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Environment Plan

Otway Phase 5 Early Dive Installation Campaign

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	10/09/21	Submission to NOPSEMA	PW	Xodus	PW

Review due	Review frequency
Annually from date of acceptance	Annually (as required)

THE THREE WHATS
What can go wrong?
What could cause it to go wrong?
What can I do to prevent it?

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Acronyms

Terms/acronym	***Definition/Expansion***
AARNO	Australian Agriculture and Natural Resources Online
AFMA	Australian Fisheries Management Authority
AHO	Australian Hydrographic Office
ALARP	As Low as Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
APPEA	Australian Petroleum Production and Exploration Association
ARS	Age-restricted searches
ASAP	As Soon as Practicable
Bass Strait CZSF	Bass Strait Central Zone Scallop Fishery
Bbl	Barrel
Beach	Beach Energy (Operations) Limited
BHP Billiton	BHP Petroleum (Australia) Pty Ltd
BIA	Biologically Important Area
BOM	Bureau of Meteorology
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
Cd	Cadmium
CH_4	Methane
CMMS	Computerised Maintenance Management System
CMT	Crisis Management Team
COLREG	Convention on The International Regulations for Preventing Collisions at Sea
CO	Carbon monoxide
Co	Cobalt
CO_2	Carbon Dioxide
CoP	Cessation of Production
Cr	Chromium
CSV	Construction Support Vehicle
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DAWR	Commonwealth Department of Agriculture and Water Resources now Department of Agriculture, Water and Environment

Terms/acronym	***Definition/Expansion***
DELWP	Victorian Department of Environment, Land, Water and Planning
DEWHA	Department of the Environment, Water, Heritage, and the Arts
DEWNR	Department of the Environment, Water and Natural Resource
DIIS	Department of Industry, Innovation and Science
DISER	Department of Industry, Science, Energy and Resources
DJPR	Victorian Department of Jobs, Precincts and Regions
DJPR: ERR	Victorian Department of Jobs, Precincts and Regions: Earth Resources Regulation
DNP	Commonwealth Director of National Parks
DNRE	Department of Natural Resources and Environment
DO	Dissolved Oxygen
DoE	Department of Environment
DotEE	Commonwealth Department of the Environment and Energy now Department of Agriculture, Water and Environment
DP	Dynamic Positioning
DPI	Department of Primary Industries
DPIPWE	Tasmanian Department of Primary Industries, Parks, Water and Environment
DSE	Department of Sustainability and Environment
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
ECC	Environmental Conservation Council
EES	Environmental Effects Statement
EIS	Environmental Impact Statement
EMBA	Environment That May Be Affected
EMPCA	*Environmental Management and Pollution Control Act 1994*
EMT	Emergency Management Team
ENSO	El Niño – Southern Oscillation
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPO	Environment Performance Outcome
EPS	Environment Performance Standard
ERT	Emergency Response Team
ESD	Ecologically Sustainable Development
ETBF	Eastern Tuna and Billfish Fishery

Terms/acronym	***Definition/Expansion***
FFG	Flora and Fauna Guarantee Act
GHG	Greenhouse gases
GIS	Geographic Information Systems
GSACUS	Great Southern Australian Coastal Upswelling System
H_2S	Hydrogen Sulphide
ha	Hectare
HFC	Hydrofluorocarbons
Hg	Mercury
HISC	Hydrogen Induced Stress Cracking
HRV	Hyperbaric Rescue Vehicle
HSE	Health, Safety and Environment
HSEMS	Health, Safety and Environment Management System
Hz	Hertz
IAPP	International Air Pollution Prevention
IBC	Intermediate Bulk Container
IMO	International Maritime Organisation
IMOS	Integrated Marine Observing System
IMS	Invasive Marine Species
IMT	Incident Management Team
IOGP	International Association of Oil and Gas Producers
ISQC	International Standard on Quality Control
IUCN	International Union for Conservation of Nature
JRCC	Joint Rescue Coordination Centre
KEF	Key Ecological Feature
Lattice	Lattice Energy Limited
LOC	Loss of Containment
LOR	Level of Reporting
MARPOL	International Convention for The Prevention of Pollution from Ships
MC	Measurement Criteria
MCS	Master Control Station
MDO	Marine Diesel Oil
MEG	Monoethylene Glycol
MNES	Matters of National Environmental Significance
MNP	Marine National Park

Terms/acronym	Definition/Expansion
MO	Marine Order
MoC	Management of Change
MODIS	Moderate Resolution Imaging Spectroradiometer
MODU	Mobile Offshore Drilling Unit
MT	Metric Tonne
N_2O	Nitrous oxide
NatPlan	National Plan for Maritime Environmental Emergencies
NEBA	Net Environmental Benefit Analysis
Ni	Nickel
NMFS	(US) National Marine Fisheries Service
NNTT	National Native Title Tribunal
NOO	National Oceans Office
NOOA	(US) National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOX	Nitrous Oxides
NO_2	Nitrogen dioxide
NSW	New South Wales
O_3	Ozone
OCS	Offshore Constitutional Settlement
OEMS	Operations Excellence Management System
OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act 2006
OPGGS Regulations (Vic)	Victorian Offshore Petroleum and Greenhouse Gas Storage Regulations 2011
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPP	Offshore Project Proposal
Origin	Origin Energy Resources Limited
ORP	Oxidation-Reduction Potential
OSMP	Operational and Scientific Monitoring Plan
OSTM	Oil Spill Trajectory Modelling
OWR	Oiled Wildlife Response
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PFC	Perfluorocarbons

Terms/acronym	*Definition/Expansion*
PLONOR	Posing little or no risk to the environment
PMST	Protected Matters Search Tool
POLREP	Marine Pollution Report
POWBONS Act	Pollution of Waters by Oil and Noxious Substances Act 1986
ppb	Parts Per Billion
ppm	Parts Per Million
PSV	Platform Supply Vessel
PSZ	Petroleum Safety Zone
PTS	Permanent Threshold Shift
PWS	Parks and Wildlife Service
ROV	Remotely Operated Vehicle
SBTF	Southern Bluefin Tuna Fishery
SCCP	Source Control Contingency Plan
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level
SEMR	South-East Marine Region
SESSF	Southern and Eastern Scalefish And Shark Fishery
SETFIA	South East Trawl Fishing Industry Association
SF6	Sulfur hexafluoride
SIMAP	Spill Impact Mapping Analysis Program
SIV	Seafood Industry Victoria
SMPEP	Shipboard Marine Pollution Emergency Plan
SMS	Short Message Service
SO_2	Sulphur dioxide
SOX	Sulphur Oxides
SPF	Small Pelagic Fishery
SPL	Sound Pressure Level
SPRAT	Species Profile and Threats Database
SST	Sea surface temperature
TEC	Threatened Ecological Community
TRH	Total Recoverable Hydrocarbon
TSC Act	Tasmanian Threatened Species Conservation Act
TSSC	Threatened Species Scientific Committee
TTS	Temporary Threshold Shift

Terms/acronym	*Definition/Expansion*
UNESCO	United Nations Education, Scientific, and Cultural Organisation
USBL	Ultra-short baseline
VLSFO	Very Low Sulphur Fuel Oil
VWMS	Victorian Waterway Management Strategy
WGCMA	West Gippsland Catchment Management Authority
WMO-GAW	World Meteorological Organisation-Global Atmosphere Watch
WOMP	Well Operations Management Plan
Woodside	Woodside Petroleum Ltd

1 Overview of the Activity

Beach Energy (Operations) Limited (Beach) is the part owner and nominated operator of the Otway Gas Development. The development consists of offshore and onshore infrastructure necessary for the commercialisation of gas and liquids in the Geographe and Thylacine fields off the coast of Victoria.

Development of the gas fields commenced in 2004, by Woodside Petroleum Ltd under a joint venture arrangement, with first production in mid-2007.

The scope of this Environment Plan (EP) is the early dive installation campaign in the vicinity of the Thylacine wellhead platform (Figure 1-1). The early dive installation campaign is required to prepare for the future tie-in of the Thylacine Development wells; which are expected to be drilled in 2021 – 2022 and were approved under a separate EP (Otway Development Drilling and Well Abandonment EP – accepted Feb 2021).

The following activities are not included in the scope of this EP:

- Hook-up and commissioning of infrastructure required for production from the Thylacine development wells (subject to a separate EP);
- Operations of the Otway Offshore development including Thylacine wellhead platform which is covered by the Otway Offshore Operations EP (CDN/ID 8255348); and
- Maintenance and decommissioning of any assets/facilities, which will be covered by the Otway Operations EP and specific EPs as necessary.

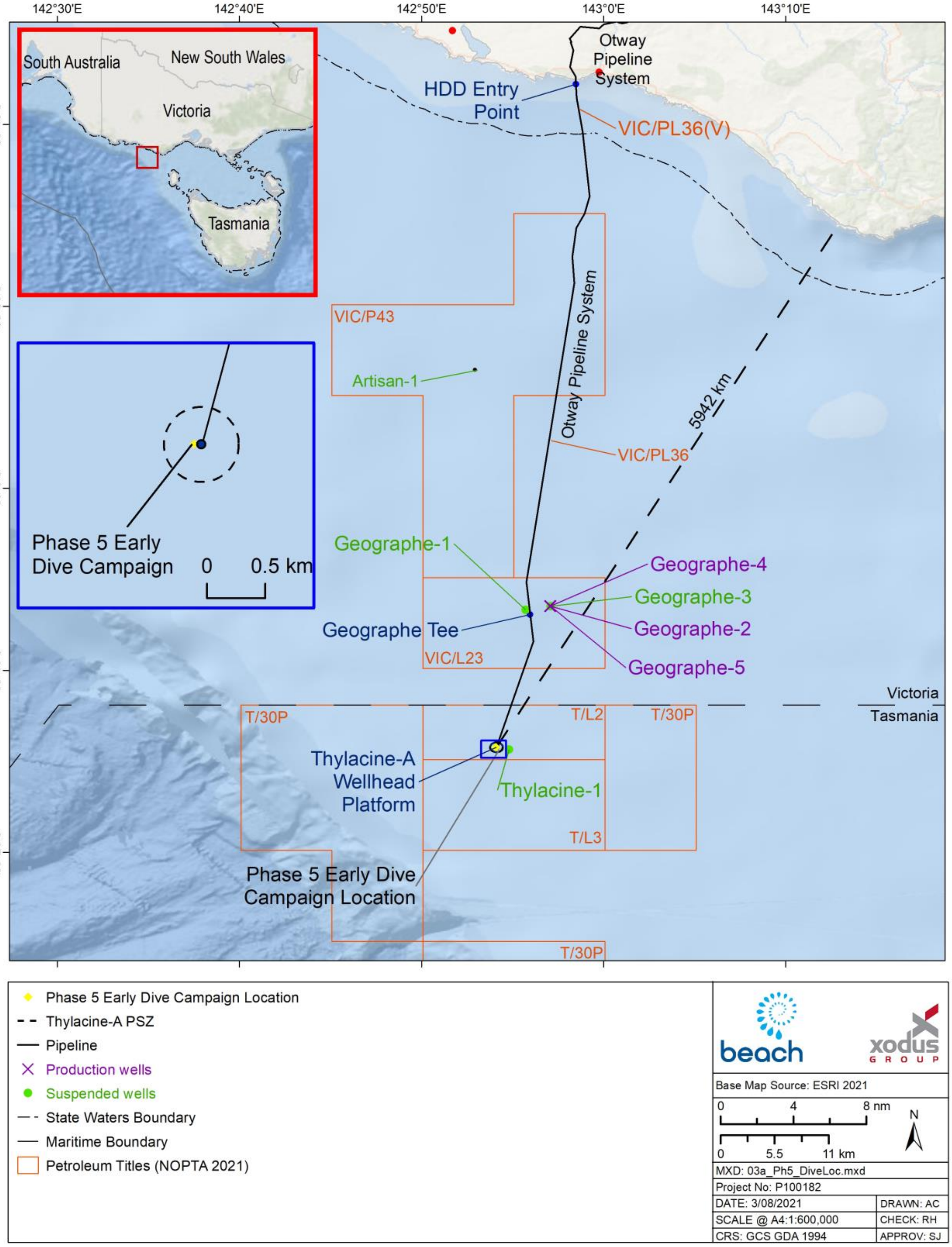


Figure 1-1: Otway Phase 5 Early Dive Installation Campaign location

1.1 Environment Plan Summary

The 'Otway Phase 5 Early Dive Installation Campaign EP Summary' has been prepared from material provided in this EP. The summary consists of the following (Table 1-1) as required by Regulation 11(4) of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R).

Table 1-1: EP Summary of material requirements

EP Summary Material Requirement	**Relevant Section of EP Containing EP Summary Material**
The location of the activity	Section 3
A description of the receiving environment	Section 4
A description of the activity	Section 3
Details of the environmental impacts and risks	Section 6
A summary of the control measures for the activity	Section 6.16
A summary of the arrangements for ongoing monitoring of the titleholder's environmental performance	Section 7
A summary of the response arrangements in the oil pollution emergency plan	Refer to OPEP
Details of consultation already undertaken and plans for ongoing consultation	Section 8
Details of the titleholders nominated liaison person for the activity	Section 1.2

1.2 Titleholder and Liaison Person Details

The operator of the Otway Gas Development is Beach Energy (Operations) Limited, a company wholly owned by Beach Energy Limited (Beach). Table 1-2 details the Titleholder and the liaison person for the title applicable to the activity.

Beach is an Australian Stock Exchange listed oil and gas exploration and production company. Beach is headquartered in Adelaide, South Australia. Beach has operated and non-operated, onshore and offshore oil and gas production assets in five producing basins across Australia and New Zealand and is a key supplier to the Australian east coast gas market.

Beach's asset portfolio includes ownership interests in strategic oil and gas infrastructure, as well as a suite of high potential exploration prospects. Beach's gas exploration and production portfolio includes acreage in the Otway, Bass, Cooper/Eromanga, Perth, Browse and Bonaparte basins in Australia, as well as the Taranaki and Canterbury basins in New Zealand (Figure 1-2).

Beach will notify National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) and the Victorian Department of Jobs, Precincts and Regions: Earth Resources Regulation (DJPR (ERR)) of any change in Titleholder, a change in the Titleholder's nominated liaison person, or a change in the contact details for either the Titleholder or the liaison person as soon as practicable after such a change takes place.

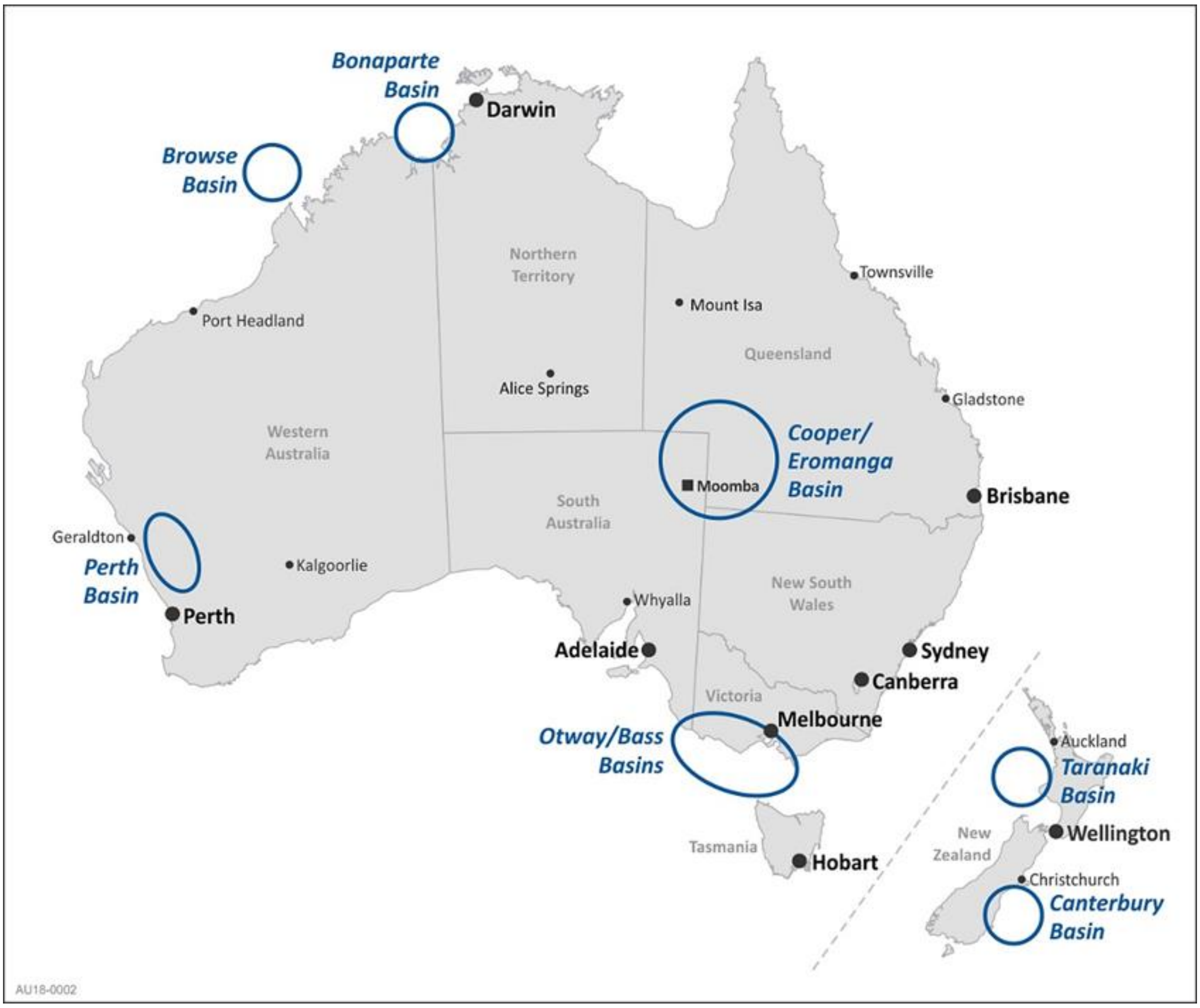


Figure 1-2: Beach operations

Table 1-2: Details of titleholder and liaison person.

Petroleum Title	Details	
T/L2	Titleholder	Beach Energy (Operations) Limited – Operator Beach Energy (Otway) Limited OGOG (Otway) Pty Ltd
	Business address	Level 8 80 Flinders Street Adelaide South Australia 5000
	Telephone number	(08) 8338 2833
	Fax number	(08) 8338 2336
	Email address	info@beachenergy.com.au
	Australian Company Number	ACN: 007 845 338
Titleholder Liaison Person		
Mr Rod McKellar Project Manager Otway Offshore Phase 5	Business address	Level 15 150 Lonsdale Street Melbourne Victoria 3001
	Telephone number	(08) 8338 2833
	Fax number	(08) 8338 2336
	Email address	info@beachenergy.com.au

2 Applicable Requirements

This section provides information on the requirements that apply to the activity, in accordance with Regulation 13(4) of the OPGGS(E)R. Requirements include relevant laws, codes, other approvals and conditions, standards, agreements, treaties, conventions or practices (in whole or part) that apply to the jurisdiction that the activity takes place in.

The proposed activity is located within Commonwealth waters. Relevant Commonwealth requirements are summarised in Table 2-2. On the basis that a worst-case credible oil spill has the potential to intersect Victorian and Tasmanian waters, relevant Victorian and Tasmanian requirements are described in Table 2-3 and Table 2-4 respectively.

2.1 EPBC Act Primary Approval

Woodside Petroleum Ltd (Woodside), as the original operator of the Otway Development, submitted an Environmental Impact Statement (EIS) under the Environment Protection and Biodiversity Conservation (EPBC) Act for the Otway Development which was approved by the Minister of the Environment in 2004 (EPBC 2002/621). In March 2010, Origin Energy Resources Ltd purchased the Otway Development from Woodside and commenced operatorship of the development (later changing its name to Lattice Energy Limited (Lattice)). In February 2018, Beach acquired Lattice, which included the acquisition of the Otway Development.

The EIS preferred development concept consisted of:

- Production from the Thylacine unmanned platform consisting of dry well heads and telecommunication control links to the onshore gas processing plant;
- Subsea well heads and infrastructure at the Geographe field;
- Subsea tie-ins consisting of the construction and operation of subsea wells, flowlines and other related infrastructure within the development area for the purpose of extracting gas from the Thylacine and Geographe gas discoveries;
- Subsea pipeline to bring gas from the Thylacine and Geographe fields to the onshore gas processing plant; and
- Separation of produced water and compression of gas at the onshore gas processing plant.

To date the Otway Development consists of:

- Four production wells (dry wells) at the Thylacine-A Wellhead Platform and telecommunication control links to the Otway Gas Plant;
- Three subsea production wells (G-2, G-4, G-5) and the G-3 well that was constructed and never operated, at the Geographe field;
- Subsea tie-in, flowlines and other related infrastructure for the purpose of extracting gas from the Geographe gas discoveries;
- Subsea pipeline to bring gas from the Thylacine and Geographe fields to the Otway Gas Plant; and
- Separation of produced water and compression of gas at the onshore Otway Gas Plant.

The scope of this EP consists of:

- Early works to support tie-in of new subsea wells for the purpose of extracting gas from the Thylacine field.

The activities described in this EP forms part of the Otway Development and was approved by the Minister (EPBC (2002/621). A separate Offshore Project Proposal is not therefore required (Regulation 5A(2) OPGGS(E)R). The activity approved by the Minister included:

- Gas production, subsea manifolds and flowlines and the possibility of an offshore platform at either Thylacine or Geographe and is therefore equivalent with the description of activity within this EP;
- The location of the development in the Thylacine field is the same as those described within the EIS and approved under EPBC (2002/621);
- The wells, Thylacine-A Wellhead Platform and subsea infrastructure are located in the same petroleum titles as those described within the EIS and approved under EPBC (2002/621);
- The environment that may be affected by the operations is the same as that previously considered during the development of the EIS;
- The environmental impact assessment within the EIS considered similar aspects and cause effect pathways to similar receptors as those detailed within this EP, although the EP includes a greater level of detail consistent with the requirements of regulation 13 (3) of the OPGGS(E) Regs 2009; and
- The consequence evaluation for environmental impacts associated with the activity is consistent with those described within the EIS.

As such, the proposed activity does not trigger a requirement for further approval under the EPBC Act (as would be met though an OPP) given the Environment Minister has approved, under Part 9 of the EPBC Act the taking of an action that includes the activity via the existing approval EPBC (2002/621) which is consistent with regulation 9(3)(b)(iii) of the OPGGS(E) Regulations 2009.

Conditions relating to the EPBC Act approval that are considered relevant to the scope of this EP are detailed in Table 2-1. Conditions are based on those in the Variation to Conditions Attached to Approval issued on the 22 June 2015.

2.2 EPBC Act Requirements

This EP considers the impacts to matters of national environmental significance (MNES) protected under Part 3 of the EPBC Act. Relevant requirements associated with the EPBC Act, related policies, guidelines, plans of management, recovery plans, threat abatement plans and other relevant advice issued by Department of Agriculture, Water and the Environment (DAWE), are detailed in the applicable sections within Section 4 as part of the description of the existing environment.

Recovery plans, threat abatement plans and species conservation advices applicable to species identified in Section 4.6.7 are detailed in Table 2-5.

