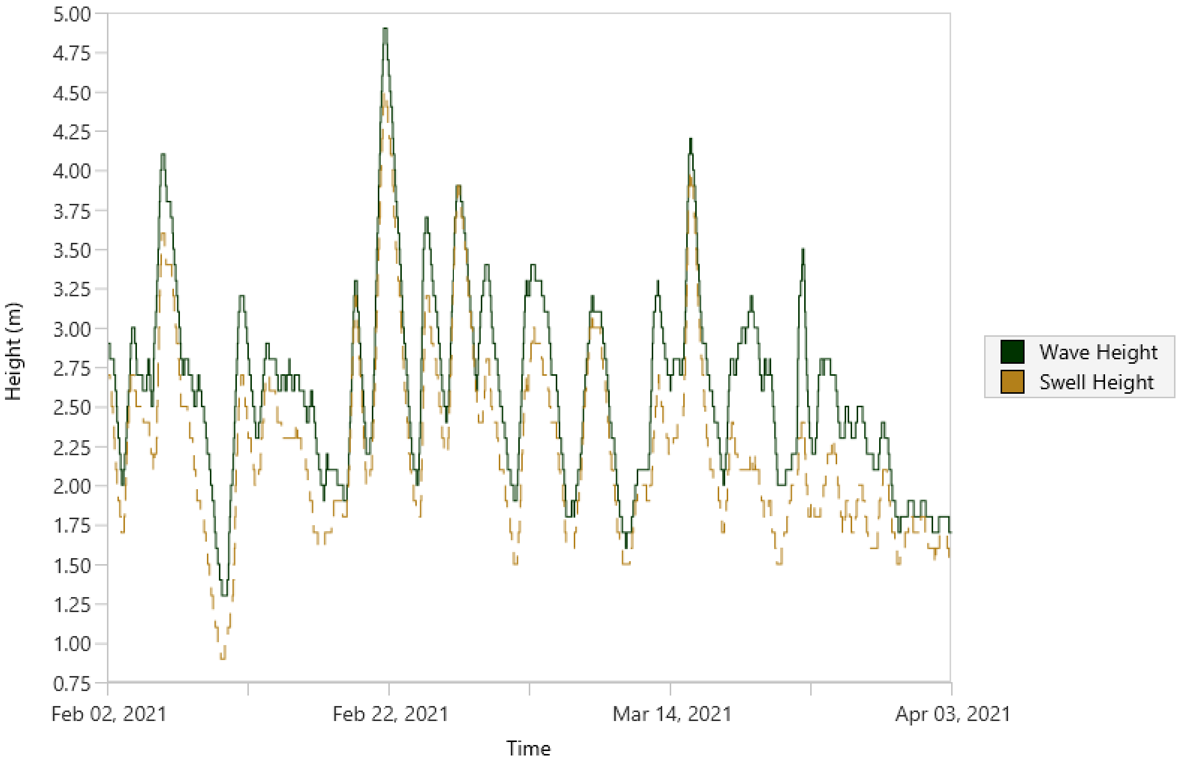

Figure 5. Hourly significant wave height (m) and significant swell height (m), with a period of greater than 8 seconds.

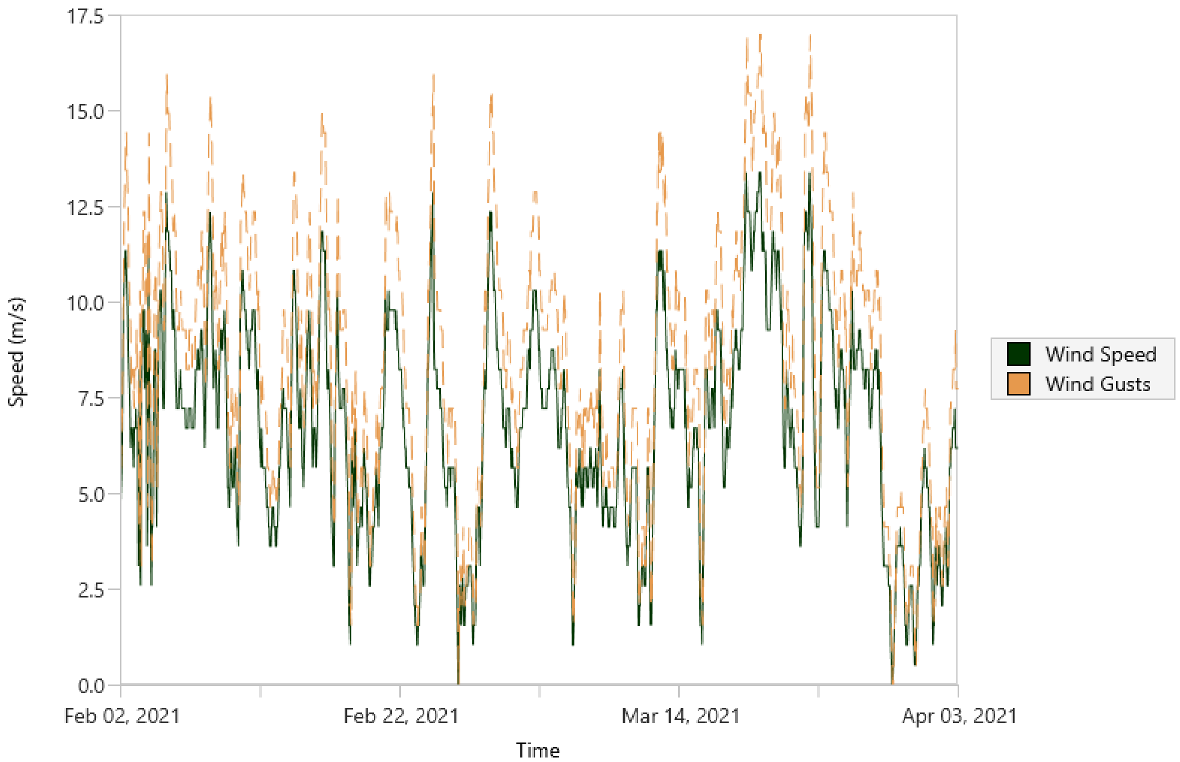

Figure 6. Hourly average wind speed (m/s) and maximum gust speed (m/s).

2.4. Geology

The propagation model used in this study considers a single geologic seabed profile for the Artisan area. The previous work by Koessler et al. (2020) considered two geologic and associated geoacoustic profiles. For deeper areas closer to the continental shelf edge, a profile characterised by well-cemented carbonate caprock (calcarenite) overlying semi-cemented calcarenite was used. Closer to the Artisan area the seabed, located in shallower waters, was characterised by a thin veneer of coarse sand/gravel overlying cemented and semi-cemented carbonate rock. This profile was selected based on a mixture of previous modelling studies (Wood and McPherson 2018) and client supplied geologic reports.

All these sources support a generalised geologic structure within the first 100 m seabed consisting of cemented or semi-cemented calcareous rock (‘calcarenite’) on the continental shelf within Artisan area. Collated information also indicated that there was the potential for a thin layer of coarse sand that could overlay the more cemented calcarenite. This was also indicated by seafloor sediment grab samples from the MARS sediment database (Heap 2009). The seabed environment was considered to be consistent with larger scale geological data and interpretations of the Australian continental shelf environment as summarised by James and Bone (2010), who indicated that the sediments along the continental shelf may be subject to transport and erosion yielding non-uniform distributions of seafloor sediment thickness.

2.5. Specific Source Measurement Operations

2.5.1. MODU Measurements

No operational requirements were requested of the *Ocean Onyx* or attendant support vessels while conducting resupply or standby operations during the drilling program due to the complexity of operationally meeting any requests. Over the course of the monitoring program, the MODU and support vessels engaged in different operational states, with different uncontrollable contributors, such as variable drilling operations, resupply and support operations, weather conditions, and merchant shipping. Operational details were obtained from the provided logs (Section 2.1).

2.5.2. Support Vessel Measurements

Specific operations were defined for the characterisation of the support vessels prior to the *Ocean Onyx* being moored, and while in transit to and from Geelong. For transit measurements, vessels were requested to pass along a defined track line according to ANSI S12.64 (R2014), with the vessel maintaining the straightest track possible and a requested separation from the AMAR of 150 m at the closest point of approach (CPA), with a water depth of 70 m. In deep water vessel noise measurements, it is a requirement for the vessels to be a minimum of either 100 m or one vessel length away from the recorder; in this case the typical vessel length is 91 m. Whilst there are standards for deep water source level measurements, there are none for shallow water environments. Methods to make accurate shallow water measurements of vessel source levels are currently being investigated by JASCO and DW Ship Consult for Transport Canada, with the findings to contribute to standard development (Ainslie et al. 2020); these methods were considered during the design of this study where possible.

The transit measurement track defined at Station 4 is shown in Figure 7, and in increased detail in Figure 8.

For measurements of dynamic positioning (DP), three exercises were defined, with *Exercise Two* completed twice. The three exercises all commenced at a horizontal separation of 150 m from the AMAR:

- *Exercise One*: Vessel to hold station, broadside to AMAR and operate at weather determined power levels for a minimum of 5 minutes.
- *Exercise Two*: Vessel to hold station, broadside to AMAR, then induce maximum reasonable thrust level and move in a perpendicular direction away from the AMAR in the up current direction for two minutes, reset and repeat exercise.
- *Exercise Three*: Vessel to hold station, broadside to AMAR, then using DP, step the vessel to the corners of a 10 × 10 m box using weather determined thruster levels.

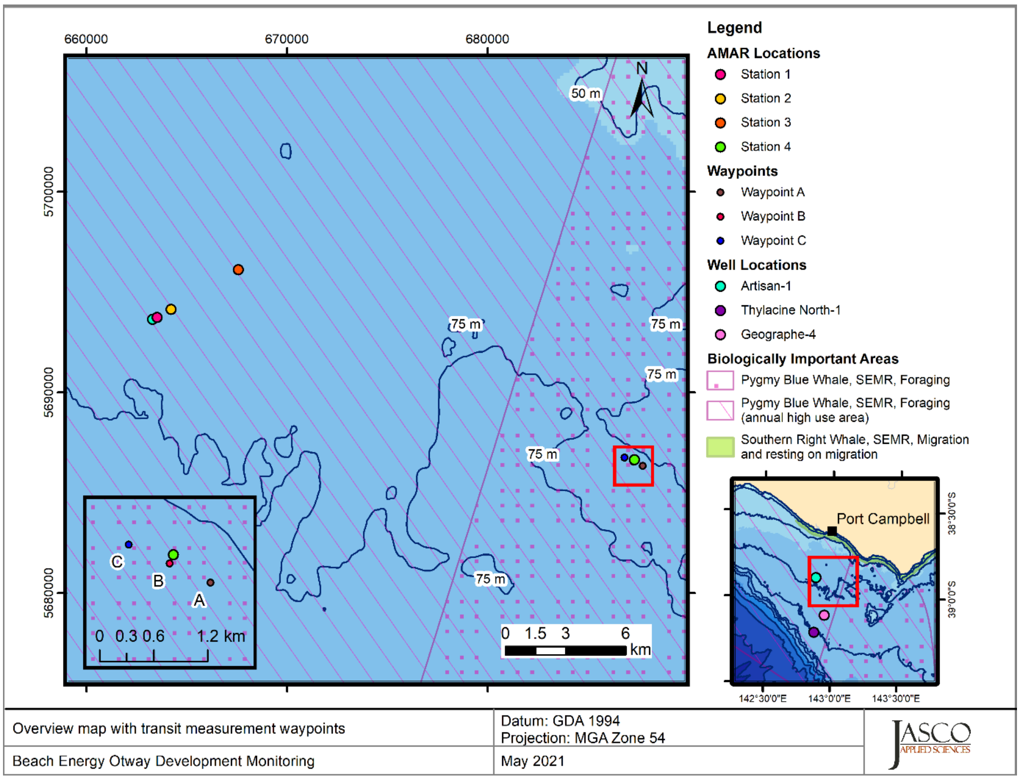

Figure 7. Map showing AMAR locations along with the three waypoints for the measurement track at Station 4 for transit vessels, Waypoints A, B, and C.

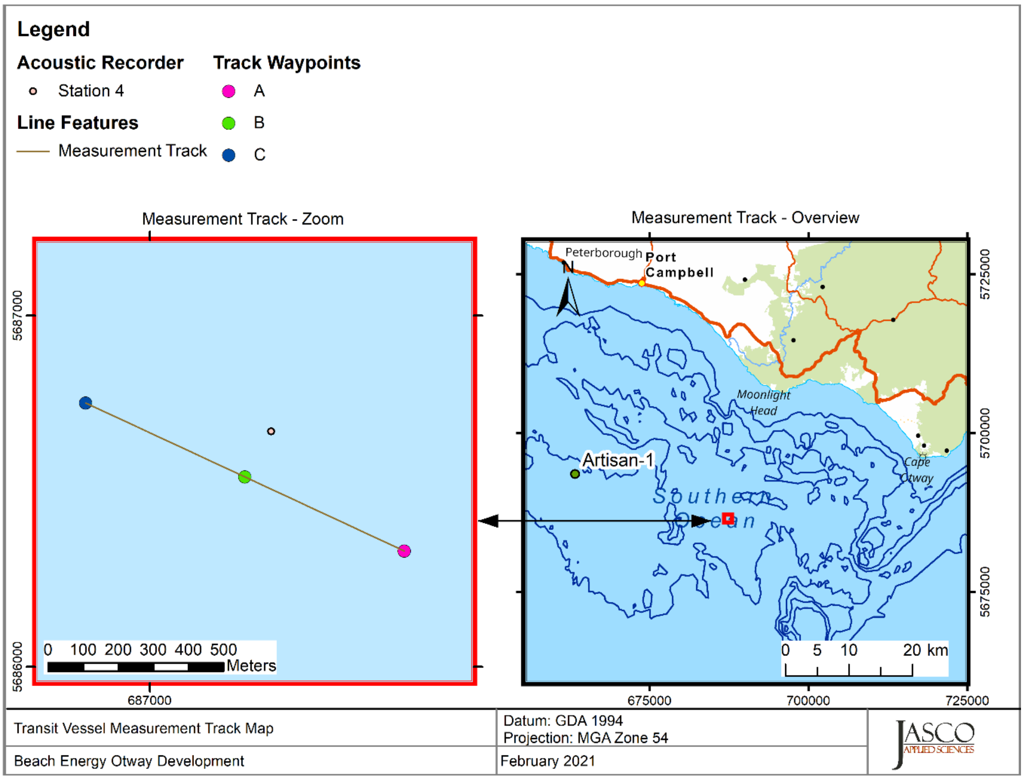

Figure 8. Zoom in of measurement track at Station 4 for transit vessels, as shown in Figure 7.

2.6. Noise Effect Criteria

To assess the potential effects of a sound-producing activity, it is first necessary to establish exposure criteria (thresholds) for which sound levels may be expected to have a negative effect on animals. Whether acoustic exposure levels might injure or disturb marine fauna is an active research topic. Since 2007, several expert groups have developed sound exposure level (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) and Southall et al. (2019). 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, sound pressure level (SPL), and SEL (Appendix A), 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 h time period. Appropriate subscripts indicate any applied frequency weighting applied. The acoustic metrics in this report reflect the amended ANSI and ISO standards for acoustic terminology, ANSI S1.1 (S1.1-2013), and ISO 18405:2017 (2017a).

The following thresholds and guidelines for this study were chosen because they represent the best available science, and sound levels presented in literature for fauna with no defined thresholds:

1. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from the US National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals for non-impulsive sources.
2. Marine mammal behavioural threshold based on the current interim U.S. National Oceanic and Atmospheric Administration (NOAA) (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources.

The criteria applied in this study to assess possible effects of vessel noise on marine mammals are summarised in Table 6, with frequency weighting explained in Appendix E.

Table 6. Criteria for effects of continuous noise exposure, including vessel noise, for marine mammals: Unweighted sound pressure level (SPL) and 24 h sound exposure level (SEL_{24h}) thresholds.

Hearing group	NOAA (2019)	NMFS (2018)	
	Behaviour	PTS onset thresholds (received level)	TTS 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	199	179
High-frequency (HF) cetaceans		198	178
Very high-frequency (VHF) cetaceans		173	153
Phocid seals		201	181
Otariid seals		219	199

L_p denotes sound pressure level period 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 µPa²s.

3. Marine Acoustic Environment

3.1. Ambient Ocean Soundscape

The ambient acoustic environment, or soundscape, consists of cumulative contributions from abiotic (geophonic), biotic (biophonic), and man-made (anthrophonic) sound sources (Krause 2008). Variation in soundscape characteristics over time and space can act as proxies for geographical, biological, and anthropogenic events occurring within an environment.

In the marine environment, geophonic elements of the soundscape commonly correlate with oceanographic conditions. Increased sea state and wind speed lead to higher sound intensities across frequencies ranging from 500 Hz to 30 kHz, via sound produced by breaking waves, cavitation, surface flow noise, and pressure changes (Knudsen et al. 1948, Wenz 1962) (Figure 9). Rainfall elevates sound levels in the 1–15 kHz frequency range, via surface impacts and bubble entrainment (Heindsmann et al. 1955, Bom 1969, Scrimger et al. 1987). The specific frequency band affected by rainfall depends on rain strength and droplet size. Abiotic acoustic contributions are often unpredictable or irregular (Urick 1983). For example, significant low frequency acoustic energy can be contributed to marine soundscapes by earthquakes and sea ice movement (Urick 1974, Matsumoto et al. 2014). On the other hand, biophonic contributions often feature seasonal and diel activity patterns (Hannay et al. 2013, Erbe et al. 2017). Water movement, or flow noise, is considered to be a pseudo-noise that results from eddies and vortices forming as water flows past an acoustic receiver, and is not considered to be part of a marine soundscape (Strasberg 1979).

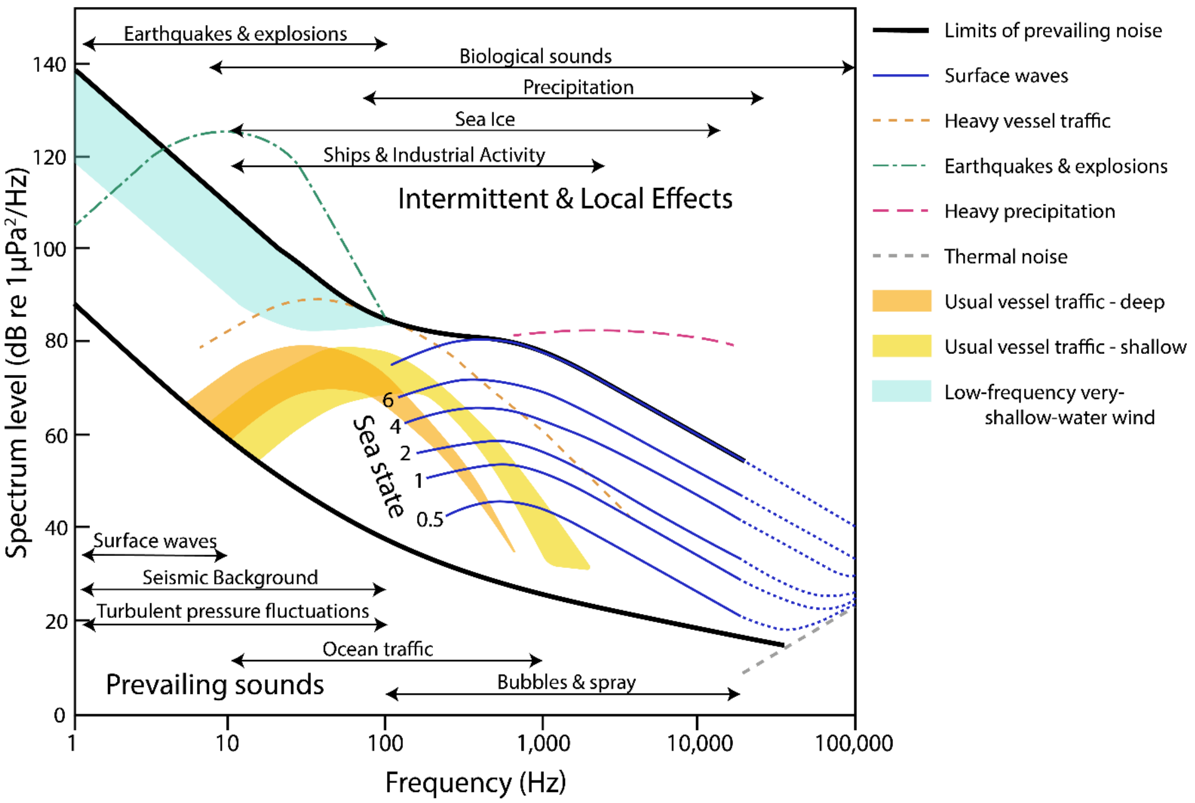

Figure 9. Wenz curves describing pressure spectral density levels of marine ambient sound from weather, wind, geologic activity, and commercial shipping (adapted from NRC 2003, based on Wenz 1962). Thick lines indicate limits of prevailing ambient sound.

3.2. Anthropogenic Contributors to the Soundscape

Anthropogenic (human-generated) sounds are relatively recent additions to soundscapes and, unlike biophonic contributors, often overlap in frequency, space, or time (Cato 1997, van Opzeeland and Boebel 2018). Anthrophonic contributors to global ocean noise include vessel traffic (commercial and recreational) at frequencies mainly in the frequency band 50–500 Hz. This sound can be a by-product of vessel operations, such as engine sound radiating through vessel hulls and cavitating propulsion systems, or it can be a product of active acoustic data collection with seismic surveys, military sonar, and depth sounding as the main contributors.

Marine construction projects involve vessel operations and project specific noise sources that can produce a range of both impulsive and non-impulsive noise. The contribution of anthropogenic sources to the ocean soundscape has increased from the 1950s to 2010, largely due to greater maritime shipping traffic (Ross 1976, Andrew et al. 2011). Oil and gas exploration with seismic airguns, marine pile driving, and oil and gas production platforms elevate sound levels over significant ranges when present (Bailey et al. 2010, Miksis-Olds and Nichols 2016, Delarue et al. 2018).The extent of seismic survey sounds has increased substantially following the expansion of oil and gas exploration into deep water, and seismic sounds have been detected across ocean basins (Nieukirk et al. 2004). Recent trends suggest that global sound levels are leveling off or potentially decreasing in some areas (Andrew et al. 2011, Miksis-Olds and Nichols 2016).

A recent paper examining seasonal fluctuations of ambient sound level in the Pacific Ocean (Ainslie et al. 2021) determined that a 5 dB increase in ambient sound level in the frequency range 63–125 Hz was caused by increases in vessel traffic and vessel size in the second half of the 20th century. A larger (approximate 10 dB) increase at lower frequencies (~16–32 Hz), often attributed incorrectly to shipping, occurs in bands dominated by baleen whale vocalisations. This paper also found that the seasonal dependence in ambient sound level is explained by seasonal changes in average sea surface temperature. This work provides a holistic and valuable examination of long-term trends.

3.3. Soniferous Marine Life

Biophonic contributors to marine soundscapes include tonal and pulsive vocalisations produced by marine mammals, fish, and invertebrates to communicate, orientate, and feed. Seasonal trends in biophonic sounds can act as proxies for behaviours, such as the migration of whales (e.g., Leroy et al. 2016, Gavrilov et al. 2018, Jolliffe et al. 2019). Other sounds of animal origin that contribute to marine soundscapes include by-products of behaviour, such as the snaps produced by snapping shrimp (*Alpheus heterochaelis*) during agonistic or foraging behaviours (Versluis et al. 2000). Snapping shrimp can increase background sound levels by a factor of 10 (20 dB) in the 500 Hz to 20 kHz frequency band (Hildebrand 2009). When a large number of sound-producing animals are present, both voluntary and involuntary sounds can combine to generate choruses where individual sounds cannot be distinguished. Chorusing fish can temporarily elevate the background sound levels by greater than tenfold in the 100 and 2000 Hz frequency band (Cato 1992, Zelick et al. 1999).

Diel trends in choruses can be indicative of time-specific behaviours, such as crepuscular or nocturnal fish activity (McCauley and Cato 2000, D'Spain and Batchelor 2006, McCauley and Cato 2016), with a variety of different species contributing the to the soundscape (Parsons et al. 2016, Parsons et al. 2017).

Many fish species produce sound during the breeding season or when engaged in agonistic behaviours (Amorim 2006). Several species of gadids (cod family), such as Northern cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*), form spawning aggregations that have been detected acoustically (Nordeide and Kjellsby 1999, Hawkins et al. 2002). The acoustic monitoring of fish is hindered by a limited understanding of their acoustic repertoire and behaviour. Nevertheless, the stereotypical nature of acoustic signals produced by some species have led to the development of dedicated acoustic detectors (e.g., cod; see Urazghildiiev and Van Parijs 2016). These detectors allow for a more systematic analysis of acoustic data for fish occurrence. Irrespective of species identity, fish choruses can raise ambient noise levels and therefore influence local soundscapes (Erbe et al. 2015).

The main, best documented, biological contributors to the ocean soundscape are marine mammals. All studied cetacean and pinniped species produce sounds ranging in frequency from ~8 Hz for blue whale (*Balaenoptera musculus*) and fin whale (*B. physalus*) vocalisations to 150 kHz for some porpoise and dolphin vocalisations (Richardson et al. 1995).

Baleen whale sounds can double background sound levels within their frequency bands and persist for extended periods of time (McDonald et al. 2008), such as species off southern Australia, including pygmy blue and southern right whales, that are all notable contributors when present (Cato 1991, McCauley et al. 2001, Gavrilov and McCauley 2013, Erbe et al. 2016, McPherson et al. 2017). For instance, fin whale songs can raise noise levels in the 18–25 Hz band by 15 dB for extended durations (Simon et al. 2010).

Marine mammals, cetaceans in particular, rely almost exclusively on sound for navigating, foraging, breeding, and communicating (Clark 1990, Edds-Walton 1997, Tyack and Clark 2000). Although species differ widely in their vocal behaviour, most can be reasonably expected to produce sounds on a regular basis. Passive acoustic monitoring is therefore increasingly preferred as a cost-effective and efficient survey method. Seasonal and sex- or age-biased differences in sound production, as well as signal frequency, source level, and directionality, all influence the applicability and success rate of acoustic monitoring, thus its effectiveness must be considered separately for each species.

In most cases, baleen whale signals can be reliably identified to the species level, although, seasonal variation in the types of vocalisations produces results in seasonal differences in our ability to detect these species acoustically. For example, the tonal signals produced by blue, fin, and sei (*B. borealis*) whales tend to show lots of similarities in late spring and summer, but they are markedly different from September to April. These issues are considered and discussed on a case-by-case basis.

Knowledge of the acoustic signals of the marine mammals expected in the study area varies across species. These sounds can be split into two broad categories: Tonal signals, including baleen whale moans and delphinid whistles, and echolocation clicks produced by all odontocetes mainly for foraging and navigating. Although the signals of most species have been described to some extent, these descriptions are not always sufficient for reliable, systematic identification, let alone to design automated detectors to process large data sets.

3.4. Changes to Sound as it Travels in the Ocean

A key question in the study of underwater sound is how a sound changes in nature as it propagates from its source to a receiver some distance away. Understanding and modelling sound propagation in the ocean is a complex topic that is the subject of numerous studies. This section provides a descriptive overview of key sound propagation concepts to assist with the results presented in this report. These concepts are integral to interpreting how sounds emitted by a source are transformed into those received some distance away. The sounds are transformed by 1) geometric spreading losses; 2) reflection, scattering, and absorption at the seabed and sea surface; 3) refraction due to changes in sound speed with depth; and 4) absorption by sea water. This section does not address point 3), as sound refraction plays only a minor role in shallow water, such as the Otway Development area.

At one extreme, the echolocation clicks of porpoises at 130 kHz travel only 500 m before becoming inaudible (Au et al. 1999). At the other extreme, sounds from fin whales (20 Hz) and low frequency energy from seismic airguns (5–100 Hz) can be detected thousands of km away under the right conditions (Nieukirk et al. 2012).

Geometric spreading losses: Sound levels from an omnidirectional point source in the water column are reduced with range, a process known as *geometric spreading loss*. As sound leaves the source, each spherical sound wave propagates outward and the sound energy is spread out over this ever-expanding sphere. The farther you are from the source, the lower the sound level you will receive. The received sound pressure levels at a recorder located a distance R (in m) from the source are $20\log_{10}R$ dB lower than the source level (SL) referenced to a standard range of 1 m. However, the sound cannot spread uniformly in all directions forever. Once the waves interact with the sea surface and seabed, the spreading becomes cylindrical rather than spherical and is limited to the cylinder formed by the surface and seabed with a lower range-dependent decay of $10\log_{10}R$ dB. Thus, the water depth is a key factor in predicting spreading losses and thus received sound levels. These spherical and cylindrical spreading factors provide limits for quick approximations of expected levels from a given source. In very shallow waters, sound rapidly attenuates if the water depth is less than a quarter of a wavelength (Urick 1983).

Reflection, scattering, absorption at the sea surface and seabed: If geometric spreading were the only factor governing sound attenuation in water, then at a given distance from a source, sound levels in shallow waters would almost always be higher than those in deep waters. In shallow water, however, the sound interacts with the seabed and sea surface more often than sound travelling in deep waters does, and these interactions reflect, absorb, and scatter the sounds. The sea surface behaves approximately as a pressure release boundary, where incident sound is almost completely reflected with opposite phase. As a result, the sum of the incident and reflected sounds at the sea-surface is zero. At the seabed, many types of interactions can occur depending on the composition of the bottom. Soft silt and clay bottoms absorb sound, sand and gravel bottoms tend to reflect sound like a partially reflective mirror, and some hard yet elastic bottoms, such as limestone, reflect some of the sound while absorbing some of the energy by converting the compressional waves to elastic shear waves.

Absorption by sea water: As sound travels through the ocean, some of the energy is absorbed by molecular relaxation in the seawater, which turn the acoustic energy into heat. The amount of absorption that occurs is quantified by an attenuation coefficient, expressed in units of decibels per kilometre (dB/km). This absorption coefficient depends on the temperature, salinity, pH, and pressure of the water, as well as the sound frequency. In general, the absorption coefficient increases with the square of the frequency, so low frequencies are less affected. The absorption of acoustic wave energy has a noticeable effect (>0.05 dB/km) at frequencies above 1 kHz. For example, at 10 kHz the absorption loss over 10 km distance can exceed 10 dB, as computed according to the formulae of François and Garrison (1982a, b).

4. Methods

4.1. Acoustic Data Acquisition

Underwater sound was recorded with four Autonomous Multichannel Acoustic Recorders (AMARs, JASCO; Figure 10). The AMARs were each fitted with M36 omnidirectional hydrophones (GeoSpectrum Technologies Inc., −164 re 1 V/μPa at 1 kHz sensitivity) and recorded continuously at 24-bit resolution at 64 kHz. Three AMARs stored acoustic data with three SD cards with 512 GB memory each (1.5 TB total), and one AMAR (Station 4) used seven SD-cards with 512 GB memory each (3.5 TB total). Appendix C provides details about the calibration procedure.

The deployment of the AMARs coincided with an inspection trip of the pre-laid anchors at the Artisan 1 drilling location by the Siem *Sapphire*. They were deployed on 3 Feb 2021, for an intended deployment duration of approximately 60 days. The deployment of one of the moorings is shown in Figure 11. The mooring at Station 3 released upon contact with the seafloor, potentially due to the lander striking a rock on the seafloor. It was immediately retrieved, and after sourcing a new weight plate and being re-configured, it was re-deployed on 24 Feb 2021. The retrieval of the moorings was conducted by Beach under guidance from JASCO on 3 Apr 2021.

The AMARs were deployed as part of a JASCO C-lander, with tandem acoustic releases (Figure 10). Each mooring consisted of:

- An AMAR G4 and battery packs,
- A Xeos Apollo Locator Beacon,
- Custom syntactic foam,
- A tandem acoustic release system (EdgeTech), and
- An anchor weight.

The AMAR hydrophones were protected by a hydrophone cage, which was covered with a nylon shroud to minimise noise artifacts from water flow (described in Section 3.1). The AMAR at Station 4 was configured with three hydrophones to allow for directional analysis (Thode et al. 2019).

Figure 10. The four C-Lander bottom moorings with Autonomous Multichannel Acoustic Recorders (AMAR G4s; JASCO) used for the project prior to loading onto the Siem *Sapphire*.

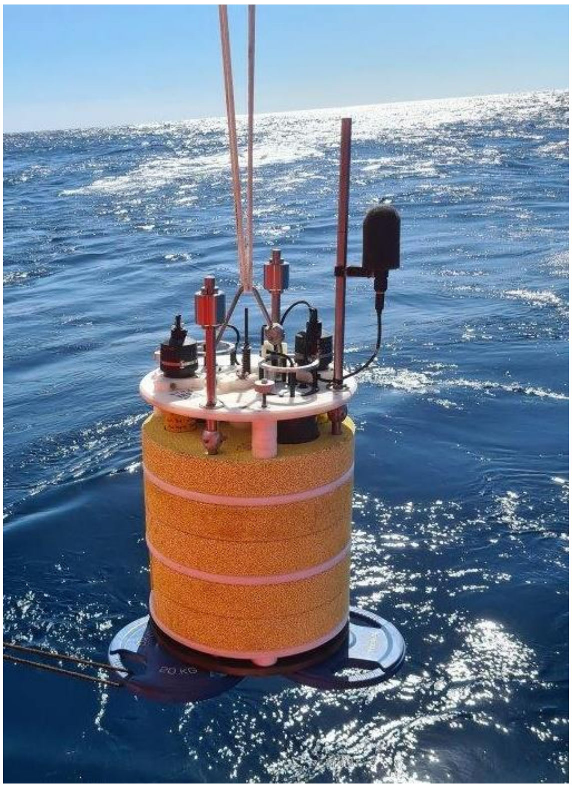

Figure 11. A single hydrophone C-Lander bottom mooring during deployment.

Table 7. Operation period, location, and depth of the Autonomous Multichannel Acoustic Recorders (AMARs) deployed at the Otway Project Area

<table>
<tr><th>Station</th><th>AMAR</th><th>Deployment</th><th>Recording duration (days)</th><th>Retrieval</th><th>Deployment duration (days)</th><th>Hydrophone details</th></tr>
<tr><td>1</td><td>628</td><td>3 Feb 2021</td><td>63</td><td>3 Apr 2021</td><td>58</td><td rowspan="3">One M36-V35-900</td></tr>
<tr><td>2</td><td>626</td><td>3 Feb 2021</td><td>63</td><td>3 Apr 2021</td><td>58</td></tr>
<tr><td>3</td><td>627</td><td>24 Feb 2021</td><td>42</td><td>3 Apr 2021</td><td>37</td></tr>
<tr><td>4</td><td>629</td><td>3 Feb 2021</td><td>63</td><td>3 Apr 2021</td><td>58</td><td>Three M36-V35-900</td></tr>
</table>

4.2. Data Analysis

The AMARs collected approximately 10.46 TB of acoustic data during this study, the equivalent of 1 year and 85 days JASCO used a specialised computing platform (PAMlab; JASCO) capable of processing acoustic data hundreds of times faster than real time. The system performed automated analysis of total ocean noise and sounds from vessels, other anthropogenic sources, and marine mammal vocalisations to provide context for the ambient ocean soundscape, anthropogenic contributors, and soniferous marine life (Section 3). Appendix D outlines the stages of the automated analysis.

4.2.1. Total Ocean Sound Levels

The data collected for the project spanned a frequency band between 10 Hz and 32 kHz. The goal of the total ocean sound analysis was to present the expansive data in a manner that documented the underwater sound conditions near Artisan-1 and allowed a comparison over time, along with external factors that change sound levels, such as weather and human activities.

The first stage of the total sound level analysis involves computing the peak sound pressure level and root-mean-square sound pressure level (SPL) for each minute of data collected. This reduced the data to a manageable size without compromising the value for characterising the soundscape (ISO 2017b, Ainslie et al. 2018, Martin et al. 2019). The SPL analysis was performed by averaging 120 fast-Fourier transforms (FFTs) that each include 1 s of data with a 50% overlap and that use the Hann window to reduce spectral leakage. The 1-minute average data were stored as power spectral densities (1 Hz resolution up to 455 Hz and millidecades frequency bands above 455 Hz) and summed over frequency to calculate decidecade band SPL levels. The millidecade band analysis approach is described in Martin et al. (2021). Millidecades are logarithmically spaced frequency bands but have a bandwidth equal to 1/1000th of a decade. The use of millidecades instead of 1 Hz frequency bands reduces the size of the spectral data by a large factor without compromising the use of the data.

Decidecade band levels are very similar to 1/3-octave-band levels. Table B-1 lists the decidecade band frequencies, and Table B-2 lists the decade-band frequencies. The decidecade analysis sums the frequency range from the millidecade bands (representing the frequency range 10 Hz to 32 kHz) in the power spectral density data to a manageable set of 45 bands. The decade bands further summarise the sound levels into four frequency bands for manageability. Detailed descriptions of the acoustic metrics and decidecade analysis can be found in Appendices B.1 and B.2.

In Section 5, the total sound levels are presented as:

- **Band-level plots**: These strip charts show the averaged received sound pressure levels as a function of time within a given frequency band. We show the total sound levels (across the entire recorded bandwidth from 10–32,000 Hz) and the levels in the decade bands of 10–100 (Decade A), 100–1000 (Decade B), 1000–10,000 (Decade C). The 10–100 Hz band is associated with pygmy blue whales, large shipping vessels, flow (or pseudo-noise) and mooring noise, and seismic survey impulses. Sounds within the 100–1000 Hz band are generally associated with the physical environment such as wind and wave conditions but can also include both biological and anthropogenic sources such as minke and humpback whales, fish, nearby vessels, seismic surveys, and pile driving. Sounds above 1000 Hz include high-frequency components of humpback whale sounds, odontocete whistles and echolocation signals, wind- and wave-generated sounds, and sounds from human sources at close range including pile driving, vessels, seismic surveys, and sonars.

- **Long-term Spectral Averages (LTSAs)**: These colour plots show power spectral density levels as a function of time (*x*-axis) and frequency (*y*-axis). The frequency axis uses a logarithmic scale, which provides equal vertical space for each decade increase in frequency and allows the reader to equally see the contributions of low and high-frequency sound sources. The LTSAs are excellent summaries of the temporal and frequency variability in the data.
- **Decidecade box-and-whisker plots**: In these figures, the ‘boxes’ represent the middle 50% of the range of sound pressure levels measured, so that the bottom of the box is the sound level 25th percentile (L_{25}) of the recorded levels, the bar in the middle of the box is the median (L_{50}), and the top of the box is the level that exceeded 75% of the data (L_{75}). The whiskers indicate the maximum and minimum range of the data.
- **Spectral density level percentiles**: The decidecade box-and-whisker plots are representations of the histogram of each band’s sound pressure levels. The power spectral density data has too many frequency bins for a similar presentation. Instead, coloured lines are drawn to represent the L_{eq}, L_5, L_{25}, L_{50}, L_{75}, and L_{95} percentiles of the histograms. Shading is provided underneath these lines to provide an indication of the relative probability distribution. It is common to compare the power spectral densities to the results from Wenz (1962), which documented the variability of ambient spectral levels off the US Pacific coast as a function of frequency of measurements for a range of weather, vessel traffic, and geologic conditions. The Wenz levels are appropriate for approximate comparisons only because the data were collected in deep water, largely before an increase in low-frequency sound levels due to human activities (Andrew et al. 2011).
- **Daily sound exposure levels (SEL; $L_{E,24h}$)**: The SEL represents the total sound energy received over a 24 h period, computed as the linear sum of all 1-minute values for each day. It has become the standard metric for evaluating the probability of temporary or permanent hearing threshold shift in marine mammals. Long-term exposure to sound impacts an animal more severely if the sounds are within its most sensitive hearing frequency range. Therefore, during SEL analysis, recorded sounds are typically filtered by the animal’s auditory frequency weighting function (Appendix E) before integrating to obtain SEL. For this analysis, the 10 Hz and above SEL were computed as well as the SEL weighted by the marine mammal auditory filters (NMFS 2018).

4.2.2. Directional Processing: Maximum Likelihood Beamforming

A maximum likelihood beamformer was applied to direction finding of the Station 4 acoustic data. For random continuous and impulsive signals, such as ship noise, anthropogenic noise, and marine animal vocalisations, the beamforming technique is reduced to Distance of Arrival (DOA) estimation. The sufficient statistic for random signals is the sampled covariance matrix,

$$\boldsymbol{C}(f,t) = \sum_t^{t+T_C} \boldsymbol{x}(f,t)\boldsymbol{x}^+(f,t)\,, \tag{1}$$

computed using N-dimensional DFT spectrums of array outputs, $\boldsymbol{x}(f,t) = [x_1(f,t), \dots, x_N(f,t)]^T$; where $x_n(f,t) = DFT\{x_n(t)\}$ is the short-time discrete Fourier Transform of the output of the *n*th hydrophone, $x_n(t)$. The output of the beamformer can be represented as:

$$P(f,t,\theta,\varepsilon) = \boldsymbol{w}^+(f,\theta,\varepsilon)\boldsymbol{C}(f,t)\boldsymbol{w}(f,\theta,\varepsilon)\,, \tag{2}$$

where $\boldsymbol{w}(f,\theta,\varepsilon) = [w_1(f,\theta,\varepsilon), \dots, w_N(f,\theta,\varepsilon)]^T$ is the N-dimensional vector of weighting coefficients of the array; and symbol “+” denotes transpose and complex conjugation, θ is the azimuth angle and ε is the estimation error. Figure 12 shows an example of the beamformer output in azimuth domain, $P(f,t,\theta,\varepsilon = 0)$. In this figure, colour represents the azimuth. The azimuth and elevation estimates of random signals can be computed for each frequency f and time slice t as:

$$\{\hat{\theta}(f,t), \hat{\varepsilon}(f,t)\} = arg \max_{\theta,\varepsilon} P(f,t,\theta,\varepsilon)\,. \tag{3}$$

An example of the directional information we obtain from this approach is shown in Figure 12. The performance of the beamformer is presented in Urazghildiiev and Hannay (2017). This method is most effective between 50 and 3000 Hz. The direction of true North was obtained using AIS data compared to vessel movements observed in the acoustic data.

