



Environment Plan Appendices

Artisan-1 Exploration Well Drilling

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
1	19/12/2019	Issued to NOPSEMA for assessment	PW	Xodus	MP
2	31/01/2020	Issued to NOPSEMA for assessment	PW	Xodus	MP
3	26/02/2020	NOPSEMA Accepted	PW	Xodus	MP
4	15/07/2020	Revised and issued to NOPSEMA for assessment	PW	Xodus	MP
5	2/11/2020	Revised and issued to NOPSEMA for assessment	PW	Xodus	TF
6	18/12/2020	Issued to NOPSEMA OMR	PW	Xodus	TF

Review due	Review frequency
Annually from date of acceptance	1 year/s

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THE THREE WHATS

What can go wrong?

What could cause it to go wrong?

What can I do to prevent it?

Table of Contents

Appendix A: EPBC Act Protected Matters Search Reports

A1: Spill EMBA

A2: Operational Area – 2 km

A3: Light and Noise Behaviour EMBA – 20 km

A4: Noise 24 hr EMBA – 3 km

A5: Waste Water EMBA – 2.5 km

Appendix B: RPS APASA Artisan-1 Spill Model Report

Appendix E: Environmental Survey – Otway Basin

Appendix F: Jasco Modelling Report

Appendix G: Otway Drilling Whale Management Process

Appendix A: EPBC Act Protected Matters Search Reports

A1: Spill EMBA



EPBC Act Protected Matters Report

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

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: 07/12/20 12:58:25

[Summary](#)

[Details](#)

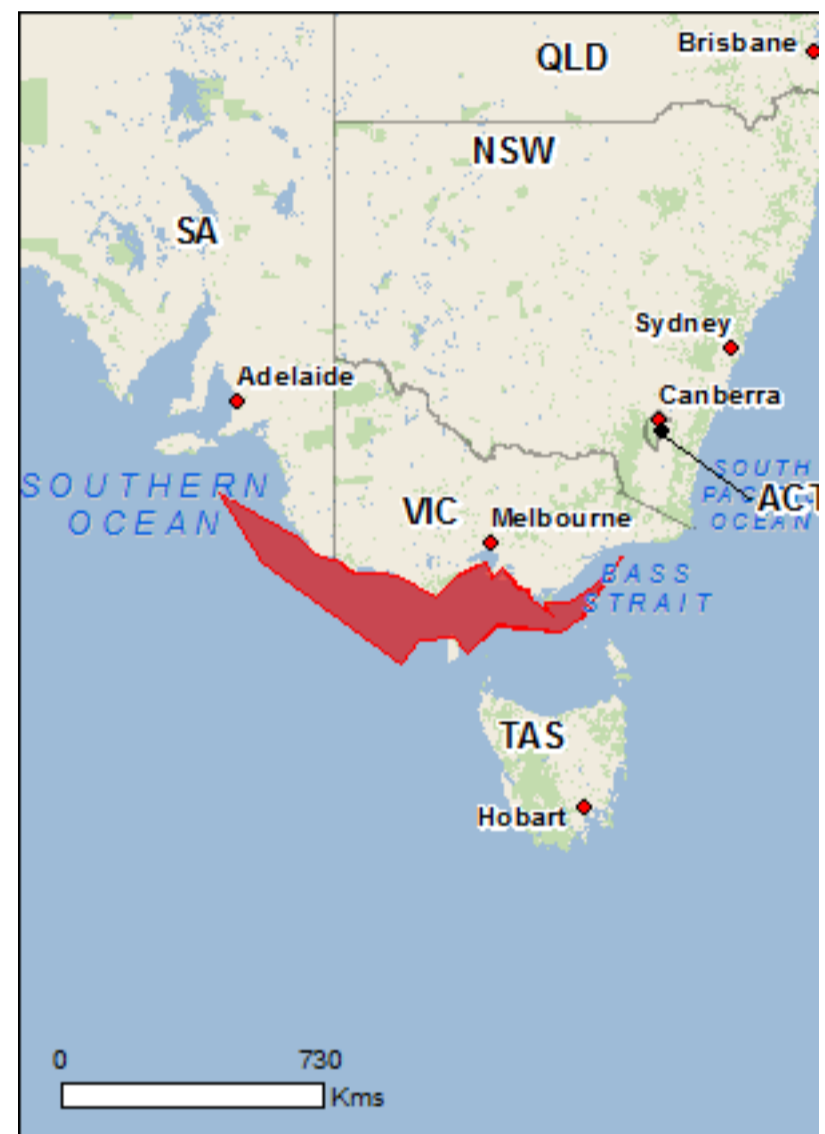
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

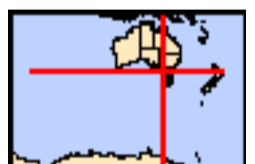
[Acknowledgements](#)



This map may contain data which are
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[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:	3
Wetlands of International Importance:	6
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	8
Listed Threatened Species:	108
Listed Migratory Species:	78

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:	7
Commonwealth Heritage Places:	8
Listed Marine Species:	130
Whales and Other Cetaceans:	30
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	5

Extra Information

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

State and Territory Reserves:	67
Regional Forest Agreements:	3
Invasive Species:	56
Nationally Important Wetlands:	10
Key Ecological Features (Marine)	3

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place
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 Ramsar site
Lavinia		Within Ramsar site
Piccaninnie ponds karst wetlands		Within 10km of Ramsar
Port phillip bay (western shoreline) and bellarine peninsula		Within Ramsar site
Western port		Within Ramsar site

Commonwealth Marine Area	[Resource Information]
Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside 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
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	Community likely to occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community likely to occur within area
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (Eucalyptus ovata / E. brookeriana)	Critically Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species	[Resource Information]	
Name	Status	Type of Presence

Name	Status	Type of Presence
Birds		
Acanthiza pusilla archibaldi King Island Brown Thornbill, Brown Thornbill (King Island) [59430]	Endangered	Species or species habitat likely to occur within area
Acanthornis magna greeniana King Island Scrubtit, Scrubtit (King Island) [82329]	Critically Endangered	Species or species habitat known to occur within area
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Aquila audax fleayi Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) [64435]	Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	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 known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii graptogyne South-eastern Red-tailed Black-Cockatoo [25982]	Endangered	Species or species habitat may occur within area
Ceyx azureus diemenensis Tasmanian Azure Kingfisher [25977]	Endangered	Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to 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

Name	Status	Type of Presence within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	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
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known 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 likely to 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 known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
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
Platycercus caledonicus brownii Green Rosella (King Island) [67041]	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	Foraging, feeding or related behaviour likely to 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
Strepera fuliginosa colei Black Currawong (King Island) [67113]	Vulnerable	Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or

Name	Status	Type of Presence
Thalassarche bulleri_platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	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 eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to 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 known to occur within area
Nannoperca obscura Yarra Pygmy Perch [26177]	Vulnerable	Species or species habitat likely to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known 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 known to occur within area
Insects		
Synemon plana Golden Sun Moth [25234]	Critically Endangered	Species or species habitat may occur within area
Mammals		
Antechinus minimus maritimus Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
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 known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isodon 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 known to 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	Roosting known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE Mainland) [66645]	Vulnerable	Species or species habitat known to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys shortridgei Heath Mouse, Dayang, Heath Rat [77]	Endangered	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Plants		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat known to occur within area
Caladenia calcicola Limestone Spider-orchid [10065]	Vulnerable	Species or species habitat likely to occur within area
Caladenia colorata Coloured Spider-orchid, Small Western Spider-orchid, Painted Spider-orchid [54999]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence within area
Caladenia hastata Melblom's Spider-orchid [16118]	Endangered	Species or species habitat likely to occur within area
Caladenia insularis French Island Spider-orchid [24372]	Vulnerable	Species or species habitat likely to occur within area
Caladenia orientalis Eastern Spider Orchid [83410]	Endangered	Species or species habitat known to occur within area
Caladenia robinsonii Frankston Spider-orchid [24375]	Endangered	Species or species habitat likely to occur within area
Caladenia tensa Greencomb Spider-orchid, Rigid Spider-orchid [24390]	Endangered	Species or species habitat may occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Euphrasia collina subsp. muelleri Purple Eyebright, Mueller's Eyebright [16151]	Endangered	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Grevillea infecunda Anglesea Grevillea [22026]	Vulnerable	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Hypolepis distans Scrambling Ground-fern [2148]	Endangered	Species or species habitat likely to occur within area
Ixodia achillaeoides subsp. arenicola Sand Ixodia, Ixodia [21474]	Vulnerable	Species or species habitat known to occur within area
Lachnagrostis adamsonii Adamson's Blown-grass, Adamson's Blowngrass [76211]	Endangered	Species or species habitat may occur within area
Leiocarpa gatesii Wrinkled Buttons [76212]	Vulnerable	Species or species habitat likely to occur within area
Leucochrysum albicans subsp. tricolor Hoary Sunray, Grassland Paper-daisy [89104]	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 likely to occur within area
Pomaderris halmaturina subsp. halmaturina Kangaroo Island Pomaderris [21964]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
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 known 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 known to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Pterostylis ziegeleri Grassland Greenhood, Cape Portland Greenhood [64971]	Vulnerable	Species or species habitat may occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Taraxacum cygnorum Coast Dandelion [2508]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat known to occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Delma impar Striped Legless Lizard, Striped Snake-lizard [1649]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may 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

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
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		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 eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	to occur within area 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
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour 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
Rhincodon typus Whale Shark [66680]	Vulnerable	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]		Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting 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 known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area

Name	Threatened	Type of Presence
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known 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
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa incana Wandering Tattler [831]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known 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 - CROWS NEST CAMP - QUEENSCLIFF
 Defence - HMAS CERBERUS
 Defence - STAFF COLLEGE-FORT QUEENSCLIFF
 Defence - SWAN ISLAND TRAINING AREA
 Defence - TRAINING CENTRE (Norris Barracks) - Portsea
 Defence - WEST HEAD GUNNERY RANGE

Commonwealth Heritage Places

[\[Resource Information \]](#)

Name	State	Status
Natural		
HMAS Cerberus Marine and Coastal Area	VIC	Listed place
Swan Island and Naval Waters	VIC	Listed place
Historic		
Cape Wickham Lighthouse	TAS	Listed place
Fort Queenscliff	VIC	Listed place
HMAS Cerberus Central Area Group	VIC	Listed place
Sorrento Post Office	VIC	Listed place
Swan Island Defence Precinct	VIC	Listed place
Wilsons Promontory Lighthouse	VIC	Listed place

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
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to 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 known 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]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within

Name	Threatened	Type of Presence area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Heteroscelus incanus Wandering Tattler [59547]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to 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 known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat likely to 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
Morus capensis Cape Gannet [59569]		Breeding known to occur within area
Morus serrator Australasian Gannet [1020]		Breeding known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence
Numenius minutus Little Curlew, Little Whimbrel [848]		within area Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known 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
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding 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
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to 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
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur

Name	Threatened	Type of Presence
Sterna caspia Caspian Tern [59467]		within area Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		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 eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to 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 glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Campichthys tryoni Tryon's Pipefish [66193]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypsognathus 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

Name	Threatened	Type of Presence
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
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
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		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
Vanacampus vercoi Verco's Pipefish [66286]		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]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour 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
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 Dolphin, 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

Name	Status	Type of Presence
Lissodelphis peronii Southern Right Whale Dolphin [44]		habitat likely to occur within area 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 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 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)
Murray	Multiple Use Zone (IUCN VI)
Nelson	Special Purpose Zone (IUCN VI)
Zeehan	Special Purpose Zone (IUCN VI)

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Aire River	VIC
Aireys Inlet B.R.	VIC
Anglesea B.R.	VIC
Anser Island	VIC
Bay of Islands Coastal Park	VIC
Bucks Lake	SA
Canunda	SA
Cape Liptrap Coastal Park	VIC
Cape Nelson	VIC
Cape Patterson N.C.R.	VIC
Cape Wickham	TAS
Cape Wickham	TAS
Carpenter Rocks	SA
Cone Islet	TAS
Crib Point G228 B.R.	VIC
Crib Point G229 B.R.	VIC
Curtis Island	TAS
Devils Tower	TAS
Disappointment Bay	TAS
Discovery Bay Coastal Park	VIC
Douglas Point	SA
East Moncoeur Island	TAS
Edna Bowman N.C.R.	VIC
Fingal B.R.	VIC
Flinders G234 B.R.	VIC
Flinders N.F.R.	VIC
French Island	VIC
French Island G230 B.R.	VIC
Great Otway	VIC
Hogan Group	TAS
Kilcunda N.C.R.	VIC
Lady Julia Percy Island W.R.	VIC
Lake Connewarre W.R.	VIC
Lake Flannigan	TAS
Latrobe B.R.	VIC
Lavinia	TAS
Lawrence Rocks W.R.	VIC
Lily Pond B.R.	VIC
Lonsdale Lakes W.R.	VIC
Marengo N.C.R.	VIC
Merricks Creek B.R.	VIC
Mornington Peninsula	VIC
Mount Vereker Creek	VIC
Nene Valley	SA
North East Islet	TAS
Parker River	VIC
Phillip Island Nature Park	VIC
Point Nepean	VIC
Port Campbell	VIC
Princetown W.R.	VIC
Queenscliff N.F.R.	VIC
Reef Island and Bass River Mouth N.C.R.	VIC
Rodondo Island	TAS
Rosebud B.R.	VIC
Seal Islands W.R.	VIC
Southern Wilsons Promontory	VIC
Stony Creek (Otways)	VIC
Swan Bay - Edwards Point W.R.	VIC
Unnamed (No.HA26)	SA
Ventnor B.R.	VIC
Vereker Creek	VIC
Warrengine Creek SS.R.	VIC
West Moncoeur Island	TAS

Name	State
Wilsons Promontory	VIC
Wilsons Promontory	VIC
Wilsons Promontory Islands	VIC
Wonthaggi Heathlands N.C.R	VIC

Regional Forest Agreements [\[Resource Information \]](#)

Note that all areas with completed RFAs have been included.

Name	State
Gippsland RFA	Victoria
Tasmania RFA	Tasmania
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 Resources Audit, 2001.

Name	Status	Type of Presence
Birds		
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
Callipepla californica California Quail [59451]		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
Gallus gallus Red Junglefowl, Feral Chicken, Domestic Fowl [917]		Species or species habitat likely to occur within area
Meleagris gallopavo Wild Turkey [64380]		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
Pavo cristatus Indian Peafowl, Peacock [919]		Species or species habitat likely to occur within area
Phasianus colchicus Common Pheasant [920]		Species or species habitat likely to occur

Name	Status	Type of Presence 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
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

Name	Status	Type of Presence
Anredera cordifolia		habitat likely to occur within area
Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		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
Austrocylindropuntia spp. Prickly Pears [85132]		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
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		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
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

Name	Status	Type of Presence 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
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		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
Anderson Inlet	VIC
Lake Connewarre State Wildlife Reserve	VIC
Lake Flannigan	TAS
Lavinia Nature Reserve	TAS
Lower Aire River Wetlands	VIC
Mud Islands	VIC
Powlett River Mouth	VIC
Princetown Wetlands	VIC
Swan Bay & Swan Island	VIC
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
Upwelling East of Eden	South-east
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

-38.8428 143.5383,-38.7126 143.7366,-38.5023 144.002,-38.3574 144.2852,-38.1751 144.7888,-38.362 144.9108,-38.4825 144.9108,-38.293 145.2239,-38.4865 145.428,-38.6681 145.622,-38.674 145.827,-38.8843 145.9514,-39.1399 146.3834,-38.9745 146.2708,-38.9361 146.8688,-38.6257 147.4575,-38.0947 148.1286,-39.2583 147.1622,-39.5083 146.637,-39.3863 145.0864,-39.9321 144.3422,-39.6229 144.0166,-39.6679 143.0985,-40.1452 142.6635,-38.1752 139.2053,-36.7803 138.1301,-37.6875 140.1321,-37.9495 140.4363,-38.0705 140.6391,-38.0964 141.0461,-38.4018 141.5279,-38.395 142.1668,-38.4546 142.6148,-38.6539 143.0869,-38.8428 143.5383

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.

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A2: Operational Area – 2 km



EPBC Act Protected Matters Report

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

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: 07/12/20 13:00:24

[Summary](#)

[Details](#)

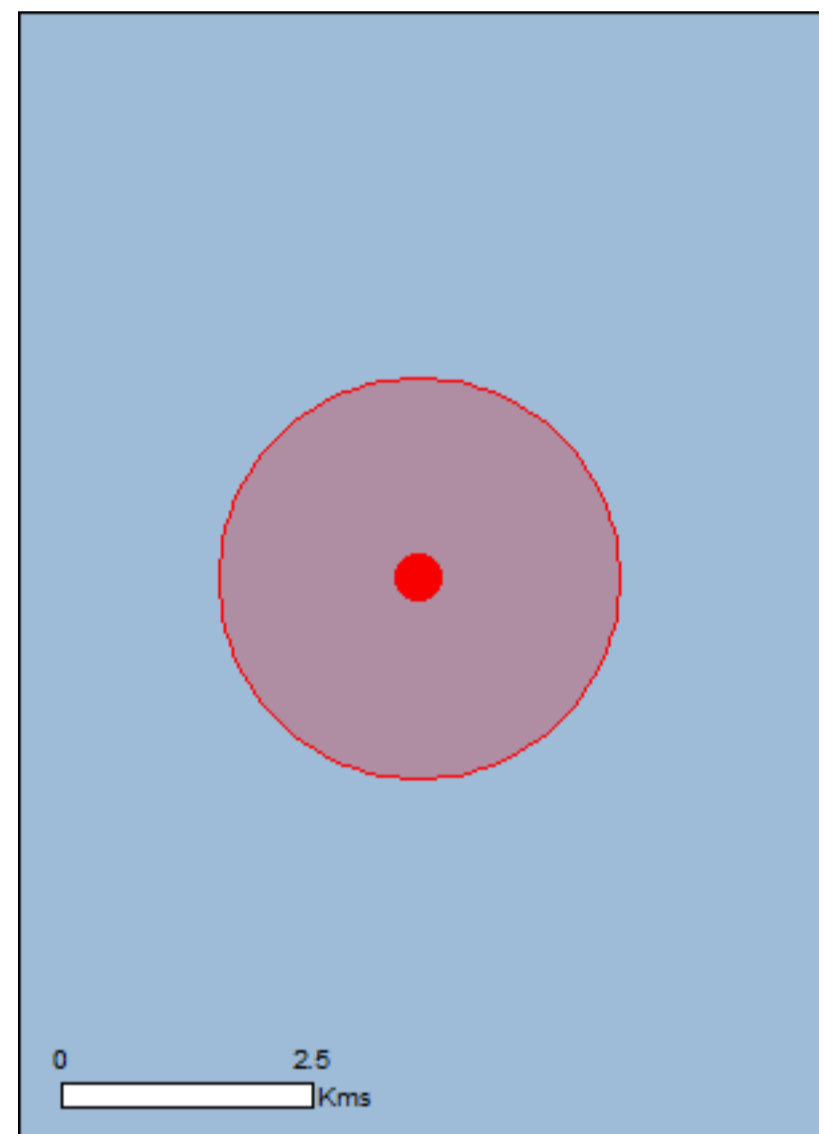
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

Buffer: 2.0Km



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
Phoebastria 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	Species or species habitat may 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
Phoebastria 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	Species or species habitat may 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
Phoebastria 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	Species or species habitat may 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
Hypsognathus 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 Dolphin, 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

-38.88469 142.86928

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.

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A3: Light and Noise Behaviour EMBA – 20 km



EPBC Act Protected Matters Report

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

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: 07/12/20 13:00:57

[Summary](#)

[Details](#)

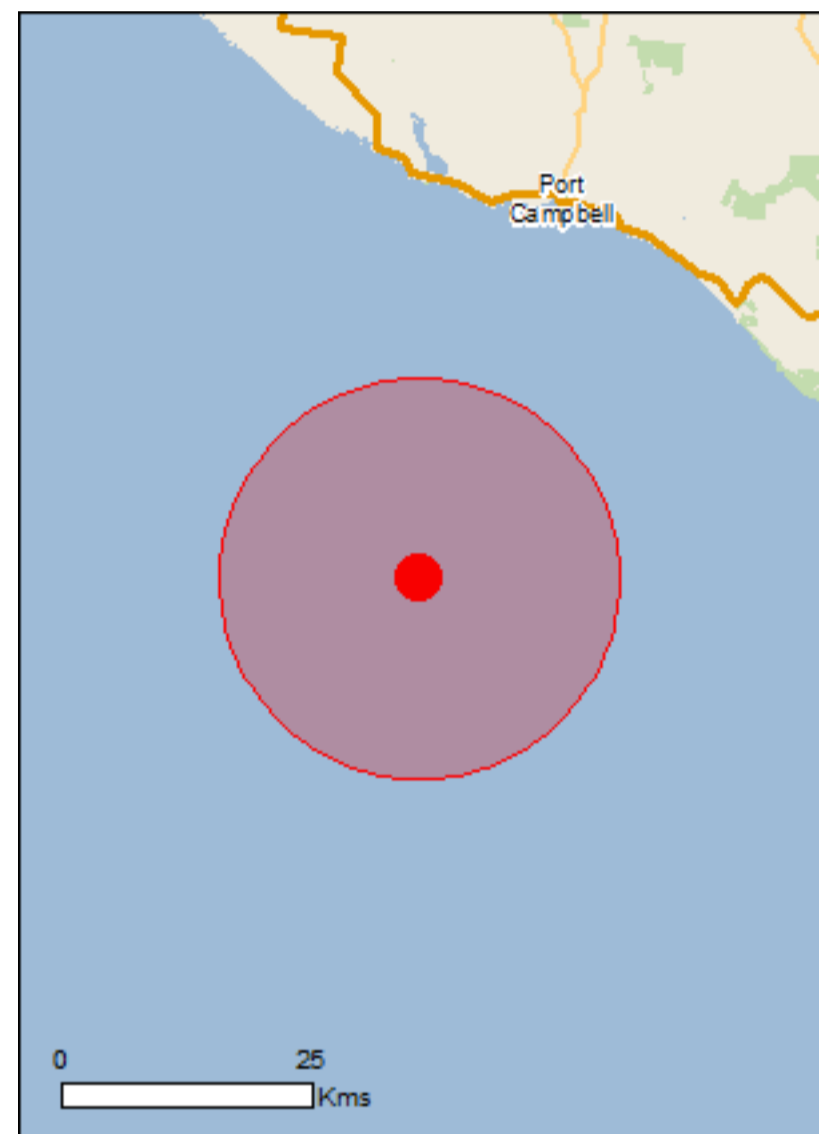
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

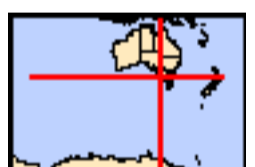
[Acknowledgements](#)



This map may contain data which are
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[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:	35
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:	62
Whales and Other Cetaceans:	14
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
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
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
Thinornis cucullatus cucullatus Hooded Plover (eastern), Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat may occur within area
Fish		
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	to occur within area 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 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		
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 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

Name	Threatened	Type of Presence
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
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

Name	Threatened	Type of Presence
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
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
Pandion haliaetus Osprey [952]		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
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
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
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
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Phoebastria 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

Name	Threatened	Type of Presence
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	habitat may occur within area 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 rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat may 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
Hypsognathus 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		Species or species

Name	Threatened	Type of Presence
[66249]		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
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

Name	Threatened	Type of Presence
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		habitat may occur within area 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 to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	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 aduncus Indian Ocean Bottlenose Dolphin, Spotted		Species or species

Name	Status	Type of Presence
Bottlenose Dolphin [68418]		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

-38.88469 142.86928

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.

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EPBC Act Protected Matters Report

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

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: 07/12/20 13:01:24

[Summary](#)

[Details](#)

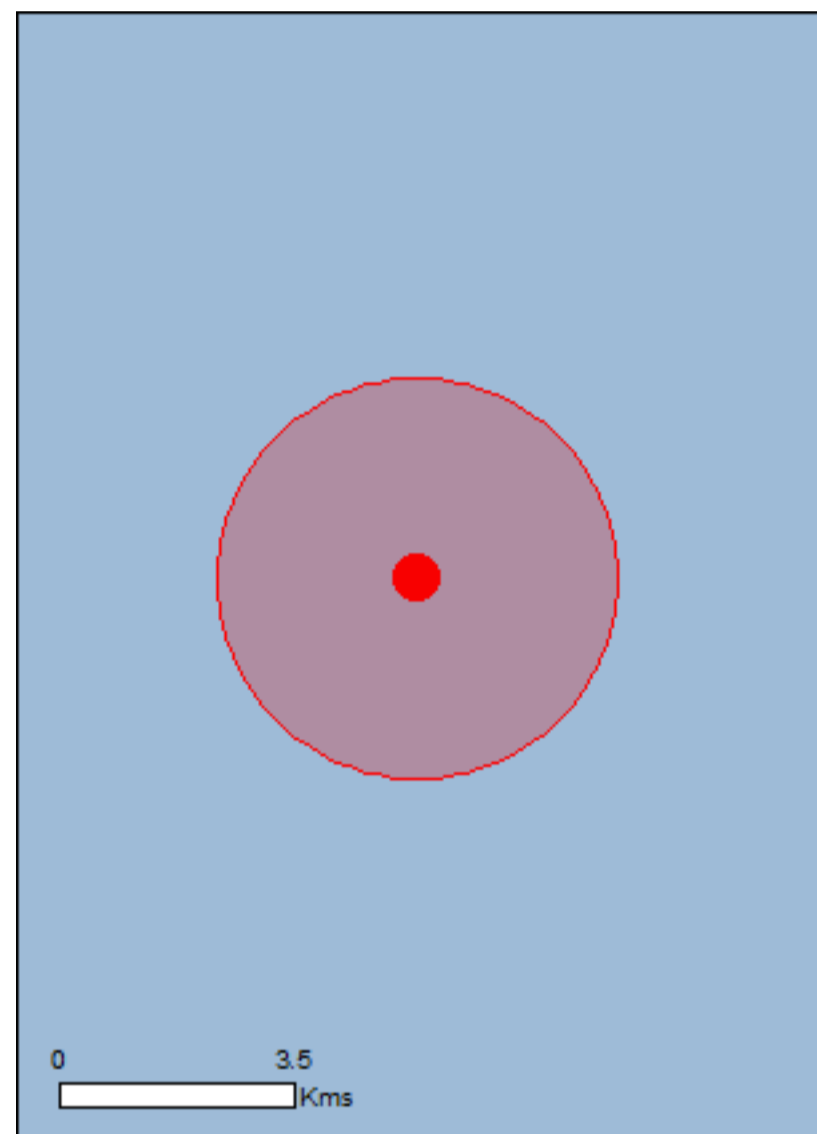
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

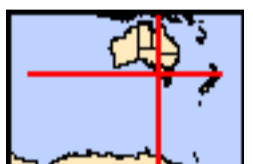
[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

Buffer: 3.0Km



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:	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:	59
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
Phoebastria 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	Species or species habitat may 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
Phoebastria 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	Species or species habitat may 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
Pandion haliaetus Osprey [952]		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
Pandion haliaetus Osprey [952]		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	Species or species habitat may 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 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
Delphinus delphis Common Dolphin, 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

-38.88469 142.86928

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.

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A5: Waste Water EMBA – 2.5 km



EPBC Act Protected Matters Report

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

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: 07/12/20 13:03:10

[Summary](#)

[Details](#)

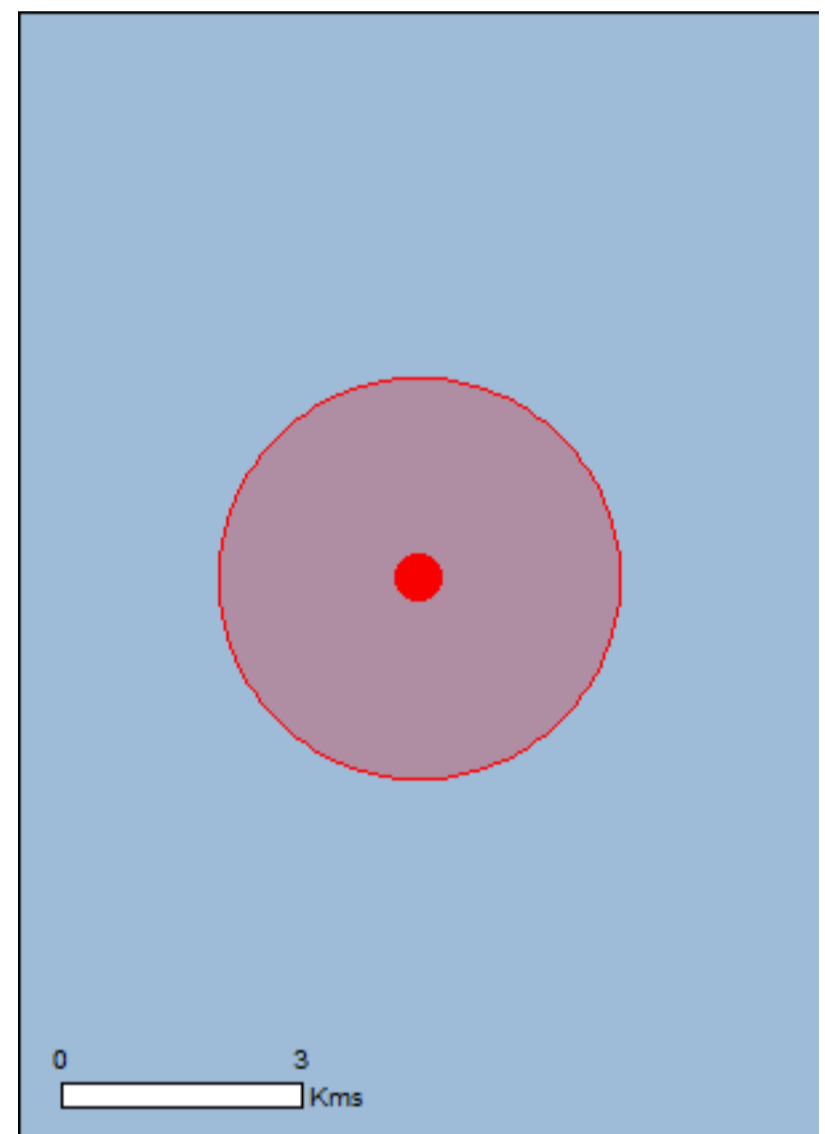
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

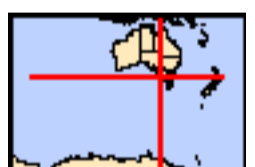
[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

Buffer: 2.5Km



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:	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:	59
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	Species or species habitat may 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
Phoebastria 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	Species or species habitat may 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
Pandion haliaetus Osprey [952]		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
Pandion haliaetus Osprey [952]		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	Species or species habitat may 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 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
Delphinus delphis Common Dolphin, 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

-38.88469 142.86928

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](#)
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- [-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](#)
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- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
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- [-Australian National Herbarium, Canberra](#)
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- [-CSIRO](#)
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- [-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.

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Appendix B: RPS APASA Artisan-1 Spill Model Report

13 JUNE 2019

Beach Energy Artisan-1 Exploration Well

Oil Spill Modelling

Document status

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Contents

TERMS AND ABBREVIATIONS	VIII
EXECUTIVE SUMMARY	XI
Background	xi
Methodology	xi
Oil Properties	xi
Key Findings	xii
1 INTRODUCTION	1
2 SCOPE OF WORK	1
3 REGIONAL CURRENTS	1
3.1 Tidal Currents	3
3.1.1 Grid Setup	3
3.1.2 Tidal Conditions	5
3.1.3 Surface Elevation Validation	5
3.2 Ocean Currents	9
3.3 Surface Currents at the release site	9
4 WIND DATA	13
5 WATER TEMPERATURE AND SALINITY	17
6 NEAR-FIELD MODEL – OILMAP-DEEP	19
7 OIL SPILL MODEL – SIMAP	21
7.1 Stochastic Modelling	21
7.2 Sea surface, Shoreline and In-Water Exposure Thresholds	22
7.2.1 Sea Surface Exposure Thresholds	23
7.2.2 Shoreline Exposure Thresholds	24
7.2.3 Dissolved and Entrained Hydrocarbon Thresholds	25
7.3 Oil Properties	26
7.3.1 Marine Diesel Oil	26
7.3.2 Thylacine Condensate	27
7.4 Model Settings	30
8 PRESENTATION AND INTERPRETATION OF MODEL RESULTS	31
8.1 Seasonal Analysis	31
8.2 Receptors Assessed	32
9 RESULTS: 300 M³ SURFACE RELEASE OF MARINE DIESEL OIL	41
9.1 Stochastic Analysis	41
9.1.1 Sea Surface Exposure	41
9.1.2 Water Column Exposure	42

10	RESULTS: 222,224 BBL SUBSEA RELEASE OF CONDENSATE	52
10.1	Stochastic Analysis	52
10.1.1	Sea Surface Exposure and Shoreline Contact	52
10.1.2	Water Column Exposure	56
11	REFERENCES	72

Tables

Table 1	Location of the Artisan-1 well location used for the oil spill modelling study.	1
Table 2	Statistical comparison between the observed and predicted surface elevations.	6
Table 3	Predicted monthly average and maximum surface current speeds adjacent to the release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2008-2012 (inclusive).	10
Table 4	Predicted monthly average and maximum winds for the wind node adjacent to the release location. Data derived from CFSR hindcast model from 2008-2012 (inclusive).	14
Table 5	Monthly average sea surface temperature and salinity in the 0–5 m depth layer near the Artisan-1 well location.	17
Table 6	Input characteristics and key results from the subsea modelling.	19
Table 7	Exposure and contact threshold values used for the Artisan-1 oil spill modelling study.	22
Table 8	Bonn Agreement Oil Appearance Code.	23
Table 9	Physical properties of MDO and Thylacine condensate.	27
Table 10	Boiling point ranges of MDO and Thylacine condensate.	27
Table 11	Summary of the oil spill model settings.	30
Table 12	Summary of receptors used to assess surface, shoreline and in-water exposure to hydrocarbons.	32
Table 13	Maximum distance and direction travelled on the sea surface by a single spill trajectory from the release location to the specified oil exposure thresholds.	41
Table 14	Summary of the potential sea surface exposure to individual receptors.	42
Table 15	Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer conditions.	43
Table 16	Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during winter conditions.	44
Table 17	Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during summer conditions.	46
Table 18	Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during winter conditions.	49
Table 19	Maximum distance and direction travelled on the sea surface by a single spill trajectory from the release location to the specified oil exposure thresholds.	53
Table 20	Summary of the potential sea surface exposure to individual receptors.	53
Table 21	Summary of potential oil contact to any shoreline for each season assessed.	54
Table 23	Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer conditions.	57
Table 24	Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during winter conditions.	60
Table 25	Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during summer conditions.	64
Table 26	Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during winter conditions.	68

Figures

Figure 1	Locality map of the Artisan-1 exploration well.....	1
Figure 2	HYCOM averaged seasonal surface drift currents during summer and winter.	2
Figure 3	Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.	4
Figure 4	Bathymetry defined throughout the tidal model domain.	4
Figure 5	Tide stations used to calibrate surface elevation within the model.	6
Figure 6	Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).....	7
Figure 7	Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).	8
Figure 8	Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and sholas.....	8
Figure 9	Monthly surface current rose plots near the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive).....	11
Figure 10	Seasonal surface current rose plots near the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive).....	12
Figure 11	Image showing the CFSR modelled wind nodes.	13
Figure 12	Monthly wind rose distributions derived from the CFSR hindcast model from 2008–2012 (inclusive), for the nearest wind node to the release location.....	15
Figure 13	Seasonal wind rose distributions derived from the CFSR hindcast model from 2008–2012 (inclusive), for the nearest wind node to the release location.....	16
Figure 14	Monthly water temperature and salinity profiles near the release location.	18
Figure 15	Example of a blowout plume illustrating the various stages of the plume in the water column (Source: Applied Science Associates, 2011).	20
Figure 16	Depleting release rate used for the LOWC scenario	20
Figure 17	Predicted movement of four single oil spill simulations predicted by SIMAP for the same scenario (left image). All model runs are overlain (shown as the stacked runs on the right) and the number of times that trajectories contact a given location at a concentration is used to calculate the probability.....	22
Figure 18	Photograph showing the difference between oil appearance on the sea surface (source: OilSpillSolutions.org, 2015).....	24
Figure 19	Weathering of a 300 m ³ surface release of MDO over 6 hours (tracked for 30 days) under three static winds conditions (5, 10 and 15 knots).	28
Figure 20	Receptor map for Marine National Parks.....	33
Figure 21	Receptor map for Australian Marine Parks.....	34
Figure 22	Receptor map for Marine Parks.....	34
Figure 23	Receptor map illustrating the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) receptors.	35
Figure 24	Map illustrating the Interim Biogeographic Regionalisation of Australia (IBRA) receptors.....	35
Figure 25	Receptor map of Key Ecological Features (KEF).....	36
Figure 26	Receptor map of Reefs, Shoals and Banks (RSB).....	36
Figure 27	Receptor map of RAMSAR sites.....	37
Figure 28	Receptor map of Local Government Areas (LGA) (1/3).....	37
Figure 29	Receptor map of Local Government Areas (LGA) (2/3).....	38
Figure 30	Receptor map of Local Government Areas (LGA) (3/3).....	38
Figure 31	Receptor map of Sub-Local Government Areas (Sub-LGA) (1/3).....	39

Figure 32	Receptor map of Sub-Local Government Areas (Sub-LGA) (2/3)	39
Figure 33	Receptor map of Sub-Local Government Areas (Sub-LGA) (3/3)	40
Figure 34	Receptor map of state waters.	40

Terms and Abbreviations

°	Degrees
'	Minutes
"	Seconds
Actionable oil	Oil which is thick enough for effective use of mitigation strategies, such as mechanical clean up (e.g. skimmers), booms, dispersed, or burned
AMP	Australian marine parks
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
API	American Petroleum Institute gravity (A measure of how heavy or light a petroleum liquid in comparison to water)
ASTM	American Society for Testing and Materials
Bonn Agreement Oil Appearance Code	An agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983, includes: Governments of the Kingdom of Belgium, the Kingdom of Denmark, the French Republic, the Federal Republic of Germany, the Republic of Ireland, the Kingdom of the Netherlands, the Kingdom of Norway, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland and the European Union
°C	Degree Celsius (unit of temperature)
cP	Centipoise (unit of viscosity)
CFSR	Climate Forecast System Reanalysis
cm	Centimetre (unit of length)
Decay	The process where oil components are changed either chemically or biologically (biodegradation) to another compound. It includes breakdown to simpler organic carbon compounds by bacteria and other organisms, photo-oxidation by solar energy, and other chemical reactions
Dissolved hydrocarbons	Dissolved hydrocarbons within the water column with alternating double and single bonds between carbon atoms forming rings, containing at least one six-membered benzene ring
g/m ²	Grams per square meter (unit of surface or area density)
EIA	Environmental impact assessment
Entrained oil	Droplets or globules of oil that are physically mixed (but not dissolved) into the water column. Physical entrainment can occur either during pressurised release from a subsurface location, or through the action of breaking waves (>12 knots)
EP	Environmental plan
EEZ	Exclusive Economic Zone
Evaporation	The process whereby components of the oil mixture are transferred from the sea-surface to the atmosphere
GODAE	Global Ocean Data Assimilation Experiment
HYCOM	Hybrid Coordinate Ocean Model is a data-assimilative, three-dimensional ocean model
HYDROMAP	Advanced ocean/coastal tidal model used to predict tidal water levels, current speed and current direction
IOA	Index of Agreement gives a non-dimensional measure of model accuracy or performance
IBRA	Interim Biogeographic Regionalisation for Australia

IMCRA	Integrated Marine and Coastal Regionalisation of Australia
Isopycnal layers	Water column layers with corresponding water densities
ITOPF	The International Tanker Owners Pollution Federation
KEF	Key Ecological Feature
km	Kilometre (unit of length)
km ²	Square Kilometres (unit of area)
KEF	Key ecological feature
Knot	unit of wind speed (1 knot = 0.514 m/s)
LGA	Local Government Area
LOWC	Loss of Well Control
m	Metres (unit of length)
m ²	Metres squared (unit of area)
m ³	Metres cubed (unit of volume)
m/s	Metres per Second (unit of speed)
MAE	Mean Absolute Error is the average of the absolute values of the difference between model predicted and observed data (e.g. surface elevations)
MB	Marine boundary
MNP	Marine National Park
RSB	Reefs, Shoals and Banks
MS	Marine Sanctuary
NASA	National Aeronautics and Space Administration
NCEP	National Centres for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
nm	nautical mile (unit of distance; 1 nm = 1.852 km)
NP	National Parks
Ocean current	Large scale and continuous movement of seawater generated by forces such as breaking waves, wind, the Coriolis effect, and temperature and salinity gradients. It is the main flow of ocean waters
OECD	Organisation for Economic Co-operation and Development
ppb	Parts per billion (concentration)
ppb.hrs	ppb multiplied for hours (concentration x time)
PSU	Practical salinity units
Ramsar site	A wetland site designated of international importance under the Ramsar Convention
Ramsar Convention	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
Sea surface exposure	Floating oil on the sea surface equal to or above reporting threshold (e.g. 0.5 g/m ²)
Shoreline contact	Stranded oil on the shoreline equal to or above reporting threshold (e.g. 10 g/m ²)

SIMAP	Spill Impact Mapping Analysis Program
US EPA	United States Environmental Protection Agency
Visible oil	Floating oil on the sea surface equal to or above reporting threshold (e.g. 0.5 g/m ²)

EXECUTIVE SUMMARY

Background

Beach Energy is intending to undertake further development of the Otway offshore natural gas reserves. The proposed development will include the drilling of offshore exploration wells situated in the Otway Basin, starting with the Artisan-1 gas well. In order to support the development of environmental approvals for the drilling program, a comprehensive oil spill modelling study was commissioned which considered the following two hypothetical spill scenarios:

- 300 m³ surface release of marine diesel over 6 hours in the event of a containment loss from a vessel at the Artisan-1 well location; and
- 222,224 bbl subsea release of condensate over 86 days to represent an unrestricted open-hole loss of well control (LOWC) event from the Artisan-1.

SIMAP's (Spill Impact Mapping Analysis Program) stochastic model was used to quantify the probability of exposure from a spill to the sea (surface and in-water), and the probability of shoreline contact from hypothetical spill scenarios. The SIMAP system and the methods and analysis presented herein, use modelling algorithms which have been peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 "*Standard Practice for Development and Use of Oil Spill Models*".

Methodology

The modelling study was carried out in several stages. Firstly, a five-year current dataset (2008–2012) that includes the combined influence of three-dimensional ocean and tidal currents was developed. Secondly, the currents, spatial winds and then detailed hydrocarbon properties were used as inputs in the oil spill model to simulate the drift, spread, weathering, entrainment and fate of the spilled hydrocarbons.

As spills can occur during any set of wind and current conditions, a total of 100 spill trajectories per hypothetical spill scenario per season (e.g. summer and winter) were initiated at random times within a 5-year period (2008–2012) to enable a robust statistical analysis.

Each simulation was configured with the same spill information (i.e. spill volume, duration and oil type) except for the start time and date which in turns, ensures that the predicted transport and weathering of an oil slick is subject to a wide range of current and wind conditions.

Oil Properties

The marine diesel oil (MDO) used for Scenario 1, is a light-persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m³ (API of 37.6), a low pour point (-14°C) and low viscosity (4cP). According to the International Tankers Owners Pollution Federation (ITOPF, 2014) and AMSA (2015a) guidelines, this oil is categorised as a group II oil (light-persistent).

Thylacine condensate was used for the loss of well control scenario (Scenario 2). The condensate has an API of 44.3, density of 804.6 kg/m³ at 15°C) with low viscosity (0.875 cP), classifying it as a Group I oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and USEPA/USCG classifications. The condensate comprises a significant portion of volatiles and semi to low volatiles (99% total) with very little residual components (<1%).

Key Findings

Scenario: 300 m³ surface release of marine diesel oil

Sea surface exposure

- No shoreline contact above the minimum threshold (>10 g/m²) was predicted for any of the seasons modelled.
- During summer conditions, low (0.5 g/m²) and moderate (10 g/m²) exposure to surface hydrocarbons were predicted to travel a maximum distance of 68 km and 12 km from the release location, respectively. During winter, low and moderate exposure of surface hydrocarbons extended to a maximum distance of 93 km and 10 km from the release location, respectively.
- The modelling results demonstrated a 1% probability of oil exposure on the sea surface for the Central Victoria Integrated Marine and Coastal Regionalisation of Australia (IMCRA) receptor, during the summer season.
- During winter conditions, there was a 1% probability of oil exposure on the sea surface for several receptors including the Central Victoria and Central Bass Strait IMCRA, Apollo Australian Marine Park (AMP) and within Victorian State Waters.
- None of the receptors were exposed at or above the moderate or high (>25 g/m²) thresholds with the exception of the Otway IMCRA. This receptor registered low, moderate and high exposure to sea surface hydrocarbons due to the release location being situated within the boundaries of this receptor.

Dissolved hydrocarbon exposure

- There was no dissolved hydrocarbon exposure (over the 48-hour window) in the 0-10 m depth layer to receptors at or above the low threshold (6 ppb), with the exception of the Otway IMCRA which registered 8 ppb and 9 ppb during summer and winter conditions, respectively. None of the receptors recorded exposure (over 48 hours) at or above the moderate (50 ppb) or high (400 ppb) thresholds.
- At the depths of 0-10 m, the dissolved hydrocarbon exposure over 1 hour was predicted for the Otway IMCRA, with the maximum concentration of 76 ppb during summer and 59 ppb during winter. No moderate or high dissolved hydrocarbons exposure (over 1 hour) was predicted for any receptors, except for the Otway IMCRA.

Entrained hydrocarbon exposure

- At the depths of 0-10 m, the maximum entrained hydrocarbon exposure (over a 48-hour window) during summer and winter conditions was 2,182 ppb and 792 ppb, respectively. None of the receptors were exposed at or above the moderate (10-100 ppb) or high (>1,000 ppb) thresholds, excluding the Otway IMCRA.
- Within the 0-10 m depth layer, the maximum entrained hydrocarbon exposure (over 1 hour) for the Otway IMCRA was 5,933 ppb and 5,046 ppb, during summer and winter conditions, respectively. For receptors other than the Otway IMCRA (83% summer and 93% winter), the probability of exposure to entrained hydrocarbons at or above the moderate threshold (100-1,000 ppb) ranged from 1% (Cape Patton sub-Local Government Area (sub-LGA)) to 8% (within Victorian State Waters) during summer conditions and 1% (Twelve Apostles Marine National Park (MNP)) to 16% (Apollo AMP) during winter conditions. No other receptors were exposed at or above the high threshold (>1,000 ppb), except for the Otway IMCRA.

Scenario: 222,224 bbl subsea release of condensate over 86 days

Sea surface exposure

- During summer conditions, low (0.5 -10 g/m²) and moderate (10 - 25 g/m²) exposure to surface hydrocarbons were predicted to travel a maximum distance of 52 km and 4 km from the release location, respectively. Under winter conditions, low and moderate exposure from surface hydrocarbons extended to a maximum distance of 53 km and 3 km from the release location, respectively. Note, no high exposure was predicted on the sea surface for any of the seasons assessed.
- During summer conditions, the probability of hydrocarbon exposure on the sea surface at or above the low threshold was predicted to range from 6% (Otway Ranges Interim Biogeographic Regionalisation for Australia (IBRA) sub-region) to 16% (Colac Otway and Cape Otway West sub-LGAs and within Victorian State Waters). The exception is the Otway IMCRA (100% during both seasons). The winter modelling results demonstrated a larger number of receptors exposed to surface hydrocarbons at or above the low threshold. The probability ranged from 3% (Twelve Apostles MNP and Otway Ranges IBRA) to 40% (Otway Plain IBRA; Cape Otway West sub-LGA and Colac Otway LGA). No other receptors except the Otway IMCRA were exposed to moderate or high levels for any seasons assessed.

Shoreline contact

- The probability of contact to any shoreline was 16% and 57% for the summer and winter season, respectively. While the minimum time for visible surface hydrocarbons to reach a shoreline was 3 days for 5 days, respectively.
- The maximum volume of hydrocarbons predicted to come ashore was 15 m³ and 33 m³, during summer and winter conditions, respectively, while the maximum length of shoreline contacted above the low threshold (10 – 100 g/m²) was 7.0 km and 11.0 km, respectively. Note, no shoreline loading was predicted for the high threshold (above 1,000 g/m²).
- Cape Otway West LGA was the receptor predicted with the greatest probability of contact above the low and moderate thresholds during summer (16% and 15%, respectively) and winter (40% for both thresholds) conditions. The modelling results during winter conditions demonstrated additional shoreline contact to Moyne, Corangamite, Moonlight head and Childers Cove.

In-water exposure

- At the depth of 0-10 m, the maximum concentration of dissolved hydrocarbons over the 48-hour window was 30 ppb in summer and 34 ppb in winter, and hence no moderate or high exposure was predicted during either season. For summer conditions, the probability of low exposure to dissolved hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF, Moyne LGA, Bay of Islands and Childers Cove sub-LGAs) to 17% (Otway Plain IBRA, Colac Otway LGA, Cape Otway West sub-LGA and within Victoria State Waters)The Otway IMCRA recorded a probability of 50% during summer. During winter conditions, the probability of low exposure to dissolved hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF, Bay of Islands and Lorne sub-LGA) to 16% (within Victoria State Waters). The Otway IMCRA registered a probability of 42% for winter. None of the receptors were exposed to moderate (50 – 400 ppb) or high (>400 ppb) dissolved hydrocarbons (over a 48-hour basis) during the summer or winter season.
- At the depths of 0-10 m, the maximum dissolved hydrocarbon concentrations predicted over the 1-hour period was 309 ppb during summer and 289 ppb for winter, which occurred within the Otway IMCRA and the Victoria State Waters. During summer conditions, the probability of moderate exposure to

dissolved hydrocarbons ranged from 1% (Glenelg Plain and Bridgewater IBRA's; Glenelg, Moyne and Surf Coast LGAs; Lorne, Bay of Islands, Childers Cove and Cape Nelson sub-LGAs) to 43% (Otway Plain IBRA, Colac Otway LGA, Cape Otway West sub-LGA and within Victorian State Waters). The probability for Otway IMCRA was 58%. Under winter conditions, the probability of moderate exposure (over 1 hour) to dissolved hydrocarbons ranged from 1% (Gippsland Plain IBRA; Flinders IMCRA; Point Addis and Wilsons Promontory MNP; Mornington Peninsula LGA; Lorne, Mornington Peninsula and Childers Cove sub-LGAs) to 57% for the Victorian State Waters. The probability of exposure to the Otway IMCRA was 68%. None of the receptors were exposed high concentrations during the summer or winter season.

- The maximum entrained hydrocarbon concentrations time-averaged over 48 hours for the summer and winter season was 559 ppb and 569 ppb, respectively. No moderate or high exposure was predicted for any of the receptors predicted for any of the seasons. During summer conditions, the probability of low exposure to entrained hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF; Moyne LGA; Bay of Islands and Childers Cove sub-LGAs) to 17% (Otway Plain IBRA; Colac Otway LGA; Cape Otway West sub-LGA and within Victorian State Waters), with the exception of IMCRA – Otway (50%). During winter conditions, the probability of low exposure to entrained hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF; Bay of Islands and Lorne sub-LGAs) to 16% (Victoria State Waters), with the exception of Otway IMCRA (42%).
- Within the 0-10 m depth layer, the maximum concentration of entrained hydrocarbons over 1 hour was 948 ppb during summer and 932 ppb during winter, occurring within the Otway IMCRA. During summer conditions, the probability of moderate entrained hydrocarbon exposure ranged from 7% (Cape Patton sub-LGA) to 73% (Victorian State Waters). The probability of exposure to the Otway IMCRA receptor was 100% during both seasons. For other receptors during winter conditions, the probability of moderate entrained hydrocarbon exposure ranged from 8% (along the shoreline of Childers Cove sub-LGA; Moyne and Warrnambool LGA) to 73% (within Victorian State Waters).

1 INTRODUCTION

Beach Energy¹ is seeking approval to undertake further development of the Otway offshore natural gas reserves. The proposed development will include the drilling of offshore exploration wells situated in the Otway Basin starting with the Artisan-1 gas exploration well. In order to obtain environmental approvals for the drilling program, Beach Energy commissioned RPS to undertake a comprehensive oil spill modelling based on the following two hypothetical spill scenarios:

- 300 m³ surface release of marine diesel over 6 hours in the event of a containment loss from a vessel at the Artisan-1 well location; and
- 222,224 bbl subsea release of condensate over 86 days to represent an unrestricted open-hole loss of well control (LOWC) event from the Artisan-1 well location.

Figure 1 and Table 1 present the location and coordinates of Artisan-1 which was used as the release location for the two scenarios.

The potential risk of exposure to the surrounding waters and contact to shorelines was assessed for summer (October to March) and winter (April to September) conditions. This approach assists with identifying the environmental values and sensitivities that would be at risk of exposure on a seasonal basis.

The purpose of the modelling is to further improve understanding of a conservative 'outer envelope' of the potential area that may be affected in the unlikely event of hydrocarbon release. The modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that would be implemented in response to the spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbon may influence.

The spill modelling was performed using an advanced three-dimensional trajectory and fates model; Spill Impact Mapping Analysis Program (SIMAP). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

The hydrocarbon spill model, the method and analysis applied herein uses modelling algorithms which have been peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the American Society for Testing and Materials (ASTM) Standard F2067-13 "*Standard Practice for Development and Use of Oil Spill Models*".

Table 1 Location of the Artisan-1 well location used for the oil spill modelling study.

Well location	Latitude	Longitude	Water Depth (m)
Artisan-1	38° 53' 29.4' S	142° 52' 55.7' E	60

¹ It should be noted that Beach Energy is the 100% owner of Lattice Energy. Lattice Energy are the permit titleholder.

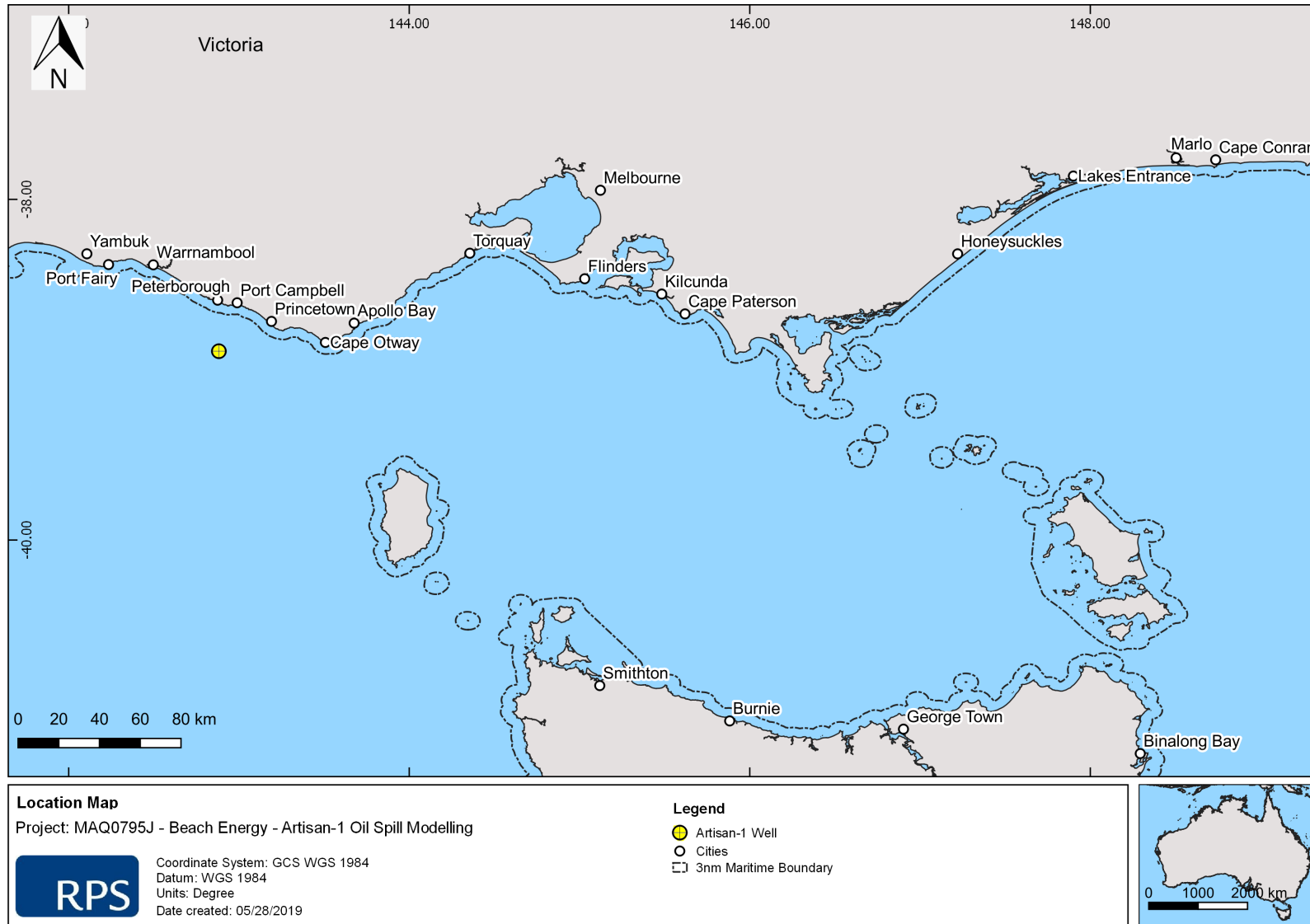


Figure 1 Locality map of the Artisan-1 exploration well.