Table 2-1: Conditions from the Otway Development (2002/621) applicable to the Otway Phase 5 Early Dive Installation Campaign

Condition No.	Condition	Relevant Section of EP
8	If the person taking the action proposes to undertake any subsea tie-in not included in approved plans pursuant to conditions 1, 3, 4 and 5, the person taking the action must revise such plans or submit a new plan or plans so as to address the activities associated with, and potential environmental impacts of, the subsea tie-in. Activities associated with subsea tie-ins may not be commenced until each such plan or revised plan has been approved by the Minister. Each plan or revised plan that has been approved by the Minister must be implemented. Note: subsea tie-in is not defined in the conditions dated 22 June 2015. The definition in conditions dated 13 April 2004 is "the construction and operation of eight subsea wells, flowlines and other related infrastructure within the development area for the purpose of extracting gas from the Thylacine and Geographe discoveries." Conditions dated 22 June 2015 do not have conditions 3 or 4.	This EP.
11	A plan required by condition 1, 3, 5, 8 or 9 is automatically deemed to have been submitted to, and approved by, the Minister if the measures (as specified in the relevant condition) are included in an environment plan (or environment plans) relating to the taking of the action that: a) was submitted to NOPSEMA after 27 February 2014; b) either: (i) is in force under the OPGGS(E)R; or (ii) has ended in accordance with regulation 25A of the OPGGS(E)R.	This EP.
11B	Where an environment plan which includes measures specified in the conditions referred to in conditions 11 is in force under the OPGGS(E)R that relates to the taking of the action, the person taking the action must comply with those measures as specified in that environment plan.	This EP. Section 6.16 Environmental Performance Outcomes, Standards and Measurement Criteria Section 7 – Implementation Strategy

Table 2-2: Commonwealth environmental legislation relevant to the Otway Phase 5 Early Dive Installation Campaign

Legislation	Scope	Related International Conventions	Administering Authority
Australian Maritime Safety Authority Act 1990	This Act facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are effected through Australian Maritime Safety Authority (AMSA) who administers the National Plan for Maritime Environmental Emergencies (NatPlan). **Application to activity**: AMSA is the designated Control Agency for oil spills from vessels in Commonwealth waters. *These arrangements are detailed in the OPEP.*	International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969 Articles 198 and 221 of the United Nations Convention on the Law of the Sea 1982	Australian Maritime Safety Authority (AMSA)
Australian Ballast Water Management Requirements (Commonwealth of Australia, 2020)	The Australian Ballast Water Management Requirements set out the obligations on vessel operators with regards to the management of ballast water and ballast tank sediment when operating within Australian seas. **Application to activity**: Provides requirements on how vessel operators should manage ballast water when operating within Australian seas to comply with the Biosecurity Act. *Section 6.9 details these requirements in relation to the management of ballast water.*	International Convention for the Control and Management of Ships' Ballast Water and Sediments (adopted in principle in 2004 and in force on 8 September 2017)	Department of Agriculture, Water and the Environment (DAWE)
Biosecurity Act 2015 Biosecurity Regulations 2016	This Act replaced the *Quarantine Act 1908* in 2015 and is the primary legislation for the management of the risk of diseases and pests that may cause harm to human, animal or plant health, the environment and the economy. The objects of this Act are to provide for: (a) managing biosecurity risks; human disease; risks related to ballast water; biosecurity emergencies and human biosecurity emergencies;	International Convention for the Control and Management of Ships' Ballast Water and Sediments (adopted in principle in 2004 and in force on 8 September 2017)	DAWE

Legislation	Scope	Related International Conventions	Administering Authority
	(b) to give effect to Australia's international rights and obligations, including under the International Health Regulations, the Sanitary and Phytosanitary Agreement and the Biodiversity Convention. **Application to activity**: The Biosecurity Act and regulations apply to 'Australian territory' which is the airspace over and the coastal seas out to 12 m from the coastline. For the activity the Act regulates vessels entering Australian territory regarding ballast water and hull fouling. *Biosecurity risks associated with the activity are detailed in Section 6.9.*		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	This Act applies to actions that have, will have or are likely to have a significant impact on matters of national environmental or cultural significance. The Act protects Matters of National Environmental Significance (MNES) and provides for a Commonwealth environmental assessment and approval process for actions. There are eight MNES, these being: • World heritage properties; • Ramsar wetlands; • listed Threatened species and communities; • listed Migratory species under international agreements; • nuclear actions; • Commonwealth marine environment; • Great Barrier Reef Marine Park; and • water trigger for coal seam gas and coal mining developments. **Application to activity**: Petroleum activities are excluded from within the boundaries of a World Heritage Area (Sub regulation 10A(f)). *The activity is not within a World Heritage Area.*	1992 Convention on Biological Diversity and 1992 Agenda 21 Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 Agreement between the Government and Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 Agreement between the Government and Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 Agreement between the Government of Australia and the Government of the Republic of Korea on The Protection of Migratory Birds 2006 Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971 (Ramsar)	DAWE

Legislation	Scope	Related International Conventions	Administering Authority
	The EP must describe matters protected under Part 3 of the EPBC Act and assess any impacts and risks to these. *Section 3 describes matters protected under Part 3 of the EPBC Act.* The EP must assess any actual or potential impacts or risks to MNES from the activity. *Section 6 provides an assessment of the impacts and risks from the activity to matters protected under Part 3 of the EPBC Act.*	International Convention for the Regulation of Whaling 1946 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979	
Environment Protection and Biodiversity Conservation Regulations 2000	Part 8 of the regulations provide distances and actions to be taken when interacting with cetaceans. **Application to activity**: The interaction requirements are applicable to the activity in the event that a cetacean is sighted. *Section 2.2 details how these requirements will be applied.*	-	DAWE
Marine Pest Plan 2018–2023: National Strategic Plan for Marine Pest Biosecurity	Australia's national strategic plan for marine pest biosecurity. It outlines a coordinated approach to building Australia's capabilities to manage the threat of marine pests over the next five years. It represents agreed priorities and actions of governments, marine industries, and other stakeholders to achieve a common purpose: to manage the risks posed by marine pests and minimise their potential harm to marine industries, communities and the environment. **Application to activity**: Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species *Section 6.9 details how these requirements will be applied.*	-	DAWE
National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry 2009	The guidance document provides recommendations for the management of biofouling risks by the petroleum industry. **Application to activity**: Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species.	Certain sections of International Convention for The Prevention of Pollution from Ships (MARPOL) International Convention for the Safety of Life at Sea 1974	DAWE

Legislation	Scope	Related International Conventions	Administering Authority
	Section 6.9 details the requirements applicable to vessel activities.	Convention on the International Regulations for Preventing Collisions at Sea (COLREG) 1972	
National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds (CoA 2020)	The Guidelines outline the process to be followed where there is the potential for artificial lighting to affect wildlife. **Application to activity**: Applying the recommendations within this document and implementing effective controls can reduce the impact of light to sensitive receptors. *Section 6.2 details the requirements applicable to the activity.*		DAWE
National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Commonwealth of Australia, 2017a)	The overarching goal of the strategy is to provide guidance on understanding and reducing the risk of vessel collisions and the impacts they may have on marine megafauna. **Application to activity**: Applying the recommendations within this document and implementing effective controls can reduce the risk of the vessel collisions with megafauna. *Section 6.10 details the requirements applicable to vessel activities.*		DAWE
Navigation Act 2012	This Act regulates ship-related activities and invokes certain requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) relating to equipment and construction of ships. Several Marine Orders (MO) are enacted under this Act relating to offshore petroleum activities, including: • MO 21: Safety and emergency arrangements. • MO 30: Prevention of collisions. • MO 31: SOLAS and non-SOLAS certification. **Application to activity**: The CSV (according to class) will adhere to the relevant MO with regard to navigation and preventing collisions in Commonwealth waters. *Section 6.5 details the requirements applicable to vessel activities.*	Certain sections of MARPOL International Convention for the Safety of Life at Sea 1974 COLREG 1972	AMSA

Legislation	Scope	Related International Conventions	Administering Authority
Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) OPGGS(E)R	The Act addresses all licensing, health, safety, environmental and royalty issues for offshore petroleum exploration and development operations extending beyond the three-nautical mile limit. Part 2 of the OPGGS(E)R specifies that an EP must be prepared for any petroleum activity and that activities are undertaken in an ecologically sustainable manner and in accordance with an accepted EP. **Application to activity**: The OPGGS Act provides the regulatory framework for all offshore petroleum exploration and production activities in Commonwealth waters, to ensure that these activities are carried out: • consistent with the principles of ecologically sustainable development as set out in section 3A of the EPBC Act. • so that environmental impacts and risks of the activity are reduced to ALARP. • so that environmental impacts and risks of the activity are of an acceptable level. *Demonstration that the activity will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities are ALARP and acceptable is provided in Section 6.*	-	NOPSEMA
Protection of the Sea (Prevention of Pollution from Ships) Act 1983	This Act regulates Australian regulated vessels with respect to ship-related operational activities and invokes certain requirements of the MARPOL Convention relating to discharge of noxious liquid substances, sewage, garbage, air pollution etc. **Application to activity**: All ships involved in petroleum activities in Australian waters are required to abide to the requirements under this Act. Several MOs are enacted under this Act relating to offshore petroleum activities, including:	Various parts of MARPOL	AMSA

Legislation	Scope	Related International Conventions	Administering Authority
	• MO 91: Marine Pollution Prevention – Oil. • MO 93: Marine Pollution Prevention – Noxious Liquid Substances. • MO 94: Marine Pollution Prevention – Packaged Harmful Substances. • MO 95: Marine Pollution Prevention – Garbage. • MO 96: Marine Pollution Prevention – Sewage. • MO 97: Marine Pollution Prevention – Air Pollution. *Section 6 details the requirements applicable to vessel activities.*		
Protection of the Sea (Harmful Antifouling Systems) Act 2006	Under this Act, it is an offence for a person to engage in negligent conduct that results in a harmful anti-fouling compound being applied to or present on a ship. The Act also provides that Australian ships must hold 'anti-fouling certificates', provided they meet certain criteria. **Application to activity**: All ships involved in offshore petroleum activities in Australian waters are required to abide to the requirements under this Act. The MO 98: Marine Pollution Prevention – Anti-fouling Systems is enacted under this Act. *Section 6 details the requirements applicable to vessel activities.*	International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001	AMSA
Underwater Cultural Heritage Act 2018	Protects the heritage values of shipwrecks, sunken aircraft and relics (older than 75 years) in Australian Territorial waters from the low water mark to the outer edge of the continental shelf (excluding the State's internal waterways). The Act allows for protection through the designation of protection zones. Activities / conduct prohibited within each zone will be specified. **Application to activity**: In the event of removal, damage or interference to shipwrecks, sunken aircraft or relics declared to be	Agreement between the Netherlands and Australia concerning old Dutch Shipwrecks 1972	DAWE

Legislation	Scope	Related International Conventions	Administering Authority
	historic under the legislation, activity is proposed with declared protection zones, or there is the discovery of shipwrecks or relics. *Section 4.8.1 identifies no known shipwrecks or sunken aircraft in the EMBA.*		

Table 2-3: Victorian environment legislation relevant to potential impacts and risks to State waters and lands

Legislation	Scope	Application to Activity	Administering Authority
Environment Protection Act 1970 (& various regulations)	This is the key Victorian legislation which controls discharges and emissions (air, water) to the environment within Victoria (including state and territorial waters). It gives the Environment Protection Authority (EPA) powers to licence premises discharges to the marine environment, control marine discharges and to undertake prosecutions. Provides for the maintenance and, where necessary, restoration of appropriate environmental quality.	Oil pollution management in Victorian State waters	Environment Protection Authority (EPA)
	The State Environment Protection Policy (Waters of Victoria) designates: • spill response responsibilities by Victorian Authorities to be undertaken in the event of spills (DJPR) with EPA enforcement consistent with the *Environment Protection Act 1970* and the *Pollution of Waters by Oil & Noxious Substances Act 1986*. • requires vessels not to discharge to surface waters sewage, oil, garbage, sediment, litter or other wastes which pose an environmental risk to surface water beneficial uses. To protect Victorian State waters from marine pests introduced via domestic ballast water, ballast water management arrangements applying to all ships in State and territorial waters must be observed as per the *Environment Protection (Ships' Ballast Water) Regulations 2006, Waste Management Policy (Ships' Ballast Water)* and the *Protocol for Environmental Management*. High risk domestic ballast water (ballast water which leachates from an Australian port or within the territorial sea of Australia (to 12 nm)), regardless of the source, must not be discharged into Victorian State waters. Ship masters must undertake a ballast water risk assessment on a voyage by voyage basis to assess risk level, provide accurate and comprehensive information to the EPA on the status and risk of ballast water contained on their ships (i.e. domestic/international), and to manage domestic ballast water discharges with EPA written approval.	Discharge of domestic ballast water from emergency response vessels into Victorian State waters must comply with these requirements.	

Legislation	Scope	Application to Activity	Administering Authority
Emergency Management Act 2013 (& Regulations 2003)	Provides for the establishment of governance arrangements for emergency management in Victoria, including the Office of the Emergency Management Commissioner and an Inspector-General for Emergency Management. Provides for integrated and comprehensive prevention, response and recovery planning, involving preparedness, operational co-ordination and community participation, in relation to all hazards. These arrangements are outlined in the Emergency Management Manual Victoria.	Emergency response structure for managing emergency incidents within Victorian State waters. Emergency management structure will be triggered in the event of a spill impacting or potentially impacting State waters. See OPEP.	Department of Justice and Regulation (Inspector General for Emergency Management)
Flora and Fauna Guarantee Act 1988 (& Regulations 2011)	The purpose of this Act is to protect rare and threatened species; and enable and promote the conservation of Victoria's native flora and fauna and to provide for a choice of procedures that can be used for the conservation, management or control of flora and fauna and the management of potentially threatening processes. Where a species has been listed as threatened an Action statement is prepared setting out the actions that have or need to be taken to conserve and manage the species and community.	Action Statement controls for threatened species present in the zone of potential impact (Environment that May Be Affected (EMBA)) as adopted (as relevant) within this EP. Triggered if an incident results in the injury or death of a FFG Act listed species (e.g. collision with a whale).	Department of Environment, Land, Water and Planning (DELWP)
Heritage Act 1995	The purpose of the Act is to provide for the protection and conservation of historic places, objects, shipwrecks and archaeological sites in state areas and waters (complementary legislation to Commonwealth legislation). Part 5 of the Act is focused on historic shipwrecks, which are defined as the remains of all ships that have been situated in Victorian State waters for 75 years or more. The Act addresses, among other things, the registration of wrecks, establishment of protected zones, and the prohibition of certain activities in relation to historic shipwrecks.	May be triggered in the event of impacts to a known or previously un-located shipwreck in Victorian State waters whilst undertaking emergency response activities.	Heritage Victoria (DELWP)

Legislation	Scope	Application to Activity	Administering Authority
Marine Safety Act 2010 (& Regulations 2012)	Act provides for safe marine operations in Victoria, including imposing safety duties on owners, managers and designers of vessels, marine infrastructure and marine safety equipment; marine safety workers, masters and passengers on vessels; regulation and management of vessel use and navigation in Victorian State waters; and enforcement provisions of Police Officers and the Victorian Director of Transport Safety. This Act reflects the requirements of international conventions - *Convention on the International Regulations for Preventing Collisions at Sea* & *International Convention for the Safety of Life at Sea*. The Act also defines marine incidents and the reporting of such incidents to the Victorian Director of Transport Safety.	Applies to vessel masters, owners, crew operating vessels in Victorian State waters.	Maritime Safety Victoria
National Parks Act 1975	Established a number of different types of reserve areas onshore and offshore, including Marine National Parks and Marine Sanctuaries. A lease, licence or permit under the OPGGS Act 2010 that is either wholly or partly over land in a marine national park or marine sanctuary is subject to the *National Parks Act 1975* and activities within these areas require Ministerial consent before activities are carried out.	Applies where there are activities within marine reserve areas.	DELWP
Pollution of Waters by Oil and Noxious Substances Act 1986 (POWBONS) (& Regulations 2002)	The purpose of the *Pollution of Waters by Oils and Noxious Substances Act 1986* (POWBONS) is to protect the sea and other waters from pollution by oil and noxious substances. This Act also implements the MARPOL Convention (the International Convention for the Prevention of Pollution from Ships 1973) in Victorian State waters. Requires mandatory Reporting of marine pollution incidents. Act restricts within Victorian State waters the discharge of treated oily bilge water according to vessel classification (>400 tonnes); discharge of cargo substances or mixtures; prohibition of garbage disposal and packaged harmful substances; restrictions on the discharge of sewage; regulator reporting requirements for incidents; ship construction certificates and survey requirements. Restriction on discharges within Victorian State waters incorporated into EP.	Triggered in the event of a spill impacting or potentially impacting State waters.	Jointly administered by DJPR and EPA

Legislation	Scope	Application to Activity	Administering Authority
Wildlife Act 1975 (& Regulations 2013)	The purpose of this Act is to promote the protection and conservation of wildlife. Prevents wildlife from becoming extinct and prohibits and regulates persons authorised to engage in activities relating to wildlife (including incidents). The *Wildlife (Marine Mammal) Regulations 2009* prescribe minimum distances to whales and seals/seal colonies, restrictions on feeding/touching and restriction of noise within a caution zone of a marine mammal (dolphins (150 m), whales (300 m) and seals (50 m).	Applies where vessels are within State waters responding to a spill event. Prescribed minimum proximity distances to whales, dolphins and seals will be maintained. Triggered if an incident results in the injury or death of whales, dolphins or seals.	DELWP

Table 2-4: Tasmanian Environment Legislation Relevant to potential impacts to State waters and lands

Legislation	Scope	Application to Activity	Administering Authority
Environmental Management and Pollution Control Act 1994 (EMPCA) (& Regulations)	EMPCA is the primary environment protection and pollution control legislation in Tasmania. It is a performance-based style of legislation, with the fundamental basis being the prevention, reduction and remediation of environmental harm. The clear focus of the Act is on preventing environmental harm from pollution and waste. Relevant regulations under the EMPCA include: • Environmental Management and Pollution Control (General) Regulations 2017 • Environmental Management and Pollution Control (Waste Management) Regulations 2010 The EPA Division Compliance Policy provides the Director of the EPA powers of compliance.	Defines the EPA's jurisdiction during a spill event. Prescribes the fee structure to waste events and environmental protection notices. Regulates the management and control of controlled wastes. See OPEP	Department of Primary Industries, Parks, Water and Environment (DPIPWE)
Pollution of Waters by Oil and Noxious Substances Act 1987	Pollution of the sea in Tasmanian State waters may be regulated by general pollution laws such as the EMPCA (see above), but the Pollution of Waters by Oil and Noxious Substance Act 1987 deals specifically with discharges of oil and other pollutants from ships. In accordance with current national arrangements, the Pollution of Waters by Oil and Noxious Substance Act 1987 gives effect in Tasmania to the MARPOL international convention on marine pollution.	Gives effect to MARPOL in Tasmanian waters.	DPIPWE

Table 2-5: Recovery plans, threat abatement plans and species conservation advices relevant to the Otway Phase 5 Early Dive Installation Campaign

Relevant Plan/Advice	***Description***	***Applicable Threats or Management Advice***
The Threat Abatement Plan for the impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean (Commonwealth of Australia, 2018)	The plans focus on strategic approaches to reduce the impacts of marine debris on vertebrate marine life.	***Marine debris*** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
Wildlife Conservation Plan for Migratory Shorebirds – 2015 (DoE, 2015b)	The long-term recovery plan objective for migratory shorebirds is to minimise anthropogenic threats to allow for the conservation status of these bird species.	Habitat degradation/ modification (oil pollution)
Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2019c)	The Plan aims to provide a strategic national framework for the research and management of listed marine and migratory seabirds and to outline national activities to support the conservation of listed seabirds in Australia and beyond.	***Habitat modification*** Evaluate the risk of oil spill impacts on the ability of a seabird to use an area for breeding, roosting or foraging.
National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (DSEWPaC, 2011a)	The recovery plan is a co-ordinated conservation strategy for albatrosses and giant petrels listed as threatened.	***Marine pollution*** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented. ***Marine debris*** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (TSSC, 2015c)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the soft-plumaged petrel.	None identified.
Approved Conservation Advice for *Sternula nereis nereis* (Australian fairy tern) (DSEWPC, 2011c)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy tern.	***Marine pollution*** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.

Relevant Plan/Advice	***Description***	***Applicable Threats or Management Advice***
Draft National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*) (Commonwealth of Australia, 2019b)	Draft recovery plan for actions so species no longer qualifies for listing as threatened under any of the EPBC Act listing criteria.	Habitat degradation and loss of breeding habitat Pollution
Conservation Advice for *Numenius madagascariensis* (eastern curlew) (DoE, 2015e)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the eastern curlew.	Habitat degradation/ loss (oil pollution)
Conservation Advice *Limosa lapponica baueri* (bar-tailed godwit (western Alaskan)) (TSSC, 2016a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the bar-tailed godwit (western Alaskan).	Habitat degradation/ loss
Approved Conservation Advice for *Pachyptila subantarctica* (fairy prion (southern)) (TSSC, 2015d)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy prion (southern).	None identified.
Approved Conservation Advice for *Rostratula australis* (Australian painted snipe) (DSEWPaC, 2013c)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australian painted snipe.	None identified.
Draft National Recovery Plan for the Australian Painted Snipe (Commonwealth of Australia, 2019e)	The plan considers the conservation requirements of the species across its range and identifies the actions to be taken to ensure the species' long-term viability in the wild, and the parties that will undertake those actions.	Deterioration of water quality, human disturbance.
Conservation Advice for *Charadrius leschenaultia* (greater sand plover) (TSSC, 2016b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the greater sand plover.	Habitat degradation/ loss (oil pollution)

Relevant Plan/Advice	***Description***	***Applicable Threats or Management Advice***
Conservation Advice *Calidris ferruginea* (curlew sandpiper) (DoE, 2015f)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the curlew sandpiper.	Habitat degradation/ loss (oil pollution)
Approved Conservation Advice for *Calidris canutus* (red knot) (TSSC, 2016d)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the red knot.	***Marine pollution*** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian bittern) (TSSC, 2019)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australasian bittern.	None identified.
National Recovery Plan for *Pterodroma leucoptera leucoptera* (Gould's petrel) (DEC NSW, 2006)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Gould's petrel.	None identified.
National Recovery Plan for the *Neophema chrysogaster* (orange-bellied parrot) (DELWP, 2016)	The recovery plan is a co-ordinated conservation strategy for the orange-bellied parrot.	Illuminated boats and structures: evaluate risk of lighting on vessels and offshore structures.
National Recovery Plan for the *Lathamus discolour* (swift parrot) (Saunders and Tzaros, 2011) Draft National Recovery Plan for the Swift Parrot (*Lathamus discolor*) (CoA, 2019d)	The recovery plan is a co-ordinated conservation strategy for the swift parrot.	None identified.

Relevant Plan/Advice	***Description***	***Applicable Threats or Management Advice***
Approved Conservation Advice for the *Halobaena caerulea* (blue petrel) (TSSC, 2015e)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the blue petrel	None identified.
National Recovery Plan for the *Prototroctes maraena* (Australian grayling) (Backhouse et al., 2008)	The recovery plan is a co-ordinated conservation strategy for the Australian grayling.	Poor water quality and siltation: Typically, from onshore sources. Impact of introduced fish: Typically, from onshore sources.
Recovery Plan for the *Carcharodon carcharias* (white shark) (DSEWPaC, 2013a)	The recovery plan is a co-ordinated conservation strategy for the white shark.	None identified.
Approved Conservation Advice for the *Rhicodon typus* (whale shark) (TSSC, 2015b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the whale shark	Vessel strike.
Recovery Plan for Marine Turtles in Australia, 2017-2027 (Commonwealth of Australia, 2017b)	The long-term recovery plan objective for marine turtles is to minimise anthropogenic threats to allow for the conservation status of marine turtles	• chemical and terrestrial discharge. • marine debris. • light pollution. • habitat modification. • vessel strike. • noise interference. • vessel disturbance.
Approved Conservation Advice for *Dermochelys coriacea* (leatherback turtle) (DEWHA, 2008)	See above for the recovery plan for marine turtles in Australia, 2017-2027.	
Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015b)	The long-term recovery plan objective for blue whales is to minimise anthropogenic threats to allow for their conservation status to improve	***Noise interference*** Evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented. ***Vessel disturbance***

Relevant Plan/Advice	Description	Applicable Threats or Management Advice
		Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015g)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the sei whale.	***Noise interference*** Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. ***Vessel disturbance*** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015a)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the humpback whale.	***Noise interference*** Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. ***Vessel disturbance*** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Conservation Management Plan for the Southern Right Whale 2011-2021 (DSEWPaC, 2012a)	Conservation management plan provides threat abatement activities that can be undertaken to ensure the conservation of the southern right whale.	***Noise interference*** Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. ***Vessel disturbance*** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015f)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the fin whale.	***Noise interference*** Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. ***Vessel disturbance*** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion) (TSSC, 2010)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Australian sea lion.	Known threats to this species include habitat and prey availability, competition with other seals, fisheries bycatch (bottom-set gillnet, rock lobster), entanglement in marine debris, disturbance, harassment and displacement, predation and direct killing.

Relevant Plan/Advice	*Description*	*Applicable Threats or Management Advice*
		Potential threats to this species include habitat degradation, oil spills, pollution, toxins and climate change
Recovery Plan for the *Neophoca cinerea* (Australian sea lion) (DSEWPaC, 2013b).	The plan considers the conservation requirements of the species across its range and identifies the actions to be taken to ensure its long-term viability in nature and the parties that will undertake those actions.	***Habitat degradation*** No explicit relevant management actions ***Vessel strike*** Collect data on direct killings and confirmed vessel strikes ***Pollution (oil spills, toxins)*** implement jurisdictional oil spill response strategies as required ***Climate change*** No explicit relevant management actions

3 Description of the Activity

3.1 Activity Location

The activity is located in the Thylacine field (Petroleum Title T/L2), entirely within Commonwealth waters approximately 70 km offshore from Port Campbell, Victoria. Water depth at the activity location is approximately 100 m.