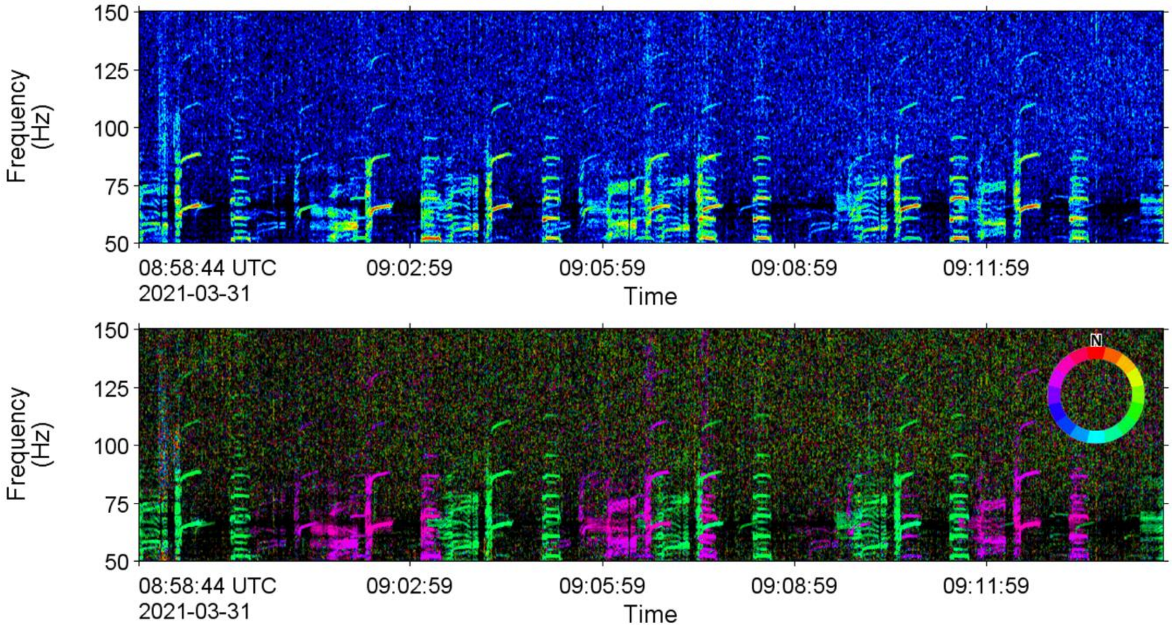

Figure 12. Spectrogram (top) versus directogram (bottom) of same data. In the directogram, colour represents the direction of arrival, with the colour legend shown in the top right corner. In the spectrogram, we cannot tell how many pygmy blue whales are vocalising; however, the directional information allows us to see that there were two animals singing.

4.2.3. Source Level Measurements with ShipSound

4.2.3.1. Overview

JASCO's ShipSound software monitors sound level measurements and AIS broadcasts from passing vessels. For vessel transiting scenarios, it identifies vessels that traverse a predefined transit area and then automatically extracts the corresponding acoustic data for analysis. It uses a vessel's broadcast speed together with a cepstral analysis of the Lloyd mirror pattern to determine the timing and location of closest point of approach (CPA) of the vessel's acoustic centre. For stationary sources, such as MODU or vessels in DP, it processes acoustic data within the specified period for the activity. ShipSound can analyse streaming data from a hydrophone in real time or, as in the case of the Beach Otway recorders, analyse archival hydrophone data downloaded from autonomous recorders. The vessel AIS data were based on Marine Traffic AIS data, vessel measurement logs, as well as client-provided data. AIS data were fed into the ShipSound system for vessel source level analysis. Environmental conditions, such as wind speed, were also recorded for each measurement. Ocean current data can be used to calculate speed through water (STW) from speed over ground (SOG) information received via AIS for each vessel measurement. However, current speed was not available in this project area, so STW was not calculated.

For transiting vessel measurements, the ANSI/ASA S12.64 data window is defined by the period over which the acoustic centre is within ±30° of the CPA. ShipSound can automatically determine the data window. For stationary sources, ShipSound determines the data window based on input specified time. ShipSound processes a single acoustic channel in 1-second periods stepped in 0.5-second intervals (Figure 13). Spectrum measurements are calculated using 1-second fast Fourier transforms, shaded using a Hanning window.

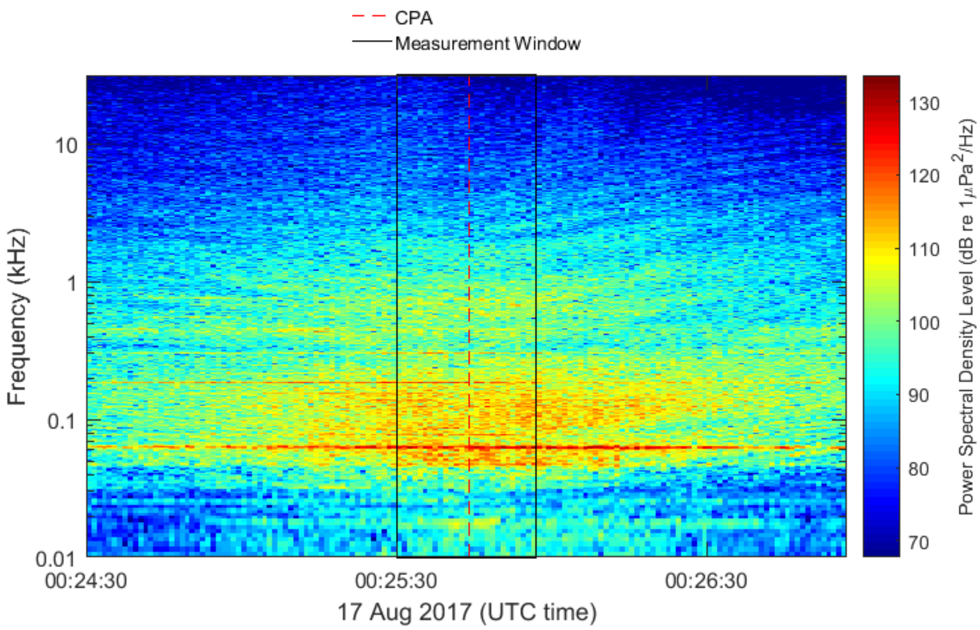

Figure 13. Spectrogram of a single transiting vessel measurement from ShipSound, showing the closest point of approach (CPA) time (dashed red line) and the measurement window (black box) used for calculating vessel source levels. The spectrogram shows the spectrum of the underwater sound pressure recorded on the hydrophone versus time and frequency.

ShipSound calculates two kinds of vessel source levels from the data window: Radiated Noise Level (RNL) and Monopole Source Level (MSL). RNL is equal to the measured sound pressure level, back-propagated according to the distance between a source and the hydrophone. The software applies the ANSI/ASA S12.64 Grade-A method for back-propagation distance: it determines instantaneous vessel range (R) in metres from the measurement hydrophone for each 1-second step within the data window. The RNL back propagation method of 20 x $\text{Log}_{10}(R)$ is applied to the spectra of each step separately. MSL is equal to the measured sound pressure level scaled according to a numerical acoustic propagation loss (PL) model that accounts for the effect of the local environment on sound propagation (i.e., sea-surface reflection, water column refraction and absorption, and bottom loss). Since no single acoustic model is applicable at all sampled ranges and frequencies, a hybrid TL model was used to calculate MSL as follows:

1. At frequencies less than 4 kHz and ranges less than 120 m, PL was calculated using a wavenumber integration model (Hannay et al. 2010, Jensen et al. 2011), which computes reflection coefficients for layered elastic media (Brekhovskikh 1980).
1. At frequencies less than 4 kHz and ranges greater than 240 m, PL was calculated using a wide-angle parabolic equation model (Collins 1993), modified to treat reflection losses for an elastic seabed using a complex-density equivalent fluid approximation (Zhang and Tindle 1995).
2. At frequencies less than 4 kHz and ranges between 120 m and 240 m, PL was calculated from the average of the parabolic equation and wavenumber integration models.
3. At frequencies greater than 4 kHz, PL was calculated using an image-method model (Brekhovskikh and Lysanov 2003), which accounts for surface and seabed reflection coefficients and frequency-dependent absorption (François and Garrison 1982b).

Average TL in each decidecade band was based on the mean propagation factor calculated at 50 frequencies, which were spaced logarithmically between the minimum and maximum band limits. Mean source depth for the MSL calculation was taken to be:

1. For vessel transit, source depth is defined as shaft depth minus 0.7 of the propeller radius. The stern propeller diameter of 4.2 m was used for the calculation.
2. For vessel in DP, since all the thrusters were operating and each are at different depths, the source depth is defined as 0.7 times vessel static draft reported on AIS.
3. For the MODU, the source depth is defined as half the static draft reported on AIS, which gives 11 m of the source depth.

The TL was smoothed by assuming the source depth had a Gaussian distribution, in a manner similar to Wales and Heitmeyer (2002), where the standard deviation was taken to be 30% of the source depth. Additional details regarding the automated source level measurement system are given in Hannay et al. (2016b). ShipSound also calculates background noise in each frequency band. For vessel measurements, ShipSound only accepts measured source band levels if they exceed the background levels by 3 dB or more. ShipSound corrects the band levels if they exceed background levels by 3–10 dB but rejects them if they are less than 3 dB above background. Adjusted and rejected levels are flagged in the database. Figure 14 summarises this approach.

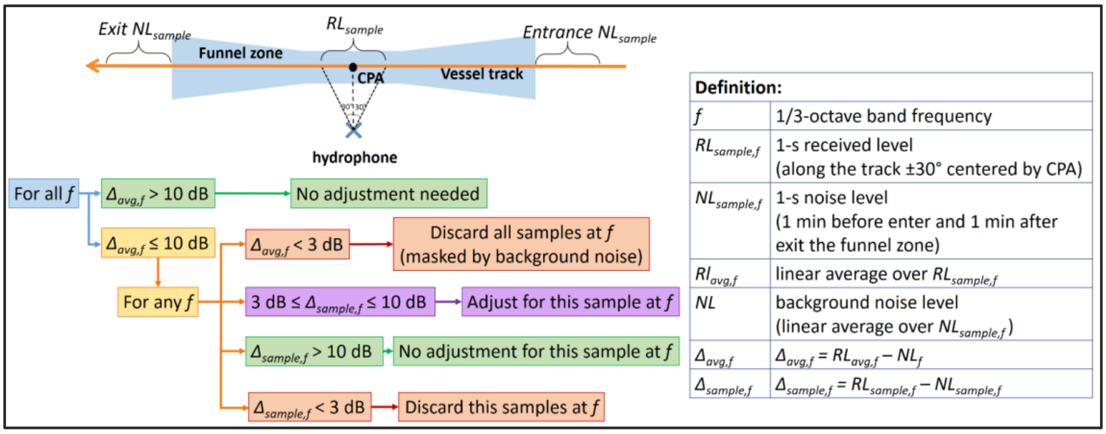

Figure 14. Background noise comparison and adjustment process.

PortListen includes a web-based user interface to access vessel and measurement information. A table view screen lets the user select and view multiple measurements by vessel criteria. This information, including broadband MSL and RNL source levels, can be exported as a spreadsheet. Vessel measurements are summarised in PDFs, presenting vessel and environment information, and the 1/3-octave-band MSL and RNL source levels. A manual quality review of every measurement was performed by an experienced analyst using the web-based interface. An analyst may reject a measurement because it contains interference from other vessels, has high levels of background noise, or if a vessel does not have constant speed and a straight track inside the data window.

MSL was the preferred metric for noise modelling because MSL back-propagation better accounts for the effect of the environment on vessel source levels (e.g., from absorption, surface, and seabed reflections) than RNL back-propagation. Measurements for vessel transits were obtained at different speeds, Ross's classical power law model (Ross 1976) was used to adjust the source levels to a reference speed. The change in source level (SL) to relative changes in speed:

$$\mathrm{SL} - \mathrm{SL}_{\mathrm{ref}} = C_v \times 10\log_{10}\left(\frac{v}{v_{\mathrm{ref}}}\right). \tag{4}$$

In this equation, SL is the source level at speed v, $\mathrm{SL}_{\mathrm{ref}}$ is the source level at some reference speed v_{ref}, and $\mathrm{C_v}$ = 6, which is a coefficient corresponding to the slope of the curve.

4.2.3.2. MODU

The provided drill logs for the Artisan-1 well were reviewed to identify periods of activity defined as drilling, as this was the activity considered in the modelling study Koessler et al. (2020). Activities associated with mooring operations, cementing, installation of the Blow Out Preventer (BOP), or running casing were not considered. Twenty time periods for drilling were identified, and Long-term Spectral Averages (LSTAs) were created to review the data. From these data, 115 ten-minute time periods were identified as suitable or of interest for processing with ShipSound, listed in Table 8. Of these measurements, 70 were accepted (i.e., passed a manual quality review). Some measurements were rejected by the contamination of nearby vessels in DP (by checking both AIS data and noise spectrum). Source level measurements were matched with drill logs and the source levels were grouped by the drilling activities. The MSL was calculated over three different drilling depth ranges and presented as mean and maximum levels.

Table 8. Details of selected measurement periods for the *Ocean Onyx* mobile offshore drilling unit (MODU) and corresponding drill activities.

Drill activity	Date	Start	End	QC status
Spudded Artisan 1 at 2100 h. Drilled from 94.7 m (seabed) to 115 mMDRT. Pumped 100 bbl PHG sweep and took MWD survey at connection. Survey at 95.62 mMDRT: 0.82 deg inc, 13.97 deg azimuth. *Parameters*: 10–40 rpm, 3–5 kft-lbs torq, 8–10 klbs WOB, 600 gpm, 170 psi SPP	2021 Feb 23	10:05:00	10:15:00	Rejected
		10:25:00	10:35:00	Rejected
		10:55:00	11:05:00	Rejected
		11:00:00	11:10:00	Accepted
		11:25:00	11:35:00	Accepted
		11:45:00	11:55:00	Accepted
Continued drilling 26 × 42" hole from 115 to 171 m (SectionTD). Several small stringers encountered at 140 and 157 m. Pumped 100 bbl PHG sweep and took MWD survey at connection. Survey at 135 mMDRT: 0.5 deg inc. *Parameters*: 60 rpm, 3–5 kft-lb tq, 10 klbs WOB, 800–1,100 gpm, 400–550 psi SPP	2021 Feb 23	13:05:00	13:15:00	Accepted
		13:25:00	13:35:00	Accepted
		13:55:00	14:05:00	Accepted
		14:25:00	14:35:00	Rejected
		14:55:00	15:05:00	Accepted
		15:25:00	15:35:00	Accepted
		15:55:00	16:05:00	Rejected
		16:25:00	16:35:00	Rejected
		16:55:00	17:05:00	Accepted
		17:25:00	17:35:00	Accepted
		17:55:00	18:05:00	Rejected
		18:15:00	18:25:00	Accepted
Drilled 26 × 42” hole from 171 to 171.7 m with seawater at 60 rpm, 2 kft-lbs tq and 8 klbs WOB, 945 gpm with 400 psi.	2021 Feb 23	19:05:00	19:15:00	Accepted
		19:25:00	19:35:00	Rejected
		19:55:00	20:05:00	Rejected
Continued to drill 17.5” hole from 365 to 621 m with S/W and PHG sweeps. Pumped 50 bbls mid stand and spotted 100 bbls on around BHA at connections. Bubble watch in place on surface and ROV in TMS at LPWHH monitoring for shallow gas on sonar. *Parameters*: Flow: 1,100 gpm; Press: 2,240 psi; RPM: 80 surface. Total 201 Torque: 2–5 kft/lbs; WOB: 15–20 kft/lbs; Average ROP: 31 m/h P/U wt: 252 k, S/O 265 k, Rot 260 k.	2021 Feb 26	19:05:00	19:15:00	Rejected
		19:25:00	19:35:00	Accepted
		19:55:00	20:05:00	Accepted
		20:25:00	20:35:00	Accepted
		20:55:00	21:05:00	Accepted
		21:25:00	21:35:00	Accepted
		21:55:00	22:05:00	Accepted
		22:25:00	22:35:00	Accepted
		22:55:00	23:05:00	Rejected

		23:25:00	23:35:00	Accepted
	2021 Feb 27	23:55:00	00:05:00	Accepted
		00:25:00	00:35:00	Accepted
		00:55:00	01:05:00	Accepted
		01:25:00	01:35:00	Accepted
		01:55:00	02:05:00	Accepted
		02:25:00	02:35:00	Accepted
		02:55:00	03:05:00	Accepted
Held JHA for P/U and RIH with the 12 1/4"" BHA. Picked up and RIH with the 12 1/4"" BHA from surface to 50 m. Picked up the SLB motor and RIH from surface to 8.5 m. DSV confirmed that the motor configured with a 0.78 deg bend. Installed a non-ported, plunger type float valve into the motor-DSV on the drill floor and witnessed. Made up the SLB ARC-9 tool onto the motor and picked up the assembly above the RT and installed the 12 1/4"" PDC bit. Continued RIH with the BHA to 50 m.	2021 Mar 4	07:05:00	07:15:00	Rejected
		07:25:00	07:35:00	Rejected
		07:55:00	08:05:00	Rejected
		08:25:00	08:35:00	Rejected
		08:55:00	09:05:00	Rejected
		09:15:00	09:25:00	Accepted
Continued RIH with the 12 1/4"" BHA on 8 1/4"" DC. Picked up and made up 3x singles of 8 1/4"" DC, RIH from 50 to 80 m. Picked up and made up the 8"" Drilling Jar (with 2x 8 1/4"" DC) and continued RIH from 80-107 m. Picked up and made up the Jar Intensifier (with 2 x 8 1/4"" DC) and continued RIH from 107 to 135 m. Weight below the jars (40 klbs). Continued RIH with the 12 1/4"" BHA on 5 7/8"" Spiral HWDP. Made up 3x stand of 5 7/8"" spiral HWDP, RIH from 135 m to 220 mRT. Total string weight 65 klbs.	2021 Mar 4	09:35:00	09:45:00	Accepted
		09:55:00	10:05:00	Accepted
		10:25:00	10:35:00	Accepted
		10:55:00	11:05:00	Accepted
		11:25:00	11:35:00	Accepted
Continued RIH with the 12 1/4"" BHA on 5 7/8"" drill pipe from 220–278 m. Filled string on first stand of drill pipe.	2021 Mar 4	12:20:00	12:30:00	Accepted
		12:40:00	12:50:00	Accepted
PU off bottom 5 m. Staged up pump rate to drill out cement. Drilled out cement from 558 to 563 m. *Parameters*: ROP: 6.7 m/h; Flow: 750 gpm; Rotary: 30 rpm; SPP: 821 psi; WOB: 2–5 klbs; Off Bottom Tq: 1–2 kft-lbs; On Bottom Tq: 2–5 kft-lbs; ECD: 8.77 ppg	2021 Mar 4	16:35:00	16:45:00	Accepted
		16:50:00	17:00:00	Accepted
		17:05:00	17:15:00	Accepted
Continued drilling out cement with the 12 1/4"" BHA from 563 to 565 m. *Parameters*: ROP: 2.7 m/h; Flow 750 gpm; Rotary 30 rpm; SPP 821 psi; WOB-2–5 klbs; Off Bottom Tq 1–2 kft-lbs; On Bottom Tq 2–5 kft-lbs; ECD 8.77ppg	2021 Mar 4	18:15:00	18:25:00	Accepted
		18:30:00	18:40:00	Accepted
		18:45:00	18:55:00	Accepted
Continued to drill hard cement, float Collar and shoe track cement from 565 to 612 m (3 m from shoe) with seawater and 50 bbl PHG sweeps as required. *Parameters*: *ROP*: 13.4 m/h; Flow 800 gpm; Rotary 60 rpm; SPP 1000 psi; WOB 10–12 klbs; Off Bottom Tq 1–2 kft-lbs; On Bottom Tq 2–5 kft-lbs ECD 8.87 ppg; P/U weight 232 klbs; S/O weight 250 klbs; Rot weight 246 klbs	2021 Mar 4	19:05:00	19:15:00	Accepted
		19:25:00	19:35:00	Accepted
		19:55:00	20:05:00	Accepted
		20:25:00	20:35:00	Accepted
		20:55:00	21:05:00	Rejected
		21:25:00	21:35:00	Rejected
		21:55:00	22:05:00	Rejected
		22:25:00	22:35:00	Rejected
Drilled 12 1/4"" hole from 647 to 711 m. *Parameters*: Flow: 800 gpm; Press: 1,640 psi; RPM: 51 surface. 137 bit Torque: 1–3 kft/lbs; WOB: 4–5 kft/lbs; Average ROP: 21.3 m/h; P/U wt: 240 k, S/O 255 k, Rot 250 k. ESD: 10.1 ppg; ECD: 10.57 ppg	2021 Mar 5	10:05:00	10:15:00	Rejected
		10:25:00	10:35:00	Rejected
		10:55:00	11:05:00	Rejected
		11:25:00	11:35:00	Rejected
		11:55:00	12:05:00	Rejected
		12:25:00	12:35:00	Rejected

Drilled 12 1/4"" hole from 711 to 804 m. Parameters: Flow: 1002 gpm; Press: 2365 psi; RPM: 98 surface. 205 bit; Torque: 1–10 kft/lbs; WOB: 2–5 klbs; Average ROP: 46.5 m/h; P/U wt: 244 klbs, S/O 260 klbs, Rot 253 klbs. ESD: 10.18 ppg, ECD: 10.63 ppg	2021 Mar 5	13:05:00	13:15:00	Rejected
		13:25:00	13:35:00	Rejected
		13:55:00	14:05:00	Rejected
		14:25:00	14:35:00	Rejected
		14:45:00	14:55:00	Rejected
Drilled 12 1/4"" hole from 804 to 869 m. *Parameters*: *Flow*: 991 gpm; Press: 2390 psi; RPM: 99 surface. 206 bit; Torque: 2–5 kft/lbs; WOB: 2–5 kft/lbs; Average ROP: 18.57 m/h; P/U wt: 250 klbs, S/O 270 klbs, Rot 265 klbs. ESD: 10.2 ppg, ECD: 10.47 ppg	2021 Mar 5	15:35:00	15:45:00	Rejected
		15:55:00	16:05:00	Rejected
		16:25:00	16:35:00	Rejected
		16:55:00	17:05:00	Rejected
		17:25:00	17:35:00	Rejected
		17:55:00	18:05:00	Rejected
		18:25:00	18:35:00	Rejected
		18:45:00	18:55:00	Rejected
Drilled 12–1/4"" hole from 1,000 to 1,001 m. *Parameters*: Flow: 800 gpm; SPP: 2,650–2,800 psi; RPM: 79 surface/176 bit; Tq: Off 2 kft-lbs/On 5–15 kft-lbs. WOB: 5–20 klbs; Average ROP: 1 m/h; ESD: 10.11 ppg, ECD: 10.4 ppg; Slow drilling due to hard stringer. Boosted riser with 325 gpm at 75 psi.	2021 Mar 6	12:05:00	12:15:00	Accepted
		12:25:00	12:35:00	Accepted
		12:45:00	12:55:00	Accepted
Drilled ahead 12–1/4"" hole from 1,006 to 1014 m. *Parameters*: Flow: 900 gpm; SPP: 2,210 psi; RPM: 60 surface/170 bit; Tq: Off 1–2 kft-lbs/On 1–10 kft-lbs; WOB: 1–5 klbs P/U wt: 260 klbs, S/O wt: 280 klbs, Rot: 275 klbs; Average ROP: 8 m/h; ESD: 10.14 ppg, ECD: 10.52 ppg	2021 Mar 7	12:05:00	12:15:00	Accepted
		12:25:00	12:35:00	Accepted
		12:45:00	12:55:00	Accepted
Drilled ahead 12–1/4"" hole from 1,146 to 1,164 m. *Parameters*: Flow: 920 gpm; SPP: 2,330 psi; RPM: 100–120 surface/197–217 bit; Tq: Off 1–2 kft-lbs/On 1–10 kft-lbs; WOB: 1–5 klbs P/U wt: 266 klbs, S/O wt: 288 klbs, Rot: 285 klbs. Average ROP: 24 m/h. ESD: 10.39 ppg, ECD: 10.68 ppg	2021 Mar 7	18:20:00	18:30:00	Accepted
		18:40:00	18:50:00	Accepted
Drilled ahead 12–1/4"" hole from 1,433 to 1,545 m. *Parameters*: Flow: 1,000 gpm; Boost Pump: 250 gpm; SPP: 3,000 psi; RPM: 120 surface/217 bit; Tq: Off 1–2 kft-lbs/On 5–10 kft-lbs; WOB: 5–15 klbs P/U wt: 300 klbs, S/O wt: 325 klbs, Rot: 315 klbs; Average ROP: 18.6 m/h; ESD: 11.18 ppg, ECD: 11.37 ppg; Offline: Displaced the Boost line and flushed the MGS utilising the boost pump-total of 20 strokes pumped (10 bbls). At 1,510 m MW over the shakers recorded at 10.7 ppg (ESD-10.88 ppg). Ceased centrifuging and weighted up the mud with additions of barite. MW at 1543 m recorded at 11.1 ppg.	2021 Mar 8	13:05:00	13:15:00	Accepted
		13:25:00	13:35:00	Accepted
		14:25:00	14:35:00	Accepted
		14:55:00	15:05:00	Accepted
		15:25:00	15:35:00	Accepted
		15:55:00	16:05:00	Accepted
		16:25:00	16:35:00	Accepted
		16:55:00	17:05:00	Accepted
		17:25:00	17:35:00	Accepted
		17:55:00	18:05:00	Accepted
		18:25:00	18:35:00	Accepted
		18:45:00	18:55:00	Accepted
Continued to drill 12–1/4” hole from 1,623 to 1,655 m. *Parameters*: Flow: 805 gpm; SPP: 2,135 psi; RPM: 120 surface/206 bit; Tq: Off 1–2 kft-lbs/On 4–15 kft-lbs; WOB: 5–15 klbs; P/U wt: 310 klbs, S/O wt: 330 klbs, Rot: 325 klbs; Average ROP: 11m/h including connections; ESD: 11.13 ppg; ECD: 11.39 ppg	2021 Mar 9	08:45:00	08:55:00	Rejected
		09:10:00	09:20:00	Rejected
		09:40:00	09:50:00	Accepted
		10:10:00	10:20:00	Accepted
		10:40:00	10:50:00	Accepted

		11:10:00	11:20:00	Accepted
		11:35:00	11:45:00	Accepted
Continued to drill 12–1/4” hole from 1,830 to 1,851 m. *Parameters*: Flow: 920 gpm; SPP: 2,750 psi; RPM: 100 surface/198 bit; Tq: Off 1–2 kft-lbs/On 3–10 kft-lbs.; WOB: 10–20 klbs; P/U wt: 320 klbs, S/O wt: 345 klbs, Rot: 325 klbs; Average ROP: 19.3 m/h including connections. ECD: 11.40 ppg; ROP controlled to max 30 m/h for flow rate, mud rheology and surface equipment.	2021 Mar 10	01:35:00	01:45:00	Accepted
		01:55:00	02:05:00	Accepted
		02:25:00	02:35:00	Accepted
		02:45:00	02:55:00	Accepted

4.2.3.3. Vessels

ShipSound was used to process a total of 4 vessel DP measurements collected from Station 2, five vessel transit measurements collected from Station 2, and 16 vessel transit measurements collected from Station 4. All these measurements were accepted measurements. Details of the measurements were shown in Table 9. The classical power law model of Ross (1976) was used to calculate source levels to a referenced speed (Section 4.2.3.1), with the speed scaling coefficients C_v = 6 proposed by Ross (1976).

Table 9. Vessel measurements collected from Stations 2 and 4.

MMSI	Vessel	Activity	Speed (kn)	CPA time	CPA distance (m)	QC status
Station 2						
257544000	SIEM *SAPPHIRE*	DP	0.6	2021 Feb 4 01:23:00	162.3	Accepted
257544000	SIEM *SAPPHIRE*	DP	0.6	2021 Feb 4 01:38:30	183.9	Accepted
257544000	SIEM *SAPPHIRE*	DP	0.6	2021 Feb 4 01:47:30	182.6	Accepted
257544000	SIEM *SAPPHIRE*	DP	0.8	2021 Feb 4 02:00:00	185.6	Accepted
257544000	SIEM *SAPPHIRE*	Transit	8	2021 Feb 4 02:32:48	189.4	Accepted
257544000	SIEM *SAPPHIRE*	Transit	6.9	2021 Feb 4 08:10:52	165.6	Accepted
257544000	SIEM *SAPPHIRE*	Transit	7.7	2021 Feb 4 08:29:14	165.5	Accepted
257544000	SIEM *SAPPHIRE*	Transit	6.5	2021 Feb 4 08:45:40	184.6	Accepted
257544000	SIEM *SAPPHIRE*	Transit	7.9	2021 Feb 4 09:01:22	160.7	Accepted
Station 4						
257544000	SIEM *SAPPHIRE*	Transit	9.3	2021 Feb 5 15:02:57	187.6	Accepted
257662000	SIEM *AQUAMARINE*	Transit	9.3	2021 Feb 15 02:33:00	147.7	Accepted
257544000	SIEM *SAPPHIRE*	Transit	6.3	2021 Feb 15 04:19:19	128.9	Accepted
257709000	SIEM *TOPAZ*	Transit	8.8	2021 Feb 17 06:50:05	121.5	Accepted
257709000	SIEM *TOPAZ*	Transit	10.4	2021 Feb 20 08:38:36	118.2	Accepted
257709000	SIEM *TOPAZ*	Transit	10	2021 Feb 23 17:11:01	113.8	Accepted
257662000	SIEM *AQUAMARINE*	Transit	14.7	2021 Feb 25 10:35:02	133.4	Accepted
257662000	SIEM *AQUAMARINE*	Transit	10.1	2021 Feb 27 18:45:40	118.9	Accepted
257544000	SIEM *SAPPHIRE*	Transit	9.9	2021 Mar 1 05:41:49	108.7	Accepted
257544000	SIEM *SAPPHIRE*	Transit	8.6	2021 Mar 3 21:48:03	120.6	Accepted
257662000	SIEM *AQUAMARINE*	Transit	8.2	2021 Mar 8 05:01:58	120.1	Accepted
257662000	SIEM *AQUAMARINE*	Transit	9.4	2021 Mar 10 21:56:02	35.3	Accepted
257709000	SIEM *TOPAZ*	Transit	6.6	2021 Mar 13 00:22:58	118.7	Accepted
257544000	SIEM *SAPPHIRE*	Transit	8.7	2021 Mar17 12:14:59	124.8	Accepted
257662000	SIEM *AQUAMARINE*	Transit	10.1	2021 Mar 21 06:29:56	144.5	Accepted
257662000	SIEM *AQUAMARINE*	Transit	11.1	2021 Mar 23 09:51:01	131.0	Accepted

4.2.4. Fit Equations

For each minute of data at each station, the analysis provided the range and received sound levels, with the metric of interest being SPL. To be able to understand the trends of the change in sound levels with range, and to interpolate the sound levels in between the measurement locations, it is required to obtain equations which represent the measurement data. The data were fit using linear models from 'R' (R Core Team 2020) of the form:

$$\text{model} = lm(\text{SPL} \sim \log(range) + range)\,. \tag{5}$$

The tilde (~) is used to separate the left- and right-hand sides in a model formula. The models provide the following values that fit the data:

- An intercept,
- Coefficients multiplied by log10(range), and
- Range.

The coefficient of log10(range) may be interpreted as the average geometric spreading for the environment. The coefficient of range may be interpreted as an additional loss term that models the effects of reflection and scattering when the sound interacts with the surface and seabed. This simple model formulation is valid when:

- There are no systematic changes to the geometric spreading–i.e., it is not valid very close to the Ocean Onyx and associated vessel movements within the 500 m zone where DP is required,
- The seabed geoacoustic properties are approximately constant, and
- The water depth does not significantly vary.

The models were used to predict the most likely data values for ranges of 20 to 6000 m, as well as the 90% prediction interval. The top of the prediction interval corresponds to the value that is greater than 95% of the measured data. The distance to 95% of the measured data is not the same as the $R_{95\%}$ range determined through modelling.

The coefficient of determination (r2) was used to assess the validity of the fit, with fits where r2 was less than 0.85 being flagged as suspect.

The per-minute SPL at each station was influenced by both the operations centred on the Ocean Onyx and sound sources close to each station. To create a model which focuses on understanding the trends of the change in sound level with range in relation to activities closes to Station 1, the data was split into three different sets. The data was therefore presented in the following ways:

- All per-minute SPL data from Station 1–3 while the Ocean Onyx was operational (01:00 12 Feb through until 00:00 25 Mar)
- Per-minute SPL data for per-minute SPL at Station 1 between 130 and 150 dB re 1µPa, thereby excluding periods when high noise levels, likely due to a close support vessel, or support vessels operating at high thrust levels which might skew the fit.
- Per-minute SPL data for per-minute SPL at Station 1 over 150 dB re 1µPa, to examine the trends in change in sound level with range for notably loud period at Station 1.
- The low-frequency weighted per-minute SPL can be adjusted by $10{*}\log_{10}(T)$, where T is 1440 (the number of minutes in 24 h) to determine the daily SEL for each of the three data sets.

4.2.5. Vessel Noise Detection

Outside of the specific individual vessel analysis requirements, vessels are detected in two steps (Martin 2013):

1. Detect constant, narrowband tones produced by a vessel's propulsion system and other rotating machinery (Arveson and Vendittis 2000). These sounds are also referred to as tonals. We detect the tonals as lines in a 0.125 Hz resolution spectrogram of the data (8 s of data, Hann window, 2 s advance).
2. Assess the SPL for each minute in the 40–315 Hz shipping frequency band, which commonly contains most sound energy produced by mid-sized to large vessels. Background estimates of the shipping band SPL and system-weighted SPL are then compared to their mean values over a 12 h window, centred on the current time.

Vessel detections are defined by the following criterion (Figure 15):

1. SPL in the shipping band (40–315 Hz) is at least 3 dB above the 12 h mean for the shipping band for at least 5 min.
2. AND at least three shipping tonals (0.125 Hz bandwidth) are present for at least 1 min per 5 min window. Tonals are difficult to detect during turns and near the closest points of approach (CPA) due to Lloyds' mirror and Doppler effects.
3. AND SPL in the shipping band is within 12 dB of the system weighted SPL.

The duration where these constraints are valid is identified as a period with shipping present. A 10 min shoulder period before and after the detection period is also included in the shipping period. The shipping period is searched for the highest 1 min SPL in the vessel detection band, which is then identified as the CPA time. This algorithm is designed to find detectable shipping, meaning situations where the vessel noise can be distinguished from the background. It does not identify cases of two vessels moving together or cases of continuous noise from stationary platforms, such as oil and gas drilling and dynamic positioning operations. Those situations are easily identified from tools such as the daily SEL and long-term spectral average figures.

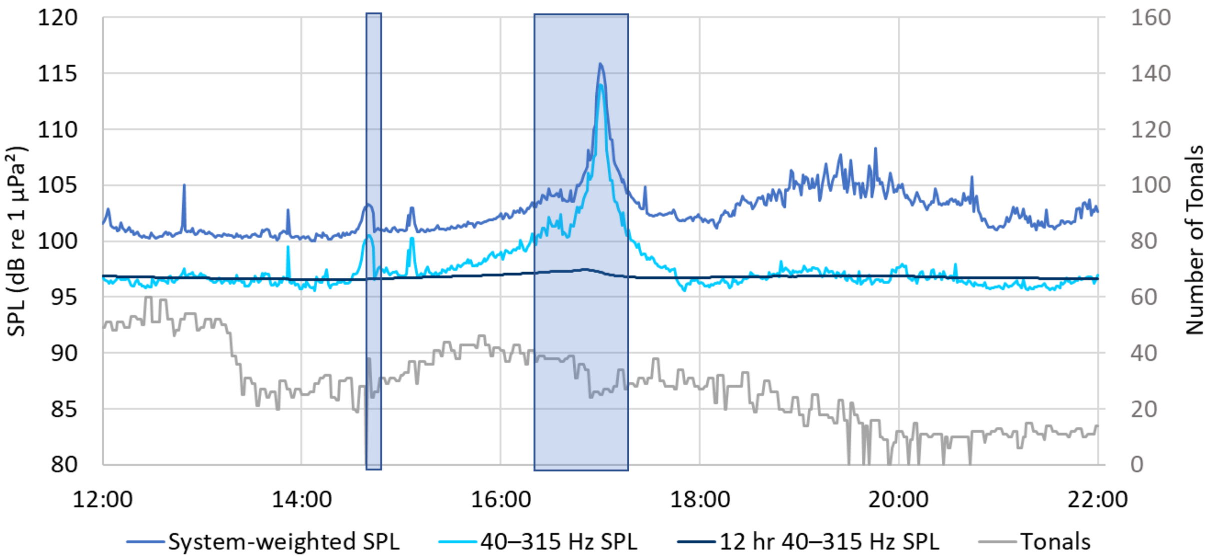

Figure 15. Example of broadband and 40–315 Hz band sound pressure level (SPL), as well as the number of tonals detected per minute as a vessel approached a recorder, stopped, and then departed. The shaded area is the period of shipping detection. Fewer tonals are detected at the vessel's closest point of approach (CPA) at 17:00 because of masking by broadband cavitation noise and due to Doppler shift, that affects the tone frequencies.

4.2.6. Seismic Survey Event Detection

Seismic pulse sequences were looked for using correlated spectrogram contours. The processing calculated spectrograms using a 300 s long window with 4 Hz frequency resolution and a 0.05 s time resolution (Reisz window). All frequency bins were normalised by their medians over window the 300 s window. The detection threshold was set to three times the median value at each frequency. If pulses were found, contours were created by joining the time-frequency bins above threshold in the 7–1000 Hz band using a 5 × 5 bin kernel. Contours 0.2–6 s in duration with a bandwidth of at least 60 Hz are then further analysed.

The process is used to create an “event” time series by summing the normalised value of the frequency bins in each time step that contained detected contours. The event time series is auto correlated to look for repeated events. The correlated data space was normalised by its median, and a detection threshold of 3 was applied. Peaks larger than their two nearest neighbours can be identified, and the list of peaks searched for entries with a set repetition interval. The allowed spacing between the minimum and maximum time peaks was 4.8–65 s, which captures the normal range of seismic pulse periods. If at least six regularly spaced peaks occur, the original event time series is searched for all peaks that match the repetition period within a tolerance of 0.25 s. The duration of the 90% SPL window of each peak can be determined from the originally sampled time series, and pulses more than three second long were rejected.

Despite the flexibility of the detection process, no impulses were detected, and thus no results are presented for seismic survey impulses.

4.2.7. Marine Mammal Detection Overview

We used a combination of automated detector-classifiers (referred to as automated detectors) and manual review by experienced analysts to determine the presence of sounds produced by marine mammals in the acoustic data. First, a suite of automated detectors was applied to the full data set (Appendices D.1 and D.2). Second, a subset (0.5%) of acoustic data was selected for manual analysis of marine mammal acoustic occurrence. The subset was selected based on automated detector results via our Automatic Data Selection for Validation (ADSV) algorithm (Kowarski et al. 2021) (Appendix D.3). Third, manual analysis results were compared to automated detector results to determine automated detector performance (Appendix D.4). Finally, hourly marine mammal occurrence plots were created that incorporated both manual and automated detections as well as automated detector performance metrics to provide a reliable representation of marine mammal presence in the acoustic data (Section 5.7). These marine mammal analysis steps are summarised here and described in detail in Appendix D.

4.2.7.1. Automated Click Detection

Odontocete clicks are high-frequency impulses ranging from 5 to over 150 kHz (Au et al. 1999, Møhl et al. 2000). We applied an automated click detector to the acoustic data to identify clicks from sperm whales and delphinids. This automated detector is based on zero-crossings in the acoustic time series. Zero-crossings are the rapid oscillations of a click’s pressure waveform above and below the signal’s normal level (e.g., Figure D-1). Zero-crossing-based features of automatically detected events are then compared to templates of known clicks for classification (see Appendix D.1 for details).

4.2.7.2. Automated Tonal Signal Detection

Tonal signals are narrowband, often frequency-modulated, signals produced by many species across a range of taxa (e.g., baleen whale moans and delphinids whistles). They range predominantly between 15 Hz and 20 kHz (Steiner 1981, Berchok et al. 2006, Risch et al. 2007). The automated tonal signal detector identified continuous contours of elevated energy and classified them against a library of marine mammal signals (see Appendix D.2 for details).

4.2.7.3. Evaluating Automated Detector Performance

JASCO's suite of automated detectors are developed, trained, and tested to be as reliable and broadly applicable as possible. However, the performance of marine mammal automated detectors varies across acoustic environments (e.g., Hodge et al. 2015, Širović et al. 2015, Erbs et al. 2017, Delarue et al. 2018). Therefore, automated detector results must always be supplemented by some level of manual review to evaluate automated detector performance. Here, we manually analysed a subset of 5 min acoustic files for the presence/absence of marine mammal acoustic signals via spectrogram review in JASCO's PAMlab software. A subset (0.5%) of acoustic data from each station was selected via ADSV for manual review (Appendix D.3).

To determine the performance of the automated detectors at each station per 5 min acoustic file, the automated and manual results (excluding files where an analyst indicated uncertainty in species occurrence) were fed into an algorithm that calculates precision (*P*), recall (*R*), and Matthew's Correlation Coefficient (*MCC*) (see Appendix D.4 for formulas). *P* represents the proportion of files with detections that are true positives. A *P* value of 0.90 means that 90% of the files with automated detections truly contain the targeted signal, but it does not indicate whether all files containing acoustic signals from the species were identified. *R* represents the proportion of files containing the signal of interest that were identified by the automated detector. An *R* value of 0.90 means that 90% of files known to contain a target signal had automated detections, but it says nothing about how many files with automated detections were incorrect. An MCC is a combined measure of *P* and *R*, where an MCC of 1.00 indicates perfect performance–all events were correctly detected. The algorithm determines a per file automated detector threshold (the number of automated detections per file at and above which automated detections were considered valid) that maximizes the MCC.

The acoustic occurrence of each species (both automated and manual results) was plotted using JASCO's Ark software as time series showing presence/absence by hour over each day of the recording period. Automated detector performance metrics are provided alongside these figures and should be considered wen interpreting results.

4.3. Modelling Validation

In order to validate the modelled predictions presented in Koessler et al. (2020), the calculated Monopole Source Levels (MSLs), which were computed from measured data using the method outlined in Section 4.2.3, were used to update the acoustic model inputs for the scenarios from Koessler et al. (2020). This process yielded new ranges to thresholds based on in-situ measured data. Only the scenarios for Artisan (i.e., Scenario 5 – 8 in Koessler et al. (2020)) were consider for a validation exercise.

The following process was implemented for updating the inputs to the acoustic model.

1. Update the sound speed profile to use predictions from the Global Ice Ocean Prediction System (GIOPS) forecasting system for the period when the data was acquired. Determine and median profile to best represent potential propagation conditions over the February 2021 – March 2021 periods.
2. Update the decidecade MSLs and MSL source depth based on the results of the ShipSound analysis presented in Section 5.5.
3. Re-run all propagation modelling, gridding and radii calculations as detailed in Koessler et al. (2020) with these updated input parameters for all scenarios.

During this process, the data fit plots discussed in Section 4.2.4 and presented Section 5.3 were reviewed in the context of results from previous modelled scenarios and newly acquired MSLs to infer the appropriateness of the seabed selection for the Artisan development area and its effect on the distances to thresholds. Further detail can be found in Section 6.2.