2 SCOPE OF WORK

The scope of work included the following components:

1. Generate tidal current patterns of the region using the ocean/coastal model, HYDROMAP;
2. Use HYCOM (Hybrid Coordinate Ocean Model) ocean currents combined with HYDROMAP tidal currents over a 5-year period (2008 to 2012) to account for large scale flows offshore and tidal flows nearshore;
3. Use 5 years of high-resolution wind, aggregated current data and oil characteristics as input into the 3-dimensional oil spill model SIMAP to represent the movement, spreading, entrainment, weathering of the oil over time; and
4. Use SIMAP's stochastic model (also known as a probability model) to calculate exposure to surrounding waters (sea surface and water column) and shorelines; and
5. Undertake a high-level deterministic analysis of the "worst case" LOWC scenario.

3 REGIONAL CURRENTS

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area of the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the strait are primarily driven by tides, winds, incident continental shelf waves and density driven flows; high winds and strong tidal currents are frequent within the area (Jones, 1980).

The Otway Basin is part of the western field of the Bass Strait and lies along a north-west to south-east axis. It is approximately 500 km long and extends from Cape Jaffa in South Australia to north-west Tasmania and forms part of the Australian Southern Rift System.

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 2 displays seasonal surface current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving through the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward in offshore waters.

To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with 2-dimensional tidal currents developed by RPS. The following sections provide a summary of the hybrid regional data set.

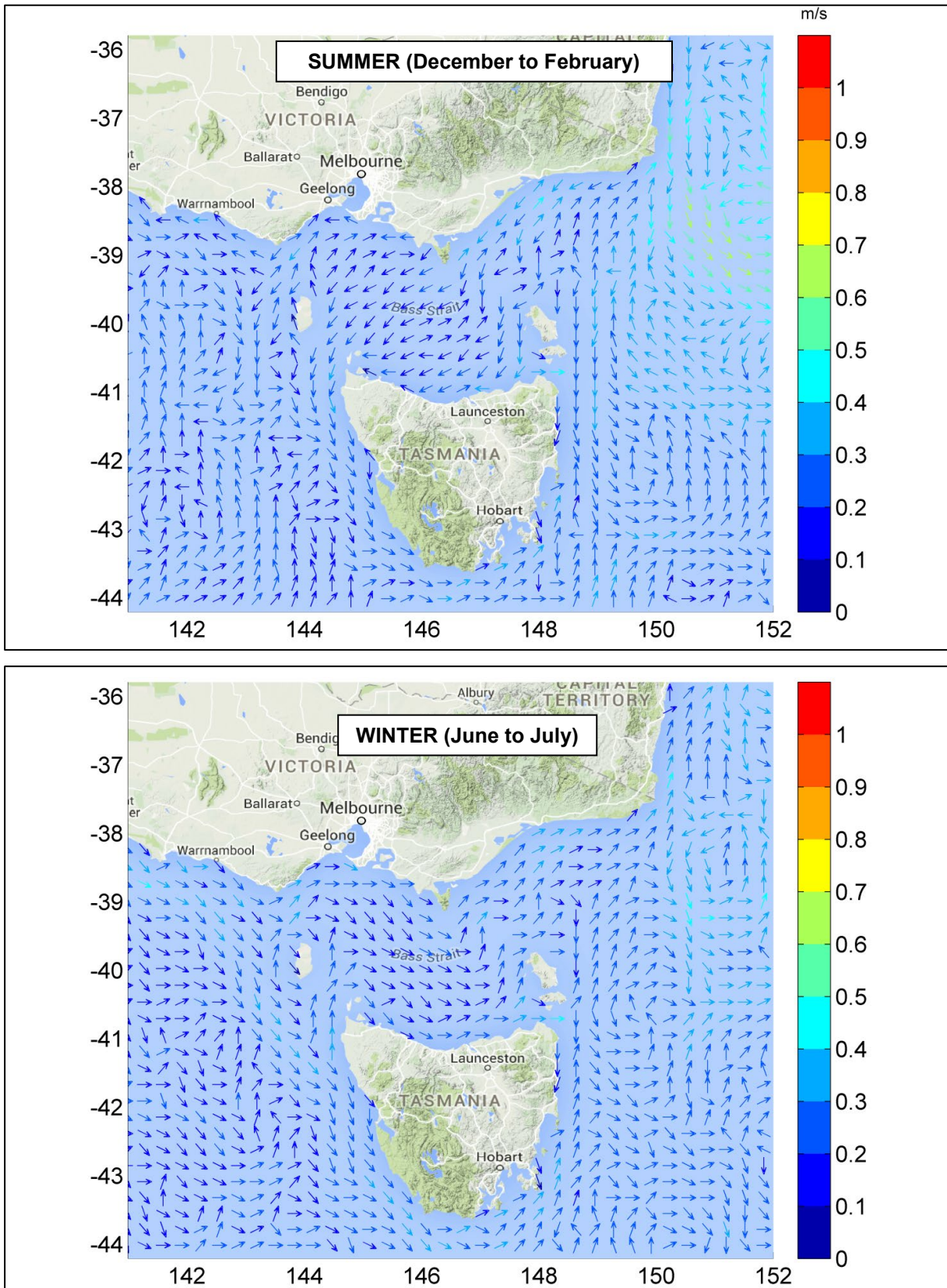


Figure 2 HYCOM averaged seasonal surface drift currents during summer and winter.

3.1 Tidal Currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world over the past 32 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

3.1.1 Grid Setup

The tidal model domain has been sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids were allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3 shows the tidal model grid covering the study domain.

A combination of datasets were used and merged to describe the shape of the seabed within the grid domain (Figure 4). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

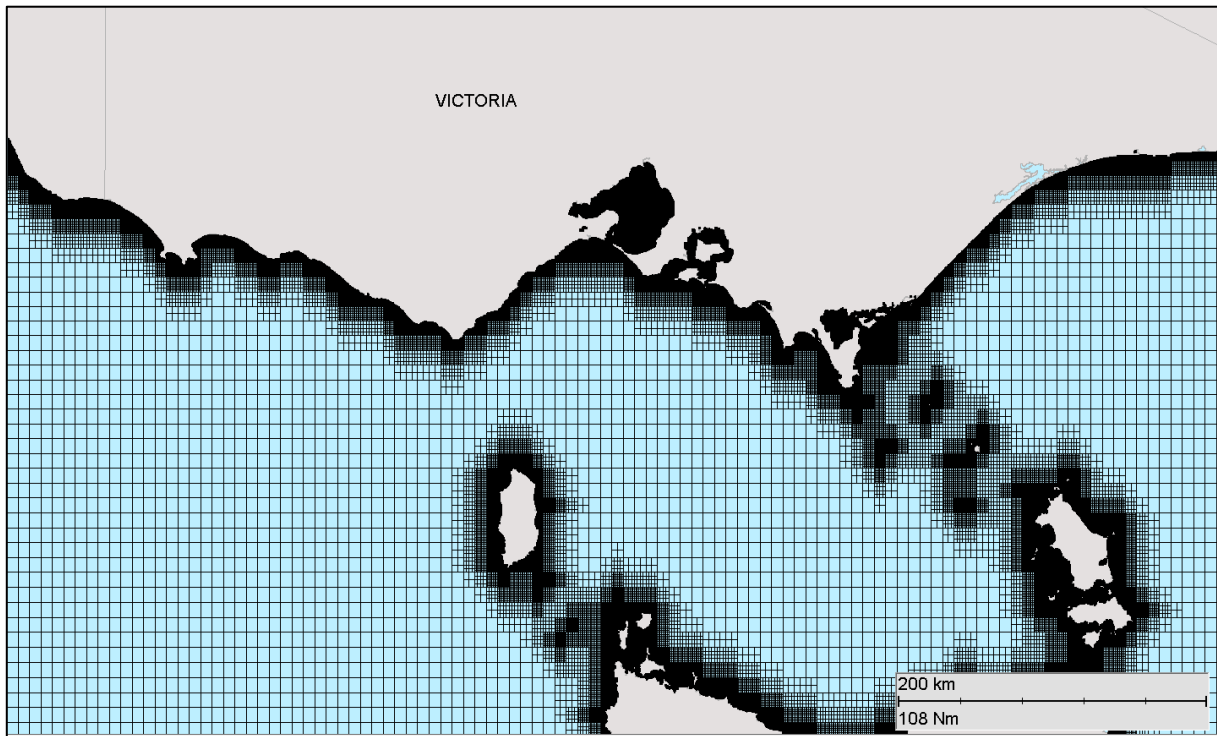


Figure 3 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

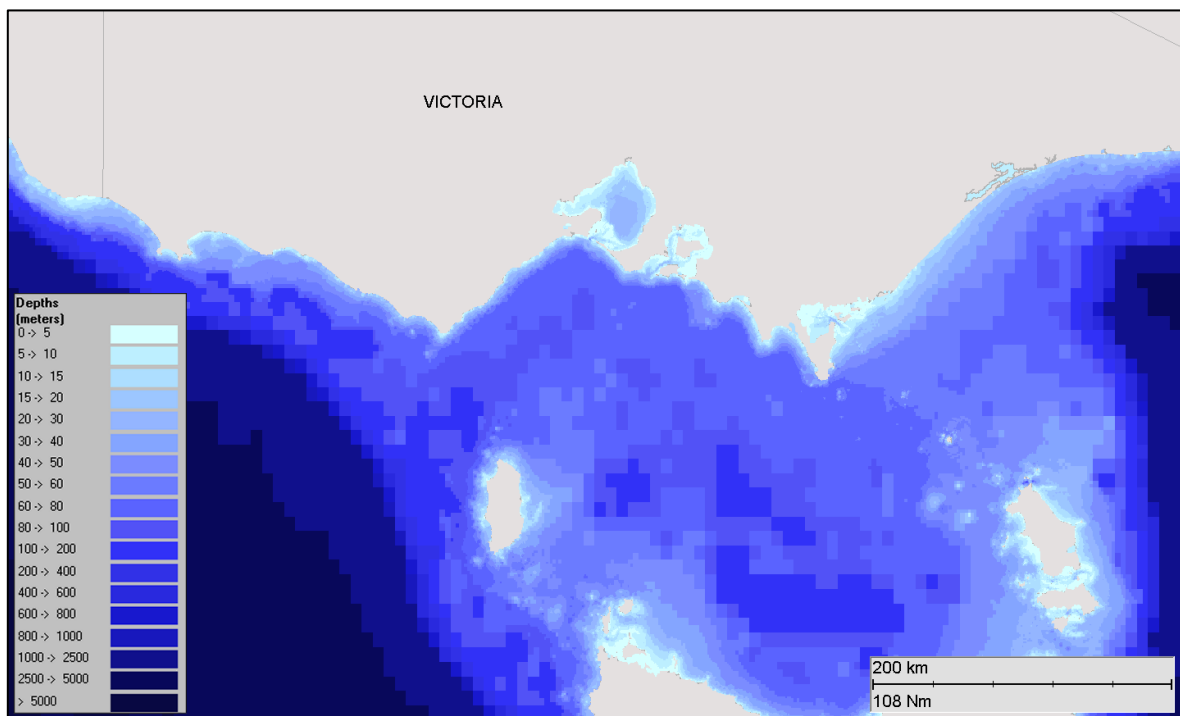


Figure 4 Bathymetry defined throughout the tidal model domain.

3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 7.2) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were K_2 , S_2 , M_2 , N_2 , K_1 , P_1 , O_1 and Q_1 . Using the tidal data, surface heights were firstly calculated along the open boundaries, at each time step in the model.

The TOPEX/Poseidon satellite data has a global resolution of 0.25 degrees and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The satellites equipped with two highly accurate altimeters and capable of taking sea level measurements with an accuracy of ± 5 cm measured oceanic surface elevations (and the resultant tides) for over 13 years (1992–2005). In total, these satellites carried out 62,000 orbits of the planet.

The TOPEX/Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk and Tangdong, 2004; Qiu and Chen 2010). As such the TOPEX/Poseidon tidal data is considered suitably accurate for this study.

3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at five locations (see Figure 5).

To provide a statistical measure of the model performance, the Index of Agreement (IOA - Willmott (1981)) and the Mean Absolute Error (MAE - Willmott (1982) and Willmott and Matsuura (2005)) were used.

The MAE (Eq.1) is simply the average of the absolute values of the difference between the model-predicted (P) and observed (O) variables. It is a more natural measure of the average error (Willmott and Matsuura, 2005) and more readily understood. The MAE is determined by:

$$MAE = N^{-1} \sum_{i=1}^N |P_i - O_i| \quad \text{Eq.1}$$

Where: N = Number of observations

P_i = Model predicted surface elevation

O_i = Observed surface elevation

The Index of Agreement (IOA; Eq. 2) in contrast, gives a non-dimensional measure of model accuracy or performance. A perfect agreement between the model predicted and observed surface elevations exists if the index gives an agreement value of 1, and complete disagreement between model and observed surface elevations will produce an index measure of 0 (Willmott, 1981). Willmott et al (1985) also suggests that values larger than 0.5 may represent good model performance. The IOA is determined by:

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \bar{X}_{obs}| + |X_{obs} - \bar{X}_{obs}|)^2} \quad \text{Eq.2}$$

Where: X_{model} = Model predicted surface elevation

X_{obs} = Observed surface elevation

Clearly, a greater IOA and lower MAE represent a better model performance.

Figure 6 and Figure 7 illustrate a comparison of the predicted and observed surface elevations for each location for January 2014. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles. Table 2 shows the statistical comparison between the observed and predicted surface elevations. For all of the stations, the IOA is well within the limits

highlighting a good model performance. Hence, the tidal model predictions are considered accurate for this study.

Table 2 Statistical comparison between the observed and predicted surface elevations.

Tide Station	IOA	MAE (m)
Gabo Island	0.98	0.08
Port MacDonnell	0.98	0.05
Port Welshpool	0.92	0.30
Portland	0.97	0.07
Gabo Island	0.96	0.22

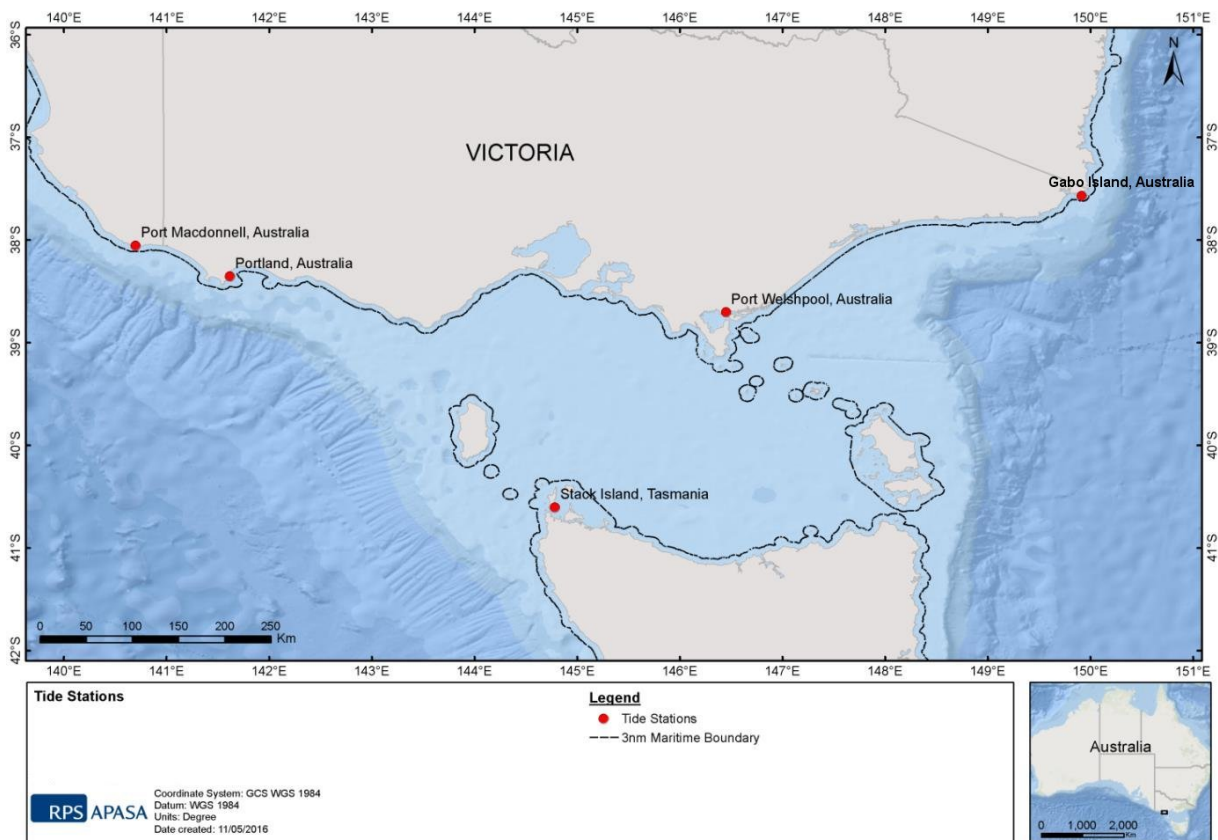


Figure 5 Tide stations used to calibrate surface elevation within the model.

Figure 8 is a snapshot of the predicted tidal current vectors.

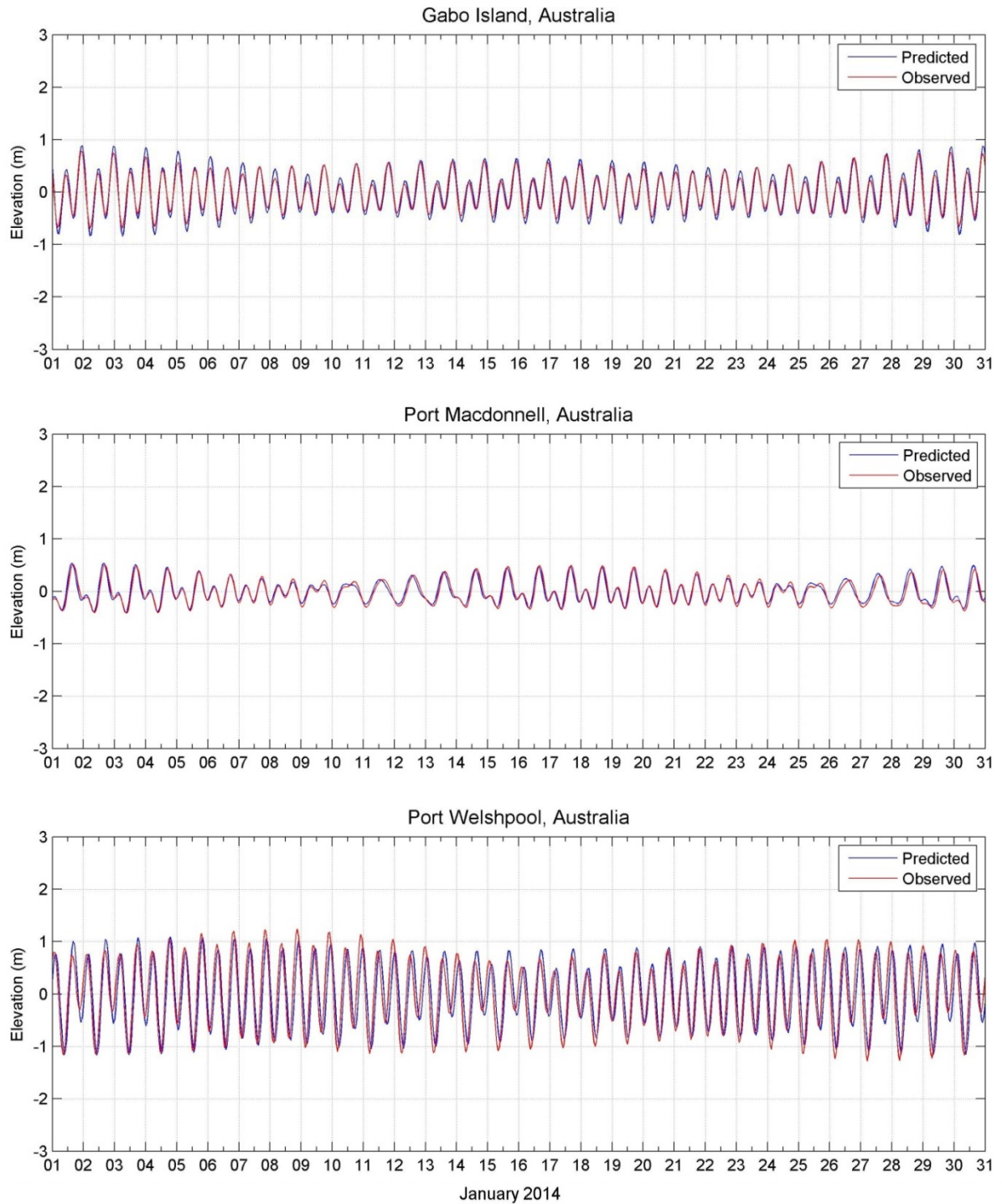


Figure 6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).

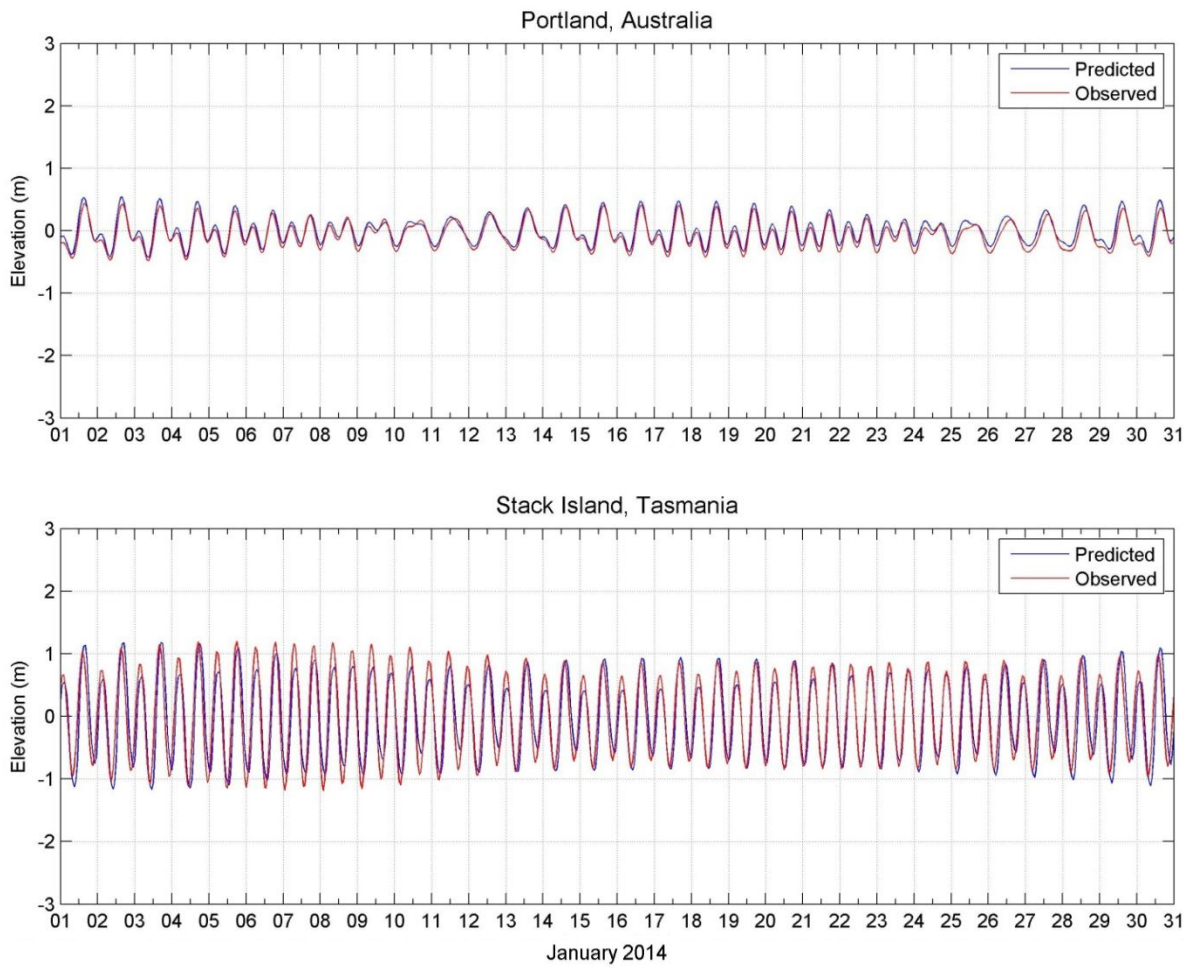


Figure 7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).

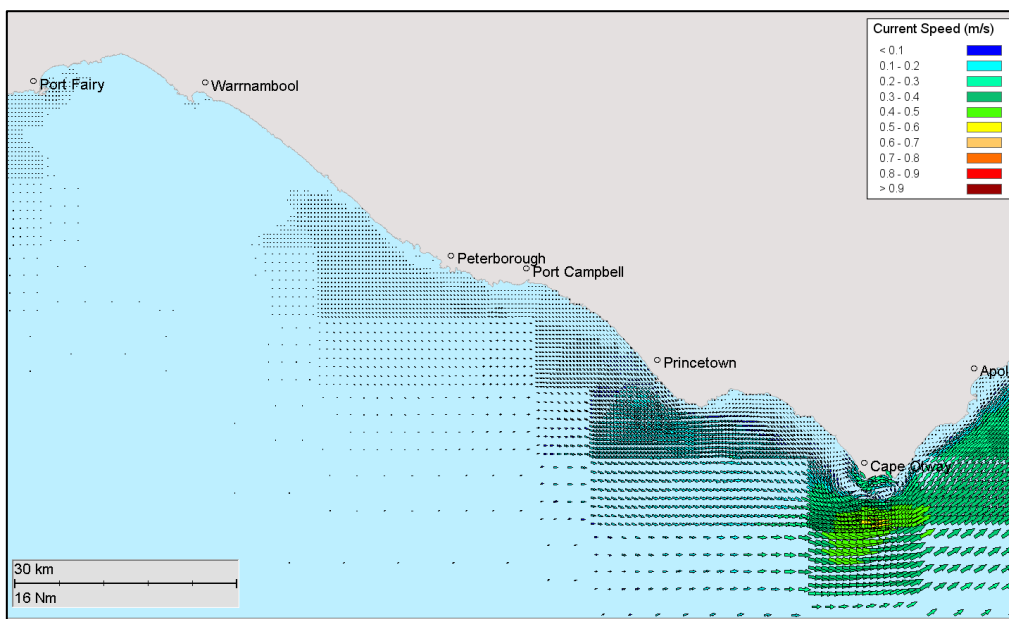


Figure 8 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and shoals.

3.2 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12th of a degree) over the region, at a frequency of once per day. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

For this study, the HYCOM reanalysis hindcast currents were obtained for the years 2008 to 2012 (inclusive). Five years of data has been found to be suitably sufficient to account for the inter-annual variations and conditions with Bass Strait.

3.3 Surface Currents at the release site

Table 3 displays the predicted average and maximum surface current speed near the release location. Figure 9 and Figure 10 illustrate the monthly and seasonal current rose distributions (2008-2012 inclusive) derived from combining HYCOM ocean current data and HYDROMAP tidal data, respectively.

Note the convention for defining current direction throughout this report is the direction the current flows towards. Each branch of the current rose distribution represents the currents flowing to that direction, with north to the top of the diagram. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.1 m/s are predominantly used in these current roses. The length of each coloured segment within a branch is proportional to the frequency of currents flowing within the corresponding speed and direction.

The combined current data (ocean plus tides) indicated that during April to December the currents predominately flowed east and west during January to March. Monthly average surface current speed was similar throughout the year (0.16 to 0.25 m/s), while the maximum surface current speed ranged between 0.60 m/s (November and January) and 1.22 m/s (July).

Table 3 Predicted monthly average and maximum surface current speeds adjacent to the release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2008-2012 (inclusive).

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
January	0.17	0.60	WNW and ENE
February	0.18	0.69	WNW
March	0.16	0.85	WNW and ENE
April	0.16	1.20	E
May	0.16	0.78	E
June	0.22	0.99	E
July	0.22	1.22	E
August	0.25	1.01	ESE
September	0.22	0.90	E
October	0.18	0.68	E
November	0.17	0.60	E
December	0.19	0.68	E
Minimum	0.16	0.60	
Maximum	0.25	1.22	

RPS Data Set Analysis Current Speed (m/s) and Direction Rose (All Records)

Longitude = 142.88°E, Latitude = 38.89°S
Analysis Period: 01-Jan-2008 to 31-Jan-2012

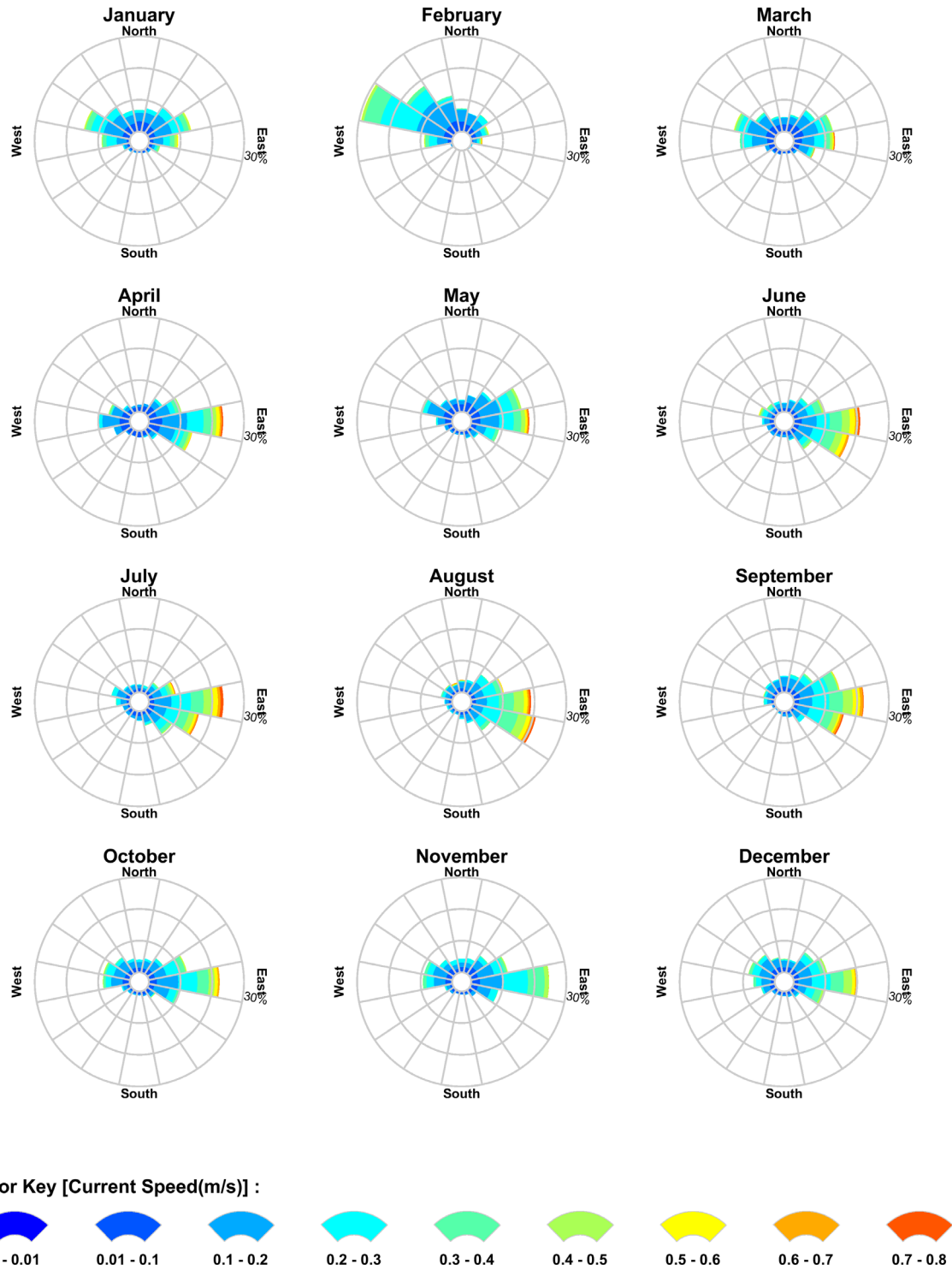


Figure 9 Monthly surface current rose plots near the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive).

RPS Data Set Analysis Current Speed (m/s) and Direction Rose (All Records)

Longitude = 142.88°E, Latitude = 38.89°S
Analysis Period: 01-Jan-2008 to 31-Jan-2012

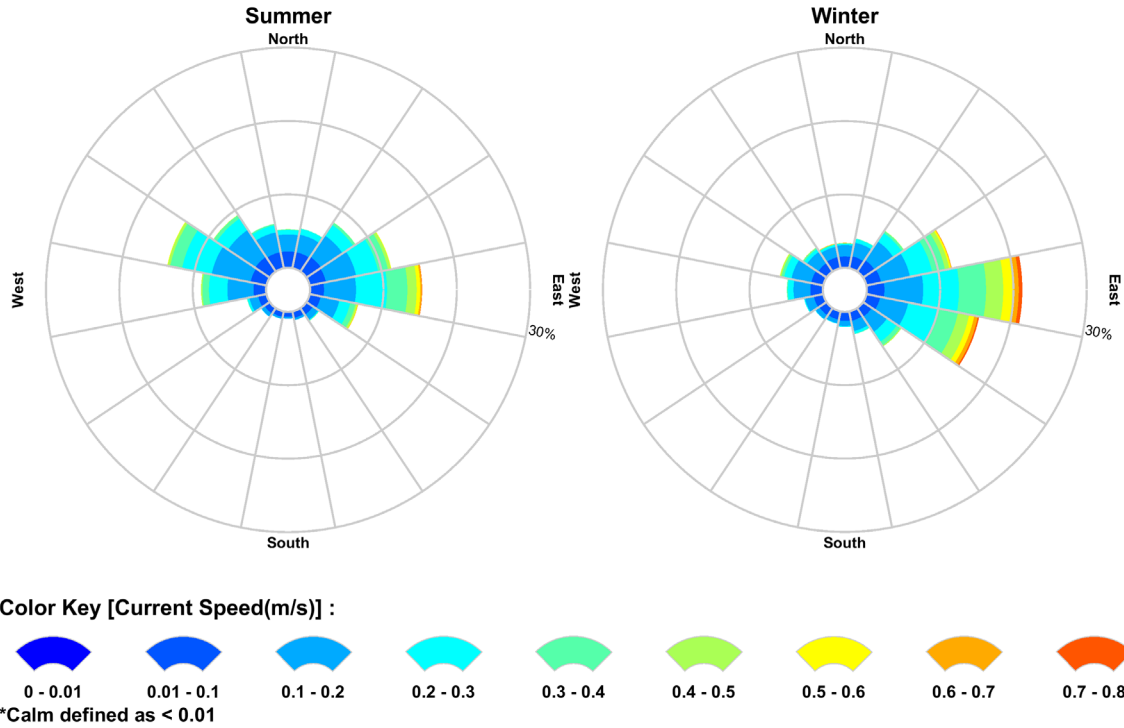


Figure 10 Seasonal surface current rose plots near the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive).

4 WIND DATA

High resolution wind data was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR; see Saha et al., 2010) from 2008 to 2012 (inclusive). The CSFR wind model includes observations from many data sources; surface observations, upper-atmosphere air balloon observations, aircraft observations and satellite observations and is capable of accurately representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at $\frac{1}{4}$ of a degree resolution (~ 33 km) and 1-hourly time intervals. Figure 11 shows the spatial resolution of the wind field used as input into the oil spill model. Table 4 shows the monthly average and maximum winds derived from the CSFR node located adjacent to the release site. Figure 12 and Figure 13 show the monthly and seasonal wind rose distributions, respectively.

Note the convention for defining wind direction throughout this report is the direction the wind blows from. Each branch of the wind rose distribution represents wind coming from that direction, with north to the top of the diagram. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 3 knot intervals, excluding the calm and near calm conditions are used in these wind roses. The length of each coloured segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

The wind data analysis indicated that winds in the region are generally moderate to strong throughout the year, with a monthly average oscillating between ~ 13 knots (March) to ~ 18 knots (August). A maximum wind speed of 49 knots was recorded during September, while the lowest maximum speed of 34 knots occurred in December.

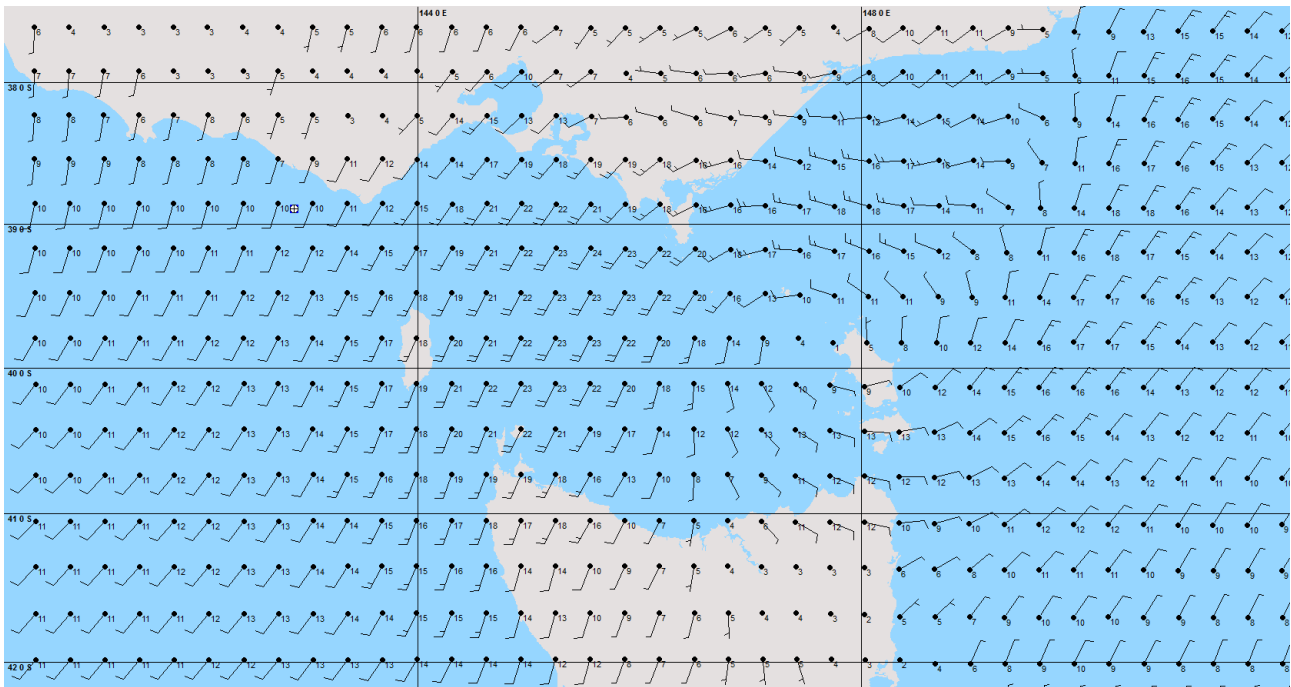


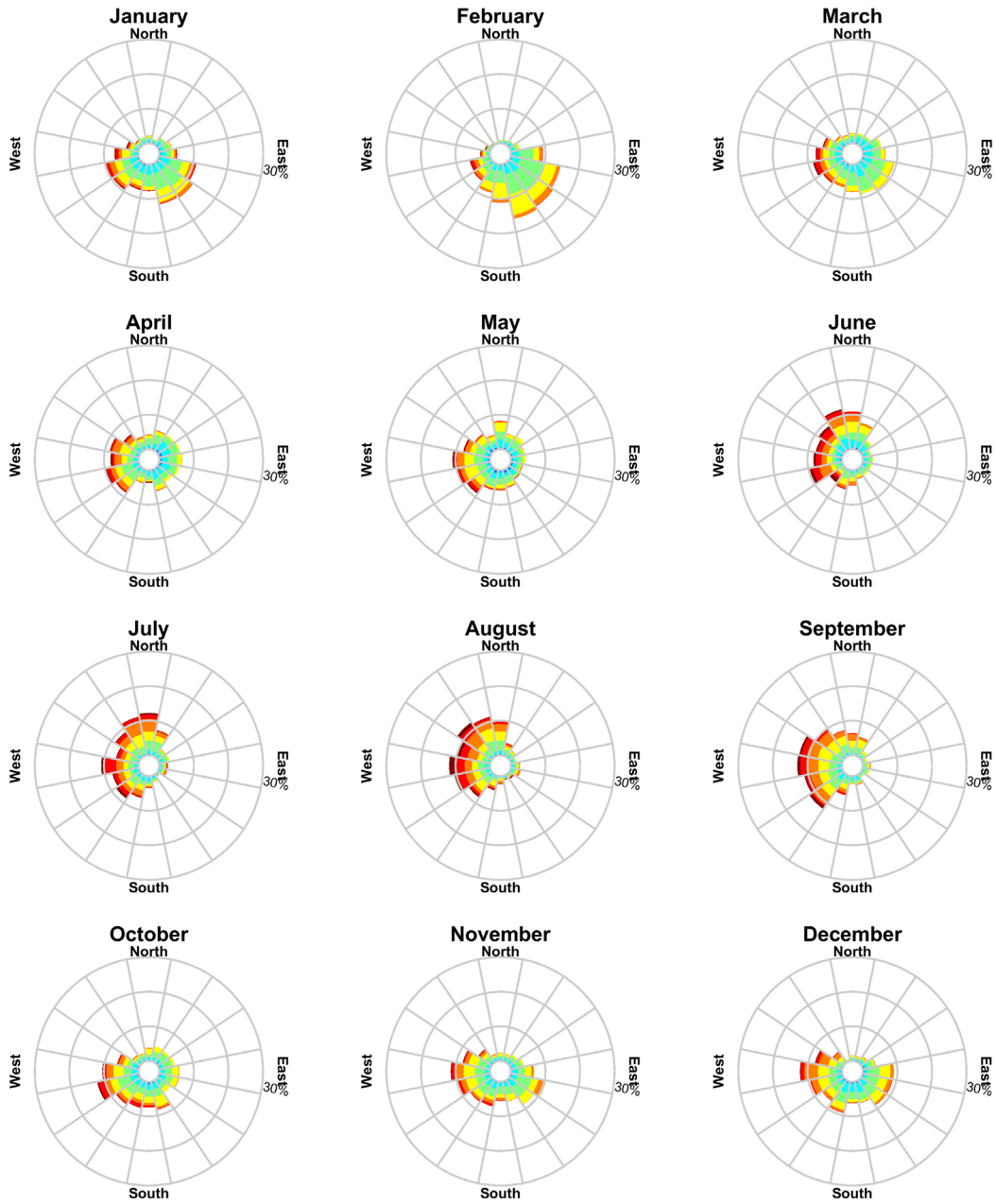
Figure 11 Image showing the CFSTR modelled wind nodes.

Table 4 Predicted monthly average and maximum winds for the wind node adjacent to the release location. Data derived from CFSR hindcast model from 2008-2012 (inclusive).

Month	Average wind (knots)	Maximum wind (knots)	General direction (from)
January	13	37	Variable SW to SE
February	14	37	SE
March	13	38	Variable
April	14	44	W
May	13	36	W
June	16	46	SW to NW
July	18	44	SW to NW
August	18	46	SW to NW
September	17	49	SW
October	14	35	SW to S
November	14	38	W to SE
December	14	34	W to E
Minimum	13	34	
Maximum	18	49	

RPS Data Set Analysis
Wind Speed (knots) and Direction Rose (All Records)

Longitude = 142.88°E, Latitude = 38.89°S
 Analysis Period: 01-Jan-2008 to 31-Jan-2012



Color Key [Wind Speed (knots)] :

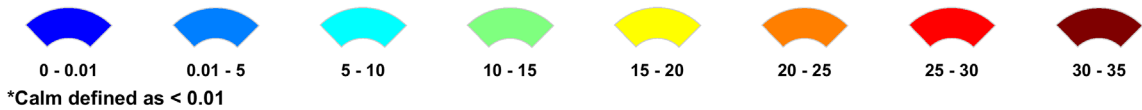


Figure 12 Monthly wind rose distributions derived from the CFSR hindcast model from 2008–2012 (inclusive), for the nearest wind node to the release location.

RPS Data Set Analysis Wind Speed (knots) and Direction Rose (All Records)

Longitude = 142.88°E, Latitude = 38.89°S
Analysis Period: 01-Jan-2008 to 31-Jan-2012

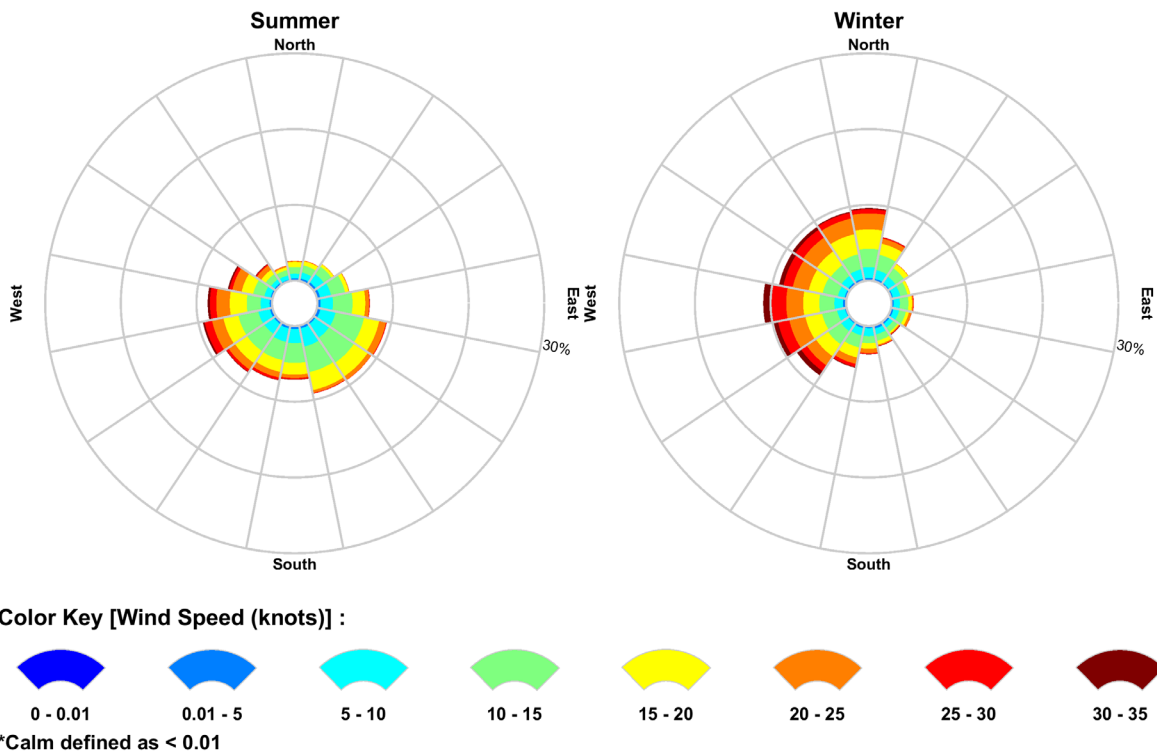


Figure 13 Seasonal wind rose distributions derived from the CFSR hindcast model from 2008–2012 (inclusive), for the nearest wind node to the release location.

5 WATER TEMPERATURE AND SALINITY

The monthly depth-varying water temperature and salinity profiles at 5 m intervals through the water column adjacent to the release location (refer to Figure 14) was obtained from the World Ocean Atlas 2013 (WOA13) produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) (see Levitus et al., 2013). The data is to inform the weathering, movement and evaporative loss of hydrocarbon spills in the surface and subsurface layers.

Table 5 summarises the monthly average sea surface temperatures and salinity (0-5 m depth layer). The sea surface temperatures were shown to range from 13.3°C (September) and 18.0°C (January). Salinity remained consistent throughout the year ranging from 35.1 to 35.6 psu.

Table 5 Monthly average sea surface temperature and salinity in the 0–5 m depth layer near the Artisan-1 well location.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	18.0	17.2	17.9	16.4	16.3	16.0	14.9	13.6	13.3	14.6	14.4	16.1
Salinity (psu)	35.4	35.1	35.4	35.4	35.4	35.4	35.6	35.3	35.3	35.4	35.4	35.4

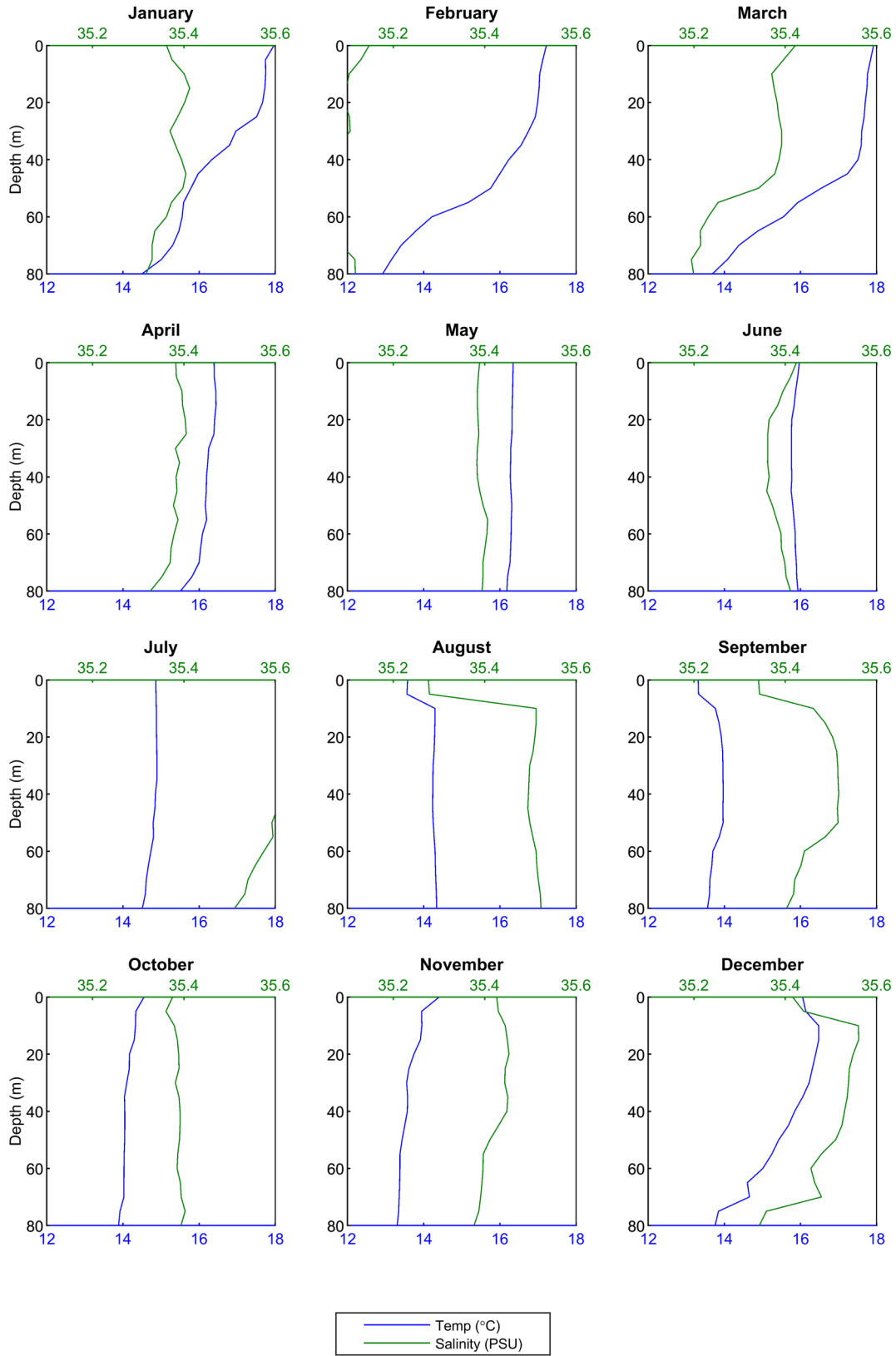


Figure 14 Monthly water temperature and salinity profiles near the release location.

6 NEAR-FIELD MODEL – OILMAP-DEEP

Near-field modelling was carried out for the loss of well control scenario to better understand the plume dynamics due to the amalgamation of condensate and gas at the seabed using the advanced OILMAP-DEEP blowout model. OILMAP-DEEP was developed by RPS and designed to provide the near-field behaviour of multi-phase gas-condensate plumes during subsurface blowout releases.

The model simulates the plume rise dynamics in two phases, the initial jet phase and the buoyant plume phase. The initial jet phase governs the plume dynamics directly above the subsea release location and is predominantly driven by the exit velocity. During this phase, the condensate droplet size and distribution are calculated. Next, the rise dynamics are dominated by the buoyant nature of the plume until the termination of the plume phase (known as the trapping depth). At this point, the results from OILMAP-DEEP (including plume trapping depth, plume diameter and droplet size distribution) are integrated into the far-field model SIMAP to simulate the rise and dispersion of the condensate droplets.

More details on the OILMAP-DEEP model, can be found in Spaulding et al. (2015). The model has been validated against observations from Deepwater Horizon as well as small and large-scale laboratory studies on subsurface oil releases (Brandvik et al 2013, 2014; Belore 2014; Spaulding et al. 2015; Li et al. 2017). Figure 15 illustrates the various stages of an example blowout plume.

Table 6 presents the input parameters and key results of the subsea modelling. Note that a depleting release rate illustrated in Figure 16 was used for the LOWC scenario, starting from 3,758 bbl/day on day 1 and decreasing to 1,718 bbl/day on day 86. The near-field modelling showed that in the event of a blowout from a well, the gas/liquid will propel the condensate upward from the seabed and the plume would rupture the sea surface. Due to the velocity of the plume, the model predicted droplet sizes would be relatively small, ranging from 100 to 400 μm .

Table 6 Input characteristics and key results from the subsea modelling.

Input Variable	Value
Scenario	86-day loss of well control
Water depth (m)	60
Tubing diameter (inch)	8.5"
Condensate Rate (stb/day)	3,758 bbl (day 1) depleting to 1,718 bbl (day 86)
Water Rate (stb/day)	189 bbl (day 1) depleting to 137 bbl (day 86)
Gas Rate (scf/day)	290,000,000 scf (day 1) depleting to 132,000,000 scf (day 86)
Gas to Condensate ratio (scf/bbl)	81,727 (average)
Gas to Total Liquids ratio (scf/bbl)	76,868 (average)
Reservoir temperature ($^{\circ}\text{C}$)	93
Release Pressure (psia)	2,583 (day 1) depleting to 256 (day 86)
Key Results	
Plume execution depth (m)	Plume ruptures the sea surface
Droplet Sizes	100 – 400 μm

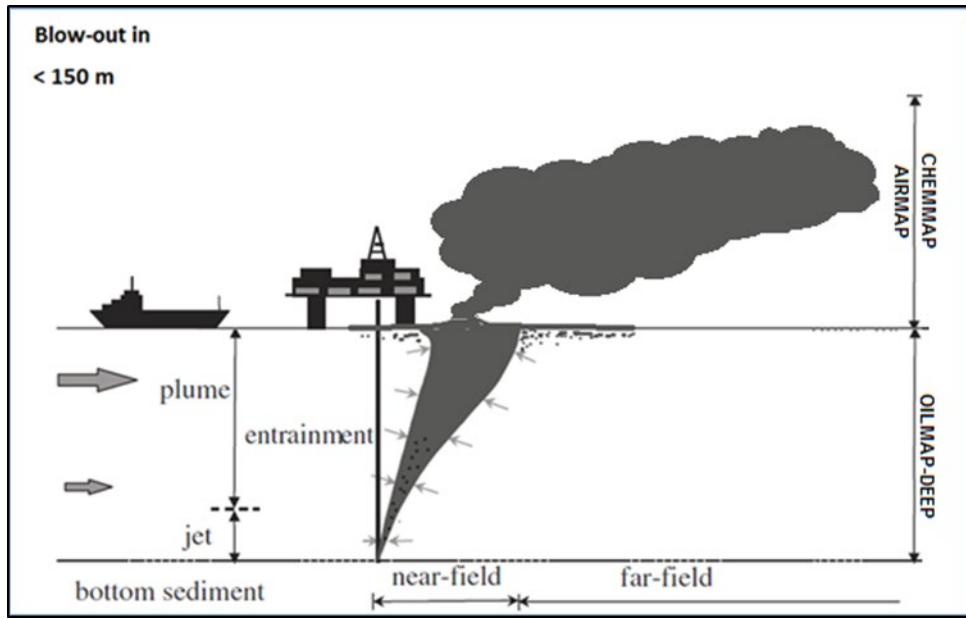


Figure 15 Example of a blowout plume illustrating the various stages of the plume in the water column (Source: Applied Science Associates, 2011).