Early dive Installation activities will be centred around the Thylacine Diverless Integration Skid (T-DIS), which is located approximately 30 m from the base of the Thylacine-A Wellhead Platform. Indicative co-ordinates of the T-DIS installation location and the Thylacine-A Wellhead Platform are shown in Table 3-1.

Table 3-1 Indicative co-ordinates of the T-DIS and Thylacine-A Wellhead Platform

Location	*Eastings*	*Northings*	*Latitude*	*Longitude*
T-DIS	664110.38	5655154.31	39° 14.245'	142° 54.091'
Thylacine-A Wellhead Platform	664110.38	5655154.31	39° 14.245'	142° 54.091'

Datum GDA94, Grid MGA54

3.2 Operational Area

The operational area is defined as the area where activities managed under this EP will occur. For this petroleum activity, the operational area is a 1 km radius around the T-DIS (Figure 3-1). The operational area is located partially within the Thylacine-A Wellhead Platform Petroleum Safety Zone (PSZ).

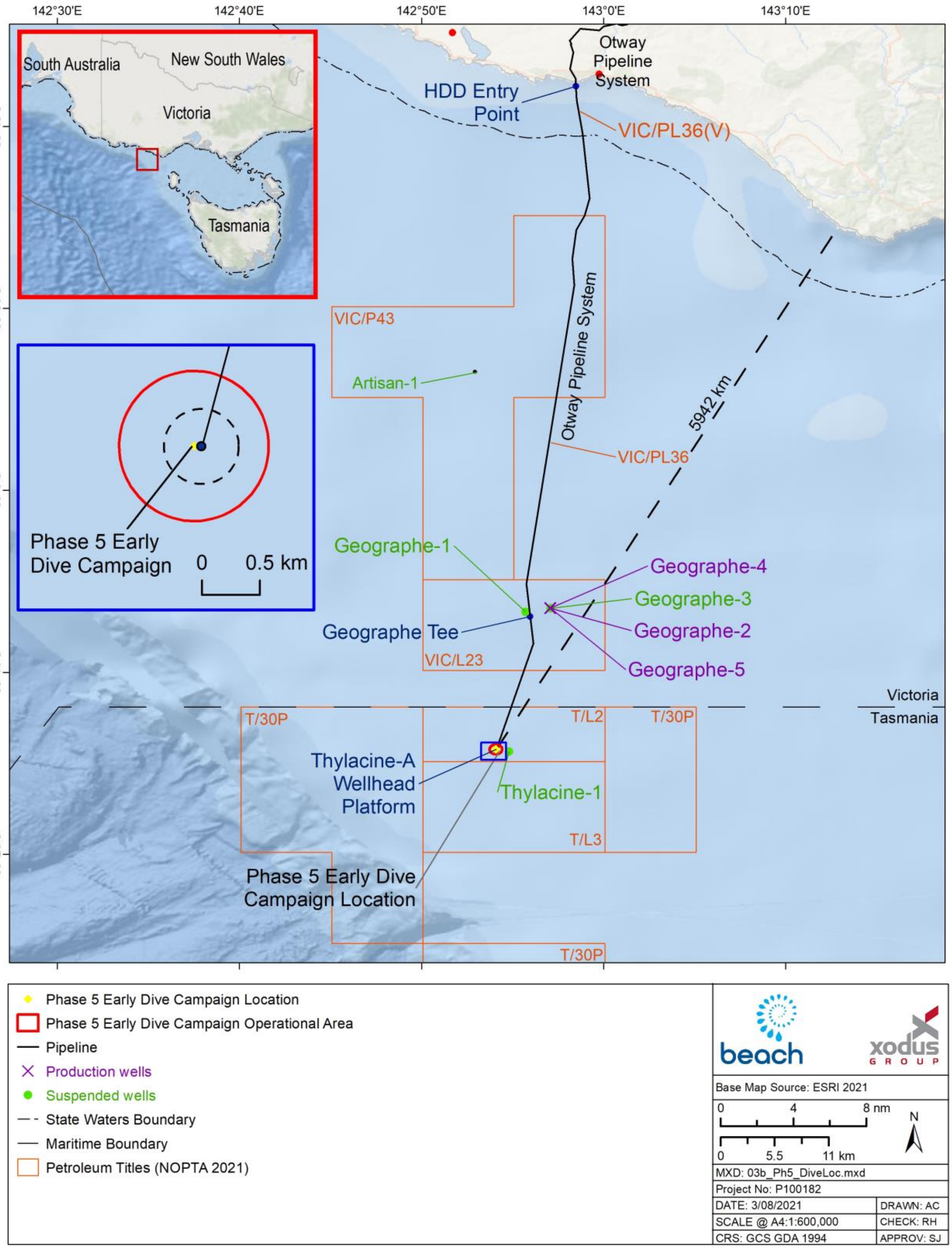


Figure 3-1: T-DIS location and Operational Area

3.3 Activity Timing

The early dive installation will be undertaken in a single campaign, expected to take approximately 7 to 21 days (accounting for potential weather delays). The campaign is planned to be undertaken during an offshore campaign window in Q2 – Q3 2022, however could occur at any time up to end 2022.

Vessel based activities will be conducted on a 24-hour basis for the duration of the campaign. Platform support will likely be limited to daylight operations, but may extend to 24-hr.

3.4 Activities that have the potential to impact the environment

This section outlines the planned activities covered within the scope of this EP which have the potential to result in environmental aspects, leading to impacts to receptors.

3.4.1 Installation of new subsea infrastructure

The T-DIS will be installed approximately 30 m to the west of the Thylacine-A Wellhead Platform (Figure 3-2). Installation of the T-DIS will allow future connection of flowlines to the field to be undertaken using an ROV, without the need for divers. Rigid spools will be installed connecting the T-DIS to the existing production and MEG facilities at the Thylacine-A Wellhead Platform.

The installation sequence will be:

- Mark out T-DIS & spool termination target box locations (divers walk the area and check for debris)
- Install production spool sections (riser end 1st)
- Install MEG spool sections (riser/tee branch end 1st)
- Install T-DIS structure
- Complete flange make-ups.

New infrastructure will be overboarded from the installation vessel (refer to Section 3.4.4.1) away from the installation location but within the operational area, and then lowered into position using ultra-short baseline (USBL) transponders positioned on the infrastructure and installation vessel hull near the sea surface. If the window for overboarding is short, the vessel may lower new infrastructure directly onto the seabed away from the installation location, and temporarily wet-park items prior to installation. Wet parking will occur within the operational area and will be temporary.

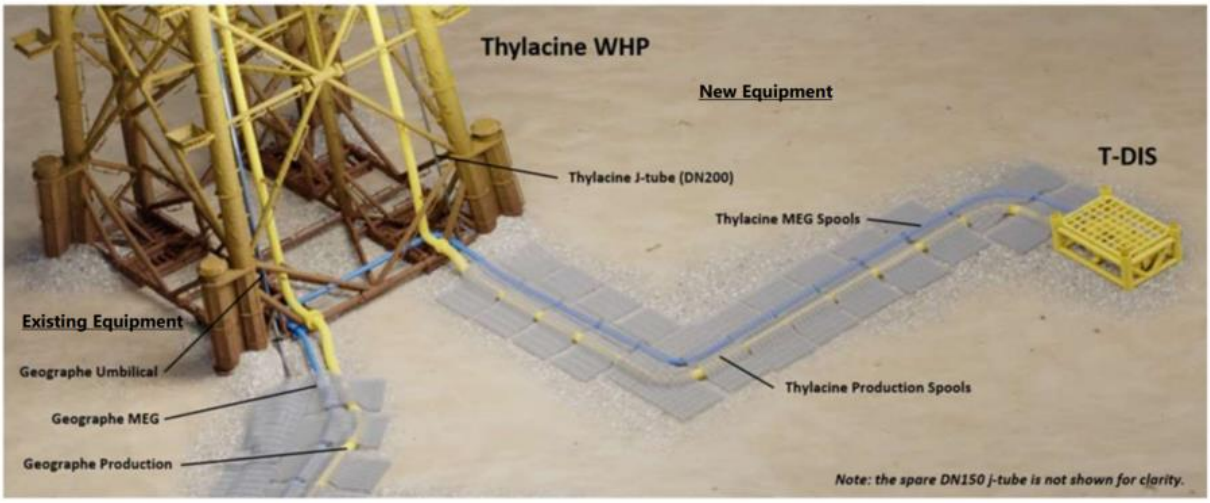


Figure 3-2 T-DIS Tie-in General Arrangement

3.4.1.1 Spool Installation

Two rigid tie-in spools will be installed between the T-DIS and the Thylacine-A Wellhead Platform:

- T-DIS to Production Riser Tie-In Spool; and
- T-DIS to MEG Riser/Tee Branch Tie-in Spool.

The rigid production spool will connect the T-DIS to the spare DN200 production riser on the Thylacine-A Wellhead Platform. It will be ~ 33.7 m long (9.7, 20, 4 m sections of the Z-shape). The rigid MEG spool will connect to the Thylacine-A Wellhead Platform MEG riser / tee branch. It will be ~ 36.2 m long (11.2, 20, 5 m sections of the Z-shape).

Cutting tools (such as diamond wire cutter or disk cutter) may be required to prepare the Thylacine J-tube (DN200) for connection to the new rigid production spool.

The production and MEG spools will be strength / hydrotest tested onshore prior to installation, and pre-filled with preservation fluid (40% MEG solution).

The spools will be installed next to each other, with sufficient space to accommodate spool movement. The rigid spools will have misalignment flanges to allow installation without requiring metrology.

The divers will use pipe handling frames to support the spool sections during installation. Each frame has a footprint on the seabed of approximately 6 m^2. Multiple frames will be required to effect pipe alignment and flange make-up.

Spools may require span rectification (either pre or post spool installation) via jetting or grout bag/sand cement bag installation.

Once installed, the rigid spools will be covered with concrete stabilisation mattresses for dropped object protection. Concrete mattresses are lowered over the spools by the vessel and each mattress typically cover an area of 18 m^2 (6 m x 3 m x 0.5 m). In total, 11 concrete mattresses will be required, with a total combined footprint of 198 m^2. Sand/cement filled bags will be used to fill any gaps in the mattress protection, if required.

3.4.1.2 T-DIS Installation

The T-DIS structure is likely to have the dimensions of 7.4 m x 6.4 m x 2.7 m, and a seabed footprint of 47 m^2. It is a gravity based structure, as opposed to relying on skirts to provide sliding resistance and will have an integrated foundation to enable installation in a single lift. Piling is not required for installation.

The T-DIS structure piping will be strength/hydrotest tested onshore prior to installation, and pre-filled with preservation fluid (40% MEG solution). Pressure caps will be installed on the diverless hubs, which allow future installation and commissioning activities to be undertaken diverless i.e. with an ROV.

A T-DIS alignment frame will be lowered into position by the Construction Support Vessel (CSV; refer to Section 3.4.4.1), and clump weights will be used to retain alignment frame position. The T-DIS structure will then be lowered onto the alignment frame and checked for correct positioning, then the alignment frame and clump weights will be recovered to the vessel.

3.4.2 Pre-commissioning Philosophy

The purpose of pre-commissioning is to verify the integrity of the installation, and to preserve the infrastructure or future activities. The pre-commissioning philosophy for the Phase 5 Early Dive Installation Campaign has been designed to eliminate discharging chemically treated spool fluids by installing pipework pre-flooded, however flushing has been retained as a contingency option as described below.

Pre-commissioning will require personnel to be onboard the Thylacine-A Wellhead Platform, and therefore will be conducted during daylight hours.

Production Spool

The rigid production spool will be connected to an existing production riser on the Thylacine- A wellhead platform. The production riser is currently air filled (confirmed via flooded member detection in February 2021), and will be flooded with a mix of inhibited potable water or seawater (oxygen scavengers, biocide, corrosion inhibitors and tracer dye) and MEG (40%) at the beginning of the campaign from IBCs on the Thylacine-A wellhead platform. The riser will be filled to the natural seawater level, requiring approximately 4 m^3 of fluid.

The production spool will be installed in three sections. Each section will be pre-filled with a mix of inhibited potable water (oxygen scavengers, biocide, corrosion inhibitors and tracer dye) and 40% MEG solution (total of ~1 m^3), with temporary blinds sealing the section during positioning. Sections will be installed sequentially from the production riser to the T-DIS. For each spool connection, the divers will remove the temporary blind (resulting in a small release of MEG solution; less than 1 litre) and insert a dissolvable chemical stick. The dissolvable chemical sick contains preservation chemicals (corrosion inhibitors, biocides etc) to ensure preservation of the spool until commissioning. Once the dissolvable chemical sticks are inserted, the next spool piece will be connected and no discharge of chemicals from the dissolvable chemical stick are expected.

MEG Spool

The MEG spool will connect to the MEG riser on the Thylacine-A wellhead platform. This is a 'live' system, with operating pressures inside the MEG riser of approximately 200 bar. Prior to commencing installation, the MEG manifold will be isolated and tested to verify seal integrity. This might result in a small release of MEG (less than 1 litre), while isolation is verified.

If the necessary isolation cannot be provided, the valves will be replaced (diver installation) to allow safe diver installation of the MEG tie-in spool. In the event that the MEG riser has to be depressurised, a maximum volume of 60 m^3 of MEG would be discharged at the base of the Thylacine MEG riser for system testing, flushing and contingency purposes.

Once isolated, the MEG spool sections will be installed in the same way as the production spool sections; 3 x spool sections, pre-filled with a mix of inhibited potable water (oxygen scavengers, biocide, corrosion inhibitors and tracer dye) and 40% MEG solution (total of ~0.5 m^3). Sections will be installed from the riser to the T-DIS, with divers inserting a dissolvable chemical stick before connection.

T-DIS

The T-DIS will be installed fluid filled with preservation fluid, a mix of inhibited potable water (oxygen scavengers, biocide, corrosion inhibitors and tracer dye) and 40% MEG solution, to minimise the egress of raw seawater during installation.

The pre-commissioning philosophy has been design to avoid flushing, however in the unlikely event that flushing to sea is required, flushing of the T-DIS and spools will take place in a loop through the MEG and production lines, with flushing fluid (MEG and inhibited seawater or potable water) pumped from the vessel (via a flexible line overboarded from an IBC on the vessel) or from the Thylacine-A Wellhead Platform. The total volume of flushing fluid (MEG and inhibited seawater) discharged would be up to 200% of the total volume of the system, which totals ~ 11 m^3.

Post Tie-In Leak Test

The T-DIS and associated production and MEG spools include a number of new connections which need to be tested to ensure they will be leak free during operation.

The leak test can be undertaken separately for the production and MEG systems or combined (preferred option) using a temporary crossover loop (Figure 3-3). During the leak test, the system will be pressurised to a set testing pressure to confirm integrity of connections, before depressurising back to ~2 bar above seabed ambient pressure and isolated. Leak testing will occur within a closed-system, with fluids either returning to the platform or a vessel and resulting in no discharges to the marine environment.

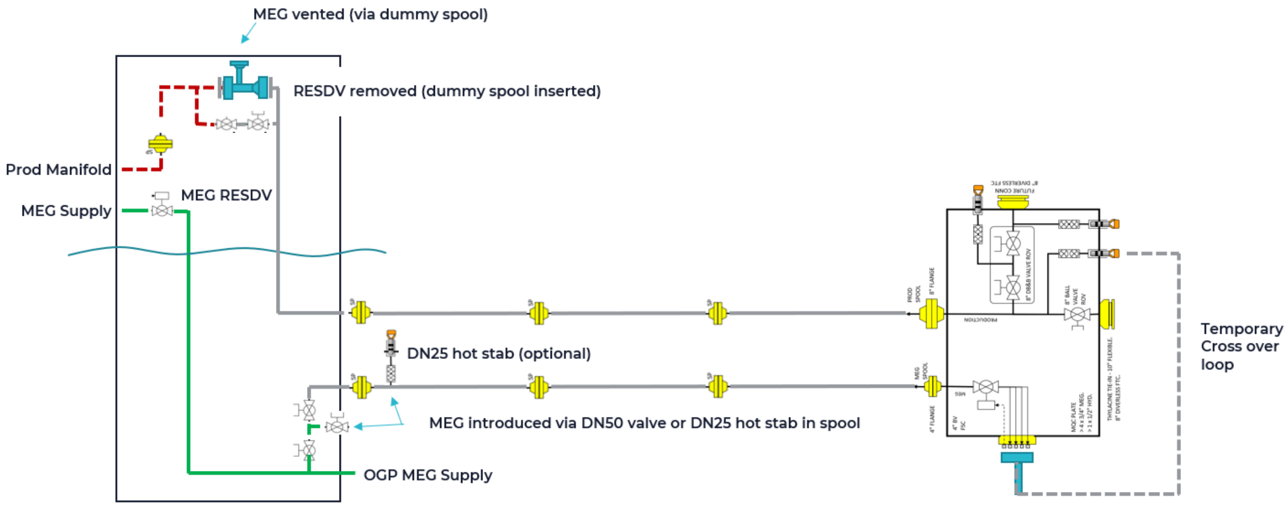


Figure 3-3 Combined pressure test

3.4.3 As-left survey

Following installation, an as-left survey will be undertaken to document the final position and orientation of the T-DIS and position of the rigid spools, concrete mattresses and sand/cement bags, as well as any spool span rectification. The as-left survey will be a visual survey, conducted using ROV.

The new infrastructure will be added to the Operations CMMS system and maintained under the Otway Operations EP.

3.4.4 Routine Operations

3.4.4.1 Vessel Operations

The activity will be undertaken by a construction support vessel (CSV), likely to be the Skandi Singapore or similar (Figure 3-4), utilising saturation diving operations (Section 3.4.4.2) and ROV operations (Section 3.4.4.3).

Figure 3-4: Skandi Singapore Construction Support Vessel

A safety exclusion zone will be established around the vessel for the duration of the activity, and the activity will be listed in a Notice to Mariners.

The CSV will use dynamic positioning (DP) to maintain position during activities, therefore no anchoring is required. No refuelling or bunkering will occur in the field. Crew change will not be required.

3.4.4.2 Diving Operations

The CSV has an integrated saturation diving spread to support diving for installation activities. The 18-man integrated saturation diving system is rated to a water depth of 350 m and has one diving bell to transport divers to and from the surface to the work area.

A hypobaric rescue vessel (HRV) will be on standby close to the CSV (outside of the Operational Area) throughout the activity.

3.4.4.3 ROV Operations

Underwater remotely operated vehicles (ROVs) are deployed and controlled from the CSV to undertake and or assist installation activities. In the event that an ROV is required to temporarily park on the seabed, it will be within the Operational Area.

The CSV will be equipped with two work class ROVs. These ROVs are equipped with a video camera and lighting and have the ability to monitor the subsea infrastructure and surrounding environment. ROVs are also used to deploy specialist tooling and equipment. Tooling and equipment may be operated with the use of electrics or hydraulics. Hydraulics on ROVs are closed system, where hydraulic fluid is circulated, without being released, to move components.

3.4.4.4 SIMOPS

The Thylacine-A Wellhead Platform and Otway pipeline system will remain operational throughout the activity, unless a shutdown is required (such as if MEG riser / tee branch valve replacement is required). The section of the

Otway pipeline system close to the Thylacine-A Wellhead Platform is protected from dropped objects by concrete mattresses.

Brownfield construction activities on the Thylacine-A Wellhead Platform may be undertaken concurrently with the Phase 5 Early Dive Campaign. This will involve daily helicopter flights to the platform and the presence of a platform supply vessel (PSV).

3.5 Future activities

Following completion of the activities described in this EP, the T-DIS and associated infrastructure will remain on the seabed in preparation for future tie-in of the Thylacine development wells, and will be managed under the Otway Operations EP. The equipment that forms part of this EP will be added to Beach's CMMS to facilitate inspection and maintenance of the equipment to ensure it remains in good condition and repair and so as to facilitate future removal and decommissioning. This meets the requirements of the OPGGS Act s572(2). The Otway Operations EP will also detail the requirements to meet OPGGS Act s572(3) to remove all structures when they are no longer used.

3.6 Decommissioning

Decommissioning of the Otway Gas Development will be undertaken in accordance with the relevant Commonwealth and Victorian State regulatory requirements in force at the time of decommissioning or as described in an approved decommissioning EP. In accordance with EPBC referral 2002/621 (Condition 5) a decommissioning plan will be submitted for approval prior to decommissioning of any components associated with the development (i.e. the platform, wells, flowlines or any associated infrastructure). Section 572(3) of the OPGGS Act imposes an obligation on the duty holder to remove all structures, equipment and property within the title area that will not be used for the purposes of petroleum production, and there may be requirements under the Environmental Protection (Sea Dumping) Act 1981 (Cth) that apply to some decommissioning activities.

Beach fully acknowledges that the default position through Section 572 of the OPGGS Act and NOPSEMA Policy Section 572 Maintenance and Removal of Property (N-00500-PL1903, A720369, November 2020) is for removal of all property when it is no longer in use and that any deviations from this position will need to be evaluated and approved by NOPSEMA. Beach will incorporate the requirements of this policy into the Otway Offshore decommissioning concept study.

The decision to commence decommissioning activities will be based on whether Beach can continue to economically commercialise the extracted reservoir fluids from the gas fields in a responsible manner that protects people, communities and environmental values. The current variation to the field development plan has an end of field life of 2035.

3.6.1 Decommissioning Planning Process

Decommissioning is covered by Beach's OEMS Element 6. The suspension of assets is divided into:

1. Temporary suspension;
2. Mothballing;
3. Preliminary abandonment; and
4. Final abandonment and removal.

The requirement to initiate preliminary or final abandonment for assets of the scale of the Otway Gas Development is managed through a dedicated capital project and the decommissioning process requires a multi-disciplinary team. Final approval to undertake the work must be granted by the regional General Manager

Operations and General Manager Development. Consideration for the environmental approvals process is part of the decommissioning standard.

3.6.2 Decommissioning Environmental Approvals

Decommissioning guidelines will be considered during the decommissioning planning process, including the former Commonwealth Department of Industry, Innovation and Science (DIIS) (now the Department of Industry, Science, Energy and Resources, DISER) released an Offshore Petroleum Decommissioning Guideline (January 2018); and the NOPSEMA Decommissioning Compliance Strategy (April 2021).

Issues likely to be explored in the decommissioning EP (and addressed through the stakeholder consultation process) include:

- Decommissioning options (leave platform and pipeline in situ vs complete removal vs partial removal);
- If equipment is left in situ:
  - Ongoing monitoring requirements;
  - Impacts to commercial fisheries of remaining infrastructure;
  - Clearance below sea level for commercial fishers (current regulatory requirements in Commonwealth waters for decommissioned platforms are to provide a 30 m clearance from the sea surface in the water column); and
- Re-purposing of decommissioned infrastructure to create marine habitat for recreational fishers and divers, either in situ or moved to more accessible location/s.

The timeframe allocated to planning for decommissioning allows for the preparation of a Cessation of Production (CoP) EP and/or decommissioning EP and to have each assessed by NOPSEMA sufficiently in advance of activities commencing to ensure each EP is accepted prior to activities commencing.

Beach has undertaken some initial decommissioning planning and developed a preliminary decommissioning methodology and cost estimate for the development in line with current decommissioning practices in Australia (Worley Parsons 2015).

Aspects of the preliminary plan considers:

- Platform decommissioning: all or partial removal of equipment above the seabed, transportation to shore for dismantling and recycling or reuse as scrap.
- Well decommissioning: removal of wellheads and tubing where feasible. Where feasible, the well will be sealed, and the conductor and casing strings cut off below the seabed. All conductor and casing strings above that point will be removed.
- Subsea equipment decommissioning: removal of equipment such as the manifold with transportation to shore for recycling. Pipeline decommissioning - thorough cleaning and disconnection. The offshore pipeline is likely to be flooded and left open ended on the seabed.

3.6.3 Maintaining Inventory

All property owned by Beach, including its condition, is listed in an asset register that is retained within the CMMS and maintained by the Technical Services Team. If any equipment is retained in the title areas after the decommissioning process is complete, the assets register will be updated to reflect this.

All equipment associated with the Otway Gas Development is being inspected, monitored and maintained in accordance with the CMMS to ensure that it is in good condition and can be safely decommissioned when required.

3.7 Summary of Planned Emissions, Discharges and Disturbance

A summary of planned emissions, discharges and disturbance from activities covered by this EP is provided in Table 3-2.