5. Results

5.1. Soundscape Characterisation

Long-term spectra averages, power spectral density, and decidecade band box plots are shown in Figure 16 for all stations during the period the *Ocean Onyx* was moored (01:00 12 Feb through 00:00 25 Mar 2021), with the decade band percentile levels presented in Table 10.

The same plots are presented for two examples of operational activity at the *Ocean Onyx* (Table 8), Figure 17, from 5 Mar 2021, which included resupply and drilling operations, and Figure 18, from 26 Feb 2021, for a drilling operations with support vessels further from the *Ocean Onyx*.

5.1.1. Spectrograms and Statistical Analysis

The spectrogram and band-level plots for all stations (Figure 16) provide an overview of the sound variability in time and frequency presenting an overview of presence and level of contribution from different sources. Short-term events appear as vertical stripes on the spectrograms and spikes on the band level plots. Long-term events affect (increasing or decreasing accordingly) the band level over the event period and appear in the spectrograms as horizontal bands of colour.

The most prominent feature to note is the decrease in sound level with distance from the drill rig. Stations 1 and 2, located 336 m and 1132 m from the platform respectively, demonstrate elevated sound levels across all frequencies, but particularly at frequencies under approximately 2000 Hz. This is consistent with the bands most typically impacted by seismic and pressure fluctuations, as well as vessel noise, as can be seen in the Wenz curves of Figure 9. At these two stations, the L_{50} and above, as well as the L_{mean} percentiles exceed the upper limit of the Wenz curve across all frequencies. At Stations 3 and 4, located 5 km and 25 km from the platform respectively, the sound levels are much reduced. Station 3 still receives some sound energy emitted from the platform and associated operations, whereas these contributions are not notable within Station 4’s soundscape, as can be seen in the two right side panels of Figure 16. The soundscape of these two stations is more influenced by vessel traffic, apparent by the ‘ripples’ in the L_{mean} percentiles between 40 and approximately 100 Hz, which are due to narrowband tones produced by vessel propulsion systems.

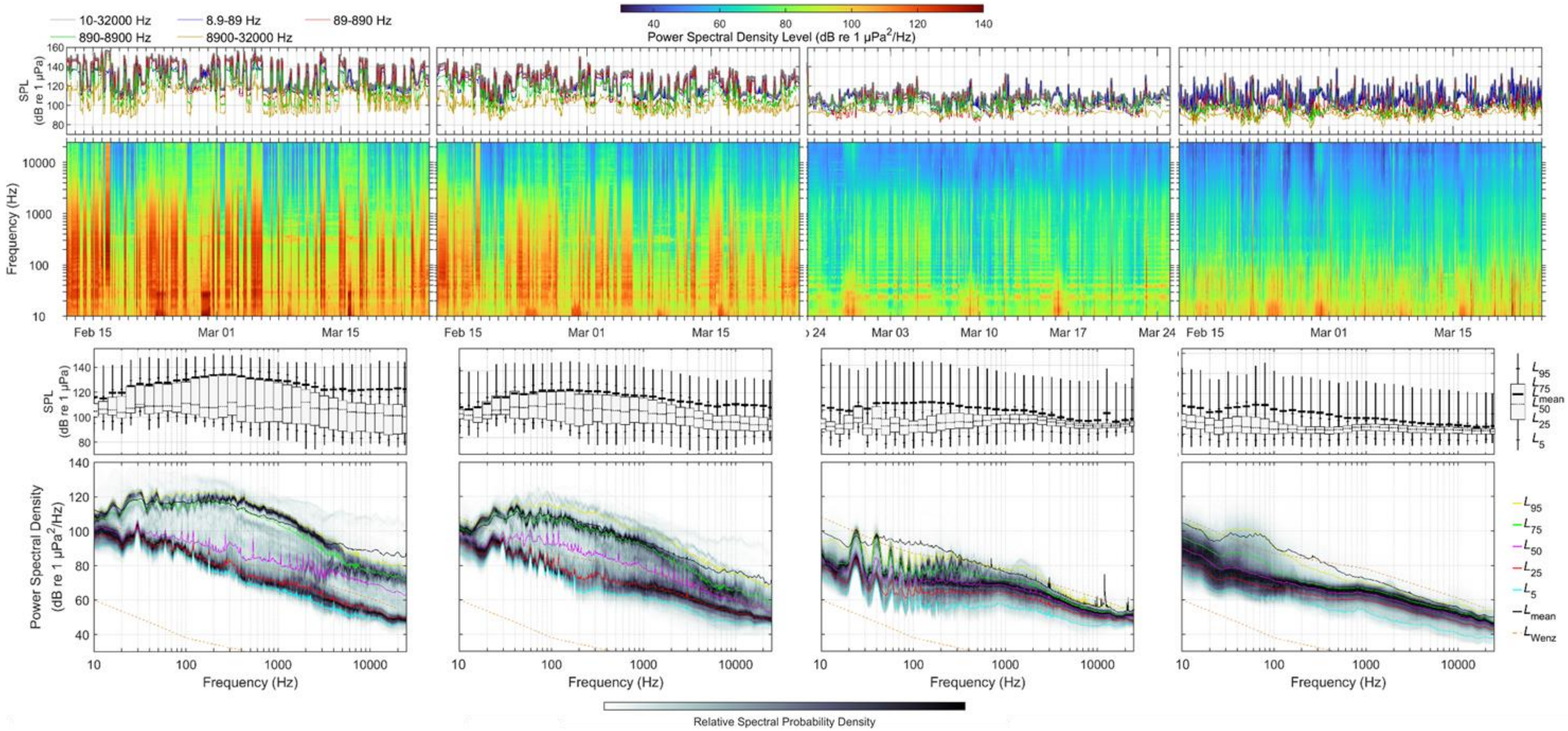

Figure 16. *Entire Ocean Onyx moored period*: (Top row) In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound, (bottom row) percentiles and mean of decidecade sound pressure level (SPL) and percentiles and probability density (grayscale) of 1-min power spectral density levels, by station compared to the Wenz curve limits (coloured lines) of prevailing noise (Wenz 1962), for 01:00 12 Feb through until 00:00 25 Mar, for Stations 1, 2 and 4, or from 12:00 24 Feb for Station 3.

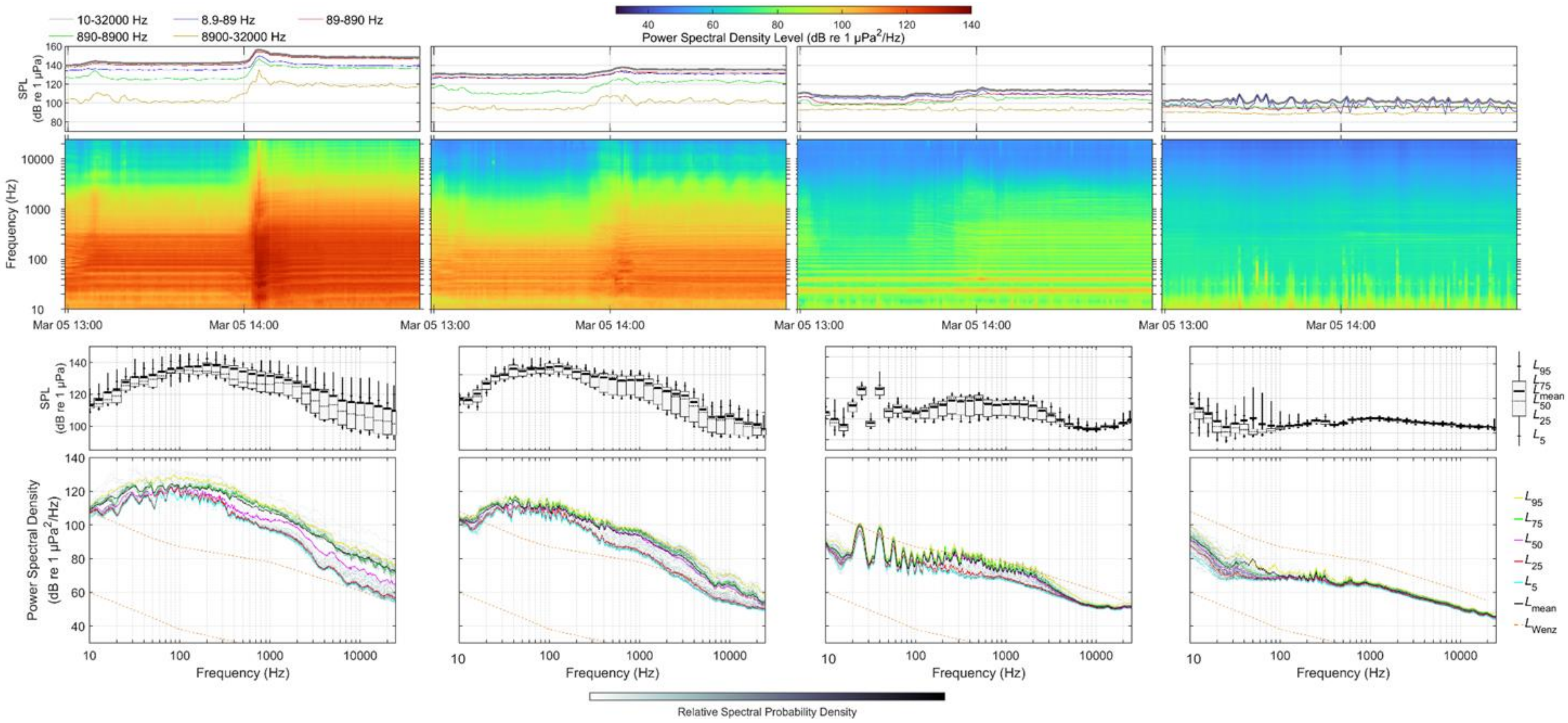

Figure 17. *Drilling and vessel operation 5 Mar 2021*: (Top row) In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound, (bottom row) percentiles and mean of decidecade sound pressure level (SPL) and percentiles and probability density (grayscale) of 1-min power spectral density levels, by station for a drilling period on 5 Mar 2021 (Table 8) which included resupply and support vessels, compared to the Wenz curve limits (coloured lines) of prevailing noise (Wenz 1962).

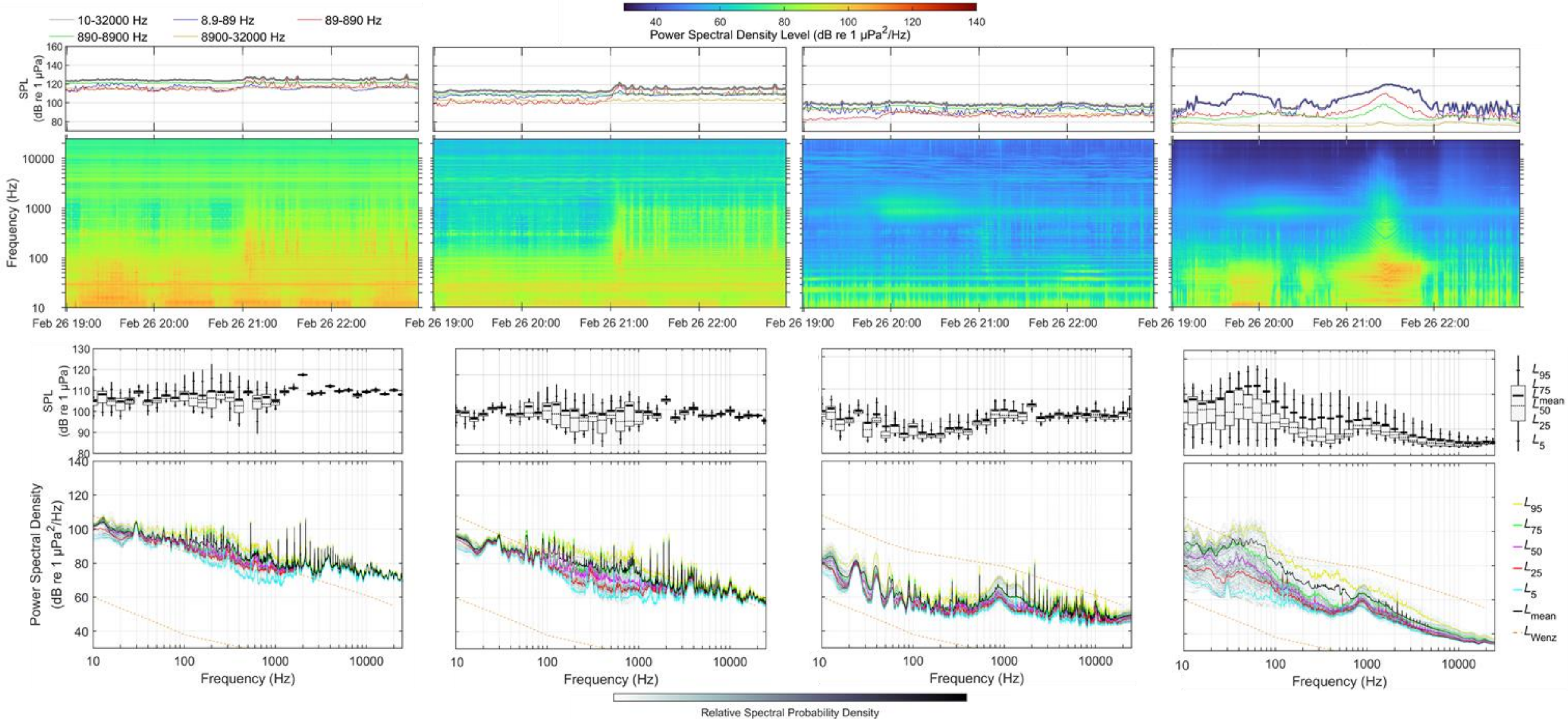

Figure 18. *Drilling operations 26 Feb 2021*: (Top row) In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound, (bottom row) percentiles and mean of decidecade sound pressure level (SPL) and percentiles and probability density (grayscale) of 1-min power spectral density levels, by station for a drilling period on 5 Mar 2021 compared to the Wenz curve limits (coloured lines) of prevailing noise (Wenz 1962).

Table 10. Statistical a0nalysis of sound levels while *Ocean Onyx* was moored, 01:00 12 Feb through until 00:00 25 Mar 2021, for Stations 1, 2, and 4, or from 12:00 24 Feb 2021 for Station 3. SPL units: dB re 1 µPa.

Sound level statistic	Station	Sound level				
		10–32000 Hz	8.9–89 Hz	89–890 Hz	890–8900 Hz	8900–32000 Hz
Minimum	1	107.6	105.1	102.2	92.5	85.5
	2	101.1	98.5	92.6	83.1	82.2
	3	91.9	83.5	80.1	82.6	84.4
	4	86.6	79.3	80.2	80.9	77.2
L_5	1	112.9	110.7	106.7	98.1	90.7
	2	107	105.1	98.4	94.5	89.5
	3	97.5	89.4	87.6	91.5	89
	4	96.3	88.4	87.3	86.4	82
L_{25}	1	117.1	114.2	110.6	103.7	94.3
	2	112	109.1	104.1	101.9	93.5
	3	102.1	94.4	94.1	96.8	92
	4	101.1	95.5	92.6	92.6	87.7
L_{50}	1	124.6	118.3	119.7	119.3	109.6
	2	121.3	116.2	117.4	110.7	99.5
	3	106.4	101.3	99.2	100.2	93.7
	4	104.5	101.8	95.9	96.2	90.9
L_{75}	1	143.8	135.4	142.4	132.6	117.2
	2	132.1	127.8	129.5	119.9	105.8
	3	111.3	107.8	105.7	103.5	95
	4	110.1	109.2	99.1	98.7	93.1
L_{95}	1	149	139.4	147.8	139.8	124.3
	2	141.3	133.6	138.9	130.2	114.1
	3	115.8	111.8	111.3	110.2	98.8
	4	120.7	120	109.8	102	98.2
Maximum	1	159	155	156.5	152.6	151.3
	2	158.6	154.2	156.2	147.9	139.3
	3	153.4	150	150.4	139.8	137.4
	4	153.6	153.1	145.1	138.6	128.6
Mean	1	144	135.5	142.3	135.7	129.6
	2	133.4	127.5	131.3	123.6	116
	3	117.8	114	114.8	106.8	99.9
	4	118.3	117	111.7	103.2	95.1

5.1.2. Frequency Weighted Sound Exposure Levels

The perception of underwater sound depends on the hearing sensitivity of the receiving animal in the frequency bands of the sound. Hearing sensitivity in animals, however, varies over the frequency band of their hearing (the hearing curve (audiogram) usually resembling a U-shaped form). The frequency range of hearing and hearing sensitivity differ between species, resulting in the fact that different species will perceive underwater sound differently. Auditory (frequency) weighting functions (Appendix E) are applied to account for this difference as they reflect an animal's ability to hear a sound, emphasising the frequency band of best sensitivity over frequencies animals do not hear well. Figure 19 shows the difference between perceived ambient noise by low-, mid- and high frequency cetaceans. Similar to the figures in Section 5.1.1, Figure 19 demonstrates the decrease in sound levels with distance from the drilling platform. Station 4 is more exposed to general shipping traffic within the shipping lanes when compared to Station 3 (Figure 3), and thus its daily SEL were more variable, being less influenced or driven by activity close to the *Ocean Onyx* more by the frequency of shipping traffic. The low-frequency cetacean weighted daily SEL for all stations, along with the thresholds for PTS and TTS (Section 2.6) are shown in Figure 20.

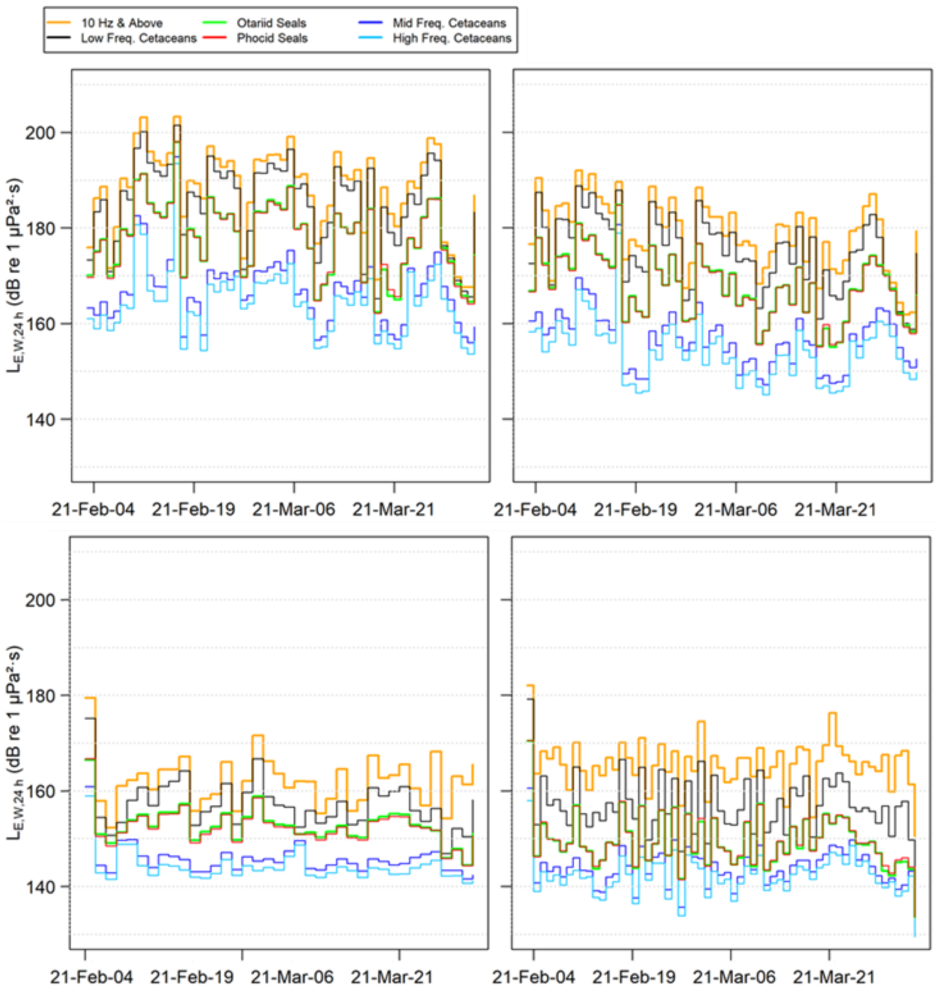

Figure 19. Auditory frequency weighted ambient noise (10 Hz and above) over the measurement period shown as daily sound exposure levels (SEL) (NMFS 2018). (Top left to right) Stations 1 and 2 and (bottom left to right) Stations 3 and 4. Locations are provided in Table 4.

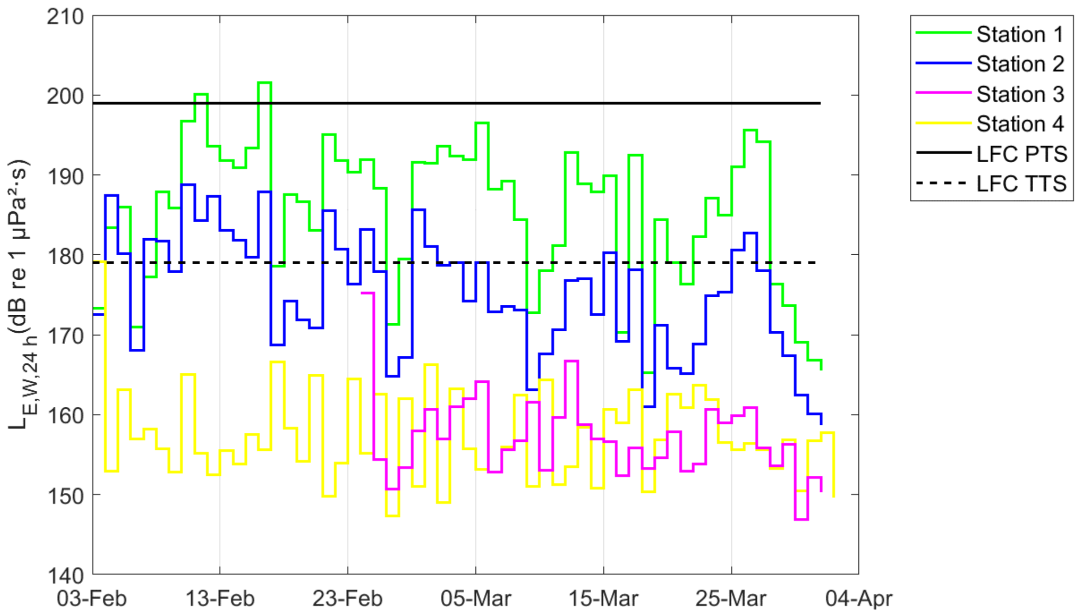

Figure 20. Daily low-frequency cetacean (LFC) weighted sound exposure levels (SEL) (NMFS 2018) at each station (composite created from Figure 19, station locations provided in Table 4), including thresholds for permanent threshold shift (PTS) and temporary threshold shift (TTS) (Table 6).

5.2. Environmental Correlations

The environmental conditions during the drilling period, specifically the wave height and wind speed, were compared to sound pressure levels during the drilling period in the 20 Hz, 80 Hz, 630 Hz, 3150 Hz, and 125000 Hz decidecade bands in the correlograms in Figure 21. Correlograms offer two ways to visualise correlations between two variables: the upper right panels show the scatter plot between each variable pair, and the bottom left show the strength of the correlation both by amount of the circle filled and depth of the colour. Blue represents a positive correlation, and red a negative. The four panels show Stations 1 to 4, respectively. The impact of wind and wave conditions on underwater soundscape is generally above 100 Hz, as shown in Figure 9 (Wenz 1962).

Stations 1 and 2, at 336 and 1132 m from the drill rig respectively, show very little correlation of sound level at any band with wind or wave conditions. At these stations, the soundscape was dominated by drilling operations. As the distance to the station increases, i.e., for Stations 3 and 4 at 5 and 25 km, the wind speeds and wave heights have a positive correlation with sound levels, although the relationship with wind speed is much stronger than that for wave height.

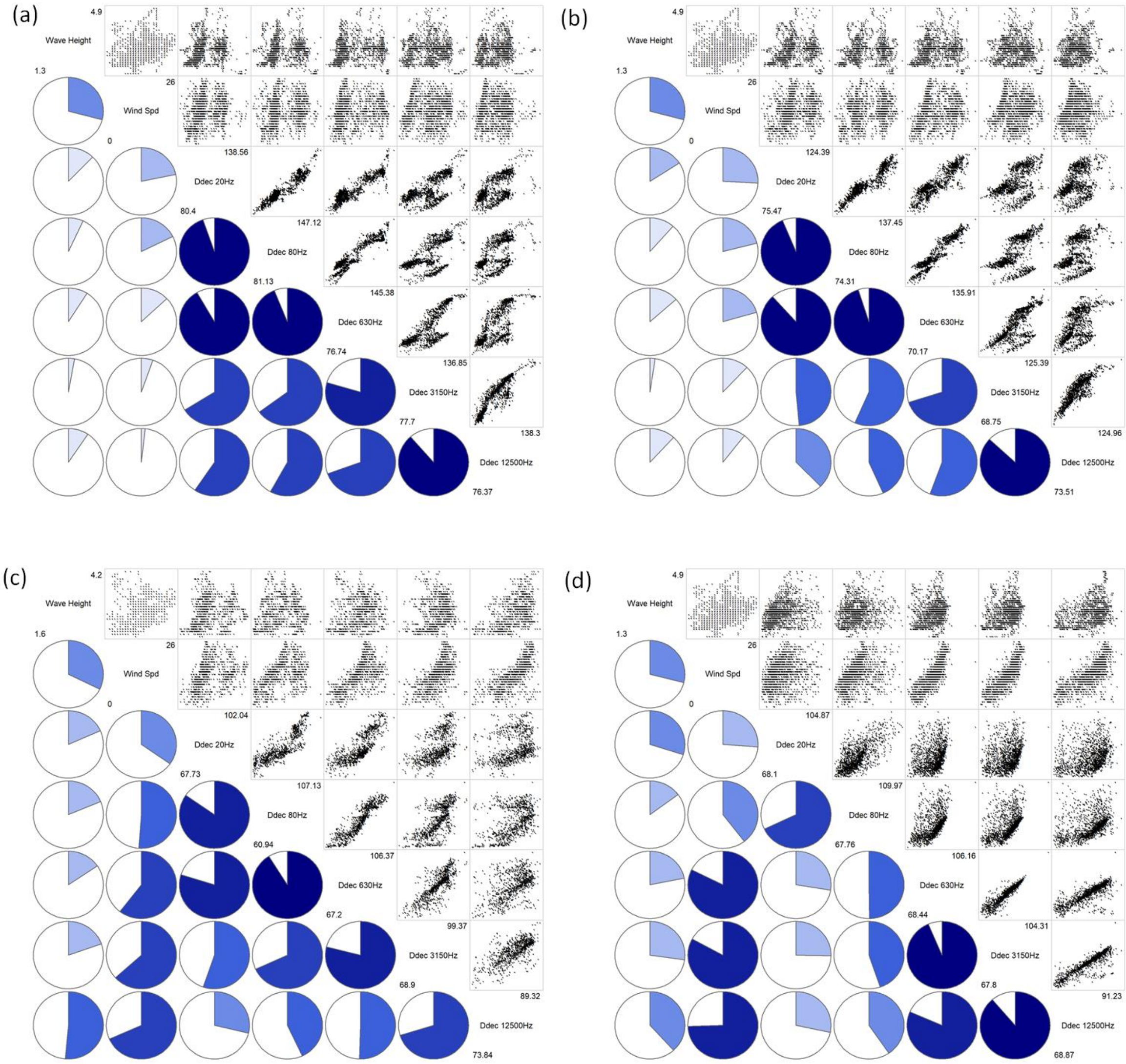

Figure 21. Correlogram comparing weather conditions to sound levels in five specified decidecade bands for (a) Station 1 at 300 m; (b) Station 2 at 1 km; (c) Station 3 at 5 km; and (d) Station 4 channel 1 at 25 km.

5.3. Data Fits

The per-minute SPL data from Station 1–3 while the Ocean Onyx was moored (01:00 12 Feb through until 00:00 25 Mar 2021) was analysed according to the methods detailed in Section 4.2.4, with the results presented in Figures 22 and 23. These fits were used to gain an understanding of the propagation loss environment, and to complete the validation analysis (Section 4.3), as discussed in Section 6.2.

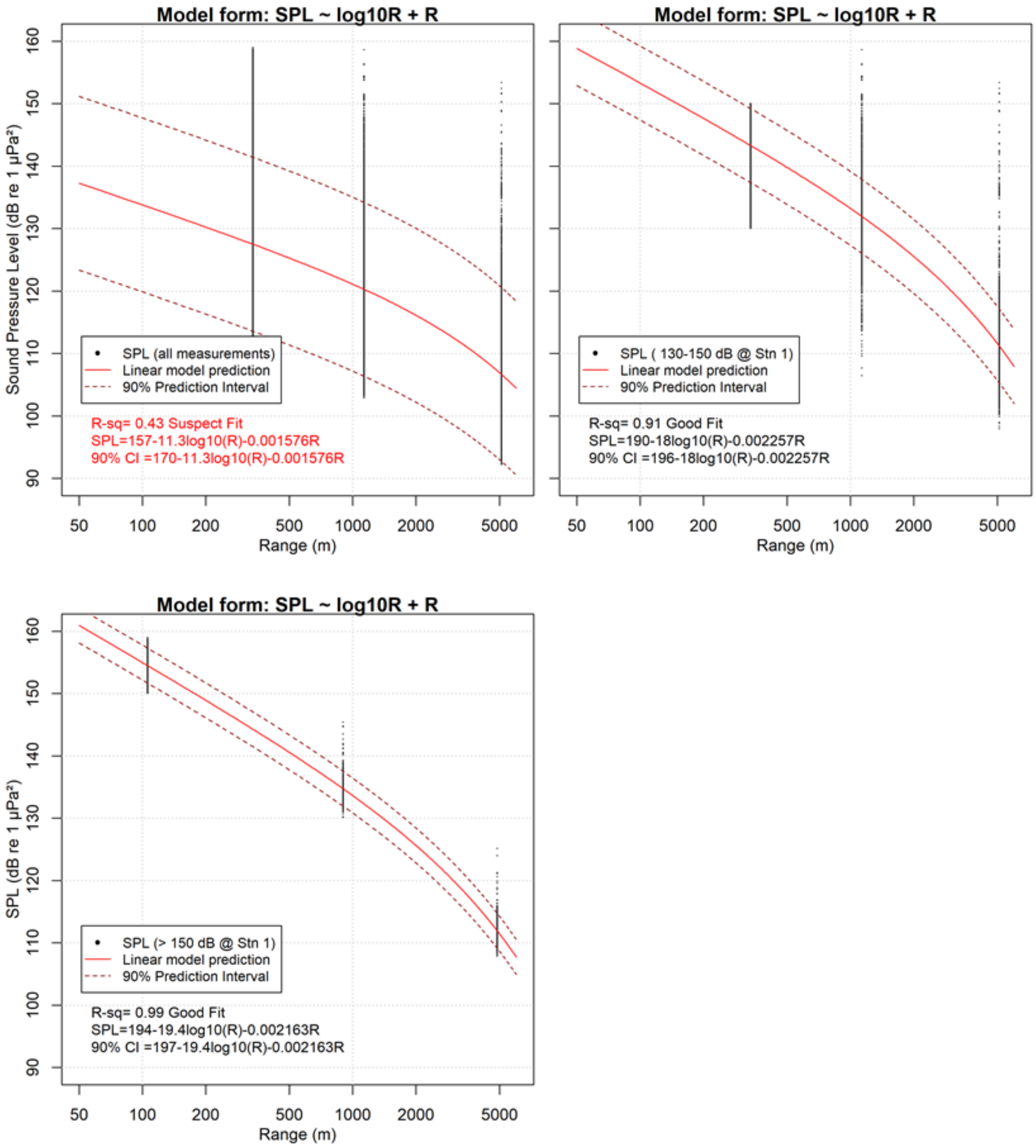

Figure 22. Per-minute sound pressure level (SPL) plotted against range for Stations 1–3, for the entire period the *Ocean Onyx* is present (top-left), levels at Station 1 between 130 and 150 dB re 1µPa (top-right), and levels at Station 1 above 150 dB re 1µPa (bottom-left).

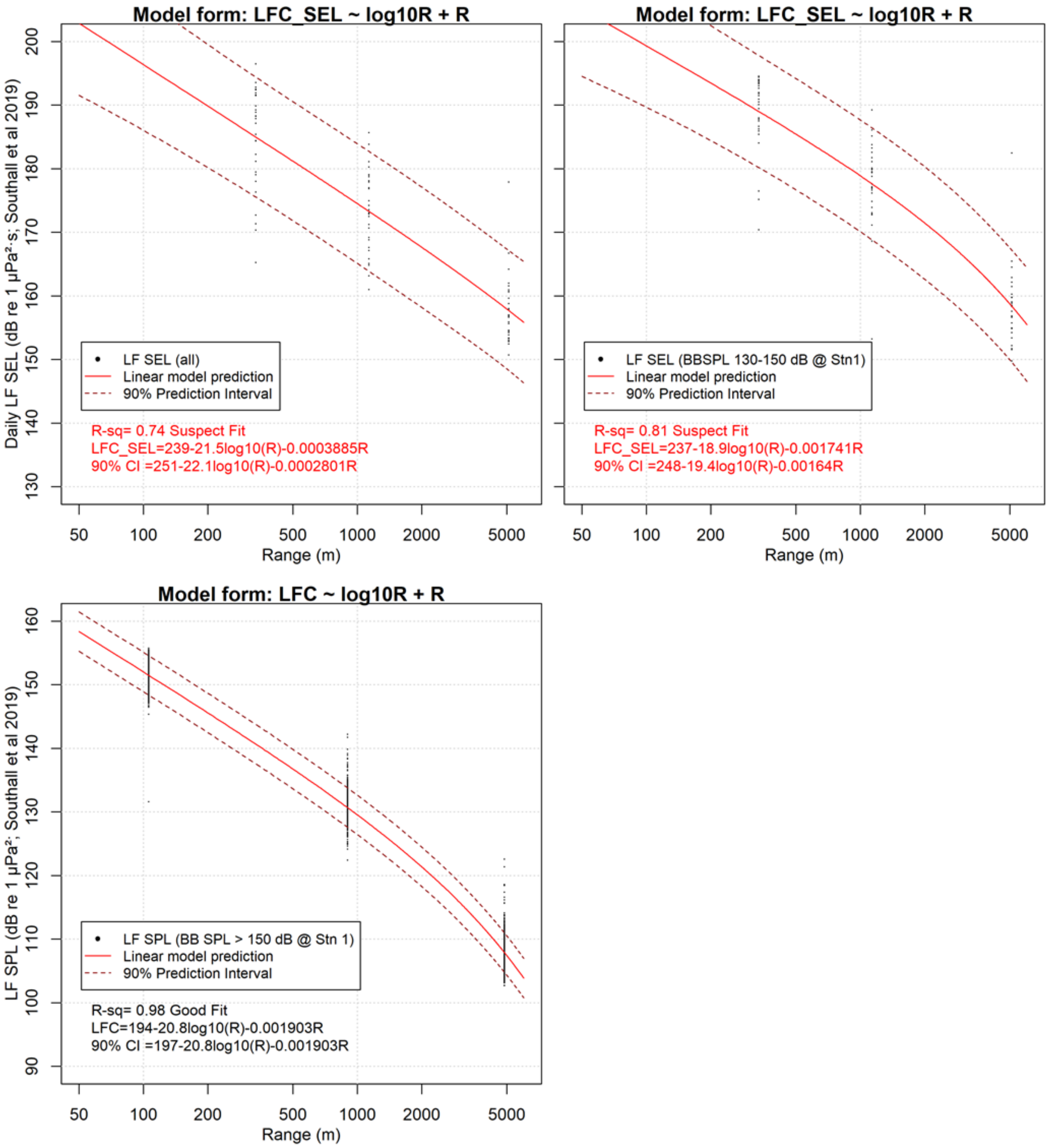

Figure 23. Daily low-frequency cetacean weighted sound exposure level (SEL) (calculated from frequency weighted per-minute sound pressure level (SPL)) plotted against range for Stations 1–3, for the entire period the *Ocean Onyx* is present (top-left), levels at Station 1 between 130 and 150 dB re 1µPa (top-right), and levels at Station 1 above 150 dB re 1µPa (bottom-left).

5.4. Drilling Operations

A detailed analysis was undertaken on two file snippets from Station 1, focused on correlating the acoustic signals to the drilling logs, and providing details on some of the signals observed in the acoustic data.

5.4.1. Snippet 1

A snippet of data from Station 1 for 22 Feb 2021 from 14:14:37 was examined to look for alignment between the acoustic data and the drilling logs to provide a detailed insight into the noise producing sources. The drilling log for this period stated:

> Continued drilling 26" x 42" hole from 115m to 171m (SectionTD). Several small stringers encountered at 140m and 157m. Pumped 100bbl PHG sweep and took MWD survey at connection. Survey @ 135mMDRT: 0.5deg inc.
>
> Parameters: 60rpm, 3-5kft-lb tq, 10klbs WOB, 800-1,100gpm, 400-550psi SPP

The spectrogram of the entire wav file is shown in Figure 24, with a shorter timescale and more focused frequency range shown in Figure 25, both showing components above 10 Hz only. In this data, drilling tonals with a spacing of 155 Hz were identified (Figure 26), and the analysis of the very low frequency tonals (Figure 27) clearly shows a 1 Hz tonal, which aligns with the 60 rpm drilling speed in the logs. A steady state pump operating at centre frequencies of 2992 Hz and 3062 Hz, with a strong correlation to high frequency harmonics (Figure 28). In this snippet there were three unstable narrowband noise sources present which are likely due to the drilling operations. This is considered likely due to their harmonic spacing under varying loads of operations. Tonals indicate that something, potentially the drill bit or the main aperture rod, is rotating between 52 and 74 RPM. This appears unrelated to the steady state pumps, which are likely high pressure pumps that fluctuate very little over time or load. During this recording, a vessel was also present although it did not appear to be operating under DP.

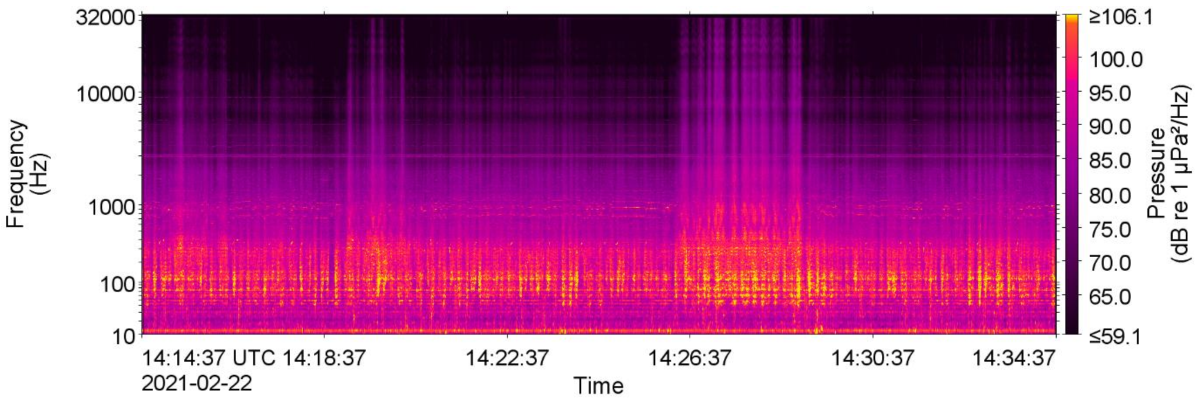

Figure 24. Spectrogram of 20 minutes of drilling operations on 22 Feb 2021 from 14:14:37 at Station 1(0.2 Hz frequency resolution, 1 s time window, 0.5 s time step, Hamming window).

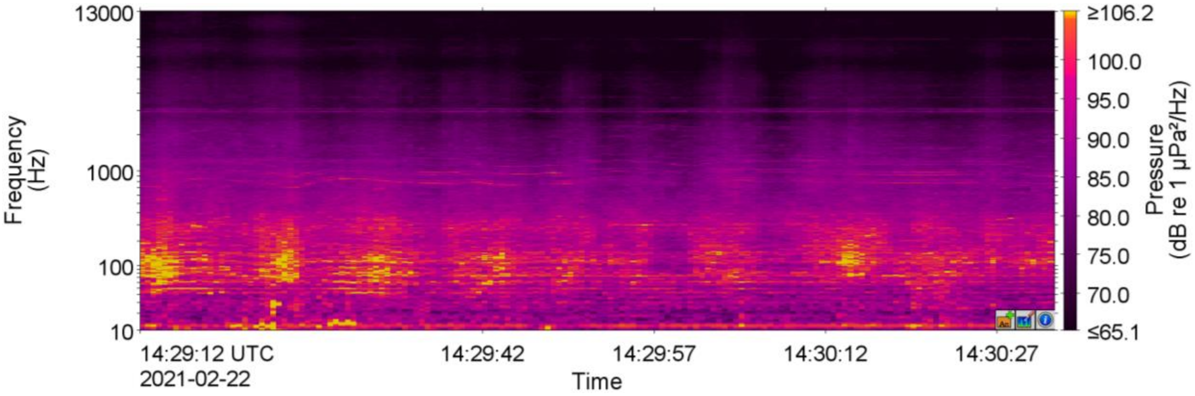

Figure 25. Spectrogram of 80 s minutes of drilling operations on 22 Feb 2021 from 14:29:12 at Station 1(0.2 Hz frequency resolution, 1 s time window, 0.5 s time step, Hamming window).