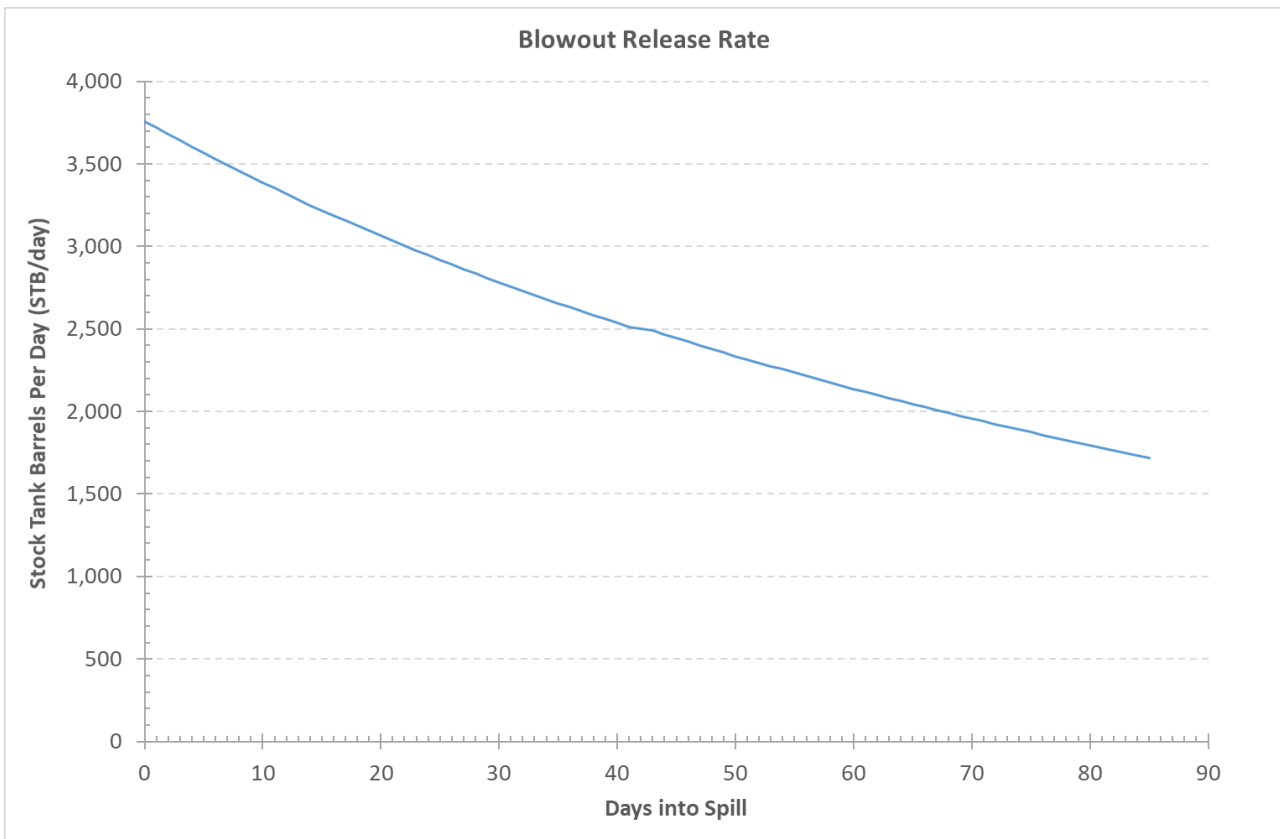


Figure 16 Depleting release rate used for the LOWC scenario

7 OIL SPILL MODEL – SIMAP

Modelling of the fate of oil was performed using SIMAP. SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases (Spaulding et al. 1994; French et al. 1999; French-McCay, 2003; French-McCay, 2004; French-McCay et al. 2004).

SIMAP has been used to predict the weathering and fate of oil spills during and after major incidents including: Montara (Australia) well blowout August 2009 in the Timor Sea (Asia-Pacific ASA, 2010); Macondo (USA) well blowout April 2010 in the Gulf of Mexico; Bohai Bay (China) oil spill August 2011; and the pipeline oil spill July 2013 in the Gulf of Thailand

The SIMAP model calculates the transport, spreading, entrainment, evaporation and decay of surface hydrocarbon slicks as well as the entrained and dissolved oil components in the water column, either from surface slicks or from oil discharged subsea. The movement and weathering of the spilled oil is calculated for specific oil types. Input specifications for oil mixtures include the density, viscosity, pour point, distillation curve (volume lost versus temperature) and the aromatic/aliphatic component ratios within given boiling point ranges. The SIMAP model uses an interpolation scheme based on an area-weighting scheme of the four nearest points of the wind and currents from the oil particle location.

SIMAP is a 3D model that allows for various response actions to be modelled including oil removal from skimming, burning, or collection booms, and surface and subsurface dispersant application.

The SIMAP oil spill model includes advanced weathering algorithms, specifically focussed on unique oils that tend to form emulsions and/or tar balls. The weathering algorithms are based on 5 years of extensive research conducted in response to the Deepwater Horizon oil spill in the Gulf of Mexico (French et al., 2015).

Biodegradation is included in the oil spill model. In the model, SIMAP, degradation is calculated for the surface slick, deposited oil on the shore, the entrained oil and dissolved constituents in the water column, and oil in the sediments. For surface oil, water column oil, and sedimented oil a first order degradation rate is specified. Biodegradation rates are relatively high for hydrocarbons in dissolved state or in dispersed small droplets.

7.1 Stochastic Modelling

Stochastic oil spill modelling is created by overlaying a great number (often 100 hundred) simulated hypothetical oil spills (e.g. Figure 17). Stochastic modelling involves running numerous individual oil spill simulations using a range of prevailing wind and current conditions that are historically representative of the season of where the spill event may occur.

For the stochastic modelling presented herein, 100 spills for each of season were simulated and each using the same spill information (release location, spill volume, duration and oil type) but with varied start dates and times corresponding to the period represented by the available wind and current data. During each simulation, the model records whether any grid cells are exposed to any oil concentrations, the concentrations involved and the elapsed time before exposure. The results of all 100 oil spill simulations were analysed to determine the following statistics for every grid cell:

- Exposure load (concentrations and volumes);
- Minimum time before exposure;
- Probability of contact above defined concentrations;
- Volume of oil that may strand on shorelines from any single simulation;
- Concentration that might occur on sections of individual shorelines; and
- Exposure (concentration x duration of exposure) to entrained and dissolved hydrocarbons in the water column.

Exposure (concentration x duration of exposure) to entrained and dissolved hydrocarbons in the water column

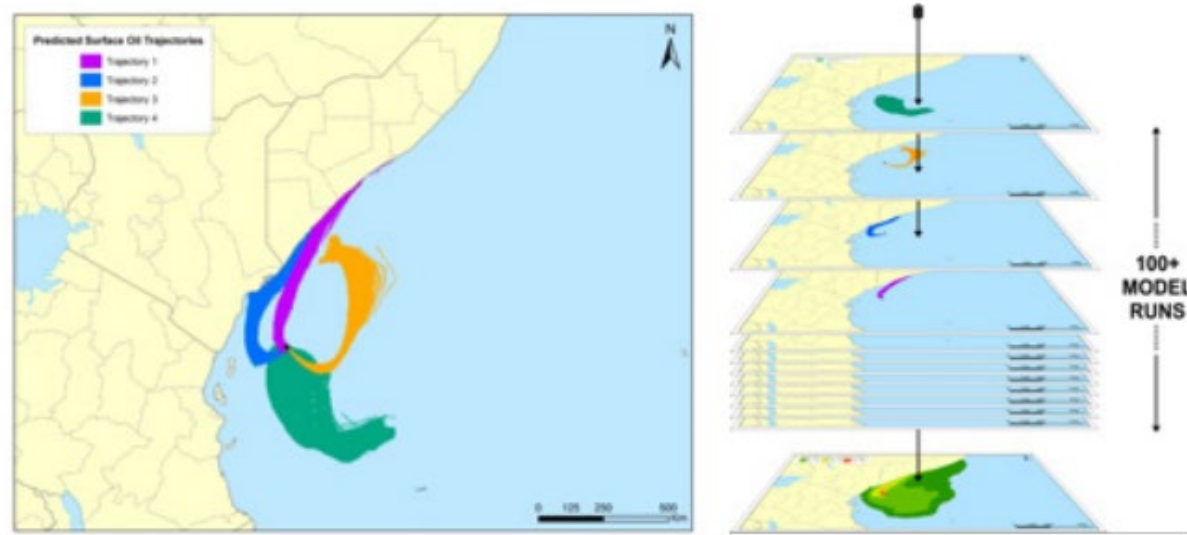


Figure 17 Predicted movement of four single oil spill simulations predicted by SIMAP for the same scenario (left image). All model runs are overlain (shown as the stacked runs on the right) and the number of times that trajectories contact a given location at a concentration is used to calculate the probability.

7.2 Sea surface, Shoreline and In-Water Exposure Thresholds

The thresholds for the sea surface, shoreline and water column (entrained and dissolved hydrocarbons) is presented in Table 7 and their relationship to exposure, are presented in Sections 7.2.1 to 7.2.3. Supporting justifications of the adopted thresholds applied during the study and additional context relating to the area of influence are also provided. It is important to note that the thresholds are in line with the thresholds recommended in the NOPSEMA oil spill modelling bulletin April 2019 (<https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf>), In some instances, slightly more conservative. For example, the low surface exposure of $>0.5 \text{ g/m}^2$ was adopted in the study, while the NOPSEMA bulletin recommends 1 g/m^2 .

Table 7 Exposure and contact threshold values used for the Artisan-1 oil spill modelling study.

Level	Sea Surface Exposure (g/m^2)	Shoreline Contact (g/m^2)	Dissolved Hydrocarbon Concentration (ppb) [#]	Entrained Hydrocarbon Concentrations (ppb) [#]
Low	0.5	10	6	10
Moderate	10	100	50	100
High	25	1,000	400	1,000

[#]These thresholds were assessed for a) 1 hour exposure and b) 48-hour exposure windows. Both sets of results are provided in the result section(s).

7.2.1 Sea Surface Exposure Thresholds

The minimum sea surface reporting level for each spill simulation was 0.5 g/m², which equates to an average thickness of approximately 0.5 µm. Oil of this thickness is described as a rainbow to metallic sheen in appearance according to the Bonn Agreement Oil Appearance Code (Bonn Agreement, 2009, Table 8). This thickness is considered the minimum level for observing oil in the marine environment by the Australian Maritime Safety Authority (AMSA, 2015). Furthermore, this threshold is considered below levels which would cause environmental harm and it is more indicative of the areas perceived to be affected due to its visibility on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure.

Ecological impact has been estimated to occur at 10 g/m² (a film thickness of approximately 10 µm or 0.01 mm) according to French et al. (1996) and French-McCay (2009) as this level of fresh oiling has been observed to mortally impact some birds through adhesion of oil to their feathers, exposing them to secondary effects such as hypothermia. The appearance at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009). Concentrations above 10 g/m² is also considered the lower actionable threshold, where oil may be thick enough for containment and recovery as well as dispersant treatment (AMSA, 2015).

Scholten et al. (1996) and Koops et al. (2004) indicated that at oil concentrations on the sea surface of 25 g/m² (or greater), would be harmful for all birds that have landed in an oil film due to potential contamination of their feathers, with secondary effects such as loss of temperature regulation and ingestion of oil through preening. The appearance of oil at this thickness is also described as metallic sheen (Bonn Agreement, 2009).

The sea surface reporting thresholds applied in this study were 0.5–10 g/m² (low), 10–25 g/m² (moderate) and above 25 g/m² (high) (Table 7).

Note that the higher threshold applied in this study falls below the thickness that would begin to present as patches of true oil colour (Table 8).

Figure 18 shows examples of the differences between oil colour and corresponding thickness on the sea surface. Hydrocarbons in the marine environment may appear differently due the ambient environmental conditions (wind and wave action).

Table 8 Bonn Agreement Oil Appearance Code

Code	Description Appearance	Layer Thickness Interval (g/m ² or µm)	Litres per km ²
1	Sheen (silvery/grey)	0.04 – 0.30	40 – 300
2	Rainbow	0.30 – 5.0	300 – 5,000
3	Metallic	5.0 – 50	5,000 – 50,000
4	Discontinuous True Oil Colour	50 – 200	50,000 – 200,000
5	Continuous True Oil Colour	200 –>	200,000 –>

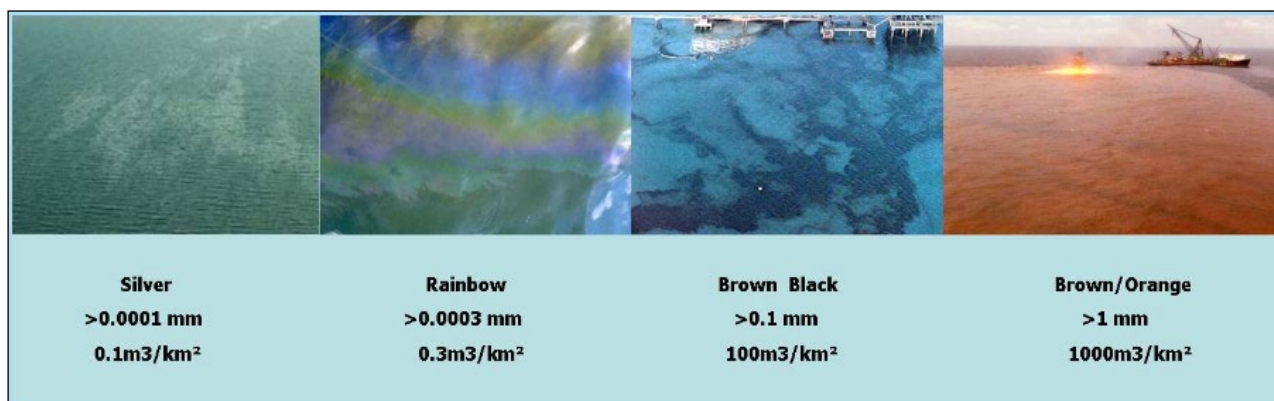


Figure 18 Photograph showing the difference between oil appearance on the sea surface (source: OilSpillSolutions.org, 2015).

The generic oil colour categories used in this report are meant as a guide only. For more accurate description of oil appearance on the sea surface a detailed analysis of an oil should be undertaken.

The specific oil type will determine appearance (i.e. colour) and behaviour on the sea surface. Lighter oils such as marine diesel and condensate, have true oil colours that are pale or transparent. As such, these oil types may not increase beyond a rainbow or metallic sheen, despite their thickness increasing beyond 25 g/m² (~25 µm). Moreover, the physical properties and appearance of oil types will change due to weathering on the sea surface. For example, oils with high paraffinic wax content will form waxy sheets that break up into flakes or nodules after the more volatile components have evaporated. Take up of water by the oil (emulsification) will also significantly change the appearance and thickness of floating oil. Stable water-in-oil emulsions will have a higher combined mass and thickness and will present as thick, semi-solid, aerated layers that tend to be coloured strongly red/brown, orange or yellow, rather than the true oil colour.

It should be noted that in the case of solidified or emulsified oils, mass per area estimates cannot be directly referenced to the Bonn Agreement visibility scale that refers only to oil present as films or slicks of oil alone.

7.2.2 Shoreline Exposure Thresholds

The reporting threshold of 10 g/m² was applied as the visible limit for oil on shore. This threshold may trigger socio-economic impact, such as triggering temporary closures of beaches to recreation or fishing, or closure of commercial fisheries and might trigger attempts for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). In previous risk assessment studies, French-McCay et al (2005a; 2005b) used a threshold of 10 g/m², equating to approximately two teaspoons of oil per square meter of shoreline, as a low impact threshold when assessing the potential for shoreline exposure.

French et al. (1996) and French-McCay (2009) define a shoreline oil threshold of 100 g/m², or above, as having potentially harm shorebirds and wildlife (furbearing aquatic mammals and marine reptiles on or along the shore) based on studies for sub-lethal and lethal impacts. This threshold has been used in previous environmental risk assessment studies (see French-McCay, 2003; French-McCay et al., 2004, French-McCay et al., 2011, 2012; NOAA, 2013). Additionally, a shoreline concentration of 100 g/m², or above, is the minimum limit that the oil can be effectively cleaned according the AMSA (2015) guidelines. This threshold equates to approximately ½ a cup of oil per square meter of shoreline exposure. The appearance is described as a thin oil coat.

The higher threshold of 1,000 g/m², and above, was adopted to inform locations that might receive oil accumulation levels that could have a higher potential for ecological effect. Observations by Lin and Mendelsohn (1996), demonstrated that loadings of more than 1,000 g/m² of oil during the growing season

would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing oil impacts on mangroves (Grant et al., 1993; Suprayogi & Murray, 1999). This concentration equates to approximately 1 litre or 4 ¼ cups of fresh oil per square meter of shoreline exposure. The appearance is described as an oil cover.

The shoreline reporting thresholds applied in this study were 10–100 g/m² (low), 100–1,000 g/m² (moderate) and above 1,000 g/m² (high) (Table 7).

7.2.3 Dissolved and Entrained Hydrocarbon Thresholds

Oil is a mixture of thousands of hydrocarbons of varying physical, chemical, and toxicological characteristics, and therefore, demonstrate varying fates and impacts on organisms. As such, for in-water exposure, the SIMAP model provides separate outputs for dissolved and entrained hydrocarbons from oil droplets. The consequences of exposure to dissolved and entrained components will differ because they have different modes and magnitudes of effect.

Entrained hydrocarbon concentrations were calculated based on oil droplets that are suspended in the water column, though not dissolved. The composition of this oil would vary with the state of weathering (oil age) and may contain soluble hydrocarbons when the oil is fresh. Calculations for dissolved hydrocarbons specifically calculates oil components which are dissolved in water, which are known to be the primary source of toxicity exerted by oil.

7.2.3.1 Dissolved hydrocarbons

Laboratory studies have shown that dissolved hydrocarbons exert most of the toxic effects of oil on aquatic biota (Carls et al., 2008; Nordtug et al., 2011; Redman, 2015). The mode of action is a narcotic effect, which is positively related to the concentration of soluble hydrocarbons in the body tissues of organisms (French-McCay, 2002). Dissolved hydrocarbons are taken up by organisms directly from the water column by absorption through external surfaces and gills, as well as through the digestive tract. Thus, soluble hydrocarbons are termed “bioavailable”.

Hydrocarbon compounds vary in water-solubility and the toxicity exerted by individual compounds is inversely related to solubility, however bioavailability will be modified by the volatility of individual compounds (Nirmalakhandan & Speece, 1988; Blum & Speece, 1990; McCarty, 1986; McCarty et al., 1992a, 1992b; Mackay et al., 1992; McCarty & Mackay, 1993; Verhaar et al., 1992, 1999; Swartz et al., 1995; French-McCay, 2002; McGrath et al., 2009). Of the soluble compounds, the greatest contributor to toxicity for water-column and benthic organisms are the lower-molecular-weight aromatic compounds, which are both volatile and soluble in water. Although they are not the most water-soluble hydrocarbons within most oil types, the polynuclear aromatic hydrocarbons (PAHs) containing 2-3 aromatic ring structures typically exert the largest narcotic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant accumulation to occur (Anderson et al., 1974, 1987; Neff & Anderson, 1981; Malins & Hodgins, 1981; McAuliffe, 1987; NRC, 2003). The monoaromatic hydrocarbons (MAHs), including the BTEX compounds (benzene, toluene, ethylbenzene, and xylenes), and the soluble alkanes (straight chain hydrocarbons) also contribute to toxicity, but these compounds are highly volatile, so that their contribution will be low when oil is exposed to evaporation and higher when oil is discharged at depth where volatilisation does not occur (French-McCay, 2002).

French-McCay (2002) reviewed available toxicity data, where marine biota was exposed to dissolved hydrocarbons prepared from oil mixtures, finding that 95% of species and life stages exhibited 50% population mortality (LC₅₀) between 6 and 400 ppb total PAH concentration after 96 hrs exposure, with an average of 50 ppb. Hence, concentrations lower than 6 ppb total PAH value should be protective of 97.5% of species and life stages even with exposure periods of days (at least 96 hours). Early life-history stages of fish appear to be more sensitive than older fish stages and invertebrates.

Exceedances of time averaged exposure (based on 96 hours) at 6, 50 or 400 ppb was applied to indicate increasing potential for sub-lethal to lethal toxic effects (or low to high).

Furthermore, in accordance with the NOPSEMA oil spill modelling bulletin, the same thresholds were assessed over a 1 hour time step (see Table 7).

7.2.3.2 Entrained hydrocarbons

Entrained hydrocarbons consist of oil droplets that are suspended in the water column and insoluble. As such, insoluble compounds in oil cannot be absorbed from the water column by aquatic organisms, hence are not bioavailable through absorption of compounds from the water. Exposure to these compounds would require routes of uptake other than absorption of soluble compounds. The route of exposure of organisms to whole oil alone include direct contact with tissues of organisms and uptake of oil by direct consumption, with potential for biomagnification through the food chain (NRC, 2005).

The 10 ppb threshold represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC (2000) water quality guidelines. Due to the requirement for relatively long exposure times (> 24 hours) for these concentrations to be significant, they are likely to be more meaningful for juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes, or when entrained hydrocarbons adhere to organisms or trapped against a shoreline for periods of several days or more.

This exposure zone is not considered to be of significant biological impact and is therefore outside the adverse exposure zone. This exposure zone represents the area contacted by the spill. This area does not define the area of influence as it is considered that the environment will not be affected by the entrained hydrocarbon at this level.

Thresholds of 10 ppb, 100 ppb and 500 ppb were applied as time averaged exposure (over 96 hours, see Table 7), to cover the range of thresholds outlined in the ANZECC/ARMCANZ (2000) water quality guidelines and the incremental change for greater potential effect.

A complicating factor that should be considered when assessing the consequence of dissolved and entrained oil distributions is that there will be some areas where both physically entrained oil droplets and dissolved hydrocarbons co-exist. Higher concentrations of each will tend to occur close to the source where sea conditions can force mixing of relatively unweathered oil into the water column, resulting in more rapid dissolution of soluble compounds.

Furthermore, in accordance with the NOPSEMA oil spill modelling bulletin, the same thresholds were assessed over a 1 hour time step (see Table 7).

7.3 Oil Properties

7.3.1 Marine Diesel Oil

Marine Diesel Oil (MDO) is a light-persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m³ (API of 37.6) and a low pour point (-14°C). The low viscosity (4 cP) indicates that this oil will spread quickly when released and will form a thin to low thickness film on the sea surface, increasing the rate of evaporation. According to the International Tankers Owners Pollution Federation (ITOPF, 2014) and AMSA (2015a) guidelines, this oil is categorised as a group II oil (light-persistent).

Table 9 details the physical properties of MDO, while Table 10 presents the boiling point ranges of the MDO used in this study.

Figure 19 illustrates the weathering graph for a 300 m³ release of MDO over 6 hours during three wind speeds. The 5, 10 and 15 knot wind speeds were selected given that breaking waves and in turn entrainment takes place between 10 – 12 knots. The results illustrate that the prevailing wind speeds can

and do influence the weathering and fate of the MDO. Under lower wind-speeds (5 knots), the MDO will remain on the surface longer, spread quicker, and in turn greater evaporation. Conversely, sustained stronger winds (>15 knots) will generate breaking waves at the surface, causing a higher amount of MDO to be entrained into the water column and reducing the amount available to evaporate.

7.3.2 Thylacine Condensate

Thylacine condensate was used for the loss of well control scenario (Scenario 2). The condensate has an API of 44.3, density of 804.6 kg/m³ at 15°C) with low viscosity (0.875 cP) (refer to Table 9), classifying it as a Group I oil according to the (ITOPF, 2014) and USEPA/USCG classifications. The condensate comprises a significant portion of volatiles and semi to low volatiles (99% total) with very little residual components (<1%) (refer to Table 10). This means that the majority of the condensate will evaporate readily when on the water surface, with a minimal amount of persistent components to remain on the water surface over time.

Figure 1 displays the weathering graph for a 24-hour release (3,758 bbl) of Thylacine condensate during three static wind speeds. The weathering graph shows rapid evaporation occurs during the first 24 hours (while the condensate is still being released) during all three wind speeds. Thylacine condensate is predicted to readily entrain into the water column under the higher wind speeds (10 and 15 knots). Due to the high volatility of the condensate, little is predicted to remain on the water surface after the spill ceases.

Table 9 Physical properties of MDO and Thylacine condensate

Characteristic	MDO	Thylacine Condensate
Density (kg/m ³) at 15°C	829.1	804.6
API	37.6	44.3
Dynamic viscosity (cP) at 20°C	4	0.875
Pour Point (°C)	-14	-50
Wax content (%)	1	NA
Hydrocarbon property category	Group II	Group I
Hydrocarbon property classification	Light - Persistent	Non-persistent oil

Table 10 Boiling point ranges of MDO and Thylacine condensate

Characteristic	Not Persistent			Persistent
	Volatile	Semi-volatile	Low volatility	Residual
Boiling point (°C)	< 180	180 - 265	265 - 380	>380
MDO	6.0	34.6	54.4	5.0
Thylacine condensate	64.0	19.0	16.0	1

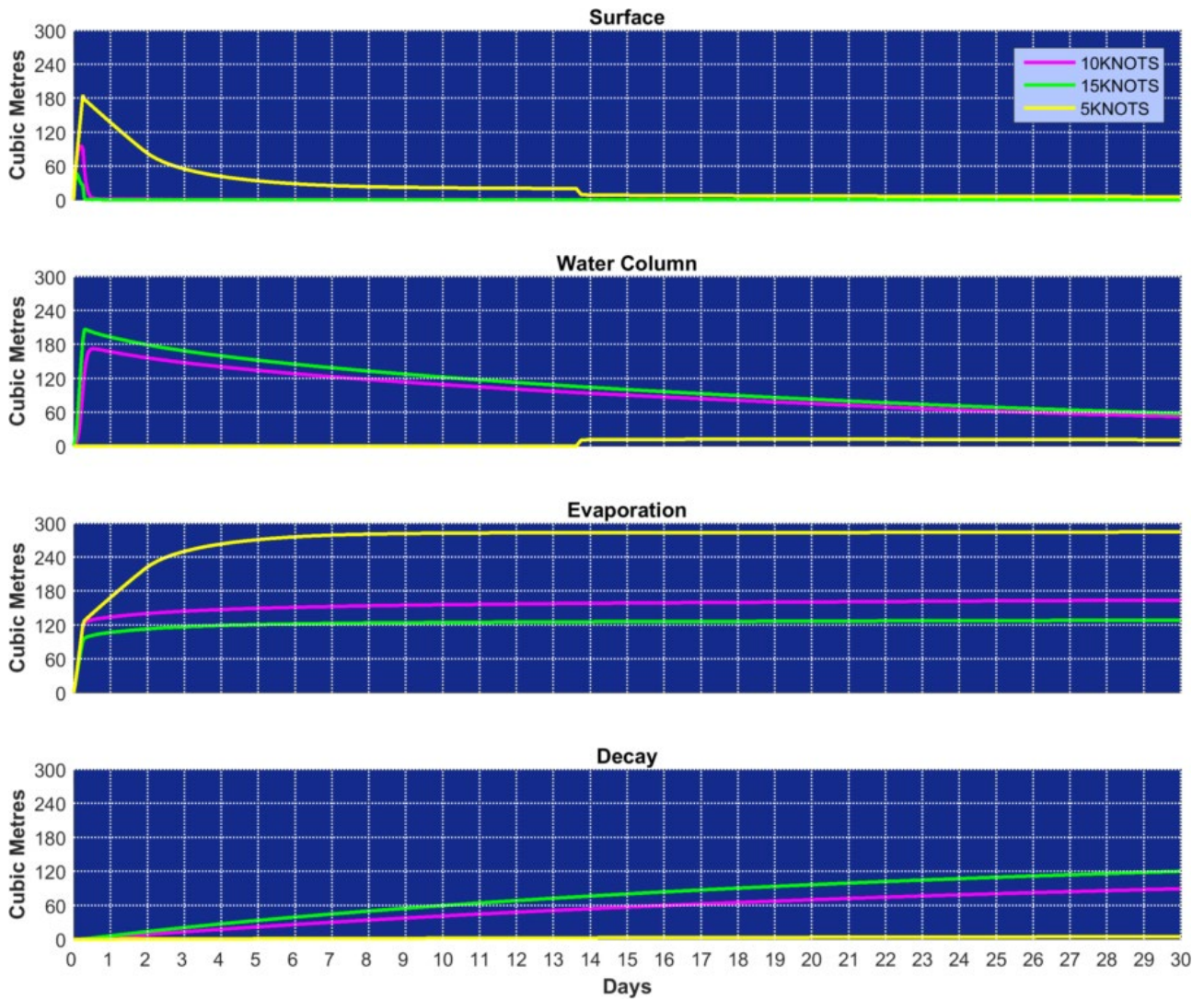


Figure 19 Weathering of a 300 m³ surface release of MDO over 6 hours (tracked for 30 days) under three static winds conditions (5, 10 and 15 knots).

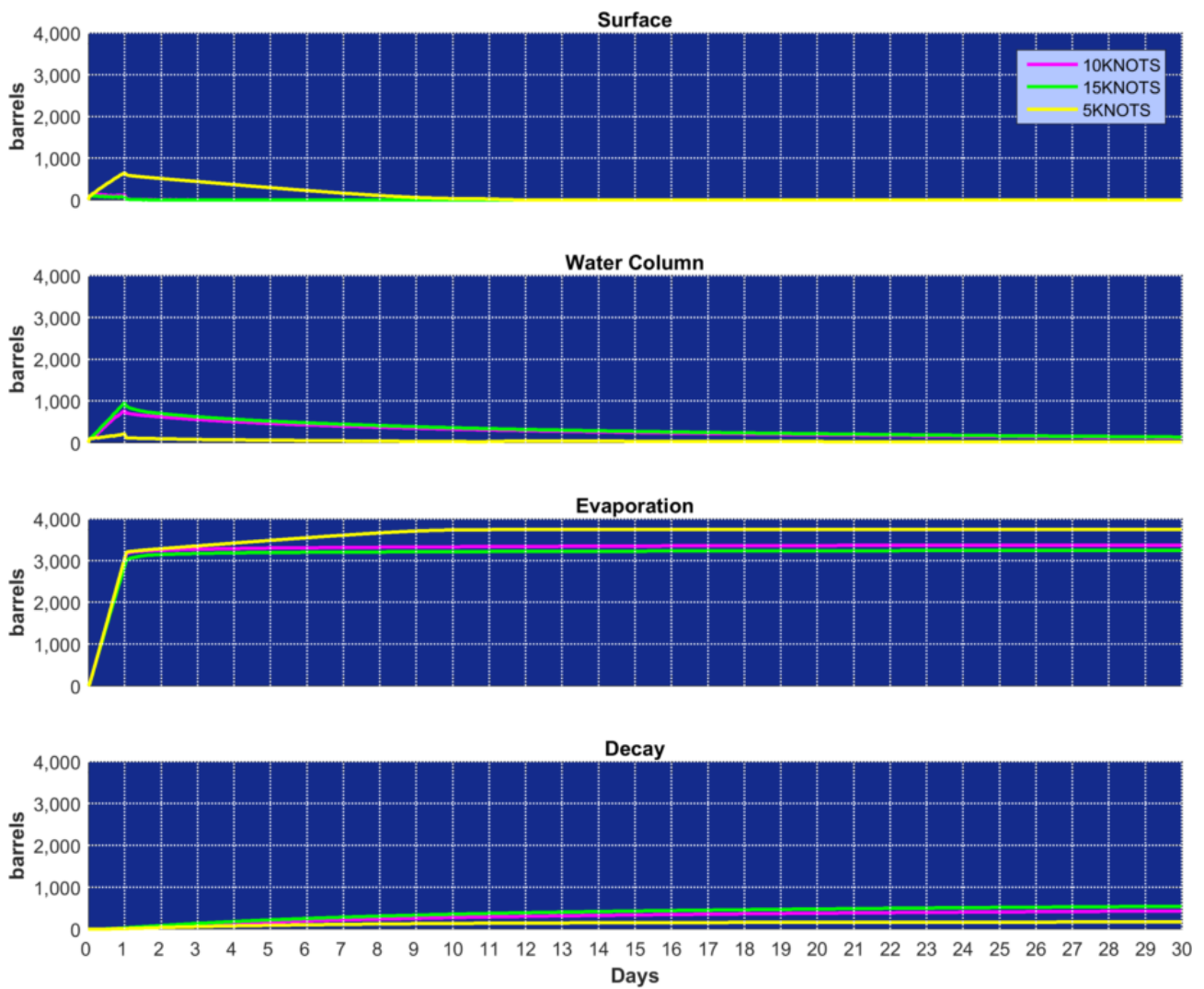


Figure 1 Weathering of 3,758 bbl subsea release of Thylacine condensate over 24 hours (tracked for 30 days) under three static wind speeds (5,10 and 15 knots).

7.4 Model Settings

This oil spill modelling study quantified the seasonal risk and potential exposure to the surrounding waters and shorelines for two plausible, yet hypothetical scenarios:

- 300 m³ surface release of marine diesel over 6 hours in the event of a containment loss from a vessel at the Artisan-1 well location; and
- 222,224 bbl subsea release of condensate over 86 days to represent an unrestricted open-hole loss of well control (LOWC) event from the Artisan-1 well location

Table 11 provides a summary of the oil spill model settings.

Table 11 Summary of the oil spill model settings

Parameter	Oil Spill Scenario	
	Subsea Loss of Well Control	Loss of Containment from a Vessel
Scenario description		
Model period	Summer (October to March) Winter (April to September)	
Number of randomly selected spill start times and locations per season	100 (200 total)	100 (200 total)
Oil type	Thylacine condensate	MDO
Spill volume	222,224 bbl	300 m ³
Release type	Subsea (60m)	Surface
Release duration	86 days	6 hr
Simulation length (days)	114	30
Surface oil concentration thresholds	0.5 g/m ² , 10 g/m ² , >25 g/m ²	
Shoreline load threshold	10 g/m ² , 100 g/m ² , >1,000 g/m ²	
Dissolved hydrocarbon exposure to assess the potential exposure (ppb). <i>These thresholds were assessed for 1 hour and 48-hour exposure windows.</i>	6 ppb, potential low exposure 50 ppb, potential moderate exposure 400 ppb, potential high exposure	
Entrained hydrocarbon exposure to assess the potential exposure (ppb). <i>These thresholds were assessed for 1 hour and 48-hour exposure windows.</i>	10 ppb, potential low exposure 100 ppb, potential moderate exposure 1,000 ppb, potential high exposure	

8 PRESENTATION AND INTERPRETATION OF MODEL RESULTS

The results from the modelling study are presented in a number of statistical tables, which aim to provide a comprehensive understanding of the predicted sea-surface and in-water (subsurface) exposure and shoreline contact (if predicted).

8.1 Seasonal Analysis

The seasonal analysis is presented in the form of statistical tables based on the following principles:

- The **greatest distance travelled by a spill trajectory** – is determined by a) recording the maximum and b) second greatest distance travelled (or 99th percentile) by a single trajectory, within a scenario, from the release location to the identified exposure thresholds.
- The **probability of shoreline contact** – is determined by recording the number of spill trajectories to contact the shoreline, at a specific threshold, divided by the total number of spill trajectories within that scenario.
- The **minimum time before oil exposure** – is determined by recording the minimum time for a grid cell to record exposure, at a specific threshold.
- The **average volume of oil ashore for a single spill** – is determined by calculating the average volume of the all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The **maximum volume of oil ashore from a single spill trajectory** – is determined by identifying the single spill trajectory within a scenario/season, that recorded the maximum volume of oil to come ashore and presenting that value.
- The **average length of shoreline contacted by oil** – is determined by calculating the average of the length of shoreline (measured as grid cells) contacted by oil above a specified threshold.
- The **maximum length of shoreline contacted by oil** – is determined by recording the maximum length of shoreline (measured as grid cells) contacted by oil above a specified threshold.
- The **probability of oil exposure to a receptor** – is determined by recording the number of spill trajectories to reach a specified sea surface or subsea threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.
- The **minimum time before oil exposure to a receptor** – is determined by ranking the elapsed time before sea surface exposure, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.
- The **probability of oil contact to a receptor** – is determined by recording the number of spill trajectories to reach a specified shoreline contact threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.
- The **minimum time before shoreline contact to a receptor** – is determined by ranking the elapsed time before shoreline contact, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.
- The **average potential oil loading within a receptor** – is determined taking the average of the maximum loading to any grid cell within a polygon, for all simulations within a scenario/season, that recorded shoreline.
- The **maximum potential oil loading within a receptor** – is determined by identifying the maximum loading to any grid cell within a receptor polygon, for a scenario.

- The **average volume of oil ashore within a receptor** – is determined by calculating the average volume of oil to come ashore within a receptor polygon, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The **maximum volume of oil ashore within a receptor** – is determined by recording the maximum volume of oil to come ashore within a receptor polygon, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The **average length of shoreline contacted within a receptor** – is determined by calculating the average of the length of shoreline (measured as grid cells) contacted by oil within a receptor polygon, at a specified threshold, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The **maximum length of shoreline contacted by oil** – is determined by recording the maximum length of shoreline (measured as grid cells) contacted by oil within a receptor polygon, at a specified threshold, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.

8.2 Receptors Assessed

A range of environmental receptors and biological receptors and shorelines were assessed for sea surface exposure, shoreline contact and water column exposure as part of the study (see Table 12). The receptors are presented graphically in Figure 20 to Figure 34.

Note, the release location is situated within the Otway Integrated Marine and Coastal Regionalisation of Australia (IMCRA) receptor and hence this receptor will register all maximum values predicted by the modelling.

Table 12 Summary of receptors used to assess surface, shoreline and in-water exposure to hydrocarbons

Receptor Category	Acronym	Hydrocarbon Exposure Assessment		
		Water Column	Sea Surface	Shoreline
Marine National Park	MNP	✓	✓	✗
Australian Marine Park	AMP	✓	✓	✗
National Park	NP	✓	✓	✗
Integrated Marine and Coastal Regionalisation of Australia	IMCRA	✓	✓	✗
Interim Biogeographic Regionalisation of Australia	IBRA	✓	✓	✓
Key Ecological Feature	KEF	✓	✓	✗
Reefs, Shoals and Banks	RSB	✓	✓	✗
Ramsar	Ramsar	✓	✓	✓
State Waters	State Waters	✓	✓	✗
Local Government Areas	LGA	✓	✓	✓

Receptor Category	Acronym	Hydrocarbon Exposure Assessment		
		Water Column	Sea Surface	Shoreline
Sub-Local Government Areas	Sub-LGA	✓	✓	✓

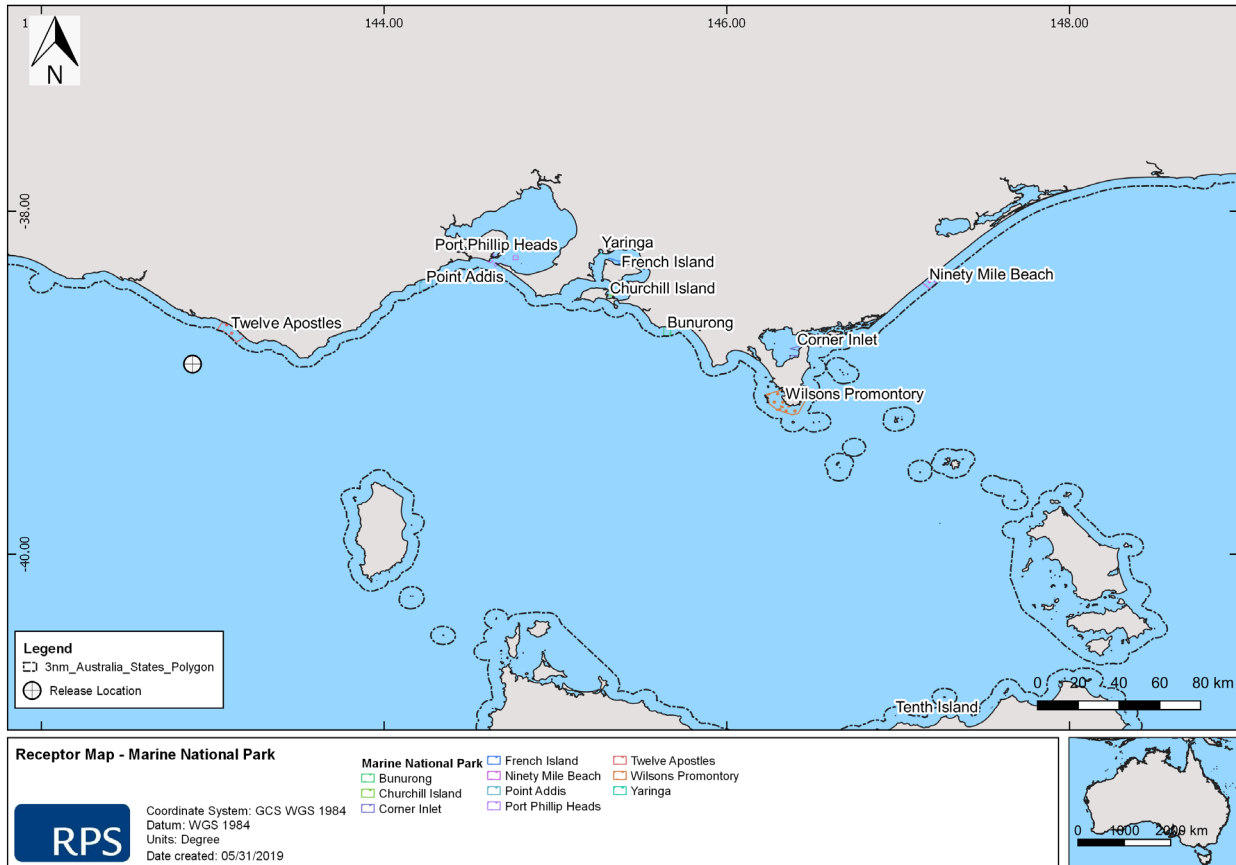


Figure 20 Receptor map for Marine National Parks.

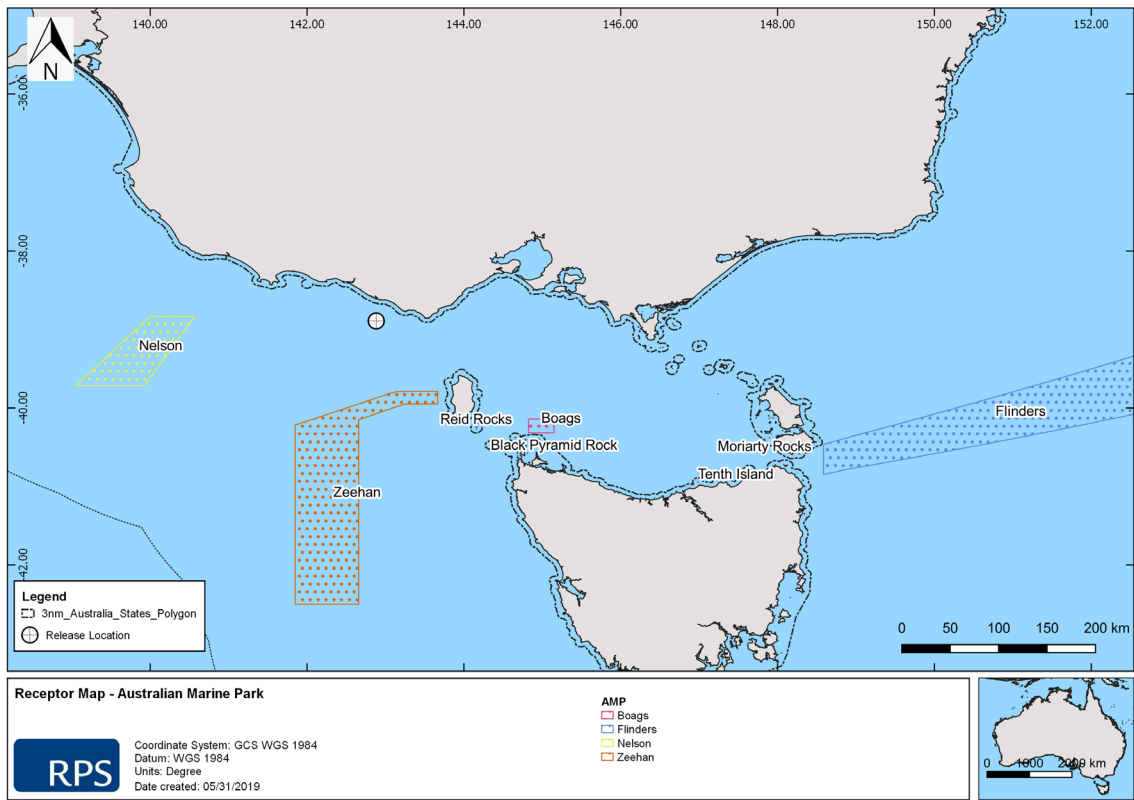


Figure 21 Receptor map for Australian Marine Parks.

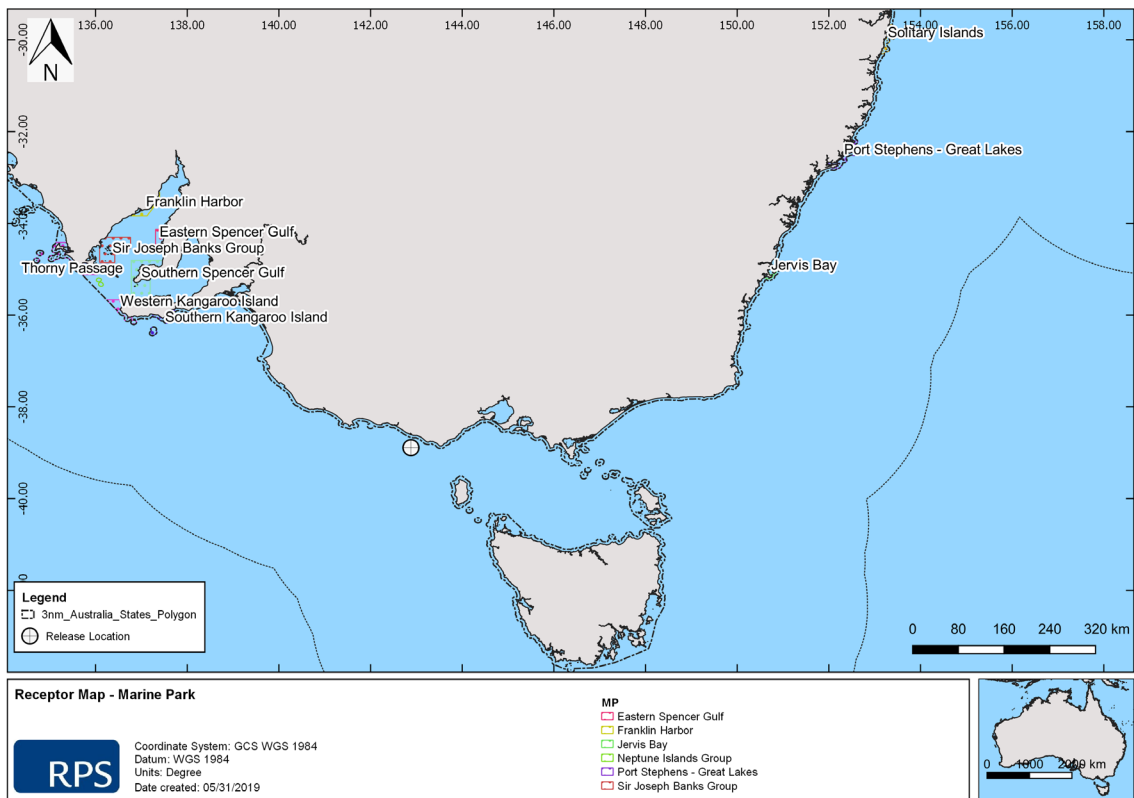


Figure 22 Receptor map for Marine Parks.

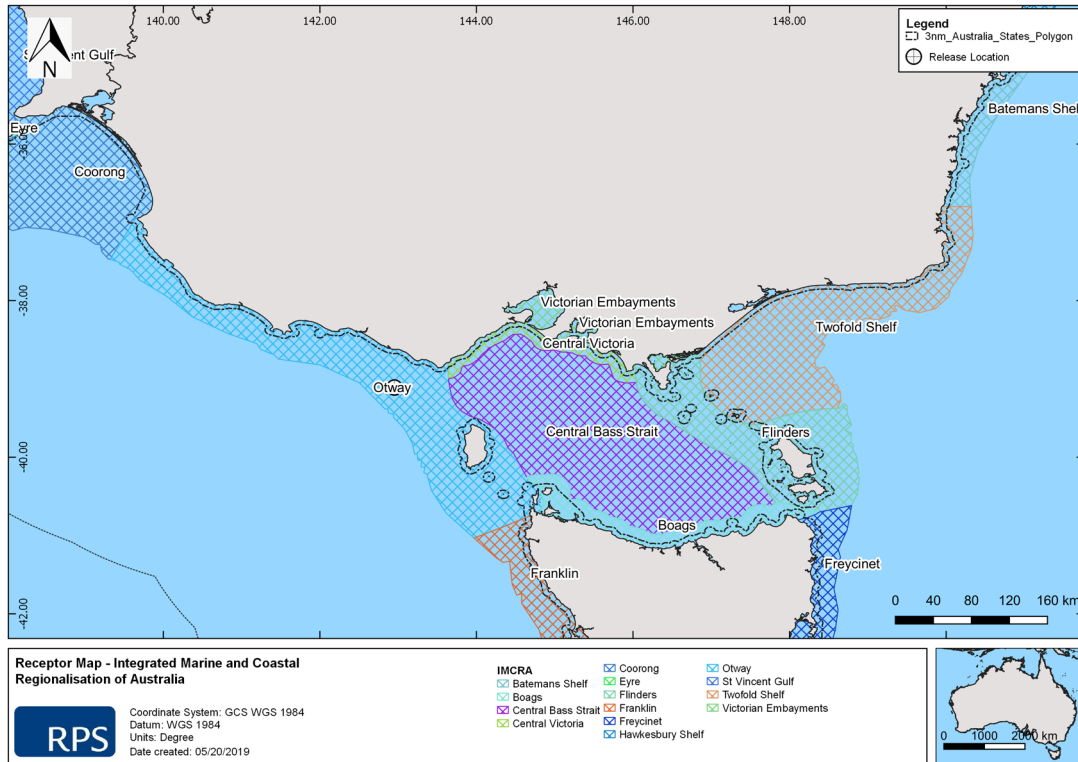


Figure 23 Receptor map illustrating the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) receptors.

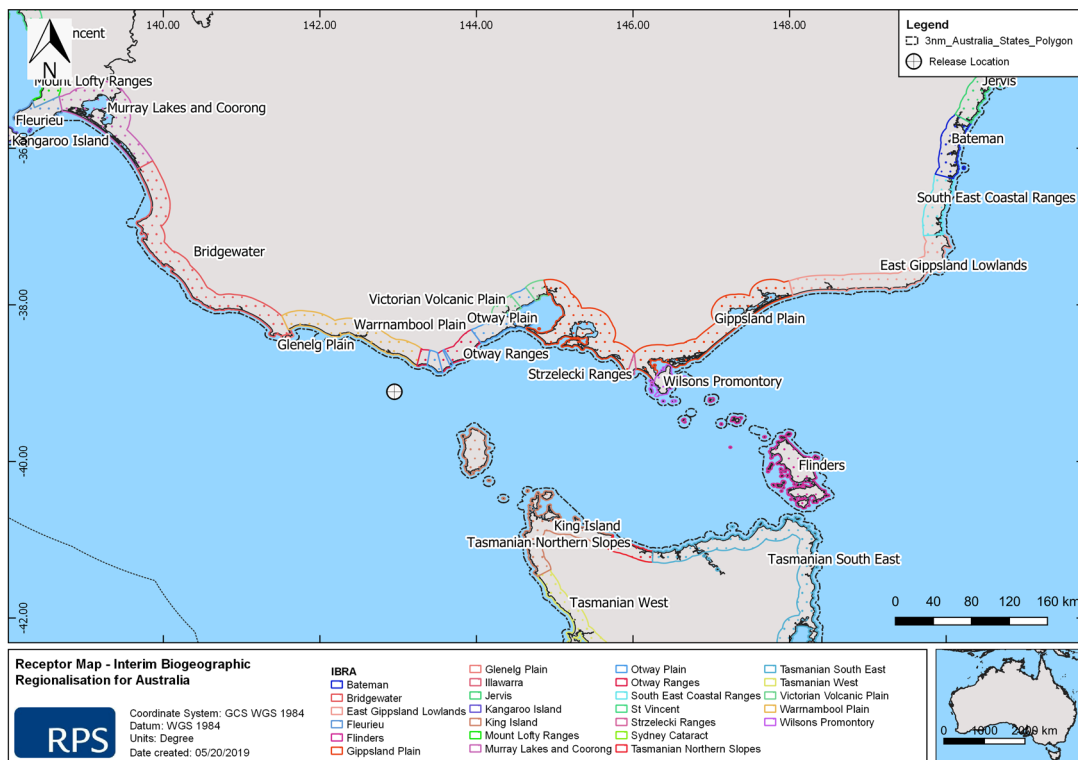


Figure 24 Map illustrating the Interim Biogeographic Regionalisation of Australia (IBRA) receptors.