Table 3-2 Planned Emissions, Discharges and Disturbances

Activity	***Description***	***Planned Emission, Discharge or Disturbance***
Installation of new subsea infrastructure		
Lowering of infrastructure into position	Transponders Temporary wet-parking (contingency)	Benthic disturbance
	USBL transponders used for positioning	Underwater sound emissions
T-DIS installation	Installation of the T-DIS on the seabed Installation aids such as alignment frame and clump weights.	Benthic disturbance
Rigid spool installation	Installation of rigid spools Installation of concrete mattresses, sand / cement bags and grout bags and jetting for stabilisation and span rectification Installation aids such as pipe handling frames and clump weights	Benthic disturbance
	Cutting tools	Underwater sound emissions
Pre-commissioning Philosophy	Minor discharges of MEG and inhibited potable water or seawater Flushing fluid - MEG and inhibited potable water or seawater (contingency)	Planned marine discharges – pre-commissioning
As-left survey	Visual survey with ROV	None
Support Operations		
Vessels	• Food scraps, sewage and grey water • Discharge of bilge water treated to contain <15ppm oil in water • Uncontaminated engine cooling water • Water and approved cleaning chemical	Planned marine discharge – vessel
	Fuel combustion products discharged to atmosphere	Atmospheric emissions
	Deck and navigational lighting	Light emissions
	Hold position and standby	Underwater sound emissions
	Safety exclusion zone	Physical presence – other marine users
ROV operations	Hydraulic control fluid - closed system	None

4 Description of the Environment

The physical, biological and socio-economic environment that may be affected (EMBA) is described in this section, together with the values and sensitivities.

4.1 Regulatory context

The OPGGS(E)R define 'environment' as the ecosystems and their constituent parts, natural and physical resources, qualities and characteristics of areas, the heritage value of places and includes the social, economic and cultural features of those matters. In accordance with the Regulations, this document describes the physical, ecological, and social components of the environment.

Under the OPGGS(E)R, the EP must describe the EMBA (Regulation 13(2a)), including details of the particular values and sensitivities (if any) within that environment (Regulation 13(2b)), Identified values and sensitivities must include, but are not necessarily limited to, the matters protected under Part 3 of the EPBC Act.

A greater level of detail is provided for those particular values and sensitivities as defined by the Regulations 13(3) of the OPGGS(E)R which states that particular relevant values and sensitivities may include any of the following:

a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act;

b) the national heritage values of a National Heritage place within the meaning of that Act;

c) the ecological character of a declared Ramsar wetland within the meaning of that Act;

d) the presence of a listed Threatened species or listed Threatened Ecological Community within the meaning of that Act;

e) the presence of a listed Migratory species within the meaning of that Act;

f) any values and sensitivities that exist in, or in relation to, part or all of:

   i. Commonwealth marine area within the meaning of that Act; or
   ii. Commonwealth land within the meaning of that Act.

With regards to 13(3)(d) and (e) more detail has been provided where listed Threatened or Migratory species have a spatially defined biologically important area (BIA), habitat critical to survival or identified biologically important behaviour such as breeding, foraging, resting or migration.

With regards to 13(3)(f) more detail has been provided in Section 4.4.13 for Key Ecological Features (KEFs) as they are considered as conservation values of the Commonwealth marine area; and in Section 4.4.2 for Australian Marine Parks (AMPs) as they are enacted under the EPBC Act.

4.2 Environment that may be affected

The EMBA by the activity has been defined as an area where a change to ambient environmental conditions may potentially occur as a result of planned activities or unplanned events. It is noted that a change does not always imply that an adverse impact will occur; for example, a change may be required over a particular exposure value or over a consistent period of time for a subsequent impact to occur.

Table 4-1 and Figure 4-1 detail the EMBA zones associated with the Activity that are used to describe the environmental context relevant to the Activity and to support the impact and risk assessments.

Table 4-1: Description of EMBA Zones

EMBA Zones	***Description***
Operational area	For the activity, the Operational Area is a 1 km radius around the T-DIS installation location (as described in Section 3.2). Planned operational discharges, physical presence and seabed disturbance that occur during the activity will be within the operational area. The EPBC Protected Matters Report for the operational area is in Appendix A.2.
Spill EMBA	The spill EMBA extends between approximately Wilsons Prom (VIC) in the east, Beachport (SA) in the west and King Island in the south (Figure 4-1). Section 6.14.2 details how the spill EMBAs was developed. The EPBC Protected Matters Report for the spill EMBA is in Appendix A.1.

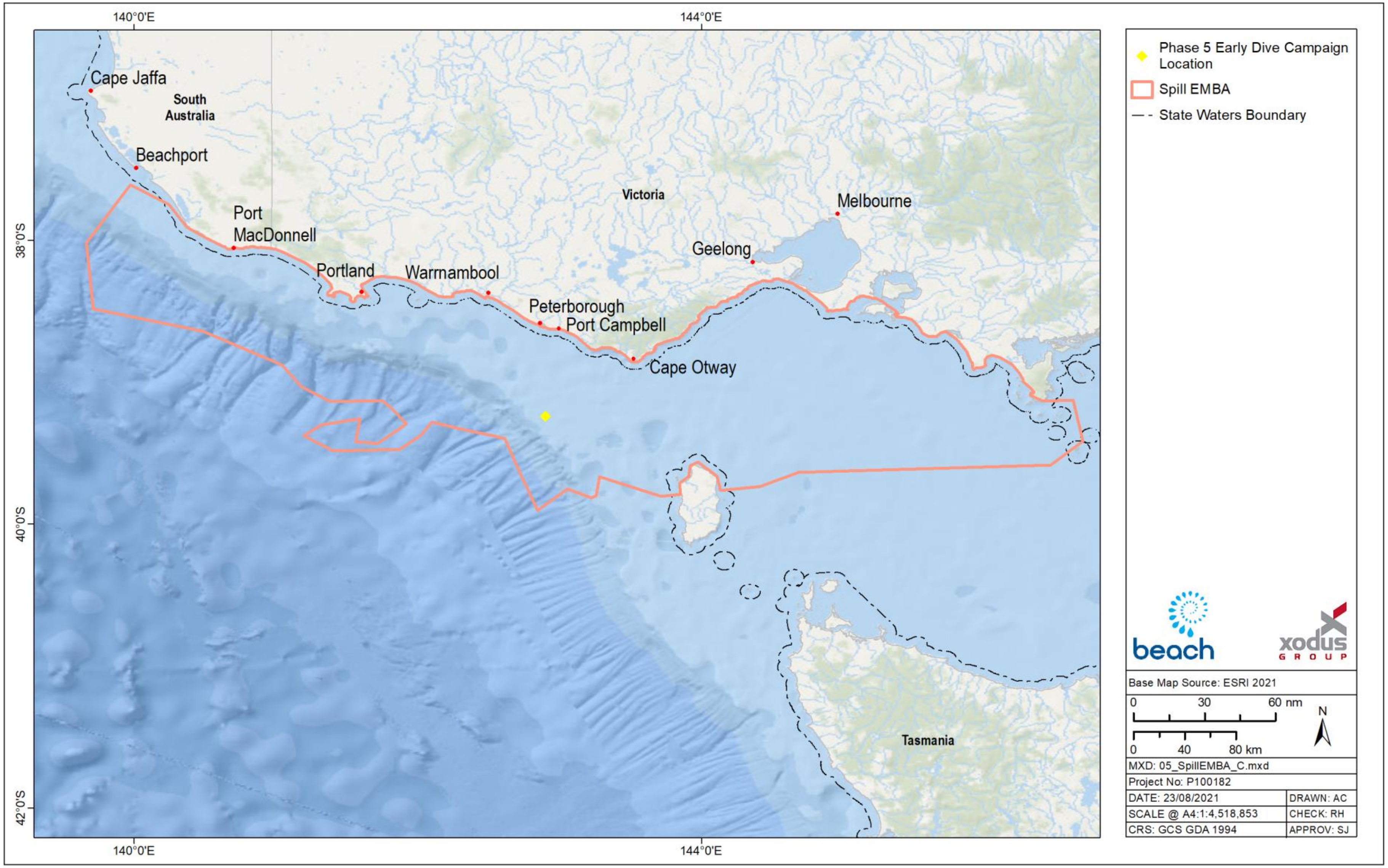


Figure 4-1: Spill EMBA for the Otway Phase 5 Early Dive Installation Campaign

4.3 Regional environmental setting

The operational area and spill EMBA are located within the South-East Commonwealth Marine Region (SEMR), which extends from the south coast of New South Wales to Kangaroo Island in South Australia and around Tasmania (DNP, 2013).

There are significant variations in seafloor features throughout the SEMR including seamounts, canyons, escarpments, soft sediments and rocky reefs, which support high levels of biodiversity and species endemism (DoE 2015a). Compared to other marine areas, the SEMR is relatively low in nutrients and primary production; however localised areas of high productivity are known to occur. There are areas of continental shelf, which includes Bass Strait and Otway Shelf, which have rocky reefs and soft sediments that support a wide range of species. The shelf break increases currents, eddies and upwelling, and the area is especially biodiverse, including species that are fished recreationally and commercially. There are seafloor canyons along the continental shelf which provide habitat for sessile invertebrates such as temperate corals. The Bonney Coast Upwelling KEF is an area of seasonally higher primary productivity which attracts baleen whales and other species (including EPBC-listed species) which feed on the plankton swarms (krill).

The SEMR has a high diversity of species and also a large number of endemic species. The fish fauna in the region includes around 600 species, of which 85% are thought to be endemic. Additionally, approximately 95% of molluscs, 90% of echinoderms, and 62% of macroalgae (seaweed) species are endemic to these waters (DNP, 2013).

4.4 Conservation values and sensitivities

The following section details the conservation values and sensitivities identified within the spill EMBA.

No conservation values or sensitivities were identified in the operational area.

4.4.1 World Heritage Properties

The PMST Reports (Appendix A) did not identify any World Heritage Areas in the operational area or spill EMBA.

4.4.2 Australian Marine Parks

The South-east Commonwealth Marine Reserves (SEMR) Network was designed to include examples of each of the provincial bioregions and the different seafloor features in the region (DNP, 2013). Provincial bioregions are large areas of the ocean where the fish species and ocean conditions are broadly similar. Ten provincial bioregions in the SEMR are represented in the network. As there is a lack of detailed information on the biodiversity of the deep ocean environment, seafloor features were used as surrogates for biodiversity to design the Marine Reserves Network. The SEMR network contains representative examples of the 17 seafloor features found in the Commonwealth waters of the region.

No Australian Marine Parks (AMPs) were identified within the operational area (Appendix A). Three AMPs were identified within the spill EMBA PMST report and are shown in Figure 4-2, the AMPs are:

- Apollo
- Beagle
- Zeehan

All the AMPs, (excluding a Section of Zeehan Marine Park) in whole or part, are classified as International Union for Conservation of Nature (IUCN) VI – Multiple Use Zones, in which a wide range of sustainable activities are allowed if they do not significantly impact on benthic (seafloor) habitats or have an unacceptable impact on the values of the area. Allowable activities include commercial fishing, general use, recreational fishing, defence and emergency response. Some forms of commercial fishing, excluding demersal trawl, Danish seine, gill netting (below 183 m) and scallop dredging, are allowed, provided that the operator has approval from the Director of National Parks and abides by the conditions of that approval.

The Zeehan Commonwealth Marine Reserve also has an IUCN VI - Special Purpose Zone, which allows for limited mining and low-level extraction of natural resources. Permitted activities are similar to Multiple Use Zones; however, commercial fishing is not permitted.

The SEMR are managed under the (SEMR) Network Management Plan (DNP, 2013).

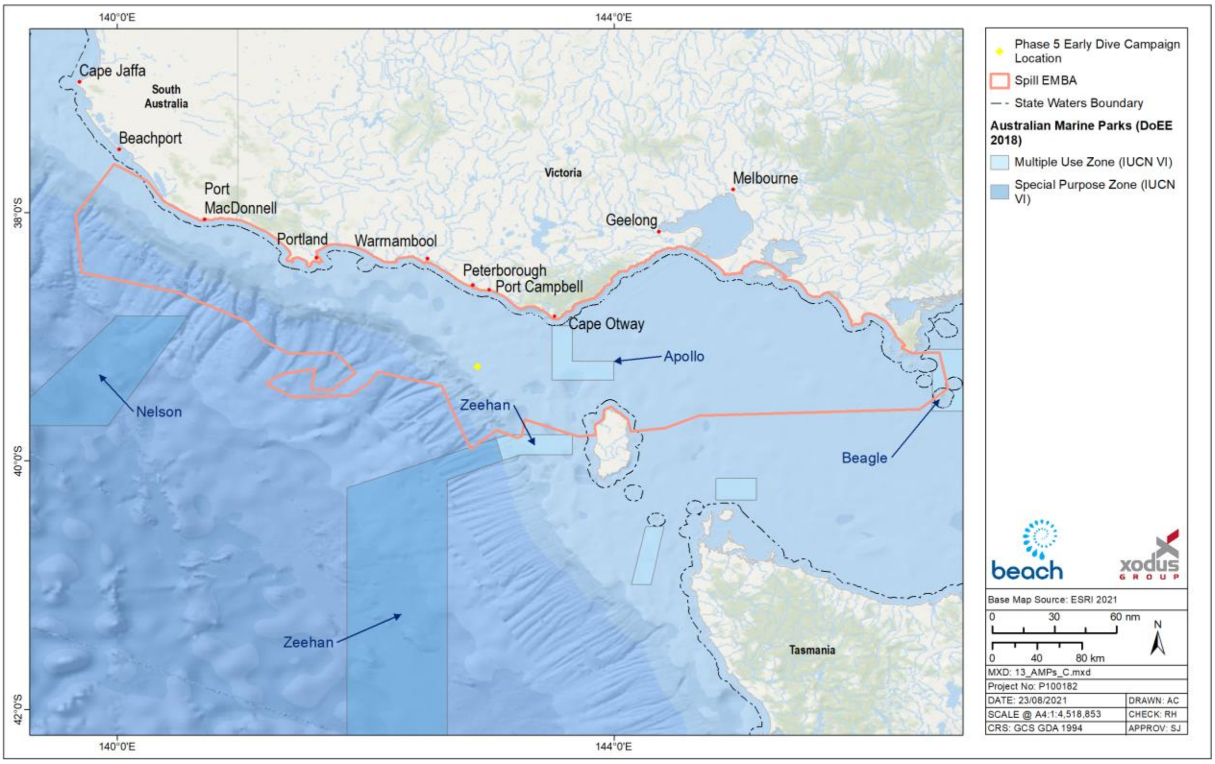


Figure 4-2: Australian Marine Parks within the spill EMBA

4.4.2.1 Apollo AMP

The Apollo AMP is located off Apollo Bay on Victoria's west coast in waters 80 m to 120 m deep on the continental shelf. The reserve covers 1,184 km^2 of Commonwealth ocean territory (DNP, 2013). The reserve encompasses the continental shelf ecosystem of the major biological zone that extends from South Australia to the west of Tasmania. The area includes the Otway Depression, an undersea valley that joins the Bass Basin to the open ocean. Apollo AMP is a relatively shallow reserve with big waves and strong tidal flows; the rough seas provide habitats for fur seals and school sharks (DNP, 2013).

The major conservation values of the Apollo AMP are:

- ecosystems, habitats and communities associated with the Western Bass Strait Shelf Transition and the Bass Strait Shelf Province and associated with the seafloor features: deep/hole/valley and shelf.
- important migration area for blue, fin, sei and humpback whales.
- important foraging area for black-browed and shy albatross, Australasian gannet, short-tailed shearwater and rested tern.
- cultural and heritage site - wreck of the MV City of Rayville (DNP, 2013).

4.4.2.2 Beagle AMP

The Beagle AMP is an area in shallow continental shelf depths of about 50 m to 70 m, which extends around south-eastern Australia to Tasmania covering an area of 2,928 km^2 (DNP, 2013). The reserve includes the fauna of central Bass Strait; an area known for its high biodiversity. The deeper water habitats are likely to include rocky reefs supporting beds of encrusting, erect and branching sponges, and sediment composed of shell grit with patches of large sponges and sparse sponge habitats.

The reserve includes islands that are important breeding colonies for seabirds and the Australian fur seal, and waters that are important foraging areas for these species. The species-rich waters also attract top predators such as killer whales and great white sharks.

The major conservation values of the Beagle AMP are:

- Ecosystems, habitats and communities associated with the Southeast Shelf Transition and associated with the seafloor features: basin, plateau, shelf and sill.
- Important migration and resting areas for southern right whales.
- It provides important foraging habitat for the Australian fur-seal, killer whale, great white shark, shy albatross, Australasian gannet, short-tailed shearwater, Pacific and silver gulls, crested tern, common diving petrel, fairy prion, black-faced cormorant and little penguin.
- Cultural and heritage sites including the wreck of the steamship SS Cambridge and the wreck of the ketch Eliza Davies (DNP, 2013).

4.4.2.3 Zeehan AMP

The Zeehan AMP covers an area of 19,897 km^2 to the west and south-west of King Island in Commonwealth waters surrounding north-western Tasmania (DNP, 2013). It covers a broad depth range from the shallow continental shelf depth of 50 m to the abyssal plain which is over 3,000 m deep. The reserve spans the continental shelf, continental slope and deeper water ecosystems of the major biological zone that extends from South Australia to the west of Tasmania. Four submarine canyons incise the continental slope, extending from the shelf edge to the abyssal plains. A rich community made up of large sponges and other permanently attached or fixed invertebrates is present on the continental shelf, including giant crab (*Pseudocarcinus gigas*). Concentrations of larval blue wahoo (*Seriolella brama*) and ocean perch (*Helicolenus spp*.) demonstrate the role of the area as a nursery ground.

Rocky limestone banks provide important seabed habitats for a variety of commercial fish and crustacean species including the giant crab. The area is also a foraging area for a variety of seabirds such as fairy prion, shy albatross, silver gull and short tail shearwater (DNP, 2013).

The major conservation values for the Zeehan AMP are:

- Examples of ecosystems, habitats and communities associated with the Tasmania Province, the West Tasmania Transition and the Western Bass Strait Shelf Transition and associated with the seafloor features: abyssal plain/deep ocean floor, canyon, deep/hole/valley, knoll/abyssal hill, shelf and slope.
- Important migration area for blue and humpback whales.
- Important foraging habitat for black-browed, wandering and shy albatrosses, and great-winged and cape petrels (DNP, 2013).

4.4.3 National Heritage Places

The places of National Heritage that were identified in the spill EMBA PMST Report (Appendix A) are located onshore, outside the spill EMBA (Figure 4-3), and do not include marine or coastal components. These are:

- Great Ocean Road and Scenic Environs (historic);
- Point Nepean Defence Sites and Quarantine Station Area (historic); and
- Quarantine Station and Surrounds (historic).

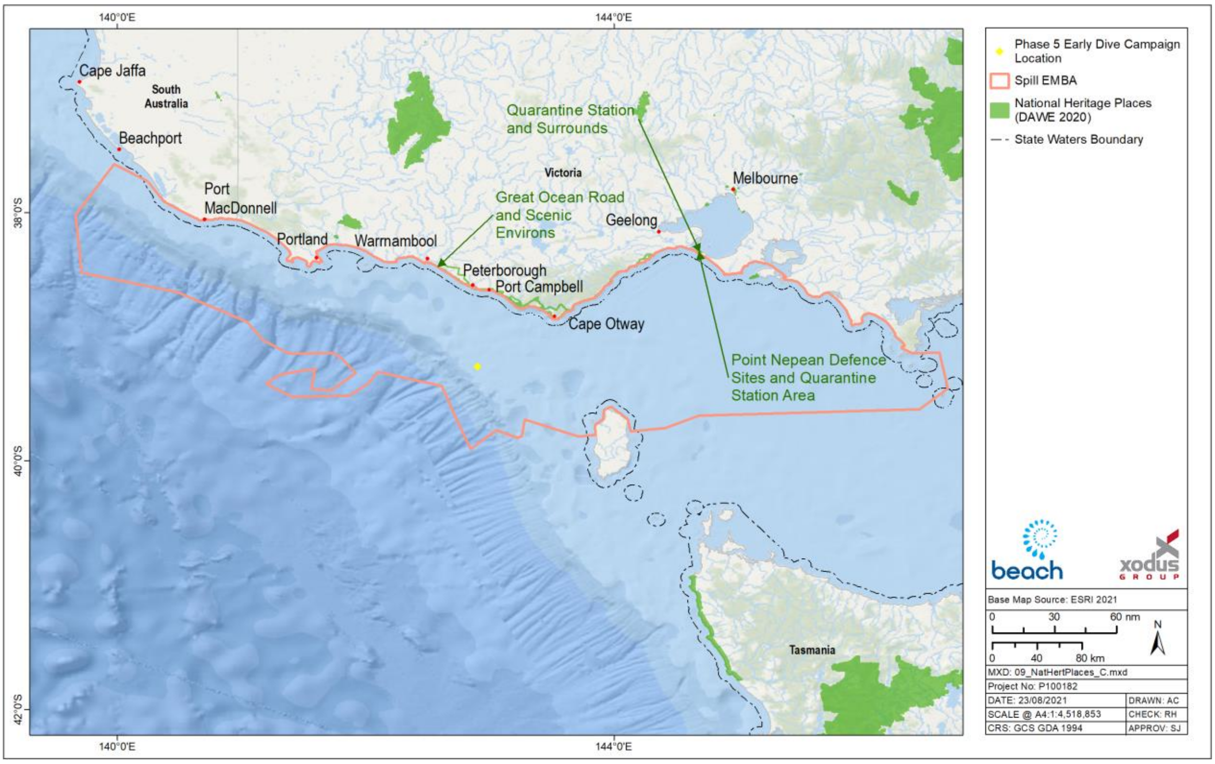


Figure 4-3: National Heritage Places present within the EMBA.

4.4.4 Commonwealth Heritage Places

The spill EMBA PMST Report (Appendix A) identified three Commonwealth Heritage Places, most of which are historic heritage places located on land and therefore are outside the spill EMBA (Figure 4-4). The three heritage places are:

- HMAS Cerberus Marine and Coastal Area (Natural, Listed place);
- Cape Northumberland Lighthouse (Historic, Listed place); and
- Sorrento Post Office VIC (Historic, Listed place).

The HMAS Cerberus Marine and Coastal Area includes natural coastal areas within the spill EMBA and is discussed further below.

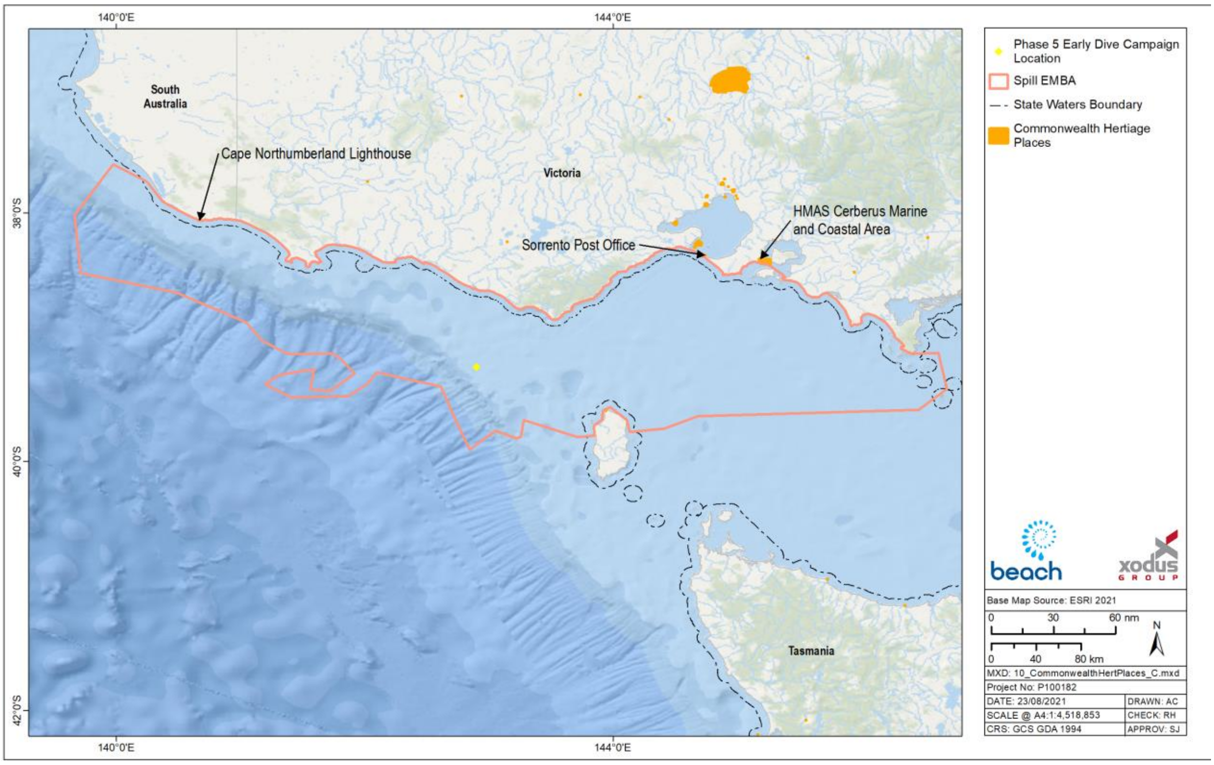


Figure 4-4: Commonwealth Heritage Places present within the spill EMBA

4.4.4.1 HMAS Cerberus Marine and Coastal Area

The Sandy Point/HMAS Cerberus area has high geomorphological, botanical and zoological significance. Sandy Point is one of the largest spit systems on the Victorian coast and one of the State's most dynamic shorelines. Western Port as a whole is a wetland of international significance listed under the Ramsar Convention on Wetlands. It is recognised as the third most important site for migratory and resident waders in Victoria behind Corner Inlet and Swan Bay. The official values of the area include (DotEE, 2004a):

- Relict spits in Hanns Inlet indicate that the sediment regime at the site has changed rapidly, possibly due to the extension of Sandy Point.
- Sandy Point supports some of the best remaining examples of Coastal Banksia Woodland, Coastal Grassy Forest, and Coastal Dune Scrub in the Greater Melbourne region. These communities have been extensively cleared and degraded in the Westernport Catchment and on the Mornington Peninsula.
- Sandy Point is one of the largest spit systems on the Victorian coast and one of the States most dynamic shorelines.
- Continuing shoreline progradation at Sandy Point reveals several stages in sand dune succession.