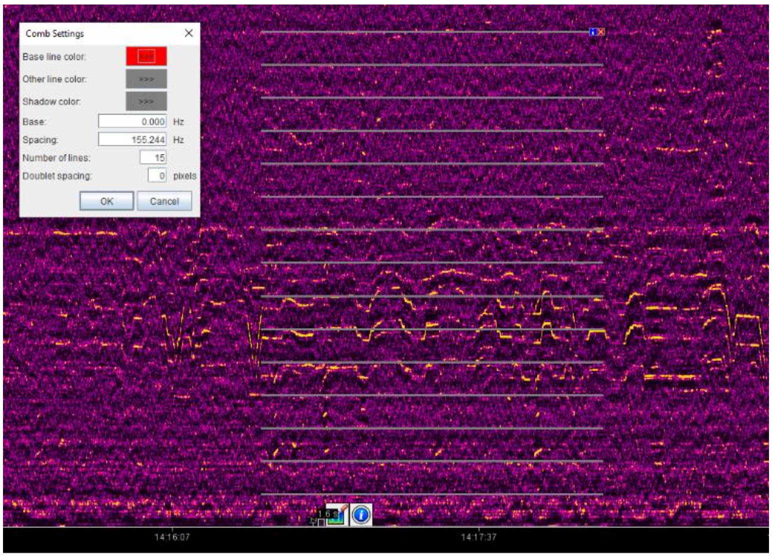

Figure 26. Drilling tonals, spaced at 155 Hz

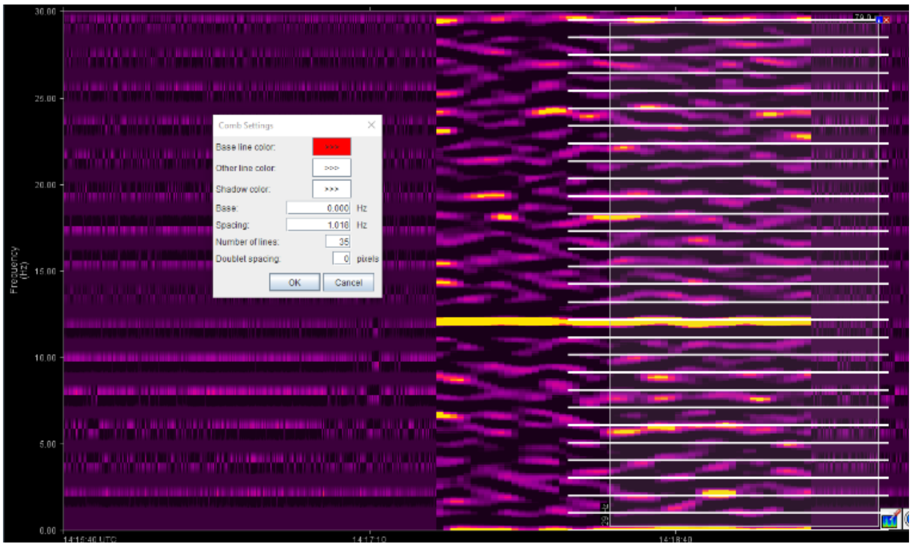

Figure 27. Very low frequency tonal analysis correlates with 60 rpm drilling speed

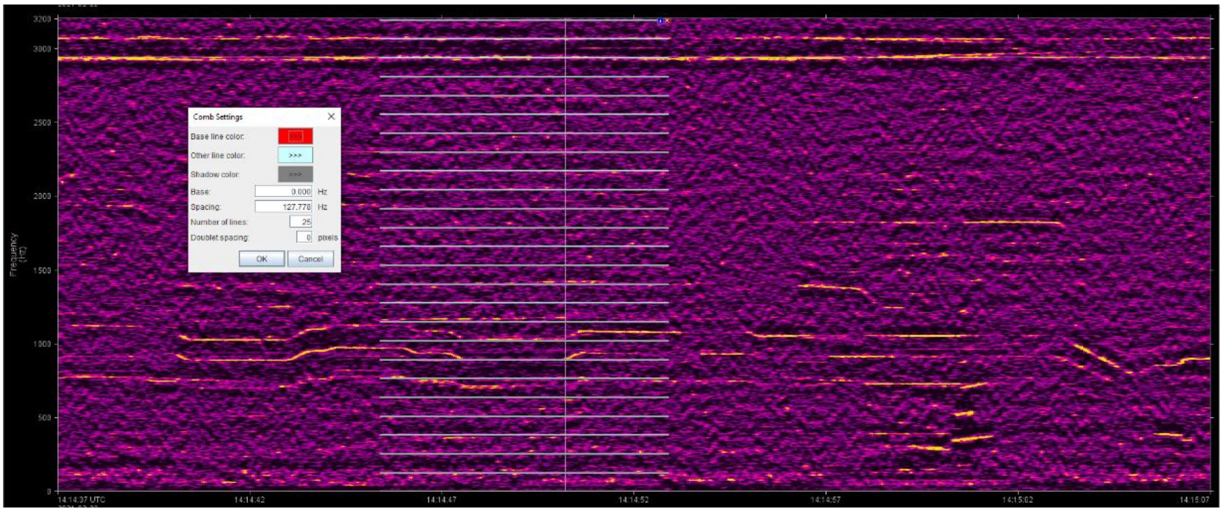

Figure 28. Example of correlation between harmonics and load on main pump with centre frequencies of 2992 and 3062 Hz. The example also shows the diesel generators with engine firings rates fluctuating between 149 and 152 Hz while under hotel load from *Ocean Onyx*.

5.4.2. Snippet 2

A snippet of data from Station 1 for 08 Mar 2021 from 18:14:40 was examined to look for alignment between the acoustic data and the drilling logs to provide a detailed insight into the noise producing sources. The drilling log for this period stated:

> Drilled ahead 12-1/4" hole from 1,433m to 1,545m.
> Parameters:
> Flow: 1,000gpm, Boost Pump-250gpm, SPP: 3,000psi, RPM: 120 surface/217 bit
> Tq: Off 1-2kft-lbs/On 5-10kft-lbs. WOB: 5-15klbs P/U wt: 300klbs, S/O wt: 325klbs, Rot: 315klbs. Average ROP: 18.6m/hr
> ESD: 11.18ppg, ECD: 11.37ppg
> Offline: Displaced the Boost line and flushed the MGS utilising the boost pump - total of 20 strokes pumped (10bbls).
> At 1,510m MW over the shakers recorded at 10.7ppg (ESD-10.88ppg).
> Ceased centrifuging and weighted up the mud with additions of barite. MW at 1543m recorded at 11.1ppg.

The spectrogram of the entire wav file is shown in Figure 29, with a shorter timescale and more focused frequency range shown in Figure 30, both showing components above 10 Hz only. In this snippet there is no secondary source, such as a support vessel, present, just the *Ocean Onyx*. The narrowband tonals below 200 Hz indicate that the revolutions-per-minute fluctuate between 178 and 220 rpm, this aligns with data pins 9, 13 and 16 in Figure 31, along with various higher frequency harmonics. A second low-frequency rotating source, with a speed of 120.6 rpm was detected, Figure 32, and it demonstrates no apparent relationship between the 1.63:1 reduction ratio present in the low frequency spectrum to the other source. These frequencies align with information provided in the drill logs.

The data indicates various generator (diesel gensets and pumps) running in multiple configurations. All appear to be running in a steady-state fashion with varying loads, apparent through the fluctuations in frequency. Two distinct gensets are noted in particular as running hotel load, as they are more stable than the others which are likely being used for the *Ocean Onyx* drilling operations, and thus having changing requirements which changes their load. The tone at 3 kHz which is consistent without fluctuation, shown clearly in Figure 34, is probably a high-pressure pump which does not fluctuate with power draw, as no banding (harmonics) are observed, the motor is not a pole motor.

Figure 35 shows three distinct gensets (one tonal each) with accompanying cylinder firing rates throughout the spectrogram. These appear related to *Ocean Onyx* drilling operations as there are no secondary contacts on spectrogram (such as vessels) and the tonals fluctuate with power draw over time.

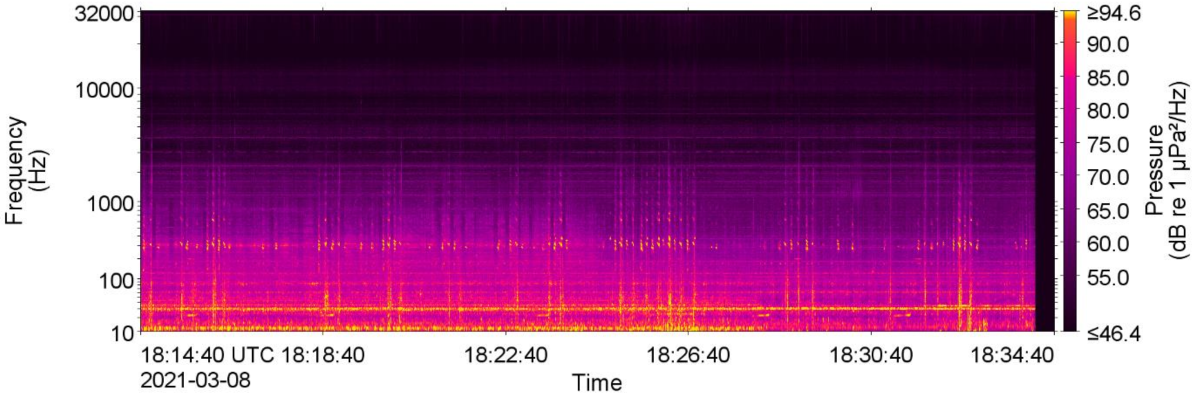

Figure 29. Spectrogram of 20 minutes of drilling operations on 08 Mar 2021 from 18:14:40 at Station 1(0.2 Hz frequency resolution, 1 s time window, 0.5 s time step, Hamming window).

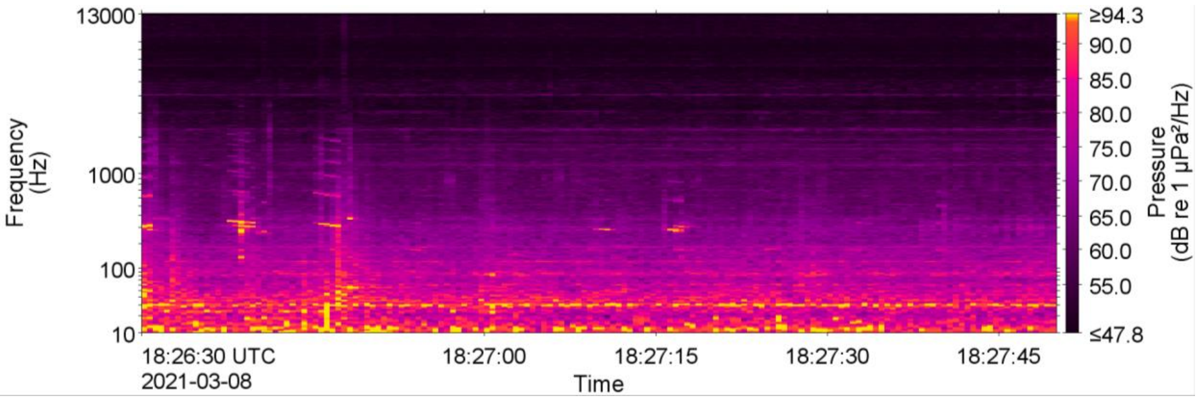

Figure 30. Spectrogram of 80 s of drilling operations on 08 Mar 2021 from 18:26:30 at Station 1(0.2 Hz frequency resolution, 1 s time window, 0.5 s time step, Hamming window).

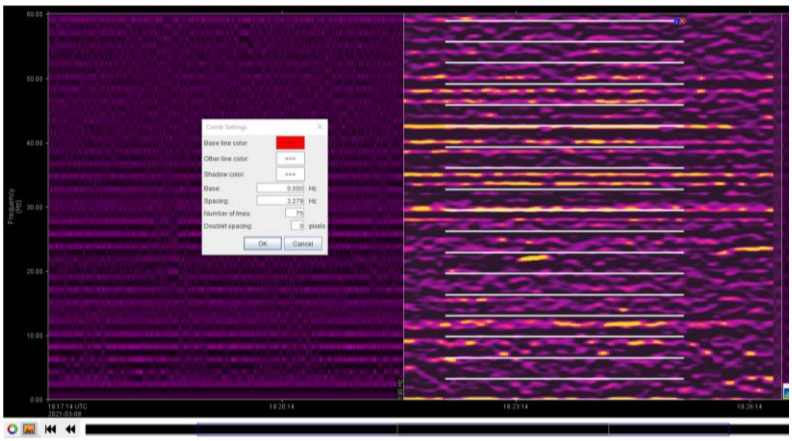

Figure 31. Low frequency analysis – rotating source contribution from first source.

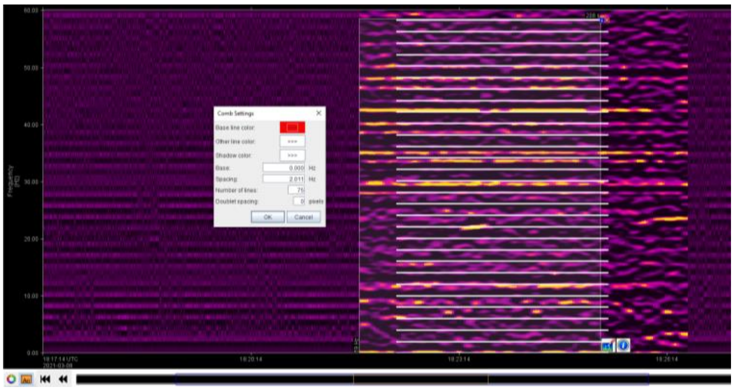

Figure 32. Low frequency analysis – rotating source contribution from second source rotating at 120.6 rpm.

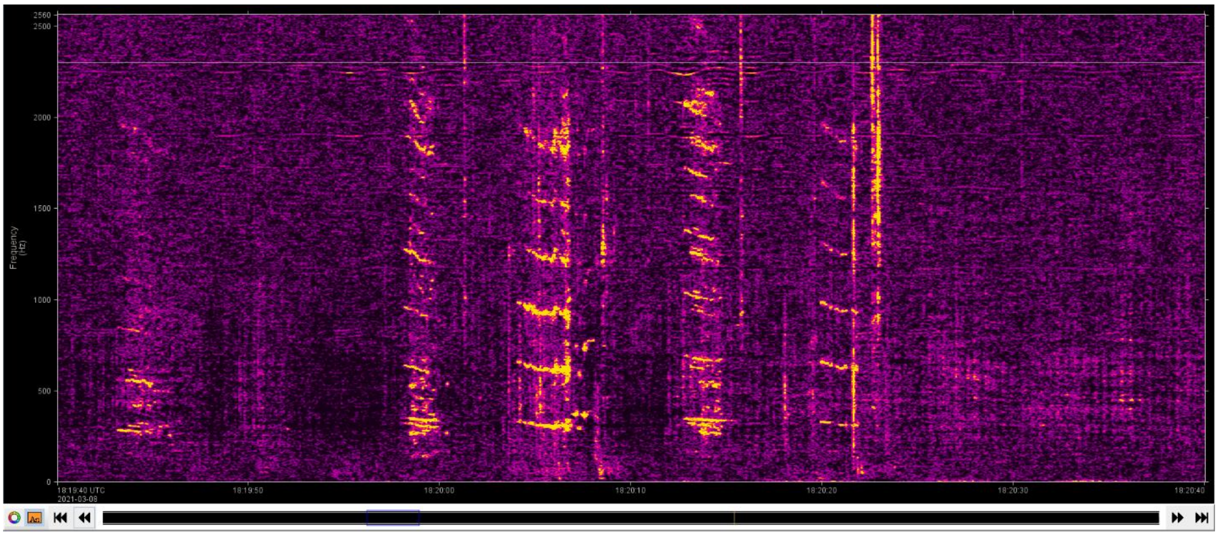

Figure 33. Transient noise from Mobile Offshore Drilling Unit (MODU) due to sea state or other movement on the anchored position (spectrogram normalised across transients).

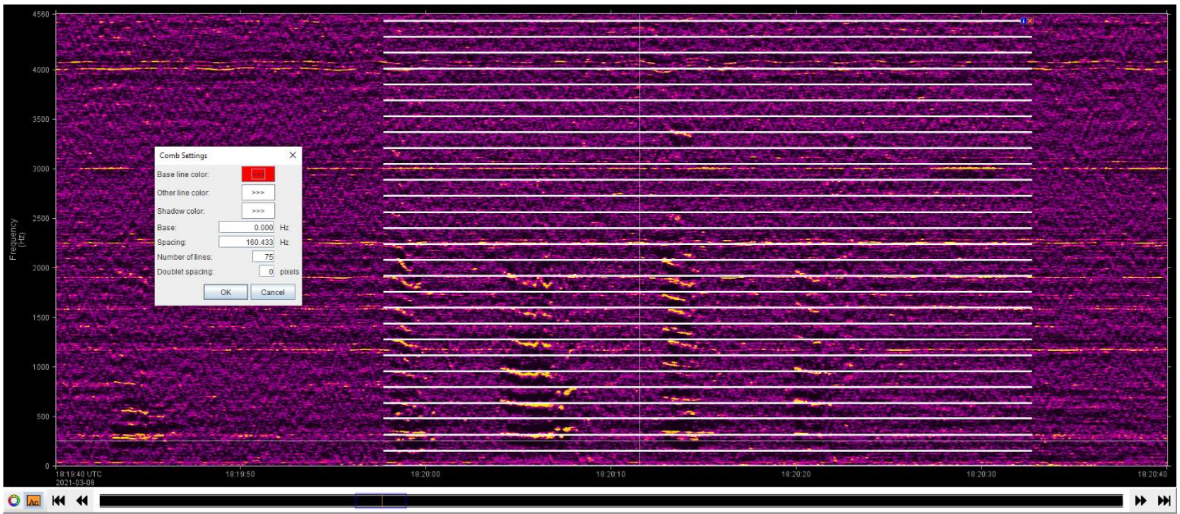

Figure 34. Generator analysis showing hotel load tonals.

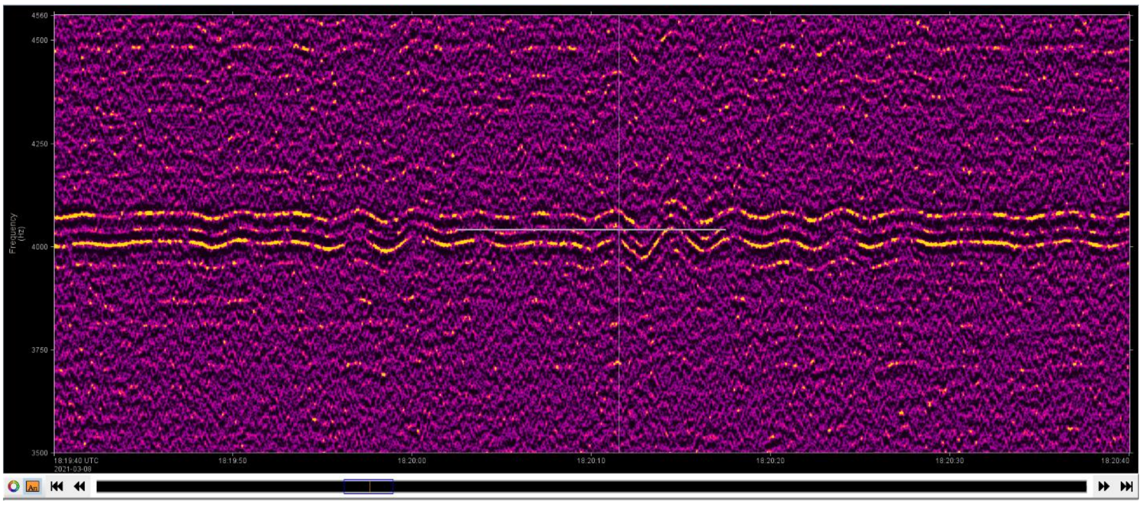

Figure 35. Three distinct gensets with accompanying cylinder firing rates throughout the spectrogram. These appear related to MODU operations as there are no secondary contacts on spectrogram and the tonals fluctuate with power draw.

5.5. Source Levels

ShipSound was used to determine the source levels for the *Ocean Onyx* and support vessels under dynamic positioning and during transits using the methods detailed in Section 4.2.3 and the operations described in Section 2.5. The following sections detail the Monopole Source Levels for each of these sources.

5.5.1. MODU

Following the method detailed in Section 4.2.3.2 and the periods specified in Table 8, the mean and maximum MSL for the *Ocean Onyx* was determined for three drilling depth ranges (Figure 36). The mean MSL is more representative of typical levels for each drilling depth and therefore suitable for comparison to the levels used in Koessler et al. (2020). Three example ShipSound reports are provided in Appendix G.1, and a spectrogram of drilling activities extracted from the ShipSound report included in Appendix G.1.2 is shown in Figure 37.

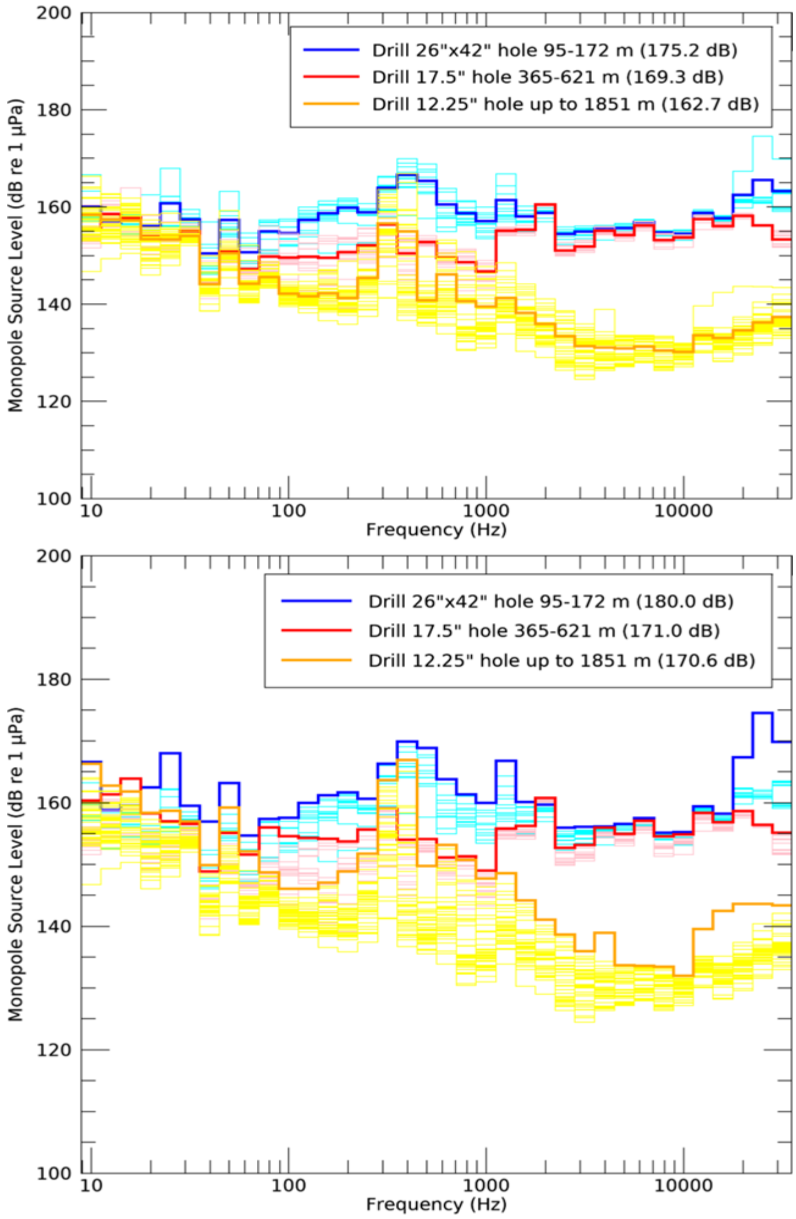

Figure 36. Monopole Source Level (MSL) and spectra for *Ocean Onyx* Mobile Offshore Drilling Unit (MODU) from Station 1 ShipSound processing, averaged over a ShipSound measurements over three different drilling depths, mean (top) and maximum (bottom).

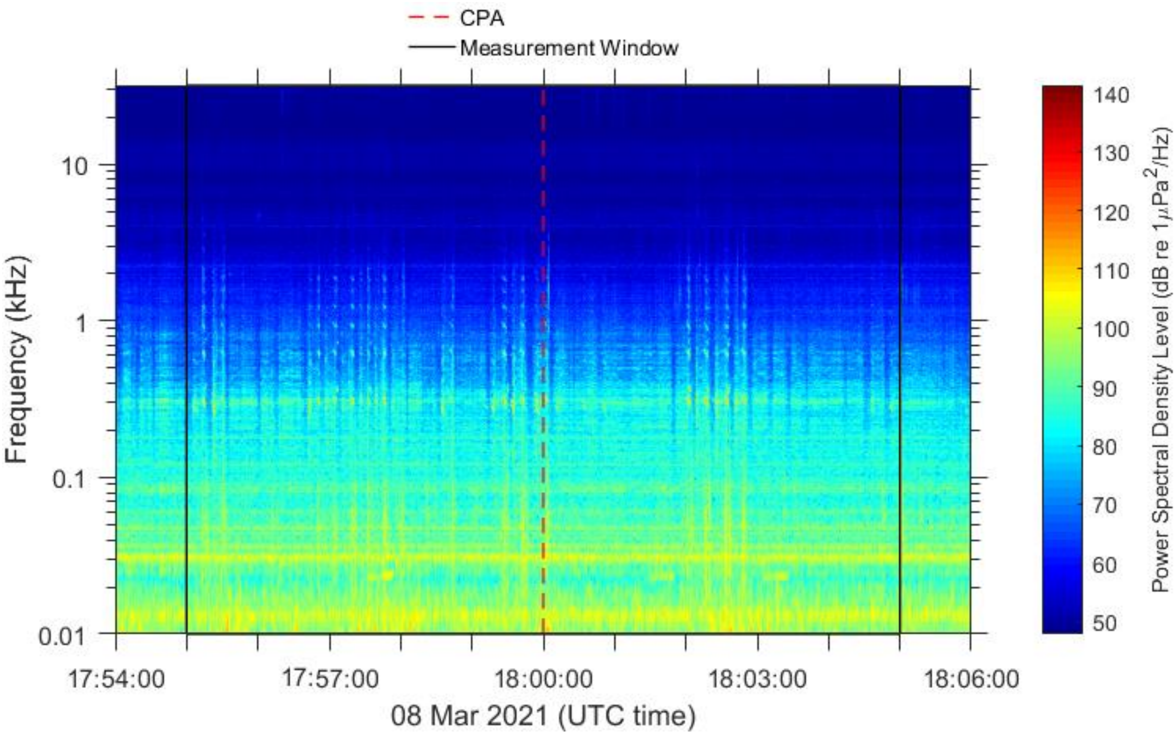

Figure 37. Spectrogram from ShipSound report included in Appendix G.1.2, with a calculated Monopole Source Level (MSL) of 159.6 dB re 1µPa m.

Table 11. *Ocean Onyx* monopole source levels (MSLs) from Figure 36.

Measurement	Monopole source level (dB re 1 µPa m)	
	Mean	Maximum
Drilling 26”x42” hole from 95–172 m	175.2	180.0
Drilling 17.5” hole from 365–621 m	169.3	171.0
Drilling 12.25” hole up to 1851 m	162.7	170.6

5.5.2. Vessels under Dynamic Positioning

Following the method detailed in Section 4.2.3 for vessels under dynamic positioning, the mean MSL was determined to be 193.9 dB re 1 µPa (Figure 38). The mean representative of typical levels from the trials of dynamic positioning is therefore suitable for comparison to the levels used in Koessler et al. (2020). One example ShipSound report is provided in Appendix G.2.

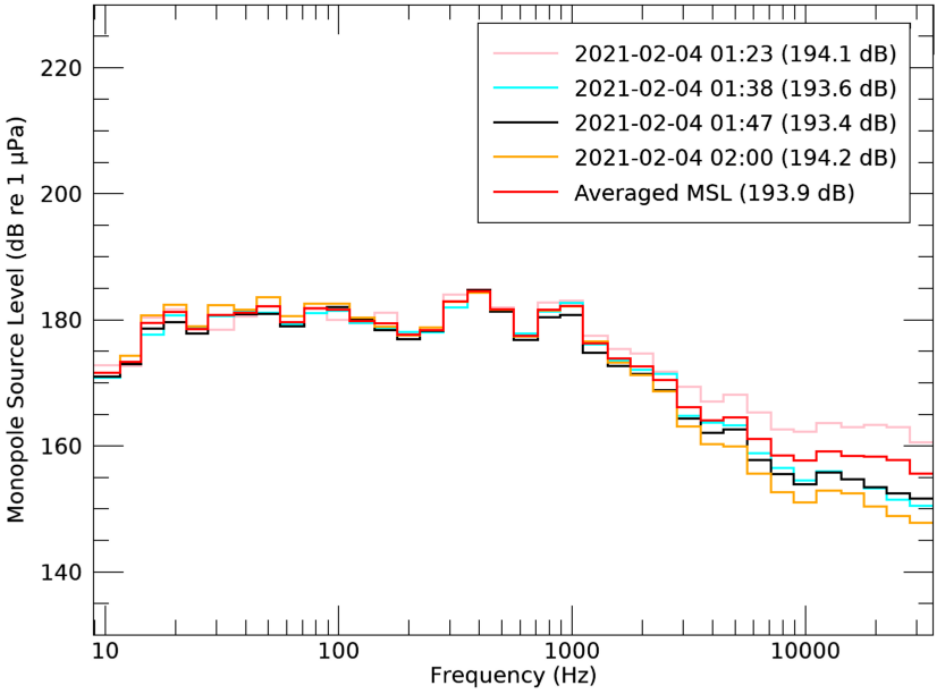

Figure 38. Monopole Source Level (MSL) and spectra for Siem *Sapphire* in dynamic positioning (DP) from Station 2 ShipSound processing. The MSL was averaged over all ShipSound measurements.

5.5.3. Vessels during Transit

Following the method detailed in Section 4.2.3 for vessels under transit, the mean MSL was determined for each vessel, the Siem *Sapphire* under transit at both 7 and 9 kn (Figures 39 and 40), and the Siem *Aquamarine* and *Topaz* at 9 kn (Figures 41 and 42). The two transit speeds are therefore suitable for comparison to the levels used in Koessler et al. (2020). One example ShipSound report is provided in Appendix G.3.

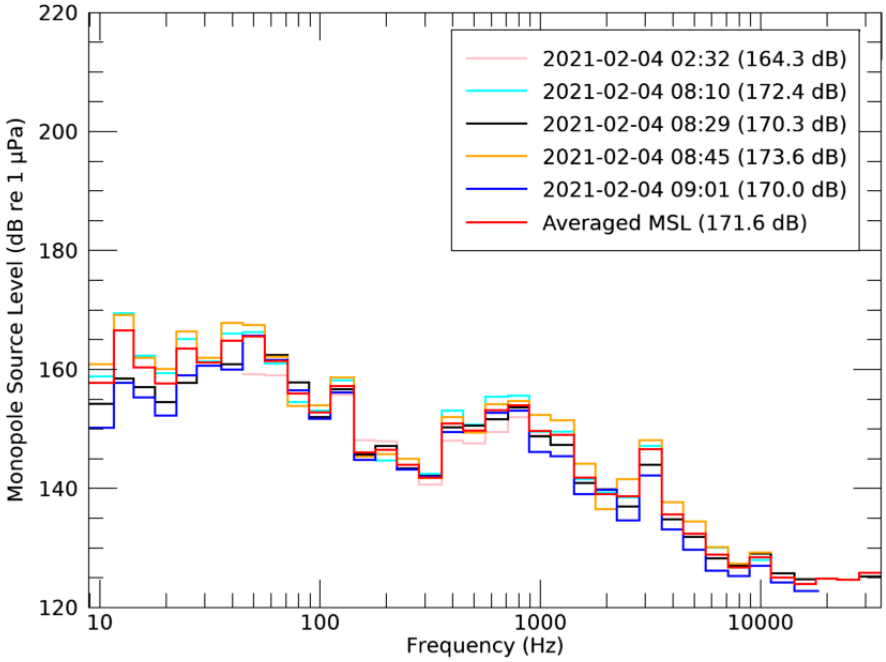

Figure 39. Monopole Source Level (MSL) and spectra for Siem *Sapphire* from Station 2 ShipSound processing. The MSL was converted to 7 kn and averaged over a few ShipSound measurements.

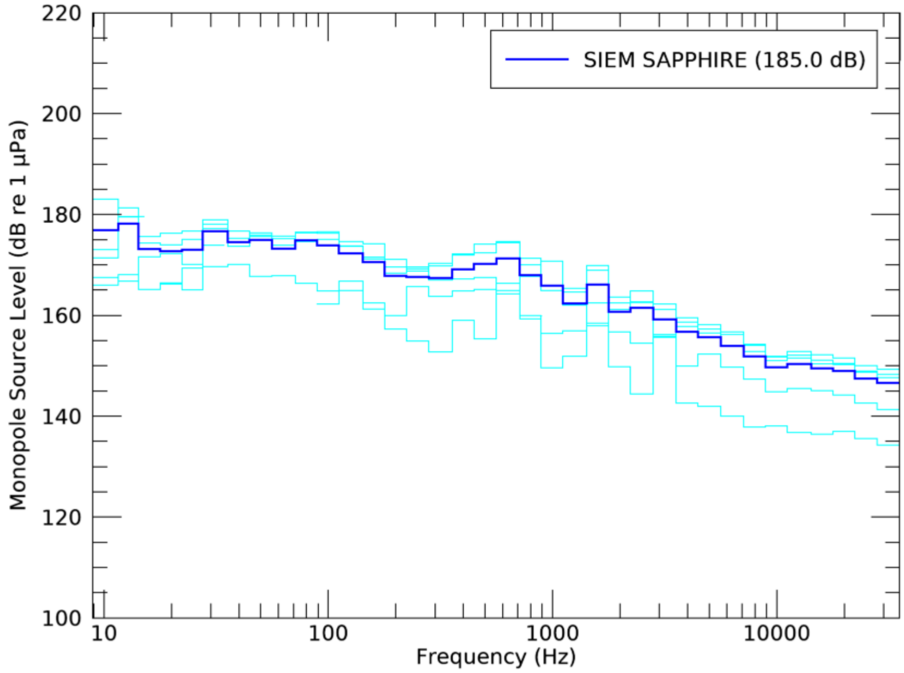

Figure 40. Monopole Source Level (MSL) and spectra for Siem *Sapphire* from Station 4 ShipSound processing. The MSL was converted to 9 kn and averaged over a few ShipSound measurements.

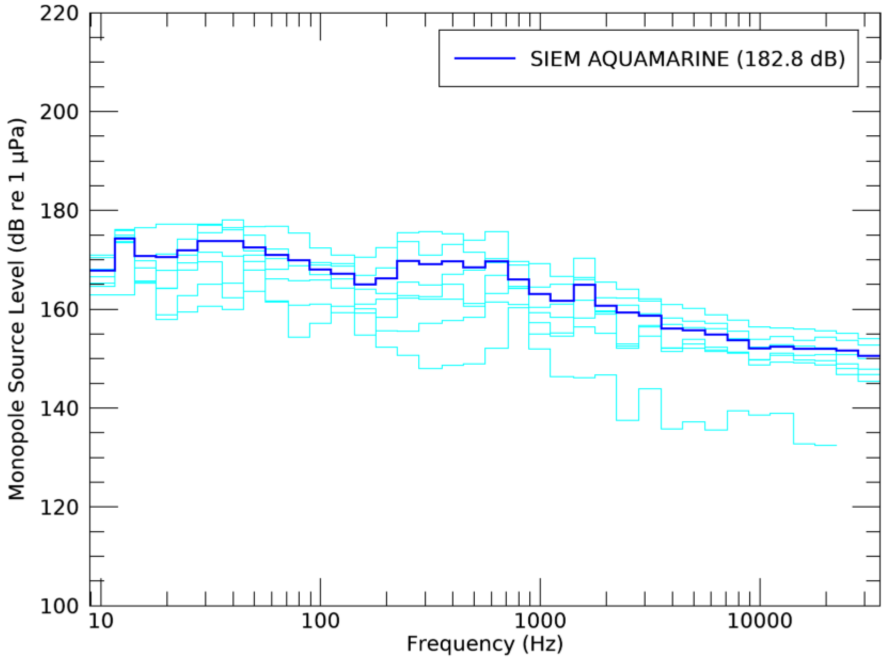

Figure 41. Monopole Source Level (MSL) and spectra for Siem *Aquamarine* from Station 4 ShipSound processing. The MSL was converted to 9 kn and averaged over a few ShipSound measurements.

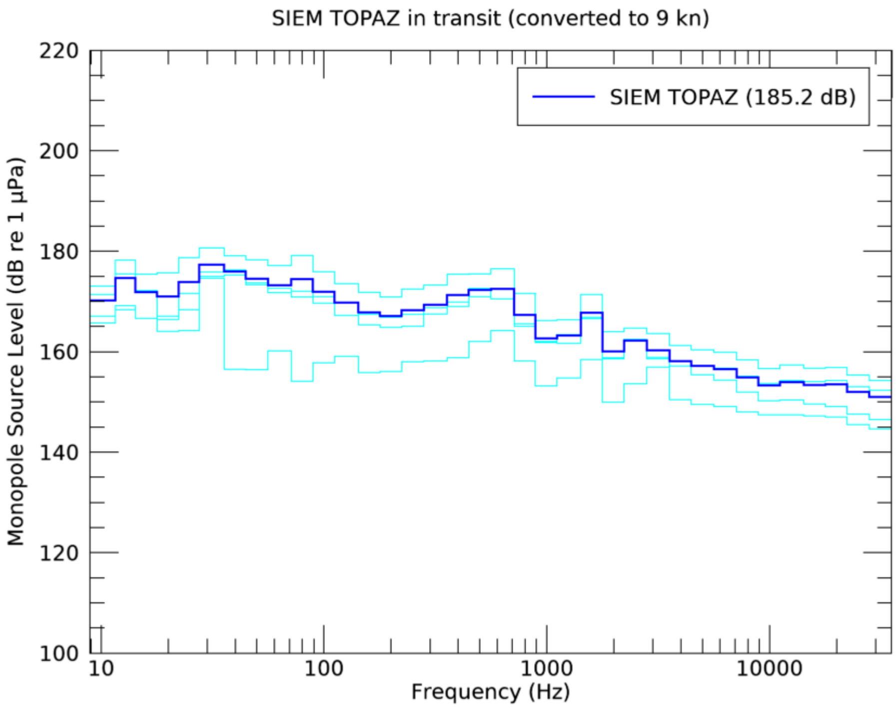

Figure 42. Monopole Source Level (MSL) for Siem *Topaz* from Station 4 ShipSound processing. The MSL was converted to 9 kn and averaged over a few ShipSound measurements.

5.6. Vessel Detections

Vessels were detected throughout the entire recording period using the automated detection algorithm described in Section 4.2.2. Results are shown for the two stations farthest from the *Ocean Onyx*, Stations 3 and 4 (Figure 43). Figure 44 shows an example of a large container vessel passing with a Lloyd's mirror pattern, and the map of the pass is shown in Figure 45, along with less defined contributions from vessel operations at the *Ocean Onyx* to the north-west (purple) between 100 and 1000 Hz. A spectrogram of a closer vessel pass and associated map are shown in Figures 46 and 47.

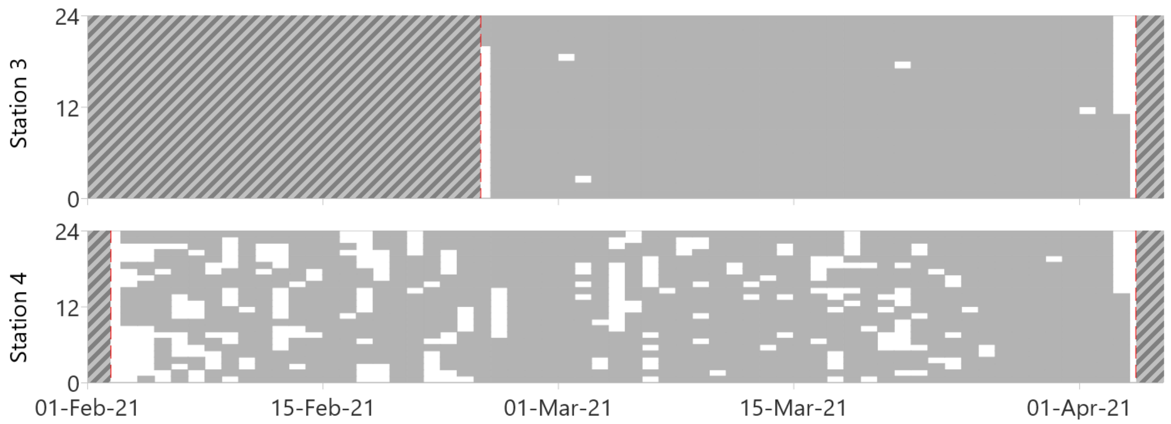

Figure 43. Vessel detections each hour (vertical axis) compared to date (horizontal axis) over the entire recording period at Stations 3 and 4. Vertical dashed lines (red) indicate AMAR deployment and retrieval dates.

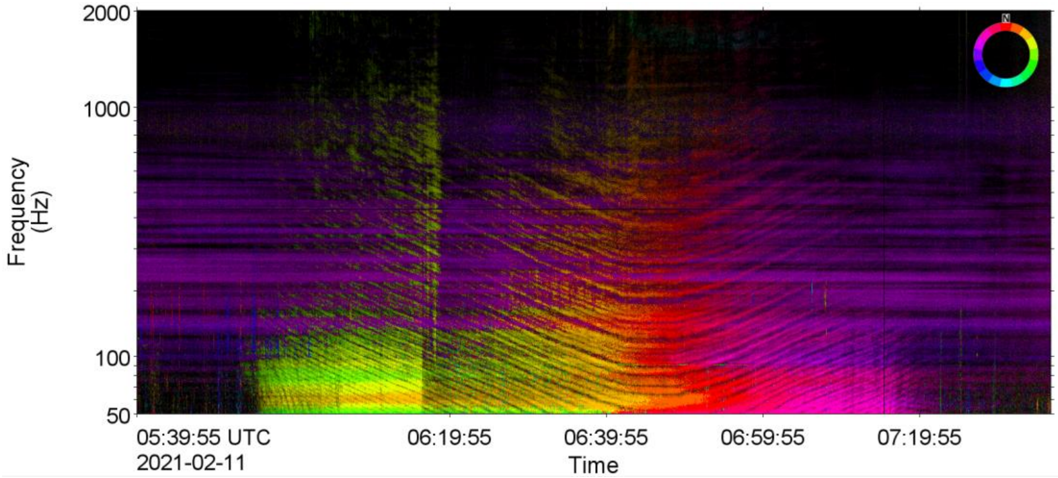

Figure 44. Example of a 334 m long container ship (*E.R. Tokyo*) travelling at 16 kn passing within 5.9 km north of Station 4 from east to west (green/yellow through to purple) that illustrates the Lloyd's mirror, or bathtub pattern over 2 h, with less defined contributions from vessel operations at the *Ocean Onyx* to the north-west (purple) between 100 and 1000 Hz. This pattern is caused by constructive and destructive interference between direct and reflected paths of sound (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time).