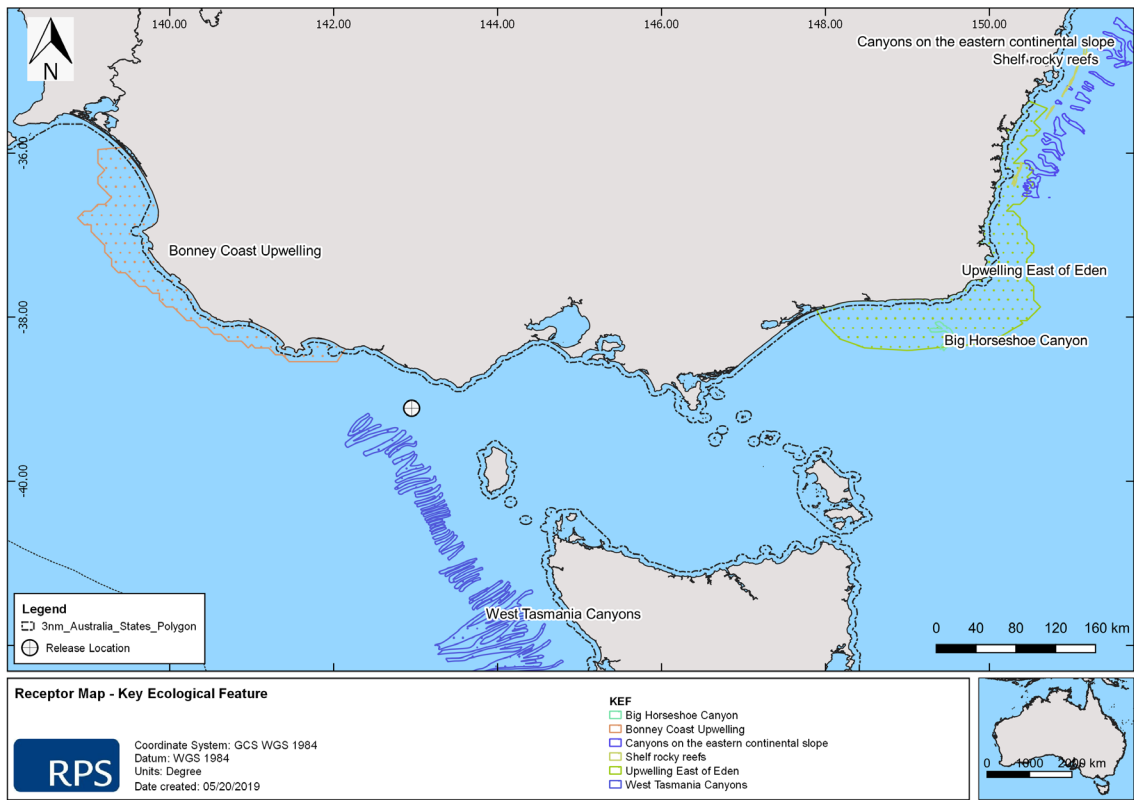


Figure 25 Receptor map of Key Ecological Features (KEF)

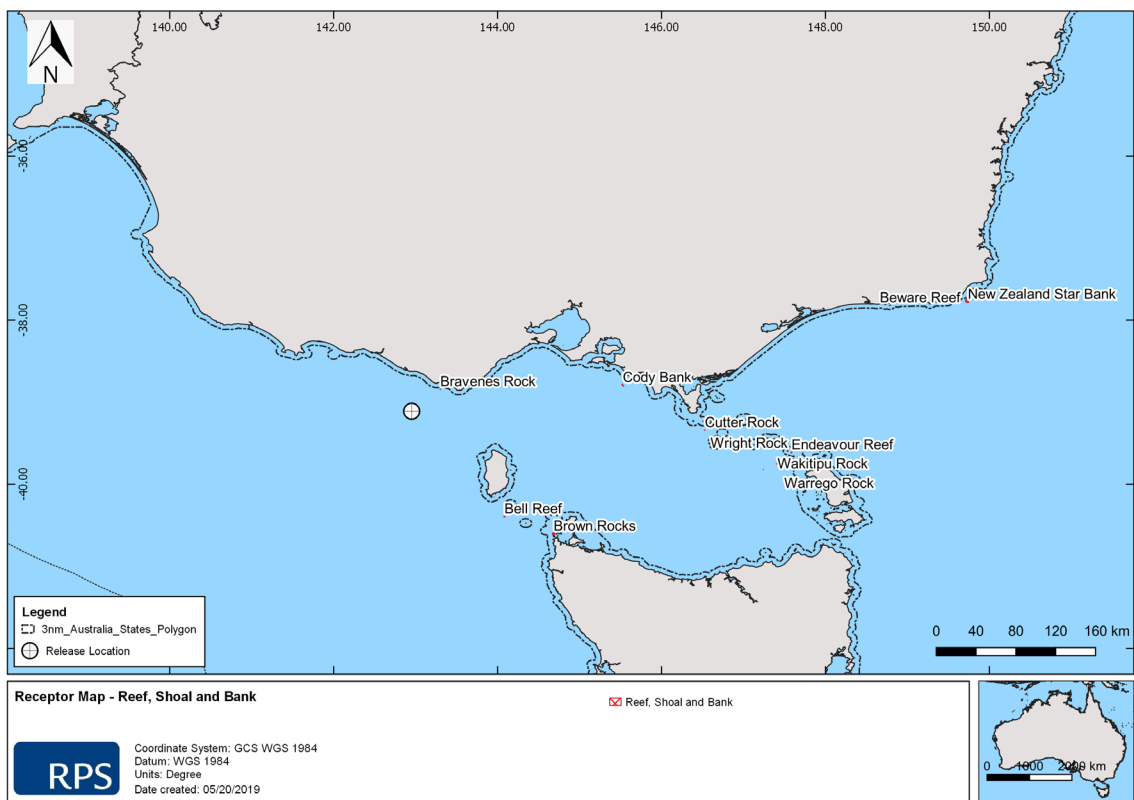


Figure 26 Receptor map of Reefs, Shoals and Banks (RSB)

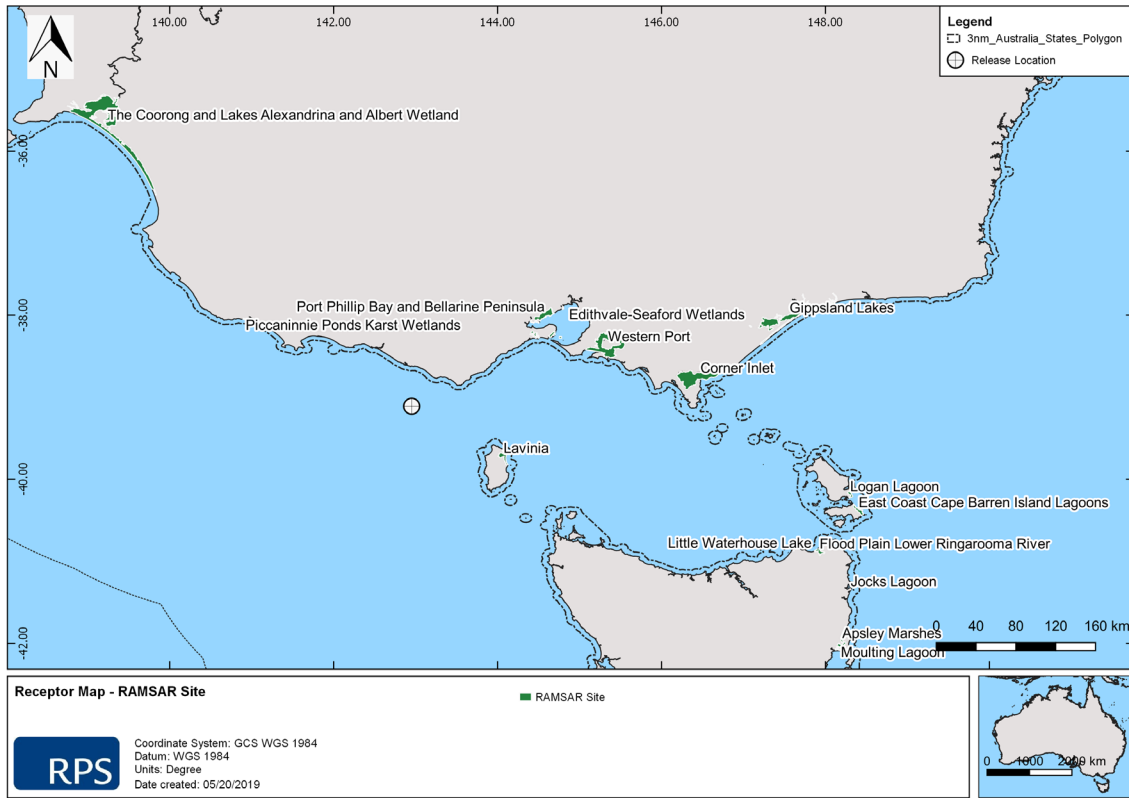


Figure 27 Receptor map of RAMSAR sites

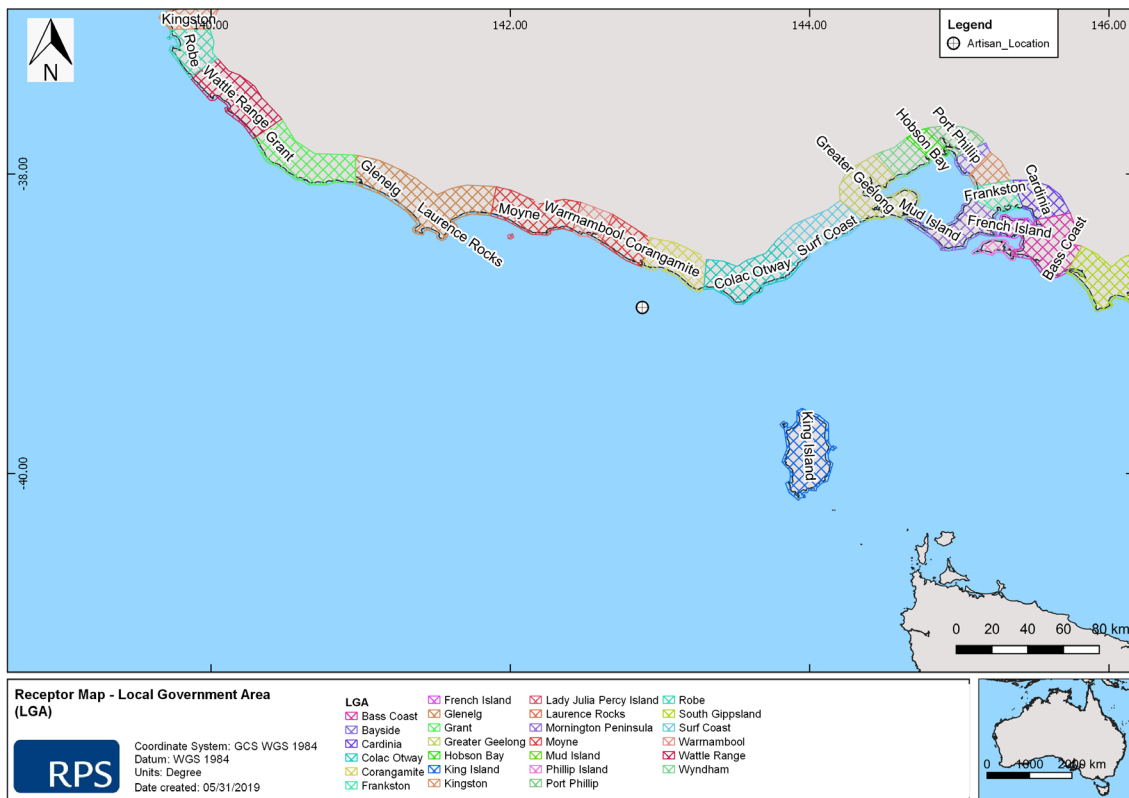


Figure 28 Receptor map of Local Government Areas (LGA) (1/3)

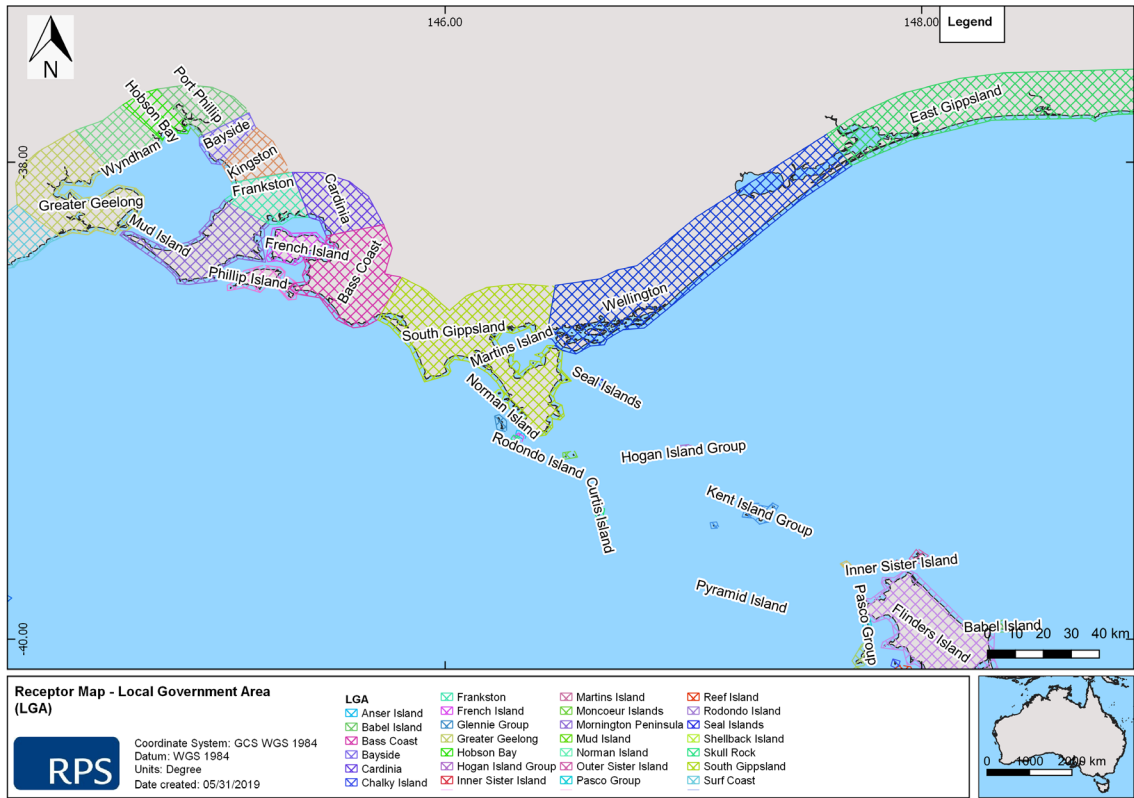


Figure 29 Receptor map of Local Government Areas (LGA) (2/3)

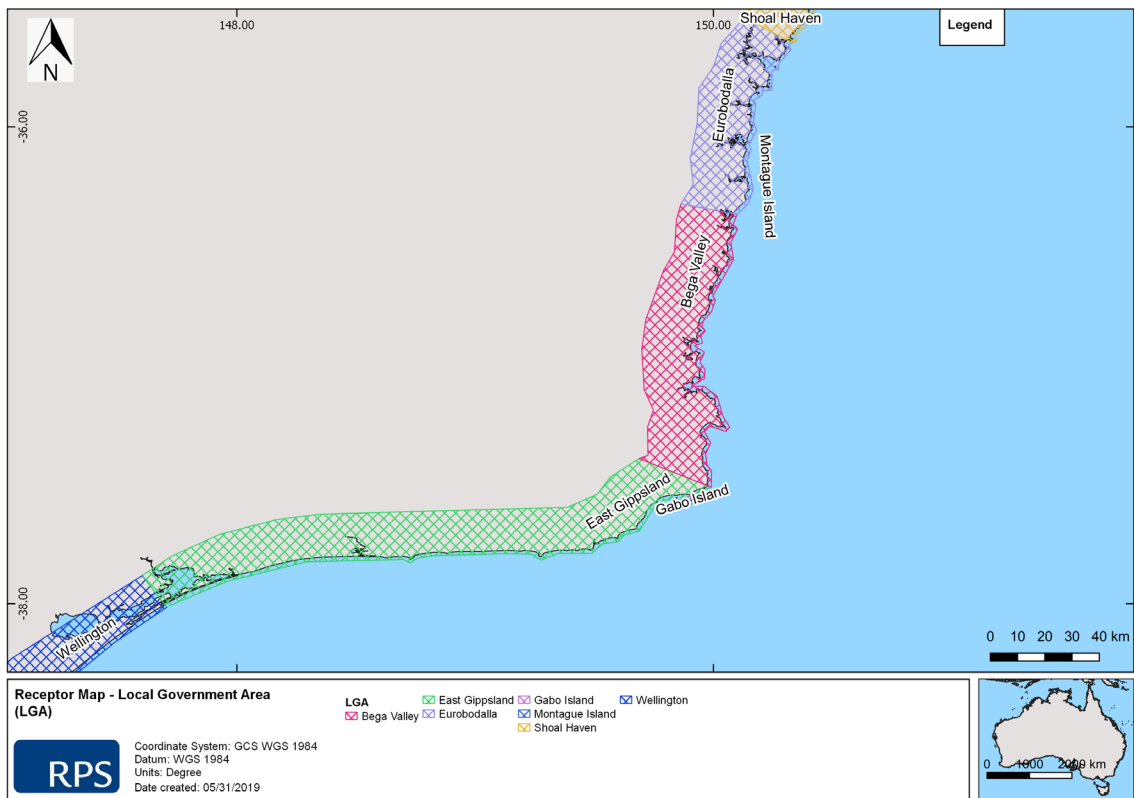


Figure 30 Receptor map of Local Government Areas (LGA) (3/3)

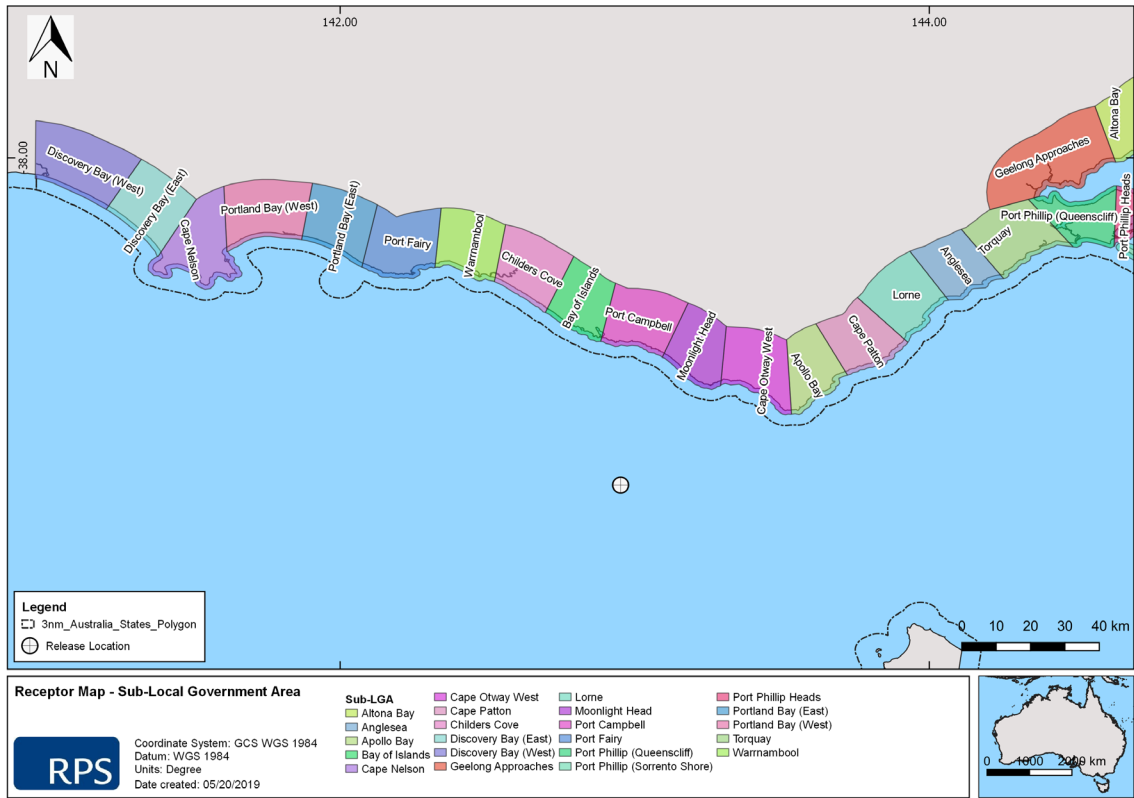


Figure 31 Receptor map of Sub-Local Government Areas (Sub-LGA) (1/3)

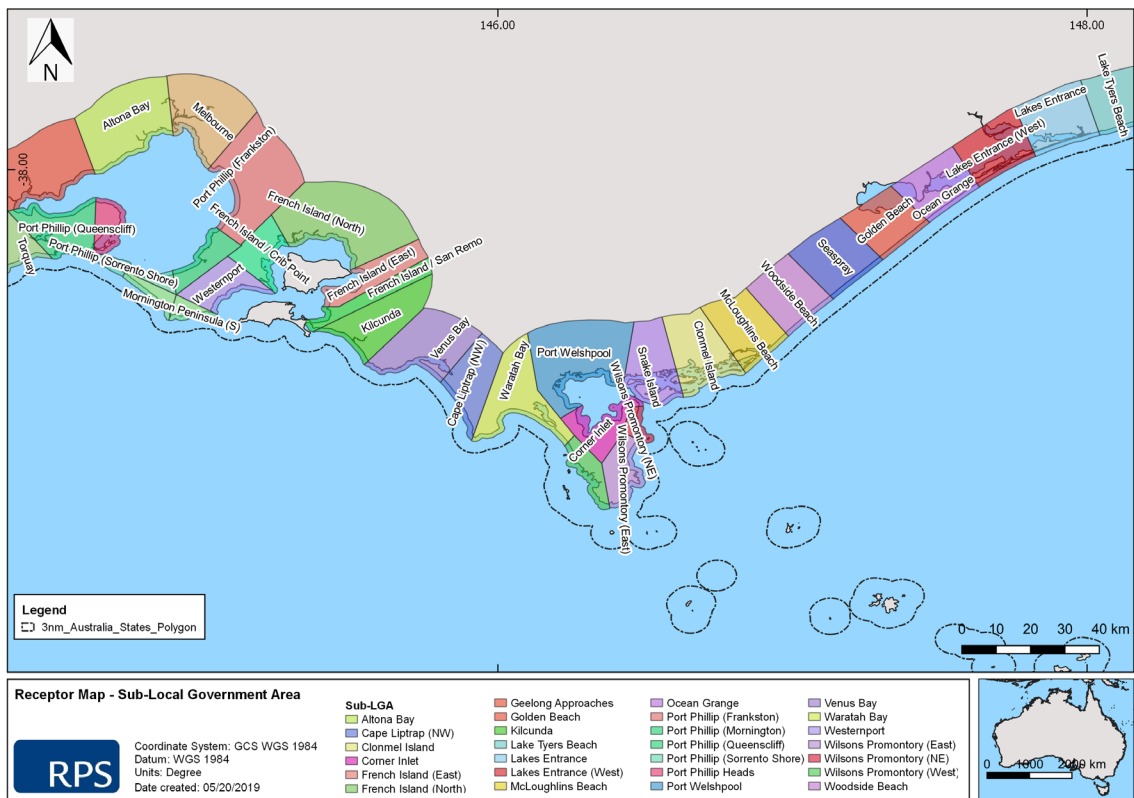


Figure 32 Receptor map of Sub-Local Government Areas (Sub-LGA) (2/3)

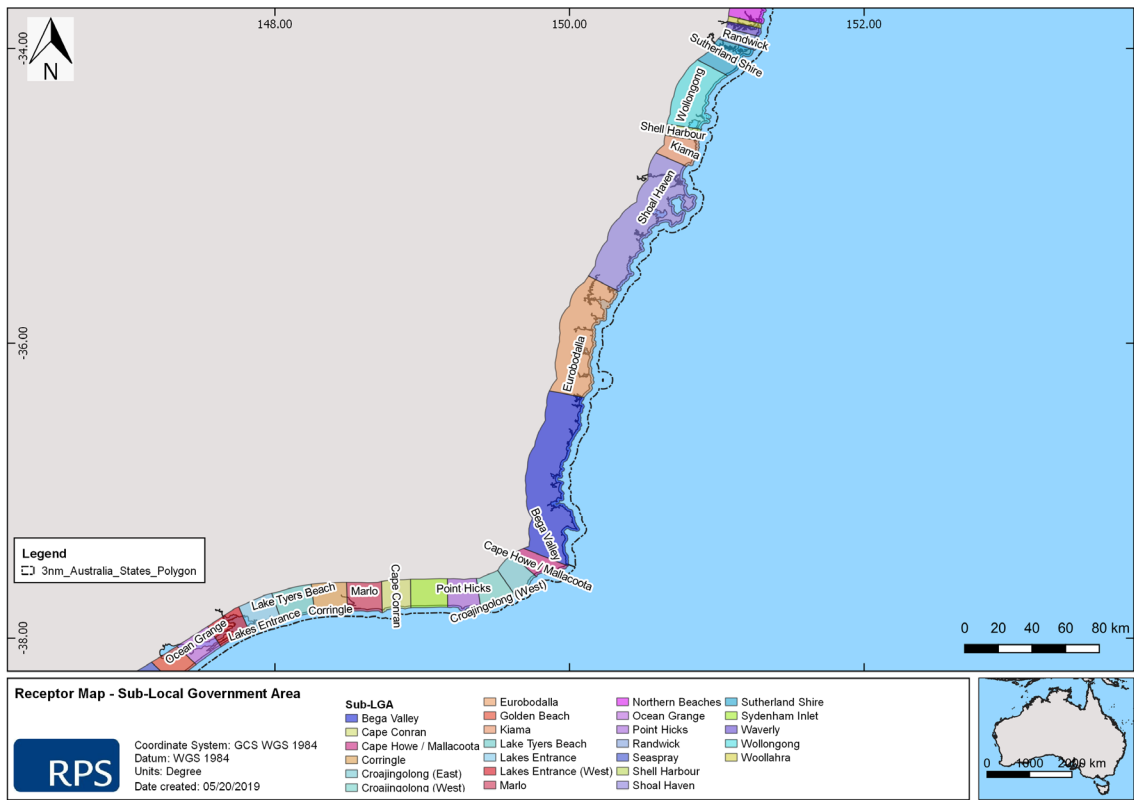


Figure 33 Receptor map of Sub-Local Government Areas (Sub-LGA) (3/3)

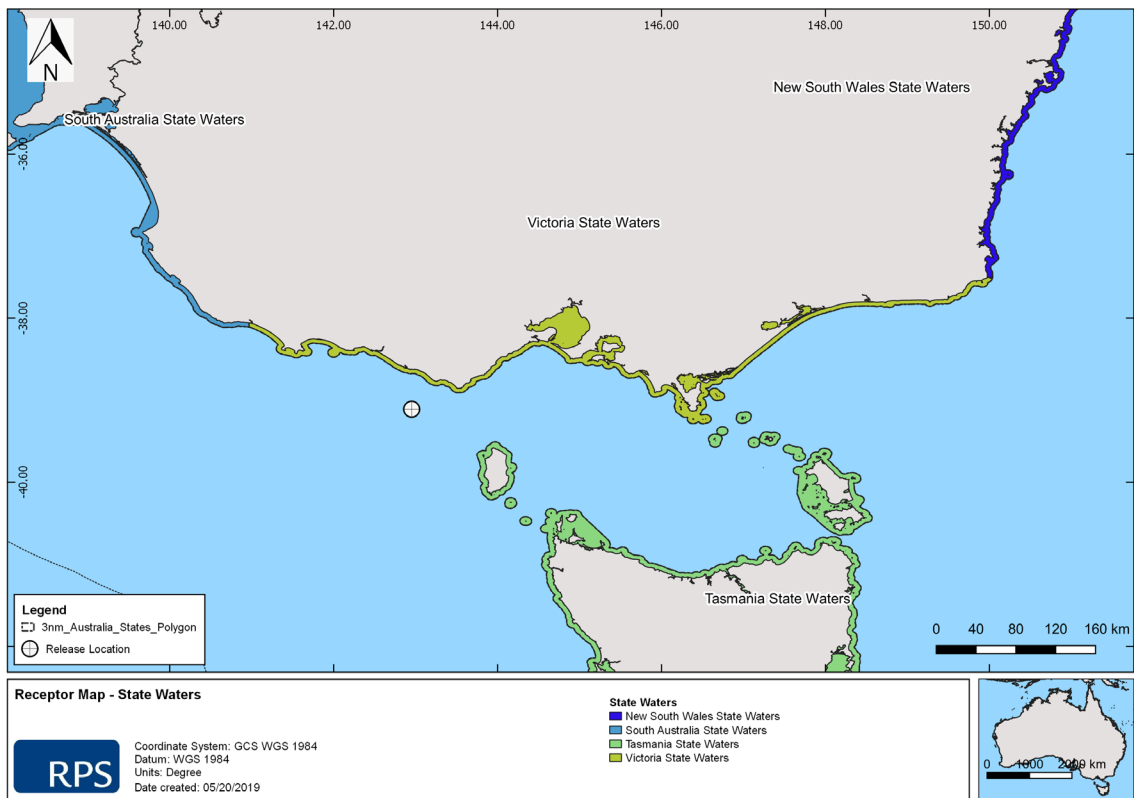


Figure 34 Receptor map of state waters.

9 RESULTS: 300 M³ SURFACE RELEASE OF MARINE DIESEL OIL

The scenario examined a 300 m³ release of MDO over 6 hours (tracked for 30 days) to represent a containment loss from a vessel at the Artisan-1 well location. A total of 100 spill trajectories were simulated for each of the seasons assessed, summer and winter.

Section 9.1 presents stochastic results in tabulated format.

Note, no shoreline contact was predicted for any of the seasons modelled above the minimum threshold.

9.1 Stochastic Analysis

9.1.1 Sea Surface Exposure

Table 13 presents a summary of the maximum distances and directions travelled by oil on the sea surface at the low (0.5-10 g/m²), moderate (10-25 g/m²) and high (>25 g/m²) exposure thresholds for the two seasons. During summer conditions, low and moderate exposure was predicted up to 68 km and 12 km from the release location, respectively. Under winter conditions, low and moderate exposure was predicted up to 93 km and 10 km from the release location, respectively.

Table 14 presents the potential sea surface exposure to individual receptors predicted during summer and winter conditions. The modelling results demonstrated a 1% probability of oil exposure on the sea surface for the Central Victoria IMCRA receptor during the summer conditions. Stochastic results obtained during winter conditions exhibited a 1% probability of oil exposure on the sea surface for several receptors including the Central Victoria and Central Bass Strait IMCRA receptors, Apollo AMP and within Victorian State Waters.

None of the receptors were exposed at or above the moderate or high thresholds, with the exception of Otway IMCRA. The Otway IMCRA receptor recorded low, moderate and high exposure due to the release location being situated within the boundaries of this receptor.

Table 13 Maximum distance and direction travelled on the sea surface by a single spill trajectory from the release location to the specified oil exposure thresholds.

Season	Distance and direction	Zones of potential sea surface exposure		
		Low	Moderate	High
Summer	Max. distance from release location (km)	68	12	6
	Max distance from release location (km) (99 th percentile)	35	11	6
	Direction	E	NNE	E
Winter	Max. distance from release location (km)	93	10	6
	Max distance from release location (km) (99 th percentile)	56	10	6
	Direction	E	WNW	ENE

Table 14 Summary of the potential sea surface exposure to individual receptors

Season	Receptor		Probability of oil exposure on the sea surface (%) for each threshold			Minimum time before oil exposure on the sea surface (hours) for each threshold		
			Low	Moderate	High	Low	Moderate	High
Summer	IMCRA	Otway	100	98	48	1	1	1
		Central Victoria	1	-	-	89	-	-
Winter	IMCRA	Otway	100	98	41	1	1	1
		Central Victoria	1	-	-	133	-	-
		Central Bass Strait	1	-	-	71	-	-
	AMP	Apollo	1	-	-	35	-	-
	State Waters	Victoria State Waters	1	-	-	133	-	-

9.1.2 Water Column Exposure

9.1.2.1 Dissolved Hydrocarbons

Table 15 and Table 16 summarise the probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer and winter conditions.

The averaged dissolved hydrocarbon concentrations over 48 hours was highest within the Otway IMCRA receptor which registered 8 ppb and 9 ppb during summer and winter conditions, respectively. A 1% probability of exposure. No other receptors were exposed at or above the specified thresholds.

Based on the 1 hour exposure window, the Otway IMCRA receptor recorded the greatest dissolved hydrocarbon concentration of 76 ppb during summer and 59 ppb during winter. The Otway IMCRA receptor recorded a probability of 2% and 3% during the summer and winter conditions, respectively, based on the moderate threshold. There was no predicted exposure to other receptors at the moderate or high thresholds.

Table 15 Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer conditions.

SUMMER Receptor		Maximum dissolved hydrocarbon exposure (ppb) for 48 hour window	Probability of time-averaged dissolved hydrocarbon exposure for 48 hour window			Maximum dissolved hydrocarbon exposure (ppb) for 1 hour window	Probability of instantaneous dissolved hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
LGA	Colac Otway	1	-	-	-	6	1	-	-
SUB-LGA	Apollo Bay	1	-	-	-	6	1	-	-
IMCRA	Otway	8	1	-	-	76	47	2	-
	Central Victoria	1	-	-	-	21	2	-	-
	Central Bass Strait	1	-	-	-	20	1	-	-
IBRA	Otway Ranges	1	-	-	-	6	1	-	-
	Otway Plain	1	-	-	-	5	-	-	-
AMP	Apollo	1	-	-	-	22	3	-	-
State Waters	Victoria State Waters	1	-	-	-	17	2	-	-

Table 16 Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during winter conditions.

WINTER Receptor		Maximum dissolved hydrocarbon exposure (ppb) for 48 hour window	Probability of time-averaged dissolved hydrocarbon exposure*			Maximum dissolved hydrocarbon exposure (ppb) for 1 hour window	Probability of instantaneous dissolved hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
LGA	Colac Otway	1	-	-	-	8	1	-	-
SUB-LGA	Cape Otway West	1	-	-	-	8	1	-	-
IMCRA	Otway	9	2	-	-	59	70	3	-
	Central Victoria	2	-	-	-	19	3	-	-
	Central Bass Strait	1	-	-	-	17	2	-	-
IBRA	Otway Ranges	1	-	-	-	5	-	-	-
	Otway Plain	1	-	-	-	8	1	-	-
AMP	Apollo	2	-	-	-	24	5	-	-
State Waters	Victoria State Waters	1	-	-	-	13	2	-	-

9.1.2.2 Entrained Hydrocarbons

Table 17 and Table 18 summarise the probability and maximum entrained hydrocarbon exposure for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer and winter conditions.

The maximum entrained hydrocarbon concentrations over 48 hour exposure window during summer and winter conditions was 2,182 ppb and 792 ppb, respectively. None of the receptors with the exception of the Otway IMCRA receptor were exposed at or above the moderate (100-1,000 ppb) or high (>1,000 ppb) thresholds during summer or winter conditions.

Based on the 1 hour exposure window, the maximum entrained hydrocarbon concentrations predicted for the Otway IMCRA receptor during summer and winter conditions was 5,933 ppb and 5,046 ppb, respectively. The probability of exposure at or above the moderate (100-1,000 ppb) threshold to receptors other than IMCRA Otway (83% summer and 93% winter) ranged from 1% (Cape Patton sub-LGA) to 8% (Victorian State Waters) during summer conditions and 1% (Twelve Apostles MNP) to 16% (Apollo AMP) during winter conditions. None of the receptors was exposed at or above the high threshold (1,000 ppb), with the exception of IMCRA – Otway.

Table 17 Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during summer conditions.

SUMMER Receptor		Maximum time-entrained hydrocarbon exposure (ppb) for 48 hour window	Probability of entrained hydrocarbon exposure for 48 hour window			Maximum entrained hydrocarbon exposure (ppb) for 1 hour window	Probability of entrained hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	166	-	-	-	406	25	7	-
	Glenelg Plain	58	-	-	-	33	9	-	-
	Bridgewater	58	-	-	-	31	5	-	-
IBRA	Warrnambool Plain	317	-	-	-	228	25	4	-
	Otway Ranges	254	-	-	-	218	25	2	-
	Otway Plain	284	-	-	-	208	28	3	-
	Gippsland Plain	39	-	-	-	21	1	-	-
	Wilson's Promontory	21	-	-	-	12	1	-	-
IMCRA	Otway	2,182	1	-	-	5,933	97	83	39
	Victorian Embayments	14	-	-	-	11	1	-	-
	Central Victoria	178	-	-	-	399	22	5	-
	Central Bass Strait	172	-	-	-	334	13	2	-
	Flinders	22	-	-	-	13	1	-	-
KEF	Bonney Coast Upwelling	125	-	-	-	98	22	-	-
MNP	Discovery Bay	48	-	-	-	25	3	-	-
	Twelve Apostles	372	-	-	-	278	26	6	-
NP	Lower South East	24	-	-	-	22	2	-	-
	Bunurong Marine Park	24	-	-	-	14	1	-	-
	Wilson's Promontory Marine Park	21	-	-	-	12	1	-	-
LGA	Phillip Island	20	-	-	-	19	1	-	-
	Norman Island	21	-	-	-	12	1	-	-

	Shellback Island	20	-	-	-	11	1	-	-
	Glenelg	58	-	-	-	33	9	-	-
	Warrnambool	46	-	-	-	24	8	-	-
	Moyne	172	-	-	-	96	17	-	-
	Corangamite	317	-	-	-	218	26	4	-
	Colac Otway	284	-	-	-	208	28	3	-
	Surf Coast	69	-	-	-	48	5	-	-
	Mornington Peninsula	19	-	-	-	11	1	-	-
	Bass Coast	40	-	-	-	21	1	-	-
	South Gippsland	22	-	-	-	12	1	-	-
	Grant	26	-	-	-	20	1	-	-
	Lady Julia Percy Island	73	-	-	-	43	5	-	-
	Laurence Rocks	41	-	-	-	26	7	-	-
State Waters	South Australia State Waters	31	-	-	-	26	2	-	-
	Victoria State Waters	372	-	-	-	388	30	8	-
SUB-LGA	Wilsons Promontory (West)	22	-	-	-	12	1	-	-
	Venus Bay	21	-	-	-	13	1	-	-
	Kilcunda	40	-	-	-	21	1	-	-
	French Island / San Remo	14	-	-	-	10	1	-	-
	Mornington Peninsula (SW)	18	-	-	-	10	1	-	-
	Port Phillip (Sorrento Shore)	18	-	-	-	11	1	-	-
	Anglesea	21	-	-	-	13	3	-	-
	Lorne	78	-	-	-	49	5	-	-
	Cape Patton	156	-	-	-	132	14	1	-
	Apollo Bay	168	-	-	-	208	21	3	-
	Cape Otway West	284	-	-	-	197	28	2	-
	Moonlight Head	317	-	-	-	218	26	4	-
	Port Campbell	220	-	-	-	157	18	2	-

Bay of Islands	172	-	-	-	96	17	-	-
Childers Cove	62	-	-	-	43	10	-	-
Warrnambool	27	-	-	-	23	7	-	-
Port Fairy	56	-	-	-	36	2	-	-
Portland Bay (East)	31	-	-	-	21	2	-	-
Portland Bay (West)	38	-	-	-	21	1	-	-
Cape Nelson	58	-	-	-	31	9	-	-
Discovery Bay (East)	46	-	-	-	24	2	-	-
Discovery Bay (West)	24	-	-	-	16	2	-	-

Table 18 Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during winter conditions.

WINTER Receptor		Maximum time-entrained hydrocarbon exposure (ppb) for 48 hour window	Probability of entrained hydrocarbon exposure for 48 hour window			Maximum entrained hydrocarbon exposure (ppb) for 1 hour window	Probability of entrained hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	99	-	-	-	501	54	16	-
	Beagle	6	-	-	-	11	2	-	-
IBRA	Flinders	5	-	-	-	10	1	-	-
	Warrnambool Plain	54	-	-	-	98	17	-	-
	Otway Ranges	169	-	-	-	196	21	4	-
	Otway Plain	298	-	-	-	448	27	6	-
	Gippsland Plain	20	-	-	-	23	8	-	-
	Strzelecki Ranges	12	-	-	-	13	1	-	-
	Wilsons Promontory	19	-	-	-	21	3	-	-
	Twofold Shelf	5	-	-	-	10	1	-	-
IMCRA	Otway	792	2	-	-	5,046	99	93	58
	Victorian Embayments	18	-	-	-	20	3	-	-
	Central Victoria	137	-	-	-	446	54	14	-
	Central Bass Strait	69	-	-	-	386	51	13	-
	Flinders	19	-	-	-	22	4	-	-
KEF	West Tasmania Canyons	12	-	-	-	14	1	-	-
	Bonney Coast Upwelling	13	-	-	-	15	1	-	-
MNP	Bunurong	10	-	-	-	12	1	-	-
	Point Addis	16	-	-	-	17	2	-	-
	Port Phillip Heads	15	-	-	-	19	4	-	-

	Twelve Apostles	129	-	-	-	283	15	1	-
	Wilsons Promontory	14	-	-	-	16	3	-	-
NP	Wilsons Promontory Marine Park	17	-	-	-	20	2	-	-
RAMSAR	Port Phillip Bay and Bellarine Peninsula	7	-	-	-	10	1	-	-
	Phillip Island	19	-	-	-	22	3	-	-
	Hogan Island Group	5	-	-	-	10	1	-	-
	Glennie Group	14	-	-	-	15	3	-	-
	Norman Island	19	-	-	-	20	3	-	-
	Shellback Island	17	-	-	-	21	2	-	-
	Anser Island	11	-	-	-	12	2	-	-
	Kanowna Island	10	-	-	-	12	2	-	-
	Skull Rock	10	-	-	-	12	2	-	-
LGA	Warrnambool	8	-	-	-	10	1	-	-
	Moyne	49	-	-	-	71	6	-	-
	Corangamite	44	-	-	-	98	18	-	-
	Colac Otway	298	-	-	-	448	27	6	-
	Surf Coast	21	-	-	-	23	3	-	-
	Greater Geelong	20	-	-	-	22	3	-	-
	Mornington Peninsula	20	-	-	-	23	8	-	-
	South Gippsland	18	-	-	-	21	2	-	-
	Lady Julia Percy Island	8	-	-	-	11	1	-	-
State Waters	Tasmania State Waters	6	-	-	-	11	2	-	-
	Victoria State Waters	298	-	-	-	548	40	9	-
	Wilsons Promontory (West)	18	-	-	-	21	2	-	-
SUB-LGA	Waratah Bay	12	-	-	-	13	1	-	-
	Cape Liptrap (NW)	13	-	-	-	15	1	-	-

Westernport	11	-	-	-	14	2	-	-
Mornington Peninsula (S)	14	-	-	-	16	8	-	-
Mornington Peninsula (SW)	20	-	-	-	23	8	-	-
Port Phillip (Sorrento Shore)	20	-	-	-	22	4	-	-
Port Phillip Heads	10	-	-	-	13	3	-	-
Port Phillip (Queenscliff)	11	-	-	-	15	3	-	-
Torquay	20	-	-	-	22	2	-	-
Anglesea	12	-	-	-	14	2	-	-
Lorne	16	-	-	-	18	3	-	-
Cape Patton	68	-	-	-	95	7	-	-
Apollo Bay	70	-	-	-	84	27	-	-
Cape Otway West	298	-	-	-	448	27	6	-
Moonlight Head	44	-	-	-	98	18	-	-
Port Campbell	43	-	-	-	65	7	-	-
Bay of Islands	49	-	-	-	71	6	-	-
Childers Cove	31	-	-	-	41	1	-	-

*Concentration recorded over a 48-hour window.

^Instantaneous concentration recorded over one hour.

10 RESULTS: 222,224 BBL SUBSEA RELEASE OF CONDENSATE

The scenario examined a 222,224 bbl subsea release of Thylacine condensate over 86 days (tracked for 114 days) to represent an unrestricted open-hole loss of well control from Artisan-1 well location. A total of 100 spill trajectories were simulated for each of the seasons assessed, summer and winter.

Section 10.1 presents stochastic results for sea surface, shoreline and in-water exposure in tabulated format.

10.1 Stochastic Analysis

10.1.1 Sea Surface Exposure and Shoreline Contact

Table 19 presents a summary of the maximum distance and direction travelled by condensate on the sea surface at the low (0.5-10 g/m²), moderate (10-25 g/m²) and high (>25 g/m²) exposure thresholds for each of the two seasons considered, summer and winter. During summer conditions, low and moderate exposure of surface hydrocarbons were predicted up to 52 km and 4 km from the release location, respectively, while during winter, low and moderate exposure surface hydrocarbons extended to a maximum distance of 53 km and 3 km from the release location, respectively. Note, no high exposure from surface hydrocarbons was predicted for any of the seasons assessed.

Table 20 presents the potential sea surface exposure to individual receptors predicted during summer and winter conditions. The probability of hydrocarbon exposure on the sea surface at or above the low threshold was predicted to range from 6% (Otway Ranges IBRA) to 16% (Colac Otway LGA, Cape Otway West sub-LGA and Victorian State Waters) during summer conditions, with the exception of Otway IMCRA receptor (100%). The winter stochastic modelling results demonstrated a larger number of receptors potentially exposed to surface hydrocarbons at or above low levels with a probability of exposure predicted to range from 3% (Twelve Apostles MNP and Otway Ranges IBRA) to 40% (Otway Plain IBRA, Cape Otway West sub-LGA and Colac Otway LGA), with the exception of Otway IMCRA (100%) and within Victorian State Waters (57%). None of the receptors other than the Otway IMCRA were exposed at or above the moderate or high thresholds for any seasons assessed.

Table 21 presents a summary of potential hydrocarbon contact to any shorelines for summer and winter conditions while Table 22 summarises potential shoreline contact to individual receptors, for each season.

The probability of contact to any shoreline was 16% and 57% for the summer and winter season, respectively, while the minimum time for visible surface hydrocarbon to reach a shoreline was 3 days for 5 days, respectively. The maximum volume of hydrocarbons predicted to come ashore was 15 m³ and 33 m³, during summer and winter conditions, respectively, while the maximum length of shoreline contacted above the low threshold (>10 g/m²) was 7.0 km and 11.0 km, respectively. Note, no shoreline loading above 1,000 g/m² was predicted.

The Otway IMCRA shoreline was the only receptor to record of contact above 100 g/m² with a probability of 3% during summer and 2% during winter conditions. The modelling results during winter conditions demonstrated additional shoreline contact to Moyne, Corangamite, Moonlight head and Childers Cove.

Table 19 Maximum distance and direction travelled on the sea surface by a single spill trajectory from the release location to the specified oil exposure thresholds.

Season	Distance and direction	Zones of potential sea surface exposure		
		Low	Moderate	High
Summer	Max. distance from release site (km)	52	4	NA
	Max distance from release site (km) (99 th percentile)	34	4	NA
	Direction	E	E	NA
Winter	Max. distance from release site (km)	53	3	NA
	Max distance from release site (km) (99 th percentile)	49	3	NA
	Direction	NNW	W	NA

Table 20 Summary of the potential sea surface exposure to individual receptors

Season	Receptor	Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (hours)			
		Low	Moderate	High	Low	Moderate	High	
Summer	LGA	Colac Otway	16	-	-	80	-	-
	SUB-LGA	Cape Otway West	16	-	-	80	-	-
	IMCRA	Otway	100	100	-	1	3	-
	IBRA	Otway Ranges	6	-	-	1,343	-	-
		Otway Plain	12	-	-	80	-	-
State Waters	Victoria State Waters	16	-	-	80	-	-	
Winter	LGA	Moyne	8	-	-	649	-	-
		Corangamite	14	-	-	311	-	-
		Colac Otway	40	-	-	188	-	-
	SUB-LGA	Cape Otway West	40	-	-	188	-	-
		Moonlight Head	14	-	-	311	-	-
		Childers Cove	8	-	-	649	-	-
	IMCRA	Otway	100	100	-	1	2	-
	IBRA	Warrnambool Plain	22	-	-	311	-	-
		Otway Ranges	3	-	-	413	-	-
		Otway Plain	40	-	-	188	-	-
	MNP	Twelve Apostles	3	-	-	821	-	-
State Waters	Victoria State Waters	57	-	-	188	-	-	

Table 21 Summary of potential oil contact to any shoreline for each season assessed

Shoreline statistics	Summer	Winter
Probability of contact to any shoreline (%)	16	57
Minimum time for visible oil to reach a shoreline (days)	3	5
Maximum volume of hydrocarbons ashore (m ³)	15	33
Average volume of hydrocarbons ashore (m ³)	1	5
Maximum length of the shoreline >10 g/m ² (km)	7.0	11.0
Average shoreline length (km) >10 g/m ² (km)	4.7	5.6
Maximum length of the shoreline >100 g/m ² (km)	4.0	8.0
Average shoreline length (km) >100 g/m ² (km)	2.4	3.5
Maximum length of the shoreline >1,000 g/m ² (km)	-	-
Average shoreline length (km) > 1,000 g/m ² (km)	-	-

Table 22 Summary of the potential shoreline contact to individual receptors for each season assessed

Season	Receptor	Probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m ²)		Volume on shoreline (m ³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
		>10 g/m ²	>100 g/m ²	>1,000 g/m ²	>10 g/m ²	>100 g/m ²	>1,000 g/m ²	Mean	Peak	Mean	Peak	>10 g/m ²	>100 g/m ²	>1,000 g/m ²	>10 g/m ²	>100 g/m ²	>1,000 g/m ²
Summer	Colac Otway	16	15	-	77	277	-	136	520	1	15	5	2	-	7	4	-
	Cape Otway West	16	15	-	77	277	-	136	520	1	15	5	2	-	7	4	-
Winter	Moyne	8	8	-	26	27	-	88	130	<1	5	4	2	-	5	2	-
	Corangamite	14	10	-	635	654	-	241	984	2	23	4	3	-	5	3	-
	Colac Otway	40	40	-	125	247	-	194	670	5	33	6	4	-	11	8	-
	Cape Otway West	40	40	-	109	174	-	194	670	5	33	6	4	-	11	8	-
	Moonlight Head	14	10	-	109	174	-	241	984	2	23	4	3	-	5	3	-
	Childers Cove	8	8	-	125	247	-	88	130	<1	5	4	2	-	5	2	-

10.1.2 Water Column Exposure

10.1.2.1 Dissolved Hydrocarbons

Table 23 and Table 24 summarise the probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer and winter conditions.

For the 48 hour time-averaged exposure window, dissolved hydrocarbons remained below 30 ppb in summer and 34 ppb in winter conditions, and hence no moderate or high exposure was predicted under the seasonal conditions modelled. During summer conditions, the probability of low exposure ranged from 1% (Bonney Coast Upwelling KEF, Moyne LGA, Bay of Islands and Childers Cove sub-LGAs) to 17% (Otway Plain IBRA, Colac Otway LGA, Cape Otway West sub-LGA and within Victoria State Waters) The Otway IMCRA recorded a probability of 50% during summer. During winter conditions, the probability of low exposure to dissolved hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF, Bay of Islands and Lorne sub-LGA) to 16% (within Victoria State Waters). The Otway IMCRA registered a probability of 42% for winter. None of the receptors were exposed to moderate (50 – 400 ppb) or high (>400 ppb) dissolved hydrocarbons (over a 48 hour basis) during the summer or winter season.

The analysis for the dissolved hydrocarbons over a 1 hour window showed that the maximum exposure was 309 ppb during summer and 289 ppb during winter, which was predicted within the Otway IMCRA and Victorian State Waters. During summer conditions, the probability of moderate exposure to dissolved hydrocarbons ranged from 1% (Glenelg Plain and Bridgewater IBRA's; Glenelg, Moyne and Surf Coast LGAs; Lorne, Bay of Islands, Childers Cove and Cape Nelson sub-LGAs) to 43% (Otway Plain IBRA, Colac Otway LGA, Cape Otway West sub-LGA and within Victoria State Waters). The probability for Otway IMCRA was 58%. Under winter conditions, the probability of moderate exposure (over 1 hour) to dissolved hydrocarbons ranged from 1% (Gippsland Plain IBRA; Flinders IMCRA; Point Addis and Wilsons Promontory MNP; Mornington Peninsula LGA; Lorne, Mornington Peninsula and Childers Cove sub-LGAs) to 57% for the Victorian State Waters. The probability of exposure to the Otway IMCRA was 68%. None of the receptors were exposed high concentrations during the summer or winter season.

Table 23 Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer conditions.

SUMMER		Maximum dissolved hydrocarbon exposure (ppb) for 48 hour window	Probability of time-averaged dissolved hydrocarbon exposure for 48 hour window			Maximum dissolved hydrocarbon exposure (ppb) for 1 hour window	Probability of instantaneous dissolved hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
Receptor									
AMP	Apollo	20	11	-	-	225	98	30	-
	Beagle	1	-	-	-	9	1	-	-
	Nelson	1	-	-	-	18	3	-	-
	Zeehan	1	-	-	-	19	4	-	-
IBRA	Glenelg Plain	6	-	-	-	53	25	1	-
	Bridgewater	4	-	-	-	54	20	1	-
	Warrnambool Plain	24	5	-	-	217	99	14	-
	Otway Ranges	13	7	-	-	161	100	27	-
	Otway Plain	23	17	-	-	235	98	43	-
	Gippsland Plain	3	-	-	-	28	11	-	-
	Wilsons Promontory	1	-	-	-	12	3	-	-
IMCRA	Coorong	0	-	-	-	12	1	-	-
	Otway	30	50	-	-	309	100	58	-
	Victorian Embayment	3	-	-	-	31	6	-	-
	Central Victoria	18	9	-	-	253	95	28	-
	Central Bass Strait	17	6	-	-	254	88	20	-
	Flinders	2	-	-	-	26	5	-	-
KEF	West Tasmania Canyons	2	-	-	-	34	8	-	-
	Bonney Coast Upwelling	10	1	-	-	97	60	2	-
MNP	Churchill Island	1	-	-	-	7	2	-	-
	Discovery Bay	3	-	-	-	41	15	-	-
	Point Addis	2	-	-	-	34	14	-	-
	Port Phillip Heads	2	-	-	-	21	7	-	-
	Twelve Apostles	27	6	-	-	217	98	20	-
	Wilsons Promontory	2	-	-	-	12	2	-	-

MP	Lower South East	1	-	-	-	16	3	-	-
	Bunurong Marine Park	1	-	-	-	10	3	-	-
NP	Wilson's Promontory Marine Park	1	-	-	-	6	1	-	-
	Port Phillip Bay and Bellarine Peninsula	1	-	-	-	31	4	-	-
RAMSAR	Western Port	1	-	-	-	12	2	-	-
SHORE	Phillip Island	2	-	-	-	24	11	-	-
	Mud Island	1	-	-	-	12	2	-	-
	Moncoeur Islands	1	-	-	-	9	1	-	-
	Rodondo Island	1	-	-	-	11	2	-	-
	Glennie Group	1	-	-	-	12	3	-	-
	Norman Island	1	-	-	-	10	1	-	-
	Anser Island	1	-	-	-	6	1	-	-
	Kanowna Island	1	-	-	-	10	1	-	-
	Skull Rock	1	-	-	-	7	1	-	-
	Glenelg	6	-	-	-	54	25	1	-
	Warrnambool	5	-	-	-	46	25	-	-
	Moyne	7	1	-	-	66	74	1	-
	Corangamite	24	5	-	-	217	100	17	-
	Colac Otway	23	17	-	-	235	100	43	-
	Surf Coast	5	-	-	-	57	24	1	-
	Greater Geelong	2	-	-	-	31	8	-	-
	Mornington Peninsula	3	-	-	-	28	11	-	-
	Bass Coast	1	-	-	-	21	5	-	-
	South Gippsland	1	-	-	-	7	1	-	-
	Grant	1	-	-	-	19	3	-	-
Lady Julia Percy Island	2	-	-	-	28	22	-	-	
Laurence Rocks	5	-	-	-	18	20	-	-	
State Waters	South Australia State Waters	1	-	-	-	26	6	-	-
	Victoria State Waters	30	17	-	-	309	100	43	-
SUB-LGA	Wilson's Promontory (West)	1	-	-	-	6	1	-	-
	Cape Liptrap (NW)	1	-	-	-	7	1	-	-
	Venus Bay	1	-	-	-	10	3	-	-

Kilcunda	1	-	-	-	21	5	-	-
French Island / San Remo	1	-	-	-	14	4	-	-
French Island / Crib Point	1	-	-	-	6	1	-	-
Westernport	1	-	-	-	13	6	-	-
Mornington Peninsula (S)	1	-	-	-	14	7	-	-
Mornington Peninsula (SW)	2	-	-	-	24	11	-	-
Port Phillip (Sorrento Shore)	3	-	-	-	23	8	-	-
Port Phillip Heads	1	-	-	-	31	6	-	-
Port Phillip (Queenscliff)	2	-	-	-	23	7	-	-
Torquay	3	-	-	-	23	8	-	-
Anglesea	3	-	-	-	32	12	-	-
Lorne	5	-	-	-	57	24	1	-
Cape Patton	11	2	-	-	161	85	8	-
Apollo Bay	13	4	-	-	154	95	15	-
Cape Otway West	23	17	-	-	235	100	43	-
Moonlight Head	24	5	-	-	217	100	17	-
Port Campbell	12	3	-	-	103	77	6	-
Bay of Islands	7	1	-	-	66	74	1	-
Childers Cove	7	1	-	-	55	55	1	-
Warrnambool	3	-	-	-	36	16	-	-
Port Fairy	2	-	-	-	23	11	-	-
Portland Bay (East)	1	-	-	-	10	2	-	-
Cape Nelson	6	-	-	-	54	25	1	-
Discovery Bay (East)	1	-	-	-	11	2	-	-
Discovery Bay (West)	1	-	-	-	8	1	-	-

Table 24 Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during winter conditions .