4.4.5 Wetlands of International Importance

The spill EMBA PMST Report (Appendix A) identified six marine or coastal Wetlands of International Importance (Ramsar-listed wetlands) (Figure 4-5). The ecological character and values of these Ramsar listed wetlands areas are described in the following sections. As defined in Regulations 13(3)(c) of the OPGGS(E)R, particular relevant values and sensitivities include the ecological character of a declared Ramsar wetland.

Ecological character is the combination of the ecosystem components, processes, benefits and services that characterise the wetland at a given point in time (Ramsar Convention 2005a). Changes to the ecological character of the wetland outside natural variations may signal that uses of the site or externally derived impacts on the site are unsustainable and may lead to the degradation of natural processes, and thus the ultimate breakdown of the ecological, biological and hydrological functioning of the wetland (Ramsar Convention 1996).

The ecological character description of a wetland provides the baseline description of the wetland at a given point in time and can be used to assess changes in the ecological character of these sites. Therefore, the baseline ecological character description of the Ramsar wetlands are described below. The potential to impact the ecological character of the wetlands is evaluated in the impact and risk assessments in Section 6.

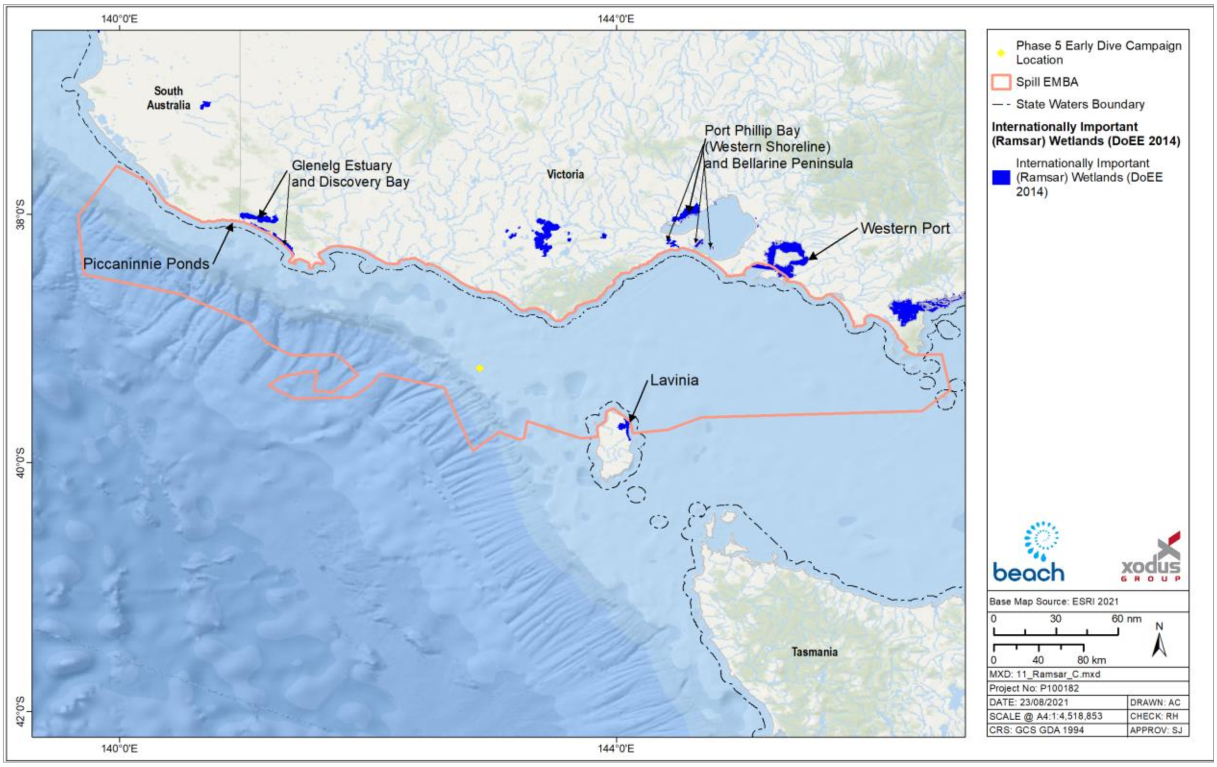


Figure 4-5: Ramsar wetlands within the spill EMBA

4.4.5.1 Corner Inlet

The Corner Inlet Ramsar Site is located approximately 250 km south-east of Melbourne and includes Corner Inlet and Nooramunga Marine and Coastal Parks, and the Corner Inlet Marine National Park. It covers 67,192 ha and represents the most southerly marine embayment and intertidal system of mainland Australia.

The major features of Corner Inlet that form its ecological character are its large geographical area, the wetland types present (particularly the extensive subtidal seagrass beds), diversity of aquatic and semi-aquatic habitats and abundant flora and fauna, including significant proportions of the total global population of a number of waterbird species (BMT WBM, 2011). The description below provides the values and baseline ecological character of the Corner Inlet Ramsar Site.

It is protected by the Corner Inlet Ramsar Site Strategic Management Plan (WGCMA, 2014), which identifies the key values as including:

- A substantially unmodified wetland which supports a range of estuarine habitats (seagrass, mud and sand flats, mangroves, saltmarsh and permanent marine shallow water).

- Presence of nationally threatened species including orange-bellied parrot, Australian grayling, fairy tern and growling grass frog.
- Non-breeding habitats for migratory shorebird species and breeding habitat for variety of waterbirds including several threatened species.
- Important habitats, feeding areas, dispersal and migratory pathways and spawning sites for numerous fish species of direct or indirect fisheries significance.
- Over 390 species of indigenous flora (15 listed species) and 160 species of indigenous terrestrial fauna (22 threatened species) and over 390 species of marine invertebrates.
- A wide variety of cetaceans and pinnipeds including bottlenose dolphins and Australian fur-seals, as well as occasional records of common dolphins, New Zealand fur-seals, leopard seals and southern right whales.
- Significant areas of mangrove and saltmarsh which are listed nationally as vulnerable ecological communities and provide foraging, nesting and nursery habitat for many species.
- Sand and mudflats, when exposed at low tide, which provide important feeding grounds for migratory and resident birds and at high tide provide food for aquatic organisms including commercial fish species (CSIRO, 2005).
- Ports and harbours – the four main ports (Port Albert, Port Franklin, Port Welshpool and Barry's Beach) service the commercial fishing industry, minor coastal trade, offshore oil and gas production and boating visitors.
- Fishing – the area supports the third largest commercial bay and inlet fishery in Victoria, including 18 licensed commercial fishermen, within an economic value of between 5 and 8 million dollars annually (DPI, 2008).
- Recreation and tourism – Corner Inlet provides important terrestrial and aquatic environments for tourism and recreational activities such as fishing, boating, sightseeing, horse riding, scuba diving, bird watching and bushwalking. Corner Inlet attracts at least 150,000 visitors each year (DNRE, 2002).
- Cultural significance to the Gunaikurnai people, with the Corner Inlet and Nooramunga area located on the traditional lands of the Brataualung people who form part of the Gunaikurnai Nation. The area has a large number of cultural heritage sites that provide significant information for the Gunaikurnai people of today about their history. The Bunurong and the Boon Wurrung peoples also have areas of cultural significance in this region.
- Thirty-one shipwrecks are present in the site.
- Research and education – the wildlife, marine ecosystems, geomorphological processes and various assemblages of aquatic and terrestrial vegetation within the Corner Inlet Ramsar Site provide a range of opportunities for education and interpretation.

4.4.5.2 Glenelg Estuary and Discovery Bay wetlands

The description below provides the values and baseline ecological character of the Glenelg Estuary and Discovery Bay Ramsar Site.

The Glenelg Estuary is a large estuarine system consisting of the main channel of the Glenelg River and a side lagoon called the Oxbow. The physical features of the area include a geological setting of Quaternary lacustrine, paludal, alluvial and coastal sediments on Quaternary aeolian sediments (DotEE, 2017a).

The Glenelg Estuary is a high value wetland for its ecological features. This wetland is of special geomorphological interest, being the only estuarine lagoon system in Victoria developed within a framework of dune calcarenite ridges. The Glenelg estuary contains the only remaining relatively undisturbed salt marsh community in western Victoria. Spits at river mouths such as those at Glenelg River provide valuable breeding sites for the little tern. This area is one of the few sites where little tern breed in Victoria.

There are ten wetland types within the Ramsar site generated by the interaction between geomorphology, hydrology and vegetation. Hydrology is a key driver in the characteristic of the site. Water sources for the Glenelg Estuary include groundwater, rainfall, river inflows and tidal exchange. Many of the wetlands in the area are groundwater dependent and are seasonally closed off from tidal exchange. During summer low river flow is unable to move displaced sand from low constructive waves creating a sand barrier. When the estuary refills with fresh water the barrier is breached and open to tidal exchange. This process creates a salt wedge comprising of three distinct layers within the estuary. One of the key geomorphic features in the Ramsar site is the dune slack system. Determined by the hydrology of the dune system, vegetation and breeding of aquatic species is influenced by variations in flooding of the dune system. The site also provides a variety of habitat for waterbird feeding, roosting and breeding. Many migratory shorebirds may use the area as 'staging' areas are important for the bird's survival (DELWP, 2017a). The connection between the marine, estuarine and freshwater components is significant for fish migration and reproduction. There are several fish species contributing to the value of the site with different migratory strategies, also supporting fisheries elsewhere in the catchment (DELWP, 2017a). There is one nationally listed ecological community and eight nationally and internationally listed species of conservation significance supported in the Ramsar site.

The western end of Discovery Bay Coastal Park at the Glenelg Estuary is popular for fishing, boating, walking and other activities. The Major Mitchell Trail meets the coast here: the river mouth marks the end of Major Mitchell's expedition of 1836. The Great South West Walk traverses the estuary. Aboriginal culture: several shell middens and surface scatters exist at Glenelg Estuary (DotEE, 2017a).

4.4.5.3 Lavinia

The description below provides the values and baseline ecological character of the Lavinia Ramsar Site.

The Lavinia Ramsar site is located on the north-east coast of King Island, Tasmania. The boundary of the site forms the Lavinia State Reserve, with major wetlands in the reserve including the Sea Elephant River estuary area, Lake Martha Lavinia, Penny's Lagoon, and the Nook Swamps.

The shifting sands of the Sea Elephant River's mouth have caused a large back-up of brackish water in the Ramsar site, creating the saltmarsh which extends up to 5 km inland. The present landscape is the result of several distinct periods of dune formation. The extensive Nook Swamps, which run roughly parallel to the coast, occupy a flat depression between the newer parallel dunes to the east of the site and the older dunes further inland. Water flows into the wetlands from the catchment through surface channels and groundwater and leaves mainly from the bar at the mouth of the Sea Elephant River and seepage through the young dune systems emerging as beach springs.

The Lavinia State Reserve is one of the few largely unaltered areas of the island and contains much of the remaining native vegetation on King Island. The vegetation communities include Succulent Saline Herbland, Coastal Grass and Herbfield, Coastal Scrub and King Island Eucalyptus globulus Woodland. The freshwater areas of the Nook Swamps are dominated by swamp forest. Nook Swamps and the surrounding wetlands contain extensive peatlands.

The site is an important refuge for a collection of regional and nationally threatened species, including the nationally endangered orange-bellied parrot. This parrot is heavily dependent upon the samphire plant, which occurs in the saltmarsh, for food during migration. They also roost at night in the trees and scrub surrounding the Sea Elephant River estuary.

Several species of birds which use the reserve are rarely observed on the Tasmanian mainland, including the dusky moorhen, nankeen kestrel, rufous night heron and the golden-headed cisticola.

The site is currently used for conservation and recreation, including boating, fishing, camping and off-road driving. There are artefacts of Indigenous Australian occupation on King Island that date back to the last ice age when the island was connected to Tasmania and mainland Australia via the Bassian Plain.

There are ten critical components and processes identified in the Ramsar site; wetland vegetation communities, regional and national rare plant species, regionally rare bird species, King Island scrubtit, orange-bellied parrot, water and sea birds, migratory birds, striped marsh frog and the green and gold frog. Elements essential to the site are the marine west coast climate, mild temperatures along with wind direction and speed. Sandy deposits dominant the site, inland sand sheets cover majority of the western area of the site. Between these sand sheets and the eastern coast there is an important geoconservation feature, several sand dunes. The dunes impede drainage from inland causing extensive swamps, lakes and river reflections. Terrestrial vegetation communities are important in providing the overall structure by buffering and supporting habitat (PWS, 2000). Wetland vegetation in the Ramsar site include swamp forest and forested peatlands are rare and vulnerable in the region. Along with other types the vegetation, the wetland provides support and provides habitat for rare flora and fauna highlighting the significance of the wetlands. Six wetland associated species have been recorded within the site. Rare bird and frog species are dependent on the wetland habitat along with ten migratory birds and other water and sea birds. Benefits provided by the Lavinia Ramsar site include aquaculture (oyster farming), tourism, education and scientific value.

There has been considerable damage caused to the saltmarsh community by vehicle disturbance in the Sea Elephant Estuary and the coastal strip (PWS, 2000). Vegetation clearance in parts of the catchment upstream as contributed to altered water balance due to less evapotranspiration of rainfall and build-up of the groundwater. There are threats to flora and fauna by invasive weeds and fungus. Although aquaculture plays a role in the Lavinia benefits risk from inputs of nutrients from feeding and occasional opening of the barred estuary for tidal flushing although with farm vehicles disturbance can impact the site.

4.4.5.4 Piccaninnie ponds karst wetlands

The description below provides the values and baseline ecological character of the Piccaninnie ponds karst wetlands Ramsar Site.

The Piccaninnie Ponds Karst Wetlands are an example of karst spring wetlands, with the largest and deepest of the springs reaching a depth of more than 110 m. The majority of the water comes from an unconfined regional aquifer and is consistently 14-15°C. The karst springs support unique macrophyte and algal associations, with macrophyte growth extending to 15 m below the surface as a result of exceptional water clarity. A number of different wetland types exist on the site, including a large area of peat fens.

There are four distinct areas of the Ramsar site. Piccaninnie Ponds (also known as Main Ponds) consists of three interconnected bodies of water - First Pond, The Chasm and Turtle Pond - rounded by an area of shrub dominated swamp. Western Wetland consists of dense closed tea-tree and paperbark shrubland over shallow dark clay on limestone soils. Eastern Wetland includes the spring-fed Hammerhead Pond. Pick Swamp, on the extreme west of the site, includes areas of fen, marshes and sedgelands as well as the spring-fed Crescent Pond on peat soils.

The system is an important remnant of an extensive system of wetlands that once occupied much of the south-east of South Australia. The major groundwater discharge points are Main Ponds, Hammerhead Pond and Crescent Pond. Water principally leaves the site via Outlet Creek and the Pick Swamp drain outlet, which connect the site to the sea. There are a number of fresh groundwater beach springs located on the site.

The geomorphic and hydrological features of the site produce a complex and biologically diverse ecosystem which supports considerable biodiversity, including a significant number of species of national and/or international conservation value. These include the orange-bellied parrot, Australasian bittern and Yarra pygmy perch.

The site attracts 20,000 visitors annually for cave diving, snorkelling, bushwalking, educational activities and birdwatching. The site also has spiritual and cultural value. The Traditional Owners of the land, the Bunganditj (Boandik) and local Indigenous people have a strong connection with the site. Traditionally the site provided a good source of food and fresh water, and evidence of previous occupation still exists (DotEE, 2017b).

The site represents two rare wetland types; karst and fen peatlands. Karst and other subterranean systems are recognised as of global importance and represents one of the few remaining permanent freshwater areas in south east of South Australia. The biota of karst wetlands contributes to the unique element of the regional biodiversity. The site falls within a national biodiversity hotspot and supports nationally and internationally listed species of significance including the critically endangered orange-bellied parrot. The site is also important spawning grounds for species within the freshwater wetlands as well as nearby marine environments. The climate, hydrological and geomorphic components provide a unique habitat. The wetlands are continually fed by groundwater discharge. Water quality in the Main Ponds are characterised by low turbidity and high nitrogen and water clarity. The vegetation is characterised by distinct zones in the karst system while the peatland fens harbour different aquatic species. The site maintains the hydrological regime through constant groundwater discharge. The geomorphology and hydrology of the site support the unique wetlands, provide physical habitat for waterbirds and other species. There are many potential threats to the site including threats to groundwater quality, land clearance, water quality, tourism and introduced species, most of which are controlled under current management (Butcher et al, 2011a).

4.4.5.5 Port Philip Bay (Western shoreline) and Bellarine Peninsula

The Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site is in the western portion of Port Phillip Bay, near the city of Geelong in Victoria. The description below provides the values and baseline ecological character of the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site.

The Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site provides important connective habitat for migratory bird species, habitat for fauna staging and foraging, is home to indigenous cultural sites, provides use of resources, and a site for commercial and recreational activities and education initiatives. The ecological character of the Ramsar site is reliant on the management of human activities and health of environment and water ways. In Victoria, the Victorian Waterway Management Strategy (VWMS) guides the management of rivers, estuaries and wetlands. The Ramsar site Management Plan (DELWP, 2018) aligns with Actions in Water for Victoria by improving waterway health and knowledge of waterways and catchments. Since the requirement for a reduction in nitrogen to ensure the health of the Bay, Melbourne water has undertaken extensive management and monitoring which aimed to maintain the ecological character of the Ramsar Site, specifically targeting six populations: growling grass frog, migratory shorebirds, waterfowl, pied cormorant, straw-necked ibis, whiskered tern (DELWP, 2018).

The Port Phillip Bay Ramsar site consists of a number of component areas that include: parts of the shoreline, intertidal zone and adjacent wetlands of western Port Phillip Bay, extending from Altona south to Limeburners Bay; and parts of the shoreline, intertidal zone and adjacent wetlands of the Bellarine Peninsula, extending from Edwards Point to Barwon Heads and including the lower Barwon River. It is protected under the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site Management Plan (DELWP, 2018), which defines the key values as;

- Representativeness – it includes all eight wetlands types.
- Natural function – the interactions of physical, biological and chemical components of wetlands that enable them to perform certain natural functions and making them a vital element of the landscape.

- Flora and fauna – contains the genetic and ecological diversity of the flora and fauna of the region, with at least 332 floral species (22 state threatened species) and 304 species of fauna (29 threatened species).
- Waterbirds – provides habitat for migratory shorebirds, including some of international and national importance.
- Cultural heritage – many aboriginal sites, particularly shell middens and artefact scatters have been found at the site.
- Scenic – provide vistas of open water and marshland in a comparatively pristine condition.
- Economic – use of natural resources in agriculture, fisheries, recreation and tourism.
- Education and interpretation – offers a wide range of opportunities for education and interpretation of wildlife, marine ecosystems, geomorphological processes and various assemblages of aquatic and terrestrial vegetation.
- Recreation and tourism – provides activities such as recreational fishing, birdwatching, hunting, boating, swimming, sea kayaking and camping and activities by commercial operators.
- Scientific – site for long-term monitoring of waterbirds and waders.

4.4.5.6 Western Port

The description below provides the values and baseline ecological character of the Western Port Ramsar Site.

Western Port is approximately 60 km south-east of Melbourne, Victoria. In 1982, a large portion was specified of international importance especially as a Waterfowl Habitat (Rasmar Convention). The area consists of large shallow intertidal areas divided by deeper channels with an adjacent narrow strip of coastal land.

Western port Bay is valued for its terrestrial and marine flora and fauna, cultural heritage, recreational opportunities and science value. The area has substantial intertidal areas supported by mangroves, saltmarsh, seagrass communities and unvegetated mudflats, which are significant for its shorebird habitat. Additionally, the saltmarsh and mangroves filter pollutants, trap and process nutrients, stabilise sediments and protect the shoreline from erosion (DSE, 2003). The intertidal mudflats provide significant food source for migratory waders, making it one for the most significant areas in south-east Australia for these birds. The interaction between critical processes and components provide habitat for many waterbirds. The mangrove and saltmarsh vegetation are reported to be of regional, national and international significance because of the role in stabilising the coastal system, nutrient cycling in the bay and providing wildlife habitat. (Ross, 2000). There are three marine parks within the Ramsar sight (Yaringa, French Island and Churchill Island Marine Nation Parks). The Ramsar site is managed by DSE, Parks Victoria, the Victorian Channels Authority, Phillip Island Nature Park, Department of Defence and committees of Management under Crown Lands. There are numerous community and government projects that help monitor, protect, raise awareness and educate the community about the Rasmar site wetland (Brown and Root, 2010).

Western Port is protected under the Western Port Ramsar Site Management Plan (DELWP, 2017d), which describes the values as:

- Supports a diversity and abundance of fish and recreational fishing.
- The soft sediment and reef habitats support a diversity and abundance of marine invertebrates.
- Supports bird species, including 115 waterbird species, of which 12 are migratory waders of international significance.

- Provides important breeding habitat for waterbirds, including listed threatened species.
- Provides habitat to six species of bird and one fish species that are listed as threatened under the EPBC Act.
- Rocky reefs comprise a small area within the Ramsar site, but includes the intertidal and subtidal reefs at San Remo, which support a high diversity, threatened community and Crawfish Rock, which supports 600 species (Shapiro, 1975).
- The Western Port Ramsar Site has three Marine National Parks, one National Park and has been designated as a Biosphere Reserve under the UNESCO's Man and the Biosphere program.
- The Ramsar site is within the traditional lands of the Boonwurrung, who maintain strong connections to the land and waters.
- The site contains the commercial Port of Hastings that services around 75 ships per year and contributes around $67 million annually to the region's economy.

4.4.6 Nationally Important Wetlands

The spill EMBA PMST Report (Appendix A) identified 10 marine or coastal Nationally Important Wetlands (Figure 4-6).