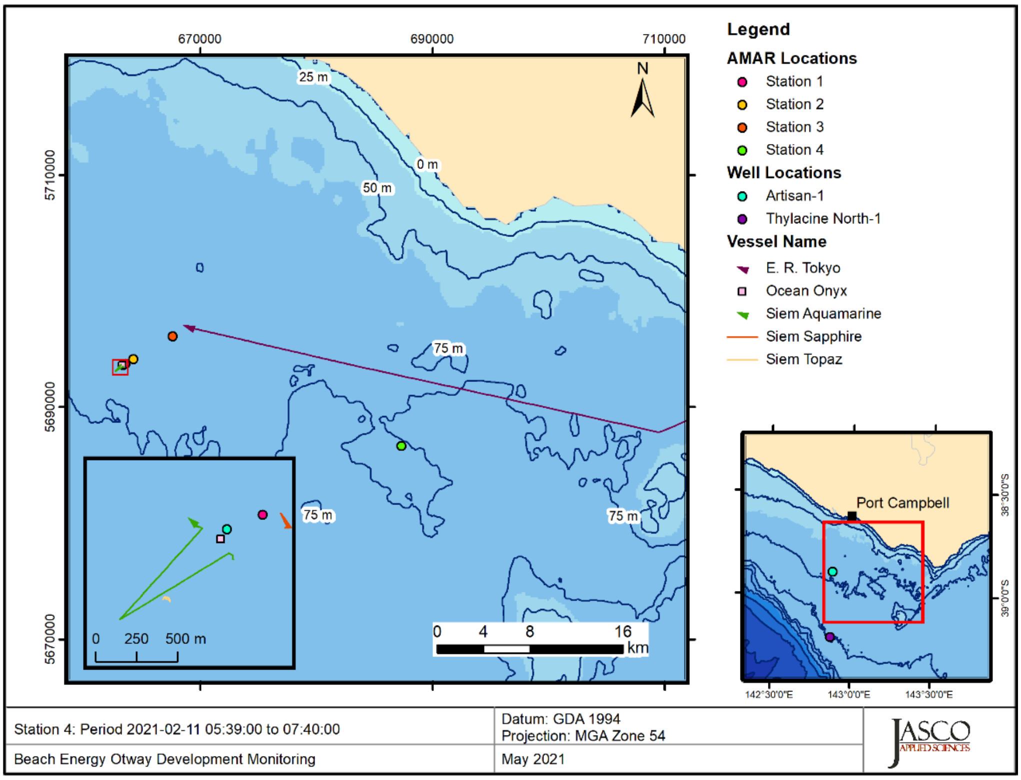

Figure 45. Map of automatic identification system (AIS) reported vessel locations for the spectrogram shown in Figure 44.

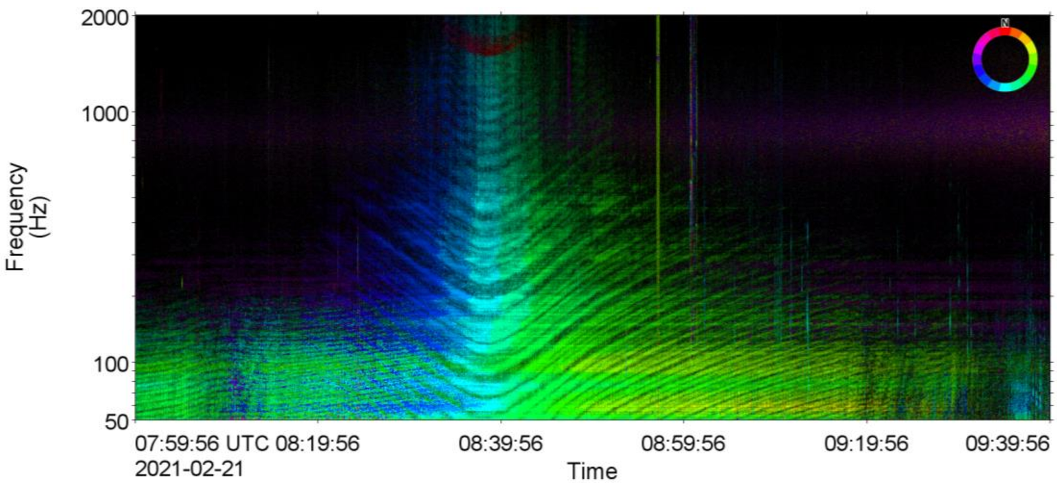

Figure 46. Example of a 200 m long vehicle carrier (*Tombarra*) travelling at 13 kn passing within 2.6 km south of Station 4 from east to west (green/yellow through to purple) that illustrates the Lloyd's mirror, or bathtub pattern over 2 h, with less defined contributions from vessel operations at the *Ocean Onyx* to the north-west (purple) between 100 and 1000 Hz. This pattern is caused by constructive and destructive interference between direct and reflected paths of sound (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time).

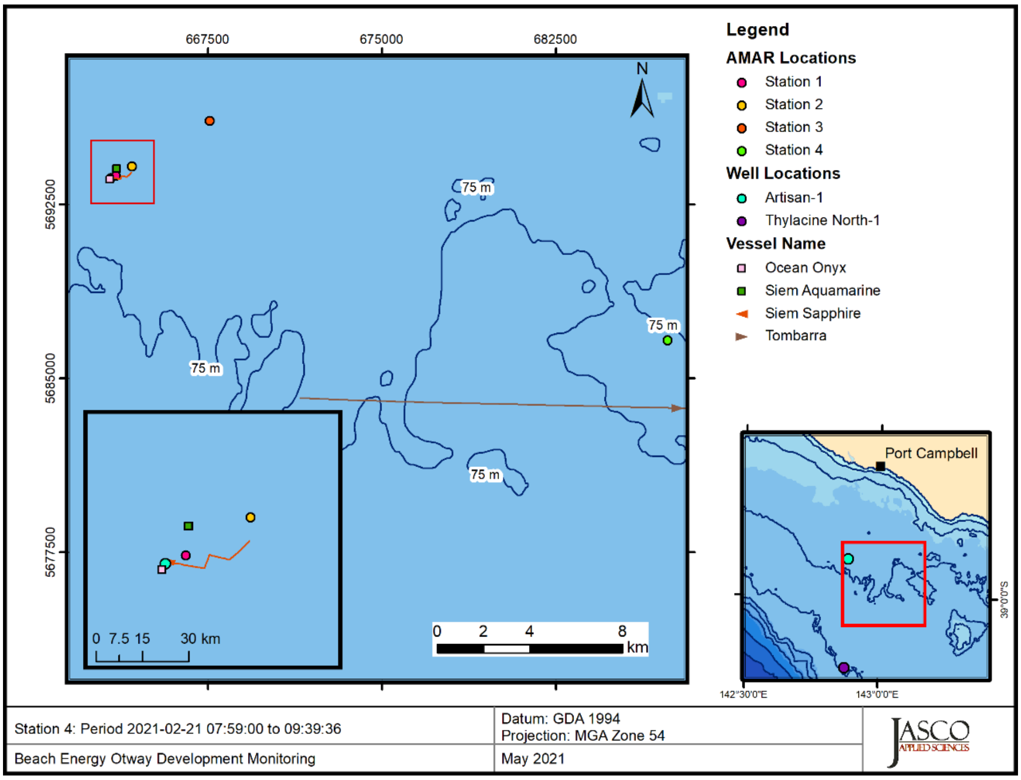

Figure 47. Map of automatic identification system (AIS) reported vessel locations for the spectrogram shown in Figure 46.

5.7. Marine Mammals

The acoustic presence of marine mammals was identified automatically by JASCO's detectors (Section 4.2.7.3) and validated via the manual review of 0.5% of the data, which represents 312 of the 5 min sound files, or 26 h worth of data. Acoustic signals of pygmy blue whales and dolphins were identified and vocalisations of other mysticetes, such as humpback and southern right whales, were not detected by the detectors (D.2), or observed during the 0.5% manual review.

5.7.1. Dolphins

Dolphins produce both impulsive (click) and tonal (whistle) sounds that show less species-level specificity than other marine mammal signals and are therefore more difficult to distinguish acoustically. Due to the directionality of impulsive clicks and the associated degradation of their spectral features when recorded at increasing angles away from the longitudinal axis of the vocalising animal, delphinid clicks cannot be confidently assigned to individual species. Furthermore, because the audible frequency of the acoustic data only reached 32 kHz, much of the energy from dolphin clicks (which can reach over 150 kHz) was not captured. Because of the overlap in spectral features of tonal signals from different dolphin species (Steiner 1981) and the expected but unquantified variability of these signals around the few described vocalisation types, we were unable to distinguish dolphin whistles by species.

The dolphin clicks and whistles observed in the data (Figure 48) were likely produced by short-beaked common dolphins (*Delphinus delphis*), and/or bottlenose dolphins (*Tursiops sp.*) (Bilgmann et al. 2007, Bilgmann et al. 2014, Charlton-Robb et al. 2015). These signals were observed at all stations throughout the recording period with detections highest at Station 4 and through the month of March at Stations 1, 2, and 3 (Figures 49 and 50). It was apparent that dolphin clicks occurred more at night than during the day, particularly at Stations 1–3 (Figure 49).

A third vocalisation type believed to be produced by dolphin calves was also observed in March at Station 3 alongside whistles (Figure 51). These lower frequency patterns of ‘chirps’ and ‘quacks’ have previously been attributed by JASCO analysts to young bottlenose dolphins.

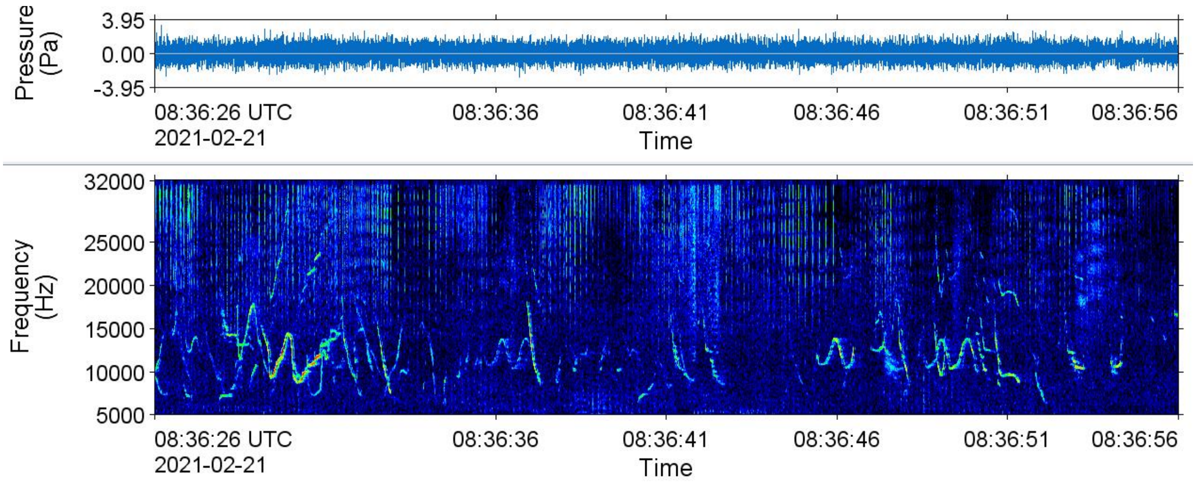

Figure 48. Spectrogram of dolphin clicks and whistles recorded on 21 Feb 2021 at Station 4 (64 Hz frequency resolution, 0.01 s time window, 0.005 s time step, Hamming window, normalised across time). The window length is 30 s.

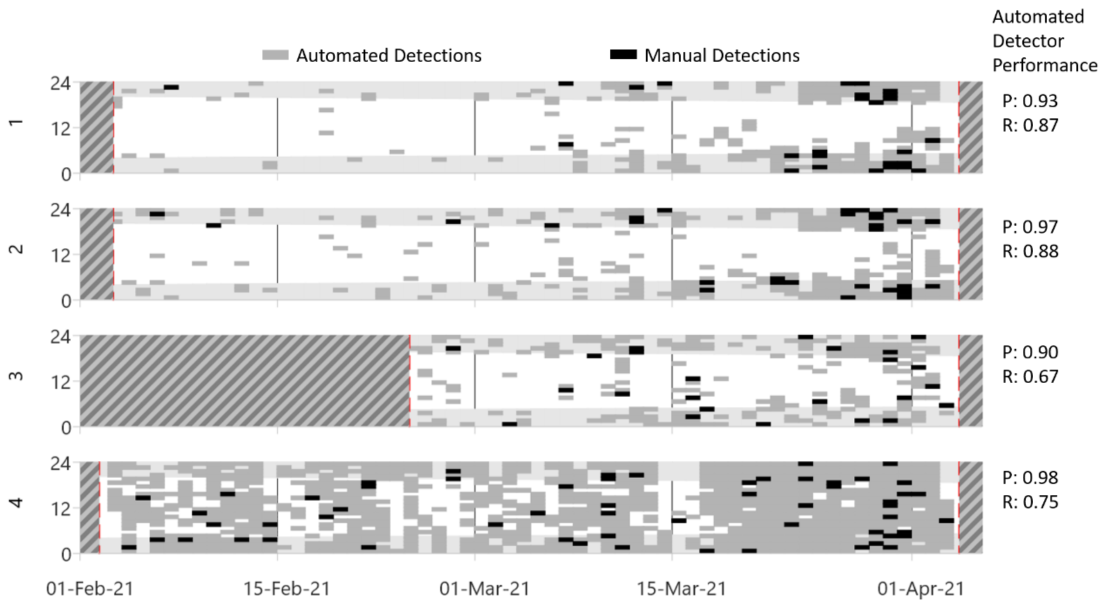

Figure 49. Daily and hourly occurrence of dolphin click detections recorded at Stations 1–4 (top – bottom) with automated detector performance metrics included along right side. The grey areas indicate hours of darkness from sunset to sunrise (Ocean Time Series Group 2009). Hashed areas indicate when there was no acoustic data and red dashed lines indicate the start and end of recordings. Automated detector results are for the dolphin click train detector.

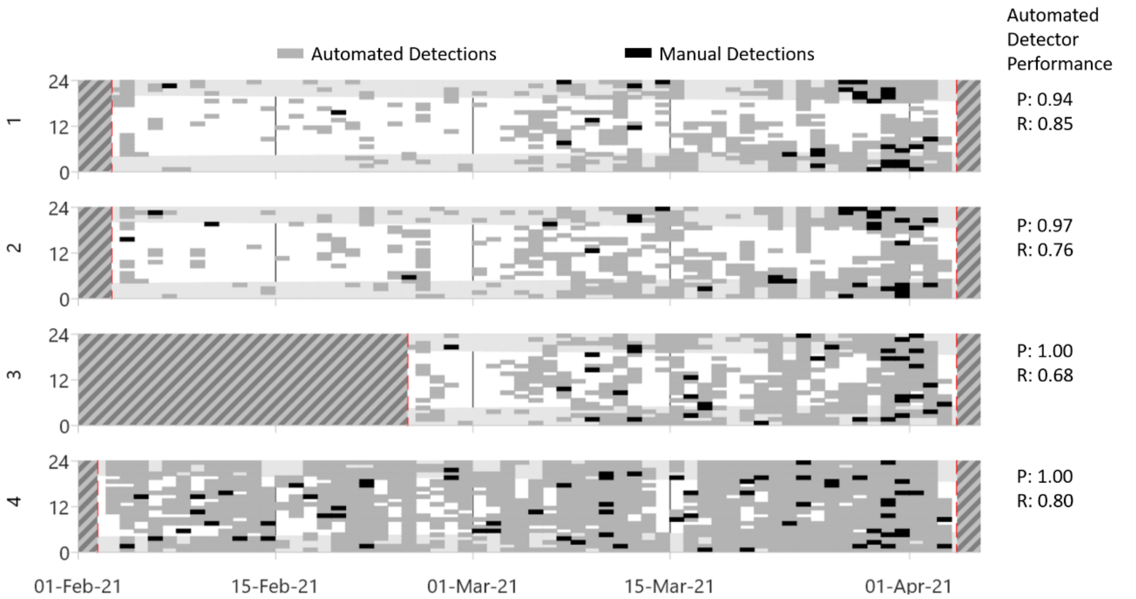

Figure 50. Daily and hourly occurrence of dolphin whistle detections recorded at Stations 1–4 (top – bottom) with automated detector performance metrics included along right side. The grey areas indicate hours of darkness from sunset to sunrise (Ocean Time Series Group 2009). Hashed areas indicate when there was no acoustic data and red dashed lines indicate the start and end of recordings. Automated detector results are for the WhistleHigh detector.

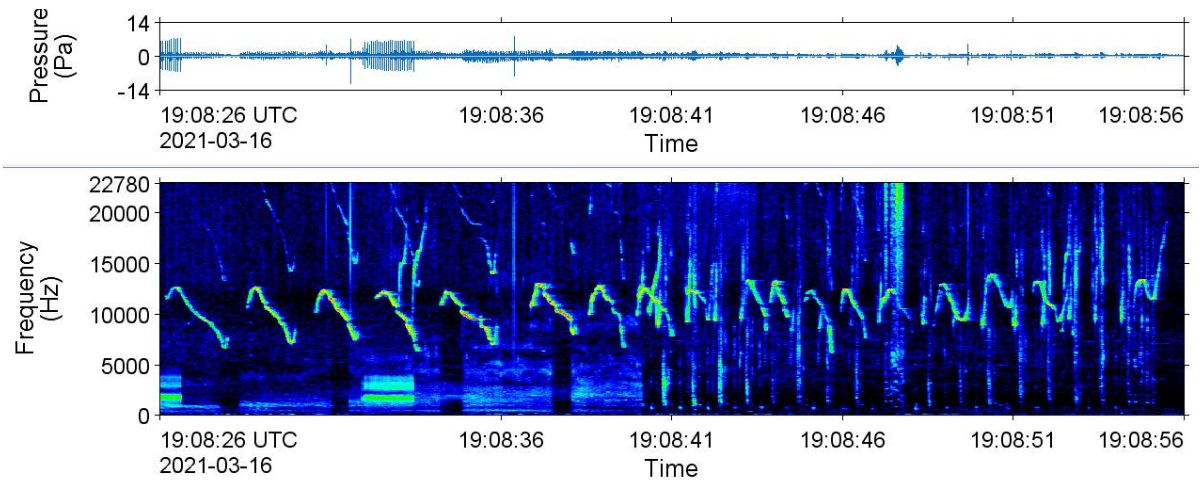

Figure 51. Spectrogram of dolphin whistles (above 5000 Hz) and sounds from young dolphins (majority present under 5000 Hz) recorded on 16 Mar 2021 at Station 3 (2 Hz frequency resolution, 0.125 s time window, 0.03125 s time step, Hamming window, normalised across time). The window length is 30 s.

5.7.2. Pygmy Blue Whales

Songs of pygmy blue whales (*Balaenoptera musculus brevicauda*; Figures 52 and 53) were detected sporadically through February and the first half of March. By the end of March, the signals were present in almost every hour of recording (Figure 54). This pattern of occurrence was reflected across all recording stations (Figure 54). In addition to the songs containing A, B, and C notes (Figures 52 and 53) (McDonald et al. 2006, Gavrilov and McCauley 2013, McCauley et al. 2018) that were the most common blue whale vocalisation in the data, blue whale D calls (Figure 55) (Recalde-Salas et al. 2014) were also present at the end of March and into April.

At Station 4, the direction of the blue whale acoustic signals relative to the recorder position was observed. An example of this is provided in Figure 52, where one blue whale is singing to the northwest, and one is singing to the southeast. Similarly, in Figure 55, the blue whale is calling from south of the recorder. When manually analysing blue whales at Station 4, an annotation was created for every direction of calling animals and the direction saved with the annotation. Figure 56 summarises these blue whale directional results from manual analysis. Blue whales occurred in all directions relative to Station 4, and there were 1–3 individuals confirmed vocalising at a time (Figure 56). Early in the recording, there is an apparent trend in the animals being more to the east and, later in the recording, being more to the west. However, the data were too sparse to confirm anything about animal movements.

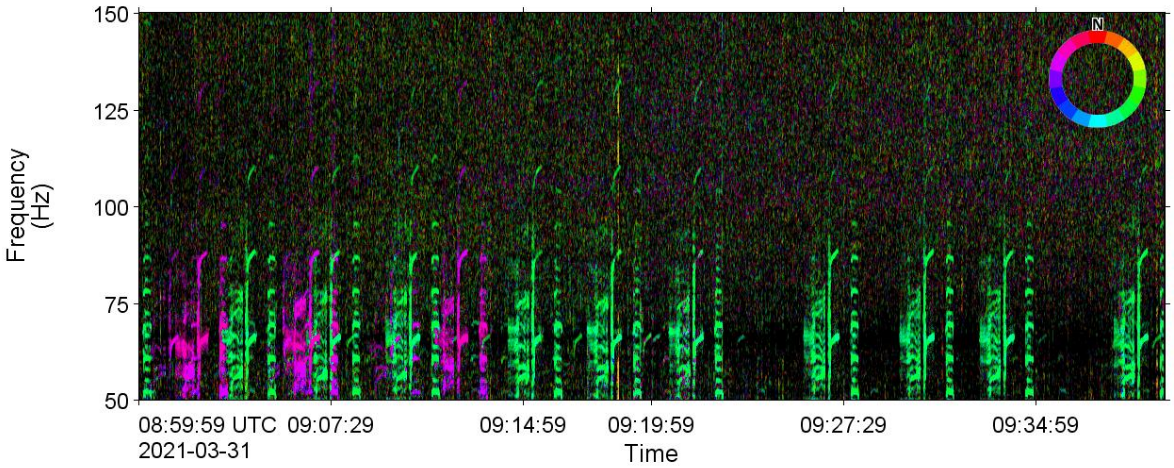

Figure 52. Directogram of pygmy blue whale songs recorded on 31 Mar 2021 at Station 4 (UTC) (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time). Displaying ~40 min of data. One blue whale is singing to the northwest of Station 4 (pink) and one is singing to the southeast of Station 4 (green).

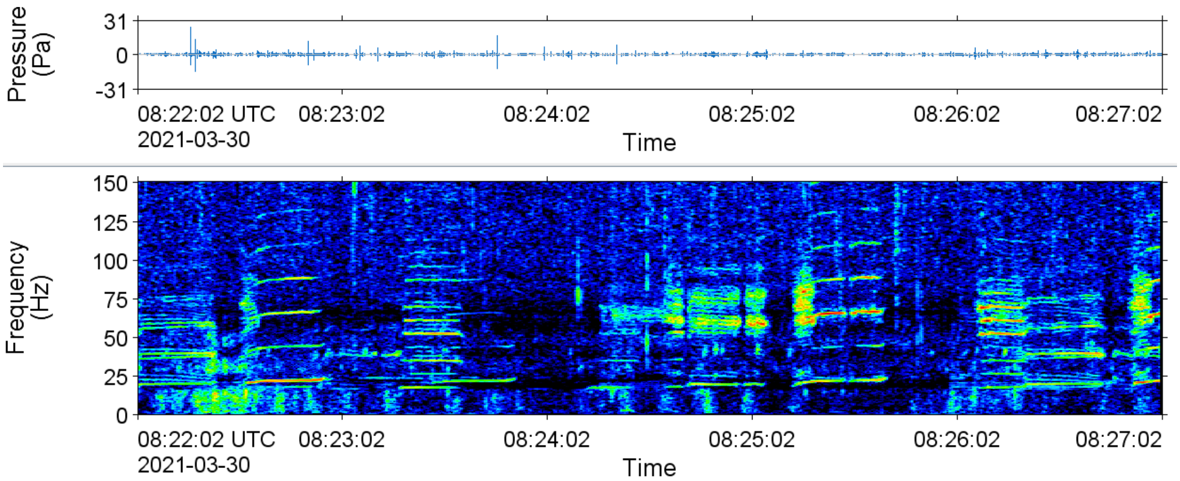

Figure 53. Spectrogram of pygmy blue whale songs recorded on 30 Mar 2021 at Station 3 (UTC) (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time). Displaying 5 min of data.

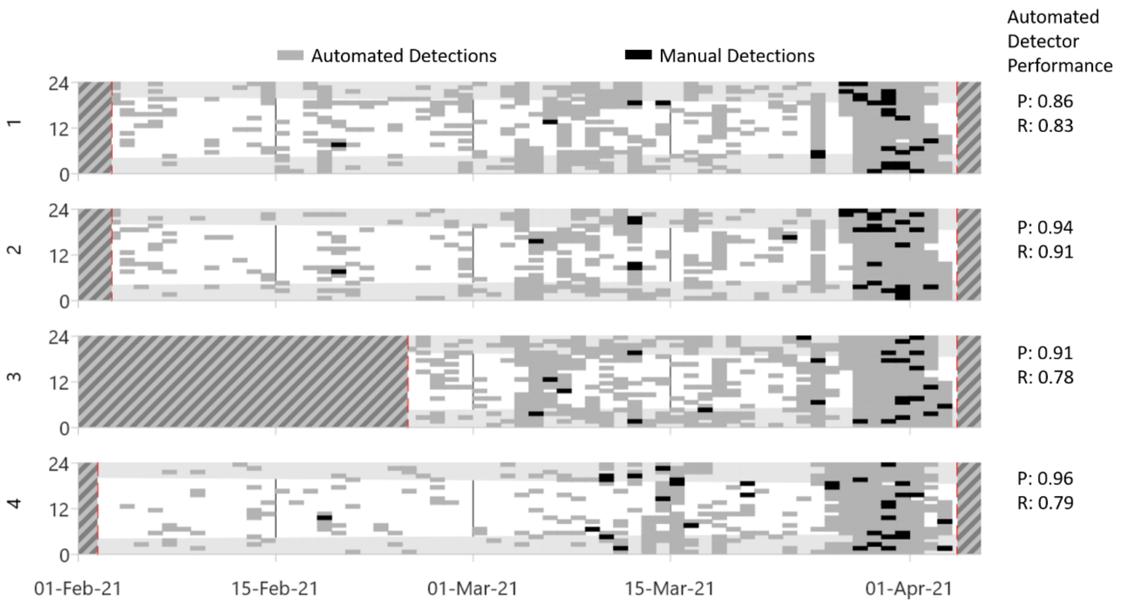

Figure 54. Daily and hourly occurrence of pygmy blue whale vocalisations recorded at Stations 1–4 (top – bottom) with automated detector performance metrics included along right side. The grey areas indicate hours of darkness from sunset to sunrise (Ocean Time Series Group 2009). Hashed areas indicate when there was no acoustic data and red dashed lines indicate the start and end of recordings. Automated detector results are for the AUS_BW_BH20 detector.

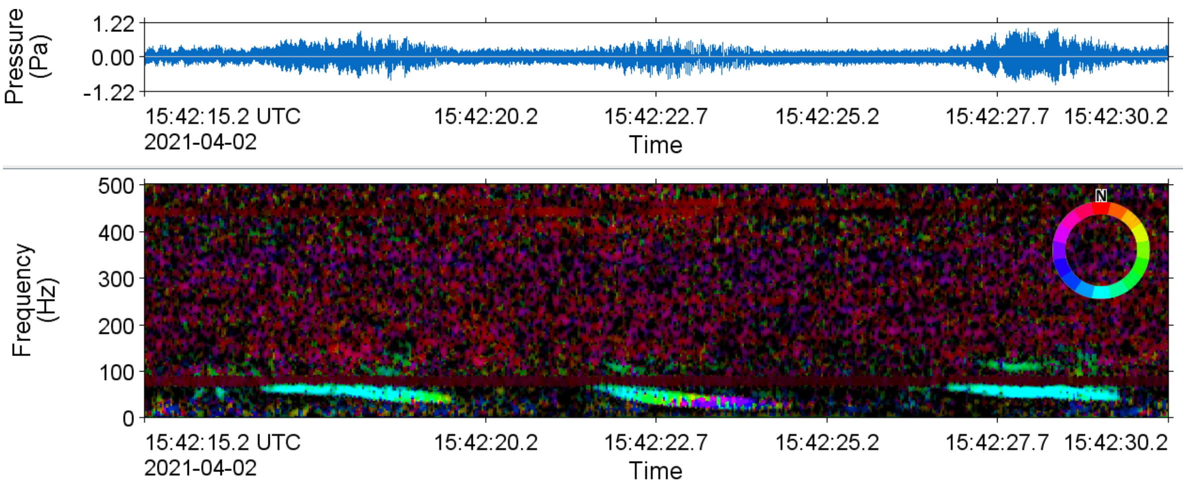

Figure 55. Directogram of pygmy blue D calls recorded on 2 Apr 2021 at Station 4 (UTC) (2 Hz frequency resolution, 0.125 s time window, 0.03125 s time step, Hamming window, normalised across time). Displaying 16 s of data. The blue whale is vocalising to the south of Station 4 (teal). In the second call, the frequencies fall below those which can be accurately determined with the hydrophone spacing using, with the colour of the signal changing from teal to purple and navy blue.

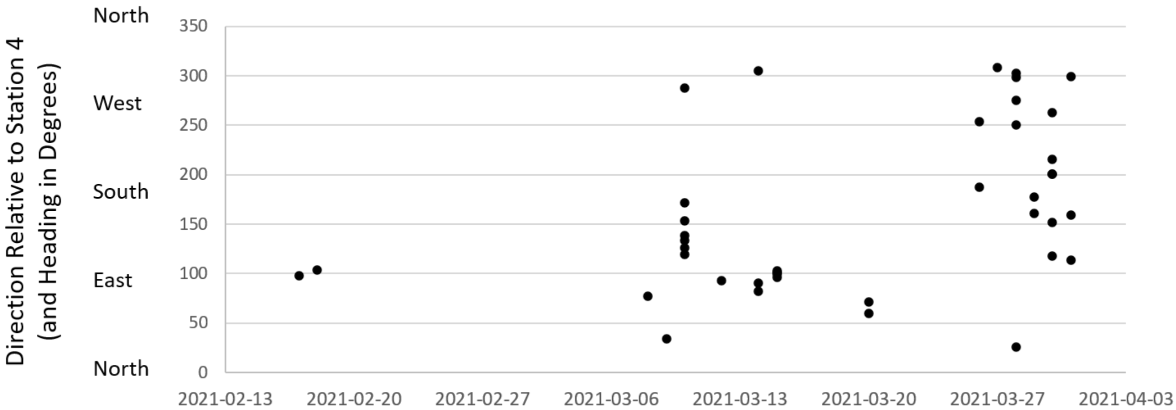

Figure 56. Plot of direction of blue whale vocalisations relative to Station 4 over the recording period where each point is a calculated from a manual annotation created during the 0.5% manual validation analysis (one annotation per direction per 5 min file analysed).

5.7.3. Other Potential Biological Sounds

Occasionally during manual analysis, pulses ranging from ~750 to 1250 Hz (Figure 57) were observed that may have been produced by fish. Alternatively, these signals could be a result of some anthropogenic activity, noises from which were noted through much of the data during manual review, particularly at Stations 1 and 2. Fish chorusing activity was apparent in the LTSAs, in particular at Station 4, with examples provided in Figures 58–60.

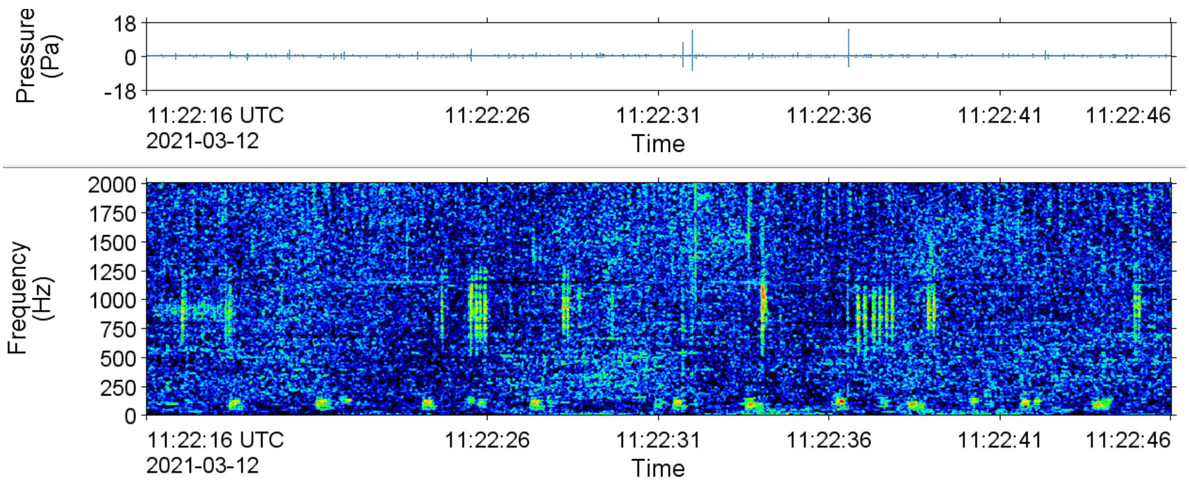

Figure 57. Spectrogram of unknown signals potentially produced by fish (pulses at 500–1250 Hz) recorded on 12 Mar 2021 at Station 3 (UTC) (2 Hz frequency resolution, 0.125 s time window, 0.03125 s time step, Hamming window, normalised across time). Displaying 30 s of data.

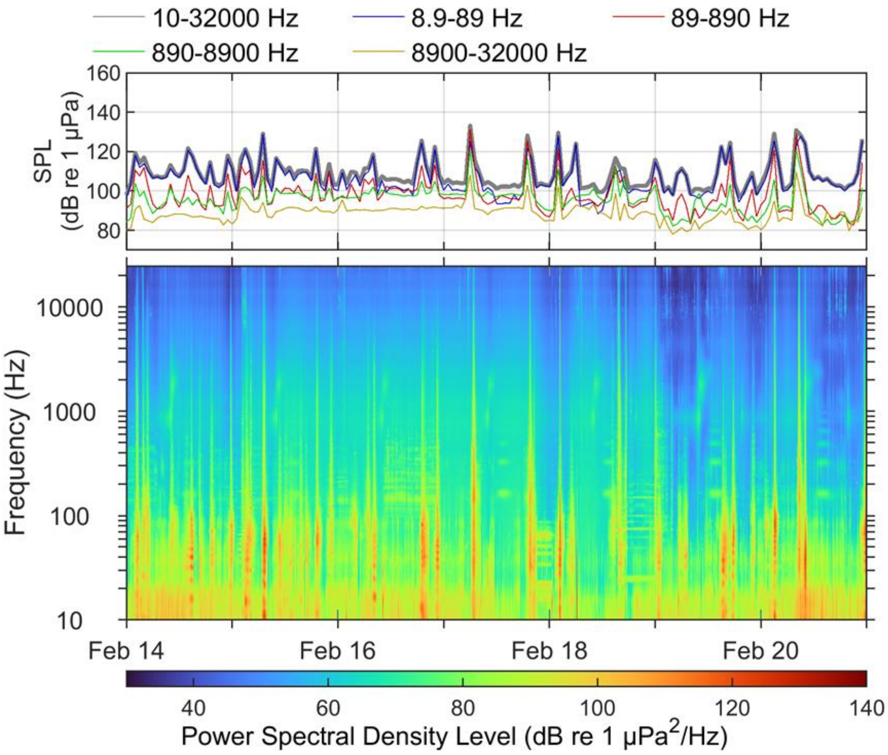

Figure 58. In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound for one week of data at Station 4, showing daily fish chorus's between 700 and 2000 kHz, and between 150 and 450 Hz, more obvious after 17 Feb 2021.

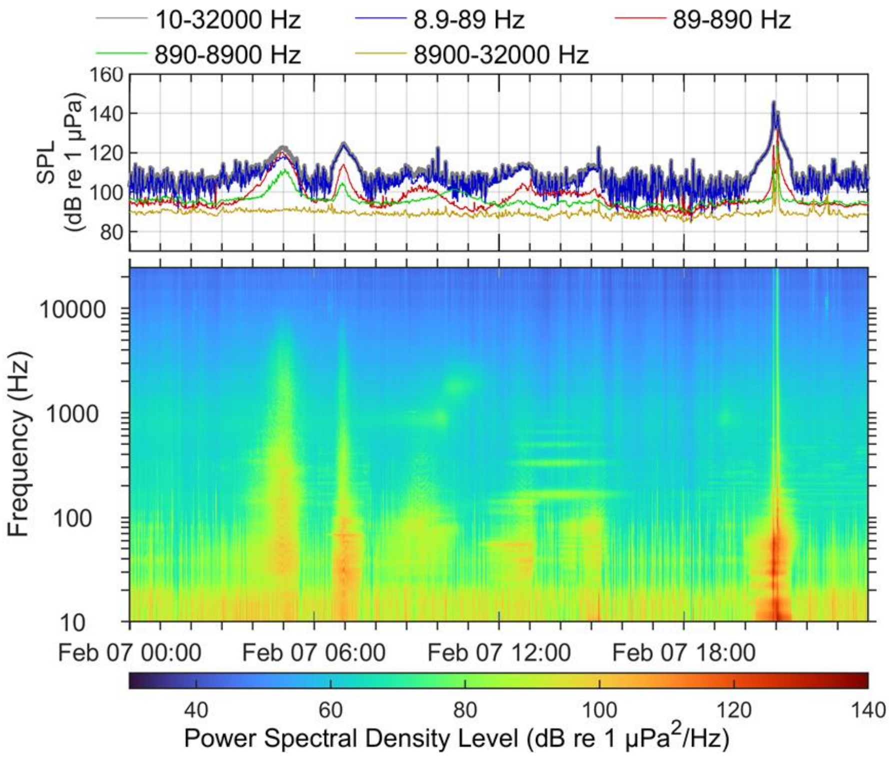

Figure 59. In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound for one day of data at Station 4, showing the daily fish chorus between 700 and 2000 kHz, and between 150 and 450 Hz, apparent in Figure 58, and six vessel transits.

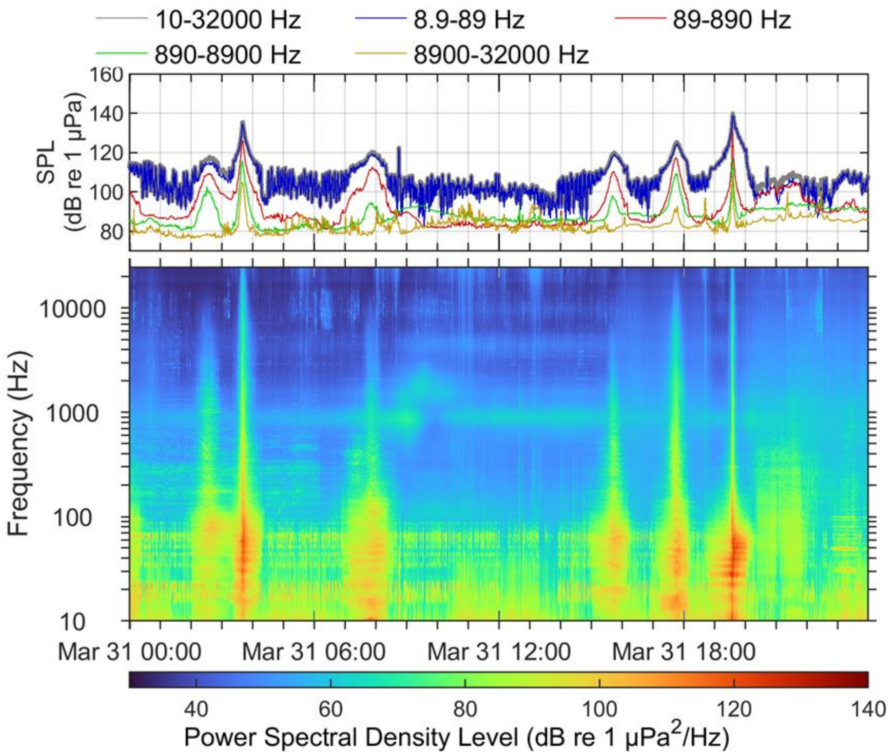

Figure 60. In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound for one day of data at Station 4, showing the daily fish chorus between 700 and 2000 kHz, lasting almost the entire day, along with six vessel transits.

6. Validation Analysis

Table 12 presents the four scenarios that need to be considered to validate the pre-measurement modelling presented in Koessler et al. (2020) for the Artisan-1. The scenarios are described in Table 12, with the modelling site locations and descriptions provided in Table 13.

Table 12. Description of modelling scenarios for the Artisan-1 development area from Koessler et al. (2020)

Well	Scenario number	Description	Associated modelled sites
Artisan-1	5	MODU, normal drilling operations	4
	6	OSV standby, independent of MODU, for 24 h	6
	7	MODU with OSV during resupply operations (including 4 hours alongside the MODU)	4, 5 and 6
	8	MODU with OSV standby (combination of Scenarios 5 and 6)	4 and 6

Table 13. Location details for the validation modelled sites.

Well	Site	Source	Latitude (S)	Longitude (E)	MGA Zone 54 (GDA94)		Water depth (m)
					X (m)	*Y* (m)	
Artisan-1	4	MODU	38° 53' 27.4106"	142° 52' 58.4450"	663300	5693640	71.5
	5	OSV	38° 53' 27.4021"	142° 53' 01.0962"	663364	5693639	71.6
	6	OSV standby	38° 53' 26.1553"	142° 54'21.4165"	665300	5693637	70.2

6.1. Source Level Comparison

The modelled source levels used in Koessler et al. (2020) are shown in Figures 61–63 alongside MSLs from the measurement program.

The mean estimated source levels for the vessels under transit used in the modelling study, which were derived based on the scaling of the power level, were similar to the MSL determined through the measurement study, which varied significantly with vessel speed (between 171.6 and 185.2 dB re µPa m). The trend of decreased MSL with speed follow those from studies on commercial shipping and ferries (MacGillivray et al. 2019). The measured MSL under dynamic positioning was different to that used in Koessler et al. (2020), in part due to the vessel power levels applied, but also because the approach used to estimate sound levels under dynamic positioning is based upon vessels under transit and is an approximation based on the Maximum Continuous Rating (MCR). Limited measurements of vessels under dynamic positioning using standardised measurement approaches are reported in literature, and there are significant differences between the thruster models and specifications, depths, and vessel dynamic positioning systems which control thruster operations. Therefore, this characterisation is a valuable contribution to understanding the MSLs for systems installed in anchor handling vessels.

The mean MSLs for the *Ocean Onyx* Figure 63 decrease as the drilling depth increases. The estimate of the *Ocean Onyx* source level spectrum was based on the Transocean *Polar Pioneer*, a similarly sized MODU. The *Polar Pioneer* was measured by JASCO while anchored and drilling, and had a broadband (10 Hz to 35 kHz) source level of 170.1 dB re 1 µPa m (Austin et al. 2018), although the source level used in the modelling was 178.7 dB re 1 µPa m. The mean maximum MSL from the measurement program was 175.2 re 1 µPa m, associated with shallowest drilling depths.