WINTER Receptor		Maximum dissolved hydrocarbon exposure (ppb) for 48 hour window	Probability of time-averaged dissolved hydrocarbon exposure for 48 hour window			Maximum dissolved hydrocarbon exposure (ppb) for 1 hour window	Probability of instantaneous dissolved hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	13	7	-	-	237	100	39	-
	Beagle	2	-	-	-	37	13	-	-
	Zeehan	1	-	-	-	16	3	-	-
IBRA	King Island	1	-	-	-	9	1	-	-
	Flinders	1	-	-	-	9	2	-	-
	Glenelg Plain	4	-	-	-	19	2	-	-
	Bridgewater	2	-	-	-	8	1	-	-
	Warrnambool Plain	14	4	-	-	237	100	21	-
	Otway Ranges	14	6	-	-	248	100	35	-
	Otway Plain	30	10	-	-	203	100	51	-
	Gippsland Plain	6	-	-	-	51	16	1	-
	Strzelecki Ranges	4	-	-	-	31	18	-	-
	Wilsons Promontory	4	-	-	-	34	21	-	-
IMCRA	Twofold Shelf	2	-	-	-	28	6	-	-
	Otway	34	42	-	-	289	100	68	-
	Victorian Embayments	4	-	-	-	36	9	-	-
	Central Victoria	25	7	-	-	235	100	33	-
	Central Bass Strait	17	4	-	-	282	100	26	-
	Flinders	5	-	-	-	66	27	1	-
KEF	West Tasmania Canyons	4	-	-	-	36	8	-	-
	Bonney Coast Upwelling	6	1	-	-	86	19	2	-
	Upwelling East of Eden	1	-	-	-	9	1	-	-
MNP	Bunurong	2	-	-	-	34	10	-	-
	Churchill Island	1	-	-	-	8	1	-	-
	Point Addis	5	-	-	-	51	41	1	-

RPS

	Port Phillip Heads	1	-	-	-	15	8	-	-
	Twelve Apostles	16	6	-	-	155	100	18	-
	Wilson's Promontory	5	-	-	-	66	23	1	-
NP	Bunurong Marine Park	1	-	-	-	24	8	-	-
	Wilson's Promontory Marine Park	4	-	-	-	33	9	-	-
RAMSAR	Port Phillip Bay and Bellarine Peninsula	1	-	-	-	14	2	-	-
	Western Port	3	-	-	-	22	2	-	-
SHORE	King Island	1	-	-	-	9	1	-	-
	Seal Islands	2	-	-	-	15	2	-	-
	Phillip Island	3	-	-	-	26	13	-	-
	French Island	1	-	-	-	10	1	-	-
	Moncoeur Islands	1	-	-	-	26	8	-	-
	Hogan Island Group	1	-	-	-	9	2	-	-
	Rodondo Island	1	-	-	-	24	13	-	-
	Glennie Group	4	-	-	-	34	21	-	-
	Norman Island	3	-	-	-	33	16	-	-
	Shellback Island	2	-	-	-	24	9	-	-
	Anser Island	2	-	-	-	27	18	-	-
	Kanowna Island	3	-	-	-	18	18	-	-
	Skull Rock	3	-	-	-	16	18	-	-
	Glenelg	4	-	-	-	19	2	-	-
	Warrnambool	5	-	-	-	34	13	-	-
	Moyne	14	4	-	-	87	60	5	-
	Corangamite	14	5	-	-	237	100	21	-
	Colac Otway	30	10	-	-	212	100	51	-
	Surf Coast	4	-	-	-	46	50	-	-
	Greater Geelong	2	-	-	-	26	15	-	-
Mornington Peninsula	6	-	-	-	52	13	1	-	
Bass Coast	2	-	-	-	24	9	-	-	
South Gippsland	4	-	-	-	43	18	-	-	
Lady Julia Percy Island	2	-	-	-	20	7	-	-	

	Laurence Rocks	1	-	-	-	19	2	-	-
State Waters	Tasmania State Waters	1	-	-	-	15	3	-	-
	Victoria State Waters	34	16	-	-	289	100	57	-
	Wilsons Promontory (East)	2	-	-	-	31	11	-	-
	Wilsons Promontory (West)	4	-	-	-	33	14	-	-
	Waratah Bay	4	-	-	-	31	18	-	-
	Cape Liptrap (NW)	4	-	-	-	43	16	-	-
	Venus Bay	2	-	-	-	24	9	-	-
	Kilcunda	1	-	-	-	18	7	-	-
	French Island / San Remo	1	-	-	-	8	2	-	-
	French Island / Crib Point	1	-	-	-	8	1	-	-
	Westernport	6	-	-	-	31	6	-	-
	Mornington Peninsula (S)	6	-	-	-	51	12	1	-
	Mornington Peninsula (SW)	4	-	-	-	33	11	-	-
	Port Phillip (Sorrento Shore)	2	-	-	-	26	10	-	-
	Port Phillip Heads	1	-	-	-	14	4	-	-
SUB-LGA	Port Phillip (Queenscliff)	2	-	-	-	25	15	-	-
	Torquay	3	-	-	-	44	16	-	-
	Anglesea	4	-	-	-	40	31	-	-
	Lorne	7	1	-	-	57	50	1	-
	Cape Patton	13	3	-	-	124	92	8	-
	Apollo Bay	14	4	-	-	212	100	21	-
	Cape Otway West	30	10	-	-	203	100	51	-
	Moonlight Head	14	4	-	-	237	100	21	-
	Port Campbell	9	3	-	-	112	67	5	-
	Bay of Islands	14	1	-	-	90	60	5	-
	Childers Cove	14	4	-	-	78	24	1	-
	Warrnambool	1	-	-	-	9	3	-	-
	Port Fairy	5	-	-	-	29	3	-	-
	Portland Bay (East)	1	-	-	-	15	1	-	-
	Cape Nelson	4	-	-	-	19	2	-	-

*Concentration recorded over a 48-hour window.

^Instantaneous concentration recorded over one hour.

10.1.2.2 Entrained Hydrocarbons

Table 25 and Table 26 summarise the probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer at, or above the exposure thresholds during summer and winter.

The maximum entrained hydrocarbon exposure over 48 hour window predicted for the summer and winter season was 559 ppb and 569 ppb, respectively, and hence no moderate or high exposure was predicted. During summer conditions, the probability of low exposure to entrained hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF; Moyne LGA; Bay of Islands and Childers Cove sub-LGAs) to 17% (Otway Plain IBRA; Colac Otway LGA; Cape Otway West sub-LGA and within Victorian State Waters), with the exception of IMCRA – Otway (50%). During winter conditions, the probability of low exposure to entrained hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF; Bay of Islands and Lorne sub-LGAs) to 16% (Victoria State Waters), with the exception of Otway IMCRA (42%).

For the 1 hour exposure window, the entrained hydrocarbon concentrations had peaked at 948 ppb during summer and 932 ppb during winter with the maximum values predicted within the Otway IMCRA. During summer conditions, the probability of moderate entrained hydrocarbon exposure ranged from 7% (Cape Patton sub-LGA) to 73% (Victorian State Waters). The probability of exposure to the Otway IMCRA receptor was 100% during both seasons. For other receptors during winter conditions, the probability of moderate entrained hydrocarbon exposure ranged from 8% (along the shoreline of Childers Cove sub-LGA; Moyne and Warrnambool LGA) to 73% (within Victorian State Waters).

Table 25 Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during summer conditions.

Receptor		Maximum time-entrained hydrocarbon exposure (ppb) for 48 hour window	Probability of entrained hydrocarbon exposure for 48 hour window			Maximum entrained hydrocarbon exposure (ppb) for 1 hour window	Probability of entrained hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	81	11	-	-	255	98	50	-
	Beagle	12	-	-	-	15	14	-	-
	Murray	7	-	-	-	10	1	-	-
	Zeehan	7	-	-	-	14	8	-	-
IBRA	Glenelg Plain	36	-	-	-	41	45	-	-
	Bridgewater	32	-	-	-	37	36	-	-
	Warrnambool Plain	255	5	-	-	293	100	38	-
	Otway Ranges	184	7	-	-	215	100	29	-
	Otway Plain	294	17	-	-	333	100	71	-
	Gippsland Plain	41	-	-	-	47	62	-	-
	Strzelecki Ranges	18	-	-	-	20	14	-	-
	Wilson's Promontory	24	-	-	-	28	21	-	-
IMCRA	Coorong	9	-	-	-	13	12	-	-
	Otway	559	50	-	-	948	100	100	-
	Victorian Embayment	37	-	-	-	42	52	-	-
	Central Victoria	117	9	-	-	255	96	50	-
	Central Bass Strait	94	6	-	-	220	95	38	-
	Flinders	24	-	-	-	28	29	-	-
KEF	West Tasmania Canyons	16	-	-	-	25	16	-	-
	Bonney Coast Upwelling	36	1	-	-	53	74	-	-
MNP	Bunurong	12	-	-	-	14	19	-	-
	Churchill Island	11	-	-	-	13	12	-	-
	Discovery Bay	14	-	-	-	17	20	-	-
	Point Addis	35	-	-	-	41	49	-	-
	Port Phillip Heads	31	-	-	-	35	49	-	-

	Twelve Apostles	256	6	-	-	302	100	60	-
	Wilson's Promontory	23	-	-	-	26	22	-	-
MP	Lower South East	10	-	-	-	13	16	-	-
NP	Bunurong Marine Park	17	-	-	-	20	36	-	-
	Corner Inlet Marine and Coastal	10	-	-	-	11	2	-	-
RAMSAR	Wilson's Promontory Marine Park	23	-	-	-	27	8	-	-
	Corner Inlet	10	-	-	-	11	2	-	-
	Port Phillip Bay and Bellarine	19	-	-	-	25	39	-	-
	Western Port	21	-	-	-	24	19	-	-
SHORE	Phillip Island	30	-	-	-	35	46	-	-
	Mud Island	23	-	-	-	28	29	-	-
	Moncoeur Islands	12	-	-	-	14	14	-	-
	Rodondo Island	13	-	-	-	17	16	-	-
	Glennie Group	22	-	-	-	25	20	-	-
	Norman Island	24	-	-	-	28	15	-	-
	Shellback Island	23	-	-	-	27	6	-	-
	Kanowna Island	14	-	-	-	16	21	-	-
	Skull Rock	15	-	-	-	17	21	-	-
	Glenelg	36	-	-	-	41	45	-	-
	Warrnambool	34	-	-	-	38	63	-	-
	Moyne	82	1	-	-	90	95	-	-
	Corangamite	255	5	-	-	293	100	30	-
	Colac Otway	294	17	-	-	333	100	71	-
	Surf Coast	47	-	-	-	59	48	-	-
	Greater Geelong	46	-	-	-	52	44	-	-
	Mornington Peninsula	41	-	-	-	47	62	-	-
	Bass Coast	20	-	-	-	23	41	-	-
	South Gippsland	24	-	-	-	27	28	-	-
	Grant	10	-	-	-	14	16	-	-
Lady Julia Percy Island	33	-	-	-	40	58	-	-	
Laurence Rocks	33	-	-	-	37	46	-	-	
State Waters	South Australia State Waters	13	-	-	-	22	17	-	-
	Victoria State Waters	296	17	-	-	336	100	73	-

SUB-LGA	Corner Inlet	10	-	-	-	12	3	-	-
	Wilson's Promontory (East)	11	-	-	-	14	17	-	-
	Wilson's Promontory (West)	24	-	-	-	27	20	-	-
	Waratah Bay	18	-	-	-	22	14	-	-
	Cape Liptrap (NW)	20	-	-	-	24	28	-	-
	Venus Bay	17	-	-	-	20	36	-	-
	Kilcunda	20	-	-	-	23	41	-	-
	French Island / San Remo	16	-	-	-	19	24	-	-
	French Island / Crib Point	9	-	-	-	12	9	-	-
	Westernport	25	-	-	-	29	42	-	-
	Mornington Peninsula (S)	33	-	-	-	39	60	-	-
	Mornington Peninsula (SW)	41	-	-	-	47	62	-	-
	Port Phillip (Sorrento Shore)	41	-	-	-	45	53	-	-
	Port Phillip (Mornington)	11	-	-	-	12	18	-	-
	Port Phillip Heads	25	-	-	-	32	41	-	-
	Port Phillip (Queenscliff)	31	-	-	-	36	44	-	-
	Torquay	46	-	-	-	52	39	-	-
	Anglesea	30	-	-	-	34	38	-	-
	Lorne	48	-	-	-	59	48	-	-
	Cape Patton	78	2	-	-	121	95	7	-
	Apollo Bay	80	4	-	-	139	95	17	-
	Cape Otway West	294	17	-	-	333	100	71	-
	Moonlight Head	255	5	-	-	293	100	30	-
	Port Campbell	155	3	-	-	196	100	27	-
	Bay of Islands	82	1	-	-	90	95	-	-
	Childers Cove	63	1	-	-	72	68	-	-
	Warrnambool	28	-	-	-	34	56	-	-
	Port Fairy	26	-	-	-	31	46	-	-
	Portland Bay (East)	15	-	-	-	18	12	-	-
	Portland Bay (West)	22	-	-	-	25	19	-	-
Cape Nelson	36	-	-	-	41	45	-	-	
Discovery Bay (East)	11	-	-	-	14	8	-	-	

*Concentration recorded over a 48-hour window.

^Instantaneous concentration recorded over one hour.

Table 26 Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during winter conditions.

Receptor		Maximum time-entrained hydrocarbon exposure (ppb) for 48 hour window	Probability of entrained hydrocarbon exposure for 48 hour window			Maximum entrained hydrocarbon exposure (ppb) for 1 hour window	Probability of entrained hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	85	7	-	-	225	100	48	-
	Beagle	18	-	-	-	24	40	-	-
IBRA	King Island	10	-	-	-	14	10	-	-
	Flinders	14	-	-	-	23	19	-	-
	Warrnambool Plain	178	4	-	-	214	100	39	-
	Otway Ranges	168	6	-	-	202	100	47	-
	Otway Plain	303	10	-	-	333	100	58	-
	Gippsland Plain	55	-	-	-	67	83	-	-
	Strzelecki Ranges	22	-	-	-	25	54	-	-
	Wilson's Promontory	69	-	-	-	79	74	-	-
	Bateman	6	-	-	-	6	-	-	-
IMCRA	Batemans Shelf	9	-	-	-	12	8	-	-
	Twofold Shelf	14	-	-	-	23	21	-	-
	Otway	569	42	-	-	932	100	100	-
	Victorian Embayments	28	-	-	-	32	57	-	-
	Central Victoria	112	7	-	-	225	100	48	-
	Central Bass Strait	105	4	-	-	227	100	23	-
	Flinders	72	-	-	-	84	75	-	-
KEF	West Tasmania Canyons	17	-	-	-	21	17	-	-
	Bonney Coast Upwelling	32	1	-	-	42	32	-	-
	Upwelling East of Eden	14	-	-	-	17	21	-	-
MNP	Bunurong	11	-	-	-	15	29	-	-
	Cape Howe	9	-	-	-	9	-	-	-
	Churchill Island	14	-	-	-	16	16	-	-
	Point Addis	34	-	-	-	38	72	-	-
	Port Phillip Heads	25	-	-	-	30	59	-	-
	Twelve Apostles	169	6	-	-	230	100	43	-

	Wilsons Promontory	71	-	-	-	84	74	-	-
AMP	Apollo	85	7	-	-	225	100	48	-
MP	Batemans	7	-	-	-	9	-	-	-
NP	Bunurong Marine Park	16	-	-	-	19	47	-	-
	Corner Inlet Marine and Coastal Park	10	-	-	-	12	10	-	-
	Shallow Inlet Marine and Coastal Park	10	-	-	-	12	9	-	-
	Wilsons Promontory Marine Park	60	-	-	-	67	72	-	-
RAMSAR	Corner Inlet	10	-	-	-	12	10	-	-
	Port Phillip Bay and Bellarine Peninsula	18	-	-	-	23	27	-	-
	Western Port	16	-	-	-	21	30	-	-
RSB	New Zealand Star Bank	7	-	-	-	9	-	-	-
SHORE	King Island	10	-	-	-	14	10	-	-
	Seal Islands	7	-	-	-	11	2	-	-
	Phillip Island	28	-	-	-	33	79	-	-
	French Island	11	-	-	-	18	11	-	-
	Mud Island	15	-	-	-	19	25	-	-
	Curtis Island	8	-	-	-	11	5	-	-
	Moncoeur Islands	18	-	-	-	24	38	-	-
	Hogan Island Group	14	-	-	-	23	19	-	-
	Rodondo Island	19	-	-	-	25	59	-	-
	Glennie Group	68	-	-	-	78	74	-	-
	Norman Island	71	-	-	-	84	74	-	-
	Shellback Island	36	-	-	-	44	69	-	-
	Montague Island	6	-	-	-	9	-	-	-
	Anser Island	41	-	-	-	49	69	-	-
	Kanowna Island	36	-	-	-	42	69	-	-
	Skull Rock	37	-	-	-	42	70	-	-
	Warrnambool	80	-	-	-	137	30	8	-
	Moyne	143	4	-	-	207	72	8	-
	Corangamite	178	5	-	-	214	100	36	-
	Colac Otway	303	10	-	-	333	100	58	-
Surf Coast	45	-	-	-	50	69	-	-	
Greater Geelong	45	-	-	-	51	54	-	-	

	Mornington Peninsula	37	-	-	-	42	83	-	-
	Bass Coast	19	-	-	-	23	52	-	-
	South Gippsland	65	-	-	-	72	73	-	-
	Eurobodalla	6	-	-	-	9	-	-	-
	Lady Julia Percy Island	32	-	-	-	37	24	-	-
	Laurence Rocks	8	-	-	-	12	4	-	-
State Waters	Tasmania State Waters	14	-	-	-	23	21	-	-
	Victoria State Waters	303	16	-	-	333	100	73	-
	New South Wales State Waters	9	-	-	-	13	11	-	-
	Eurobodalla	6	-	-	-	9	-	-	-
	Corner Inlet	10	-	-	-	12	10	-	-
	Wilson's Promontory (East)	22	-	-	-	27	56	-	-
	Wilson's Promontory (West)	65	-	-	-	72	73	-	-
	Waratah Bay	22	-	-	-	25	54	-	-
	Cape Liptrap (NW)	27	-	-	-	31	66	-	-
	Venus Bay	16	-	-	-	18	45	-	-
	Kilcunda	19	-	-	-	23	52	-	-
	French Island / San Remo	13	-	-	-	15	28	-	-
	French Island / Crib Point	12	-	-	-	19	11	-	-
	Westernport	23	-	-	-	28	64	-	-
SUB-LGA	Mornington Peninsula (S)	36	-	-	-	42	83	-	-
	Mornington Peninsula (SW)	37	-	-	-	42	83	-	-
	Port Phillip (Sorrento Shore)	31	-	-	-	35	75	-	-
	Port Phillip Heads	24	-	-	-	29	46	-	-
	Port Phillip (Queenscliff)	29	-	-	-	36	50	-	-
	Torquay	45	-	-	-	51	34	-	-
	Anglesea	29	-	-	-	34	49	-	-
	Lorne	39	1	-	-	50	69	-	-
	Cape Patton	67	3	-	-	95	99	-	-
	Apollo Bay	70	4	-	-	132	100	11	-
	Cape Otway West	303	10	-	-	333	100	58	-
	Moonlight Head	178	4	-	-	214	100	36	-
	Port Campbell	127	3	-	-	182	91	11	-

RPS

Bay of Islands	84	1	-	-	104	72	2	-
Childers Cove	143	4	-	-	207	46	8	-
Warrnambool	16	-	-	-	22	21	-	-
Port Fairy	12	-	-	-	16	14	-	-
Portland Bay (East)	9	-	-	-	11	2	-	-

*Concentration recorded over a 48-hour window.

^Instantaneous concentration recorded over one hour.

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Append E: Environmental Survey – Otway Basin



SUPPLIER DOCUMENT COVER PAGE

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ENVIRONMENTAL SURVEY OTWAY BASIN



ENVIRONMENTAL SURVEY OTWAY BASIN

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Description **Results of the environmental survey at Otway Basin for Beach Energy**

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CONTENTS

1.	Introduction	4
1.1	Background	4
1.2	Objective	4
1.3	Report Scope	4
2.	Survey Locations	5
3.	Method	8
3.1	Survey Operations	8
3.2	Water Quality	8
3.2.1	Sample Collection	8
3.2.2	Sample Processing and Analysis	10
3.3	Sediment Quality	11
3.3.1	Sample Collection	11
3.3.2	Sample Processing and Analysis	13
3.4	Infauna Ecology	14
3.4.1	Sample Collection	14
3.4.2	Sample Processing and Analysis	14
3.5	Epibenthic Ecology	16
3.5.1	Sample Collection	16
3.5.2	Sample Processing and Analysis	16
4.	Results	18
4.1	Water Quality	18
4.2	Sediment Quality	24
4.3	Infauna Ecology	31
4.4	Epibenthic Ecology	34
5.	Discussion	39
6.	References	41

TABLE OF FIGURES

Figure 1 Locations of environmental survey site extents in Otway Basin. Provided by Fugro, April 2020.	7
Figure 2 Water sampling locations for Thylacine and Artisan survey areas.	9
Figure 3 Grab sample locations for sediment and infauna for Thylacine and Artisan survey areas.	12
Figure 4 Drop camera locations for all survey areas.	17
Figure 5 Concentration of Zn in water samples from Thylacine and Artisan survey areas.	19

Figure 6 Particle size distribution (%) in sediment samples collected at Thylacine and Artisan survey areas.	24
Figure 7 Total organic content (%) in sediment samples collected at Thylacine and Artisan survey areas.	25
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).	26
Figure 9 Abundance of benthic infauna in grab samples at Thylacine and Artisan survey areas.	31
Figure 10 Diversity of benthic infauna in grab samples at Thylacine and Artisan survey areas.	31
Figure 11 Abundance of benthic infauna by taxonomic group in grab samples at Thylacine and Artisan survey areas.	32
Figure 12 Percent cover of epifauna at drop camera location in Otway Basin.	34
Figure 13 Percent cover of epifauna at drop camera sites in Otway Basin.	35
Figure 14 Example of the typical seabed epifauna with high percent cover at Thylacine 1 (TH1).	35

TABLE OF TABLES

Table 1 Location of proposed anchor points (GDA94 UTM 54 S) and water depth for drilling rig sites.	6
Table 2 Location (GDA94 UTM 54 S) and depth of water sample collection sites.	8
Table 3 Location (GDA94 UTM 54 S) and depth of sediment sample collection sites.	13
Table 4 Location (GDA94 UTM 54 S) and depth of infauna sample collection sites.	15
Table 5 Measurements made <i>insitu</i> for water samples at Thylacine and Artisan survey areas.	18
Table 6 Nutrients in water samples at Thylacine and Artisan survey areas.	20
Table 7 Metals and metalloids in water samples at Thylacine and Artisan survey areas.	20
Table 8 Polycyclic Aromatic Hydrocarbons (PAH) in water samples at Thylacine and Artisan survey areas.	21
Table 9 Total Recoverable Hydrocarbons (1999 NEPM Fractions) in water samples at Thylacine and Artisan survey areas.	22
Table 10 Total Recoverable Hydrocarbons (2013 NEPM Fractions) in water samples at Thylacine and Artisan survey areas.	22
Table 11 BTEX in water samples at Thylacine and Artisan survey areas.	23
Table 12 Measurement of oxidation reduction potential in sediment samples at Thylacine and Artisan survey areas.	24
Table 13 Nutrients in sediment samples at Thylacine and Artisan survey areas.	25
Table 14 Metals in sediment samples at Thylacine and Artisan survey areas.	27

Table 15 Polycyclic Aromatic Hydrocarbons (PAH) in sediment samples at Thylacine and Artisan survey areas.	28
Table 16 Total Recoverable Hydrocarbons (1999 NEPM Fractions) in sediment samples at Thylacine and Artisan survey areas.	29
Table 17 Total Recoverable Hydrocarbons (2013 NEPM Fractions) in sediment samples at Thylacine and Artisan survey areas.	29
Table 18 BTEX in sediment samples at Thylacine and Artisan survey areas.	30
Table 19 Polychlorinated Biphenyls in sediment samples at Thylacine and Artisan survey areas	30
Table 20 Benthic infauna present in sediment samples collected at Thylacine and Artisan survey areas.	33
Table 21 Percent cover and total abundance of epibiota at drop camera sites.	36
Table 22 Epifauna present in grab samples collected at the Artisan field.	38

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

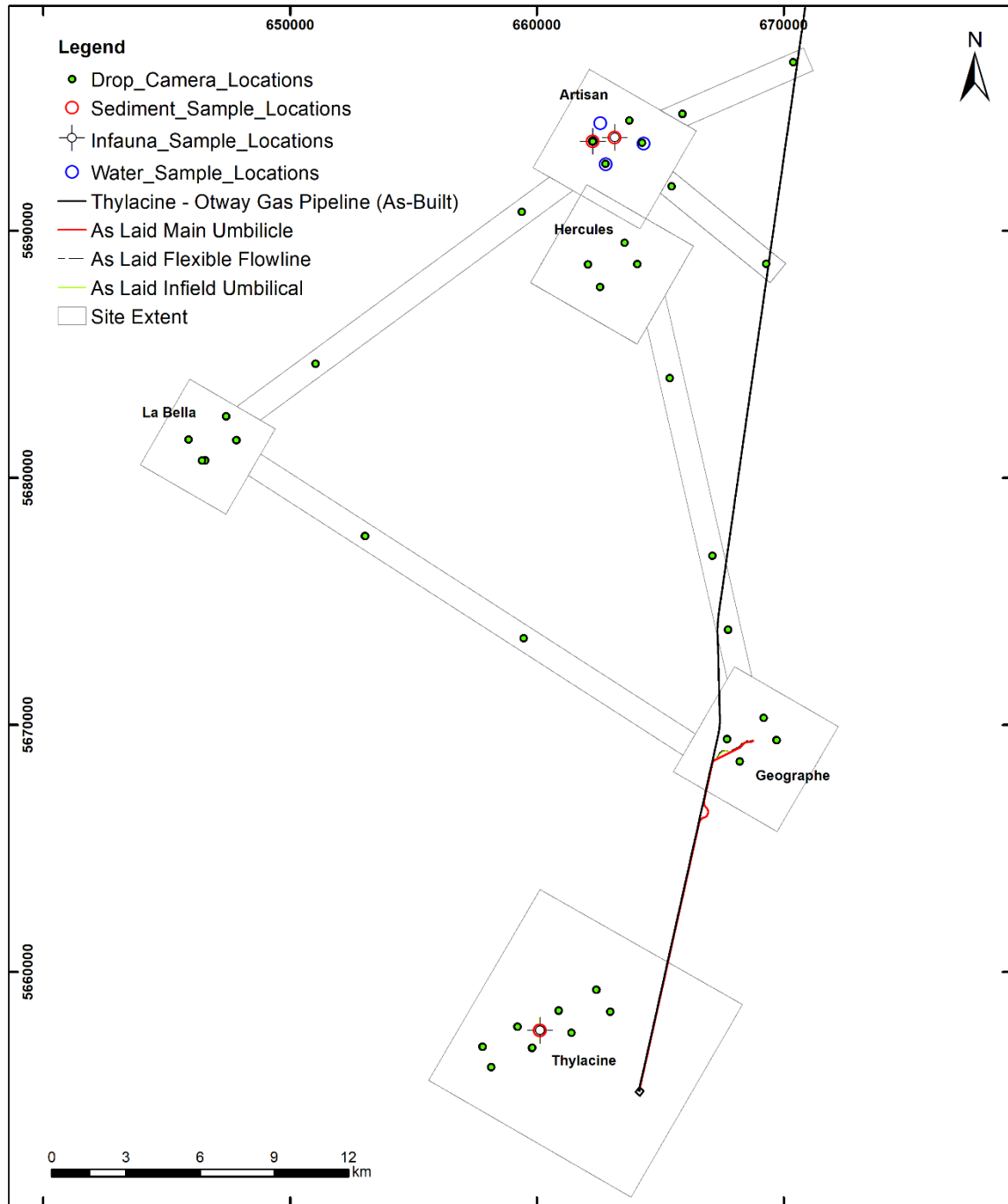


Figure 1 Locations of environmental survey site extents in Otway Basin. Provided by Fugro, April 2020.

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:

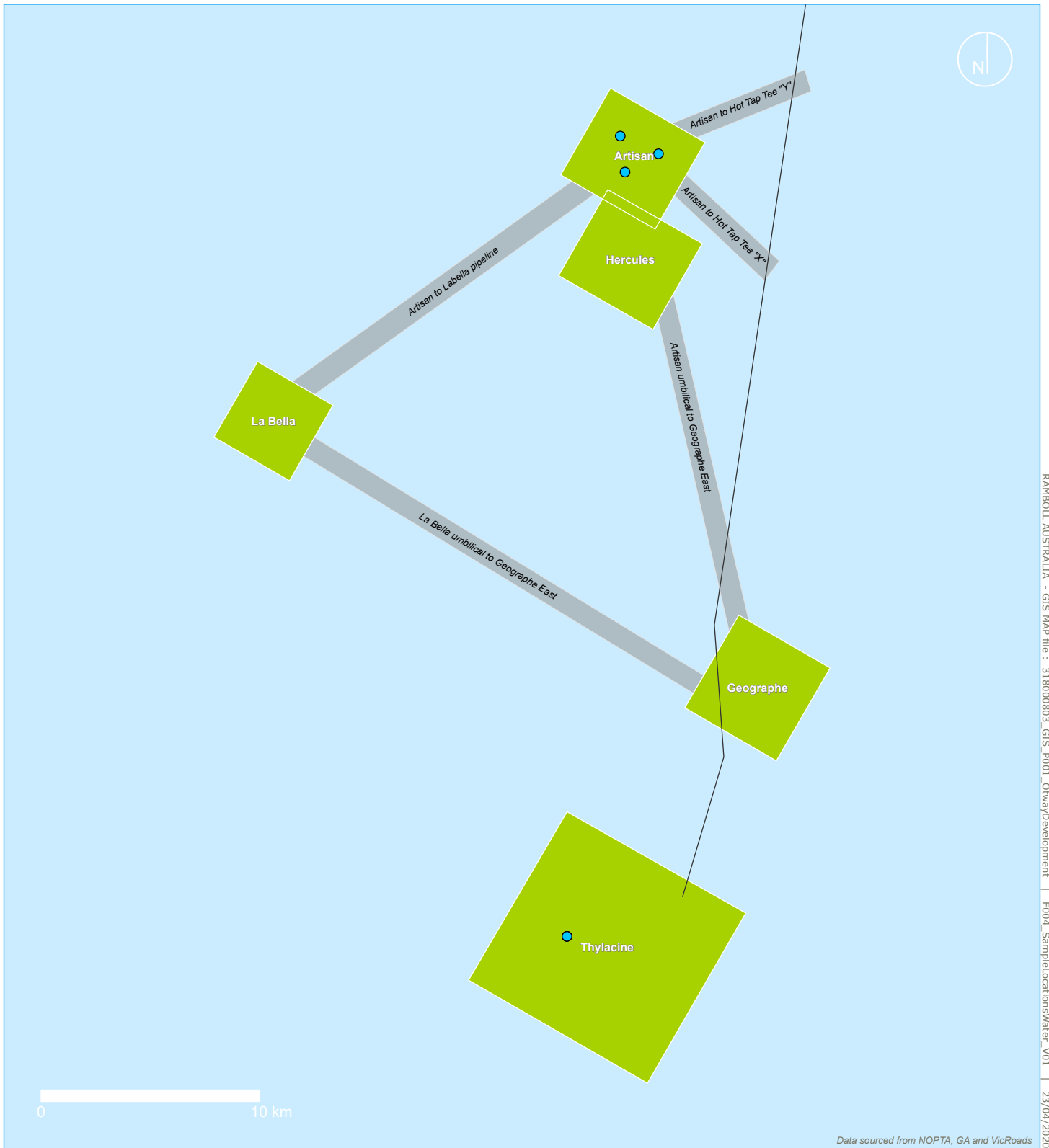
1. The sample bottle was full; and
2. Both end caps are fully closed; and
3. There was no obvious contamination (e.g. grease or paint chips on, or inside, the sampler).

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



Legend

-  Existing pipeline
-  Well site survey area
-  Site flowlines corridor
-  Water sample locations

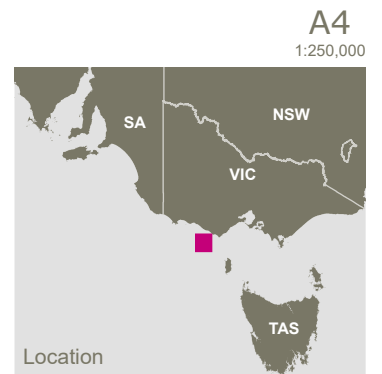


FIGURE 2 | Water sampling locations for Thylacine and Artisan survey areas.

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 (NO_x), nitrate (NO₃⁻), ammonia (NH₃), total phosphorus (TP), and total reactive phosphorus (TRP);
- Chlorophyll *a*;
- Metals/metalloids including arsenic (As), cadmium (Cd), cobalt (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.

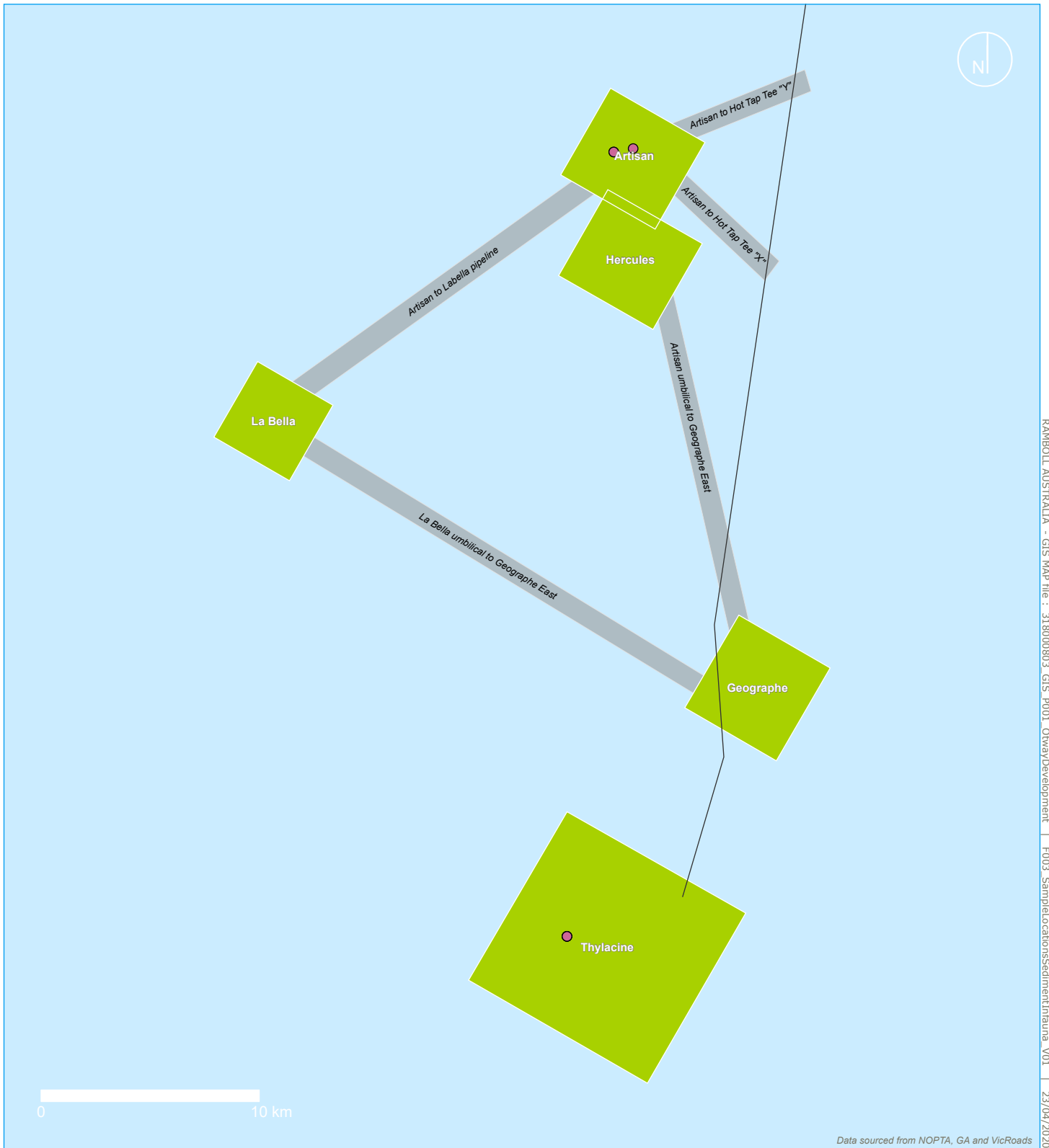
Prior to deployment, the jaws of both grabs were opened and fixed into position using a tension-based catch. The grab sampler was then winched over the stern of the vessel and lowered at a slow, steady rate to prevent the catch from being released too early. When the jaws made contact with the bottom, 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

A4

1:250,000



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 criteria 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.

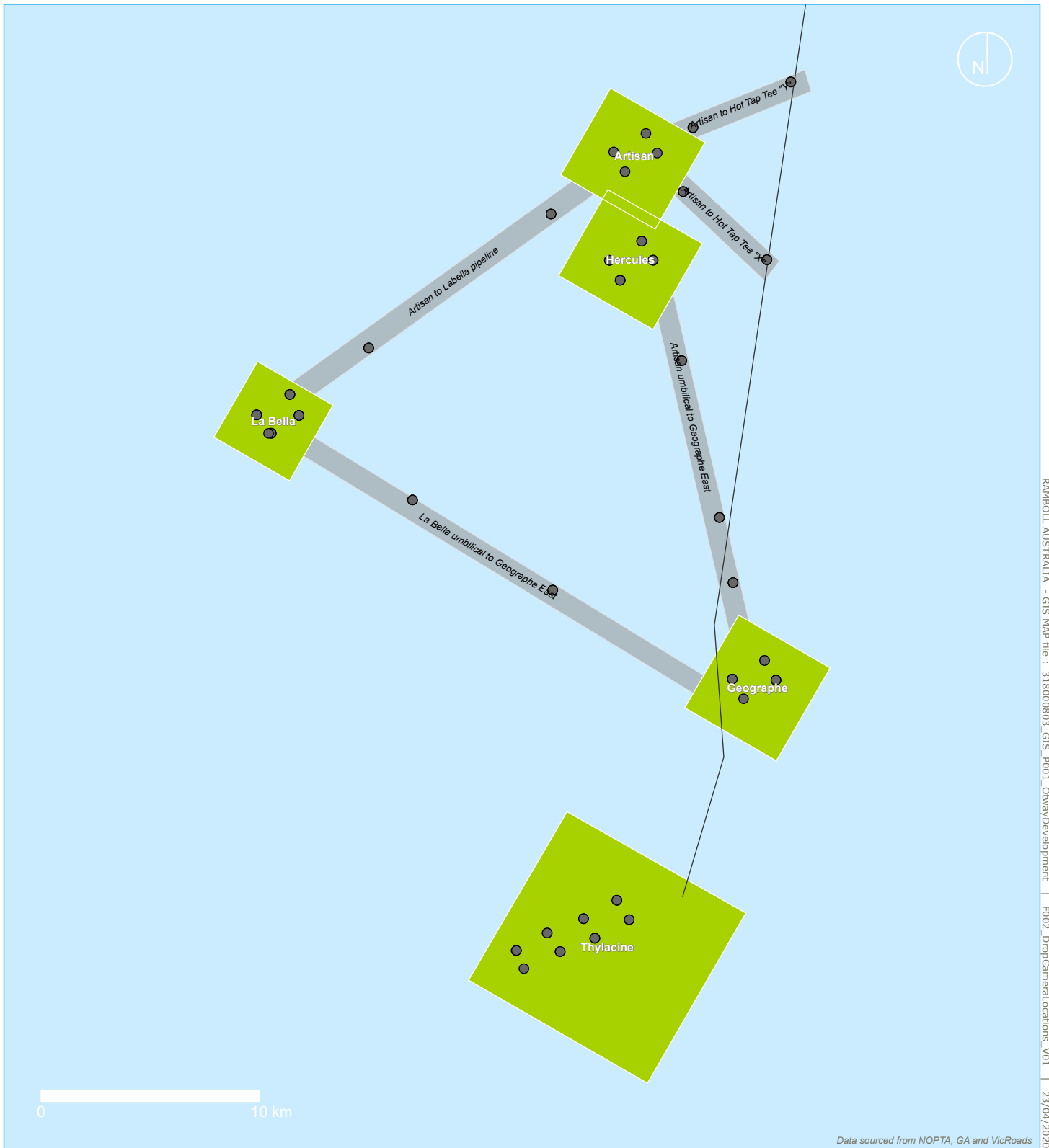
At each sampling site the camera was lowered and then to three locations approximately 1-2 m apart to obtain a collection of representative samples. At least five photographs were taken at each location to provide a selection of photographs for analysis. Drop camera sites are listed in Appendix 4. Drop 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 m².

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.



Legend

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

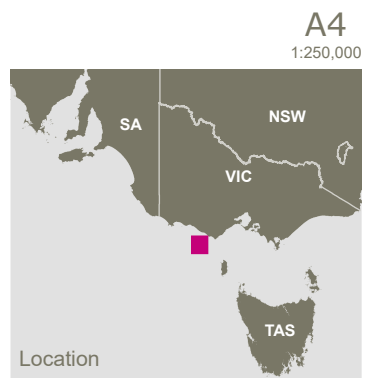


FIGURE 4 | Drop camera locations for all survey areas.

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, NO₃⁻, 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 unmodified¹ 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.

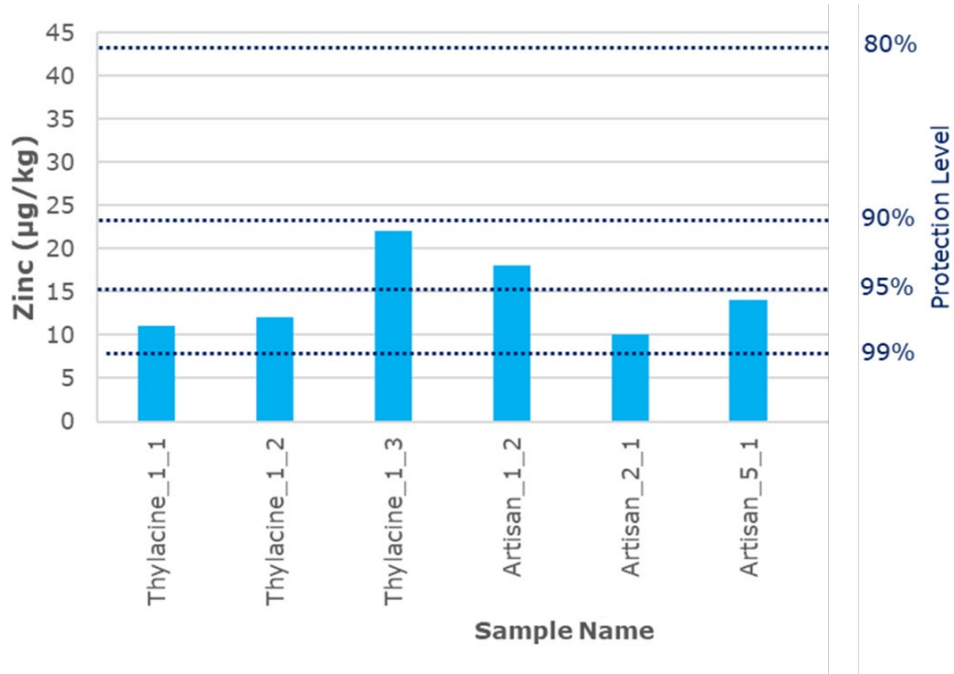


Figure 5 Concentration of Zn in water samples from Thylacine and Artisan survey areas.

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-Bromofluorobenzene (%)
	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.

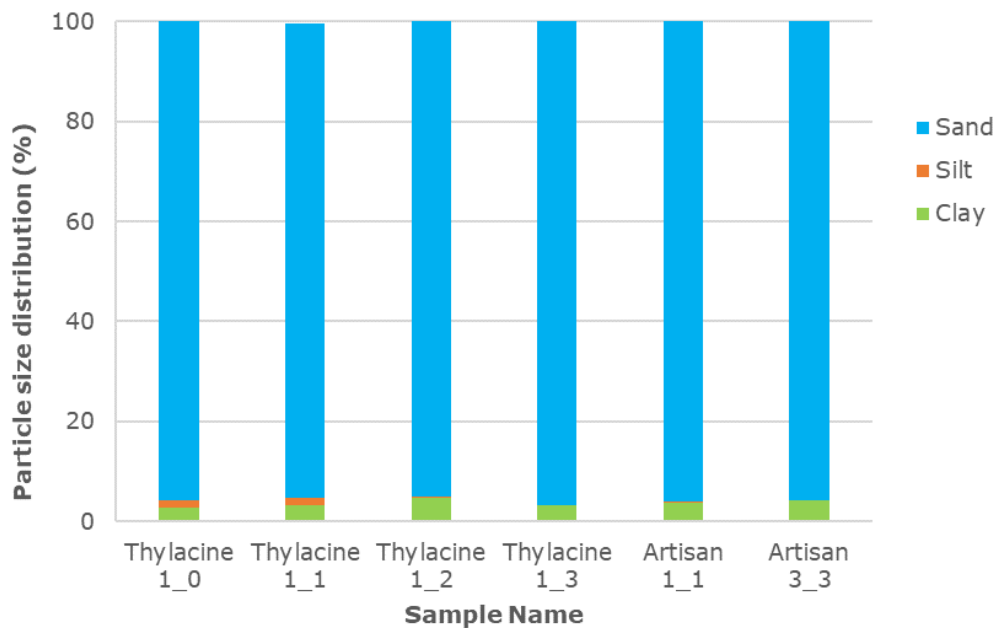


Figure 6 Particle size distribution (%) in sediment samples collected at Thylacine and Artisan survey areas.

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, unmodified 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.

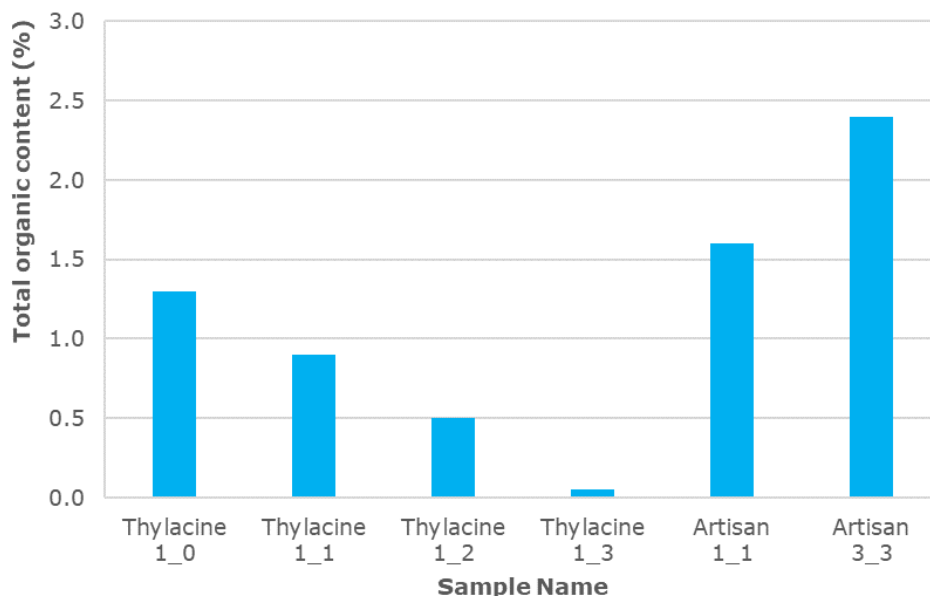


Figure 7 Total organic content (%) in sediment samples collected at Thylacine and Artisan survey areas.

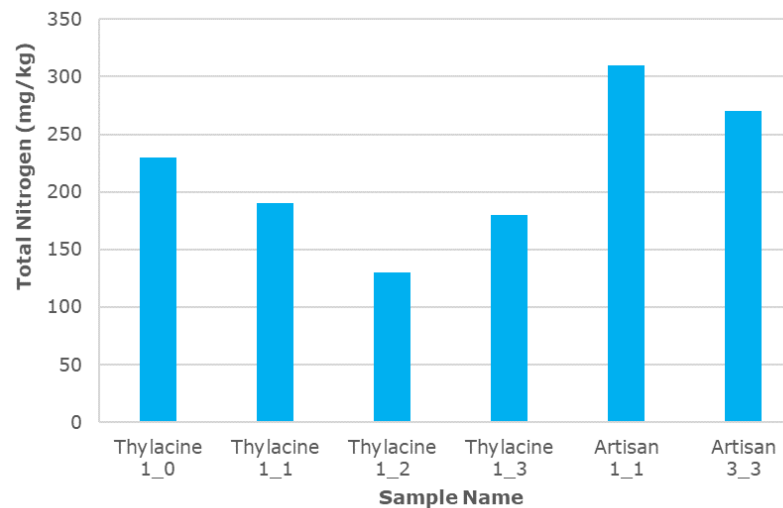
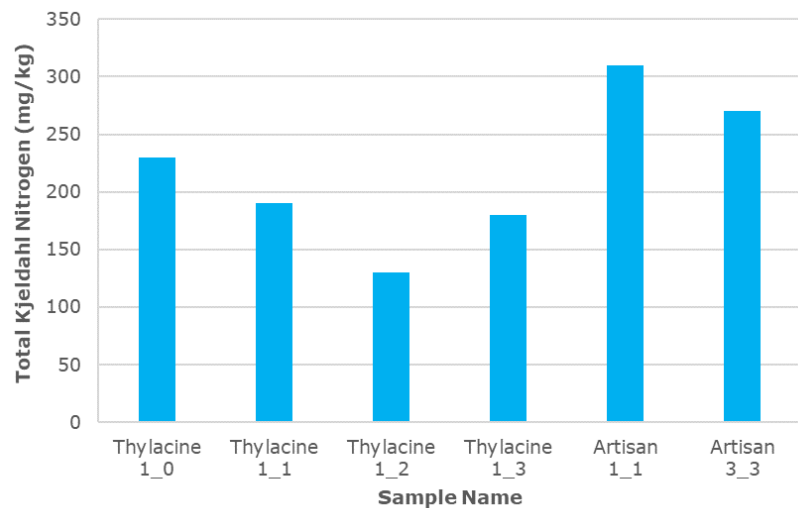
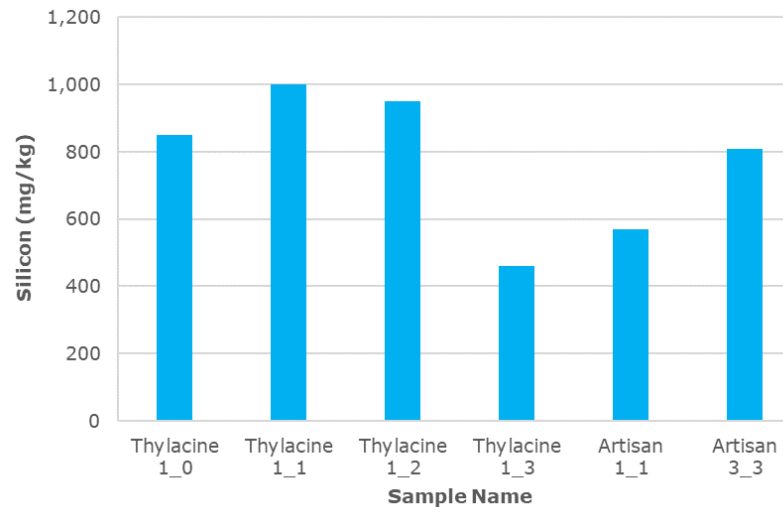
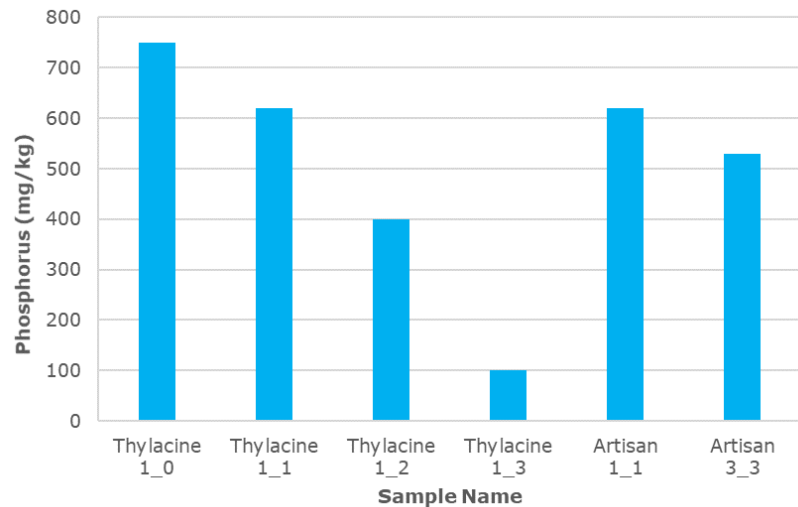


Figure 8 Nutrient concentrations (mg/kg) in sediment samples collected at Thylacine and Artisan survey areas, including phosphorus (top left), silicon (top right), total Kjeldahl nitrogen (bottom left) and total nitrogen (bottom right).

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-Bromofluorobenzene (%)
	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								Dibutylchloroendate (%)	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).

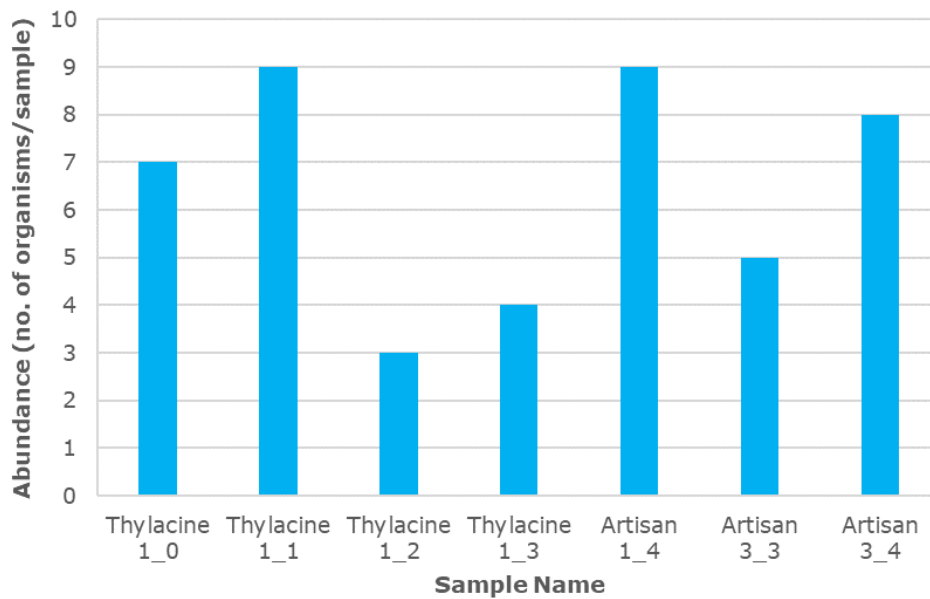


Figure 9 Abundance of benthic infauna in grab samples at Thylacine and Artisan survey areas.

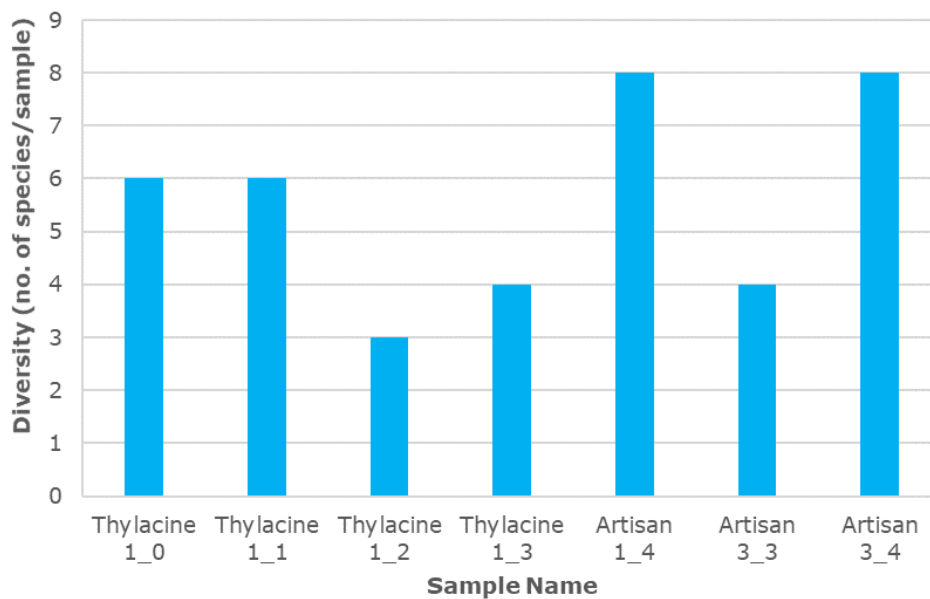


Figure 10 Diversity of benthic infauna in grab samples at Thylacine and Artisan survey areas.