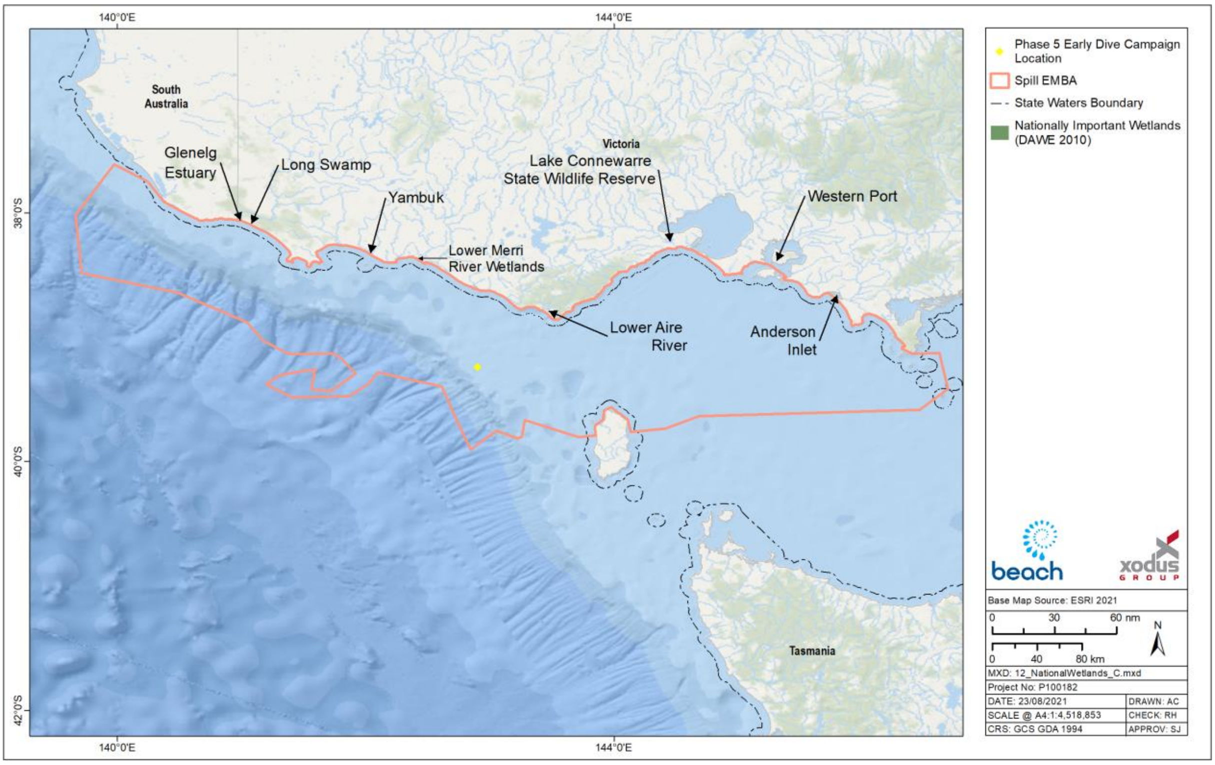


Figure 4-6: Nationally Important Wetlands within the spill EMBA

4.4.6.1 Anderson Inlet

Anderson Inlet is one of the largest estuaries on the Victorian coast. The inlet mouth is permanently open to the sea so that flushing of the estuary constantly occurs. The inlet is of high value for its fauna, including 23 waterbird species. It is popular for recreational fishing, camping, sailing, power-boating and water-skiing.

4.4.6.2 Lake Connewarre State Wildlife Reserve

The Lake Connewarre State Wildlife Reserve consists of an extensive estuarine and saltmarsh system drained by the Barwon River. It includes a large permanent freshwater lake, a deep freshwater marsh, several semi-permanent saline wetlands and an estuary.

Lake Connewarre State Game Reserve is the largest area of native vegetation remaining on the Bellarine Peninsula. The Lake Connewarre State Game Reserve consists of a wide variety of wetland habitats which support a large and diverse waterbird population and contain a significant area of natural vegetation in this part of the South East Coastal Plain.

4.4.6.3 Lower Aire River Wetlands

These Victorian wetlands consist of three shallow freshwater lakes, brackish to saline marshes and an estuary on the Aire River floodplain. This floodplain occurs at the confluence of the Ford and Calder Rivers with the Aire River. It is surrounded by the Otway Ranges and dune-capped barrier along the ocean shoreline.

The Lower Aire River Wetlands have extensive beds of Common Reed and groves of Woolly Tea-tree which can support large numbers of waterbirds. These wetlands act as a drought refuge for wildlife.

Lake Hordern is considered to be of State significance for its geomorphology.

4.4.6.4 Lower Merri River Wetlands

The Lower Merri River Wetlands consist of two connected wetlands developed in a swale between calcareous dune ridges and fed by the Merri River. These wetlands are of high value for their avifauna. There are large areas of Common Reed *Phragmites australis* with Spiky Club-sedge *Schoenoplectus pungens*, saltmarsh and mudflats.

The Lower Merri River Wetlands are of high value for their geomorphology and are a well preserved example of interdunal wetlands fed by a small drainage system.

4.4.6.5 Piccaninnie Ponds

Large spring-fed limestone wetlands bounded by coastal dunes. The site comprises: First Pond, approximately 10 m deep; Turtle Pond, 6 m deep basin at the end of a wide channel; and a 90 m deep chasm which leads into a chamber known as the Cathedral.

The ponds are a unique karst feature of the South East region and are world renowned for cave diving. The wetland is the largest rift in the Gambier Embayment. The site is the only and largest remnant of coastal peat fen reserved in South Australia, and one of a few of its type reserved in Australia.

4.4.6.6 Powlett River Mouth

The Powlett River Mouth provides valuable habitat (saltmarsh vegetation) for the endangered orange-bellied parrot (*Neophema chrysogaster)*.

4.4.6.7 Princetown Wetlands

These wetlands consist of swamps of varying salinity on the floodplains of the Gellibrand River and its tributary, the Serpentine (Latrobe) Creek. Wetlands types present are a deep freshwater marsh, semi- permanent saline marshes and a shallow freshwater marsh. The Princetown Wetlands have extensive beds of Common Reed *Phragmites australis* and meadows dominated by Beaded Glasswort *Sarcocornia australis* which can support large numbers of waterbirds.

A series of relict spits adjacent to the Gellibrand Estuary and a number of levee banks at various sites have State significance for their geomorphology.

4.4.6.8 Shallow Inlet Marine & Coastal Park

Shallow Inlet is a large tidal embayment with a single channel to the sea. The seaward side is enclosed by a sandy barrier complex of spits, bars and mobile dunes.

The coastal vegetation adjoining Shallow Inlet consists of a number of distinct communities which are relatively intact. Recently described species of significance include the Prom *Sheoke Allocasuarina media* and a Banksia sp. of uncertain taxonomic status. Marine flora includes the seagrasses Dwarf Grass-wrack (*Zostera muelleri)* and Tasman Grass-wrack (*Heterozostera tasmanica)*.

4.4.6.9 Western Port

Western Port is a large bay with extensive intertidal flats, mangroves, saltmarsh, seagrass beds, several small islands and two large islands. Refer to description in Section 4.4.5.6.

4.4.6.10 Yambuk Wetlands

The Yambuk Wetlands are a network of the estuary of the Eumeralla River and Shaw River (Lake Yambuk), associated freshwater meadows and semi-permanent saline wetlands.

The Yambuk Wetlands are high value for their flora and fauna and they act as drought refuges. The vegetation consists of extensive reed beds and narrow bands of saltmarsh. Lake Yambuk is an excellent example of an estuary with extensive overbank swamps.

4.4.7 Victorian Protected Areas – Marine

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DAWE), and the spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

Victoria has a representative system of 13 Marine National Parks and 11 Marine Sanctuaries established under the National Parks Act 1975 (Vic). Seven Marine National Parks and seven marine sanctuaries are located within the spill EMBA as shown in Figure 4-7.

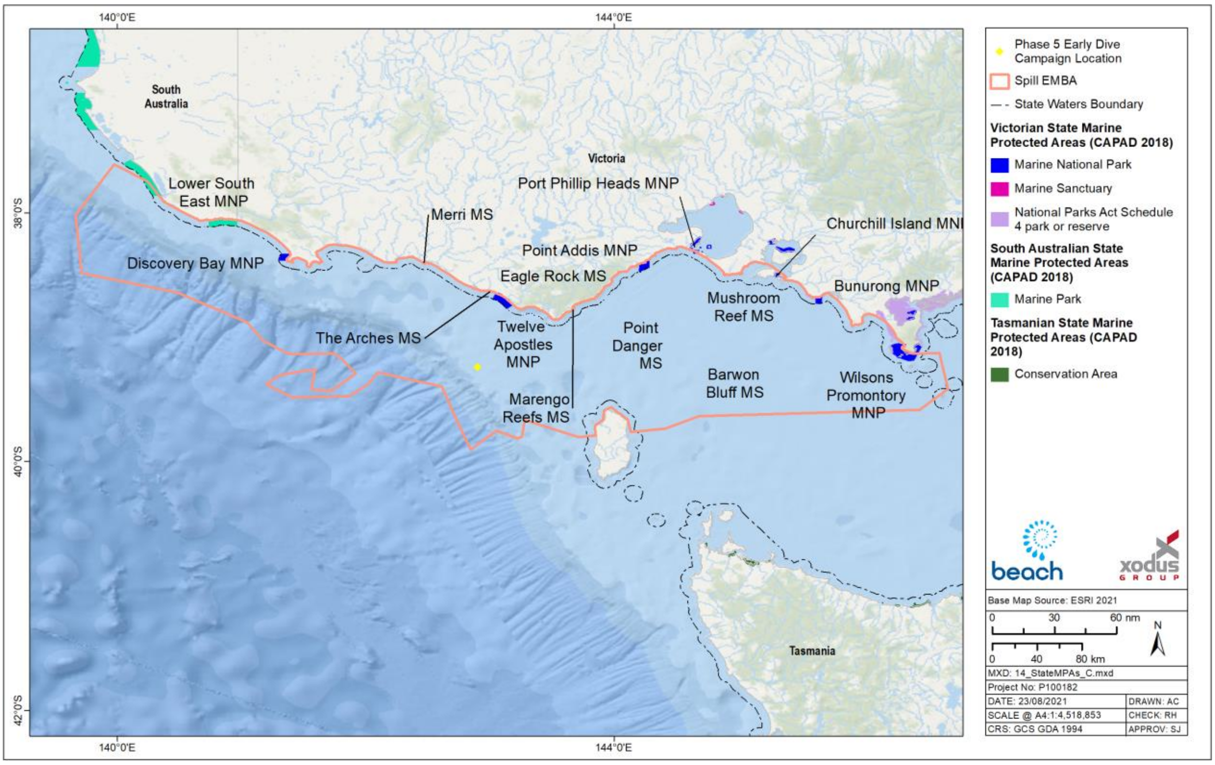


Figure 4-7: State Marine Protected Areas within the spill EMBA

4.4.7.1 Bunurong Marine National Park

The Bunurong Marine National Park and Bunurong Marine Park are managed through the Bunurong Marine National Park Management Plan (Parks Victoria, 2006a). The Plan identifies the key values of the Parks as:

- Extensive intertidal rock platforms and subtidal rocky reefs with a geology and form that is uncommon along the Victorian coast.
- Abundant and diverse marine flora and fauna including over 22 species of marine flora and fauna recorded, or presumed to be, at their eastern or western distributional limits (Plummer et al., 2003).
- Highest diversity of intertidal and shallow subtidal invertebrate fauna recorded in Victoria on sandstone (ECC 2000).
- A high proportion of the common invertebrates occurring along the Victorian coast.
- High diversity of vegetation communities, many of which are considered rare, depleted or endangered within the region (WGCMA, 2003; Carr, 2003).
- Important coastal habitat for several threatened species.
- Spectacular coastal scenery, featuring rugged sandstone cliffs, rocky headlands, intertidal rock platforms and sandy cove.
- Eagles Nest, a prominent rock stack, recognised as a site of national geological and geomorphological significance (Buckley 1993).
- One of the richest Mesozoic fossil areas in Victoria.

- Landscape and seascape of cultural significance to Indigenous people.
- Numerous places and objects of significance to Indigenous people.
- A European history rich in diversity, including sites associated with shipping, coal mining, holidaying and living on the coast.
- Two historical shipwrecks listed on the Victorian Heritage Register (Heritage Victoria, 2004).
- Opportunities for cultural values investigation in an area protected from human disturbance.
- Extensive subtidal reefs with magnificent underwater seascapes, offering numerous opportunities for diving and snorkelling.
- Highly accessible intertidal rock platforms offering opportunities for rock-pooling, marine education and interpretation.
- Spectacular coastal drive, with numerous lookouts and panoramic views of the coast and surrounding waters.
- Coastline offering opportunities for swimming, surfing, boating, fishing and rock-pooling in a natural setting.
- The Bunurong Marine National Park is classified as IUCN II (National Parks) and the Bunurong Marine Park as IUCN IV (Habitat/species management area).

4.4.7.2 Churchill Island Marine National Park

Churchill Island is located south of Rhyll, on the eastern shore of Phillip Island. The park extends from Long Point to the north point of Churchill Island. Within the park are numerous marine habitats including mangroves, sheltered intertidal mudflats, seagrass beds, subtidal soft sediments and rocky intertidal shores. Churchill Island Marine National Park is part of the Western Port RAMSAR site, along with the following National Parks:

- Yaringa Marine National Park;
- French Island Marine National Park;
- Sandstone Island; and
- Elizabeth Island.

Churchill Island is an important habitat for many bird species. Migratory waders roost and feed within the Marine National Park including the bar-tailed godwit and the red-necked stint. The seagrass beds are major food sources for many commercially viable species such as king George whiting, black bream and yellow-eyed mullet (Visit Victoria, 2019a).

4.4.7.3 Discovery Bay Marine National Park

The Discovery Bay Marine National Park is situated 20 km west of Portland and covering 2,770 ha and covers part of the largest coastal basalt formation in western Victoria. In deep water (30 – 60 m) there are low reefs forms from ancient shorelines or dunes. There is a rich diversity of marine life within this park due to the cold, nutrient rich waters of the area. The deep calcarenite reefs support diverse sponge gardens whilst the shallower reefs support the brown alga *Ecklonia radiata*. The offshore waters support a diverse array of invertebrates including southern rock lobster, black-lip abalone and gorgonians. The waters also support great white sharks and blue whales during the summer breeding season. The Discovery Bay National Park is protected as part of the

Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (Parks Victoria, 2015) which covers over 116,000 ha of public land and freehold Gunditjmaraland in south-western Victoria. The Plan (Parks Victoria, 2015) describes some key values of the Discovery Bay (which includes the National Park and the coastal reserve), namely:

- Recognised roosting, feeding and nesting area for birds such as the hooded plover.
- Important habitat for the orange-bellied parrot.
- Subtidal reefs with giant kelp forest communities (TEC).
- A foredune and dune complex that was formerly recognised on the National Estate.
- Surfing, boating and passive recreation.
- Tourism such as dune buggy tours.

4.4.7.4 Point Addis Marine National Park

Point Addis Marine National Park lies east of Anglesea and covers 4,600 ha. This park protects representative samples of subtidal soft sediments, subtidal rocky reef, rhodolith beds and intertidal rocky reef habitats. The park also provides habitat for a range of invertebrates, fish, algae, birds and wildlife. The world-famous surfing destination of Bells Beach is within Point Addis Marine National Park.

It is managed under the Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary (Parks Victoria, 2005a) and is classified as IUCN II. The plan identifies the following environmental, cultural and social values for the parks and sanctuaries:

- Sandy beaches, subtidal soft sediments, subtidal rocky reefs, rhodolith beds and intertidal reefs.
- A high diversity of algal, invertebrate and fish species.
- A high diversity of sea slugs (opisthobranchs) and other invertebrate communities within Point Danger Marine Sanctuary.
- Evidence of a long history of Indigenous use, including many Indigenous places and objects adjacent to the park and sanctuaries near dunes, headlands, estuaries and creeks.
- Surf breaks, including those at Bells Beach, which are culturally important to many people associated with surfing.
- Coastal seascapes of significance for many who live in the area or visit.
- Recreational and tourism values.
- Spectacular underwater scenery for snorkelling and scuba diving.
- Intertidal areas for exploring rock pools.
- Opportunities for a range of recreational activities.
- A spectacular seascape complementing well-known visitor experiences on the Great Ocean Road.

4.4.7.5 Port Phillip Heads Marine National Park

Port Phillip Heads Marine National Park is an area of 35.8 km^2 that is located at the southern end of Port Phillip bay. Many areas within the Port Phillip Heads Marine National Park are popular for a range of recreational activities.

The habitats that are found within the park are seagrass beds, sheltered intertidal mudflats, intertidal sandy beaches and rocky shores, subtidal soft substrate and rocky reefs. The bay has a high diversity and abundance of marine flora and fauna that provides a migratory site for wader birds (Visit Victoria, 2019b).

4.4.7.6 Twelve Apostles Marine National Park

The Twelve Apostles Marine National Park (75 km^2) is located 7 km east of Port Campbell and covers 16 km of coastline from east of Broken Head to Pebble Point and extends offshore to 5.5 km (Plummer et al, 2003).

The area is representative of the Otway Bioregion and is characterised by a submarine network of towering canyons, caves, arches and walls with a large variety of seaweed and sponge gardens plus resident schools of reef fish. The park contains areas of calcarenite reef supporting the highest diversity of intertidal and sub-tidal invertebrates found on that rock type in Victoria (DSE, 2012).

The park includes large sandy sub-tidal areas consisting of predominantly fine sand with some medium to coarse sand and shell fragment (Plummer et al, 2003). Benthic sampling undertaken within the park in soft sediment habitats at 10 m, 20 m and 40 m water depths identified 31, 29 and 32 species respectively based upon a sample area of 0.1 m^2. These species were predominantly polychaetes, crustaceans and nematodes with the mean number of individuals decreasing with water depth (Heisler & Parry, 2007). No visible macroalgae species were present within these soft sediment areas (Plummer et al, 2003; Holmes et al, 2007 cited in Barton et al., 2012). These sandy expanses support high abundances of smaller animals such as worms, small molluscs and crustaceans; larger animals are less common.

The Twelve Apostles Marine Park is managed in conjunction with the Arches Marine Sanctuary under the Management Plan for Twelve Apostles Marine National Park and The Arches Marine Sanctuary (Parks Victoria, 2006b) and is classified as IUCN II. The Plan describes the key environmental, cultural and social values as:

- Unique limestone rock formations, including the Twelve Apostles.
- A range of marine habitats representative of the Otway marine bioregion.
- Indigenous culture based on spiritual connection to sea country and a history of marine resource use.
- The wreck of the Loch Ard (shipwreck).
- Underwater limestone formations of arches and canyons.
- A diverse range of encrusting invertebrates.
- A spectacular dive site (Parks Victoria, 2006b).

4.4.7.7 Wilsons Promontory Marine National Park

Wilsons Promontory National Park is in South Gippsland, about 200 km south-east of Melbourne and at 15,550 ha is Victoria's largest Marine Protected Area. It extends along 17 km of mainland coastline around the southern tip of Wilsons Promontory and is managed through the Wilsons Promontory Marine National Park and Wilsons Promontory Marine Park Management Plan May 2006 (Parks Victoria, 2006a) and is classified as IUCN II (National Parks). The Plan describes the key environmental, cultural and social values as:

- Granite habitats, which are unusual in Victorian marine waters, including extensive heavy reefs with smooth surfaces, boulders and rubble and low-profile reefs.
- Biological communities with distinct biogeographic patterns, including shallow subtidal reefs, deep subtidal reefs.
- Intertidal rocky shores, sandy beaches, seagrass and subtidal soft substrates.
- Abundant and diverse marine flora and fauna, including hundreds of fish species and invertebrates such as sponges, ascidians, sea whips and bryozoans.
- 68 species of marine flora and fauna recorded, or presumed to be, at their eastern or western distributional limits.
- Important breeding sites for a significant colony of Australian fur seals.
- Important habitat for several threatened shorebird species, including species listed under international migratory bird agreements.
- Outstanding landscapes, seascapes and spectacular underwater scenery.
- Seascape, cultural places and objects of high traditional and cultural significance to Indigenous people.
- Indigenous cultural lore and interest maintained by the Gunai/Kurnai and Boonwurrung people.
- Important maritime and other history.
- Historic shipwrecks, many of which are listed on the Victorian Heritage Register (Parks Victoria, 2006a).

4.4.7.8 Marengo Marine Sanctuary

The Marengo Reefs Marine Sanctuary (12 ha) is in Victorian State waters near Marengo and Apollo Bay, which are on the Great Ocean Road, approximately 220 km south-west of Melbourne. The sanctuary protects two small reefs and a wide variety of microhabitats. Protected conditions on the leeward side of the reefs are unusual on this high wave energy coastline and allow for dense growths of bull kelps and other seaweed. There is an abundance of soft corals, sponges, and other marine invertebrates, and over 56 species of fish have been recorded in and around the sanctuary. Seals rest on the outer island of the reef and there are two shipwrecks (the Grange and Woolamai) in the sanctuary (Parks Victoria, 2007a).

The Marengo Reefs Marine Sanctuary Management Plan (Parks Victoria, 2007a) identifies the environmental, cultural and social values as:

- Subtidal soft sediments, subtidal rocky reefs and intertidal reefs.
- High diversity of algal, invertebrate and fish species.
- Australian fur seal haul out area.
- Evidence of a long history of Indigenous use, including many Indigenous places and objects nearby.
- Wrecks of coastal and international trade vessels in the vicinity of the sanctuary.
- Spectacular underwater scenery for snorkelling and scuba diving.

- Intertidal areas for exploring rock pools.
- Opportunities for a range of aquatic recreational activities including seal watching.

4.4.7.9 The Arches Marine Sanctuary

The Arches Marine Sanctuary protects 45 ha of ocean directly south of Port Campbell. It has a spectacular dive site of limestone formations, rocky arches and canyons. The sanctuary is also ecologically significant, supporting habitats such as kelp forests and a diverse range of sessile invertebrates on the arches and canyons. These habitats support schools of reef fish, seals and a range of invertebrates such as lobster, abalone and sea urchins. The Arches Marine Sanctuary is managed in conjunction with the Twelve Apostles Marine Park under the Management Plan for Twelve Apostles Marine National Park and The Arches Marine Sanctuary.

4.4.7.10 Barwon Bluff Marine Sanctuary

Barwon Bluff Marine Sanctuary (17 ha) is located at Barwon Heads, approximately 100 km south-west of Melbourne. The Barwon Bluff Marine Sanctuary Management Plan (Parks Victoria, 2007b) identifies the environmental, cultural and social values as:

- Intertidal reef platforms with a high diversity of invertebrate fauna and flora.
- Subtidal reefs that support diverse and abundant flora, including kelps, other brown algae, and green and red algae.
- Calcarenite and basalt reefs extending from The Bluff that are of regional geological significance.
- Intertidal habitats that support resident and migratory shorebirds, including threatened species.
- Subtidal habitats that support sedentary and mobile fish and are also used by migratory marine mammals.
- Marine habitats and species that are of scientific interest and valuable for marine education.
- Opportunities for underwater recreation, including visits to subtidal communities that are easily accessible from the shore.
- Outstanding coastal vistas, seascapes and underwater scenery.
- An important landmark and area for gathering fish and shellfish for the Wathaurong people.
- A strong historic and ongoing connection with marine education.
- Remnants from the Earl of Charlemont, a heritage-listed shipwreck.

4.4.7.11 Eagle Rock Marine Sanctuary

Eagle Rock Marine Sanctuary (17 ha) is about 40 km south-west of Geelong, close to Aireys Inlet. The sanctuary extends from high water mark around Split Point between Castle Rock and Sentinel Rock. It extends offshore for about 300 m and includes Eagle Rock and Table Rock. The main habitats protected by the sanctuary include intertidal and subtidal soft sediment, intertidal and subtidal reefs, and the water column. It is managed in conjunction with Point Addis Marine National Park and Point Danger Marine Sanctuary.

4.4.7.12 Merri Marine Sanctuary

The Merri Marine Sanctuary is on the Victorian south-west coast near Warrnambool, approximately 260 km west of Melbourne. Merri Reefs Marine Sanctuary (25 ha) is located at the mouth of the Merri River, west of Warrnambool Harbour. Merri Marine Sanctuary contains a mixture of habitats, including intertidal reef, sand, shallow reef and rocky overhang. These areas provide a nursery for many fish species and a habitat for many algae species, hardy invertebrates and shorebirds. Bottlenose dolphins and fur seals are regular visitors to the shore (Parks Victoria, 2007c).

The Sanctuary is protected with the Merri Marine Sanctuary Management Plan (Parks Victoria, 2007c) identifies the environmental, cultural and social values as:

- Culturally significant to indigenous communities that have a long association with the area.
- Merri River, wetlands and islands and headlands provide a variety of habitats.
- Provision of nursery for many fish species and habitat for algal species, hardy invertebrates and shorebirds.