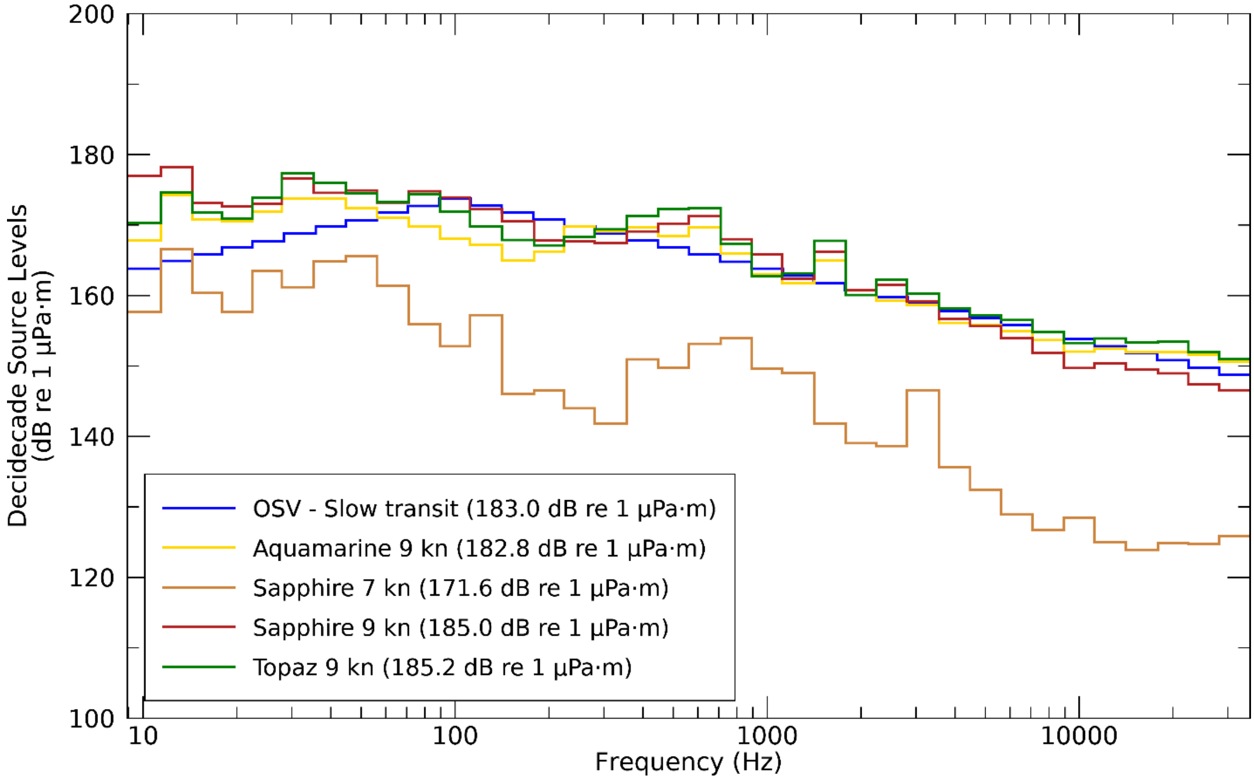

Figure 61. *Offshore Support Vessel (OSV)*: Decidecade source level spectra of the modelled OSV, slow transit (15% MCR) and Monopole source levels (MSLs) determined through the measurement program.

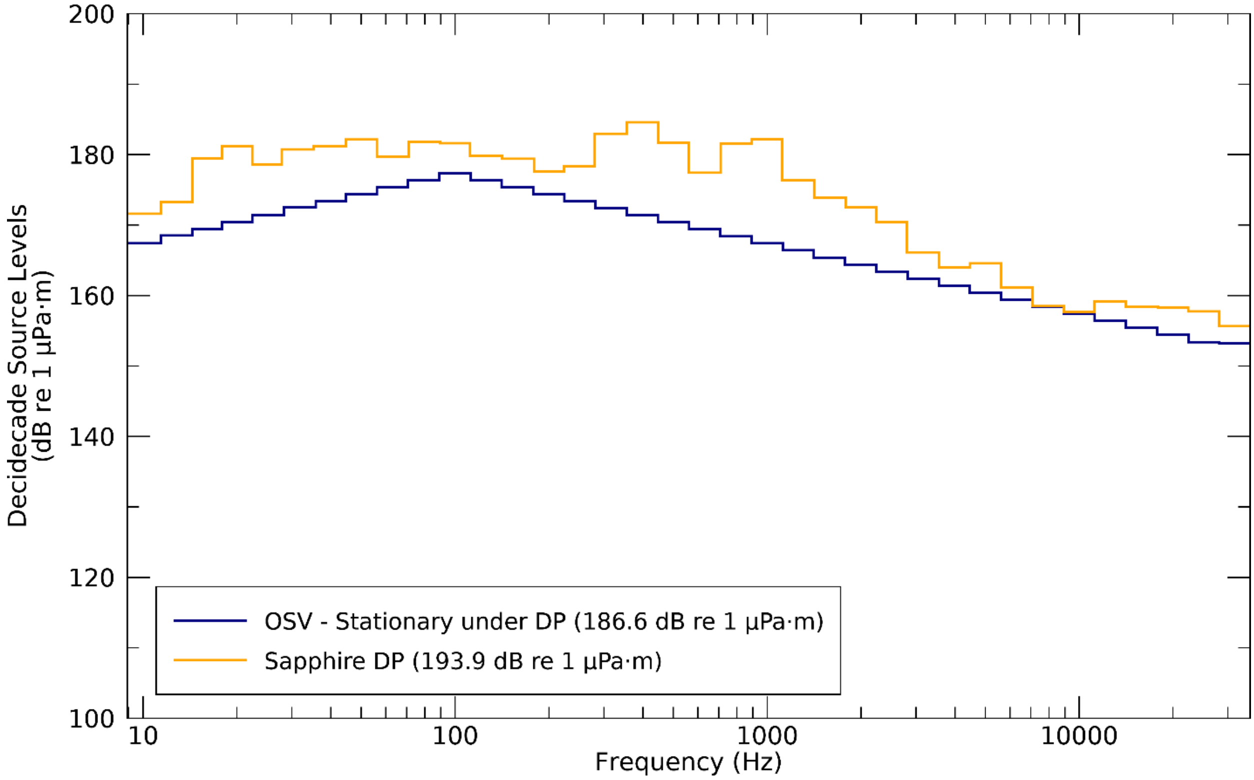

Figure 62. *Offshore Support Vessel (OSV)*: Decidecade source level spectra of the modelled DP (20% MCR) and MSLs determined through the measurement program.

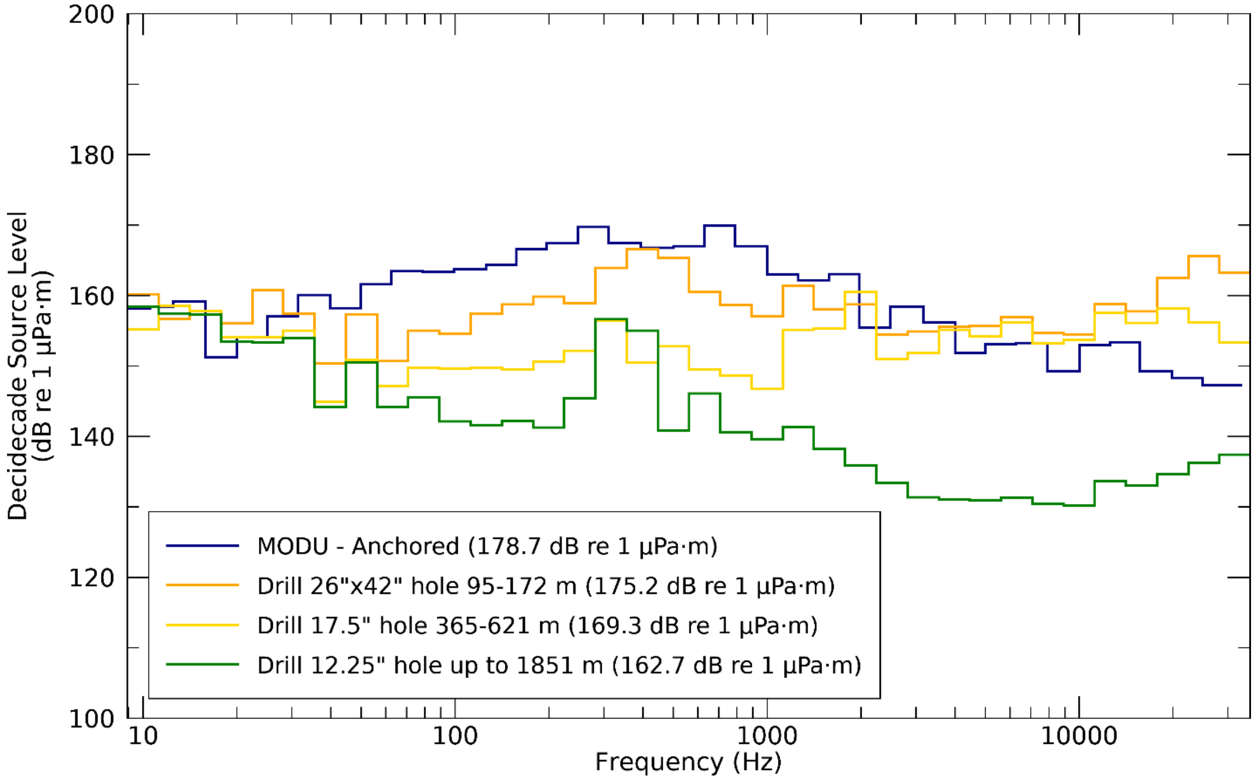

Figure 63. *Mobile Offshore Drilling Unit (MODU)*: Decidecade source level spectra of the modelled MODU, and the mean MSLs determined through the measurement program of the *Ocean Onyx* for three stages of drilling.

6.2. Understanding Propagation Loss

The plotted data and curve fits, as discussed in Section 4.2.4 and presented in Section 5.3, provide substantial detail on the environmental effects on the propagation of acoustic energy in the water column. In comparing SPL data fits for Stations 1–3, the loss rate is higher than what would have been expected in this environment, considering the higher MSLs for the support vessel on DP derived from measurements. In consideration of the potential variations in the seabed geologic compositions as indicated in Section 2.4, any difference may be attributed to the existence or absence of a thin veneer of sand.

A comparison exercise was conducted using JASCO's Marine Operations Noise Model (MONM) and JASCO's wavenumber integration model (VSTACK; Hannay et al. 2010, Jensen et al. 2011). VSTACK computes propagation loss versus depth and range for arbitrarily layered, range-independent acoustic environments using the wavenumber integration approach to solve the exact (range-independent) acoustic wave equation. Seabed reflectivity in the model is dependent on the seabed layer properties: compressional and shear wave speeds, attenuation coefficients, and layer densities. It is valid over the full angular range of the wave equation and can fully account for the elasto-acoustic properties of the sub-bottom.

A simple range-independent isovelocity water column (1500 m/s) was modelled considering a calcarenite seabed with and without a thin layer of sand as detailed in the Appendix of Koessler et al. (2020). The decidecade spectra of the measured MODU in Section 6.1 were combined with the modelled propagation loss from MONM and VSTACK to produce received level (SPL; L_p) scatter plots with range. Receivers were chosen to span the water column and the MSL source depth was located at 11 m. The results are shown below in Figures 64 and 65 when considering the mean maximum decidecade MSL presented above in Section 6.1 .

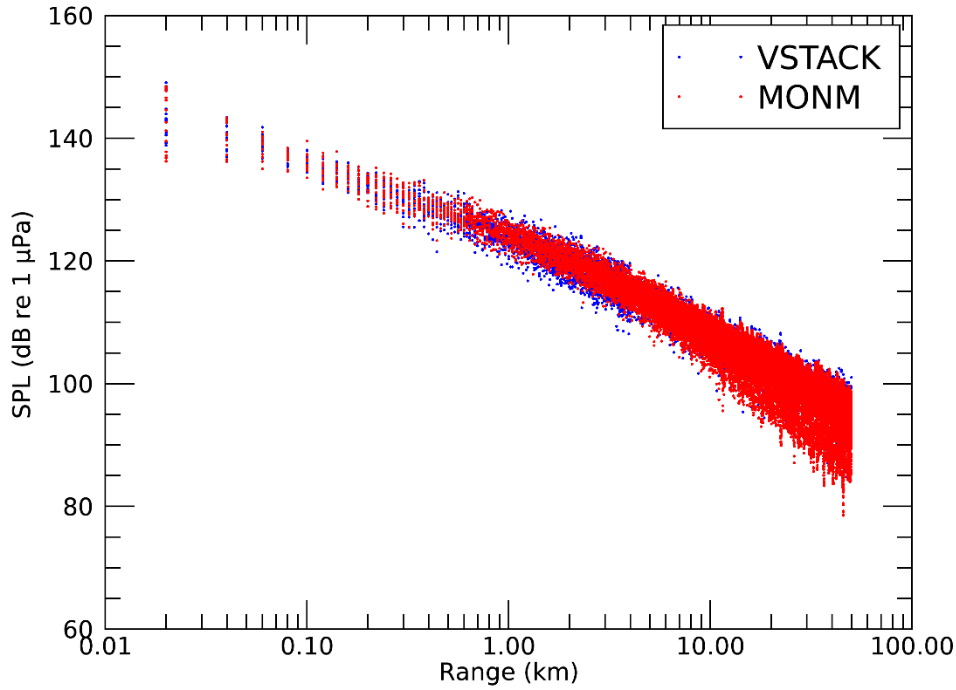

Figure 64 *Mobile Offshore Drilling Unit (MODU)*: Predicted received levels (SPL) for a simplified range independent environment with a calcarenite seabed with a thin overlying veneer of sand.

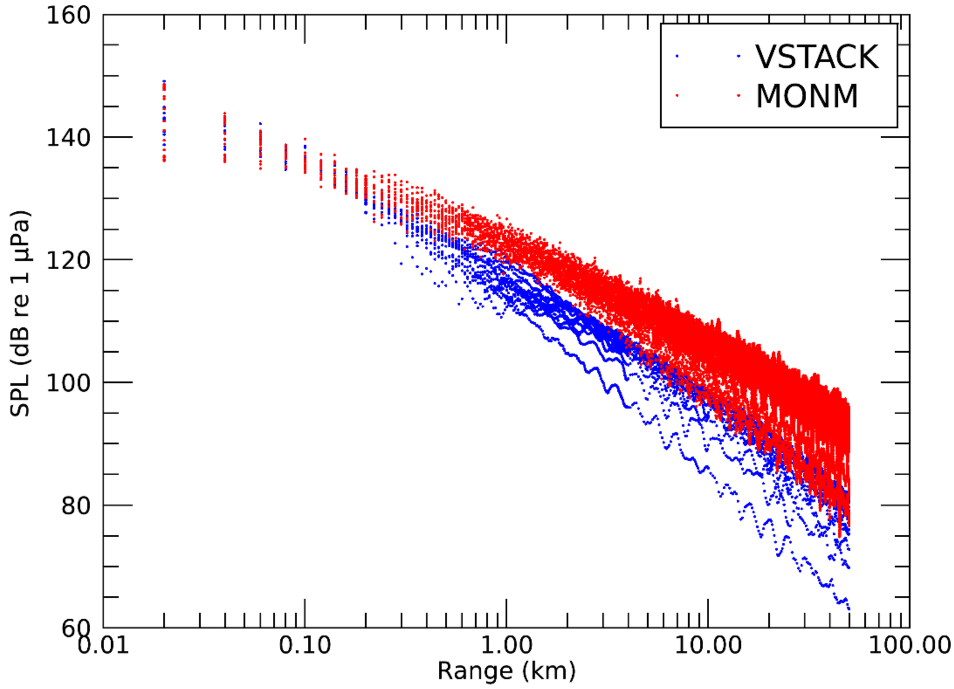

Figure 65 *Mobile Offshore Drilling Unit (MODU)*: Predicted received levels (SPL) for a simplified range independent environment with a calcarenite seabed with no sand layer.

When considering the results from VSTACK, the indication is that much higher rates of loss would be expected if no sand layer were present. Considering the variably of the distribution of seafloor sediments within the wider region, the higher rates of loss indicate that that the any overlaying sand is much thinner than or completely absent at the seafloor. In consideration of these modelled results and the SPL curve fits in in Section 5.3, the validation exercise was therefore carried out with the geoacoustic model consisting of well-cemented carbonate caprock, overlying semi-cemented carbonate rock.

An additional broadband correction was applied to the propagation loss results from MONM to account for the higher rates of loss when the full for the elasto-acoustic properties of the sub-bottom are consider. The differences between the broadband SPL from MONM and VSTACK were extracted at the same modelled ranges and depths that corresponded range independent predictions. The 90th percentile of the resultant dB differences was selected at each range to generate a generalised conversion function for each individual site to be modelled. The conversion functions were applied after the propagation loss calculation from MONM but before summing decidecade band levels, gridding, and radii calculations for each modelled site in each modelled scenario considered. Figure 66 shows an example comparison of the re-modelled results for Scenario 7 (MODU with OSV during resupply operations), at a receiver depth of 70.5 m (the median depth of measurement Stations 1–3) and an azimuth of 60°, against the data and 90th percentile data fit bounds for when the levels at Station 1 are above 150 dB re 1µPa (Figure 22). It is inferred that the data plotted here is associated with operational activity in the vicinity of the MODU and therefore may be similar to the modelled resupply operations scenario, at least for comparative purposes. The similar decay rates between the modelling and measured data indicate that re-modelled results presented here are broadly within measured range of levels for similar operations.

However, these data contain many different operations that will not exactly align with nominal representative scenarios for modelling, due to the time varying nature of the operations and associated produced sound levels. The modelled scenario produces levels that intersect the upper bound of the measured data, and therefore it is likely conservative through using the static MSL and operational representations – whilst a more detailed scenario is possible to be created (Quijano et al. 2019), that was beyond the scope of this study.

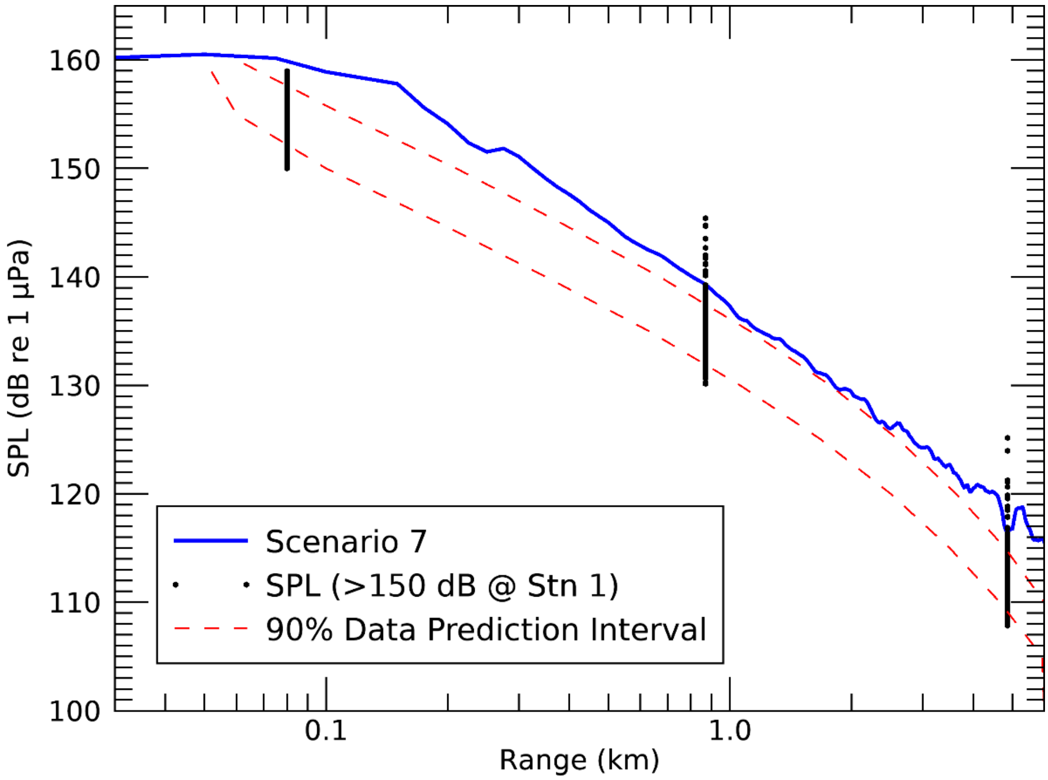

Figure 66. Generalised model validation plot.

6.3. Revised Threshold Distances

The results from the measurement study cannot be directly compared to the modelling presented in Koessler et al. (2020) due to the differences in actual events compared to the nominal representative scenarios developed and evaluated as part of the EP assessment process. Additionally, the measurements were obtained at a receiver 1.2 m off the seafloor, not at the maximum-over-depth results reported in the modelling study. The ranges obtained from the measurement study are reported in relation to the Artisan-1 well location, and thus the centre of the *Ocean Onyx*. The ranges in the modelling study are reported from a range of locations, including the centroids of multiple sources, thus it is not possible to report the measurement results in a similar fashion using the small number of recording locations used in this study.

However, the understanding of the propagation loss environment, and the revision of the representation and treatment of it as detailed in Section 6.2, enabled the modelling scenarios for activities at Artisan-1 presented in Koessler et al. (2020) to be recalculated. The revised results for distances to maximum-over-depth SPL isopleths are presented in Table 14 and compared in Table 15 to the original modelling. The revised results for distances to maximum-over-depth SEL thresholds are presented in Table 16 and compared in Table 17 to the original modelling.

Table 14. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario (see table footnotes).

SPL (L_p; dB re 1 µPa)	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7)[A]		MODU and OSV standby (Scenario 8)[B]	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	0.03	0.03	–	–
170[C]	–	–	–	–	0.06	0.06	–	–
160	–	–	–	–	0.13	0.12	–	–
158[D]	–	–	–	–	0.16	0.15	–	–
150	0.04	0.04	–	–	0.32	0.31	–	–
140	0.12	0.11	0.03	0.03	0.83	0.78	0.03	0.03
130	0.36	0.35	0.14	0.14	2.3	2.16	0.14	0.14
120[E]	1.17	1.09	0.37	0.35	7.02	6.41	2.09	1.9
110	4.74	3.87	0.91	0.88	18.03	15.85	5.21	4.54

[A] Radial distance reported from the mid-point between the MODU and the OSV on DP in resupply operations.
[B] Radial distances for isopleths/thresholds that envelope the MODU and OSV were reported from the mid-point between the MODU and the centre of the OSV standby area. Otherwise radial distances reported from the OSV in the standby area.
[C] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[D] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[E] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).
A dash indicates the level was not reached within the limits of the modelling resolution (25 m).

Table 15. Difference in maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) between Koessler et al. (2020) and modelling completed using data from measurement study. Positive values indicate and increase in distance as compared to Koessler et al. (2020), negative values indicate a decrease.

SPL (L_p; dB re 1 µPa)	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 3)		MODU and OSV standby (Scenario 4)	
	Difference R_{max} (km)	Difference $R_{95\%}$ (km)	Difference R_{max} (km)	Difference $R_{95\%}$ (km)	Difference R_{max} (km)	Difference $R_{95\%}$ (km)	Difference R_{max} (km)	Difference $R_{95\%}$ (km)
180	*	*	*	*	*	*	*	*
170	*	*	*	*	0.03	0.03	*	*
160	*	*	*	*	0.07	0.06	*	*
158	*	*	*	*	0.07	0.06	*	*
150	-0.04	-0.04	-0.05	-0.05	-0.01	0.0	-0.05	-0.05
140	-0.09	-0.09	-0.34	-0.33	-0.77	-0.75	-0.34	-0.33
130	-0.83	-0.74	-1.75	-1.67	-3.59	-3.25	-3.08	-2.68
120	-4.74	-4.3	-5.86	-5.34	-10.4	-8.99	-6.85	-5.99
110	-30.13	-18.76	-18.06	-14.43	-42.03	-32.65	-31.54	-23.44

An asterisk indicates that the difference in radial distance could not be computed due to distances less than the modelled resolution .

Table 16. Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2).

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa^2·s)[B]	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7)[A]		MODU and OSV standby (Scenario 8)[A]	
		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									
LF cetaceans	199	–	–	–	–	–	–	–	–
MF cetaceans	198	–	–	–	–	–	–	–	–
HF cetaceans	173	0.19	0.11	–	–	0.2	0.12	0.19	0.11
Phocid seals	201	–	–	–	–	–	–	–	–
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	–	–	–	–
TTS									
LF cetaceans	179	0.31	0.31	1.01	0.35	0.95	2.78	0.31	0.66
MF cetaceans	178	0.13	0.05	–	–	0.16	0.06	0.13	0.05
HF cetaceans	153	1.07	3.44	1.01	0.18	1.09	3.86	1.06	3.64
Phocid seals	181	0.12	0.05			0.35	0.28	0.12	0.05
Otariid seals	199	–	–	–	–	–	–	–	–
Turtles	200	–	–	–	–	–	–	–	–

A Radial distance reported from the centre of the MODU, unless indicated otherwise.
B Frequency weighted.

A dash indicates the level was not reached within the limits of the modelling resolution (25 m).

Table 17. Difference in maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) between Koessler et al. (2020) and modelling completed using data from measurement study. Positive values indicate and increase in distance as compared to Koessler et al. (2020), negative values indicate a decrease.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	MODU (Scenario 5)	OSV standby (Scenario 6)	MODU and OSV resupply (Scenario 7)	MODU and OSV standby (Scenario 8)
		R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)
PTS					
LF cetaceans	199	*	*	*	*
MF cetaceans	198	*	*	*	*
HF cetaceans	173	0.15	*	0.16	0.15
Phocid seals	201	*	*	*	*
Otariid seals	219	*	*	*	*
Turtles	220	*	*	*	*
TTS					
LF cetaceans	179	-0.61	-0.11	-1.78	-2.45
MF cetaceans	178	*	*		
HF cetaceans	153	0.47	-0.03	-1.59	0.02
Phocid seals	181	-0.09	*	0.14	-0.09
Otariid seals	199	*	*	*	*
Turtles	200	*	*	*	*

† Frequency weighted.
An asterisk indicates that the difference in radial distance could not be computed due to distances less than the modelled resolution.

7. Discussion and Conclusion

7.1. Ambient Soundscape

The insights into ambient soundscape within the Otway Basin and in the vicinity of the Development Drilling program can be obtained through the data recorded at Station 4, and in part, Station 3. Stations 1 and 2 are too close to the location of the Artisan-1 well and associated activity to provide any information about ambient noise while the *Ocean Onyx* is present. Whilst data exists outside the period in which the *Ocean Onyx* is present, this data includes noise from the moored rig anchor chains, which are not a typical soundscape contributor.

The correlograms (Section 5.2) show a positive correlation between wind speeds and wave heights and sound levels for frequencies over 100 Hz, with the relationship with wind speed being stronger than that for wave height. For both stations shipping is a strong contributor: most days recorded a significant number of vessel detections (Section 5.6), with the contributions at Station 4 apparent in the power spectral density and percentile plot (Figure 16), between 40 and approximately 100 Hz. If the support vessels for the Development Drilling program did not pass near Station 3 as often while under station keeping, the number of close vessel passes would have been less, and thus it is likely that the statistics presented in Table 10 would have reflected a soundscape with quieter sound levels on average.

In terms of monitoring work with the Otway and Bass Strait regions, between 2009 and 2016 the Integrated Marine Observing System (IMOS) has been recording underwater sound south of Portland, Victoria (38°32.5' S, 115°0.1'E). Prominent sound sources identified in recordings include blue and fin whales at frequencies below 100 Hz, ship noise at 20 to 200 Hz, and fish at 1 to 2 kHz (Erbe et al. 2016). In the broader region, primary contributors to background sound levels were wind, rain and currents-and waves-associated sound at low frequencies under 2 kHz (Przeslawski et al. 2016), and biological sound sources including dolphin vocalisations were also recorded.

To gain an understanding of the existing marine acoustic environment to inform the impact assessment for the Otway Gas Development, acoustic monitoring was undertaken by Woodside (2003). During April-May 2001, two underwater noise loggers were placed (5.1 km and 2.9 km) south-west of an exploration petroleum drilling vessel at the Thylacine site to measure underwater noise before, during, and after drilling activity. Only one of the loggers (5.9 km) was able to be recovered. A further logger was placed in the shipping lane approximately 60 kms due south of Port Fairy to measure ambient noise produced by physical, man-made and biological sources between late November 2001 and early March 2002.

A summary of the report states that the following features were noted with respect to underwater noise environment at the Thylacine location:

- Relatively quiet with only the passage of several boats (about ten) evident.
- The rig tender and drill rig noise show clearly from 13:00 on the 3 May 2001.
- Drill rig noise was evident as sharp tones.
- Rig tender noise was evident either at a low but persistent level for days or in short bursts of high level noise for several hours associated with manoeuvring, use of thrusters or as a close passage by the receiver.
- The horizontal banding characteristic of persistent calling by pygmy blue whales was not evident, rather these call types occurred infrequently and at low levels indicating the respective sources were at long range.
- Evidence of low-level, distant evening fish choruses only.

However, at the shipping lane location, it was noted:

- Regular passages of boats evident.
- Regular evening fish choruses, there were also dawn choruses and persistent low level calling by these sources over daytime.
- Blue whale calling persisted over many hours, an example is the first close passage for the season just before midday on 4 January 2002 followed by several more animals a day later.
- Evidence of calling from at least three other whale species.
- Baseline broadband underwater noise for the period was in the order of 93 to 97 dB re 1 µPa with shipping raising the averaged noise level above 105 dB re 1 µPa for 6% of the deployment time.

An acoustic monitoring program was also undertaken during exploratory drilling of the Casino-3 well. A sound logger located 28.03 km from the drill site did not detect drilling noise and recorded ambient noise that ranged between 90 and 110 dB re 1 µPa (McCauley 2004). Passive acoustic monitoring commissioned by Origin from April 2012 to January 2013, 5 km offshore from the coastline east of Warrnambool, identified that ambient underwater noise in coastal areas is generally higher than further offshore, with a mean of 110 dB re 1 µPa and maximum of 161 dB re 1 µPa.

JASCO has not reviewed these historical reports and the associated activity descriptions within them, or information on the vessels and MODU used, therefore direct comparison between the data collected during exploratory drilling of the Casino-3 well and the Artisan-1 well should be conducted with caution.

Comparing the results from a recorder 28.3 km from drilling operations at Casino 3 with Station 4, the results for Station 4 were a median broadband ambient noise of 104.5 dB re 1 µPa, a mean of 118.3 dB re 1 µPa, a minimum of 86.6 dB re 1 µPa, and a maximum of 153.6 dB re 1 µPa, which is both quieter and louder than those for Casino 3. The mean levels at Station 4 are 8.3 dB higher than those recorded 5 km offshore of Warrnambool, while the maximum recorded at Station 4 is lower by 7.4 dB. The use of percentiles, as provided in Section 5.1.1, Figure 16 and Table 10, in the context of contributors such as weather (Section 5.2), shipping (Section 5.6), and marine mammals (Section 5.7), provides a more nuanced understanding of sound levels received at a recording station. Local variations in ambient noise and received levels can depend upon water depth and the proximity to contributors In this case, the shipping lanes (Section 2.2) and the frequency and proximity of vessel passes are strong drivers of the ambient noise at Station 4. The use of Station 4 as a dedicated measurement location for the support vessels (Section 2.5.2) does not change the relevance of the results from this measurement location, as those vessels would still have been transiting at similar speeds and along similar tracks on trips between Geelong and Artisan-1. The quieter levels reported at Thylacine in Lattice Energy (2017) are likely due to the placement of the monitoring station at a distance from the shipping lanes (Figure 3), which limited their contributions to the data set and thus resulted in a lower reported range of received sound levels.

7.2. Modelling Validation

The Monopole Source Levels determined through the measurement study differed from those either estimated for use in the modelling study or those determined using proxy sources. The key differences are as follows:

- The support vessels are quieter than estimated when they are under slow transit speeds, such as 7 kn.
- The support vessels are louder than estimated when they are travelling at faster transit speeds, with 9 kn used to represent these speeds and the associated MSL.
- The support vessels are louder than estimated when holding station or moving under dynamic positioning.
- The drilling operations of the *Ocean Onyx* are both louder at some frequencies and quieter at others than those for the proxy rig the *Polar Pioneer* (Austin et al. 2018), although the results presented for the *Polar Pioneer* did not examine the changes in level with increased drilling depth (over time) as completed within this study.

The relationship between vessel speed and MSL is well known, with recent detailed examinations on shipping traffic associated with the Port of Vancouver (Joy et al. 2019, Trounce et al. 2019, JASCO Applied Sciences and SMRU Consulting 2020). Conducting the measurement campaign in deeper water, along with higher time resolution location reporting systems for the vessels, automated high time resolution engine information reporting, and a greater number of vessel passes at a range of speeds would further develop this dataset to allow for more accurate predictions of sound level in relation to vessel speed or operations. Predictions of sound levels using speed and operational state is preferred to estimates determined using scaling of power levels, particularly when considering the range of propulsion systems on the vessels.

The measurement of sound levels for vessels under DP is complex and time consuming. It requires dedicated operations in the absence of other activities, which is a challenge considering the task requirements of typical support and anchor handling vessels. Few studies have reported the MSL of support vessels under DP, with the majority estimating the RNL rather than MSL. The large range of thrusters and operational control systems and the variable source depths of each individual thruster contribute to the complexity of estimating source levels. Measurement studies are complicated by environmental conditions and the specifics of each vessel. The MSLs calculated from each of the three DP exercises defined (Section 2.5.2) were very similar. However, the ability to replicate these across different weather conditions and position holding constraints would likely provide valuable information which could help contextualise future modelling studies.

The MSLs reported within this study can be used as inputs to modelling studies for other operations for the same or similar vessels or MODU's. However, the reported ranges to thresholds are specific to the Artisan-1 well location, and not transferrable to other locations, particularly in different water depths, geologic environments, and sound speed profiles. The approach developed to represent the propagation loss based upon the measurement results is suitable for other locations within the continental shelf portion of the Otway Basin. However, the accuracy of the representation of the propagation loss within this environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on the calcarenite seabed within the region. In general, the thinner the sand layer, the greater the propagation loss.

The agreement between VSTACK and MONM would be expected depend on the level and frequency content of the modelled source and the thickness of any unconsolidated sediments at the seafloor as low frequency energy will be less sensitive to thin layers. For the comparison conducted here in Section 6.2, the comparison between VSTACK and MONM is excellent when only a comparatively thin 1 m thick layer of sand overlies the carbonate seabed structure. If the data decay rates were more indicative of propagation over a layer of sediment, then MONM could have been used without correction.

The distances to the effect thresholds based on the measurement study results (Section 6.3) are reduced compared to those presented in Koessler et al. (2020). The understanding of the environment gained through the measurement study allowed for the geological environment to be represented in a site specific fashion, and a more appropriate configuration of numerical models to represent the propagation loss. The application of the revised modelling approach to represent other Beach Energy activities on the continental shelf of the Otway Basin would be appropriate.

7.3. Development Drilling Program Contributions

Soundscape contributions of the Development Drilling operations were activity-dependent and depended upon proximity to both the *Ocean Onyx* and associated support vessels. At the three closest stations, the relative contributions are demonstrated through the LTSAs and percentiles for the entire period the *Ocean Onyx* was operational at Artisan-1, and two presented example periods. One of the presented example periods involved significant contributions to the sound fields at the three stations close to the rig presented in Section 5.1.1, as well as considering the per station daily SELs (Section 5.1.2).

A better understanding of the contributions from the Development Drilling operations on a regional scale is provided through the data recorded at Station 4, 25 km from the *Ocean Onyx* (whilst drilling operations were being conducted at Artisan-1), and they did not appear to be a significant contributor to the overall soundscape. While the operational contributions were not significant at Station 4, they were apparent throughout different stages of the activity. At long ranges, the contribution from the drilling itself is hard to distinguish from associated vessel operations, complicated by support vessels manoeuvring over an area greater than 100 km^2. The support vessels operating under dynamic position while completing tasks at Artisan-1 which required high thrust levels, such as anchor handling and accurate station keeping in high sea states, were apparent at Station 4 (for example Figure 44). The configuration of Station 4 to be able to present received signals with the context of direction allowed for the attribution of signals to specific sources. Whilst the recording station 28 km from the Casino 3 drilling operation reported in Lattice Energy (2017) was not able to detect drilling noise, the analysis would not have been able to attribute detected vessel noise to the support vessels for the rig. Therefore, it is likely that the Casino 3 monitoring program recorded noise associated with the drilling program but was unable to attribute it due to the lack of context provided by single omni-directional hydrophone recorder configurations (similar to Stations 1–3).

Periods with less dynamic positioning utilisation, such as between 17:00 and 18:39 on 8 Mar 2021, ShipSound report in Appendix G.1.2, with the spectrogram shown in Figure 37, had only faint potential contributions noticeable at Station 4 (Figure 67). In this figure, long tonals which originate in a north-west direction (the direction of Artisan-1) are apparent between 100 and 250 Hz. However, these are not apparent in data at Station 1 (Figure 37), and thus potentially do not originate close to the rig. In addition to these tonals, the spectrogram shown in Figure 67 shows periods of rain, the approach of the 17 m long sailing boat *Zatara* (Figure 68), which passes within 686 m of Station 4 at a speed of 8 kn, and a likely fish chorus between 800 and 1000 Hz from the north-west.

The rig move operations were apparent, similarly to other periods of high thrust levels, with contributions from the support vessels throughout the tow period matching the relative direction received at Station 4 (Figures 69 and 70). The frequency range, which was still typically detectable at long ranges, 100 to up to 1000 Hz, is above the frequency range for the fundamentals and primary harmonics for pygmy blue whale vocalisations (Section 5.7.2), as shown in Figure 69. Therefore, the potential effect on the communication and listening space (Hannay et al. 2016a), and thus masking, at longer ranges is less apparent than it is for seismic survey activity, or regions in which low frequency signals experience less loss then they do in locations with highly absorptive seabeds.

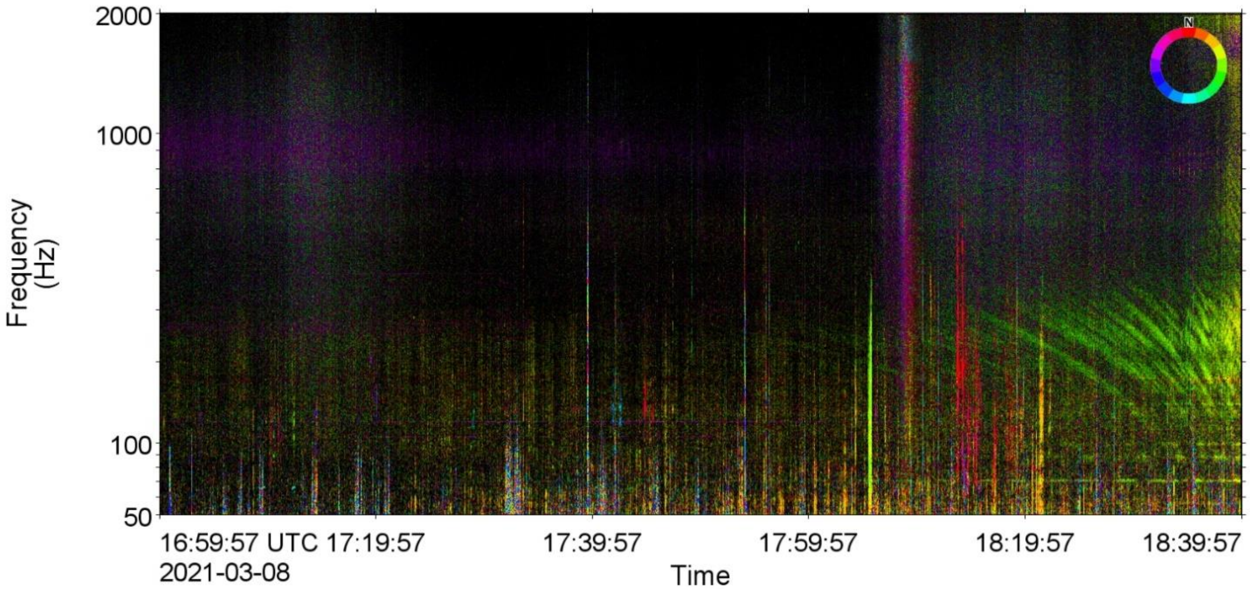

Figure 67. Data recorded on Station 4 including *Ocean Onyx* ShipSound analysis reports between 17:00 and 18:39 on 8 Mar 2021, ShipSound report in Appendix G.1.2, with the spectrogram shown in Figure 37 (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time).

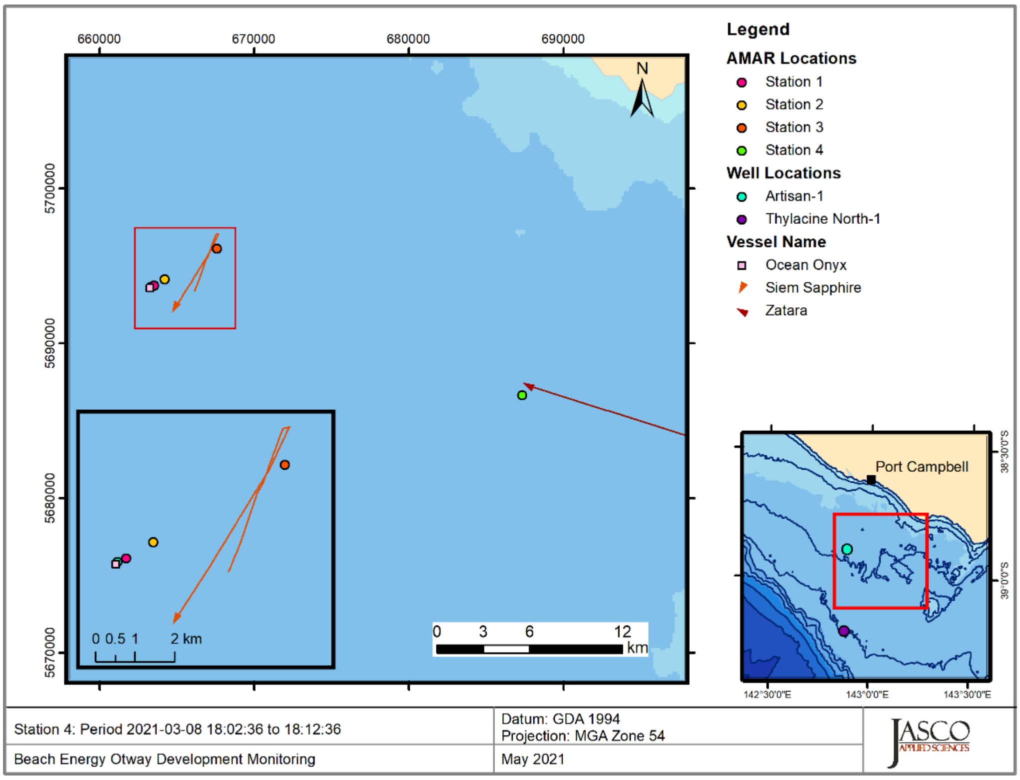

Figure 68. Map of AIS reported vessel locations for the spectrogram shown in Figure 67.