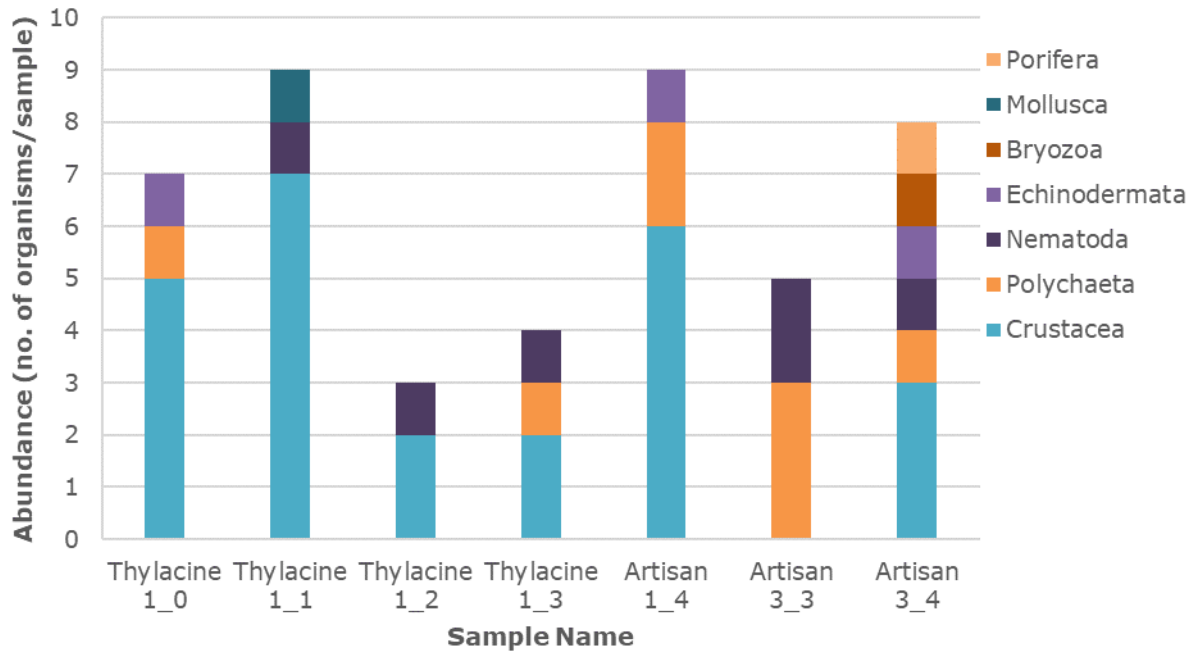


Figure 11 Abundance of benthic infauna by taxonomic group in grab samples at Thylacine and Artisan survey areas.

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 (\pm 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 (\pm 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.

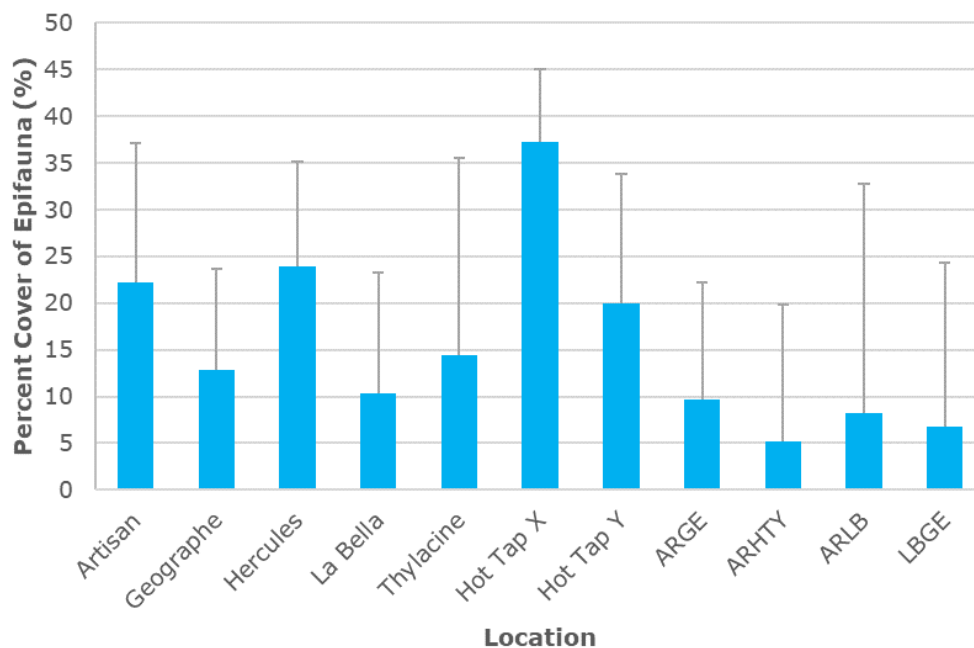


Figure 12 Percent cover of epifauna at drop camera location in Otway Basin.

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 crinoids (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.

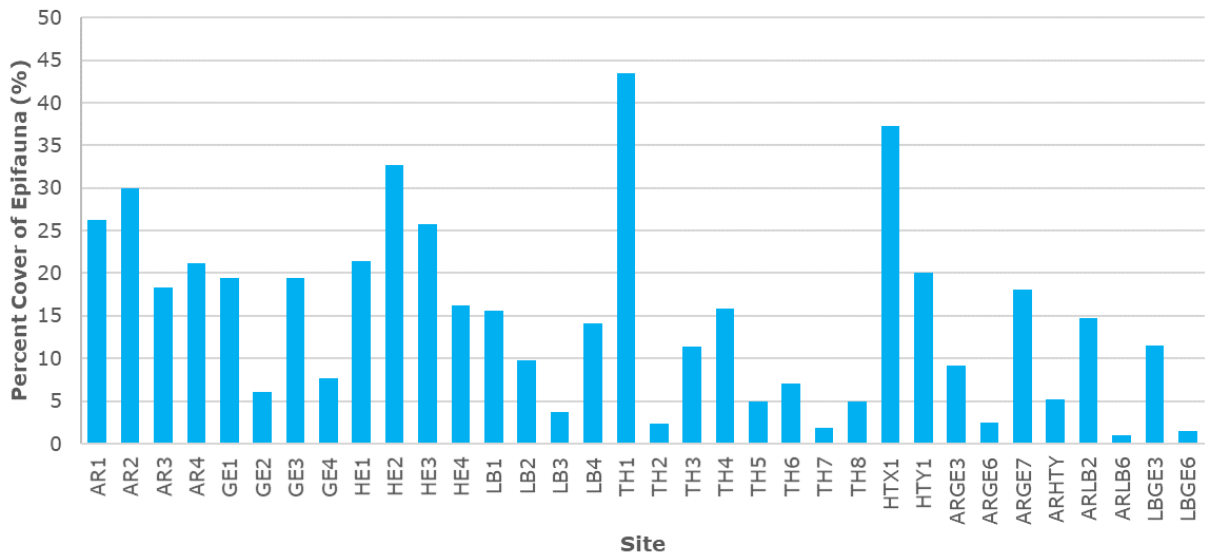


Figure 13 Percent cover of epifauna at drop camera sites in Otway Basin.

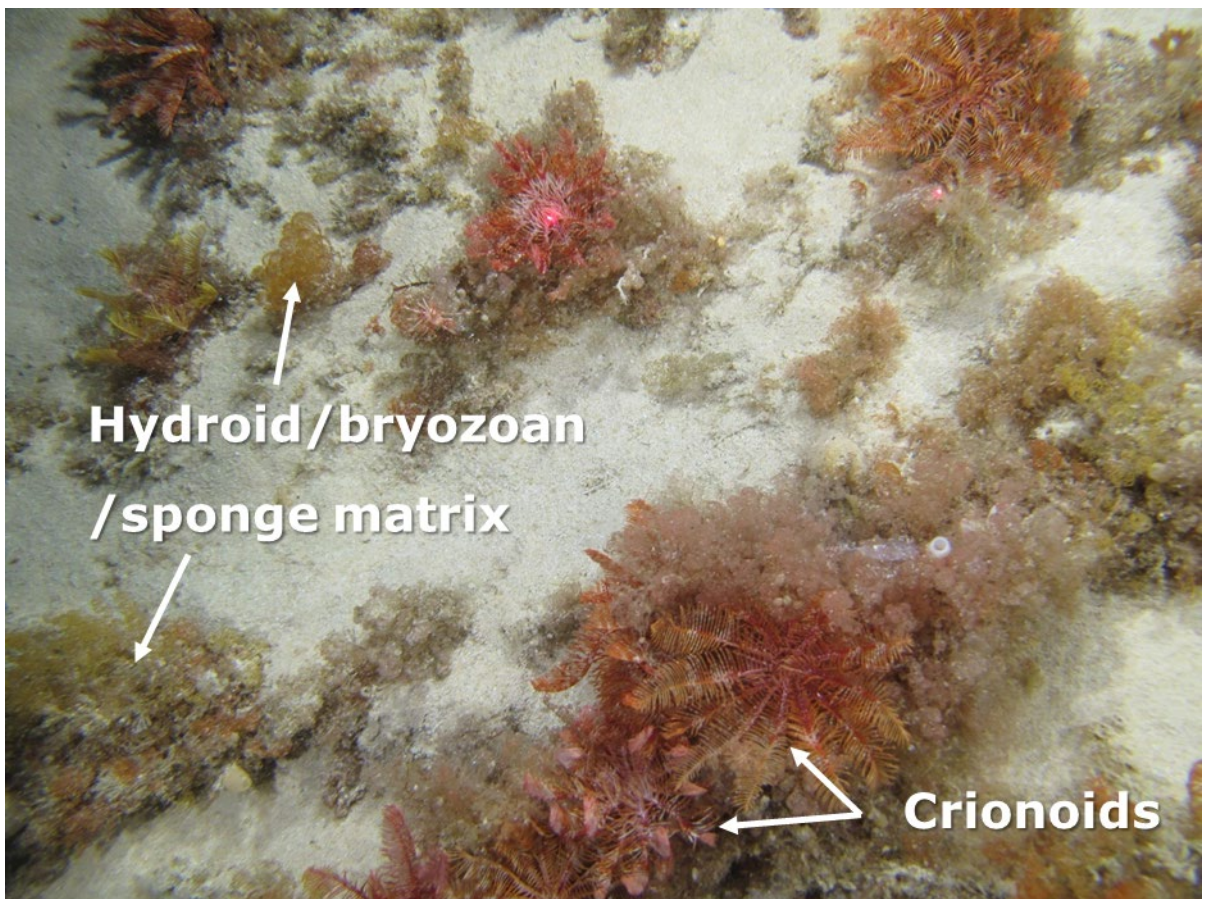


Figure 14 Example of the typical seabed epifauna with high percent cover at Thylacine 1 (TH1).

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 unmodified 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 m² on average but could be found in patches of at least 0.4 m².

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.

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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	Sampling Team: Irene Middleton	Date: 22/11/2019
Location: Artisan and Thylacine, Otway Basin	Sampling Gear: Van Dorn 2.4L and Van Veen Double benthic grab sampler	

<input checked="" type="checkbox"/>	All samples are stored on board as required for the analysis		
<input checked="" type="checkbox"/>	Once ashore samples are transported by air with the sampling team to Perth		Not required, samples sent directly from port to lab.
<input checked="" type="checkbox"/>	All Chain of Costody (COC) forms are copied and saved to cloud storage prior to sample dispatch		
<input checked="" type="checkbox"/>	Samples for contaminants analyses (metals, metalloids, hydrocarbons) are shipped by courier to EUROFINS in Melbourne with COC documentation		
<input checked="" type="checkbox"/>	Samples for infaunal analysis are shipped via courier to Benthic Australia, Gladstone, QLD with COC documentation		
<input checked="" type="checkbox"/>	Image data is saved in its entirety 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.
<input checked="" type="checkbox"/>	Image data is saved in its entirety 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).

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

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

Client Sample ID			THYLACINE_G S1_1	THYLACINE_G S1_2	THYLACINE_G 1_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_G S1_1	THYLACINE_G S1_2	THYLACINE_G 1_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)						
Ammonia (as N)	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Chlorophyll a						
Chlorophyll a	5	ug/L	< 10	< 10	< 10	< 10
Nitrate & Nitrite (as N)						
Nitrate & Nitrite (as N)	0.05	mg/L	< 0.05	< 0.05	0.10	< 0.05
Nitrate (as N)						
Nitrate (as N)	0.02	mg/L	0.03	0.02	0.10	< 0.02
Nitrite (as N)						
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (as P)						
Phosphate total (as P)	0.01	mg/L	0.03	0.02	0.02	0.02
Phosphorus reactive (as P)						
Phosphorus reactive (as P)	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahl Nitrogen (as N)						
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	< 0.2	< 0.2	2.4	< 0.2
Total Nitrogen (as N)*						
Total Nitrogen (as N)*	0.2	mg/L	< 0.2	< 0.2	2.5	< 0.2
Total Suspended Solids Dried at 103–105°C						
Total Suspended Solids Dried at 103–105°C	1	mg/L	3.4	9.7	2.4	5.9
Heavy Metals						
Arsenic						
Arsenic	0.001	mg/L	0.001	0.004	0.002	0.003
Cadmium						
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium						
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt						
Cobalt	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Copper						
Copper	0.001	mg/L	< 0.001	< 0.001	0.002	0.001
Lead						
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Mercury						
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel						
Nickel	0.001	mg/L	< 0.001	< 0.001	0.001	< 0.001
Zinc						
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						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Toluene						
Toluene	0.001	mg/L	< 0.001	< 0.001	0.003	< 0.001
Ethylbenzene						
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
m&p-Xylenes						
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene						
o-Xylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Xylenes - Total						
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)						
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)						
Ammonia (as N)	0.01	mg/L	< 0.01	< 0.01	0.03	< 0.01
Chlorophyll a						
Chlorophyll a	5	ug/L	< 10	< 10	-	-
Nitrate & Nitrite (as N)						
Nitrate & Nitrite (as N)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate (as N)						
Nitrate (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite (as N)						
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (as P)						
Phosphate total (as P)	0.01	mg/L	0.01	0.01	< 0.01	< 0.01
Phosphorus reactive (as P)						
Phosphorus reactive (as P)	0.01	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahl Nitrogen (as N)						
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	< 0.2	< 0.2	< 0.2	< 0.2
Total Nitrogen (as N)*						
Total Nitrogen (as N)*	0.2	mg/L	< 0.2	< 0.2	< 0.2	< 0.2
Total Suspended Solids Dried at 103–105°C						
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 - Method: LTM-ORG-2010 TRH C6-C40	Melbourne	Dec 09, 2019	7 Days
BTEX - Method: LTM-ORG-2010 TRH C6-C40	Melbourne	Dec 06, 2019	14 Days
Total Recoverable Hydrocarbons - 2013 NEPM Fractions - Method: LTM-ORG-2010 TRH C6-C40	Melbourne	Dec 06, 2019	7 Days
Total Recoverable Hydrocarbons - 2013 NEPM Fractions - Method: LTM-ORG-2010 TRH C6-C40	Melbourne	Dec 09, 2019	
Polycyclic Aromatic Hydrocarbons - Method: LTM-ORG-2130 PAH and Phenols in Soil and Water	Melbourne	Dec 09, 2019	7 Days
Eurofins mgt Suite B19E: Total N, TKN, NOx, NO2, NO3, NH3, Total P, Reactive P			
Ammonia (as N) - Method: LTM-INO-4200 Ammonia by Discrete Analyser	Melbourne	Dec 09, 2019	28 Days
Nitrate & Nitrite (as N) - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA	Melbourne	Dec 09, 2019	28 Days
Nitrate (as N) - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA	Melbourne	Dec 09, 2019	28 Days
Nitrite (as N) - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA	Melbourne	Dec 09, 2019	2 Days
Phosphate total (as P) - Method: APHA 4500-P E. Phosphorus	Melbourne	Dec 09, 2019	28 Days
Phosphorus reactive (as P) - Method: APHA 4500-P	Melbourne	Dec 09, 2019	2 Days
Total Kjeldahl Nitrogen (as N) - Method: LTM-INO-4310 TKN in Waters & Soils by FIA	Melbourne	Dec 09, 2019	7 Days
Chlorophyll a - Method: LTM-INO-4340 Chlorophyll a in Waters	Melbourne	Dec 06, 2019	2 Days
Total Suspended Solids Dried at 103–105°C - Method: LTM-INO-4070 Analysis of Suspended Solids in Water by Gravimetry	Melbourne	Dec 09, 2019	7 Days
Heavy Metals - Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS	Sydney	Dec 11, 2019	180 Days

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Company Name: Ramboll Australia Pty Ltd
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East Perth
WA 6004

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

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

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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Company Name: Ramboll Australia Pty Ltd
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

Internal Quality Control Review and Glossary
General

- 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.
- All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
- All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
- Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
- Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
- SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
- Samples were analysed on an 'as received' basis.
- Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
- 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

- 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.
- 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.
- Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
- Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
- 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.
- 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.
- Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
- Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
- For Matrix Spikes and LCS results a dash " - " in the report means that the specific analyte was not added to the QC sample.
- Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
TRH C10-C14	mg/L	< 0.05			0.05	Pass	
TRH C15-C28	mg/L	< 0.1			0.1	Pass	
TRH C29-C36	mg/L	< 0.1			0.1	Pass	
Method Blank							
BTEX							
Benzene	mg/L	< 0.001			0.001	Pass	
Toluene	mg/L	< 0.001			0.001	Pass	
Ethylbenzene	mg/L	< 0.001			0.001	Pass	
m&p-Xylenes	mg/L	< 0.002			0.002	Pass	
o-Xylene	mg/L	< 0.001			0.001	Pass	
Xylenes - Total	mg/L	< 0.003			0.003	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/L	< 0.01			0.01	Pass	
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
TRH >C10-C16	mg/L	< 0.05			0.05	Pass	
TRH >C16-C34	mg/L	< 0.1			0.1	Pass	
TRH >C34-C40	mg/L	< 0.1			0.1	Pass	
Method Blank							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/L	< 0.001			0.001	Pass	
Acenaphthylene	mg/L	< 0.001			0.001	Pass	
Anthracene	mg/L	< 0.001			0.001	Pass	
Benz(a)anthracene	mg/L	< 0.001			0.001	Pass	
Benzo(a)pyrene	mg/L	< 0.001			0.001	Pass	
Benzo(b&j)fluoranthene	mg/L	< 0.001			0.001	Pass	
Benzo(g,h,i)perylene	mg/L	< 0.001			0.001	Pass	
Benzo(k)fluoranthene	mg/L	< 0.001			0.001	Pass	
Chrysene	mg/L	< 0.001			0.001	Pass	
Dibenz(a,h)anthracene	mg/L	< 0.001			0.001	Pass	
Fluoranthene	mg/L	< 0.001			0.001	Pass	
Fluorene	mg/L	< 0.001			0.001	Pass	
Indeno(1,2,3-cd)pyrene	mg/L	< 0.001			0.001	Pass	
Naphthalene	mg/L	< 0.001			0.001	Pass	
Phenanthrene	mg/L	< 0.001			0.001	Pass	
Pyrene	mg/L	< 0.001			0.001	Pass	
Method Blank							
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				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	
Benzo(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	

Test	Lab Sample ID	QA Source	Units	Result 1	Result 2	RPD	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	

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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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

Chlorophyll a

- Method:

Testing Site

Melbourne

Extracted

Nov 27, 2019

Holding Time

2 Days

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

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

Company Name: Ramboll Australia Pty Ltd	Order No.:	Received: Dec 4, 2019 1:54 PM
Address: Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	Report #: 690387	Due: Dec 5, 2019
	Phone: 08 9225 5199	Priority: 7 Day
	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 mg/t 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
15	ARTISON-GSA_MET1	Nov 22, 2019		Soil	M19-No38247	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
17	ARTISON-GSA_MET2	Nov 22, 2019		Soil	M19-No38249	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
19	ARTISON-GS3_PAR1	Nov 22, 2019		Soil	M19-No38251	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

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

Company Name:	Ramboll Australia Pty Ltd	Order No.:		Received:	Dec 4, 2019 1:54 PM
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Project Name:	OTWAY OFFSHORE EBS	Phone:	08 9225 5199	Priority:	7 Day
Project ID:	318000803	Fax:		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 mg/L 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	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	24

Internal Quality Control Review and Glossary
General

- 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.
- All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
- All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
- Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
- Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
- SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
- Samples were analysed on an 'as received' basis.
- Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
- 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

- 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.
- 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.
- Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
- Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
- 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.
- 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.
- Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
- Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
- For Matrix Spikes and LCS results a dash " - " in the report means that the specific analyte was not added to the QC sample.
- 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](#).

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APPENDIX 3 SEDIMENT QUALITY LABORATORY REPORT

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

Client Sample ID			THYLACINE_G S1_3_MET1	THYLACINE_G S1_3_MET2	THYLACINE_G S1_3_PSD1	THYLACINE_G S1_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_G S-1_MET1	THYLACINE_G S-1_PSD1	THYLACINE_G S1-2_PSD1	THYLACINE_G S1-2_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_G S-1_MET1	THYLACINE_G S-1_PSD1	THYLACINE_G S1-2_PSD1	THYLACINE_G S1-2_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_G S1-2_MET2	THYLACINE_G S2_PSD1	THYLACINE_G S2_MET1	THYLACINE_G S2_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

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

Company Name:	Ramboll Australia Pty Ltd	Order No.:		Received:	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	Report #:	690387	Due:	Dec 5, 2019
Project Name:	OTWAY OFFSHORE EBS	Phone:	08 9225 5199	Priority:	7 Day
Project ID:	318000803	Fax:		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 mg/L 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	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	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	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	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	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	X
6	THYLACINE_	Nov 22, 2019		Soil	M19-No38238	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X

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Project ID:	318000803	Fax:		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 mg/L 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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Project Name:	OTWAY OFFSHORE EBS	Phone:	08 9225 5199	Priority:	7 Day
Project ID:	318000803	Fax:		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 mg/L 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

Company Name: Ramboll Australia Pty Ltd	Order No.:	Received: Dec 4, 2019 1:54 PM
Address: Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	Report #: 690387	Due: Dec 5, 2019
	Phone: 08 9225 5199	Priority: 7 Day
	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 mg/L 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										

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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 mg/t 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					X											
30	THYLACINE GS1_2	Nov 22, 2019					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

- 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.
- All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
- All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
- Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
- Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
- SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
- Samples were analysed on an 'as received' basis.
- Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
- 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

- 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.
- 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.
- Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
- Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
- 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.
- 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.
- Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
- Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
- For Matrix Spikes and LCS results a dash " - " in the report means that the specific analyte was not added to the QC sample.
- 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									
% 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](#).

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Site Number 1254

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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_G S1_3_MET1	THYLACINE_G S1_3_MET2	THYLACINE_G S1_MET2	THYLACINE_G S-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

Client Sample ID			THYLACINE_G S1_3_MET1	THYLACINE_G S1_3_MET2	THYLACINE_G S1_MET2	THYLACINE_G S-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
Dibutylchlorodate (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_G S1-2_MET1	THYLACINE_G S1-2_MET2	THYLACINE_G S2_MET1	THYLACINE_G S2_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_G S1-2_MET1	THYLACINE_G S1-2_MET2	THYLACINE_G S2_MET1	THYLACINE_G S2_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
Dibutylchloroendate (surr.)	1	%	139	112	105	64
Tetrachloro-m-xylene (surr.)	1	%	80	90	86	75
% Moisture						
	1	%	37	35	33	35

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

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

Australia

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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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
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Phone : +61 8 9251 9600
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43 Detroit Drive
Rolleston, Christchurch 7675
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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						Polyyclic 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

Australia

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Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
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Murarie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
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Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

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

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

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Company Name: Ramboll Australia Pty Ltd
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Sample Detail						Polyyclic 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

Internal Quality Control Review and Glossary
General

- 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.
- All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
- All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
- Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
- Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
- SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
- Samples were analysed on an 'as received' basis.
- Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
- 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

- 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.
- 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.
- Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
- Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
- 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.
- 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.
- Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
- Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
- For Matrix Spikes and LCS results a dash " - " in the report means that the specific analyte was not added to the QC sample.
- 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			

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](#).

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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)
21/01/2020	DC_LB4_5m	646560	5680700	97.8
	DC_LB4_Extra	646438	5680699	97.8
	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
22/01/2020	DC_HTX1R	669286	5688662	72.9
	DC_HTX1R_1m	669286	5688661	72.9
	DC_HTX1R_2m	669290	5688661	72.9
	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	Percent 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	Percent 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	Percent 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	Percent 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			

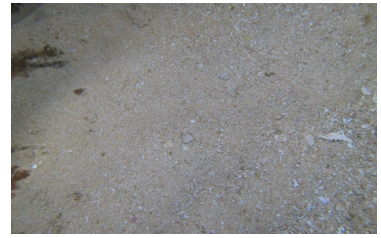
APPENDIX 6 EXAMPLE SEABED PHOTOGRAPHS



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



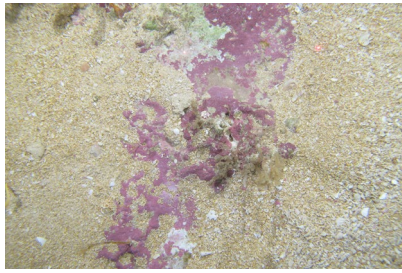
Hot Tap – HTX – HTX1R



Hot Tap – HTY – HTY1R



Hot Tap - HTY - HTY1R



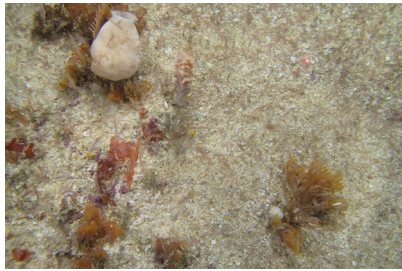
Routes - ARGE - ARGE3R



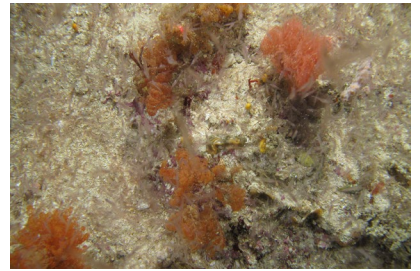
Routes - ARGE - ARGE6R



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 F: Jasco Modelling Report



Otway Offshore Project – Drilling Program

Assessing Marine Fauna Sound Exposures

Submitted to:

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Beach Energy Limited
Contract: BE00028888

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Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

EXECUTIVE SUMMARY	5
1. INTRODUCTION	7
1.1. Acoustic Modelling Scenario Details	8
2. NOISE EFFECT CRITERIA	11
2.1. Marine Mammals.....	11
2.1.1. Behavioural response	12
2.1.2. Injury and hearing sensitivity changes	12
2.2. Fish, Turtles, Fish Eggs, and Fish Larvae	12
3. METHODS AND PARAMETERS	14
3.1. Geometry and Modelled Regions	14
3.2. Accumulated SEL.....	14
3.3. Acoustic Sources	15
3.3.1. Mobile Offshore Drilling Unit (MODU).....	15
3.3.2. Offshore Support Vessel (OSV).....	16
4. RESULTS.....	19
4.1. Tabulated results.....	19
4.2. Sound Field Maps	23
4.2.1. Thylacine North-1 Well Scenarios.....	23
4.2.2. Artisan-1 Well Scenarios.....	28
5. DISCUSSION AND SUMMARY.....	32
GLOSSARY	33
LITERATURE CITED	39
APPENDIX A. ACOUSTIC METRICS	A-1
APPENDIX B. THRUSTER SOURCE LEVEL ESTIMATION.....	B-1
APPENDIX C. SOUND PROPAGATION MODELS	C-1
APPENDIX D. METHODS AND PARAMETERS.....	D-1

Figures

Figure 1. Otway Offshore Project Locations and Proposed Petroleum Safety Zones.....	7
Figure 2. Overview of the modelled area and local features.	8
Figure 3. Overview of the modelled sites and the random representative locations for the Thylacine North-1 well.	10
Figure 4. Overview of the modelled sites and the random representative locations for the Artisan-1 well.	10
Figure 5. <i>Ocean Onyx</i> semi-submersible platform.....	15
Figure 6. <i>MODU</i> : Decidecade source level spectrum.....	16
Figure 7. Photo of a Siem Anchor Handling Tug Supply (AHTS) vessel (Siem Offshore 2010).	17
Figure 8. <i>OSV</i> : Decidecade source level spectra of the two modelled <i>OSV</i> MCR percentages, slow transit (15%) and DP (20%).....	18

Figure 9. Thylacine North-1, MODU (Scenario 1), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. 23

Figure 10. Thylacine North-1, OSV standby (Scenario 2), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. 24

Figure 11. Thylacine North-1, MODU and resupply OSV on DP (Scenario 3) SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. 24

Figure 12. Thylacine North-1, MODU and OSV standby (Scenario 4), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. 25

Figure 13. Thylacine North-1, MODU (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. Refer to the radii tables in Section 4.1 for distances. 26

Figure 14. Thylacine North-1, OSV standby (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. Refer to the radii tables in Section 4.1 for distances. 26

Figure 15. Thylacine North-1, MODU and OSV on DP (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. Refer to the radii tables in Section 4.1 for distances. 27

Figure 16. Thylacine North-1, MODU and OSV standby (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. Refer to the radii tables in Section 4.1 for distances. 27

Figure 17. Artisan-1, MODU (Scenario 5), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. 28

Figure 18. Artisan-1, OSV standby (Scenario 6), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. 28

Figure 19. Artisan-1, MODU and OSV on DP (Scenario 7), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. 29

Figure 20. Artisan-1, MODU and OSV standby (Scenario 8), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. 29

Figure 21. Artisan-1, MODU (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. Refer to the radii tables in Section 4.1 for distances. 30

Figure 22. Artisan-1, OSV on DP (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. Refer to the radii tables in Section 4.1 for distances. 30

Figure 23. Artisan-1, OSV standby (Scenario 7), 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. Refer to the radii tables in Section 4.1 for distances. 31

Figure 24. Artisan-1, MODU and OSV on DP (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. Refer to the radii tables in Section 4.1 for distances. 31

Figure A-1. Auditory weighting functions for functional marine mammal hearing groups as recommended by NMFS (2018).A-4

Figure B-1. Estimated sound spectrum from cavitating propellerB-2

Figure C-1. The Nx2-D and maximum-over-depth modelling approach used by MONM. C-2

Figure D-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. D-1

Figure D-2. Bathymetry in the modelled area. D-2

Figure D-3. The modelling sound speed profile corresponding to June: top 250 m (left) and full profile (right)..... D-3

Tables

Table 1. Maximum distances (km) to marine mammal behavioural response threshold (NOAA 2019) for all considered scenarios. 6

Table 2. Description of modelling scenarios 9

Table 3. Location details for the modelled sites..... 9

Table 4. Criteria for effects of continuous noise exposure, including vessel noise, for marine mammals: Unweighted SPL and SEL_{24h} thresholds. 11

Table 5. Guidelines for vessel noise exposure for fish 13

Table 6. Acoustic effects of continuous noise on turtles, weighted SEL_{24h}, Finneran et al. (2017). 13

Table 7. *Thylacine North-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 (see table footnotes). 19

Table 8. *Artisan-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 (see table footnotes). 20

Table 9. *SPL*: Areas (km²) for modelled scenarios within isopleths corresponding to the threshold for marine mammal behavioural response to continuous noise (NOAA 2019). 20

Table 10. *Thylacine North-1*: 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). 21

Table 11. *Artisan-1*: 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). 22

Table A-1. Parameters for the auditory weighting functions used in this project as recommended by NMFS (2018).A-4

Table D-1. *Thylacine North-1*: Geoacoustic profile. Each parameter varies linearly within the stated range. D-4

Table D-2. *Artisan-1*: Geoacoustic profile. Each parameter varies linearly within the stated range... D-4

Executive Summary

JASCO Applied Sciences (JASCO) performed a modelling study of underwater sound levels associated with the Beach Energy Otway Development program. The modelling study considers specific components of the program at two representative wells, Artisan-1 and Thylacine North-1. These two wells were selected for consideration as they represent the two different seabed types and different depths within the region of the project.

The study considers the drilling activities of an anchored Mobile Offshore Drilling Unit (MODU), and an associated Offshore Support Vessel (OSV) conducting re-supply of the MODU under dynamic positioning (DP) and standing by near the MODU, and combinations of these scenarios.

The modelling study specifically assessed distances from operations where underwater sound levels reached thresholds corresponding to various levels of potential effect on marine fauna. The animals considered here included marine mammals, turtles, and fish (including fish eggs and larvae). Due to the variety of species considered, there are several different thresholds for evaluating effects, including: mortality, injury, temporary reduction in hearing sensitivity, and behavioural disturbance.

The modelling methodology considered MODU and vessel specific source levels and range-dependent environmental properties. 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. The key results of this acoustic modelling study are summarised below.

Marine mammals

- The results for the NMFS (2018) criteria applied for marine mammal PTS and TTS for MODU and vessel operations are assessed for 8 scenarios, each encompassing a day of operations (a 24 h period). PTS is only predicted to occur in either low- or high-frequency cetaceans, and unlikely to occur at distances greater than 40 m from any of the considered sources. The maximum distance predicted for TTS onset in low-frequency cetaceans is 2.73 km from any of the considered sources.
- The SEL_{24h} is a cumulative metric that reflects the dosimetric effect 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) would not 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.
- The maximum distances to the NOAA (2019) marine mammal behavioural response criterion of 120 dB re 1 μ Pa (SPL) are presented in Table 1 for each scenario considered. The distances to this isopleth are calculated in relation to the centroid of all sources within the scenario as indicated in the provided SPL maps.

Table 1. Maximum distances (km) to marine mammal behavioural response threshold (NOAA 2019) for all considered scenarios.

SPL (L_p ; dB re 1 μ Pa)	MODU	OSV standby	MODU and OSV resupply	MODU and OSV standby
Thylacine North-1				
120	4.6	4.44	13.7	6.72
Artisan-1				
120	5.91	6.23	17.4	8.94

Turtles

Considering the Finneran et al. (2017) criteria for turtle PTS and TTS for MODU and vessels, assessed here for each scenario, both PTS and TTS are not predicted to occur within the modelling resolution.

Fish

Sound produced by the MODU and/or vessel operations reach the sound levels associated with recoverable injury, and TTS for some fish species in close proximity to the sound sources (within 30 or 90 m respectively), but in order for the guidelines to be exceeded, the fish must remain at those distances for either 12 or 48h.

1. Introduction

JASCO Applied Sciences (JASCO) performed a modelling study of underwater sound levels associated with the Beach Energy Otway Development program (Figure 1). The modelling study considers specific components of the program at two representative wells, Artisan-1 and Thylacine North-1. The study considers the drilling activities of an anchored Mobile Offshore Drilling Unit (MODU) conducting drilling operations, and an associated Offshore Support Vessel (OSV), conducting re-supply of the MODU under dynamic positioning (DP) and standing by near the MODU, and combinations of these scenarios.

The modelling study specifically assessed distances from operations where underwater sound levels reached thresholds corresponding to various levels of effect to marine fauna. The animals considered here included marine mammals (cetaceans and pinnipeds), turtles, and fish (including fish eggs and larvae). Due to the variety of species considered, there are several different thresholds for evaluating effects, including: mortality, injury, temporary reduction in hearing sensitivity, and behavioural disturbance.

The modelling methodology considered MODU and vessel specific source levels and range-dependent environmental properties. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), and accumulated sound exposure levels (SEL, L_E), as appropriate for non-impulsive (continuous) noise sources.

Section 2 explains the metrics used to represent underwater acoustic fields and the effect criteria considered. Section 3 details the methodology for predicting the source levels and modelling the sound propagation, including the specifications of the vessel sources and all environmental parameters the propagation models required. Section 4 presents the results, which are then discussed and summarised in Section 5.

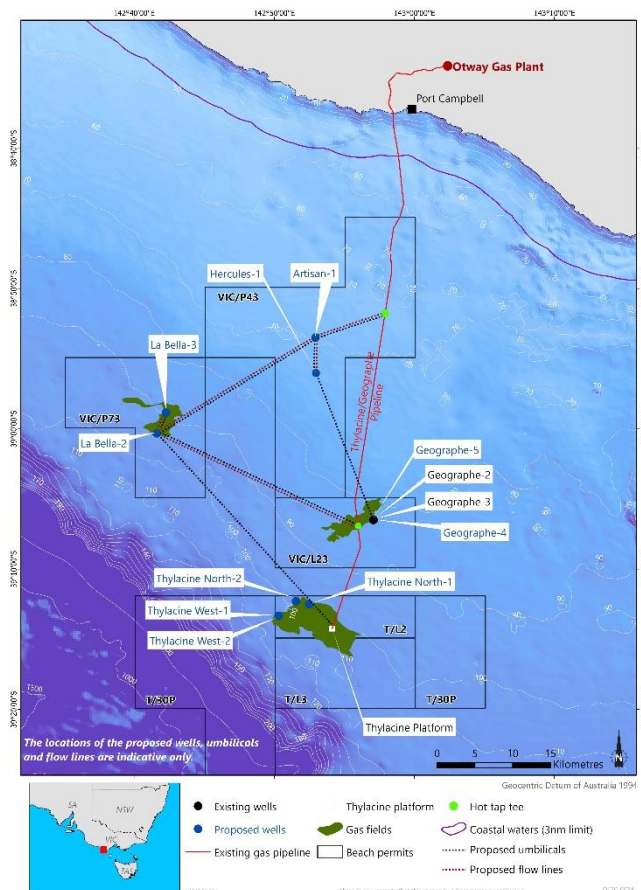


Figure 1. Otway Offshore Project Locations and Proposed Petroleum Safety Zones.

1.1. Acoustic Modelling Scenario Details

The two wells, Artisan-1 and Thylacine North-1 were selected to represent the two different seabed types in the region, and the range of depths across the Project. While both wells are located on the continental shelf, the deeper Thylacine North-1 area has a seabed characterised by well-cemented carbonate caprock (calcareenite), overlying semi-cemented carbonate rock (calcareenite). This contrasts with the shallower Artisan-1 area, which is characterised by a thin veneer of coarse sand/gravel overlying semi-cemented carbonate rock. The Thylacine North-1 location is considered representative of all wells at Thylacine, Geographe and La Bella, while Artisan-1 will also represent Hercules (Figure 1).

The study considers four scenarios at each of the two well, Artisan-1 and Thylacine North-1, Figure 2, for 8 scenarios in total. The scenarios are described in Table 2, with the modelling site locations and descriptions provided in Table 3.

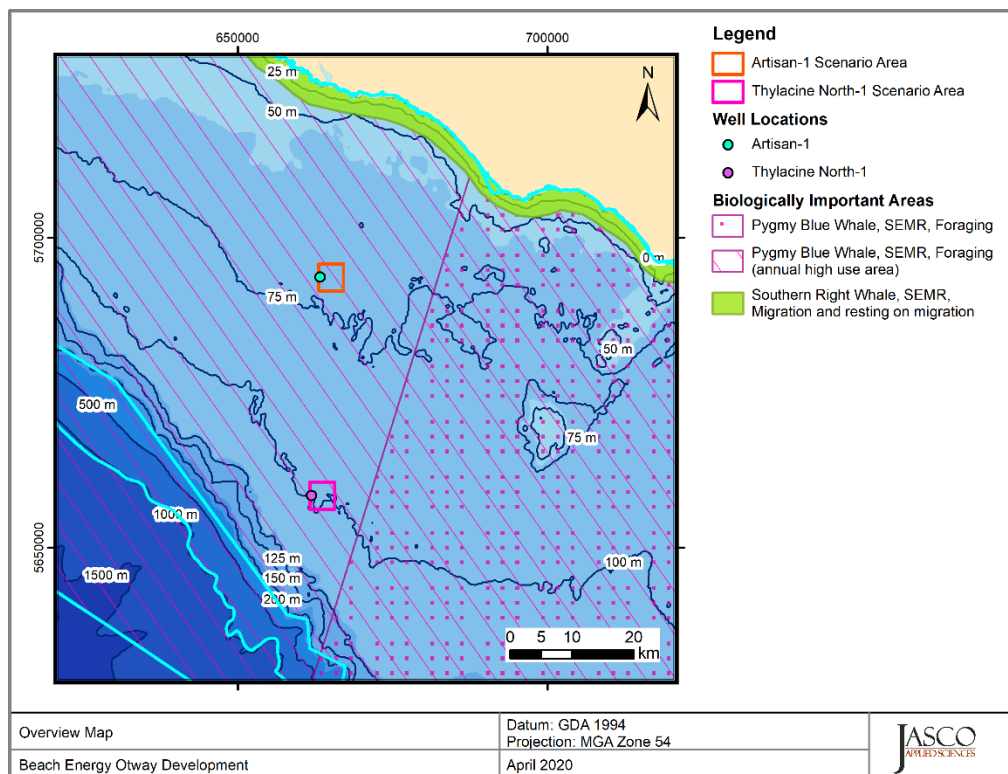


Figure 2. Overview of the modelled area and local features.

The first scenarios (Scenarios 1 and 5; Table 2) represents the operation of a representative MODU proposed for the project (Section 3.3.1). The platform is assumed to be drilling continuously, while at anchor. Scenarios 2–4 and 6–8 represent the operation of a representative OSV Anchor Handling Tug Supply (AHTS) vessel (Section 3.3.2). In Scenarios 2 and 6, the OSV is standing by within 1–3 km of the MODU, ready to respond as required. During this time, the vessel is assumed to be operating under a mix of slow transit, minimal power DP and drifting, and has been conservatively estimated to operating at 15% of the vessels Maximum Continuous Rating (MCR).

To assess the cumulative sound field over a 24 h period, an indicative area (2 km wide x 4 km long) in which the OSV could be during standby was defined at each modelled well, as shown in Figures 3 and 4. Within the defined area, the vessel was considered to be at randomly seeded locations to best approximate real world activities, and thus approximately represent sound fields for activities (see Figures 3 – 4).

Scenarios 3 and 7 combines the operation of the MODU with the OSV during resupply operations. During a 24 h period the resupply operations consist of the following vessel locations and movements:

- OSV transiting within the standby area, operating at 15% MCR,

- OSV in transit from the standby area to the MODU, operating at 15% MRC (4 knots),
- OSV under DP alongside the MODU for a period of 4 hours, operating at 20% MRC,
- OSV in transit from the MODU to the standby area, operating at 15% MRC (4 knots).

Scenarios 4 and 8 combine the operation of the MODU with the OSV keeping station in the defined area over 24 h, representing drilling operations with typical support vessel activity.

Table 2. Description of modelling scenarios

Well	Scenario Number	Description	Associated Modelled Sites
Thylacine North-1	1	MODU, normal drilling operations	1
	2	OSV standby at 15% MCR, independent of MODU, for 24 h	3
	3	MODU with OSV during resupply operations (including 4 hours alongside the MODU)	1, 2 and 3
	4	MODU with OSV standby at 15% MCR (combination of Scenarios 1 and 2)	1 and 3
Artisan-1	5	MODU, normal drilling operations	4
	6	OSV standby at 15% MRC, 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 at 15% MCR (combination of Scenarios 5 and 6)	4 and 6

Table 3. Location details for the modelled sites.

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' 30.6000"	142° 52' 29.7600"	661882	5658411	99.1
	2	OSV	39° 12' 30.5914"	142° 52' 32.4231"	661946	5658410	99.1
	3	OSV standby	39° 12' 29.3412"	142° 53' 53.1042"	663882	5658408	99.1
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

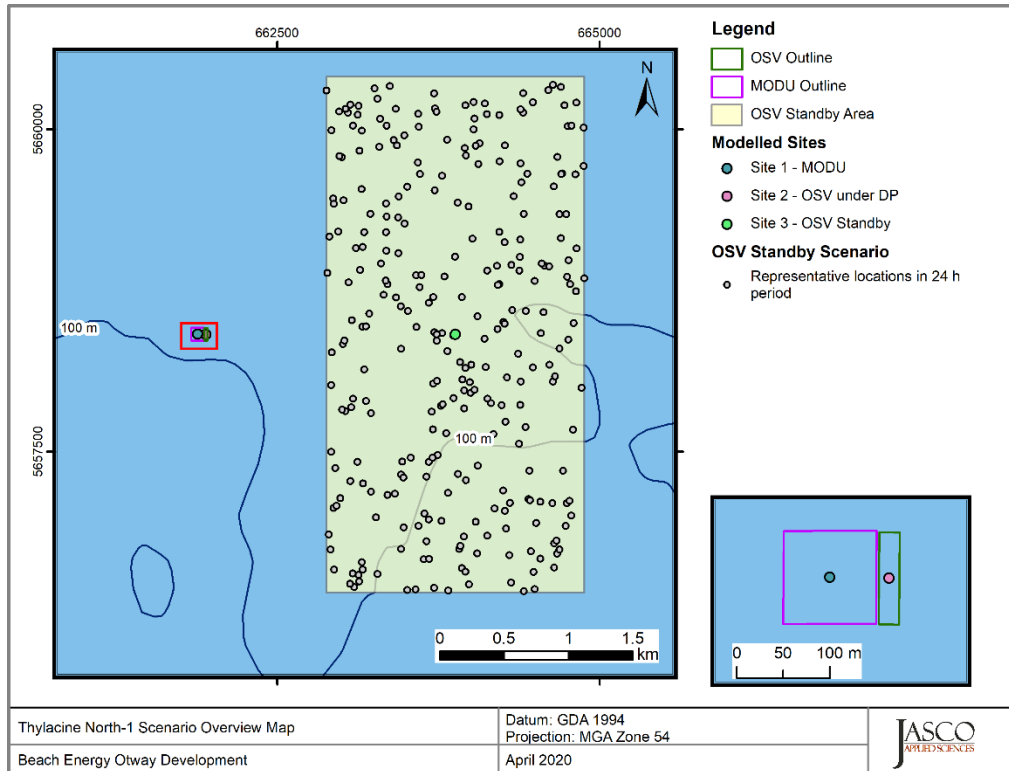


Figure 3. Overview of the modelled sites and the random representative locations for the Thylacine North-1 well.

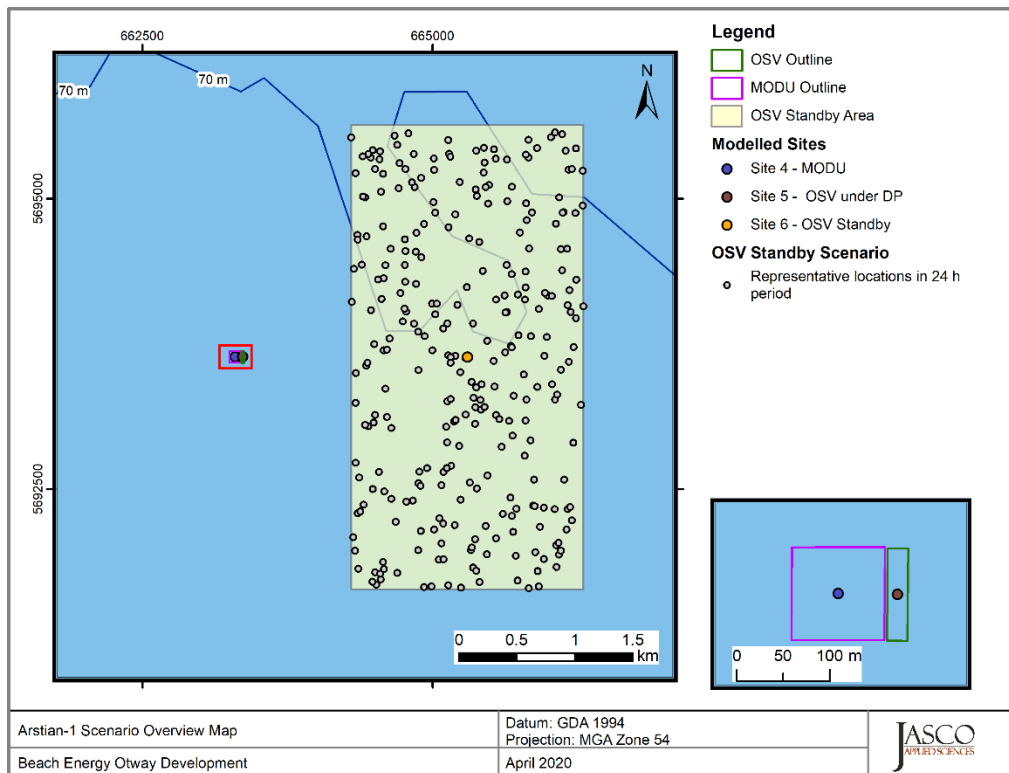


Figure 4. Overview of the modelled sites and the random representative locations for the Artisan-1 well.

2. Noise Effect Criteria

To assess the potential effects of a sound-producing activity, it is necessary to first establish exposure criteria (thresholds) for which sound levels may be expected to have 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 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, SPL, and SEL, are commonly used to evaluate non-impulsive noise and its effects on marine life (Appendix A). 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 (Appendix A.3). The acoustic metrics in this report reflect the updated ANSI and ISO standards for acoustic terminology, ANSI S1.1 (R2013) and ISO 18405:2017 (2017).

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 U.S. 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 μ Pa (SPL; L_p) for non-impulsive sound sources.
3. Sound exposure guidelines for fish, fish eggs, and larvae (Popper et al. 2014).
4. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Finneran et al. (2017) for the onset of PTS and TTS in turtles for non-impulsive sources.

The following sections (Sections 2.1 and 2.2, along with Appendix A.2 and A.3), expand on the thresholds, guidelines and sound levels for marine mammals, fish, fish eggs, fish larvae, and sea turtles.

2.1. Marine Mammals

The criteria applied in this study to assess possible effects of vessel noise on marine mammals are summarised in Tables 4 and detailed in Sections 2.1.1 and 2.1.2, with frequency weighting explained in Appendix A.3.

Table 4. Criteria for effects of continuous noise exposure, including vessel noise, for marine mammals: Unweighted SPL and 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 μ Pa)	Weighted SEL _{24h} ($L_{E,24h}$; dB re 1 μ Pa ² ·s)	Weighted SEL _{24h} ($L_{E,24h}$; dB re 1 μ Pa ² ·s)
LF cetaceans	120	199	179
HF cetaceans		198	178
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 μ Pa.

L_E denotes cumulative sound exposure over a 24 h period and has a reference value of $1 \mu\text{Pa}^2\text{s}$.

2.1.1. Behavioural response

The NMFS non-pulsed noise criterion was selected for this assessment because it represents the most commonly applied behavioural response criterion by regulators. The distances at which behavioural responses could occur were therefore determined to occur in areas ensonified above an unweighted SPL of 120 dB re $1 \mu\text{Pa}$ (NOAA 2019). Appendix A.2 provides more information about the development of this criteria.

2.1.2. Injury and hearing sensitivity changes

There are two categories of auditory threshold shifts or hearing loss: PTS, a physical injury to an animal's hearing organs; and TTS, a temporary reduction in an animal's hearing sensitivity as the result of receptor hair cells in the cochlea becoming fatigued.

To assist in assessing the potential for effect to marine mammals, this report applies the criteria recommended by NMFS (2018), considering both PTS and TTS (Table 4). Appendix A.2 provides more information about the NMFS (2018) criteria.

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

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

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

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. However, as these depend upon activity-based subjective ranges, these effects are not addressed in this report and are included in Table 5 for completeness only. Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to injury from noise exposure depends on the species and the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Turtles, fish eggs, and fish larvae are considered separately.

Table 5 lists the relevant effect guidelines from Popper et al. (2014) for shipping and continuous noise. Some evidence suggests that fish sensitive to acoustic pressure show a recoverable loss in hearing sensitivity, or injury when exposed to high levels of noise (Scholik and Yan 2002, Amoser and Ladich 2003, Smith et al. 2006); this is reflected in the SPL thresholds for fish with a swim bladder involved in hearing.

Finneran et al. (2017) presented revised thresholds for turtle PTS and TTS, considering frequency weighted SEL, which have been applied in this study for vessels (Table 6).

Table 5. Guidelines for vessel noise exposure for fish, adapted from Popper et al. (2014).

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

Sound pressure level dB re 1 µPa.

Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Table 6. Acoustic effects of continuous noise on turtles, weighted SEL_{24h}, Finneran et al. (2017).

PTS onset thresholds* (received level)	TTS onset thresholds* (received level)
220	200

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

3. Methods and Parameters

The operations considered in this study will take place within the Beach Energy Otway Development project area, at depths 70–99 m (Appendix D.2.1). Activities could take place at any time in the year. The most conservative water sound speed profile (i.e., the profile leading to the longest acoustic propagation) was therefore selected for modelling (Appendix D.2.2). In the project area, the seabed consists of a sequence of cemented and semi-cemented calcareous sediments (Appendix D.2.3), with a thin veneer of gravel at the seabed in some locations.

This section described the methods used to characterise the vessels sound fields, including the acoustic propagation models, the frequency ranges and the accumulation periods considered.

3.1. Geometry and Modelled Regions

JASCO's Marine Operations Noise Model (MONM-BELLHOP Appendix C.2) was used to predict the underwater acoustic propagation loss from modelled sites (Table 3), at frequencies of 10 Hz to 25 kHz. This model considers the environmental variations along the propagation path. The final acoustic fields combine the MODU or the OSV source levels (Section 3.3) with the site-specific propagation loss fields.

To assess sound levels with MONM-BELLHOP, the sound field modelling calculated propagation losses up to distances of 75 km from the source in each cardinal direction, with a horizontal separation of 10 m between receiver points along the modelled radials. The sound fields were modelled with a horizontal angular resolution of $\Delta\theta = 2.5^\circ$ for a total of $N = 144$ radial planes. Receiver depths were chosen to span the entire water column over the modelled areas, from 1 m to a maximum of 4250 m, with step sizes that increased with depth. To supplement the MONM results, high-frequency results for propagation loss were modelled using BELLHOP for frequencies from 2.5 to 25 kHz. The MONM and BELLHOP results were combined to produce results for the full frequency range of interest.

To produce the maps of received sound level distributions, isopleths and calculate distances to specified sound level thresholds, the maximum-over-depth level was calculated at each sampling point within the modelled region. The radial grids of maximum-over-depth levels for resampled (by linear triangulation) to produce a regular Cartesian grid. The sound field grids from all sources were summed (Equation A-5) to produce the cumulative sound field grid with cell sizes of 25 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields.

3.2. Accumulated SEL

The MODU and the OSV continuously produce sound. The reported source levels are usually in terms of sound pressure levels (SPL), representing the average instantaneous acoustic level of the MODU or the OSV during specific operation. The evaluation of the cumulative sound field (i.e. in terms of SEL over 24 h) depends on the number of seconds of operation during the accumulation period.

As the MODU is considered stationary and continuously operational (Scenario 1 and 5), 1-second SEL, equivalent to SPL, were increased by $10 \cdot \log_{10}(T)$, where T is 86,400 (the number of seconds in 24 h).

During standby (Scenarios 2,4 and 6,8), the OSV would not be stationary but transiting the station-keeping corridor at low speed. In this case, the cumulative sound field was modelled by translating the modelled sound field at the centre of the corridor (Sites 3 and 6; Table 3) to randomly-selected locations within the corridor. The sound field was translated from SPL to SEL based on the time spent at each location, and the translated fields were added to modelled 24 h of standby. Here, 288 locations were selected, representing a location every 5 minutes for 24 hours; Figures 3 and 4 present the random locations at each well.

During resupply operations, (Scenarios 3 and 7), the vessel movements were similar to the movements for the standby scenarios, with the additional contributions of the transit to and from the

standby area to the MODU and the OSV under DP during resupply. The accumulated sound field during transit to and from the standby area to the MODU, was calculated by translating the single site modelled sound field at the centre of the corridor along a 2 km path from the centre of the station-keeping area to a location adjacent to the MODU. The accumulated SEL at locations along this path were integrated every 5 minutes (Equation A-5) based on transit speed of 4 knots. While on DP the 1-second SEL for the OSV at 20% MCR were increased by $10 \cdot \log_{10}(T)$, where T is 14,400 (the number of seconds in 4 h).

3.3. Acoustic Sources

3.3.1. Mobile Offshore Drilling Unit (MODU)

The MODU, or semi-submersible platform, considered in this study is the Ocean Onyx as it represents the type of MODU that would be used for the wells (Figure 5). While in operation, it will be held in position via anchors and chains, as opposed to using thrusters. Underwater sound from the platform while drilling is expected to originate primarily from onboard equipment vibrations, while a smaller portion of the sound is expected to be transmitted directly into the water via the vibrating drill (Austin et al. 2018). Since the dominant vibration sources (e.g. pumps, generators, and machinery) are located on or below the main deck of the platform, the modelled depth of the point source representing the MODU was set to 11 m, approximately half the draft of the Ocean Onyx (22.7 m).

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 178.7 dB re 1 μ Pa m. The decidecade source levels for the Polar Pioneer, used to represent an MODU, are shown in Figure 6. This source level is higher than that presented in Austin et al. (2018).



Figure 5. *Ocean Onyx* semi-submersible platform.