4.4.7.13 Mushroom Reef Marine Sanctuary

The Mushroom Reef Marine Sanctuary is on the Bass Strait coast at Flinders near the western entrance to Western Port, 92 km by road south of Melbourne. The Sanctuary (80 ha) abuts the Mornington Peninsula National Parkland and extends from the high-water mark to approximately 1 km offshore. The Sanctuary is protected under the Mushroom Reef Marine Sanctuary Management Plan (Parks Victoria, 2005b) which identifies the environmental, cultural and social values as:

- Numerous subtidal pools and boulders in the intertidal area that provide a high complexity of intertidal basalt substrates and a rich variety of microhabitats.
- Subtidal reefs that support diverse and abundant flora including kelps, other brown algae, and green and red algae.
- Sandy bottoms habitats that support large beds of Amphibolis seagrass and patches of green algae.
- Diverse habitats that support sedentary and migratory fish species.
- A range of reef habitats that support invertebrates including gorgonian fans, seastars, anemones, ascidians, barnacles and soft corals.
- A distinctive basalt causeway that provides habitat for numerous crabs, seastars and gastropod species.
- Intertidal habitats that support resident and migratory shorebird species including threatened species.
- An important landmark and area for gathering fish and shellfish for the Boonwurrung people.
- excellent opportunities for underwater recreation activities such as diving and snorkelling among accessible subtidal reefs.

4.4.7.14 Point Danger Marine Sanctuary

Point Danger Marine Sanctuary (25 ha) is 20 km south-west of Geelong, close to the township of Torquay and nearby Jan Juc. It extends from the high-water mark at Point Danger offshore for approximately 600 m east and 400 m south, encompassing an offshore rock platform. It is managed in conjunction with Point Addis Marine National Park and Eagle Rock Marine Sanctuary.

4.4.8 Victorian Protected Areas – Terrestrial

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DAWE) and the spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water). Figure 4-8 details that there are several Victorian National Parks, Coastal Parks and Wildlife Reserves within the spill EMBA.

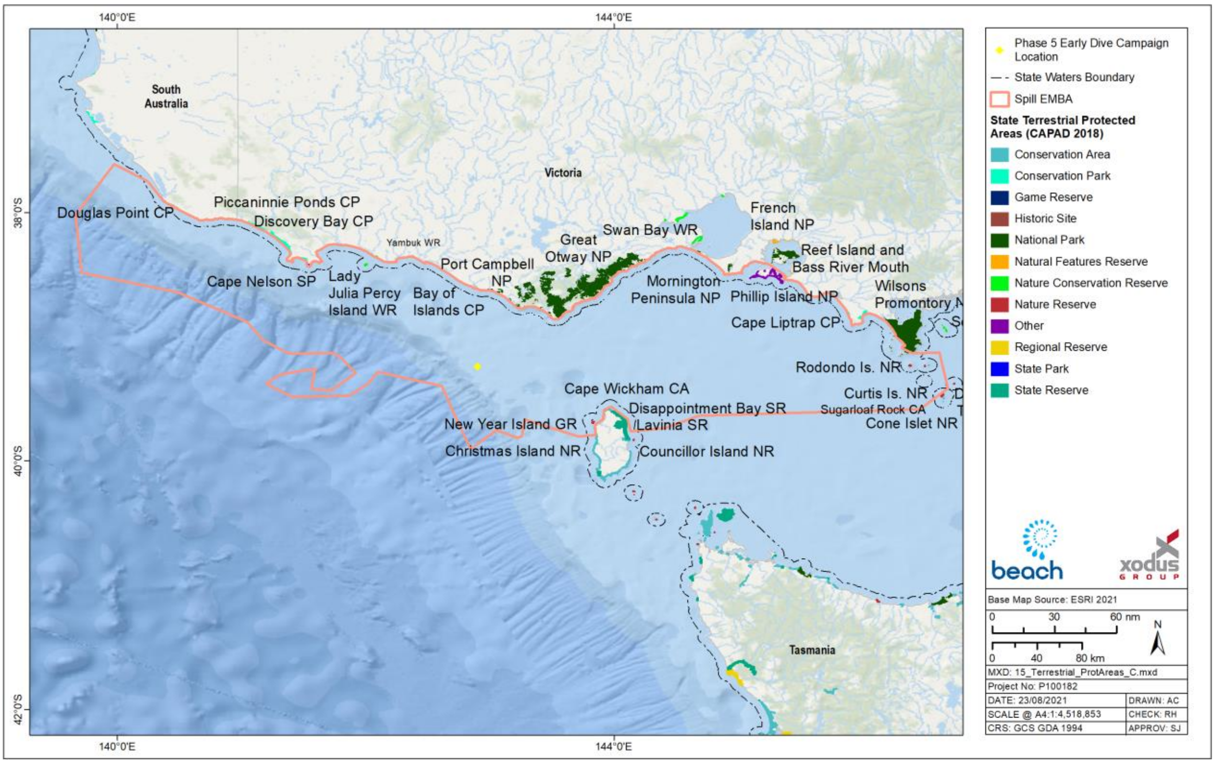


Figure 4-8: State Terrestrial Protected Areas within the spill EMBA

4.4.8.1 Cape Liptrap Conservation Park

Cape Liptrap Coastal Park is located in South Gippsland, 180 km south-east of Melbourne. It is protected under the Cape Liptrap Coastal Park Management Plan (Parks Victoria, 2003), which identifies the environmental, cultural and social values as:

- Extensive heathland and coastal forest vegetation communities.
- The occurrence of about 270 species of flowering plants, including 27 orchid species.
- Thirty threatened fauna species, including ten species listed as threatened under the Flora and Fauna Guarantee Act 1988 (Vic.), 17 migratory bird species and ten threatened flora species.
- One of the most interesting and complex geological sequences in the State, ranging from ancient Cambrian rocks to Recent sands.
- Spectacular coastal landforms at Cape Liptrap, Arch Rock and at Walkerville.
- Numerous middens and other significant Aboriginal sites.

- Relics of the lime-burning industry at Walkerville.
- Cape Liptrap lighthouse.
- Spectacular and diverse coastal scenery.
- Opportunities for fishing, nature observation, camping, and walking in natural settings.

This park protects the terrestrial environment above the low water mark of this coastline.

4.4.8.2 Cape Nelson State Park

Cape Nelson State Park is near Portland on Victoria’s southwest coast with an area of 243 ha. The park offers an archaeologically, ecologically and geologically rich and diverse attractions.

4.4.8.3 Discovery Bay Coastal Park

The Discovery Bay Coastal Park is a remote coastal park that protects 55 km of ocean beach. Inland, the park encompasses high coastal cliffs, sand dunes, freshwater lakes and swamps, with thriving coastal vegetation and wildlife. The park extends along the coast of Discovery Bay from Cape Nelson north-westwards to the border of South Australia, covering an area of 10,460 ha (Parks Victoria, 2015).

4.4.8.4 Douglas Point Conservation Park

Douglas Point Conservation Park is popular for recreational bush walking, bird watching, fishing, diving and surfing that is located 11 km north-west of Port MacDonnell. The park has natural and cultural values and conserves the coastal health habitat and associated endangered and vulnerable plant and animal species (DEH, 2003).

4.4.8.5 French Island National Park

The French Island National Park is located 10 km south of Tooradin, French Island Marine National Park is adjacent to the northern shoreline of French Island National Park in Western Port. Extending 15 km along the shoreline, the park encompasses approximately 2800 ha. It includes one of Victoria's most extensive areas of saltmarsh and mangrove communities and also includes mudflats of state geomorphological significance (Parks Victoria, 2019a).

4.4.8.6 Great Otway National Park

The Great Otway National Park (103,185 ha) is located near Cape Otway and stretches from the low water mark inland on an intermittent basis from Princetown to Apollo Bay (approximately 100 km).

Landscapes within the park are characterised by tall forests and hilly terrain extending to the sea with cliffs, steep and rocky coasts, coastal terraces, landslips, dunes and bluffs, beaches and river mouths. There is a concentration of archaeological sites along the coast, coastal rivers and reefs. The park contains many sites of international and national geological and geomorphological significance including Dinosaur Cove (internationally significant dinosaur fossil site), Lion Headland and Moonlight Head to Milanesia Beach (internationally significant coastal geology and fossils).

The park provides habitats for the conservation of the rufous bristlebird, hooded plover, white-bellied sea eagle, fairy tern, Caspian tern and Lewin’s rail and native fish such as the Australian grayling.

The park contains significant Aboriginal cultural sites adjacent to rivers, streams and the coastline including over 100 registered archaeological sites, particularly shell middens along the coast, as well as non-physical aspects such as massacre sites, song lines, family links and stories. The park also contains four sites listed on the Victorian

Heritage Register including the Cape Otway Light Station and several shipwreck features along the coast (i.e. anchors) (Parks Victoria and DSE, 2009).

This park protects the terrestrial environment above the low water mark of this coastline. The Park is protected under the Great Otway National Park and Otway Forest Park Management Plan (Parks Victoria and DSE, 2009) and relevant values are:

- A large area of essentially unmodified coastline, linking the land to marine ecosystems and marine national parks.
- A diverse range of lifestyle and recreation opportunities for communities adjacent to the parks – for local permanent residents and holiday homeowners Regionally, nationally and internationally.
- Significant tourist attractions, close to access routes and accommodation, such as spectacular coastal scenery along the Great Ocean Road, access to beautiful beaches, clifftop lookouts, picnic areas, historic sites, waterfalls and walking tracks such as the Great Ocean Walk.
- The basis for continued growth of nature-based tourism associated with the parks and the region, providing economic opportunities for accommodation providers, food and services providers, and recreation, tourism and education operators.

4.4.8.7 Lady Julia Percy Island Wildlife Reserve

Lady Julia Percy Island is off the coast of Victoria near Port Fairy. It is one of the two largest breeding sites for the Australian fur seal species in Australia (DoE, 2017a) and provides habitat to migratory seabirds. There is no management plan for Lady Julia Percy Island Wildlife Reserve.

4.4.8.8 Mornington Peninsula National Park

Mornington Peninsula National Park is situated about 70 km south of Melbourne. Mornington Peninsula National Park runs along the coast from Point Nepean, at the western tip of the Mornington Peninsula, to Bushrangers Bay, where it turns inland along the Main Creek valley, still as a narrow band, until it joins the more expansive Greens Bush section of the Park. This park protects the terrestrial environment above the low water mark of this coastline. The Park is managed under the Mornington Peninsula National Park and Arthurs Seat State Park Management Plan, which has identified the key environmental, social and cultural values as (Parks Victoria, 2013):

- Largest and most significant remaining areas of native vegetation on the Mornington Peninsula. Numerous sites and features of geomorphic significance, particularly along the coast (cliffed calcarenite coast sandy forelands and basalt shore platforms).
- Only representation in the Victorian conservation reserve system of four land systems formed within the Southern Victorian Coastal Plains and the Southern Victorian Uplands.
- Many significant native plants and vegetation communities, especially in Greens Bush and former McKellar Flora Reserve, and the most extensive remnant coastal grassy forest habitat on the Mornington Peninsula.
- Highly scenic landscape values along the ocean coast and at Port Phillip heads and the prominent landscape feature of Arthurs Seat.
- Many significant fauna species, including populations of the nationally significant hooded plover, over 30 species of State significance and many species of regional significance.
- High quality marine and intertidal habitats, with some pristine areas within Point Nepean.

- Nationally significant and fascinating historic sites at Point Nepean.
- The historic Seawinds Gardens in Arthurs Seat State Park.
- One of the highest recorded densities of Aboriginal archaeological sites along the Victorian Coast
- South Channel Fort is an important component of the historic fortification defence system of Port Phillip (and an important bird nesting and roosting site).
- Spectacular scenery and popular surf beaches associated with a wild and rugged coastline.
- Local and regional economic benefits.
- Intensively used recreational nodes, e.g. at Portsea, Sorrento, Cape Schanck and Arthurs Seat.

4.4.8.9 Phillip Island Nature Park

Phillip Island is east of Melbourne and forms a natural breakwater for the shallow waters of Western Port. Phillip Island is Biologically Important Area (BIA) for the little penguin, with breeding and foraging sites present (DAWE, 2021). There is no management plan for Phillip Island Nature Park.

4.4.8.10 Piccaninnie Ponds Conservation Park

The Piccaninnie Pond covers an area of 8.64 km^2, that has a wide diversity of fauna and flora with 60 bird species and six vegetation communities. Other vegetation found within the park includes reeds, sedge swamp, open heath and tussock grassland.

4.4.8.11 Port Campbell National Park

Port Campbell National Park is slightly west of Twelve Apostles Marine National Park and 10 km east of Warrnambool. The park is 1,750 ha that presents an extraordinary collection of wave-sculptured rock formations. Port Campbell National Park is home to various fauna such as the little penguin, short-tailed shearwater and various whale species (Parks Victoria, 2019b).

4.4.8.12 Reef Island and Bass River Mouth Nature Conservation Reserve

Reef Island and Bass River Mouth Nature Conservation Reserve is situated on the eastern shores of Westernport Bay. Reef Island is accessible at low tide via a narrow spit. The day visitor area on the banks of the Bass River is ideal for fishing and bird watching. There is no management plan for this Conservation Reserve,

4.4.8.13 Swan Bay Wildlife Reserve

Swan Bay Wildlife Reserve is an internationally recognized wetland and marine ecosystem within Port Phillip Bay. Swan Bay supports diverse saltmarsh communities which form part of the habitat critical for survival of the endangered orange bellied parrot and is an important recreational and tourism resource.

4.4.8.14 Wilsons Promontory National Park

The Wilsons Promontory National Park is in South Gippsland, about 200 km southeast of Melbourne and includes the Wilsons Promontory Wilderness Zone, Southern Wilsons Promontory Remote and Natural Area and Wilsons Promontory Islands. It is managed under the Wilsons Promontory National Park Management Plan. The Plan identifies the key environmental, social and cultural values as (Parks Victoria, 2002):

- Entire promontory of national, geological and geomorphological significance containing a number of sites of State and regional significance.
- Diverse vegetation communities, including warm temperate and cool temperate rainforest, tall open forests, woodlands, heathlands, and swamp and coastal communities.
- Unmodified rivers and streams with no introduced fish species.
- Half of Victoria's bird species.
- Intertidal mudflats, which are an internationally important habitat for migratory wading birds.
- The largest coastal wilderness area in Victoria.
- Numerous middens and other significant Aboriginal sites.
- Remains of sites of several small European settlements and past uses including timber milling, mining and grazing.
- A number of shipwrecks in the waters around Wilsons Promontory.
- The heritage buildings of Wilsons Promontory Light Station.
- Outstanding natural landscapes including spectacular and diverse coastal scenery.

This park protects the terrestrial environment above the low water mark of this coastline.

4.4.8.15 Yambuk Wetlands Natural Conservation Reserve

Yambuk Wetlands Natural Conservation Reserve is located south of Lake Yambuk along the coastline with an area of 0.77 km^2 (Protected Planet, 2019).

4.4.9 Tasmanian Protected Areas - Marine

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets from the DAWE, and the spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

As per Figure 4-7 there are no marine Tasmanian Protected Area is within the spill EMBA.

4.4.10 Tasmanian Protected Areas – Terrestrial

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DAWE), and the spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

Figure 4-8 details that there are several Tasmanian National Reserves, Conservations Areas and Game Reserves within the spill EMBA.

4.4.10.1 Cape Wickham Conservation Area

The Cape Wickham Conservation Area is on the northern tip of King Island and contains Cape Wickham lighthouse and the gravesites of the crew of Loch Leven, a ship that was wrecked nearby. It is designated as IUCN Category V which is a protected landscape/seascape. There is no management plan for the Cape Wickham Conservation Area.

4.4.10.2 Christmas Island Nature Reserve

Christmas Island is located off the west coast of King Island. It is designated IUCN 1a which is a strict nature reserve, which allows minimal human use (DPIPWE, 2015). It is a BIA for both breeding and foraging for the little penguin (DAWE, 2021). There is no management plan for the Christmas Island Nature Reserve.

4.4.10.3 Curtis Island Nature Reserve

Curtis Island is located in the Bass Strait between Wilsons Promontory and Tasmania. It is designated IUCN 1a which is a strict nature reserve, which allows minimal human use (DPIPWE, 2015). It has a large population of breeding seabirds and waders (Carlyon et al., 2011). It is also a recognised BIA for breeding and feeding for little penguins (DAWE, 2021). There is no management plan for the Curtis Island Nature Reserve.

4.4.10.4 Disappointment Bay State Reserve

The Disappointment Bay State Reserve is located on the north coast of King Island. It is designated IUCN II which is a national park (DPIPWE, 2015). There is no management plan for the Disappointment Bay State Reserve.

4.4.10.5 Lavinia State Reserve

Lavinia State Reserve is located on the north-east coast of King Island. The reserve contains a number of rare birds, including the endangered orange-bellied parrot (DPIPWE, 2013). It includes the Lavinia Ramsar site and two freshwater lakes. Lavinia Beach is a popular location for surfing and fishing.

4.4.10.6 New Year Island Game Reserve

New Year Island is located on the north-west coast of King Island. It is a game reserve for the muttonbird (short-tailed shearwater), with non-commercial harvesting of the species permitted during the open season.

4.4.10.7 Rodondo Island Nature Reserve

Rodondo Island is located in Bass Strait, approximately 10 km south of Wilsons Promontory. Both Australian and New Zealand fur-seal have haul-out sites on Rodondo Island (Carlyon et al, 2015). It hosts a number of breeding seabirds, with the short-tailed shearwater being the most common (Carlyon et al, 2015).

4.4.10.8 Sugarloaf Rock Conservation Area

Sugarloaf Rock is a small granite island, with an area of 1.07 ha, in south-eastern Australia. It is part of Tasmania's Curtis Group, lying in northern Bass Strait between the Furneaux Group and Wilson's Promontory in Victoria. Known breeding sites for the fairy prion and common diving-petrel along with known haul-out site for the Australian fur-seals.

4.4.11 South Australian Protected Areas - Marine

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DAWE), and the spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not

Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

One South Australian marine park, the Lower South East Marine Park, was identified in the spill EMBA (Figure 4-7).

The Lower South East Marine Park covers 360 km^2 and is divided into two sections: the area adjacent to Canunda National Park; and the area extending from Port MacDonnell Bay just west of French Point to the South Australian - Victorian border. The marine park borders Canunda National Park and partially overlays Piccaninnie Ponds Conservation Park.

The Lower South East Marine Park Management Plan 2012 (DEWNR, 2012) details the following values:

- High diversity of plants and animals, including blue whales, due to the influence of the Bonney coast upwelling, an ocean current that supplies nutrient-rich water to the area.
- Diverse range of habitats ranging from high-energy sandy beaches and freshwater springs, various reef types (shore platforms, fringing and limestone).
- Kelp forests and algal communities and is strongly influenced by natural processes such as the Bonney coast upwelling.
- Spring lakes such as Ewen Ponds and Piccaninnie Ponds (both Wetlands of National Importance) emerge from the beaches and are unusual in South Australia.
- Habitat for several threatened or potentially threatened species that require freshwater and marine environments during their lifecycle, including the pouched lamprey, short-headed lamprey and shortfinned eel.
- Feeding and resting grounds for migratory and resident shorebirds.
- Recreational activities including fishing, diving and snorkelling.
- Commercial fisheries including the Southern Zone Abalone Fishery, the Southern Zone Rock Lobster Fishery, the Marine Scalefish Fishery, the Charter Fishery and the Miscellaneous Giant Crab Fishery.
- The Buandig Aboriginal people have traditional associations with areas of the marine park.

4.4.12 South Australian Protected Areas - Terrestrial

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DAWE), and the spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

As per Figure 4-8, there are no terrestrial South Australian Protected Areas within the spill EMBA.

4.4.13 Key Ecological Features

KEFs are elements of the marine environment, based on current scientific understanding, are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity of a Commonwealth Marine Area.

The spill EMBA PMST Report (Appendix A) identified two KEFs:

- Bonney Coast Upwelling; and
- West Tasmanian Marine Canyons

The Bonney Coast Upwelling KEF is situated ~107 km to the west of the operational area, while the West Tasmania Canyon is situated ~16 km south of the operational area.

The following KEF have not been spatially defined, and are identified as potentially occurring within the spill EMBA:

- Shelf Rocky Reefs and Hard Substrates; and
- Bass Cascade

No spatially defined KEFs were identified within the operational area (Figure 4-9).

4.4.13.1 Bonney Coast Upwelling

The Bonney Coast upwelling is a predictable, seasonal upwelling bringing cold nutrient rich water to the sea surface and supporting regionally high productivity and high species diversity in an area where such sites are relatively rare and mostly of smaller scale (DAWE 2015). The Bonney Coast upwelling is defined as a key ecological feature as it is an area of enhanced pelagic productivity and has high aggregations of marine life (DAWE 2015). In addition to whales, many endangered and listed species frequent the area, possibly also relying on the abundance of krill that provide a food source to many seabirds and fish. The high productivity of the Bonney coast upwelling is also capitalised on by other higher predator species such as little penguins and Australian fur seals feeding on baitfish (CoA 2015c).

The Bonney Coast Upwelling KEF lies on the continental shelf situated ~120 northwest of Cape Jaffa, South Australia to Portland, Victoria (Figure 4-9). The location of the Bonney Coast Upwelling KEF was originally derived through a review of enhanced chlorophyll occurrence for summer seasonal data between the years of 1998 and 2010 (Research Data Australia 2013).

4.4.13.2 West Tasmanian Canyons

The West Tasmanian Canyons are located on the relatively narrow and steep continental slope west of Tasmania. This location has the greatest density of canyons within Australian waters where 72 submarine canyons have incised a 500 km-long section of slope (Heap & Harris 2008). The canyons in the Zeehan AMP are relatively small on a regional basis, each less than 2.5 km wide and with an average area of 34 km^2 shallower than 1,500 m (Adams et al., 2009). The Zeehan canyons are typically gently sloping and mud-filled with less exposed rocky bottoms compared with other canyons in the south-east marine region (e.g. Big Horseshoe Canyon).

Submarine canyons modify local circulation patterns by interrupting, accelerating, or redirecting current flows that are generally parallel with depth contours. Their size, complexity and configuration of features determine the degree to which the currents are modified and therefore their influences on local nutrients, prey, dispersal of eggs, larvae and juveniles and benthic diversity with subsequent effects which extend up the food chain.

Eight submarine canyons surveyed in Tasmania, Australia, by Williams et al (2009) displayed depth-related patterns with regard to benthic fauna, in which the percentage occurrence of faunal coverage visible in underwater video peaked at 200-300 m water depth, with averages of over 40% faunal coverage. Coverage was reduced to less than 10% below 400 m depth. Species present consisted of low-relief bryozoan thicket and diverse sponge communities containing rare but small species in 150 to 300 m water depth.

Sponges are concentrated near the canyon heads, with the greatest diversity between 200 m and 350 m depth. Sponges are associated with abundance of fishes and the canyons support a diversity of sponges comparable to that of seamounts. Based upon this enhanced productivity, the West Tasmanian canyon system includes fish nurseries (blue wahoo and ocean perch), foraging seabirds (albatross and petrels), white shark and foraging blue and humpback whales (TSSC, 2015a).

4.4.13.3 Shelf Rocky Reefs and Hard Substrates

Rocky reefs and hard grounds are located in all areas of the SEMR continental shelf including Bass Strait, from the sub-tidal zone shore to the continental shelf break. The continental shelf break generally occurs in 50 m to 150– 220 m water depth. The shallowest depth at which the rocky reefs occur in Commonwealth waters is approximately 50 m.

On the continental shelf, rocky reefs and hard grounds provide attachment sites for macroalgae and sessile invertebrates, increasing the structural diversity of shelf ecosystems. The reefs provide habitat and shelter for fish and are important for aggregations of biodiversity and enhanced productivity.

The shelf rocky reefs and hard substrates are defined as a key ecological feature as they are an area of high productivity and aggregations of marine life. This KEF has not yet been spatially defined (DoE, 2015a).

4.4.13.4 Bass Cascade

The Bass Cascade refers to the "underwater waterfall" effect brought about by the northward flow of Bass Strait waters in winter which are more saline and slightly warmer than surrounding Tasman Sea waters. As the water approaches the mainland in the area of the Bass Canyon group it forms an undercurrent that flows down the continental slope. The cascading water has a displacing effect causing nutrient rich waters to rise, which in turn leads to increased primary productivity in those areas. The cascading water also concentrates nutrients and some fish and whales are known to aggregate along its leading edge.

Bass Cascade is defined as a key ecological feature as it is an area of high productivity. The Bass Cascade occurs during winter months only and has not yet been spatially defined (DoE, 2015a).