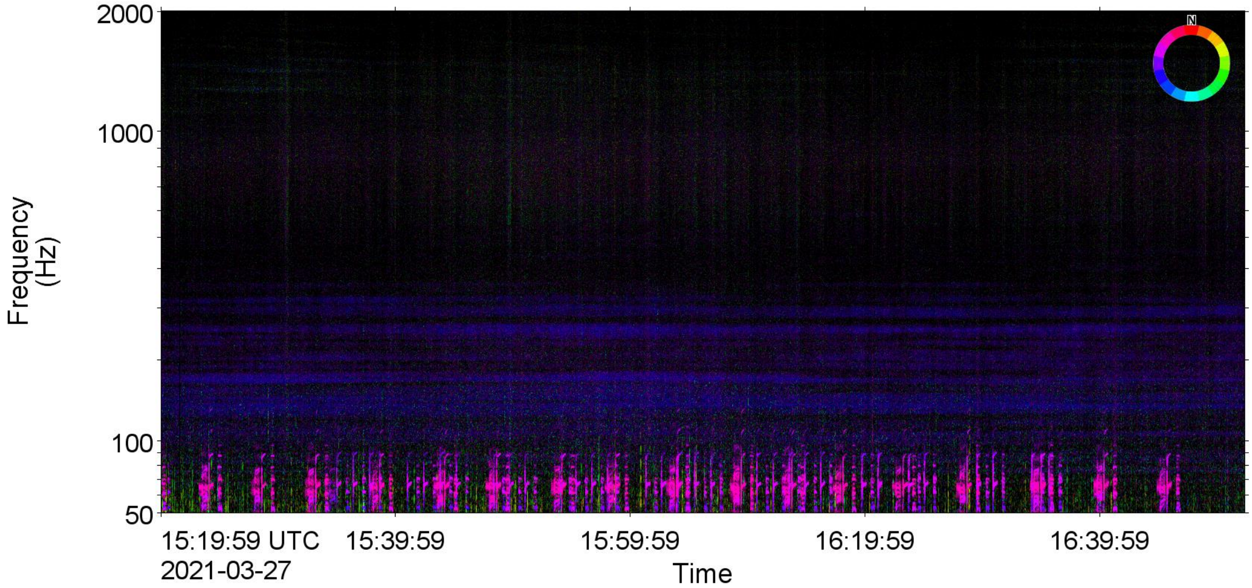

Figure 69. Example of the contribution of the three support vessels and the *Ocean Onyx* while ~23 km away in a south-west direction under tow from Artisan-1 to Geographe, apparent via the blue horizontal striations between 100 and 500 Hz, along with multiple pygmy blue whales in a west to north-west direction of Station 4 (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time).

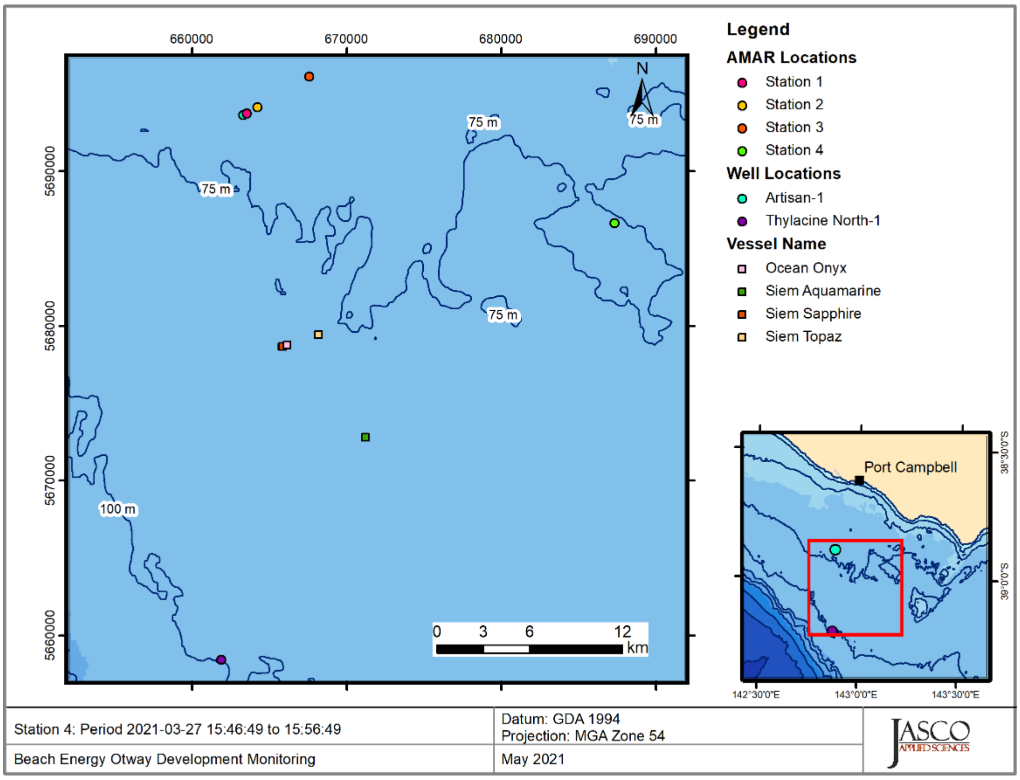

Figure 70. Map of automatic identification system (AIS) reported vessel locations for the spectrogram shown in Figure 69.

7.4. Marine Mammals

The marine mammal acoustic detection results presented in this report provide an index of acoustic occurrence for each species. Although they can be used to describe the relative occurrence of a species, several factors influence the detectability of the targeted signals. Although acoustic detection does indicate presence, an absence of detections (automated or manual) does not necessarily indicate an absence of animals. An animal may be present but not detected if no individuals were vocalising near the recorder, their signals were masked by environmental and/or anthropogenic noise sources, or a combination of these factors. Different sound propagation environments and different seasonal effects will impact the detection range of a given signal over time and, therefore, influence the number of detectable signals. The acoustic signals of both dolphins and pygmy blue whales were present in the acoustic data. vVcalisations of other mysticetes, such as humpback and southern right whales, were not detected by the detectors (D.2), or observed during the 0.5% manual review.

7.4.1. Dolphins

Dolphin species reported in offshore Victorian waters include the short-beaked common and bottlenose dolphins (Bilgmann et al. 2007, Bilgmann et al. 2014). Burrunan dolphins (*Tursiops australis*) can also occur in the region (Charlton-Robb et al. 2015), although they are likely more coastal. While it would be ideal to discriminate between species, success has been limited using automated detectors, and the detailed manual analysis required to attempt to identify individual species is beyond the scope of this report (Steiner 1981, Rendell et al. 1999, Oswald et al. 2003, Baron et al. 2008).

Based on the occurrence of echolocation clicks and whistles, dolphins occurred in the area throughout the recording period at all stations. Dolphin acoustic occurrence was low in February and increased through March at Stations 1, 2, and 3. In contrast, dolphins were consistently present at an almost hourly basis at Station 4. It is impossible to say whether the sparsity of dolphins at Stations 2 and 3 in February is a result of the animals not being common or of their signals being masked by the high noise environment (Figure 16).

The predominance of delphinid clicks during hours of darkness could correspond to foraging on prey species that follow the diel vertical migrations of zooplankton. Similar patterns have been observed in studies of a number of whale species (Víkingsson 1997, Au et al. 2000, Wiggins et al. 2005, Baumgartner and Fratantoni 2008, Sayigh et al. 2013) and by JASCO in studies conducted in northern Australian waters (McPherson et al. 2012, McPherson et al. 2014, McPherson et al. 2016). However, recent research suggests that though such patterns are common, they may not be as closely linked to prey as previously thought (Osiecka et al. 2020).

The presence of sounds believed to be produced by young bottlenose dolphins suggests that not only were dolphins using this region to socialize (indicated by presence of whistles) and forage (indicated by presence of clicks), but they also care for their young.

7.4.2. Pygmy Blue Whales

The acoustic occurrence of pygmy blue whale vocalisations in the acoustic data was unsurprising as they have previously been reported in the region and the Bonney Upwelling is a known foraging area for this species (Garcia-Rojas et al. 2018, McCauley et al. 2018, Möller et al. 2020). Tag data indicates that blue whales are most common in the recording area between January and July, coinciding with the upwelling season of the region (Möller et al. 2020). The lack of clear directional movement during the recording period is unsurprising given both the small sample size and that this area is believed to be a location where blue whales aggregate, as opposed to a migratory corridor where a more consistent pattern in direction over time would be expected. The data does indicate an apparent trend in the animals early in the recording being more to the east and later in the recording being more to the west, but the data were too sparse to confirm anything about animal movements. A monitoring program with directional stations distributed across the Otway Basin would be able to provide this information.

The presence of songs indicates the presence of male pygmy blue whales and the increased regularity of songs at the end of March at all stations corresponds with the onset of the winter singing season for this species (McCauley et al. 2018). Indeed, we cannot say whether the increased vocal activity in March is a result of increased animals in the region or a shift in acoustic behaviour. The blue whale occurrence results were extremely similar across recording stations which is unsurprising given the close vicinity of the recorders that were likely simultaneously recording the same blue whale vocalisations which can propagate great distances, as demonstrated for both pygmy and Antarctic blue whales (Gavrilov and McCauley 2013, Miller et al. 2013, Warren et al. 2021). It is believed that non-song D calls can be produced by male or female blue whales, and it may be a social call (Recalde-Salas et al. 2014).

Acknowledgements

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Glossary

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; ISO 2017a).

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.

90%-energy time window

The time interval over which the cumulative energy rises from 5 to 95% of the total pulse energy. This interval contains 90% of the total pulse energy. Symbol: T_{90}.

90% sound pressure level (90% SPL)

The root-mean-square sound pressure levels calculated over the 90%-energy time window of a pulse. Used only for pulsed sounds.

absorption

The reduction of acoustic pressure amplitude due to acoustic particle motion energy converting to heat in the propagation medium.

ambient noise

All-encompassing sound at a given place, usually a composite of sound from many sources near and far (ANSI S1.1-1994 (R2004)), e.g., shipping vessels, seismic activity, precipitation, sea ice movement, wave action, and biological activity.

annotation

A labelled selection of a period of time and frequency within a spectrogram as created by a human analyst during **manual analysis**.

attenuation

The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

audiogram

A graph of hearing threshold level (sound pressure levels) as a function of frequency, which describes the hearing sensitivity of an animal over its hearing range.

audiogram weighting

The process of applying an animal’s audiogram to sound pressure levels to determine the sound level relative to the animal’s hearing threshold (HT). Unit: dB re HT.

Auditory frequency weighting (auditory weighting function, frequency-weighting function)

The process of band-pass filtering sounds to reduce the importance of inaudible or less-audible frequencies for individual species or groups of species of aquatic mammals (ISO 2017a). One example is M-weighting introduced by Southall et al. (2007) to describe “Generalised frequency weightings for various functional hearing groups of marine mammals, allowing for their functional bandwidths and appropriate in characterizing auditory effects of strong sounds”.

automated detection

The output of an **automated detector**.

automated detector

An algorithm that includes both the **automated detection** of a sound of interest based on how it stands out from the background and its automated classification based on similarities to templates in a library of reference signals.

background noise

Total of all sources of interference in a system used for the production, detection, measurement, or recording of a signal, independent of the presence of the signal (ANSI S1.1-1994 (R2004)). Ambient noise detected, measured, or recorded with a signal is part of the background noise.

bandwidth

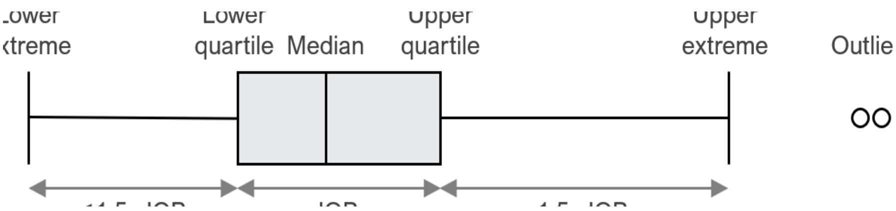
The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI and ASA S1.13-2005 (R2010)).

bar

Unit of pressure equal to 100 kPa, which is approximately equal to the atmospheric pressure on Earth at sea level. 1 bar is equal to 10^5 Pa or 10^{11} µPa.

box-and-whisker plot

A plot that illustrates the centre, spread, and overall range of data from a visual 5-number summary. The box is the interquartile range (IQR), which shows the middle 50% of the data—from the lower quartile (25th percentile) to the upper quartile (75th percentiles). The line inside the box is the median (50th percentile). The whiskers show the lower and upper extremes excluding outliers, which are data points that fall more than 1.5 × IQR beyond the upper and lower quartiles.



broadband sound level

The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured 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, mostly marine mammals and include whales, dolphins, and porpoises.

continuous sound

A sound whose sound pressure level remains above ambient sound during the observation period (ANSI and ASA S1.13-2005 (R2010)). 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 2006).

decidecade

One tenth of a decade (ISO 2017a). 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)

One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power ([ANSI] American National Standards Institute S1.1-1994 (R2004)).

delphinid

Family of oceanic dolphins, or Delphinidae, composed of approximately thirty extant species, including dolphins, porpoises, and killer whales.

duty cycle

The time when sound is periodically recorded by an acoustic recording system.

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. The distance to the acoustic far-field increases with frequency.

fast-average sound pressure level

The time-averaged sound pressure levels calculated over the duration of a pulse (e.g., 90%-energy time window), using the leaky time integrator from Plomp and Bouman (1959) and a time constant of 125 ms. Typically used only for pulsed sounds.

fast Fourier transform (FFT)

A computationally efficiently algorithm for computing the discrete Fourier transform.

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.

hearing group

Groups of marine mammal species with similar hearing ranges. Commonly defined functional hearing groups include low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

harmonic

A sinusoidal sound component that has a frequency that is an integer multiple of the frequency of a sound to which it is related. For example, the second harmonic of a sound has a frequency that is double the fundamental frequency of the sound.

hearing threshold

The sound pressure level for any frequency of the hearing group that is barely audible for a given individual in the absence of significant 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

The functional cetacean hearing group that represents those odontocetes (toothed whales) specialised for hearing high frequencies.

hydrophone

An underwater sound pressure transducer. A passive electronic device for recording or listening to underwater sound.

intermittent sound

A level of sound that abruptly drops to the background noise level several times during the observation period.

impulsive sound

Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 (R2006)). For example, seismic airguns and impact pile driving.

low-frequency (LF) cetacean

The functional cetacean hearing group that represents mysticetes (baleen whales) specialised for hearing low frequencies.

manual analysis

Human examination of acoustic data via visual review of spectrograms and/or aural inspection of data.

manual detection

The output of **manual analysis** as recorded in an **annotation**.

masking

Obscuring of sounds of interest by sounds at similar frequencies.

mean-square sound pressure spectral density

Distribution as a function of frequency of the mean-square sound pressure per unit bandwidth (usually 1 Hz) of a sound having a continuous spectrum (ANSI S1.1-1994 (R2004)). Unit: $\mu Pa^2/Hz$.

median

The 50th percentile of a statistical distribution.

mid-frequency (MF) cetacean

The functional cetacean hearing group that represents those odontocetes (toothed whales) specialised for mid-frequency hearing.

mysticete

Mysticeti, a suborder of cetaceans, use their baleen plates, rather than teeth, to filter food from water. They are not known to echolocate, but they use sound for communication. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

non-impulsive sound

Sound that is broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically does not have a high peak pressure with rapid rise time (typically only small fluctuations in decibel level) that impulsive signals have (ANSI S3.20-1995 (R2008)). For example, marine vessels, aircraft, machinery, construction, and vibratory pile driving (NIOSH 1998, NOAA 2015).

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.

peak pressure level (PK)

The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak pressure level. Unit: decibel (dB).

percentile level, exceedance

The sound level exceeded *n* % of the time during a measurement.

permanent threshold shift (PTS)

A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

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.

power spectrum density

Generic term, formally defined as power in W/Hz, but sometimes loosely used to refer to the spectral density of other parameters such as square pressure or time-integrated square pressure.

pressure, acoustic

The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

received level (RL)

The sound level measured (or that would be measured) at a defined location.

rms

root-mean-square.

signature

Pressure signal generated by a source.

sound

A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure

Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second ($Pa^2 \cdot s$) (ANSI S1.1-1994 (R2004)).

sound exposure level (SEL)

A cumulative measure related to the sound energy in one or more pulses. Unit: dB re 1 $\mu Pa^2 \cdot s$. SEL is expressed over the summation period (e.g., per-pulse SEL [for airguns], single-strike SEL [for pile drivers], 24-hour 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 (ANSI S1.1-1994 (R2004)). Unit: $\mu Pa^2 \cdot s/Hz$.

sound pressure level (SPL)

The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 (R2004)).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 µPa) and the unit for SPL is dB re 1 μPa^2:

$$L_p = 10\log_{10}(p^2/p_0^2) = 20\log_{10}(p/p_0)$$

Unless otherwise stated, SPL refers to the root-mean-square (rms) pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

source level (SL)

The sound level measured in the far-field and scaled back to a standard reference distance of 1 metre from the acoustic centre of the source. Unit: dB re 1 µPa·m (pressure level) or dB re 1 $\mu Pa^2 \cdot s \cdot m$ (exposure level).

spectral density level

The decibel level ($10 \cdot \log_{10}$) of the spectral density of a given parameter such as SPL or SEL, for which the units are dB re 1 $\mu Pa^2/Hz$ and dB re 1 $\mu Pa^2 \cdot s/Hz$, respectively.

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.

validated detection

The output of an **automated detector** that has been subsequently validated by a human analyst.

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Appendix A. Underwater Acoustics

A.1. Acoustic Metrics

Sound levels with individual metrics defined below, are presented as:

- Broadband and approximate-decade-band SPL over time for these frequency bands for the low sample rate: 10 Hz–32 kHz (Nyquist), 10–100 Hz, 100 Hz to 1 kHz, 1–10 kHz, and 10–32 kHz. For the high sample rate, the Nyquist is 256 kHz.
- Spectrograms: Ambient noise at each station was analysed by Hamming-windowed fast Fourier transforms (FFTs), with 1 Hz resolution and 50% window overlap. The 120 FFTs performed with these settings are averaged to yield 1 min average spectra.
- Statistical distribution of SPL in each decidecade. The boxes of the statistical distributions indicate the first (L_5), second (L_{50}), and third (L_{75}) quartiles. The whiskers indicate the maximum and minimum range of the data. The solid line indicates the sound pressure level (SPL) or L_{eq} in each decidecade.
- Spectral level percentiles: Histograms of each frequency bin per 1 min of data. The L_{eq}, L_5, L_{25}, L_{50}, L_{75}, and L_{95} percentiles are plotted. The L_5 percentile curve is the frequency-dependent level exceeded by 95% of the 1 min averages. Equivalently, 5% of the 1 min spectral levels are above the 95th percentile curve.
- Daily cumulative sound exposure levels (SEL (24 h)): computed for the total received sound energy. The SEL (24 h) is the linear sum of the 1 min sound exposure levels (SEL). These SEL values were weighted to mimic different functional hearing groups according to the marine mammal frequency-weighted curves described in Appendix E.

Sound is most commonly described using the sound pressure level (SPL) metric. Underwater sound amplitude levels are commonly measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa.

SPL (dB re 1 μPa) is the decibel level of the rms pressure in a stated frequency band over a time window (*T; s*) containing the acoustic event:

$$\mathrm{SPL} = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)\,dt \Big/ p_0^2\right) \quad \text{(A-1)}$$

The SPL is a measure of the effective pressure level over the duration of an acoustic event, such as the emission of one acoustic pulse or sweep. Because the window length, T, is the divisor, events more spread out in time have a lower SPL even though they may have similar total acoustic energy density.

Power spectral density (PSD) level is a description of how the acoustic power is distributed over different frequencies within a spectrum. It is expressed in dB re 1 μPa^2/Hz.

The sound exposure level (SEL, dB re 1 μPa^2·s) is a measure of the total acoustic energy contained in one or more acoustic events. The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T_{100}):

$$\mathrm{SEL} = 10\log_{10}\left(\int_{T_{100}} p^2(t)\,dt \Big/ T_0 p_0^2\right) \quad \text{(A-2)}$$

where T_0 is a reference time interval of 1 s. The SEL represents the total acoustic energy received at a location during an acoustic event; it measures the total sound energy an organism at that location would be exposed to.

Because the SPL and SEL are both computed from the integral of square pressure, these metrics are related by the following expression, which depends only on the duration of the energy time window T:

$$\mathrm{SPL} = \mathrm{SEL} - 10\log_{10}(T) \tag{A-3}$$

Sound level statistics, namely percentiles, were used to quantify the distribution of recorded sound levels. The *n*th percentile level (L_n) is the level (i.e., PSD level, SPL, or SEL) *n*% of the data are below this level. L_{eq} is the linear arithmetic mean of the sound power, which can be substantially different from the median sound level L_{50}. SPL can also be referred to as L_{eq}, which stands for 'equivalent level'. The two terms are used interchangeably throughout. L_{95}, the level exceeded by only 5% of the data, represents the highest typical sound levels measured. Sound levels between L_5 and L_{99} are generally from very close passes of vessels, very intense weather events, and other infrequent conditions. L_5 represents the quietest typical conditions.

Appendix B. Acoustic Data Analysis Methods

The data sampled at 64 kHz and 512 kHz was processed for ambient sound analysis, vessel noise detection, and detection of all marine mammal vocalisations. This section describes the ambient, vessel, and marine mammal detection algorithms employed (Figure B-1).

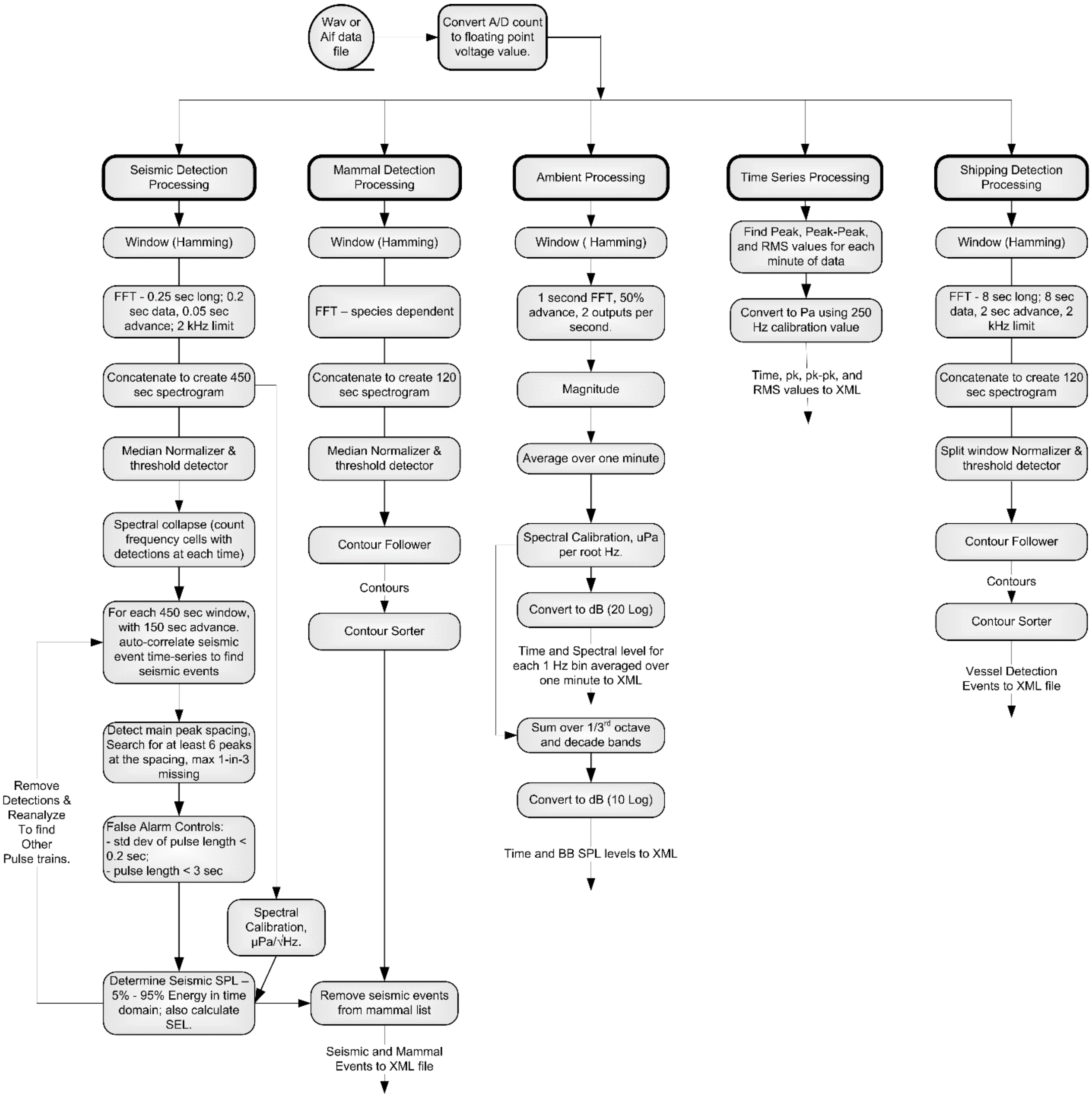


Figure B-1. Major stages of the automated acoustic analysis process performed with JASCO's custom software suite.

B.1. Total Ambient Sound Levels

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 impulsive noise 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 noise and its effects on marine life. We provide specific definitions of relevant metrics used in this report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The zero-to-peak pressure level, or peak pressure level (PK or $L_{p,pk}$; dB re 1 μPa), is the decibel level of the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$\mathrm{PK} = L_{p,\mathrm{pk}} = 10\log_{10}\frac{\max|p^2(t)|}{p_0^2} \tag{B-6}$$

PK is often included as criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of a noise event, it is generally a poor indicator of perceived loudness.

The sound pressure level (SPL or L_p; dB re 1 μPa) is the decibel level of the root-mean-square (rms) pressure in a stated frequency band over a specified time window (T; s) containing the acoustic event of interest. It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$\mathrm{SPL} = L_p = 10\log_{10}\left[\frac{1}{T}\int_T p^2(t)\,dt \Big/ p_0^2\right] \tag{B-7}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalisation, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL), but more spread out in time have a lower SPL.

The sound exposure level (SEL or L_E, dB re 1 μPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$\mathrm{SEL} = L_E = 10\log_{10}\left[\int_T p^2(t)\,dt \Big/ T_0 p_0^2\right] \tag{B-8}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple events or over a fixed duration. 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:

$$L_{E,N} = 10\log_{10}\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}} \tag{B-9}$$

To compute the SPL(T_{90}) and SEL of acoustic events in the presence of high levels of background noise, equations B-6 and B-7 are modified to subtract the background noise contribution:

$$\mathrm{SPL}(T_{90}) = L_{p90} = 10\log_{10}\left[\frac{1}{T_{90}}\int_{T_{90}}\left(p^2(t)-\overline{n^2}\right)dt \Big/ p_0^2\right] \tag{B-10}$$

$$L_E = 10\log_{10}\left[\int_T \left(p^2(t)-\overline{n^2}\right)dt \Big/ T_0 p_0^2\right] \tag{B-11}$$

where $\overline{n^2}$ is the mean square pressure of the background noise, generally computed by averaging the squared pressure of a temporally-proximal segment of the acoustic recording during which acoustic events are absent (e.g., between pulses).

Because the SPL(T_{90}) and SEL are both computed from the integral of square pressure, these metrics are related numerically by the following expression, which depends only on the duration of the time window T:

$$L_p = L_E - 10\log_{10}(T) \tag{B-12}$$

$$L_{p90} = L_E - 10\log_{10}(T_{90}) - 0.458 \tag{B-13}$$

where the 0.458 dB factor accounts for the 10% of SEL missing from the SPL(T_{90}) integration time window.

Energy equivalent SPL (dB re 1 µPa) denotes the SPL of a stationary (constant amplitude) sound that generates the same SEL as the signal being examined, $p(t)$, over the same period of time, T:

$$L_{\mathrm{eq}} = 10\log_{10}\left[\frac{1}{T}\int_T p^2(t)\,dt \Big/ p_0^2\right] \tag{B–14}$$

The equations for SPL and the energy-equivalent SPL are numerically identical; conceptually, the difference between the two metrics is that the former is typically computed over short periods (typically of 1 s or less) and tracks the fluctuations of a non-steady acoustic signal, whereas the latter reflects the average SPL of an acoustic signal over times typically of one minute to several hours.

B.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. These values directly compare to the Wenz curves, which represent typical deep ocean sound levels (Figure 9) (Wenz 1962). 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, $f_{\mathrm{c}}(i)$, is defined as:

$$f_{\mathrm{c}}(i) = 10^{\frac{i}{10}}\ \mathrm{kHz} \tag{B-1}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decade band are defined as:

$$f_{\text{lo},i} = 10^{\frac{-1}{20}} f_c(i) \quad \text{and} \quad f_{\text{hi},i} = 10^{\frac{1}{20}} f_c(i) \tag{B-2}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure B-2).

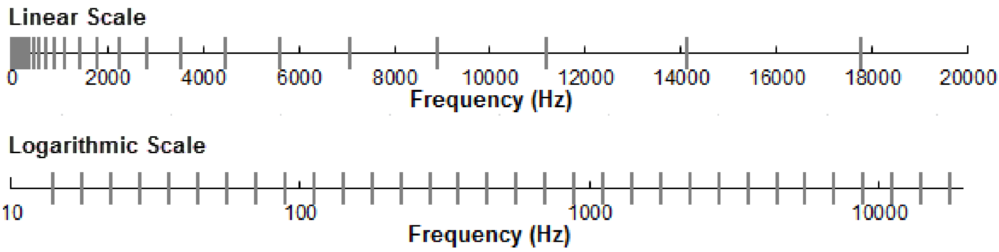


Figure B-2. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{\text{lo},i}$ and $f_{\text{hi},i}$:

$$L_{p,i} = 10 \log_{10} \int_{f_{\text{lo},i}}^{f_{\text{hi},i}} S(f)\, df \tag{B-3}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10 \log_{10} \sum_i 10^{\frac{L_{p,i}}{10}} \tag{B-4}$$

Figure B-3 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient noise signal. Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the spectral levels at higher frequencies. Decidecade band analysis is applied to continuous and impulsive noise sources. For impulsive sources, the decidecade band SEL is typically reported.

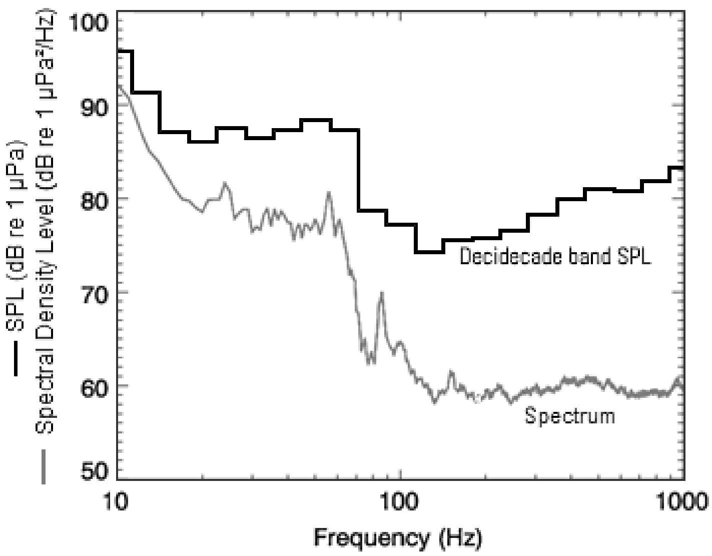


Figure B-3. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.

Table B-1. Decidecade band frequencies (Hz)

Band	Lower frequency	Nominal centre frequency	Upper frequency
10	8.9	10.0	11.2
11	11.2	12.6	14.1
12	14.1	15.8	17.8
13	17.8	20.0	22.4
14	22.4	25.1	28.2
15	28.2	31.6	35.5
16	35.5	39.8	44.7
17	44.7	50.1	56.2
18	56.2	63.1	70.8
19	70.8	79.4	89.1
20	89.1	100.0	112.2
21	112	126	141
22	141	158	178
23	178	200	224
24	224	251	282
25	282	316	355
26	355	398	447
27	447	501	562
28	562	631	708
29	708	794	891
30	891	1000	1122
31	1122	1259	1413
32	1413	1585	1778
33	1778	1995	2239
34	2239	2512	2818
35	2818	3162	3548
36	3548	3981	4467
37	4467	5012	5623
38	5623	6310	7079
39	7079	7943	8913
40	8913	10000	11220
41	11220	12589	14125
42	14260	16000	17952
43	17825	20000	22440
44	22281	25000	28050
45	28074	31500	35344

Table B-2. Decade-band frequencies (Hz)

Decade band	Lower frequency	Nominal centre frequency	Upper frequency
A	10	50	100
B	100	500	1,000
C	1,000	5,000	10,000

B.3. Millidecade Band Analysis

JASCO Applied Sciences has adopted a hybrid millidecade spectrum system to store and exchange passive acoustic spectral data to optimize data resolution while minimising data size, described in Martin et al. (2021).

Millidecades are logarithmically spaced frequency bands but have a bandwidth equal to 1/1000th of a decade. This frequency resolution is high enough to support many types of analysis, including analysing different types of soundscapes, computing weighted sound exposure levels, and summing the millidecades to find decidecades, 1/3-octave, and other desired frequency bands. The size of the millidecade files greatly compresses the acoustic data compared to 1 Hz resolution, such that data from long-term, multiple-station, high-sampling frequency projects can easily be stored at a single location. For example, there are 1,000 millidecades in each frequency decade, where a decade is an increase in the frequency by a factor of 10. A pure millidecade presentation of a spectrum from 1–100,000 Hz has 5,000 bands rather than 100,000 1 Hz bands, which results in a 20:1 decrease in the amount of data required for storage or exchange. For a 256 kHz spectrum, which is becoming a common size for recorders sampling at 512 kHz, there are 3,206 hybrid millidecades resulting in a compression ratio of 80:1.

The format uses 1-Hz resolution up to 455 Hz and millidecades frequency bands above 455 Hz. The lowest millidecades over-resolve (bin sizes <1 Hz) the space between 1–435 Hz for nearly all soundscape applications. To address this, a hybrid solution was applied that uses 1 Hz bands up to 455 Hz, where the millidecades are 1 Hz wide.

Similar to decidecades, the centre frequency for the ith millidecade (f_{c_i}) is defined as

$$f_{c\_i} = 10^{i/1,000}\ (\mathrm{Hz}) \tag{15}$$

and the lower (f_{lo_i}) and upper (f_{hi_i}) bounds for each millidecade are

$$f_{lo\_i} = f_{c\_i} \cdot 10^{-1/2,000}\ (\mathrm{Hz}) \tag{16}$$

$$f_{hi\_i} = f_{c\_i} \cdot 10^{1/2,000}\ (\mathrm{Hz})\ . \tag{17}$$

Appendix C. Recorder Calibration

The AMAR was calibrated before deployment with a pistonphone type 42AC precision sound source (G.R.A.S. Sound & Vibration A/S; Figure C-1). Due to the unforeseen delay of the retrieval the battery life was exhausted which prevented a calibration after retrieval. The pistonphone calibrator produces a constant tone at 250 Hz at a fixed distance from the hydrophone sensor in an airtight space with known volume. The recorded level of the reference tone on the AMAR yields the system gain for the AMAR and hydrophone. To determine absolute sound pressure levels, this gain was applied during data analysis. Typical calibration variance using this method is less than 0.7 dB absolute pressure.

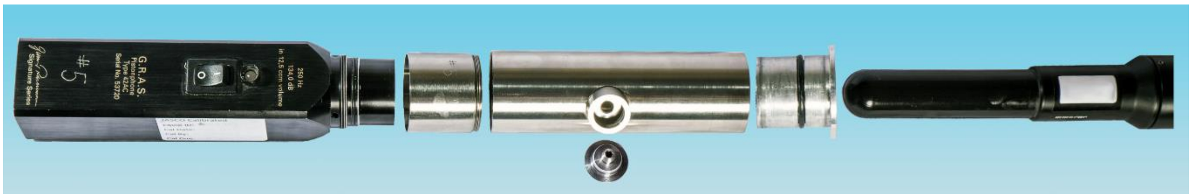


Figure C-1. Split view of a G.R.A.S. 42AC pistonphone calibrator with an M36 hydrophone.

Appendix D. Marine Mammal Detection Methodology

D.1. Automated Click Detector for Odontocetes

We applied an automated click detector/classifier to the data to detect clicks from odontocetes (Figure D-1.). This detector/classifier is based on the zero-crossings in the acoustic time series. Zero-crossings are the rapid oscillations of a click's pressure waveform above and below the signal's normal level (e.g., Figure D-1.). Clicks are detected by the following steps (Figure D-1.):

1. The raw data is high-pass filtered to remove all energy below 5 kHz. This removes most energy from other sources such as shrimp, vessels, wind, and cetacean tonal calls, yet allows the energy from all marine mammal click types to pass.
2. The filtered samples are summed to create a 0.334 ms rms time series. Most marine mammal clicks have a 0.1–1 ms duration.
3. Possible click events are identified with a split-window normaliser that divides the 'test' bin of the time series by the mean of the 6 'window' bins on either side of the test bin, leaving a 1-bin wide 'notch'.
4. A Teager-Kaiser energy detector identifies possible click events.
5. The high-pass filtered data is searched to find the maximum peak signal within 1 ms of the detected peak.
6. The high-pass filtered data is searched backwards and forwards to find the time span where the local data maxima are within 9 dB of the maximum peak. The algorithm allows for two zero-crossings to occur where the local peak is not within 9 dB of the maximum before stopping the search. This defines the time window of the detected click.
7. The classification parameters are extracted. The number of zero crossings within the click, the median time separation between zero crossings, and the slope of the change in time separation between zero crossings are computed. The slope parameter helps to identify beaked whale clicks, as beaked whales can be identified by the increase in frequency (upsweep) of their clicks.
8. The Mahalanobis distance between the extracted classification parameters and the templates of known click types is computed. The covariance matrices for the known click types, computed from thousands of manually identified clicks for each species, are stored in an external file. Each click is classified as a type with the minimum Mahalanobis distance unless none of them are less than the specified distance threshold.

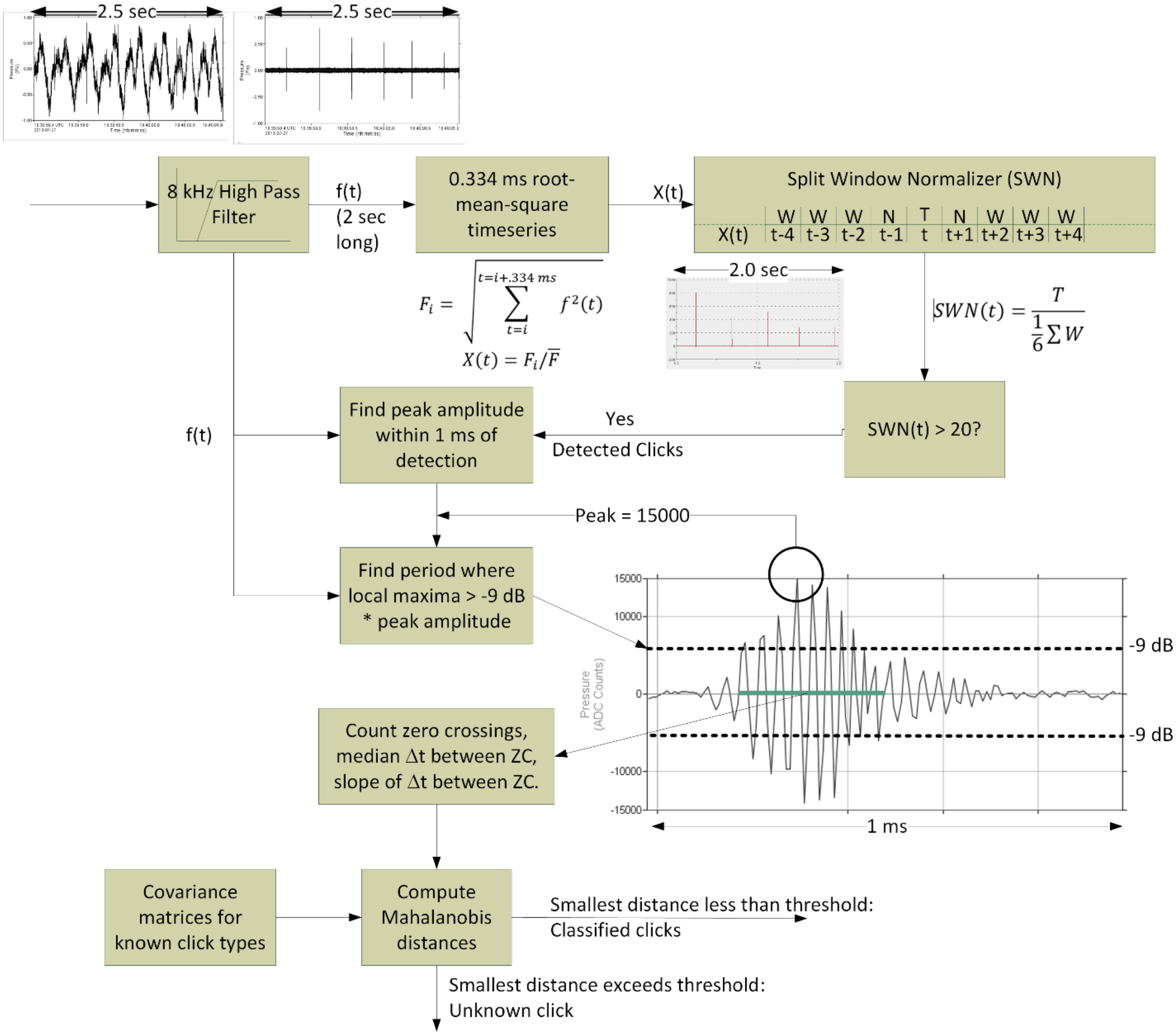


Figure D-1. The automated click detector/classifier block diagram.