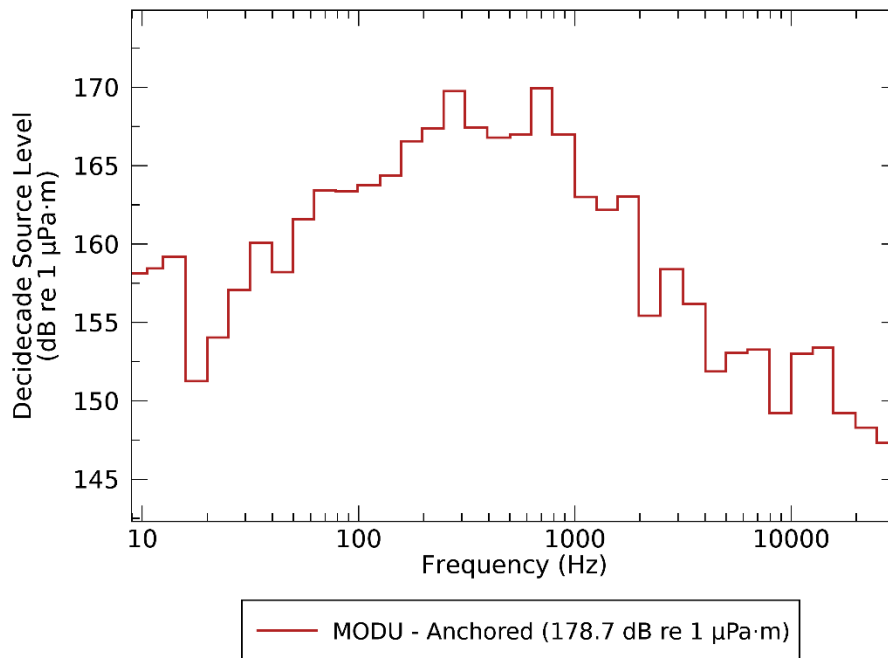


Figure 6. *MODU*: Decidecade source level spectrum. **Offshore Support Vessel (OSV)**

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

The estimates of the source levels for the OSV were based on the Siem Offshore VS491 CD design Anchor Handling Tug Supply (AHTS) vessels (Figure 7). These vessels have a bollard pull of 285-310 t, and an overall length, beam and draft of 91.0, 22.0 and 7.95 m respectively.

The main propulsion system comprises two Wärtsilä Lips Controllable Pitch Propellers (CPP). Each LIPS CPP has the following parameters:

- 4.2 m propeller diameter
- 144 rpm nominal propeller speed, and
- 9215 kW maximum continuous power input.

In addition to the main propellers, the OSV is also equipped with a single bow azimuth thruster rated at 830 kW with the following parameters:

- Assumed 1.65 m propeller diameter
- 364 rpm nominal propeller speed, and
- 830 kW maximum continuous power input.

Furthermore, the OSV also feature two bow tunnel thrusters rated at 1000 kW each and two stern tunnel thrusters rated at 880 kW each, these tunnel thrusters are unlikely to be used in normal operations, however they could potentially be engaged if the OSVs have to hold station.

Source spectra for the main propellers and bow azimuth thruster were determined by the method described in Appendix B. Source spectra for the bow and stern thrusters were based on those of the Damen platform supply vessel 3300CD, which was used in previous studies (Zykov 2016). For the Damen 3300CD, the tunnel thrusters are 735 kW maximum continuous power input, hence the spectra were offset according to Equation 1.

Estimates of the acoustic source levels for the OSV were based on the parameters of the propulsion system, and the percentage MCR at which the vessel is expected to be operating at during each scenario, confirmed with the vessel manufacturer (Siem Offshore) and their vessel masters. In cases where the modelled source levels were derived from the source levels of other vessels, the modelled source levels were adjusted using Equation 1.

$$SL = SL_{\text{ref}} + 10 \log_{10} \left(\frac{P}{P_{\text{ref}}} \right) \quad (1)$$

Here the modelled source level (SL) is estimated from the source level of the proxy source (SL_{ref}) and the propulsion powers of the modelled and proxy sources (P and P_{ref} , respectively).

The depths of the source sources were based on the approximate location of cavitation. During transit, since the main propellers will be the primary propulsion system used, the modelled source depth was set to 4.5 m, which is based on a draft of 7.95 m and propeller size on 4.2 m (Leggat et al. 1981). While using DP, the primary propulsion system will be bow and stern thrusters; in the case, the source was modelled at a depth of 6.5 m, based on a 1.65 m propeller diameter.



Figure 7. Photo of a Siem Anchor Handling Tug Supply (AHTS) vessel (Siem Offshore 2010).

The full power source spectrum was determined by summing the spectra for the individual thrusters and main propellers, and the spectrum for each modelling scenario was determined by offsetting the full power spectrum by $10 \log_{10}(\text{MCR})$, where the MCR is represented as a fraction of full power for each scenario. All thrusters have been included in the source level calculation for scenarios where the OSV was under DP. Only the main propulsion system was considered for scenarios where the vessel was transiting. The overall source levels are shown in Figure 8. An overall source level of 183.0 dB re 1 μPa m was used for transit in the standby area and 186.6 dB re 1 μPa m was used for re-supply operations when the OSV was under DP.

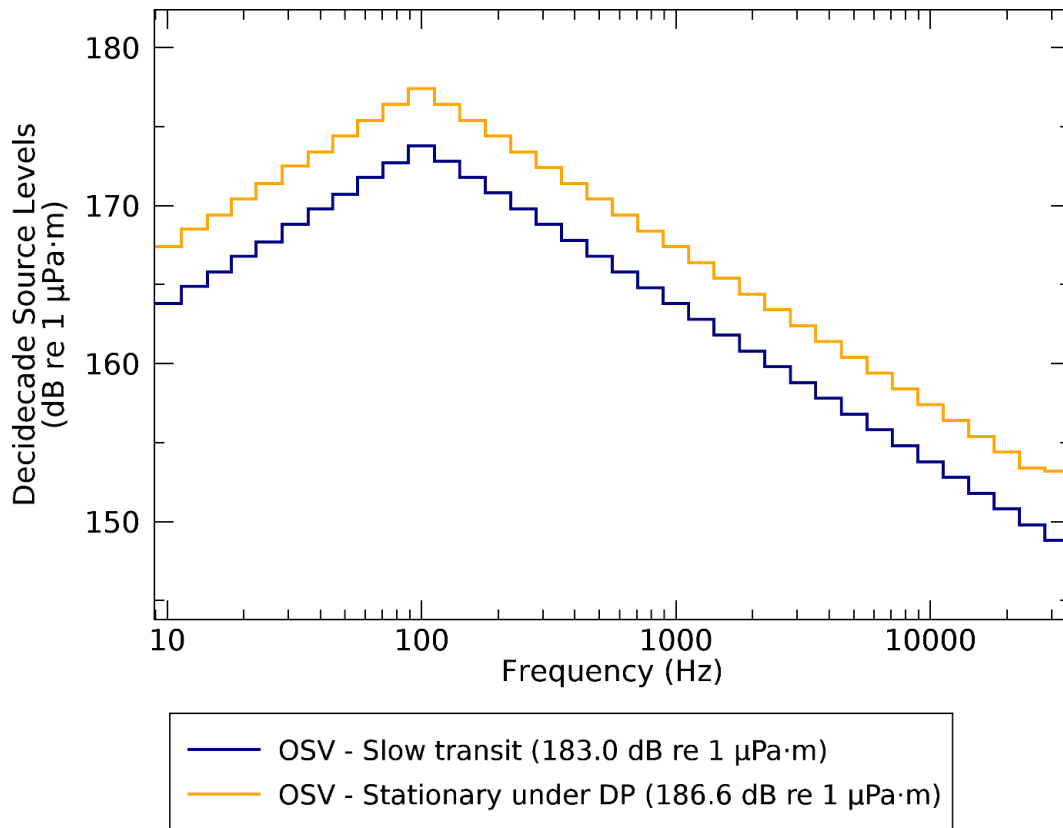


Figure 8. OSV: Decidecade source level spectra of the two modelled OSV MCR percentages, slow transit (15%) and DP (20%).

4. Results

The maximum-over-depth sound fields for the eight modelled scenarios (described in Section 1.1) are presented below in two formats: as tables of distances to sound levels and, where the distances are long enough, as contour maps showing the directivity and range to various sound levels. Tables 7 and 8 present the maximum and 95% distances (defined in Appendix D.1) to SPL thresholds for the Thylacine North-1 and Artisan-1 well locations respectively. The ensonified areas for the marine mammal behavioural response criteria are provided in Table 9. Tables 10 and 11 represent the distances to frequency-weighted SEL_{24h} threshold, as well as total ensonified area.

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.

4.1. Tabulated results

Table 7. *Thylacine North-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 (see table footnotes). A dash indicates the threshold is not reached within the limits of the modelling resolution (25 m).

SPL (L_p ; dB re 1 μ Pa)	MODU (Scenario 1)		OSV standby (Scenario 2)		MODU and OSV resupply (Scenario 3) ^A		MODU and OSV standby (Scenario 4) ^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	–	–	–	–	–	–	–	–
170 [†]	–	–	–	–	–	–	–	–
160	–	–	–	–	0.06	0.06	–	–
158 [#]	–	–	–	–	0.08	0.08	–	–
150	0.03	0.03	0.05	0.05	0.29	0.26	0.03	0.03
140	0.19	0.19	0.32	0.31	1.15	1.09	0.19	0.19
130	0.97	0.9	1.38	1.28	4.28	3.83	2.41	2.12
120 [†]	4.6	4.17	4.44	4.02	13.7	11.8	6.72	5.85
110	21.1	16.8	14.8	11.7	49.9	38.2	25.0	20.4
100	70.7	56.8	47.8	35.6	70.7	57.4	71.4	57.0

[†] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).

[#] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).

[†] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

^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 centre of standby area.

Table 8. *Artisan-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 (see table footnotes). A dash indicates the level was not reached within the limits of the modelling resolution (25 m). A slash indicates that $R_{95\%}$ is not reported when the R_{max} is greater than the maximum modelling extent.

SPL (L_p ; dB re 1 μ Pa)	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 3) ^A		MODU and OSV standby (Scenario 4) ^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 [†]	–	–	–	–	0.03	0.03	–	–
160	–	–	–	–	0.06	0.06	–	–
158 [#]	–	–	–	–	0.09	0.09	–	–
150	0.04	0.04	0.05	0.05	0.33	0.31	0.05	0.05
140	0.21	0.20	0.37	0.36	1.6	1.53	0.37	0.36
130	1.19	1.09	1.89	1.81	5.89	5.41	3.22	2.82
120 [†]	5.91	5.39	6.23	5.69	17.4	15.4	8.94	7.89
110	34.9	22.6	19.0	15.3	60.1	48.5	36.8	28.0
100	>75.0	/	56.0	46.4	>75.0	/	>75.0	/

^{*} 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).

[#] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).

[†] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

^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 centre of standby area.

Table 9. *SPL*: Areas (km²) for modelled scenarios within isopleths corresponding to the threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

SPL (L_p ; dB re 1 μ Pa)	MODU	OSV standby	MODU and OSV resupply	MODU and OSV standby
Thylacine North-1				
120 [†]	48.9	52.5	444	110
Artisan-1				
120 [†]	94.3	105	764	202

[†] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 10. Thylacine North-1: 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 (25 m).

Hearing group	SEL_{24h} Threshold ($L_{E,24h}$; dB re $1 \mu Pa^2 \cdot s$) #	MODU (Scenario 1)		OSV standby (Scenario 2)		MODU and OSV resupply (Scenario 3 ^B)		MODU and OSV standby (Scenario 4 ^B)	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
<i>PTS</i>									
LF cetaceans	199	0.03	0.004	–	–	0.03	0.004	0.03	0.004
MF cetaceans	198	–	–	–	–	–	–	–	–
HF cetaceans	173	0.04	0.006	–	–	0.04	0.006	0.04	0.006
Phocid Seals	201	–	–	–	–	–	–	–	–
Otariid Seals	219	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	–	–	–	–
<i>TTS</i>									
LF cetaceans	179	0.84	1.54	1.03	4.48	2.66 ^C	9.85	2.68 ^C	9.58
MF cetaceans	178	0.03	0.003	–	–	0.03	0.003	0.03	0.003
HF cetaceans	153	0.6	1.09	1.03	4.35	2.68 ^C	6.07	1.03 ^A	4.35
Phocid Seals	181	0.14	0.063	–	–	0.14	0.063	0.14	0.063
Otariid Seals	199	–	–	–	–	–	–	–	–
Turtles	200	–	–	–	–	–	–	–	–

Frequency weighted.

^A Radial distance reported from the centre of the OSV standby area.

^B Radial distance reported from the centre of the MODU, unless indicated otherwise.

^C Radial distance reported from the mid-point between the MODU and the centre of the OSV standby area.

Table 11. *Artisan-1*: 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 (25 m).

Hearing group	SEL _{24h} Threshold ($L_{E,24h}$; dB re 1 μ Pa ² ·s) #	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7) ^B		MODU and OSV standby (Scenario 8) ^B	
		R_{max} (km)	Area (km ²)	R_{max} (km)	Area (km ²)	R_{max} (km)	Area (km ²)	R_{max} (km)	Area (km ²)
<i>PTS</i>									
LF cetaceans	199	–	–	–	–	–	–	–	–
MF cetaceans	198	–	–	–	–	–	–	–	–
HF cetaceans	173	0.04	0.005	–	–	0.04	0.005	0.04	0.005
Phocid Seals	201	–	–	–	–	–	–	–	–
Otariid Seals	219	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	–	–	–	–
<i>TTS</i>									
LF cetaceans	179	0.92	2.49	1.12	8.21	2.73 ^C	15.5	2.76 ^C	13.9
MF cetaceans	178	–	–	–	–	–	–	–	–
HF cetaceans	153	0.60	1.09	1.04	4.23	2.68 ^C	6.05	1.04 ^A	4.23
Phocid Seals	181	0.21	0.11	–	–	0.21	0.11	0.21	0.11
Otariid Seals	199	–	–	–	–	–	–	–	–
Turtles	200	–	–	–	–	–	–	–	–

Frequency weighted.

^A Radial distance reported from the centre of the OSV standby area.

^B Radial distance reported from the centre of the MODU, unless indicated otherwise.

^C Radial distance reported from the mid-point between the MODU and the centre of the OSV standby area.

4.2. Sound Field Maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for SPL and SEL_{24h} sound fields have been presented for the eight vessel modelling scenarios (Table 2) in Figures 9–24.

4.2.1. Thylacine North-1 Well Scenarios

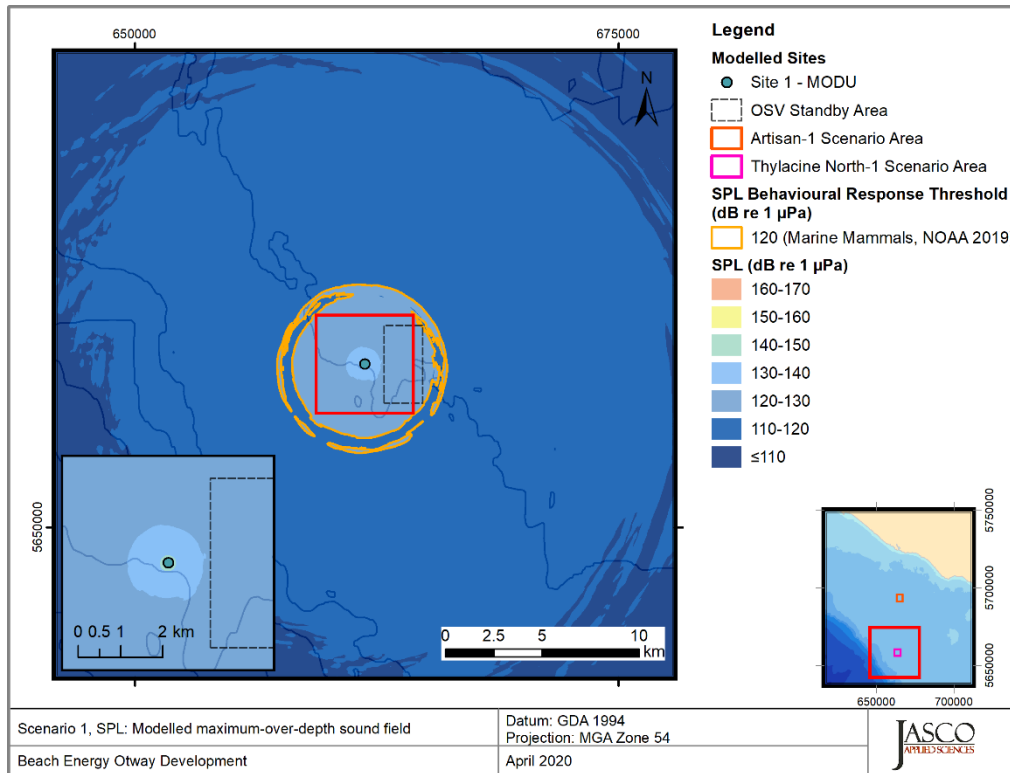


Figure 9. Thylacine North-1, MODU (Scenario 1), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isoleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

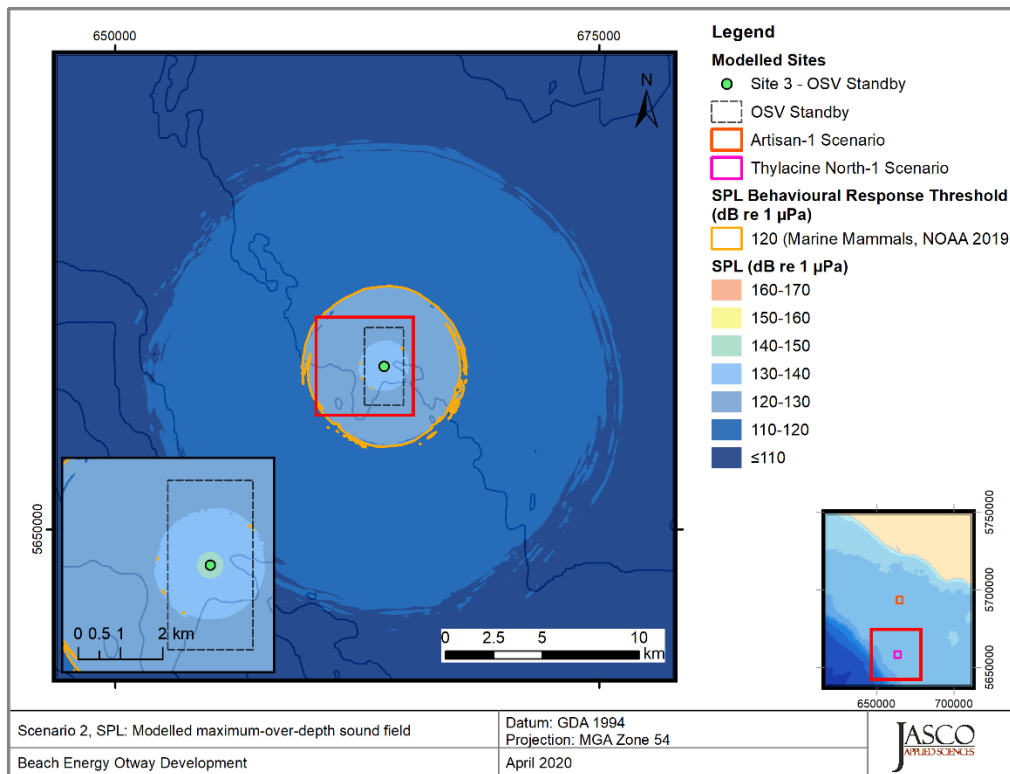


Figure 10. Thylacine North-1, OSV standby (Scenario 2), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isoleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

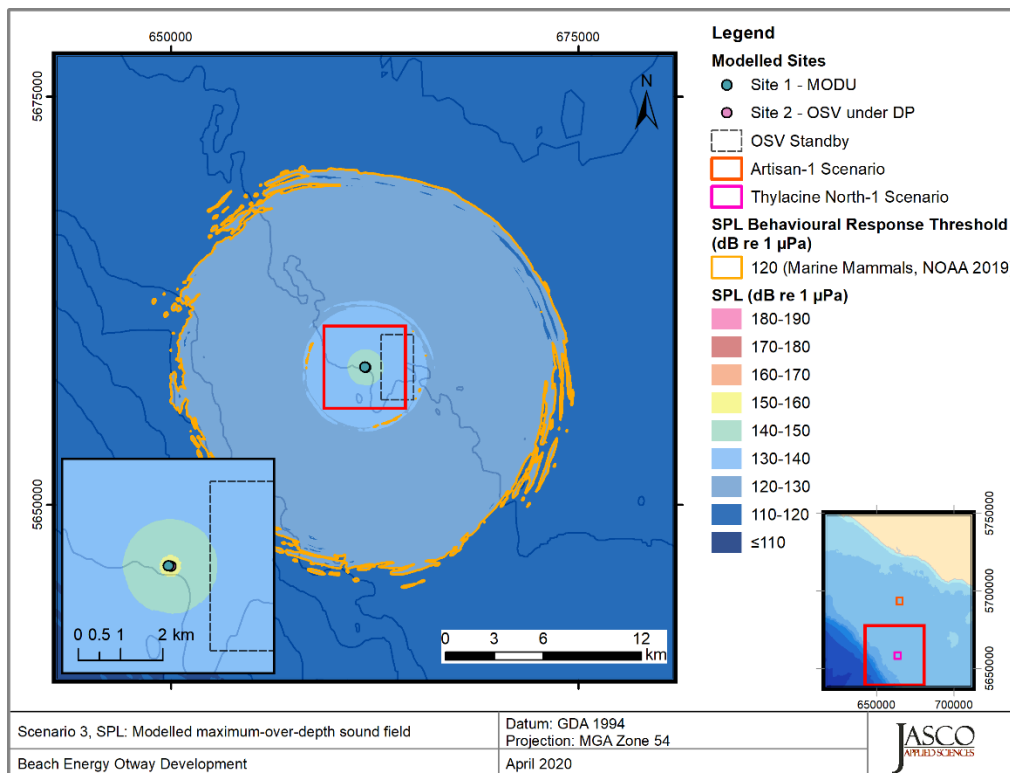


Figure 11. Thylacine North-1, MODU and resupply OSV on DP (Scenario 3) SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isoleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

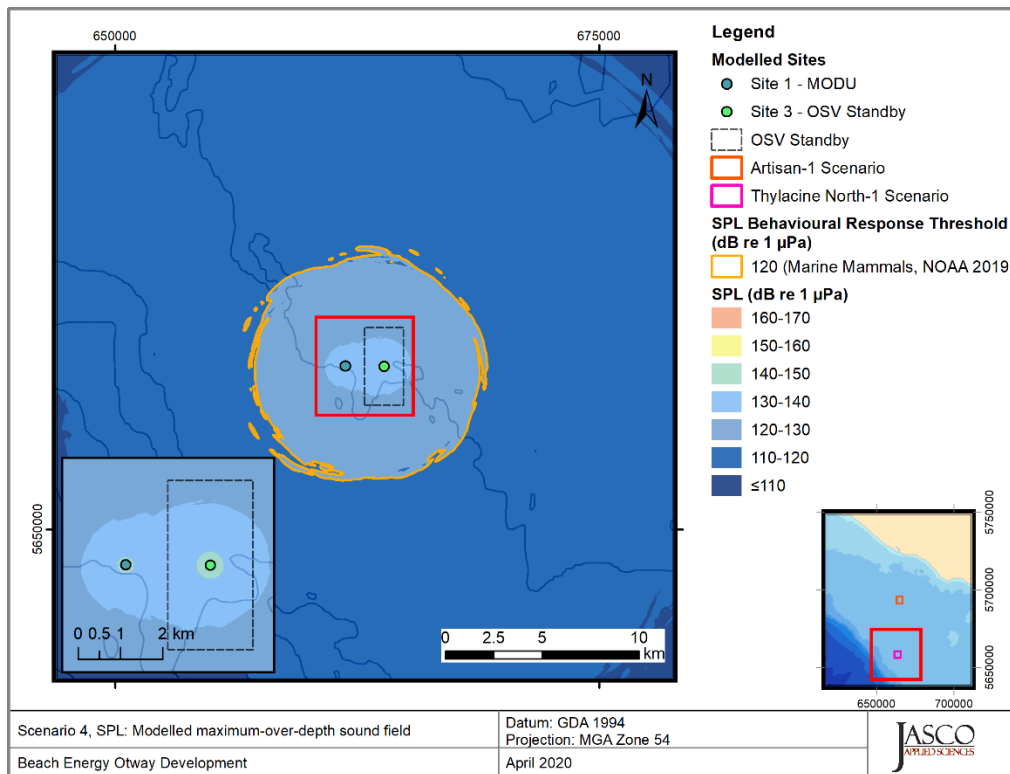


Figure 12. Thylacine North-1, MODU and OSV standby (Scenario 4), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isoleth for marine mammal (120 dB re 1 μ Pa) behavioural criteria is shown as an orange contour line.

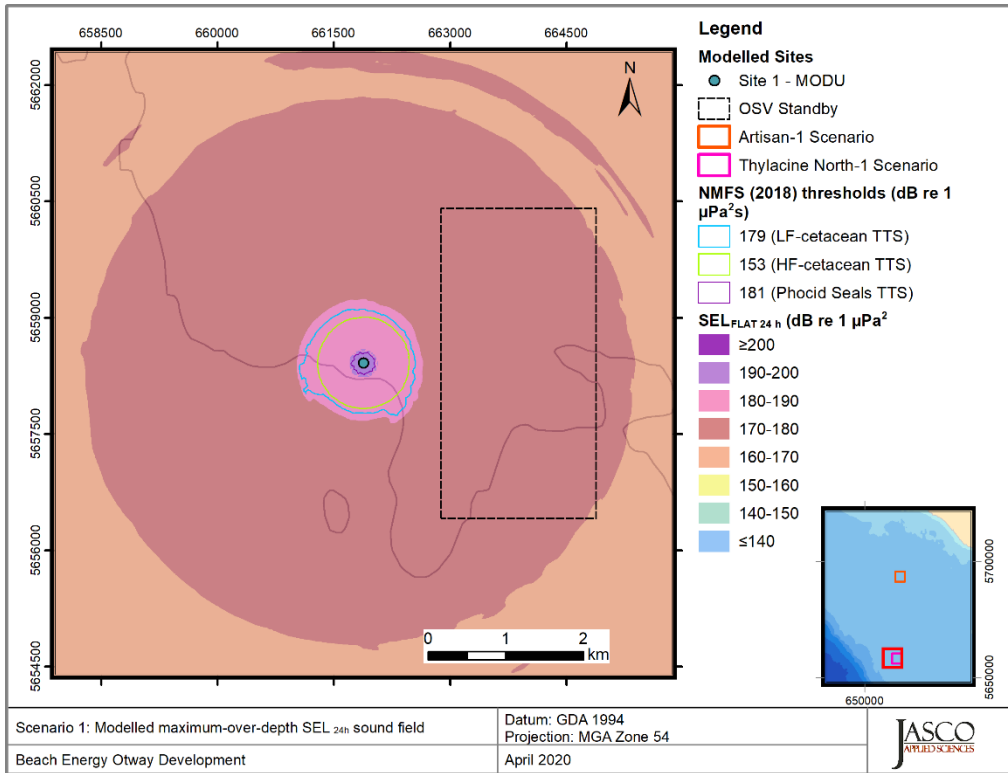


Figure 13. Thylacine North-1, MODU (Scenario 1), SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

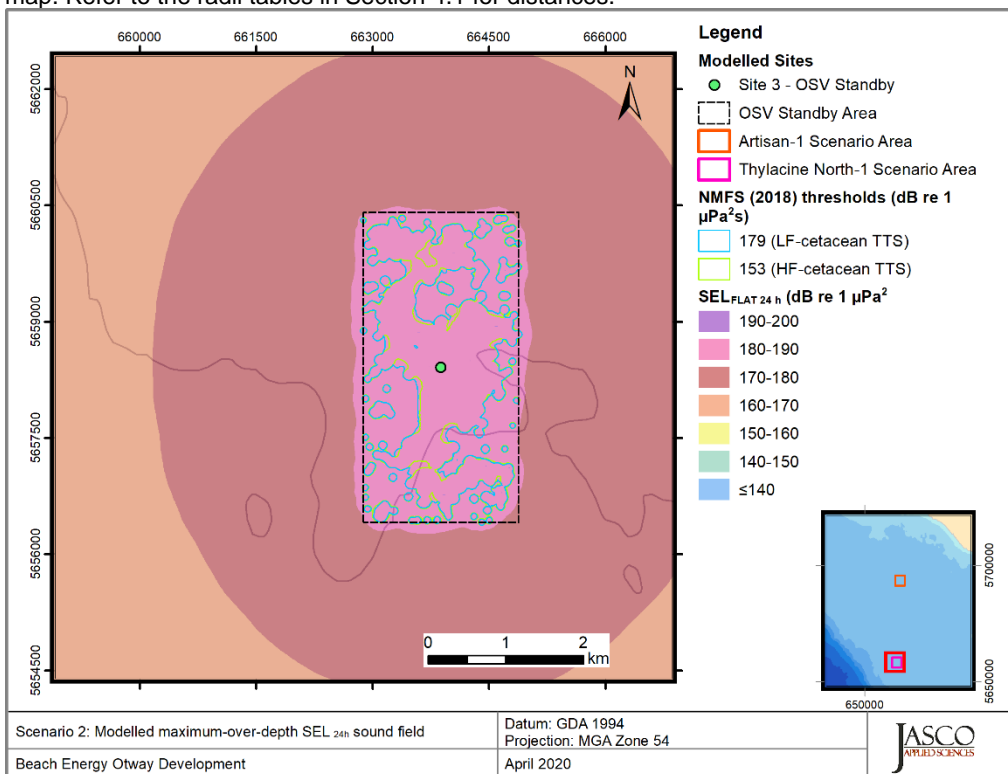


Figure 14. Thylacine North-1, OSV standby (Scenario 2), SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

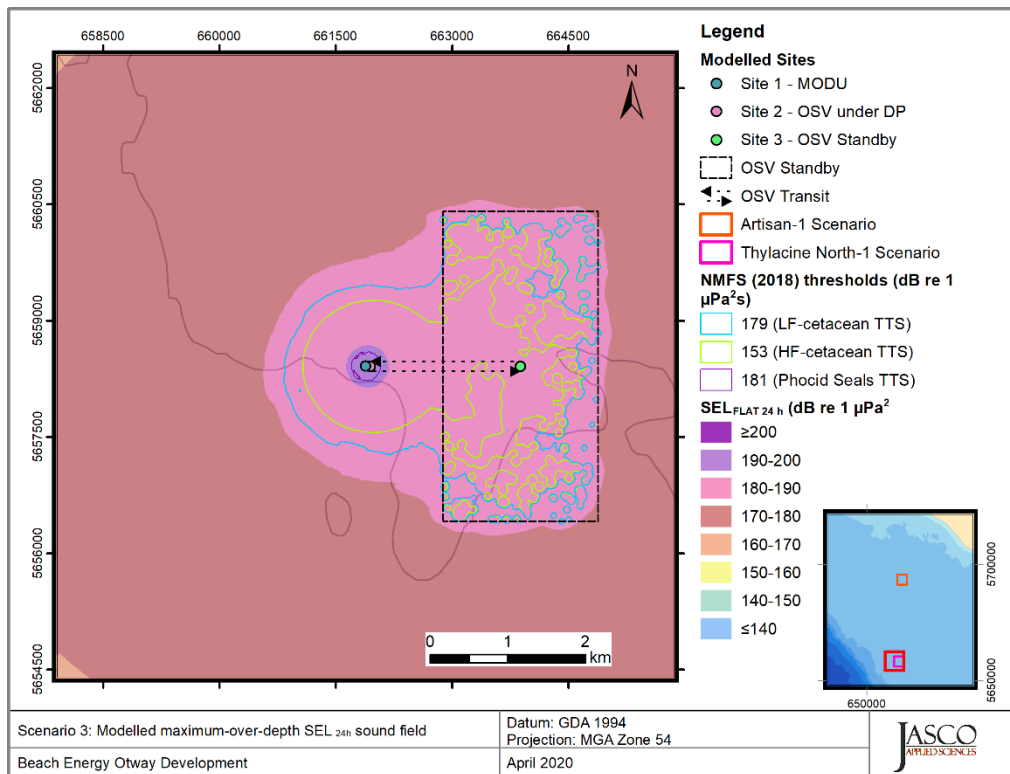


Figure 15. Thylacine North-1, MODU and OSV on DP (Scenario 3), SEL_{24h} : Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

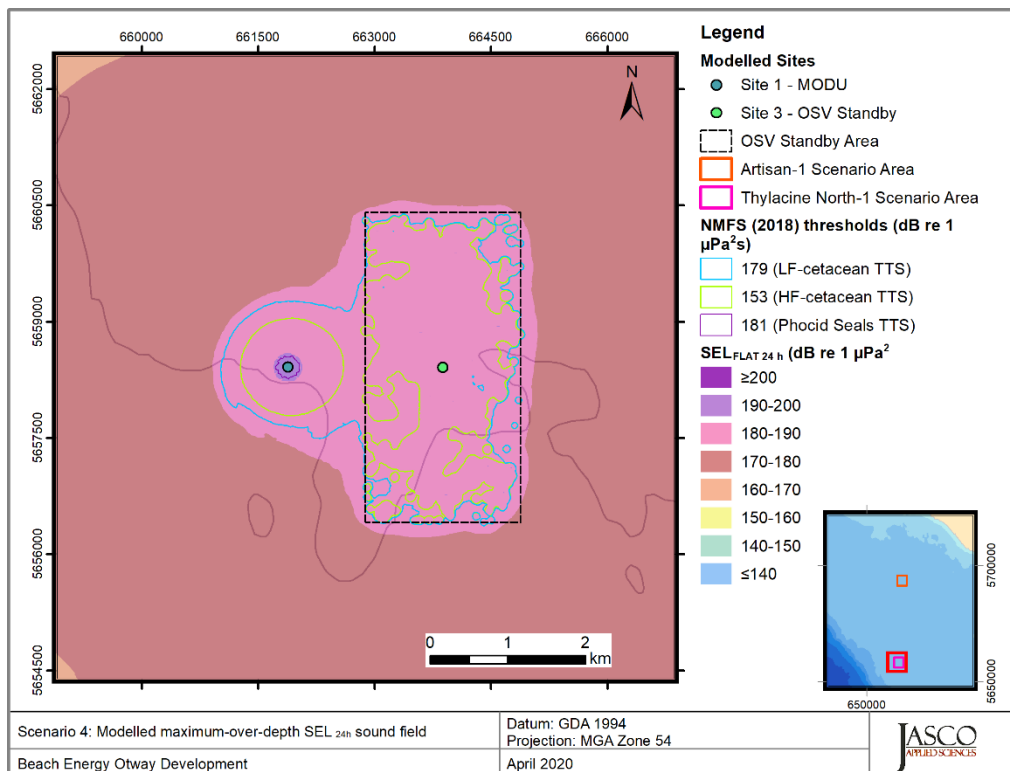


Figure 16. Thylacine North-1, MODU and OSV standby (Scenario 4), SEL_{24h} : Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

4.2.2. Artisan-1 Well Scenarios

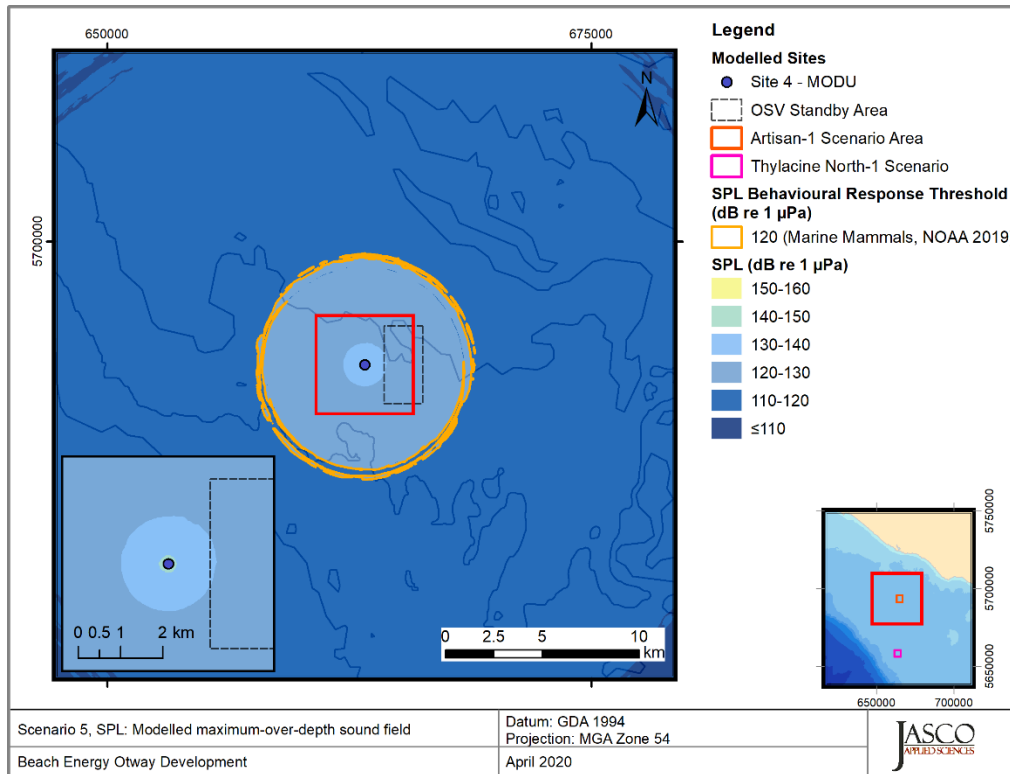


Figure 17. Artisan-1, MODU (Scenario 5), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

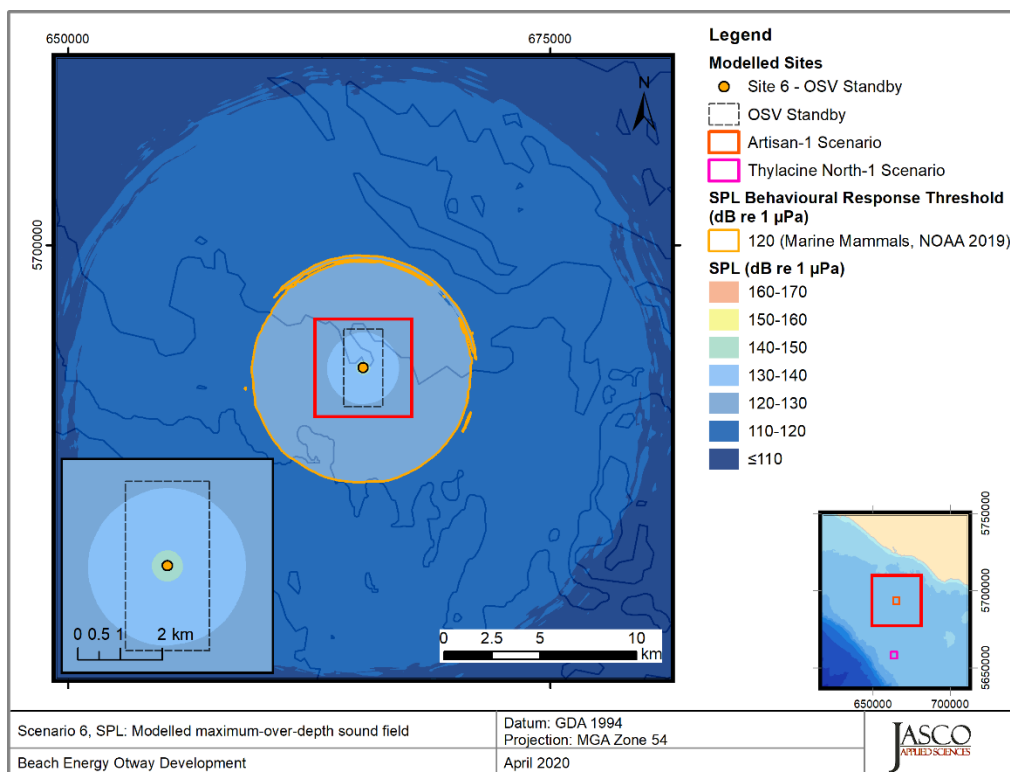


Figure 18. Artisan-1, OSV standby (Scenario 6), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

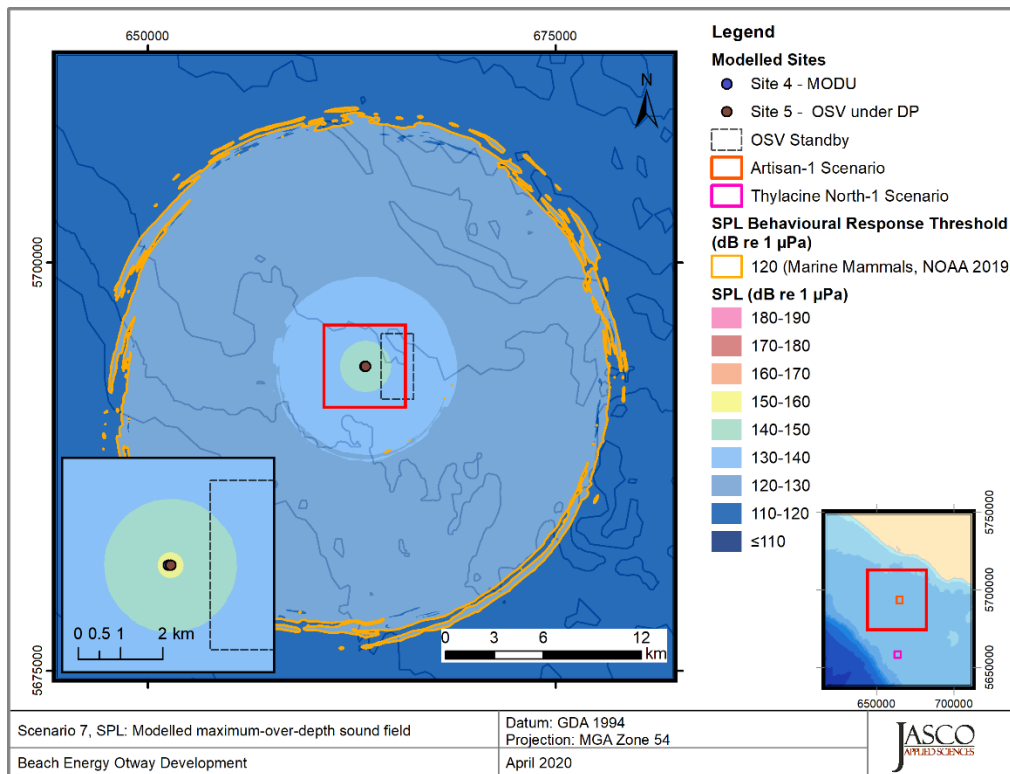


Figure 19. Artisan-1, MODU and OSV on DP (Scenario 7), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

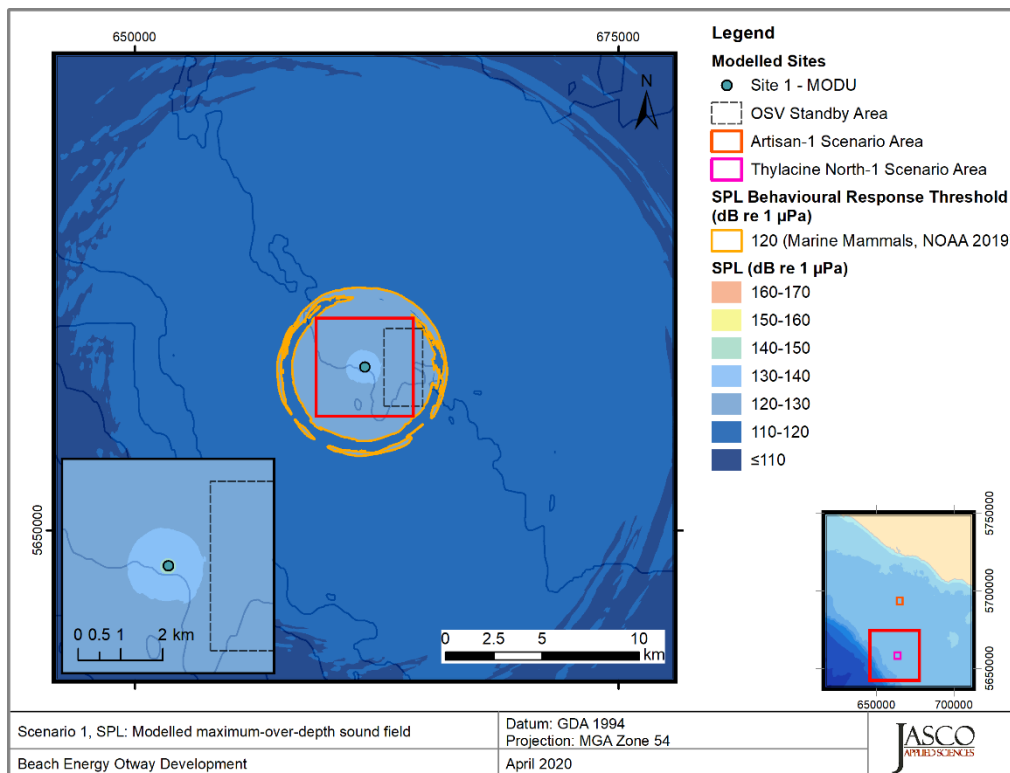


Figure 20. Artisan-1, MODU and OSV standby (Scenario 8), SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

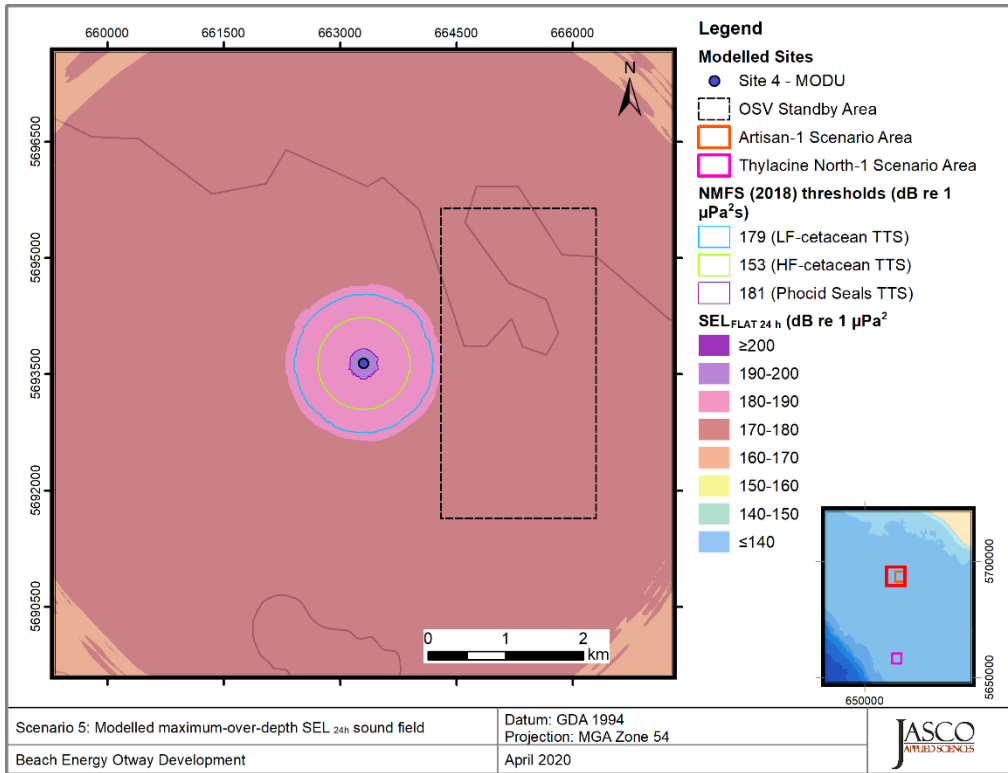


Figure 21. Artisan-1, MODU (Scenario 5), SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

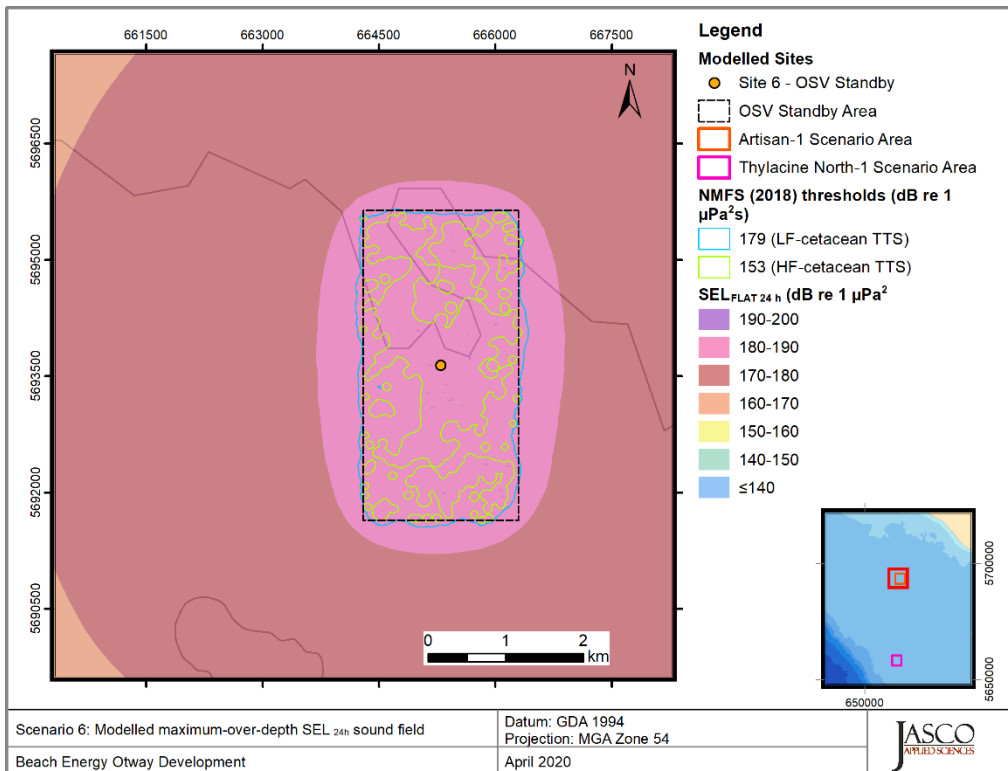


Figure 22. Artisan-1, OSV on DP (Scenario 6), SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

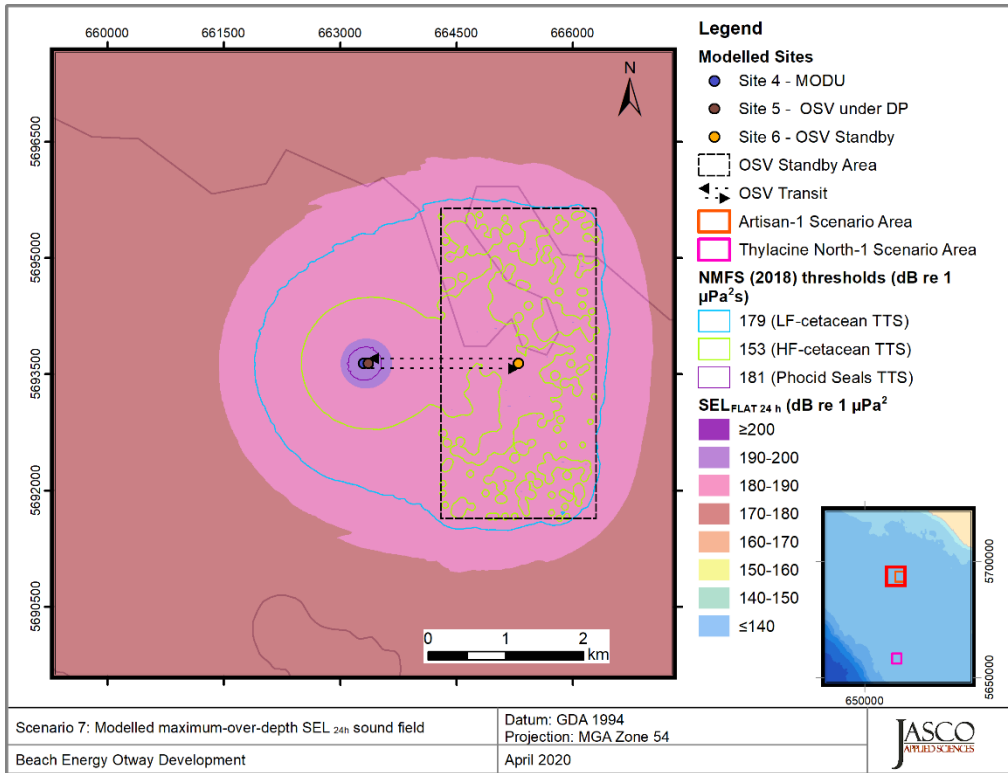


Figure 23. Artisan-1, OSV standby (Scenario 7), SEL_{24h} : Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

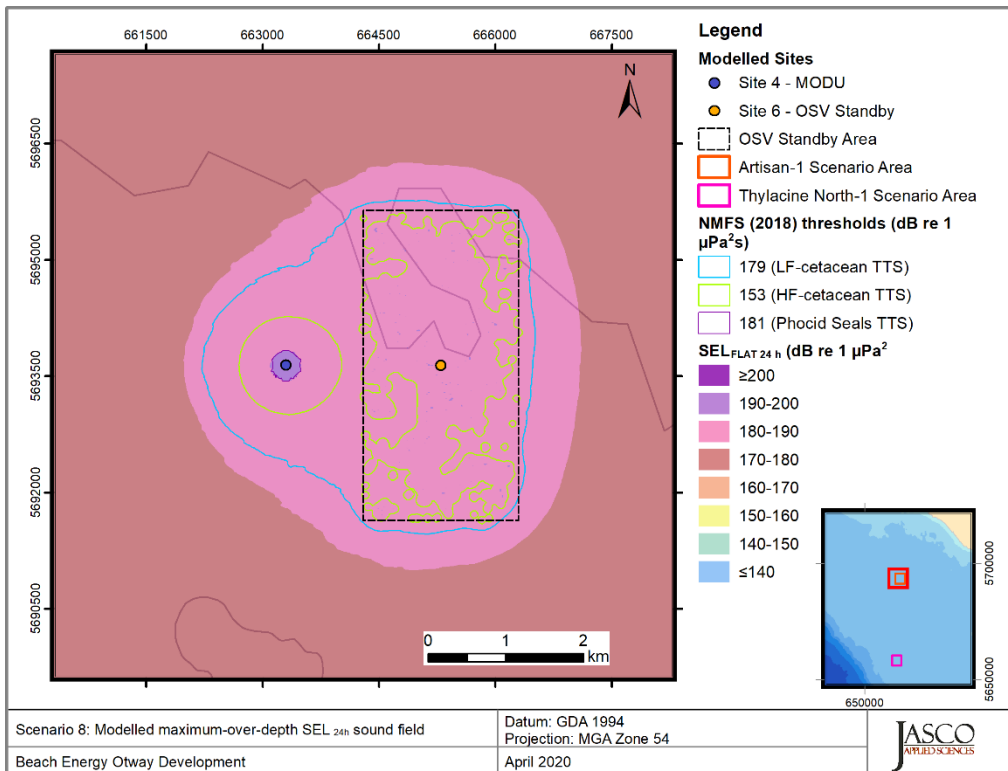


Figure 24. Artisan-1, MODU and OSV on DP (Scenario 8), SEL_{24h} : Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

5. Discussion and Summary

The sound speed profile (Appendix D.2.2) was derived from data from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). The month of June was chosen based on an analysis of the temperature, salinity and sound speed profiles extracted from this database. The final profile consisted of two profile representative profiles select within the modelled area to capture propagation effects associated with shallow and deep-water regimes.

The considered sound speed profile was primarily downward refracting apart from a slight upward refracting layer, which extended approximately 40 m down from the sea surface. This layer has the potential to trap high frequency energy near the sea surface that would otherwise dissipate more rapidly in range due to propagation, absorption, and seabed losses. The slight upward refracting layer in the sound speed profile only has the potential to effective trap frequencies above 741 Hz based on the thickness of the refracting layer (Jensen et al. 2011).

Considering both well locations are situated on the continental shelf, variations in bathymetry were generally gradual within the modelled areas. Any variations in the bathymetry had a small effect on the predicted sound field footprints as manifested in the generally symmetric sound field footprints. However, the composition of the seabed used for modelling had a more substantial influence when comparing the threshold radii and sound field footprints between the Thylacine North-1 and Artisan-1 modelled areas. The presence of a thin veneer of un-consolidated gravel overlying semi-cemented carbonate rock led to a marginally more reflective seabed and likely led to large isopleths for low level thresholds. This is most evident for the marine mammal behavioural threshold of 120 dB re 1 μ Pa (SPL) for non-impulsive sound sources, where the Artisan-1 radii and areas are larger than Thylacine North-1 radii and areas.

For the results tables present in Section 4.1 were a dash is used in place of a horizontal distance, these thresholds may or may not be reached. Due to the discretely sampled 25 m calculation grids of the modelled sound fields, distances to these levels could not be estimated for practicable computational purposes. It is likely that SPL isopleths could be reached at distances between 1 m and the modelled horizontal resolution (25 m); however, distances to injurious accumulated SEL thresholds may not be reached at any range greater than 1 m due the species specific frequency weighing functions. In addition, this is in relation to representing the vessel (MODU or OSV) using a representative source level, which is based on a 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. The indication is that these close-to-source radii are comparable to the dimensions of the modelled vessel, and therefore are levels which may only be reached within close proximity to a vessel, if at all.

Glossary

1/3-octave

One third of an octave. Note: A one-third octave is approximately equal to one decidecade ($1/3 \text{ oct} \approx 1.003 \text{ ddec}$; ISO 2017).

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.

absorption

The reduction of acoustic pressure amplitude due to acoustic particle motion energy converting to heat in the propagation medium.

acoustic impedance

The ratio of the sound pressure in a medium to the rate of alternating flow of the medium through a specified surface due to the sound wave.

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.

attenuation

The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

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 2017). One example is M-weighting introduced by Southall et al. (2007) to describe “Generalized frequency weightings for various functional hearing groups of marine mammals, allowing for their functional bandwidths and appropriate in characterizing auditory effects of strong sounds”.

azimuth

A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

bandwidth

The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI/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 $10^{11} \text{ } \mu\text{Pa}$.

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.

broadside direction

Perpendicular to the travel direction of a source. Compare with endfire direction.

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.

compressional wave

A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

continuous sound

A sound whose sound pressure level remains above ambient sound during the observation period (ANSI/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 2017). Note: An alternative name for decidecade (symbol ddec) is “one-tenth decade”. A decidecade is approximately equal to one third of an octave ($1 \text{ ddec} \approx 0.3322 \text{ oct}$) 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 S1.1-1994 R2004).

endfire direction

Parallel to the travel direction of a source. See also broadside direction.

ensonified

Exposed to sound.

far-field

The zone where, to an observer, sound originating from an array of sources (or a spatially distributed source) appears to radiate from a single point. 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 efficient 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.

geoacoustic

Relating to the acoustic properties of the seabed.

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) specialized for hearing high frequencies.

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) specialized for hearing low frequencies.

masking

Obscuring of sounds of interest by sounds at similar frequencies.

median

The 50th percentile of a statistical distribution.

mid-frequency (MF) cetacean

The functional cetacean hearing group that represents those odontocetes (toothed whales) specialized for mid-frequency hearing.

Monte Carlo simulation

The method of investigating the distribution of a non-linear multi-variate function by random sampling of all of its input variable distributions.

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/ASA 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.

otariid

A common term used to describe members of the Otariidae, eared seals, commonly called sea lions and fur seals. Otariids are adapted to a semi-aquatic life; they use their large fore flippers for propulsion. Their ears distinguish them from phocids. Otariids are one of the three main groups in the superfamily Pinnipedia; the other two groups are phocids and walrus.

parabolic equation method

A computationally efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

particle velocity

The physical speed of a particle in a material moving back and forth in the direction of the pressure wave. Unit: metre per second (m/s). Symbol: v .

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).

peak-to-peak pressure level (PK-PK)

The difference between the maximum and minimum instantaneous pressure levels. 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.

phocid

A common term used to describe all members of the family Phocidae. These true/earless seals are more adapted to in-water life than are otariids, which have more terrestrial adaptations. Phocids use their hind flippers to propel themselves. Phocids are one of the three main groups in the superfamily Pinnipedia; the other two groups are otariids and walrus.

phocid pinnipeds in water (PPW)

The functional pinniped hearing group that represents true/earless seals under water.

pinniped

A common term used to describe all three groups that form the superfamily Pinnipedia: phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

point source

A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

pressure, acoustic

The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: p .

pressure, hydrostatic

The pressure at any given depth in a static liquid that is the result of the weight of the liquid acting on a unit area at that depth, plus any pressure acting on the surface of the liquid. Unit: pascal (Pa).

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 (Pa²·s) (ANSI S1.1-1994 R2004).

sound exposure level (SEL)

A cumulative measure related to the sound energy. Unit: dB re 1 μPa²·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: μPa²·s/Hz.

sound field

Region containing sound waves (ANSI S1.1-1994 R2004).

sound intensity

Sound energy flowing through a unit area perpendicular to the direction of propagation per unit time.

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 ($p_0 = 1 \mu\text{Pa}$) and the unit for SPL is dB re 1 μPa²:

$$L_p = 10 \log_{10}(p^2/p_0^2) = 20 \log_{10}(p/p_0)$$

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.

sound speed profile

The speed of sound in the water column as a function of depth below the water surface.

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 μPa²·s·m (exposure level).

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.

temporary threshold shift (TTS)

Temporary loss of hearing sensitivity caused by excessive noise exposure.

transmission loss (TL)

The decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment. Also referred to as propagation loss.

wavelength

Distance over which a wave completes one cycle of oscillation. Unit: metre (m). Symbol: λ .

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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 $p_0 = 1 \mu\text{Pa}$. 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 zero-to-peak sound pressure level (PK; L_{pk} ; $L_{p,pk}$; dB re $1 \mu\text{Pa}$), is the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,pk} = 20 \log_{10} \left[\frac{\max(p(t))}{p_0} \right] \quad (\text{A-1})$$

PK is often included as a 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 peak-to-peak sound pressure level (PK-PK; L_{pk-pk} ; $L_{p,pk-pk}$; dB re $1 \mu\text{Pa}$) is the difference between the maximum and minimum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound, $p(t)$:

$$L_{p,pk-pk} = 10 \log_{10} \left\{ \frac{[\max(p(t)) - \min(p(t))]^2}{p_0^2} \right\} \quad (\text{A-2})$$

The sound pressure level (SPL; L_p ; dB re $1 \mu\text{Pa}$) 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:

$$L_p = 10 \log_{10} \left(\frac{1}{T} \int_T p^2(t) dt / p_0^2 \right) \quad (\text{A-3})$$

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. A fixed window length of 0.125 s (critical duration defined by Tougaard et al. (2015)) is used in this study for impulsive sounds.

The sound exposure level (SEL; L_E ; $L_{E,p}$; dB re $1 \mu\text{Pa}^2 \cdot \text{s}$) 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):

$$L_E = 10 \log_{10} \left(\int_T p^2(t) dt / T_0 p_0^2 \right) \quad (\text{A-4})$$

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 effect 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:

$$L_{E,N} = 10 \log_{10} \left(\sum_{i=1}^N 10^{\frac{L_{E,i}}{10}} \right). \quad (\text{A-5})$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LF,24h}$; Appendix A.3). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should else be specified.

A.2. Marine Mammal Noise Effect Criteria

It has been long recognised that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggested that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for injury, impairment and disturbance. The following sections summarise the recent development of thresholds; however, this field remains an active research topic.

A.2.1. Injury and Hearing Sensitivity Changes

In recognition of shortcomings of the SPL-only based injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for human; Appendix A.3). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower injury values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 $\mu\text{Pa}^2\cdot\text{s}$. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF cetaceans on results obtained from MF cetacean studies. In particular they referenced Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 $\mu\text{Pa}^2\cdot\text{s}$.

As of 2017, an optimal approach is not apparent. There is consensus in the research community that an SEL-based method is preferable either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2016). The guidance describes injury criteria with new thresholds and frequency

weighting functions for the five hearing groups described by Finneran and Jenkins (2012). The latest revision to this work was published in 2018 (NMFS 2018). Southall et al. (2019) revisited the interim criteria published in 2007; all noise exposure criteria in NMFS (2018) and Southall et al. (2019) are identical (for impulsive and non-impulsive sounds), however the mid-frequency cetaceans from NMFS (2018) are classified as high-frequency cetaceans in Southall et al. (2019), and high-frequency cetaceans from NMFS (2018) are classified as very-high-frequency cetaceans in Southall et al. (2019).

A.2.2. Behavioural response

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016).

NMFS currently uses step function (all-or-none) threshold of 120 dB re 1 µPa SPL (unweighted) for non-impulsive sounds to assess and regulate noise-induced behavioural effects to marine mammals (NOAA 2019). The 120 dB re 1 µPa threshold is associated with continuous sources and was derived based on studies examining behavioural responses to drilling and dredging (NOAA 2018), referring to Malme et al. (1983), Malme et al. (1984), and Malme et al. (1986), which were considered in Southall et al. (2007). Malme et al. (1986) found that playback of drillship noise did not produce clear evidence of disturbance or avoidance for levels below 110 dB re 1 µPa (SPL), possible avoidance occurred for exposure levels approaching 119 dB re 1 µPa. Malme et al. (1984) determined that measurable reactions usually consisted of rather subtle short-term changes in speed and/or heading of the whale(s) under observation. It has been shown that both received level and proximity of the sound source is a contributing factor in eliciting behavioural reactions in humpback whales (Dunlop et al. 2017, Dunlop et al. 2018).

A.3. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.3.1. Marine mammal frequency weighting functions

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:

$$G(f) = K + 10 \log_{10} \left[\left(\frac{(f/f_{lo})^{2a}}{[1 + (f/f_{lo})^2]^a [1 + (f/f_{hi})^2]^b} \right) \right] \quad (A-6)$$

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 effects on marine mammals (NMFS 2016, NMFS 2018). Table A-1 lists the frequency-weighting parameters for each hearing group; Figure A-1 shows the resulting frequency-weighting curves.

Table A-1. 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, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> and <i>L. australis</i>)	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

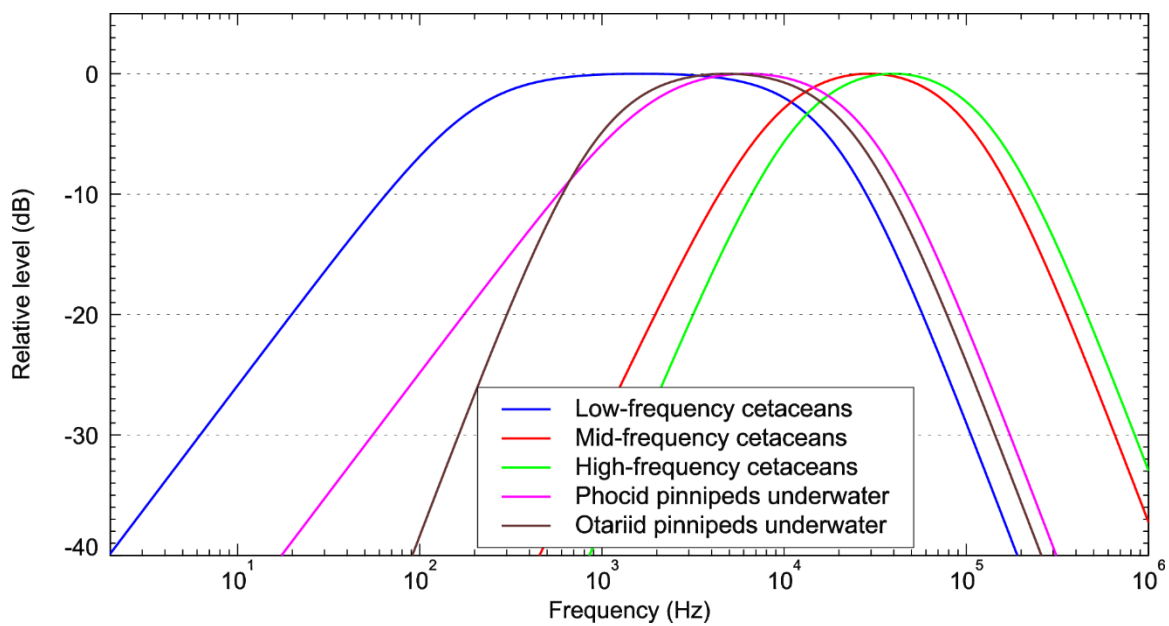


Figure A-1. Auditory weighting functions for functional marine mammal hearing groups as recommended by NMFS (2018).

Appendix B. Thruster Source Level Estimation

Underwater sound that radiates from vessels is produced mainly by propeller and thruster cavitation, with a smaller fraction of sound produced by sound transmitted through the hull, such as by engines, gearing, and other mechanical systems. Sound levels tend to be the highest when thrusters are used to position the vessel and when the vessel is transiting at high speeds. A vessel’s sound signature depends on the vessel’s size, power output, propulsion system, and the design characteristics of the given system (e.g., blade shape and size). A vessel produces broadband acoustic energy with most of the energy emitted below a few kilohertz. Sound from onboard machinery, particularly sound below 200 Hz, dominates the sound spectrum before cavitation begins—normally around 8–12 knots on many commercial vessels (Spence et al. 2007). Under higher speeds and higher propulsion system load, the acoustic output from the cavitation processes on the propeller blades dominates other sources of sound on the vessel such as machinery or hull vibration (Leggat et al. 1981).

A vessel equipped with propellers/thrusters has two primary sources of sound that propagate from the unit: the machinery and the propellers. For thrusters operating in the heavily loaded conditions, the acoustic energy generated by the cavitation processes on the propeller blades dominates (Leggat et al. 1981). The sound power from the propellers is proportional to the number of blades, the propeller diameter, and the propeller tip speed.

Based on an analysis of acoustic data, Ross (1976) provided the following formula for the sound levels from a vessel’s propeller, operating in calm, open ocean conditions:

$$L_{100} = 155 + 60\log(u/25) + 10\log(B/4), \quad (\text{B-1})$$

where L_{100} is the spectrum level at 100 Hz, u is the propeller tip speed (m/s), and B is the number of propeller blades. Equation B-1 gives the total energy produced by the propeller cavitation at frequencies between 100 Hz and 10 kHz. This equation is valid for a propeller tip speed between 15 and 50 m/s. The spectrum is assumed to be flat below 100 Hz. Its level is assumed to fall off at a rate of –6 dB per octave above 100 Hz (Figure B-1).

Another method of predicting the source level of a propeller was suggested by Brown (1977). For propellers operating in heavily loaded conditions, the formula for the sound spectrum level is:

$$SL_B = 163 + 40\log D + 30\log N + 10\log B + 20\log f + 10\log(A_c/A_D), \quad (\text{B-2})$$

where D is the propeller diameter (m), N is the propeller revolution rate per second, B is the number of blades, A_c is the area of the blades covered by cavitation, and A_D is the total propeller disc area. Similar to Ross’s approach, the spectrum below 100 Hz is assumed to be flat. The tests with a naval propeller operating at off-design heavily loaded conditions showed that Equation B-2 should be used with a value of $(A_c/A_D) = 1$ (Leggat et al. 1981).

The combined source level for multiple thrusters operating together can be estimated using the formula:

$$SL_{\text{total}} = 10\log_{10} \sum_i 10^{\frac{SL_i}{10}}, \quad (\text{B-3})$$

where $SL_{1,\dots,N}$ are the source levels of individual thrusters. If the vessel is equipped with the same type of thrusters, the combined source level can be estimated using the formula:

$$SL_N = SL + 10\log N \quad (\text{B-4})$$

where N is the total number of thrusters of the same type.

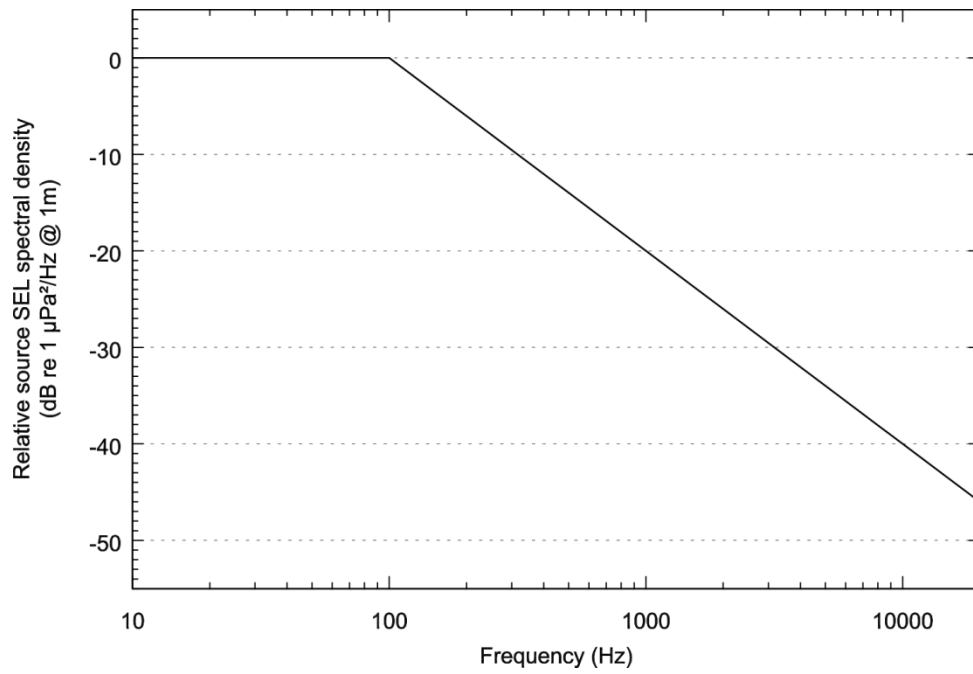


Figure B-1. Estimated sound spectrum from cavitating propeller (Leggat et al. 1981).

Appendix C. Sound Propagation Models

C.1. Transmission Loss

The propagation of sound through the environment was modelled by predicting the acoustic transmission loss—a measure, in decibels, of the decrease in sound level between a source and a receiver some distance away. Geometric spreading of acoustic waves is the predominant way by which transmission loss occurs. Transmission loss also happens when the sound is absorbed and scattered by the seawater, and absorbed scattered, and reflected at the water surface and within the seabed. Transmission loss depends on the acoustic properties of the ocean and seabed; its value changes with frequency.

If the acoustic source level (SL), expressed in dB re 1 $\mu\text{Pa}^2\text{m}^2$, and transmission loss (TL), in units of dB, at a given frequency are known, then the received level (RL) at a receiver location can be calculated in dB re 1 μPa by:

$$\text{RL} = \text{SL} - \text{TL} \quad (\text{C-1})$$

C.2. MONM-BELLHOP

Long-range sound fields were computed using JASCO's Marine Operations Noise Model (MONM). While other models may be more accurate for steep-angle propagation in high-shear environment, MONM is well suited for effective longer-range estimation. This model computes sound propagation at frequencies of 10 Hz to 1.6 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM's approximation breaks down for seafloor shear speeds greater than approximately 600 m/s and higher shear wave speeds usually found in cemented and semi-cemented carbonate rock. A similar profile was used in a similar study for Origin in the Otway Basin (McPherson et al. 2016) the results of which support the use of MONM for this model environment. MONM computes sound propagation at frequencies > 1.6 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

MONM computes acoustic fields in three dimensions by modelling transmission loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding $N = 360^\circ/\Delta\theta$ number of planes (Figure C-1).

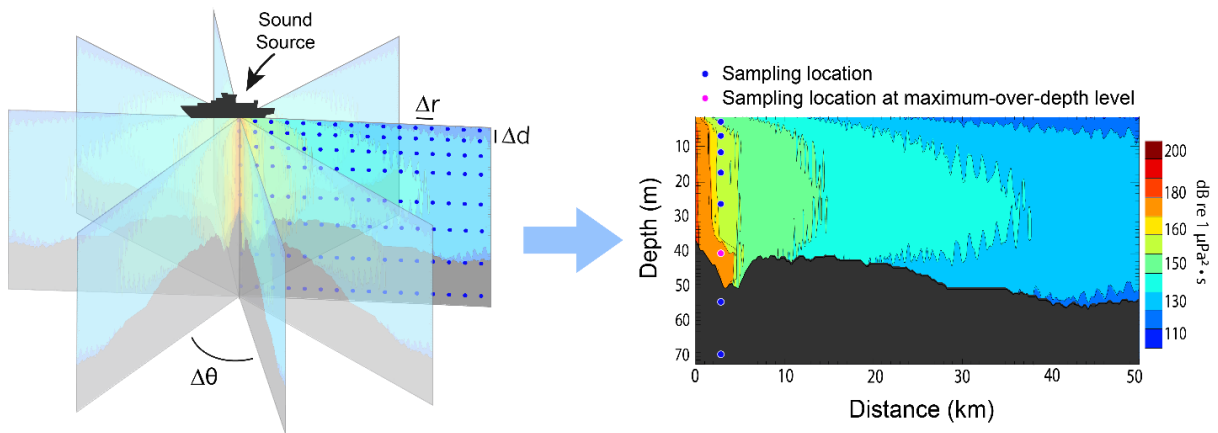


Figure C-1. The Nx2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic propagation loss at the centre frequencies of decidecade bands. Sufficiently many decidecade frequency-bands, starting at 10 Hz, are modelled to include most of the acoustic energy emitted by the source. At each centre frequency, the propagation loss is modelled within each of the N vertical planes as a function of depth and range from the source. The decidecade received per-second SEL are computed by subtracting the band propagation loss values from the directional source level in that frequency band. Composite broadband received per-second SEL are then computed by summing the received decidecade levels.

The received 1-s SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. For areas with deep water, sampling is not performed at depths beyond those reachable by marine mammals. The received per-pulse or per-second SEL at a surface sampling location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-second SEL. These maximum-over-depth per-second SEL are presented as colour contours around the source.

Appendix D. 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.

D.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 D-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 D-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 D-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.

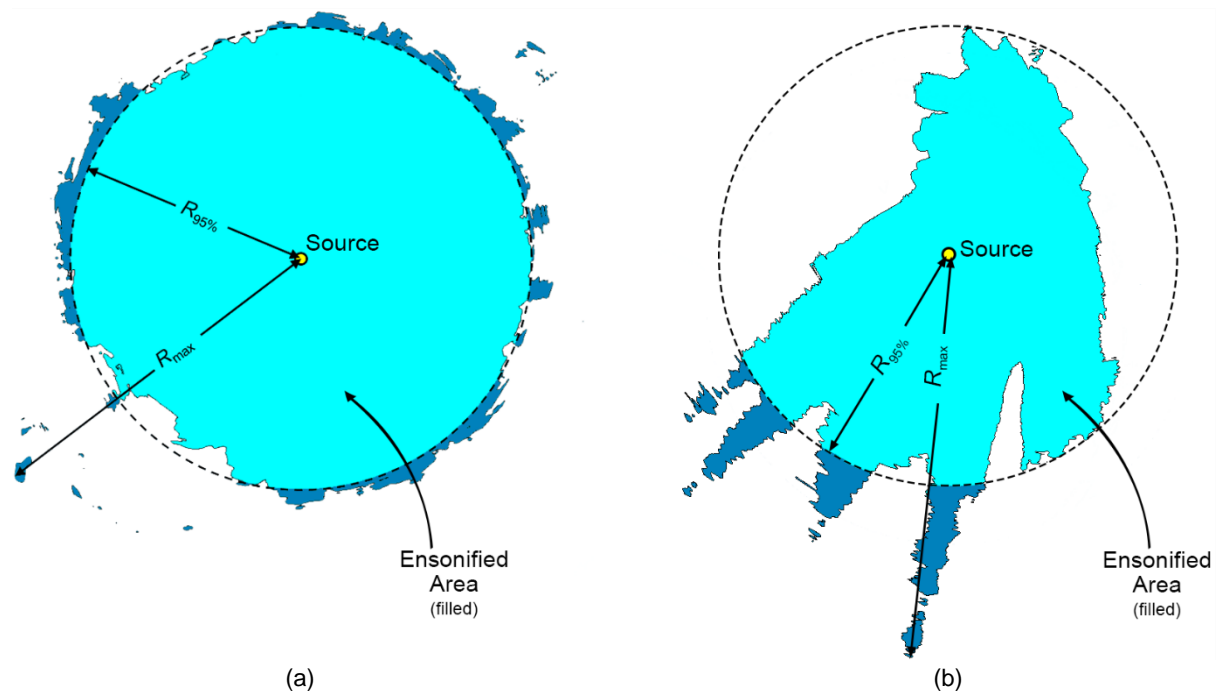


Figure D-1. Sample areas ensounded to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensounded areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max} .

D.2. Environmental Parameters

D.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.

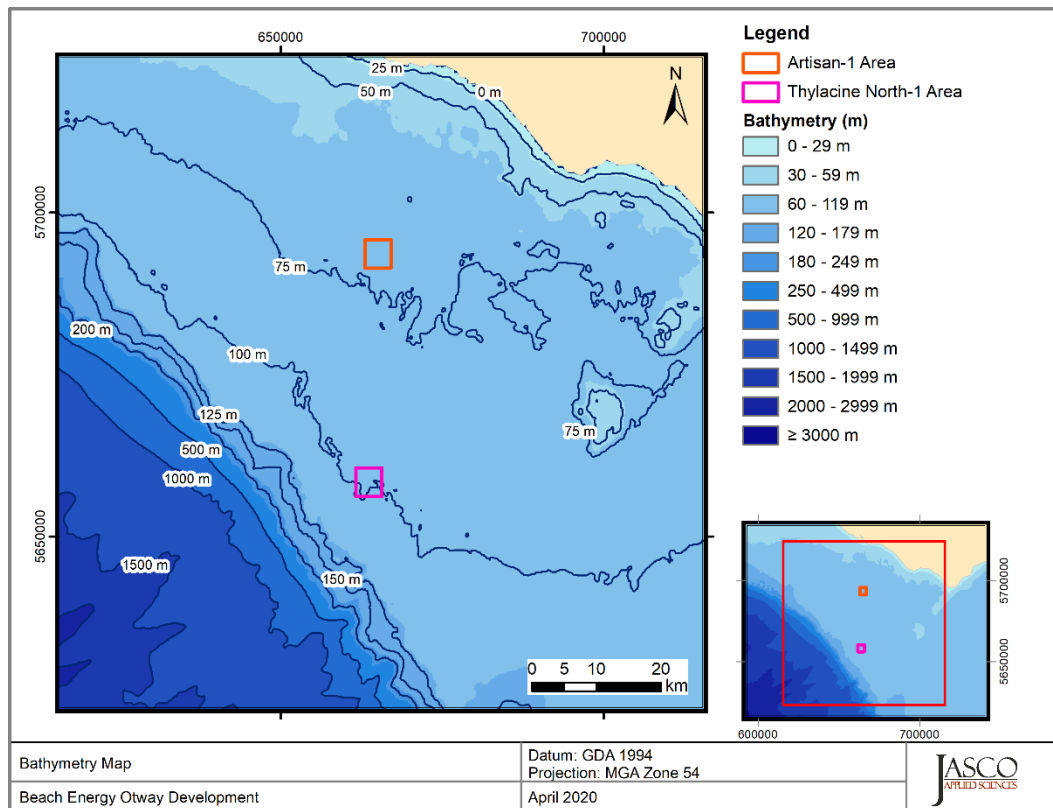


Figure D-2. Bathymetry in the modelled area.

D.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 76 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. Figure D-3 shows the resulting profile, which was used as input to the sound propagation modelling.

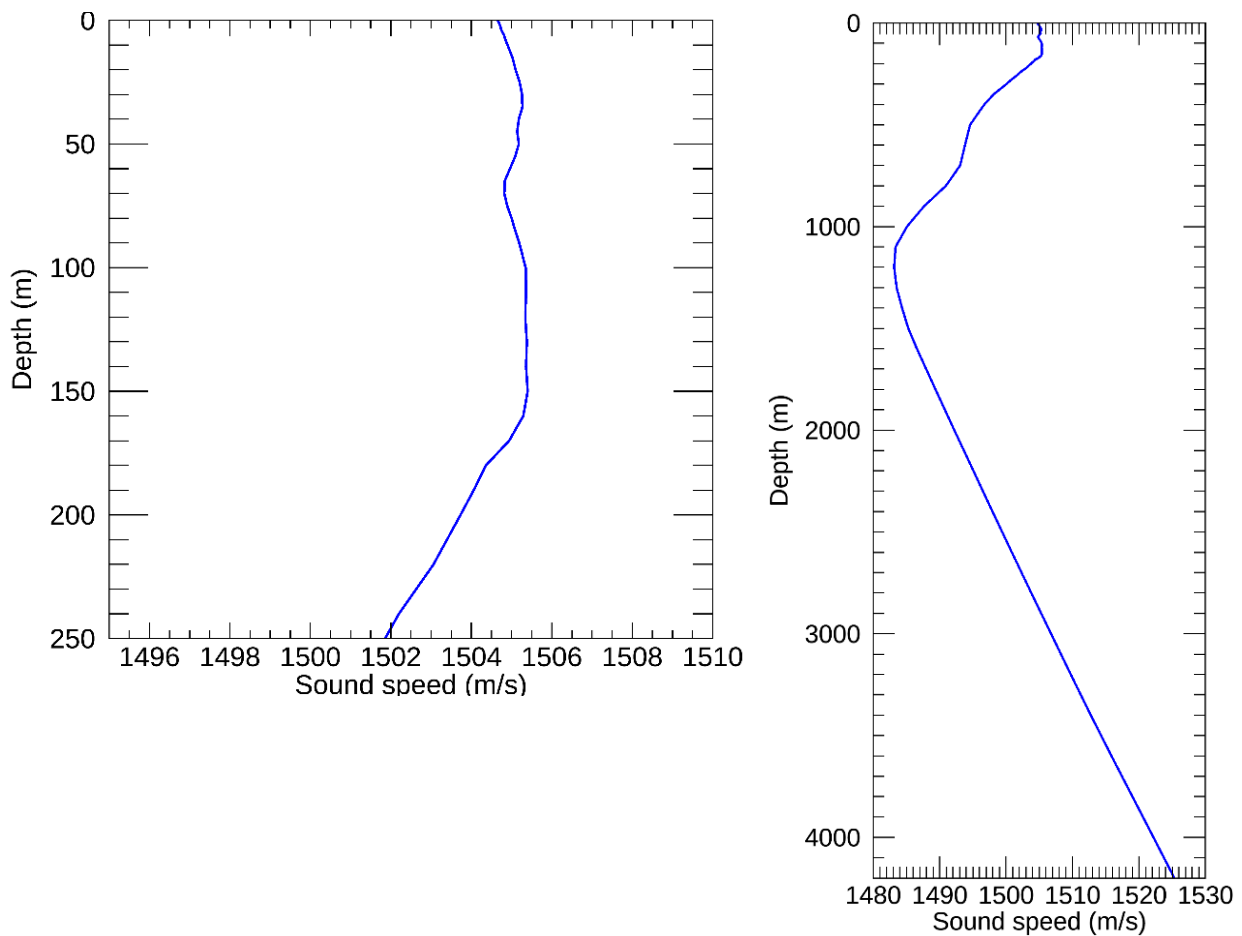


Figure D-3. The modelling sound speed profile corresponding to June: top 250 m (left) and full profile (right) Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model V 3.0* (GDEM; Teague et al. 1990, Carnes 2009).

D.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 area is closer to the continental slope in deeper waters and was characterised by well-cemented carbonate caprock (calcarenite), overlying semi-cemented carbonate rock (calcarenite). The seabed in the Artisan-1, located in shallower waters, was characterised by a thin veneer of coarse sand/gravel overlying semi-cemented carbonate rock. 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 D-1 and Table D-2 present the geoacoustic profiles used modelled sites in each respective development area.

Table D-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	500	0.4
0.5–20		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 D-2. *Artisan-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)
0–1	Coarse carbonate sand	2.03	1800	0.85	300	3.68
1–20		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		

D.3. Model Validation Information

Predictions from JASCO’s propagation models (MONM, FWRAM, and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including the United States and Canadian Arctic, Canadian and southern United States waters, Greenland, Russia and Australia (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O’Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Matthews and MacGillivray 2013, Martin et al. 2015, Racca et al. 2015, Martin et al. 2017a, Martin et al. 2017b, Warner et al. 2017, MacGillivray 2018, McPherson et al. 2018, McPherson and Martin 2018).

In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities which have included internal validation of the modelling (including McCrodan et al. 2011, Austin and Warner 2012, McPherson and Warner 2012, Austin and Bailey 2013, Austin et al. 2013, Zykov and MacDonnell 2013, Austin 2014, Austin et al. 2015, Austin and Li 2016, Martin and Popper 2016).

Appendix G Otway Drilling Whale Management Process



**OTWAY DRILLING
WHALE MANAGEMENT PROCEDURE**

Table of contents

1.	Purpose and Scope	3
2.	Assumptions	3
3.	Context	4
4.	Roles and Responsibilities	4
4.1	Beach Drilling Supervisor on MODU	4
4.2	Vessel Captains	4
4.3	Marine Mammal Observers (MMOs)	4
4.4	Beach Environment Advisor	5
4.5	All vessel and MODU crew	5
5.	Distance to Noise Criteria and Zones	5
6.	Procedure before activities commence and during activities	8
6.1	Procedural flowchart during sub-activities	11
7.	Managing uncertainty about noise impacts to blue whales	12

Revision History

Revision	Date	Notes	Author	Reviewer	Approver
Rev 0	2/11/2020	For Issue	SJ	MS	PW
Rev 1	17/12/2020	For Issue	SJ	MS	PW
Rev 2	26/12/2020	Updated with NOPSEMA comments.	MS	PW	TF

1. Purpose and Scope

The purpose of this procedure is to detail how Beach Energy (Beach) will avoid and minimise anthropogenic noise threats to whales during the Otway Drilling campaign.

This procedure applies to all whales with a focus on their critical life stage activities, such as foraging, however, it has been developed with a focus on blue whales as the activity is being undertaken within a legally recognised biologically important area (BIA) for foraging blue whales. Therefore, consistent with the Conservation Management Plan for the Blue Whale action to assess and address anthropogenic noise, this procedure will also ensure that anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area.

This procedure provides the details of the control measure (this procedure) required for Regulation 13(5)(c) of the OPGGS Environment Regulations and sets out the environmental performance outcome, standards and measurement criteria relevant to noise impacts from the Otway Drilling campaign (Regulation 13(7)).

The activities covered by this procedure are collectively called the Otway drilling campaign and include:

- Artisan-1 Exploration Well Drilling
- Otway Development Drilling and Well Abandonment

This procedure applies when MMOs are in the field from 1 November to 30 June. At all other times EPBC Regulations governing interactions with cetaceans apply.

2. Assumptions

Assumptions have been made in creating this management plan and procedure. Important assumptions have been listed below to make them explicit to users to assist in interpretation and implementation. If an aspect of this procedure is unclear, users should consider these assumptions in determining what action, if any, to take.

1. Vessel Captains and the Beach Drilling Supervisor will follow Marine Mammal Observer (MMO) advice to minimise noise threats to whales as long as it is safe to do so.
2. Conservatism has been built into how the sub-activity zone distances have been set which accounts for MMO distance judgement accuracy, weather conditions, uncertainty in the impact assessment, and whale behaviour.
3. The distances to the noise criteria and sub-activity zones (Section 5) are from modelling based on a sound source level from the Polar Pioneer. Monitoring of the MODU sound source levels and received levels will be undertaken on the first well of the Otway drilling campaign (currently Artisan-1) and the sub-activity zone distances adjusted accordingly.
4. Throughout this procedure the statement of “foraging whale” is taken as a whale positively identified as foraging and if the behaviour of a whale cannot be positively determined it will be assumed that the whale is foraging, and decisions made accordingly.
5. Once the sound source is created it is assumed that if a foraging whale comes towards the sound source it is continuing to forage within the foraging BIA and therefore only TTS and PTS need to be managed.

If there is a lack of clarity, or residual uncertainty, about the instructions in this procedure users are required to take actions in a manner that minimises noise threats to whales, are precautionary, and will keep impacts within the defined acceptable levels of impact specified in the Environment Plan.

3. Context

This procedure relates to the Artisan-1 exploration well and Otway development wells activities which each have their own Environment Plan. The Environmental Plans provide justification for this procedure and its expected environmental performance.

Within each of these activities there are four sub-activities that this procedure applies to; MODU moving onto well location, drilling, vessel on standby, and vessel resupplying the MODU. Each of these sub-activities have been assessed in each Environment Plan. Relevant details from that impact assessment are included in this procedure.

Whales may be seen at any distance and any time throughout the Otway drilling campaign. The Bonney Upwelling, starting in Nov/Dec and ending in May/June will see increased whale activity in the region. It is important that the Otway drilling activities minimise noise threats to whales and does not introduce unacceptable impacts to protected species.

This procedure specifies how this can be achieved by maintaining continuous day-light observation with trained and competent MMOs and progressively escalating the noise minimisation actions as whales are observed closer to the noise sources.

4. Roles and Responsibilities

4.1 Beach Drilling Supervisor on MODU

- Maintain open communication with MMOs.
- Communicate the status of the sub-activities (i.e. commencing, underway, or at Safe Point) to MMOs.
- Decide whether actions within this procedure can safely be implemented and take action accordingly.
- Document reasons for not following this procedure, if required.

4.2 Vessel Captains

- Maintain open communication with MMOs.
- Decide whether actions within this procedure can safely be implemented and take action accordingly.
- Document reasons for not following this procedure, if required.

4.3 Marine Mammal Observers (MMOs)

- MMOs are to be familiar with the sub-activity zones and actions as per this procedure.
- MMOs will identify whale behaviour and determine if a whale is classed as a “foraging whale” based on:
 - the whale is positively identified as foraging; or
 - the behaviour of the whale cannot be positively determined, it must be assumed that the whale is foraging.
- Maintain whale observation watch throughout daylight hours.
- Communicate whale sightings and actions required to Beach Drilling Supervisor and Vessel Captains.

4.4 Beach Environment Advisor

- Ensure this procedure is updated following analysis of the noise validation monitoring and communicated to all MMOs, Drilling Superintendent, Drilling Supervisor and Vessel Captains.

4.5 All vessel and MODU crew

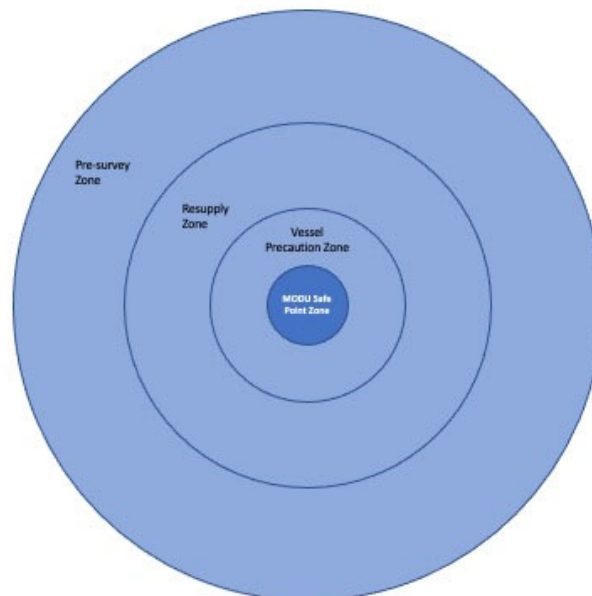
- Have an appreciation for the importance of sharing information on whale sighting with MMOs.
- Communicate whale sighting to MMOs as soon as possible.

5. Distance to Noise Criteria and Zones

This procedure is designed on a principle of escalating mitigation actions the closer whales are observed to the activities. This has led to the creation of zones at distance intervals from the noise sources. These distances change based on each sub-activity and are based on the predicted noise levels received in the environment at the relevant noise criteria.

Figure 5-1 shows the zones used within this procedure. Note that not all zones apply to each sub-activity.

Table 5-1 specifies the distances to the modelled noise criteria (Koessler et al. 2020) and the link to the sub-activity zones. The distance used for each zone is emphasised in bold type. Distances have been rounded up to cater for observer inaccuracy in distance estimation and uncertainties in the impact prediction.



Note not to scale

Figure 5-1: Zones established around the sources of noise.

Table 5-1: Distance to modelled noise criteria and link to sub-activity zones

Sub-activity	Zone	Outer Perimeter Distance of Zone	PTS 24 hr 199 dB SEL24hr	TTS 24hr 179 dB SEL24hr	Behavioural response 120 dB SPL	Justification
<i>Geographe and Thylacine</i>						
MODU moving onto well location	Pre-survey Zone	7 km from well location	0.03 km	2.68 km	6.72 km	The Pre-survey Zone is used to ensure that there will be no foraging whales that could be exposed to PTS, TTS or be displaced when the MODU moves onto a new well location.
Drilling	MODU Safe Point Zone	2 km from MODU	0.03 km	0.84 km	4.6 km	Once the MODU is on location it is assumed that if foraging whales come into the Pre-survey Zone they are not being displaced and therefore only TTS and PTS need to be managed. Due to uncertainty in the model predictions and the practicality of being able to see whales at a further distance a 2km zone has been adopted.
Vessel on standby	Vessel Precaution Zone	1.2 km from vessel	Not reached	1.03 km	4.44 km	Once the vessel is on location it is assumed that if foraging whales come into the Pre-survey Zone they are not being displaced and therefore only TTS and PTS need to be managed.
Resupply	Resupply Zone	3 km from MODU	0.03 km	2.66 km	13.7 km	Once the MODU and vessel is on location it is assumed that if foraging whales come into the Pre-survey Zone they are not being displaced and therefore only TTS and PTS need to be managed.

Sub-activity	Zone	Outer Perimeter Distance of Zone	PTS 24 hr 199 dB SEL24hr	TTS 24hr 179 dB SEL24hr	Behavioural response 120 dB SPL	Justification
<i>Artisan</i>						
MODU moving onto well location	Pre-survey Zone	9 km from well location	Not reached	2.76 km	8.94 km	The Pre-survey Zone is used to ensure that there will be no foraging whales that could be exposed to PTS, TTS or be displaced when the MODU moves onto a new well location.
Drilling	MODU Safe Point Zone	2 km from MODU	Not reached	0.92 km	5.91 km	Once the MODU is on location it is assumed that if foraging whales come into the Pre-survey Zone they are not being displaced and therefore only TTS and PTS need to be managed. Due to uncertainty in the model predictions and the practicality of being able to see whales at a further distance a 2km zone has been adopted.
Vessel on standby	Vessel Precaution Zone	1.2 km from vessel	Not reached	1.12 km	6.23 km	Once the vessel is on location it is assumed that if foraging whales come into the Pre-survey Zone they are not being displaced and therefore only TTS and PTS need to be managed.
Resupply	Resupply	3 km from MODU	Not reached	2.73 km	17.4 km	Once the MODU and vessel is on location it is assumed that if foraging whales come into the Pre-survey Zone they are not being displaced and therefore only TTS and PTS need to be managed.

6. Procedure before activities commence and during activities

There is a clear distinction between mitigation actions to take before sub-activities commence and mitigation actions once the sub-activities are underway. Table 6-1 provides instruction on the actions to be taken before the sub-activity commences (Column 2) and actions once the sub-activity is underway (Column 4). Figure 6-1 provides a supporting decision-making flowchart for when sub-activities are underway. Care has been taken to align Table 6-1 and Figure 6-1 and for the avoidance of doubt, instructions in Table 6-1 prevail.

Each sub-activity has been assigned Safe Points (Column 3 in Table 6-1) in recognition that a sub-activity may be occurring when a foraging whale is observed. Safe Points have been adopted to delineate stages where the sub-activity can proceed to before implementing further noise control actions while maintaining well integrity and personnel safety.

Table 6-1: Procedure and Flowchart Instructions

Sub-activity	Pre-start actions and start criteria	Safe Point	Noise controls actions to minimise noise and maintain safety and well integrity after the sub-activity has commenced if whales are observed
MODU moving to a new well location ¹	<p>Prior to commencing mobilisation of the MODU to a new well location¹, monitoring² by an MMO will be undertaken of the Pre-survey Zone (See Section 5 for distances).</p> <p>Commence MODU tow to next Safe Point when absence of foraging whales in the Pre-survey Zone is confirmed³.</p>	MODU on location and securely anchored	<p>Monitoring of the Pre-survey Zone will continue while the MODU is transiting to the new well location.</p> <p>If foraging whales are observed within the Pre-survey Zone whilst the MODU is in transit to a new well location, the sighting will be communicated to the Beach Drilling Supervisor and the MODU direction of travel will be adjusted and tow speed slowed where safe to do so, to allow time for the whales to move away.</p> <p>Vessels involved with the tow will comply with EPBC Regulations 8.1 Part 8 Division 8.1 interacting with cetaceans.</p> <p>Once the tow has commenced if whales have been observed within the Pre-survey Zone the MODU can only enter the Pre-survey Zone if:</p> <ul style="list-style-type: none"> No foraging whales observed for 30 min within the pre-survey zone. Foraging whales observed leaving the pre-survey zone. The safety of the MODU and other marine users necessitates such action. In this situation the decision will be made by the Beach Drilling Supervisor and reasons documented.

Notes:

1: A new well location does not include when the MODU remains on the same anchor pattern and moves (kedges) to a new well i.e. G5 to G4, TW1 to TW2 as there is no additional noise source.

2: Monitoring may be from an aircraft or vessel or a combination of both.

3: Absence of foraging whales means:

- No foraging whales observed for 30 min within the pre-survey zone.
- Foraging whales observed leaving the pre-survey zone.

Sub-activity	Pre-start actions and start criteria	Safe Point	Noise controls actions to minimise noise and maintain safety and well integrity after the sub-activity has commenced if whales are observed
Drilling	<p>Survey MODU Safe Point Zone (See Section 5 for distances) prior to commencing drilling and at each Safe Point.</p> <p>Only proceed to next Safe Point when absence of foraging whales is confirmed¹ from the MODU Safe Point Zone.</p> <p>Drilling can commence to the next Safe Point if monitoring cannot be undertaken of the MODU Safe Point Zone, such as at night or low visibility conditions, if:</p> <ul style="list-style-type: none"> no foraging whales seen within the MODU Safe Point Zone in the preceding day light hours; or confirmed absence of foraging whales from MODU Safe Point Zone; <u>and</u> less than three foraging whales seen in the MODU Safe Point Zone in preceding daylight hours. 	Next positive test of well integrity (e.g. after cementing each casing)	<p>At all times noise producing operations on the MODU should be minimised such as:</p> <ul style="list-style-type: none"> Optimising load on generators Reducing crane movements to minimum required for safety <p>Continue monitoring from all in-field vessels for whales and determine their behaviour.</p> <p>If drilling has commenced and foraging whales are within the MODU Safe Point Zone proceed to next Safe Point. Once well integrity has been confirmed implement the following noise minimisation actions as relevant and safety requirements allow:</p> <ul style="list-style-type: none"> Reduce load on mud pumps and rotary drilling equipment. Reduce load on generators. Stop non-essential equipment or safety critical equipment/activities.
<p>Note:</p> <p>1: Absence of whales means:</p> <ul style="list-style-type: none"> No foraging whales observed for 30 min within the pre-survey zone. Foraging whales observed leaving the pre-survey zone. 			
Vessel on standby	Monitor for whales.	NA	<p>Apply EPBC Regulations 8.1 Part 8 Division 8.1 interacting with cetaceans requirements.</p> <p>Maintain minimum distance of 1.2 km from foraging whales and reduce thrusters to as lower setting as possible for the ocean conditions.</p> <p>Vessel to maintain minimum safe distance from the MODU as per Safety Case requirement.</p>

Sub-activity	Pre-start actions and start criteria	Safe Point	Noise controls actions to minimise noise and maintain safety and well integrity after the sub-activity has commenced if whales are observed
Resupply	<p>Prior to commencing resupply of the MODU, monitoring¹ by an MMO will be undertaken of the Resupply Zone (See Section 5 for distances).</p> <p>Resupply can proceed to next Safe Point when absence of foraging whales is confirmed¹ from the Resupply Zone.</p> <p>Resupply can commence to the next Safe Point if monitoring cannot be undertaken of the Resupply Zone, such as at night or low visibility conditions, if:</p> <ul style="list-style-type: none"> • no foraging whales seen within the Resupply Zone in the preceding day light hours; or • confirmed absence of foraging whales from Resupply Zone; <u>and</u> • less than three foraging whales seen in the Resupply Zone in the preceding daylight hours. 	Resupply complete	<p>If a whale commences foraging within the Resupply Zone while resupply is occurring vessel to reduce thrusters if safe to do so. Resupply will cease as soon as it is safe, and the vessel will go back to being on standby.</p>

Note:

1: Absence of whales means:

- No foraging whales observed for 30 min within the pre-survey zone.
- Foraging whales observed leaving the pre-survey zone.

6.1 Procedural flowchart during sub-activities

The following flowchart provides a decision tree to support the intentions built into Table 6-1. It covers how to make decisions when sub-activities are underway. For pre-start actions refer to Table 6-1

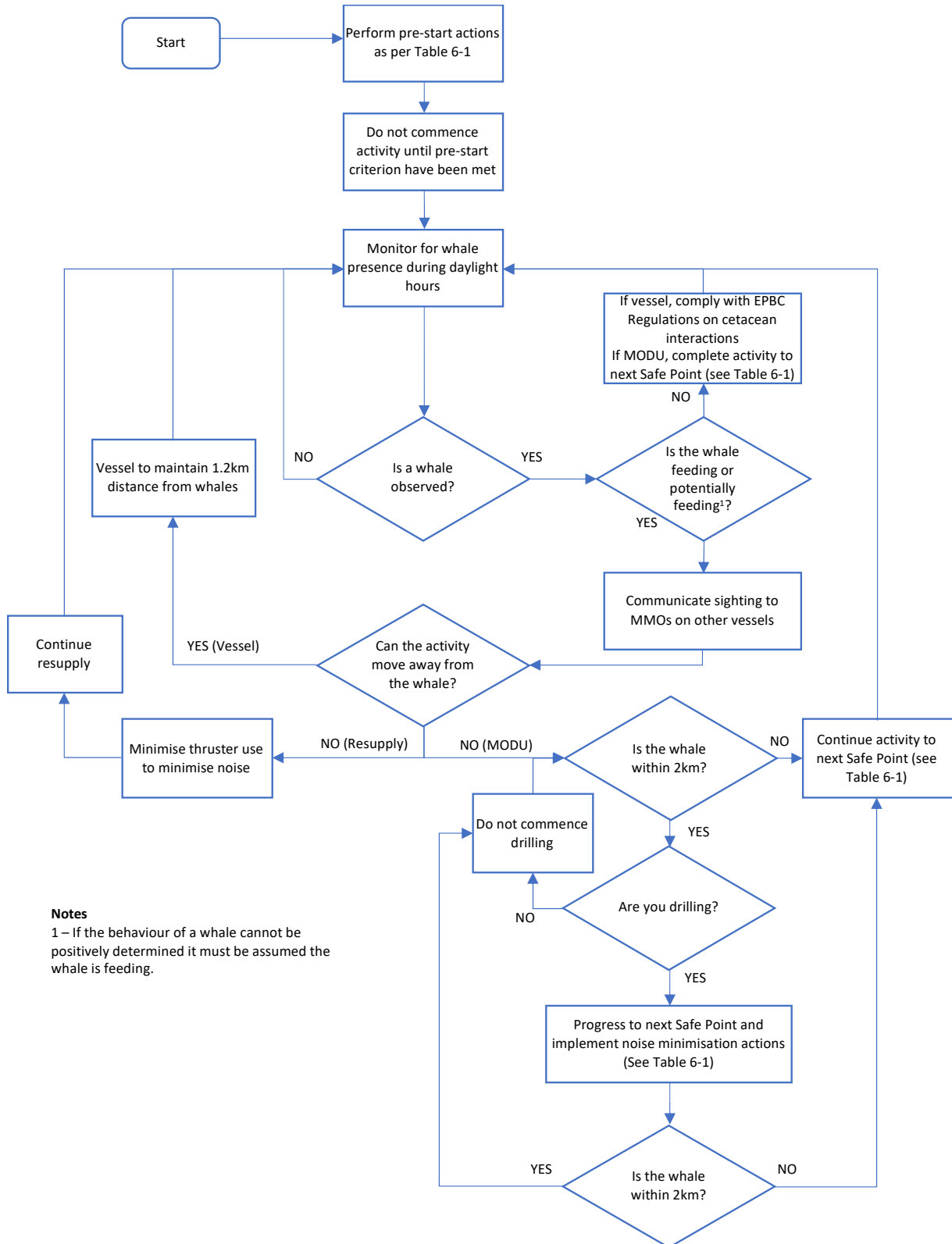


Figure 6-1: Decisions making flowchart to minimise threats to whales

7. Managing uncertainty about noise impacts to blue whales

Beach have undertaken an impact assessment of the potential impacts of noise propagation on blue whales in accordance with its internal company procedures, international standards, and national regulatory requirements. The impact assessment included independent noise modelling (using conservative – worst-case input criteria) to generate behavioural disturbance thresholds that may arise from Beach’s drilling activities at two locations in the Otway Basin.

Beach concluded that, in accordance with the ‘Conservation Management Plan for Blue Whales’ (2015) (CMP) that the impacts to blue whales would be acceptable and consistent with the CMP.

This conclusion was based on the assessment that an individual whale (or multiple whales) will be able to continue to utilise the foraging area without injury and will not be displaced from a foraging area. The basis of this conclusion is provided in the impact assessment, available in the Artisan Exploration Drilling and Otway Development Drilling Environment Plans.

Notwithstanding Beach’s conclusion that the activities will be consistent with the CMP, Beach through an abundance of caution and due to limited available data in some areas, proposes to undertake further work to address any potential areas of uncertainty. Areas of potential uncertainty that have been identified are detailed in Table 1, below.

Source of uncertainty	Measures to eliminate or manage the source of uncertainty
<p>The context and definition of terms used in the Conservation Management Plan and the intent of the management actions.</p>	<p>Engagements with NOPSEMA and DAWE have identified that protection for blue whales could be strengthened by clarifying the language and definitions in the Conservation Management Plan.</p> <p>Titleholder commitments to address this source of uncertainty:</p> <ul style="list-style-type: none"> • Beach Energy will request tripartite meetings with NOPSEMA and DAWE to resolve any interpretations gaps between the intent of the CMP and its content with the aim of ensuring Beach provides blue whales the level of protection the Australian Government requires. • Beach Energy will share the outcomes of the tripartite meetings with peak industry bodies and other titleholders in the foraging BIA to share learnings and enhance the level of protection for foraging blue whales.
<p>The lack of confidence in accurately predicting the location/s, distribution, and abundance of food sources for blue whale foraging in the foraging BIA leading to uncertainty about the extent of displacement that may occur in the presence of anthropogenic noise.</p>	<p>The available evidence about blue whale food sources is that they are patchy and broadly distributed. The food sources are not stationary and do not appear to have locational trends. Therefore, the level of disturbance to an individual foraging blue whale varies depending on the location, movement, and abundance of food sources. If this disturbance were large enough it may be possible for a whale to be displaced from foraging activities.</p> <p>Given that the context of this uncertainty is its effect on blue whales and their foraging behaviour it is most appropriate to study the location, distribution, and abundance of the whales themselves as a proxy for the location, distribution, and abundance of their food sources.</p> <p>Titleholder commitments to address this source of uncertainty:</p> <ul style="list-style-type: none"> • Beach Energy will continue to work with Blue Whale Study, who have conducted ecological research on blue whales in the Otway Basin for over 20 years, to design and implement a study of blue whale foraging behaviour throughout the duration of overlap between the foraging season and the Artisan Exploration Drilling and Otway Development Drilling activities.

	<ul style="list-style-type: none"> • The study will utilise aerial surveys. It is anticipated that these will be weekly, weather conditions permitting, and based on input from the Blue Whale Study. Weekly observations have been considered to be suitable (as per comms P Gill); however, observations may be increased on advice from Blue Whale Study. • The study will include observations for blue whales both inside and outside the ensonified area predicted by the noise modelling. • The study will assess foraging in the BIA, including the area ensonified by the Artisan Exploration Drilling and Otway Development Drilling activities, to confirm that blue whales are not being displaced from a foraging area. • The aircraft used will comply to IOGP and Beach’s Operational Excellence Management System (OEMS) to ensure the safety of the observers. • Blue Whale Study will provide the expert observers for the aerial surveys. Blue Whale Study will ensure that all the observers are suitably qualified and experienced. • The proposed design of the study has yet to be finalised; however, it is anticipated that the following actions will be considered: <ul style="list-style-type: none"> a) foraging whales within ~17 km and foraging whales outside of circle – no action b) no whales foraging either within or outside of area – no action c) foraging whales outside of area and no foraging whales inside of area – no action d) foraging whales within area and no foraging whales outside of area – ceasing resupply ops if a whale swims away from MODU across behavioural disturbance threshold (at 17.4km)– if no movement of whales within the zone, no action is required. In the event conditions consistent with this item are present Beach will: <ul style="list-style-type: none"> ▪ subject to safety considerations, take immediate action to progress to the next appropriate safe point, while implementing practicable noise minimisation measures. At this stage consideration may be given to an escalation of whale survey frequency and spatial coverage to understand risks to blue whales; ▪ as safe to do so, and if conditions regarding whale behaviour have not changed, will remain at that appropriate safe point and not progress to the next one until such time as evidence is available for conditions consistent with items a-c being present. <p style="margin-left: 40px;">or</p> <ul style="list-style-type: none"> ▪ Provide alternative measures that would achieve an equivalent or better outcomes based on the written advice of the Blue Whale Study • In the unlikely event that the study is unable to verify that blue whales are continuing to utilise the foraging area, either inside and outside the ensonified area, Beach Energy will consult with respected noise acquisitions and blue whale experts to design further protections for blue whales and/or measures to address residual uncertainty.
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