Odontocete clicks occur in groups called click trains. Each species has a characteristic inter-click-interval (ICI) and number of clicks per train. The automated click detector includes a second stage that associates individual clicks into trains (Figure D-2). The steps of the click train associator algorithm are:

1. Queue clicks for N seconds, where N is twice the maximum number of clicks per train times the maximum ICI.
2. Search for all clicks within the window that have Mahalanobis distances less than 11 for the species of interest (this gets 99% of all clicks for the species as defined by the template).
3. Create a candidate click train if:
    a. The number of clicks is greater or equal to the minimum number of clicks in a train;
    b. The maximum time between any two clicks is less than twice the maximum ICI, and
    c. The smallest Mahalanobis distance for all clicks in the candidate train is less than 4.1.
4. Create a new ‘time-series’ that has a value of 1 at the time of arrival of each clicks and zeroes everywhere else.
5. Apply a Hann window to the timeseries then compute the cepstrum.
4. A click train is classified if a peak in the cepstrum with amplitude > 5 times the standard deviation of the cepstrum occurs at a quefrency between the minimum maximum ICI.
5. Queue clicks for N seconds

6. Search for all clicks within the window that have Mahalanobis distances less than 10 (equal to the extent of the variance in the training data set).
7. If the number of clicks is greater than or equal to 3 and dT is less than 2 * max ICI, make a new time-series at the 0.333 ms rate; where the value is 1 when the clicks occurred and 0 for all other time bins. Perform the following processing on this time series:
    a. Compute cepstrum
    b. ICI is the peak of the cepstrum with amplitude > 5 * stdev and searching for quefrency between minICI and maxICI.
    c. For each click related to the previous Ncepstrum, create a new time series and compute ICI; if we get a good match, extend the click train; find a mean ICI and variance.
8. If the click features, total clicks and mean ICI match the species, output a species_click_train detection.

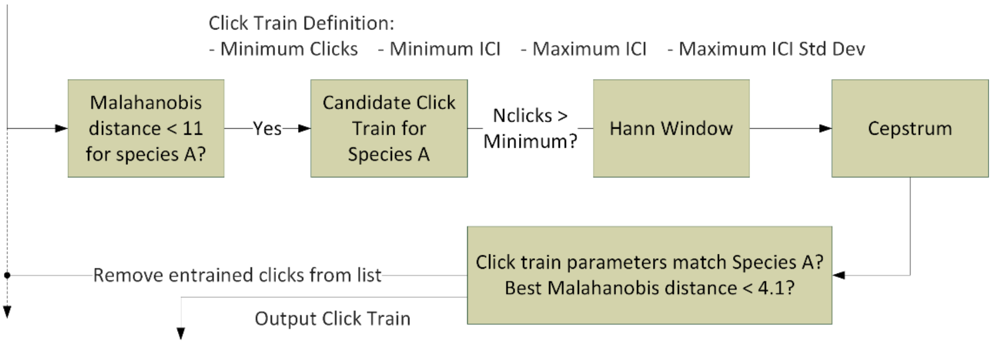


Figure D-2. The click train automated detector/classifier block diagram.

D.2. Automated Tonal Signal Detection

Marine mammal tonal acoustic signals are automatically detected by the following steps:

1. Spectrograms of the appropriate resolution for each mammal vocalisation type that were normalised by the median value in each frequency bin for each detection window Table D-1 were created.
2. Adjacent bins were joined, and contours were created via a contour-following algorithm (Figure D-3).
3. A sorting algorithm determined if the contours match the definition of a marine mammal vocalisation (Table D-2).

Due to the available time, a limited validation of the detections was performed by opening files with detections to check if actual calls were present.

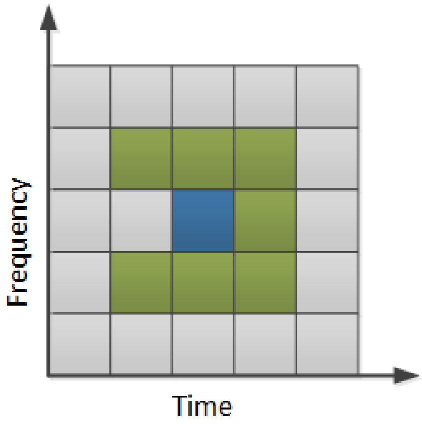


Figure D-3. Illustration of the search area used to connect spectrogram bins. The blue square represents a bin of the binary spectrogram equalling 1 and the green squares represent the potential bins it could be connected to. The algorithm advances from left to right so grey cells left of the test cell need not be checked.

Table D-1. Fast Fourier Transform (FFT) and detection window settings for all automated contour-based detectors used to detect tonal vocalisations of marine mammal species expected in the data. Values are based on JASCO's experience and empirical evaluation on a variety of data sets.

Automated detector	FFT			Detection window (s)	Detection threshold
	Resolution (Hz)	Frame length (s)	Timestep (s)		
AUS_BW_AH17	0.5	2	0.125	50	2
AUS_BW_AH60	0.5	2	0.125	50	2
AUS_BW_BH20	0.5	2	0.125	40	2
AUS_BW_BH43	0.5	2	0.125	40	2
AUS_BW_BH65	0.5	2	0.125	40	2
BW_H67	0.5	2	0.125	1200	3
BW_DS	0.05	2	0.2	5	3
NPac_BW_D	0.05	2	0.25	10	2
Brydes_DS	0.125	2	0.25	120	3
Brydes_IM_W	0.5	2	0.125	5	4
VLFMoan	2	0.2	0.05	15	4
LFMoan	2	0.25	0.05	10	3
ShortLow	7	0.17	0.025	10	3
MFMoanLow	4	0.2	0.05	5	3
MFMoanHigh	8	0.125	0.05	5	3
Omura_S1	0.25	2	0.25	120	6
Omura_S2	0.25	0.5	0.5	60	4
Omura_W	0.25	2	0.25	120	4
WhistleLow	16	0.03	0.015	5	3
WhistleHigh	64	0.015	0.005	5	3
MF Moan-LowDS-H:M	0.05	4	0.2	5	7
MF Moan-MidT-L	0.05	4	0.2	5	1.5
MF Moan-LowT-L	0.05	4	0.2	5	1.5
MF Moan-LowDS-L	0.05	4	0.2	5	3

Table D-2. A sample of vocalisation sorter definitions for the tonal vocalisations of cetacean species expected in the area.

Automated detector	Target species	Frequency (Hz)	Duration (s)	Bandwidth (B; Hz)	Other detection parameters
AUS_BW_AH17	Blue whale	10–100	6–60	1–50	Peak frequency 17–18.5
AUS_BW_AH60	Blue whale	10–100	6–60	1–50	Peak frequency 59–60.5
AUS_BW_BH20	Blue whale	10–100	6–30	1–3	Peak frequency 21–22.5
AUS_BW_BH43	Blue whale	10–100	6–30	1–3	Peak frequency 43–44.5
AUS_BW_BH65	Blue whale	10–100	6–30	1–3	Peak frequency 64–66.5
BW_H67	Blue whale	60–70	10–30	1–10	n/a
BW_DS	Blue whale	30–100	0.45–1	30–60	n/a
NPac_BW_D	Blue whale	20–100	2–10	15–50	Sweep rate −15 to −5
Brydes_DS	Bryde's whale	30–200	0.5–3	10–80	n/a
Brydes_IM_W	Bryde's whale	24–30	2–6	0.5–4	n/a
VLFMoan	Blue/fin/sei whale	10–100	0.30–10.00	>10	minF<40 Hz
LFMoan	Blue/right/sei whale	40–250	0.50–10.00	>15	InstantaneousBandwidth<50 Hz
ShortLow	Fin/baleen whale	30–400	0.08–0.60	>25	n/a
MFMoanLow	Humpback whale	100–700	0.50–5.00	>50	minF<450 Hz InstantaneousBandwidth<200 Hz
MFMoanHigh	Humpback whale	500–2500	0.50–5.00	>150	minF<1500 Hz InstantaneousBandwidth<300 Hz
Omura_S1	Omura's whale	15–60	5–12	8–40	n/a
Omura_S2	Omura's whale	10–60	3–15	8–40	n/a
Omura_W	Omura's whale	24–30	2–6	0.5–4	n/a
WhistleLow	Pilot/killer whale	1000–10000	0.50–5.00	>300	Max Instantaneous Bandwidth = 1000 Hz minF<5000 Hz
WhistleHigh	Other delphinid	4000–20000	0.30–3.00	>700	Max Instantaneous Bandwidth = 5000 Hz
MF Moan-LowDS-H:M	Humpback whale	100–1000	0.35–1.5	200–900	n/a
MF Moan-MidT-L	Humpback whale	500–1500	0.9–2.9	125–500	n/a
MF Moan-LowT-L	Humpback whale	50–950	0.9–2.9	50–500	n/a
MF Moan-LowDS-L	Humpback whale	100–1000	0.35–1.5	200–900	n/a

D.3. Automatic Data Selection for Validation (ADSV)

To standardise the file selection process for the selection of data for manual analysis, we applied our Automated Data Selection for Validation (ADSV) algorithm. Details of the ADSV algorithm are described in Kowarski et al. (2021) and a schematic of the process is provided in Figure D-4. ADSV computes the distribution of three descriptors that describe the automated detections in the full data set: the Diversity (number of automated detectors triggered per file), the Counts (number of automated detections per file for each automated detector), and the Temporal Distribution (spread of detections for each automated detector across the recording period). The algorithm removes files from the temporary data set that have the least impact on the distribution of the three descriptors in the full data set. Files are removed until a pre-determined data set size (*N*) is reached, at which point the temporary data set becomes the subset to be manually reviewed.

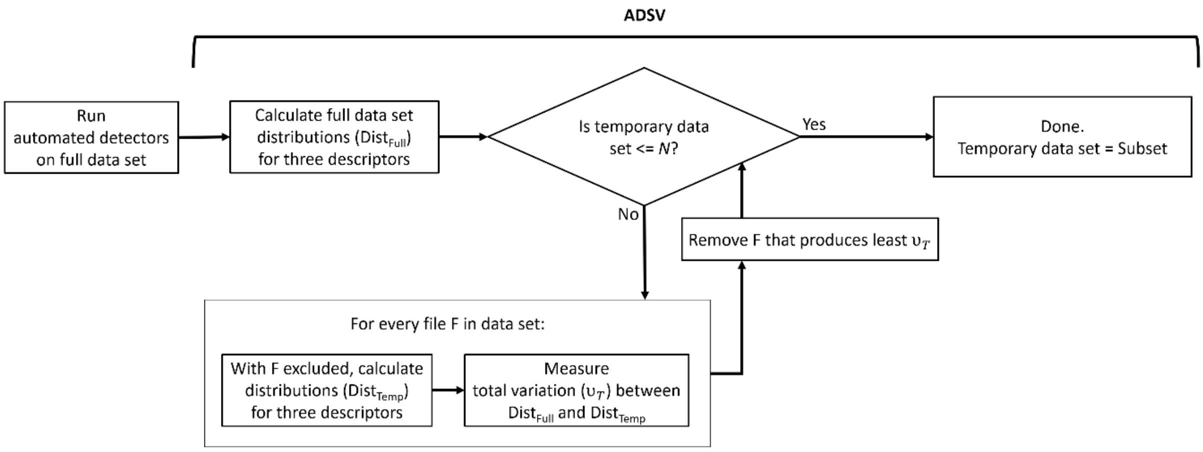


Figure D-4. Automated Data Selection for Validation (ADSV) process Figure 1 from Kowarski et al. (2021).

For the present work, an *N* of 0.5% was selected, largely due to limited scope for this project and marine mammal analysis. Even with limited manual review, the results presented here can be considered reliable, but some caveats should be considered. It is important to note that with such limited data manually reviewed, very rare species may have been missed or their occurrence underestimated. If the 0.5% subset of data manually analysed was not sufficiently large to capture the full range of acoustic environments in the full data set, the resulting automated detector performance metrics may be inaccurate and therefore should be taken as an estimate.

D.4. Automated Detector Performance Calculation and Optimization

All files selected for manual validation were reviewed by one of two experienced analysts using JASCO's PAMlab software to determine the presence or absence of every species, regardless of whether a species was automatically detected in the 5 min file. Although the automated detectors classify specific signals, we validated the presence/absence of species at the file level, not the detection level. Acoustic signals were only assigned to a species if the analyst was confident in their assessment. When unsure, analysts would consult one another, peer reviewed literature, and other experts in the field. If certainty could not be reached, the file of concern would be classified as possibly containing the species in question or containing an unknown acoustic signal. Next, the validated results were compared to the automated detector results in three phases to refine the results and ensure they accurately represent the occurrence of each species in the study area.

In phase 1, the human validated versus automated detector results were plotted as time series and critically reviewed to determine when and where automated detections should be excluded. Questionable detections that overlap with the detection period of other species were scrutinized. By restricting detections spatially and/or temporally where appropriate, we can maximize the reliability of the results. No temporal restrictions were necessary for our automated detector results.

In phase 2, the performance of the automated detectors was calculated and optimized for each species using a threshold, defined as the number of automated detections per file at and above which detections of species were considered valid.

To determine the performance of each automated detector and any necessary thresholds, the automated and validated results (excluding files where an analyst indicated uncertainty in species occurrence) were fed to a maximum likelihood estimation algorithm that maximizes the probability of detection and minimizes the number of false alarms using the Matthews Correlation Coefficient (MCC):

$$MCC = \frac{TPxTN - FPxFN}{\sqrt{(\mathrm{TP}+\mathrm{FP})(\mathrm{TP}+\mathrm{FN})(\mathrm{TN}+\mathrm{FP})(\mathrm{TN}+\mathrm{FN})}}$$

$$P = \frac{TP}{TP+FP}; R = \frac{TP}{TP+FN}$$

where *TP* (true positive) is the number of correctly detected files, *FP* (false positive) is the number of files that are false detections, and *FN* (false negatives) is the number of files with missed detections. No thresholds were necessary for our automated detector results.

In phase 3, detections were further restricted to include only those where *P* was greater than or equal to 0.75. When *P* was less than 0.75, only validated results were used to describe the acoustic occurrence of a species. All species in the present data set had automated detectors that performed sufficiently well. The occurrence of each species was plotted using JASCO's Ark software as time series showing presence/absence by hour over each day.

Appendix E. Auditory Frequency Weighting Functions

The potential for anthropogenic sounds to impact marine mammals is largely dependent on whether the sound occurs at frequencies that an animal can hear well, unless the sound pressure level is so high that it can cause physical tissue damage regardless of frequency. Auditory (frequency) weighting functions reflect an animal's ability to hear a sound (Nedwell and Turnpenny 1998, Nedwell et al. 2007). Houser et al (2017) provide an example illustrating the effect of applying a weighting function to a (hypothetical) sound (Figure E-1).

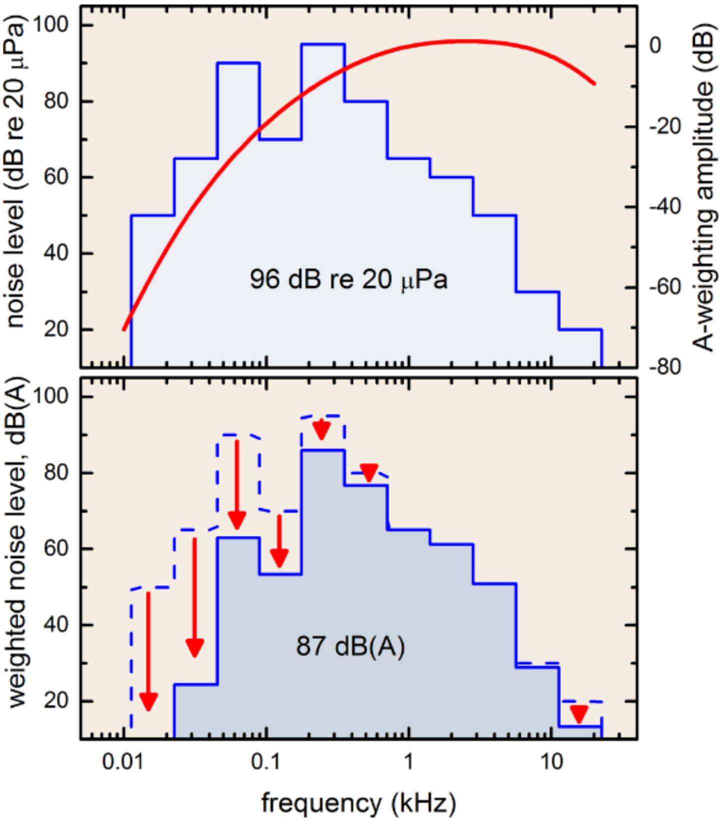


Figure E-1. Application of an auditory weighting function. Blue line shows a hypothetical, octave-band sound pressure spectrum in air, with a total sound pressure level (integrated over all octave-bands) of 96 dB re 20 µPa (This example uses in air-noise levels; therefore, a different reference pressure (20 µPa) applies. The principle is identical to underwater sound where a reference pressure of 1 µPa applies). (Top) Red line shows the human A-weighting function amplitude (A-weighting applies only to human hearing). (Bottom) To determine the weighted exposure level, the A-weighting amplitude at each frequency is added to the sound pressure level at each frequency (red arrows). The weighted spectrum has lower amplitude at the frequencies where the A-weighting function amplitudes are negative. The values from 1–4 kHz do not change substantially, because the weighting function is flat (i.e., the weights are near zero). The weighted SPL is calculated by integrating the weighted spectrum across all octave-bands; the result is 87 dBA, meaning a sound pressure level of 87 dB re 20 µPa after applying the human A-weighting function (Source: Houser et al. 2017).

To better reflect the auditory similarities between phylogenetically closely related species, but also significant differences between species groups among the marine mammals, the extant marine mammal species are assigned to functional hearing groups based on their hearing capabilities and sound production (NMFS 2018) (Table E-1). This division into broad categories is intended to provide a realistic number of categories for which individual noise exposure criteria were developed and the categorisation as such has proven to be a scientifically justified and useful approach in developing auditory frequency weighting functions and deriving noise exposure criteria for marine mammals.

Table E-1. Marine mammal hearing groups (NMFS 2018).

Hearing group	Generalised hearing range*
Low-frequency (LF) cetaceans (mysticetes or baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (odontocetes: delphinids, beaked whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (other odontocetes)	275 Hz to 160 kHz
Phocid pinnipeds (PW) (underwater)	50 Hz to 86 kHz
Otariid pinnipeds (OW) (underwater)	60 Hz to 39 kHz

* The generalised hearing range for all species within a group. Individual hearing will vary.

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).

In 2015, a U.S. 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:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \tag{E-1}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, 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 noise impacts on marine mammals (NMFS 2016, NMFS 2018). Table E-2 lists the frequency-weighting parameters for each hearing group; Figure E-2 shows the resulting frequency-weighting curves.

Table E-2. Parameters for the auditory weighting functions used in this project as recommended by NMFS (2018).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
Mid-frequency cetaceans (dolphins, plus toothed, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36
Phocid seals in water	1.0	2	1,900	30,000	0.75
Otariid seals in water	2.0	2	940	25,000	0.64

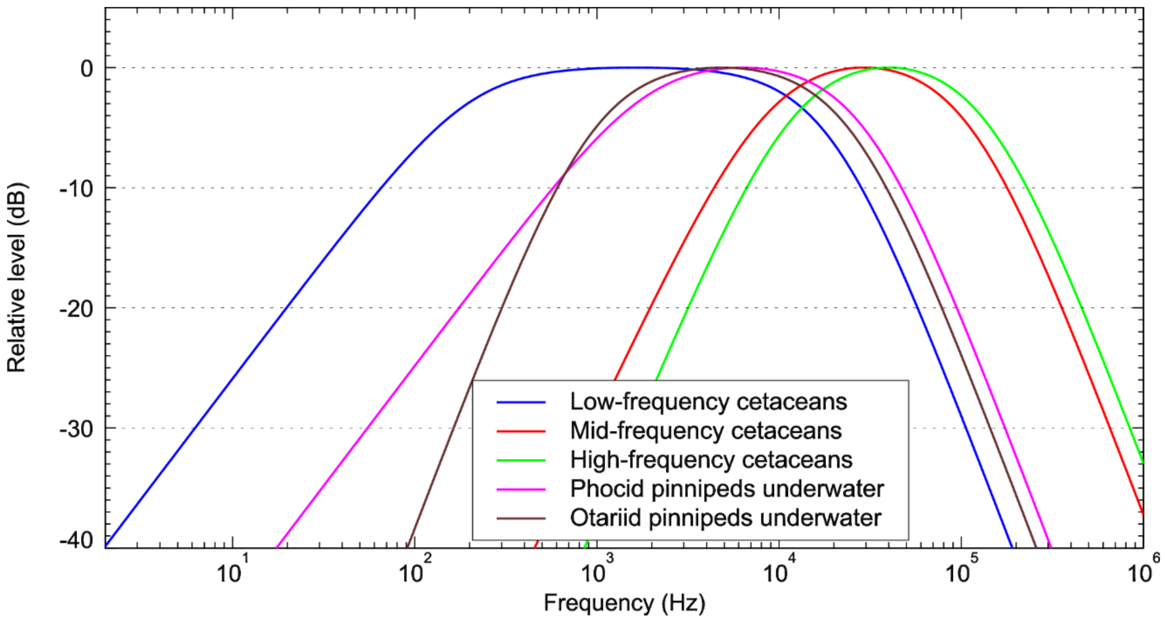


Figure E-2. Auditory weighting functions for functional marine mammal hearing groups as recommended by NMFS (2018).

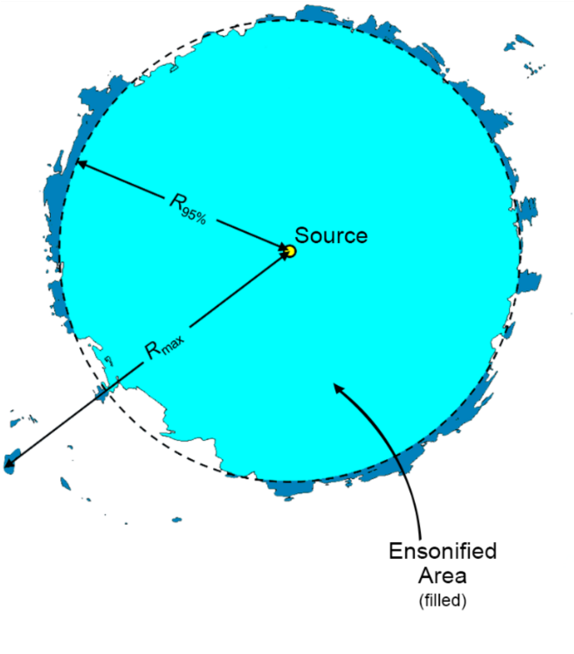
Appendix F. Methods and Parameters

This section describes the specifications of the seismic source that was used at all sites and the environmental parameters used in the propagation models.

F.1. 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 F-1).

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 F-1(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 F-1(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.



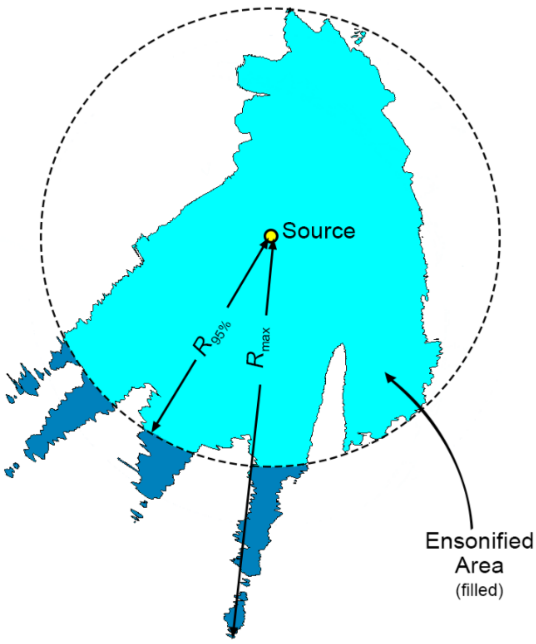


Figure F-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

F.2. Environmental Parameters

F.2.1. Bathymetry

Water depths throughout the modelled areas were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009). Bathymetry data were re-gridded onto a Map Grid of Australia (MGA) coordinate projection (Zone 54) with a regular grid spacing of 100 × 100 m.

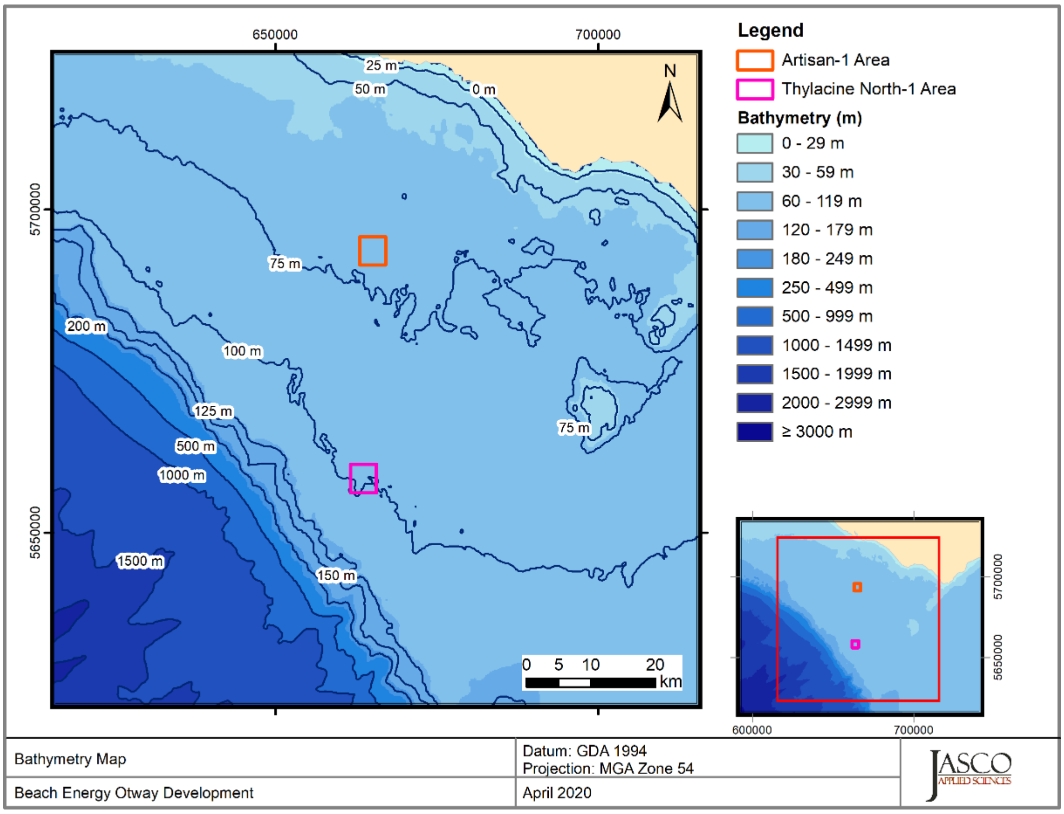


Figure F-2. Bathymetry in the modelled area.

F.2.2. Sound speed profile

Between 0–77 m water depth, mean daily sound speed profiles were derived from the Global Ice Ocean Prediction System (GIOPS) forecasting system for the period when the measurement data was acquired (February 2021 to March 2021 inclusive). A median profile determined to best represent potential propagation conditions over the periods. For deeper water depths below 77 m the sounds speed profile was combined with the sound speed profiles from GDEM (GDEM; Teague et al. 1990, Carnes 2009).

The GIOPS is a data assimilation system that combines satellite and in-situ measurements for ice and ocean analyses and forecasts. Available sea ice analysis products are generated from sea ice concentration data and other satellite measurements from the Canadian Ice Service. For oceanographic variables, GIOPS assimilates a variety of satellite and in-situ observations (Argos profiling floats, ice buoys, moorings, ship observations, and others) to provide a 3-d representation of ocean temperature and salinity, water velocity, sea surface height and mixed layer depth. Meant primarily as a forecasting tool, the daily reported results are not archived long term for general use, but JASCO started caching GIOPS output in 2017 to support Arctic programs.

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).

The February and March were selected for sound propagation modelling to ensure to align with the measurement period. Figure F-3 shows the resulting profile, which was used as input for the sound propagation modelling.

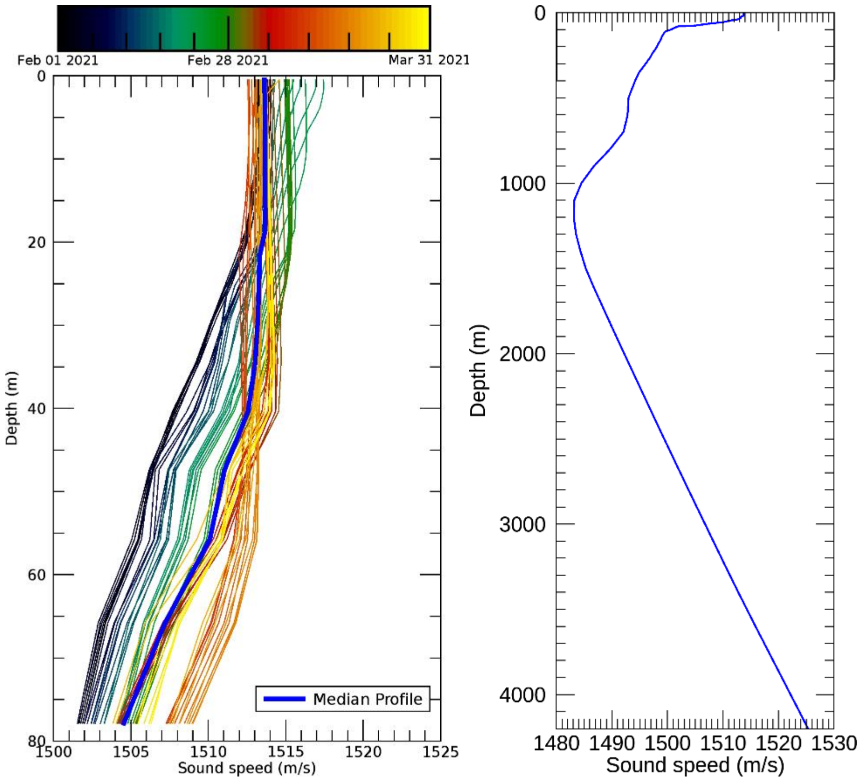


Figure F-3. The sound speed profile used for modelling: The daily and median profiles for the first 77 m from Global Ice Ocean Prediction System (GIOPS) (left) and full depth (right).

F.2.3. Geoacoustics

The propagation model used in this study consider a single geoacoustic profile for the modelled area. These profiles determine how sound is reflected from the seabed, as well as how it is transmitted, reflected, and absorbed into the sediment layers. The seabed in the Artisan-1, located in shallower waters, was characterised by cemented and semi-cemented carbonate rock (calcarenite). semi-cemented carbonate rock with the potential for a thin overlying veneer of coarse sand. This geologic model of the seabed environment is consistent with larger scale geological data and interpretations of the Australian continental shelf environment (James and Bone 2010). Tables F-1 and F-2 present the geoacoustic profiles used modelled sites for each seabed type considered.

Table F-1. *Artisan-1*: Carbonate rock geoacoustic profile. Each parameter varies linearly within the stated range.

Depth below seafloor (m)	Predicted lithology	Density (g/cm^3)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–0.5	Well-cemented carbonate caprock	2.7	2600	0.50	500	0.4
0.5–20	Increasingly cemented calcarenite	2.2	2000	0.30		
20–40		2.3	2120	0.34		
40–60		2.4	2240	0.38		
60–80		2.5	2360	0.42		
80–100		2.6	2480	0.46		
>100	Well-cemented calcarenite	2.7	2600	0.5		

Table F-2. *Artisan-1*: Carbonate rock geoacoustic profile with overlying sand veneer. Each parameter varies linearly within the stated range.

Depth below seafloor (m)	Predicted lithology	Density (g/cm^3)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–1	Coarse carbonate sand	2.03	1800	0.85	300	3.68
1–20	Increasingly cemented calcarenite	2.2	2000	0.30		
20–40		2.3	2120	0.34		
40–60		2.4	2240	0.38		
60–80		2.5	2360	0.42		
80–100		2.6	2480	0.46		
>100	Well-cemented calcarenite	2.7	2600	0.5		

Appendix G. ShipSound Reports

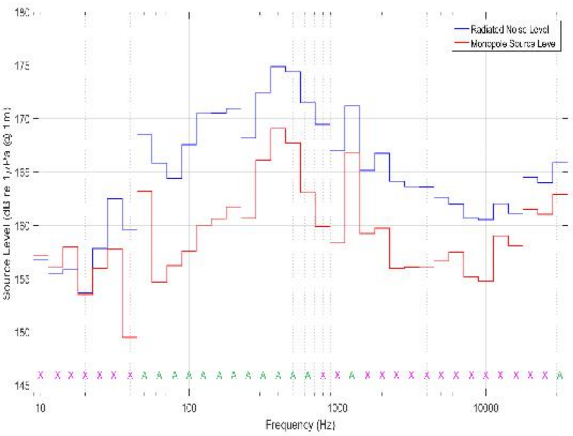
G.1. *Ocean Onyx* Reports

G.1.1. Report 1: 14:22 on 23 Feb 2021

Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information		Measurement Information	
MMSI:	538001765	Measurement Date (UTC):	February 23, 2021
IMO:	0	Closest Approach Time (UTC):	14:22:04
Name:	OCEAN ONYX	Closest Approach Distance (m):	306.6
Flag:	Marshall Is	Vessel Ground Speed (kn):	0.0
Vessel DWT (TEU):	102.0	Sail Direction over ground (deg):	326.0
PortListen Vessel Type	Other	Vessel Water Speed (kn):	N/A
Length (m):	106.35	Shaft rate (rpm):	-6000.0
Beam (m)	105.16	Vessel Percent Power/Pitch:	N/A
Maximum Draft (m):	N/A	Actual Vessel Draft max (m):	22.0
Engine Power (kW):	N/A	Monopole Source Depth (m):	11.0
Number of Shafts:	N/A	Monopole Source Level (dB/µPa):	175.4
Prop Diameter (m):	N/A	Radiated Noise Level (dB/µPa):	182.2



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

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Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	180.4	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	165.9	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	165.8	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	OCEAN ONYX
Measurement ID:	BEACHOTWAY-stn1-2021-02-538001765202102231422
Date of Measurement:	February 23, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'029"S, 142°52'056"E		
Hydrophone location (WGS-84):	-38°53'024"S, 142°53'008"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	9.0
Speed of Current (kn):	N/A	Wind Direction (deg):	184.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

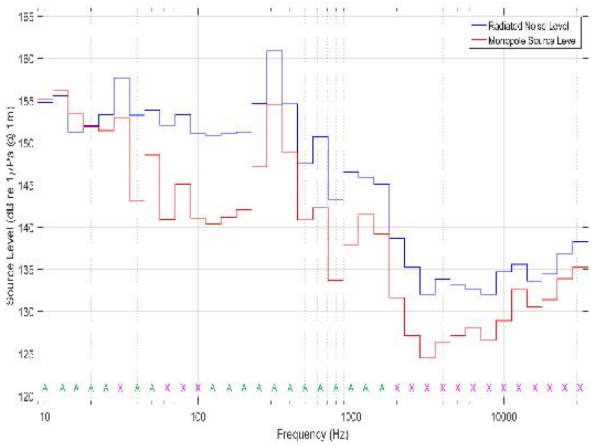
[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

G.1.2. Report 2: 17:52 on 8 Mar 2021

Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information		Measurement Information	
MMSI:	538001765	Measurement Date (UTC):	March 08, 2021
IMO:	0	Closest Approach Time (UTC):	17:52:04
Name:	OCEAN ONYX	Closest Approach Distance (m):	306.6
Flag:	Marshall Is	Vessel Ground Speed (kn):	0.0
Vessel DWT (TEU):	102.0	Sail Direction over ground (deg):	326.0
PortListen Vessel Type	Other	Vessel Water Speed (kn):	N/A
Length (m):	106.35	Shaft rate (rpm):	-6000.0
Beam (m)	105.16	Vessel Percent Power/Pitch:	N/A
Maximum Draft (m):	N/A	Actual Vessel Draft max (m):	22.0
Engine Power (kW):	N/A	Monopole Source Depth (m):	11.0
Number of Shafts:	N/A	Monopole Source Level (dB/µPa):	159.6
Prop Diameter (m):	N/A	Radiated Noise Level (dB/µPa):	165.3



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

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Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	162.6	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	126.5	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	118.2	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	OCEAN ONYX
Measurement ID:	BEACHOTWAY-stn1-2021-02-538001765202103081752
Date of Measurement:	March 08, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'029"S, 142°52'056"E		
Hydrophone location (WGS-84):	-38°53'024"S, 142°53'008"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	9.0
Speed of Current (kn):	N/A	Wind Direction (deg):	231.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

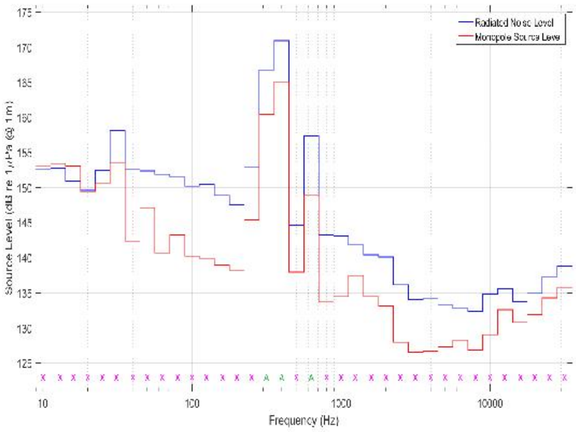
[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

G.1.3. Report 3: 18:22 on 8 Mar 2021

Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information		Measurement Information	
MMSI:	538001765	Measurement Date (UTC):	March 08, 2021
IMO:	0	Closest Approach Time (UTC):	18:22:05
Name:	OCEAN ONYX	Closest Approach Distance (m):	306.6
Flag:	Marshall Is	Vessel Ground Speed (kn):	0.0
Vessel DWT (TEU):	102.0	Sail Direction over ground (deg):	326.0
PortListen Vessel Type	Other	Vessel Water Speed (kn):	N/A
Length (m):	106.35	Shaft rate (rpm):	-6000.0
Beam (m)	105.16	Vessel Percent Power/Pitch:	N/A
Maximum Draft (m):	N/A	Actual Vessel Draft max (m):	22.0
Engine Power (kW):	N/A	Monopole Source Depth (m):	11.0
Number of Shafts:	N/A	Monopole Source Level (dB/µPa):	166.5
Prop Diameter (m):	N/A	Radiated Noise Level (dB/µPa):	172.5



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

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Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	171.5	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	130.5	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	120.5	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	OCEAN ONYX
Measurement ID:	BEACHOTWAY-stn1-2021-02-538001765202103081822
Date of Measurement:	March 08, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'029"S, 142°52'056"E		
Hydrophone location (WGS-84):	-38°53'024"S, 142°53'008"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	9.0
Speed of Current (kn):	N/A	Wind Direction (deg):	231.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

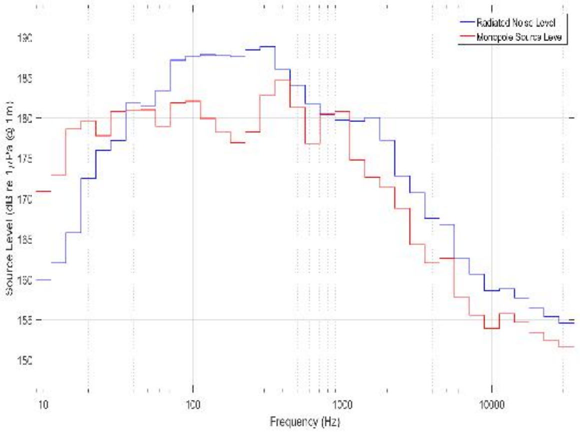
[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

G.2. Vessel DP Trial Report: 01:48 on 4 Feb 2021

Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information		Measurement Information	
MMSI:	257544000	Measurement Date (UTC):	February 04, 2021
IMO:	0	Closest Approach Time (UTC):	1:48:00
Name:	SIEM SAPPHIRE	Closest Approach Distance (m):	182.6
Flag:	Norway	Vessel Ground Speed (kn):	0.6
Vessel DWT (TEU):	4250.0	Sail Direction over ground (deg):	152.4
PortListen Vessel Type	Other	Vessel Water Speed (kn):	N/A
Length (m):	91.0	Shaft rate (rpm):	-6000.0
Beam (m)	22.04	Vessel Percent Power/Pitch:	N/A
Maximum Draft (m):	N/A	Actual Vessel Draft max (m):	7.0
Engine Power (kW):	N/A	Monopole Source Depth (m):	4.9
Number of Shafts:	N/A	Monopole Source Level (dB/µPa):	193.4
Prop Diameter (m):	N/A	Radiated Noise Level (dB/µPa):	198.0



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

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Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	195.0	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	168.4	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	164.7	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	SIEM SAPPHIRE
Measurement ID:	BEACHOTWAY-stn2-2021-02-257544000202102040148
Date of Measurement:	February 04, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'010"S, 142°53'044"E		
Hydrophone location (WGS-84):	-38°53'011"S, 142°53'036"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	13.0
Speed of Current (kn):	N/A	Wind Direction (deg):	89.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

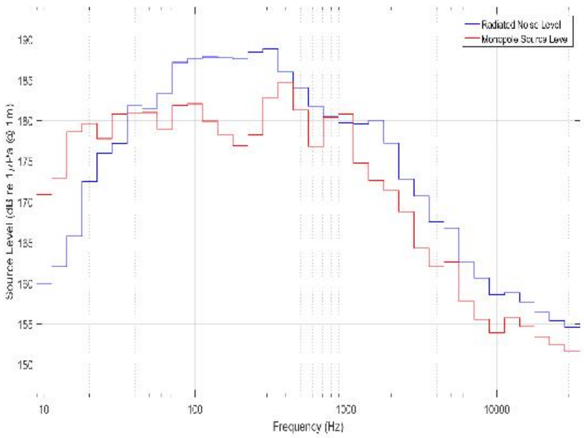
G.3. Vessel Transit Report: 21:56 on 10 Mar 2021

Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information	
MMSI:	257544000
IMO:	0
Name:	SIEM SAPPHIRE
Flag:	Norway
Vessel DWT (TEU):	4250.0
PortListen Vessel Type	Other
Length (m):	91.0
Beam (m)	22.04
Maximum Draft (m):	N/A
Engine Power (kW):	N/A
Number of Shafts:	N/A
Prop Diameter (m):	N/A

Measurement Information	
Measurement Date (UTC):	February 04, 2021
Closest Approach Time (UTC):	1:48:00
Closest Approach Distance (m):	182.6
Vessel Ground Speed (kn):	0.6
Sail Direction over ground (deg):	152.4
Vessel Water Speed (kn):	N/A
Shaft rate (rpm):	-6000.0
Vessel Percent Power/Pitch:	N/A
Actual Vessel Draft max (m):	7.0
Monopole Source Depth (m):	4.9
Monopole Source Level (dB/µPa):	193.4
Radiated Noise Level (dB/µPa):	198.0



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

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Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	195.0	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	168.4	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	164.7	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	SIEM SAPPHIRE
Measurement ID:	BEACHOTWAY-stn2-2021-02-257544000202102040148
Date of Measurement:	February 04, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'010"S, 142°53'044"E		
Hydrophone location (WGS-84):	-38°53'011"S, 142°53'036"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	13.0
Speed of Current (kn):	N/A	Wind Direction (deg):	89.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

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3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998