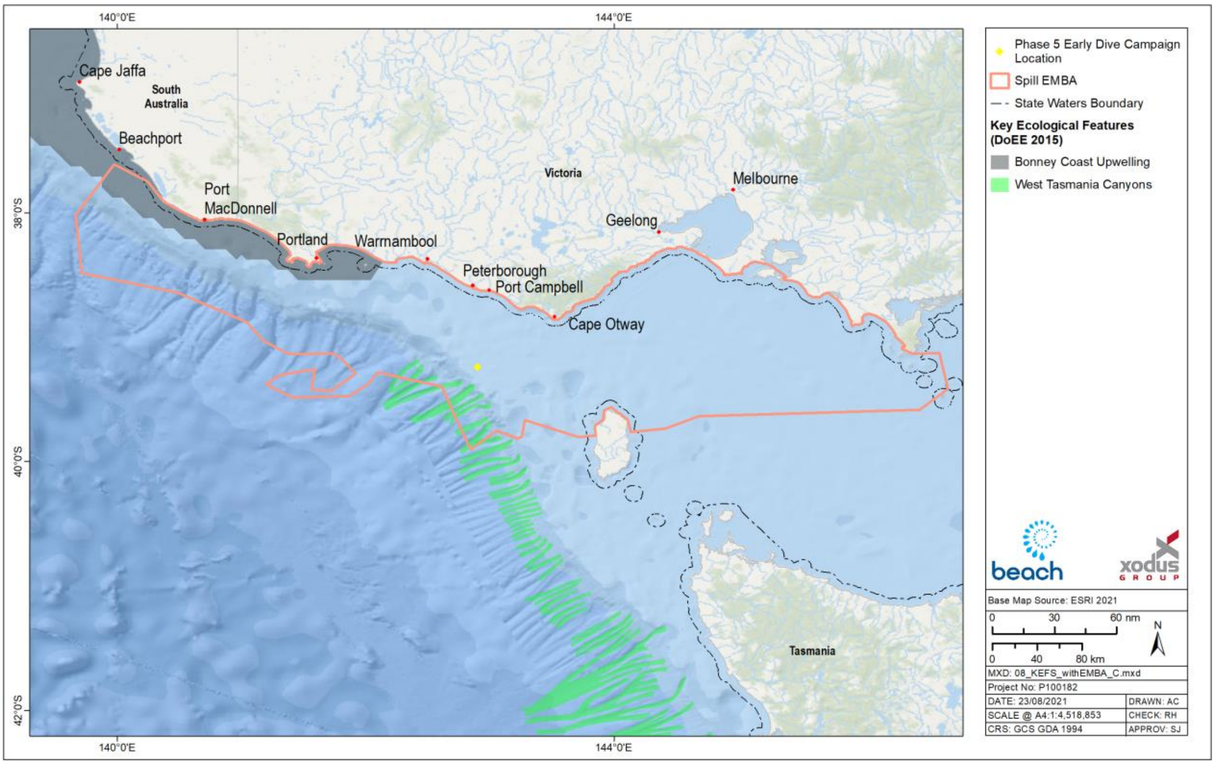


Figure 4-9: Spatially defined Key Ecological Features present within the spill EMBA

4.5 Physical environment

The physical marine environment of the Otway region is characterised by very steep to moderate offshore gradients, high wave energy and temperate waters subject to upwelling events.

4.5.1 Geomorphology

The south-eastern section of Australia's continental margin comprises the Otway Shelf and the Bonney Coast, Bass Strait, and the western shelf of Tasmania. The 400 km long Otway Shelf lies between 37° and 43.5°S and 139.5°E (Cape Jaffa) and 143.5°E (Cape Otway). The narrowest point is off Portland, where the shelf is less than 20 km wide. It broadens progressively westward, to 60 km of Robe, SA, and eastward to 80 km of Warrnambool. The Otway shelf is comprised of Miocene limestone below a thin veneer of younger sediments.

Boreen et al. (1993) examined 259 sediment samples collected over the Otway Basin and the Sorell Basin of the west Tasmanian margin. Based on assessment of the sampled sediments the authors concluded the Otway continental margin is a swell-dominated, open, cool-water, carbonate platform. A conceptual model was developed which divided the Otway continental margin into five depth-related zones – shallow shelf, middle shelf, deep shelf, shelf edge and upper slope (Figure 4-10).

The spill EMBA is within the five zones while the operational area is within the shallow and middle shelf.

The shallow shelf contains exhumed limestone substrates that host dense encrusting mollusc, sponge, bryozoan and red algae assemblages. The middle shelf is a zone of swell-wave shoaling and production of mega-rippled bryozoan sands. The deep shelf is described as having accumulations of intensely bioturbated, fine, bio clastic sands. At the shelf edge and top of slope, nutrient-rich upwelling currents support extensive, aphotic bryozoan/sponge/coral communities. The upper slope sediments are a bioturbated mixture of periplatform bioclastic debris and pelleted foraminiferal/nanno-fossil mud. The lower slope is described as crosscut by gullies with low accumulation rates, and finally, at the base of the slope the sediments consist of shelf-derived, coarse-grain turbidites and pelagic ooze.

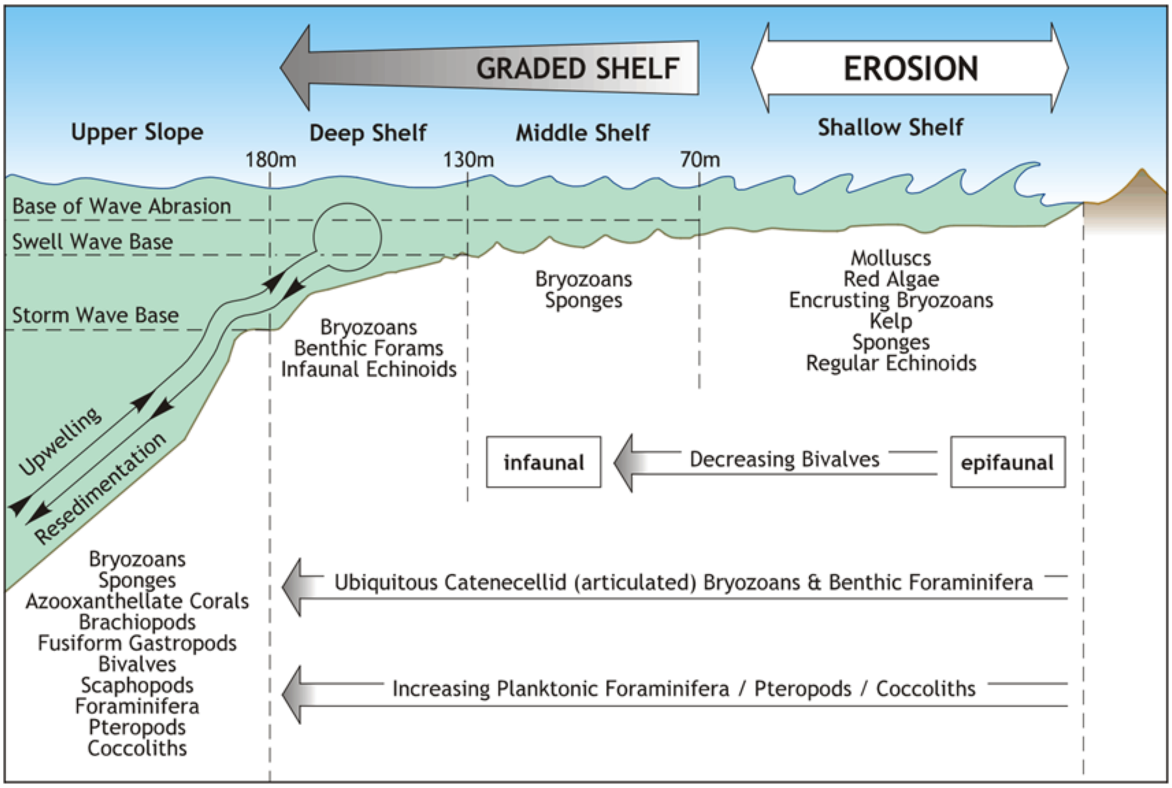


Figure 4-10: Model of the geomorphology of the Otway Shelf

4.5.2 Otway assessments and surveys - EMBA

A comprehensive assessment of the coast to continental shelf margin has been undertaken within approximately 4 km^2 of bathymetric data and video footage collected of the pipeline right-of-way options from the Otway Gas Project EIS (Woodside, 2003). These data have been supplemented by numerous benthic sampling events; however, data for this assessment have been referenced primarily from Boreen et al., (1993), and the Otway Gas Project EIS (Woodside, 2003).

In 2002, 2003 and 2004, Fugro undertook a number of bathymetric surveys of the two proposed pipeline rights of way: one constructed for the Thylacine Geographe pipeline and one extending from the completed Geographe A well to Flaxman's Hill.

A review of the available geotechnical data was carried out in March 2011 for the Geographe location (Advanced Geomatics, 2011). Overall, the seabed in the Otway area surveyed slopes to the south at a gentle average gradient of less than 1. However, the local topography is predominantly irregular in nature, varying from gently undulating and locally smooth in areas of increased sediment deposition, to areas of outcropping cemented calcrete features that are from smooth to jagged relief. These areas are covered in marine growth. ROV video survey confirmed the presence of a shallow hard underlying substrate at a depth of 50 mm below the sediment in areas of marine growth (JP Kenny, 2012).

The Flaxman's Hill alignment traverses the Thistle drilling area and the Thylacine Geographe pipeline runs parallel and north east of this area. During 2003, bathymetric data was collected, and the right of way was assessed and recorded using an underwater video camera (CEE Consultants Pty Ltd, 2003). The Flaxman's Hill pipeline route travels approximately 68 km from the Geographe gas field to the shoreline. Visual assessment of the sea floor was undertaken from a water depth of 99 m to 16 m terminating at Flaxman's Hill.

A summary of the seabed morphology and benthic assemblages is provided in Table 4-2 to Table 4-6.

Table 4-2: Otway margin geomorphology (Boreen et al., 1993)

Zone	Depth (m)	Width (m/km)	Gradient	Features
Shallow Shelf	30 - 70	4 - 28	1.5 - 10	Drops rapidly from strandline to depths of 30 m, characterised by rugged but subdued topography
Middle Shelf	70 - 130	7 - 65	1 - 8.5	Generally smooth topography with occasional rock out crops

Table 4-3: Thylacine to Geographe seabed morphology and benthic assemblages (CEE Consultants Pty Ltd, 2003)

Depth (m)	Seabed morphology	Benthic assemblage
92	High profile reef stone with deep sand gutters.	Diverse, high density sessile: sponge, coral dominated crinoids common and mobile species
88	Low profile with areas of high profile limestone ridges; incomplete sand veneer.	Diverse, high density sessile: sponge, dominated and mobile species

Table 4-4: Geographe to Flaxman's Hill seabed morphology and benthic assemblages (CEE Consultants Pty Ltd, 2003)

Depth (m)	Seabed morphology	Benthic assemblage
82	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Medium density sessile: sponge, dominated low density mobile species. (small shark)
82	Equal % of exposed low profile limestone and sand. Two reef outcrops. Low profile with areas of high profile limestone ridges; incomplete sand veneer.	Medium density, sessile: sponge, dominated
78	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Medium density, sessile: sponge, dominated Motile: sea urchins dominated
76		Medium density, sessile: sponge, dominated
76		Low - Medium density, sessile: sponge, dominated
70		Diverse, med density sessile, sponge dominated
68		Medium density, sessile: sponge, dominated
65		Diverse, med density sessile, sponge dominated
60		Medium density, sessile: sponge, dominated

Table 4-5: Geographe to Rifle Range seabed morphology and benthic assemblages (CEE Consultants Pty Ltd, 2003)

Depth (m)	Seabed morphology	Benthic assemblage
82	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Very low density sessile; large sponge.
79		Diverse, low – high density sessile
75	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Medium density, sessile: sponge, dominated. Motile: sea urchins dominated
74		Medium density, sessile: sponge, dominated
70		Low - Medium density, sessile: sponge, dominated
67		Diverse, med density sessile, sponge dominated
66	Low profile limestone with sand gutters	Medium density, sessile: sponge, dominated
66	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Diverse, med density sessile, sponge dominated
70	(Pock marks) Data not documented.	Medium density, sessile: sponge, dominated
63	Corse gravel to fine sand	High density sessile: micro algae dominated

Table 4-6: Nearshore seabed morphology and benthic assemblages (CEE Consultants Pty Ltd, 2003)

Depth (m)	Seabed morphology	Benthic assemblage
53	Sand	None observed
45		Only sea pens noted
16-30	Very high profile l/stone reef to sand	High density, sessile: sponge, macroalgae (Bull Kelp common)

A sampling survey of the surficial sediments, benthic invertebrates and demersal fishes of Bass Strait was undertaken by the Victorian Museum between 1979 and 1983 (Wilson and Poore, 1987). More than 200 sites were sampled with sites 51 through 61, 118, 119, 120, 121, 183, 186 and 192 representatives of the area (Figure 4-11). Sediments were described in the field from a visual impression or according to the classification of Shepard (Shepard, 1954) (Table 4-7). Carbonate percentage of sediments was also assessed. These samples indicate that surficial sediments throughout the area are dominated by carbonate rich medium to coarse sands. Data on benthic invertebrates and demersal fishers has not been summarised and published.

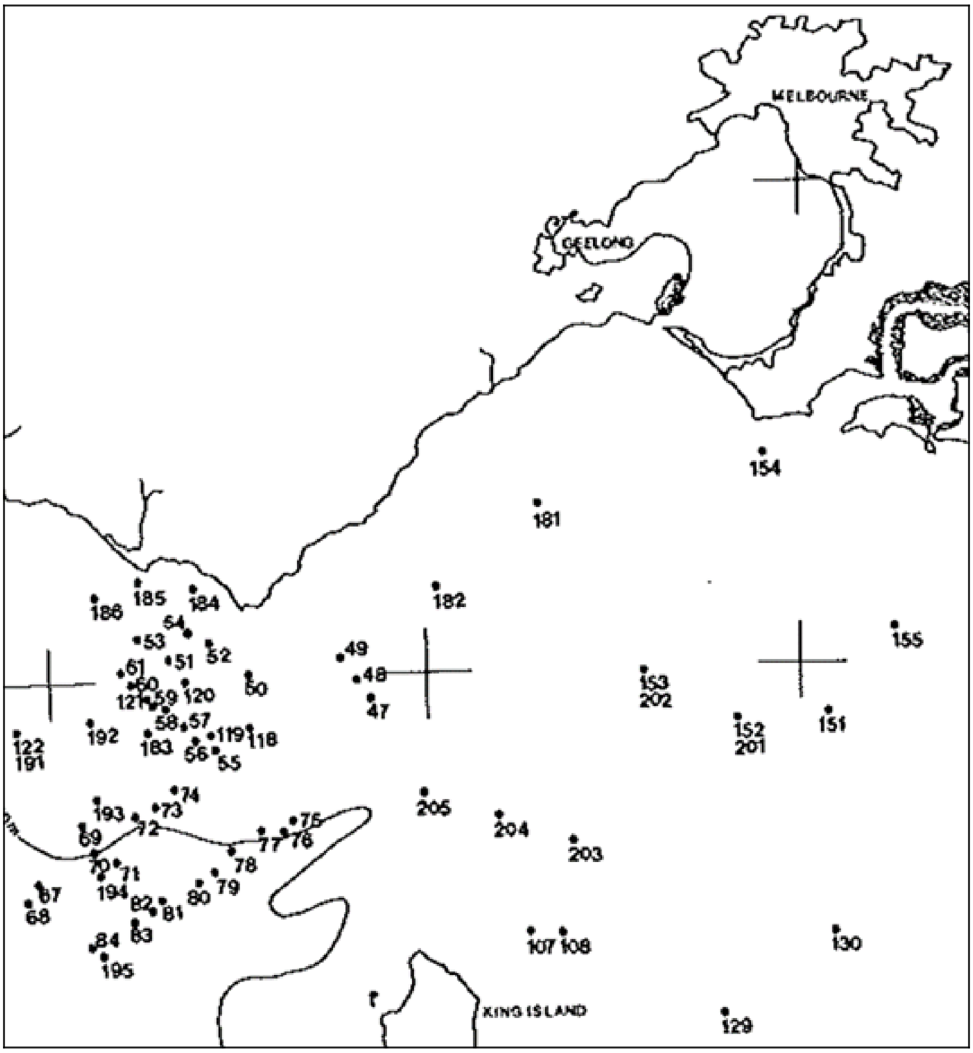


Figure 4-11: Sampling sites for the Bass Straight survey in the region of the spill EMBA (Wilson and Poore, 1987)

Table 4-7: Classification of surficial sediments sampled during the Bass Straight survey in the vicinity of the EMBA (Wilson and Poore, 1987)

Site No.	Depth (m)	Surficial sediments	Carbonate % by weight
51	67	Medium sand	ND
52	49	Coarse sand	72
53	67	Medium sand	45
54	70	Very coarse shelly sand	70
55	85	Coarse carbonate sand	93
56	77	Medium sand	ND
57	59	Coarse sand	97
58	47	Coarse sand	92
59	70	Coarse sand	89
60	79	Medium carbonate sand	100
61	68	Coarse sand	ND

Site No.	Depth (m)	Surficial sediments	Carbonate % by weight
118	95	Fine sand	96
119	92	Fine sand	99
120	84	Medium sand	90
121	84	Medium sand	ND
183	84	Coarse sand	99
186	69	Fine sand	ND
192	81	Medium sand	100

A video survey of the seabed at selected sites along proposed offshore pipeline routes for the Otway Gas Development was undertaken by BBG during 2003 (Figure 4-12). BBG (2003) found that the substrate in water depths between 82 and 66 m (such as those in the operational area) were predominantly low profile limestone with an incomplete sand veneer that supported a low to medium density, sponge dominated filter feeding community. Fish and other motile organisms were uncommon.

In shallower depths of between 63 and 30 m (such as is found in the spill EMBA), the video surveys showed a rippled, sand or sand/pebble substrate with minor sponge dominated benthic communities. The epibenthic organisms were generally attached to outcropping or sub-outcropping limestone pavements. Only in waters shallower than approximately 20 m, was an area of significant, high profile reef and associated high density macroalgae dominated epibenthos encountered. Details of the seabed and benthic epifaunal assemblage are provided in Table 4-8.

Table 4-8: Seabed characteristics and epifaunal assemblage at video survey sites (BBG, 2003)

Site No.	Depth (m)	Seabed type	Benthic Assemblage
3097	99	Bare rippled sand; minor limestone outcrops	Low density sessile; small sponge dominated
3118	99	Low profile limestone reef with sand veneer; isolated areas of raised l/stone	Low density sessile; sponge dominated
3084	99	Low profile limestone reef with incomplete sand veneer	Low density sessile; sponge dominated
3072	99	Low profile limestone reef with incomplete sand veneer	Low density sessile; sponge dominated
3054	98	Mix of low and high profile l/stone; shallow and deep sand	Low density sessile on low l/stone; high density sessile on high l/stone plus fish; sponge dominated
3185	95	Low profile limestone reef with incomplete sand veneer	Low density sessile; sponge dominated
3196	94	Low profile limestone reef with incomplete sand veneer	Low density sessile; sponge dominated
3232	92	High profile reef stone with deep sand gutters.	Diverse, high density sessile: sponge, coral dominated crinoids common and mobile species
3267	88	Low profile with areas of high profile limestone ridges; incomplete sand veneer.	Diverse, high density sessile: sponge, dominated and mobile species

Site No.	Depth (m)	Seabed type	Benthic Assemblage
2801	82	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Very low density sessile; large sponge.
2720	79		Diverse, low – high density sessile
2590	75	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Medium density, sessile: sponge, dominated. Motile: sea urchins dominated
2490	74		Medium density, sessile: sponge, dominated
2339	70		Low - Medium density, sessile: sponge, dominated
2291	67		Diverse, med density sessile, sponge dominated
2191	66	Low profile limestone with sand gutters	Medium density, sessile: sponge, dominated
2181	66	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Diverse, med density sessile, sponge dominated
1191	63	Coarse gravel to find sand	High density sessile: micro algae dominated
1668	53	Sand	None observed

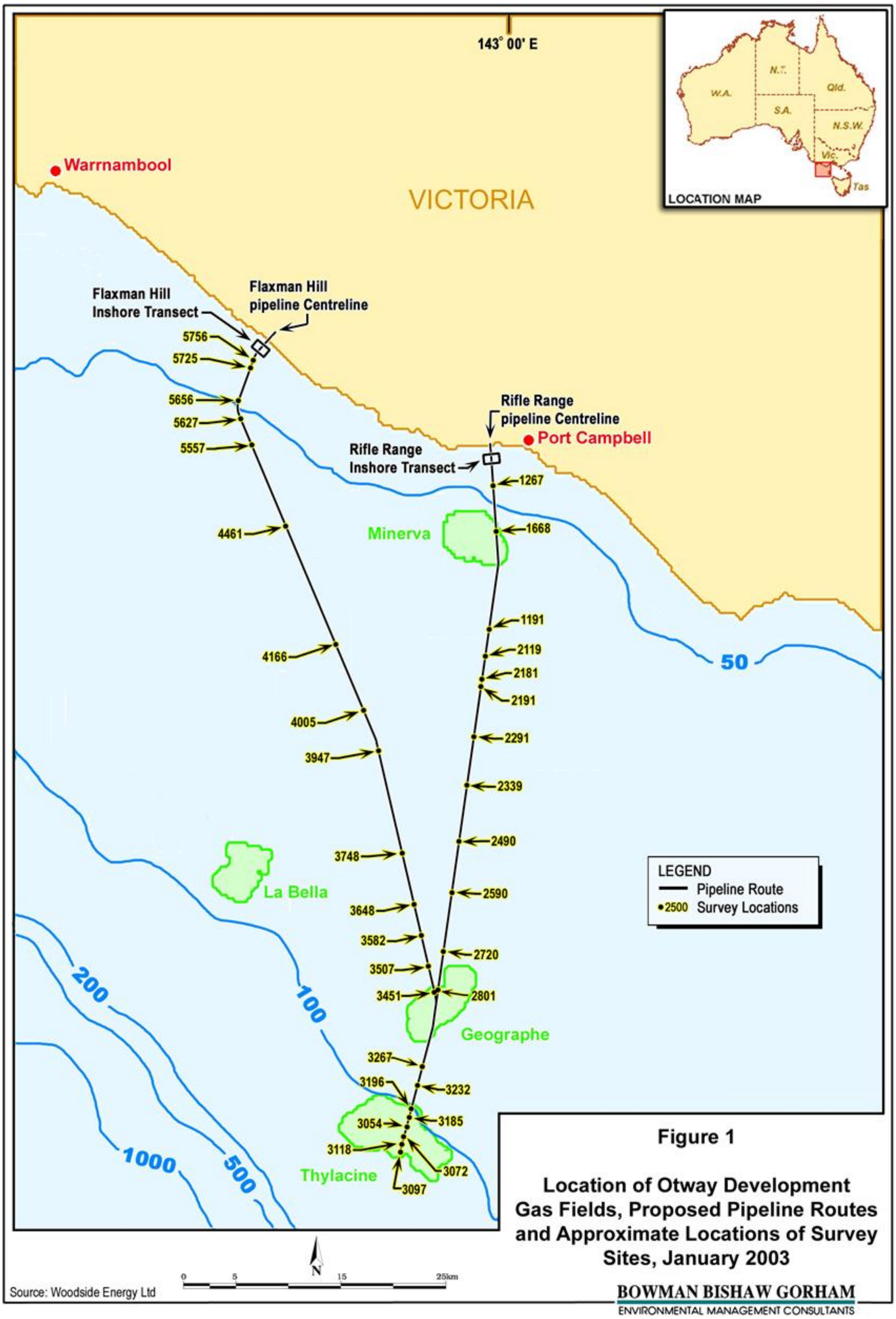


Figure 4-12: Seabed sites assessed by video survey during 2003 (BBG, 2003)

Beach commissioned a seabed site assessment for the Otway Gas Development. The seabed site assessment was undertaken from November 2019 to January 2020 and ranged in water depths from 70 to 104 m. The survey extent including the gas fields and infrastructure routes which are shown in Figure 4-13.

The objective of the seabed site assessment was to determine suitable locations for anchoring and MODU 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 manmade, natural and geological features.

Sediment samples for infauna were collected at two of the gas fields, Artisan and Thylacine (Ramboll, 2020. Appendix E). Due to poor weather conditions sampling had to be reduced. It was decided that the Artisan field would be representative of the infauna closer to shore (such as within the spill EMBA), while sampling at the Thylacine field is within the operational area.

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, most of which were polychaete worms or crustaceans. These results are reflective of the sedimentary environment at the Thylacine and Artisan fields. 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 laminar flows 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 types of species that were present in the samples were all those which can be expected to tolerate this somewhat dynamic environment. 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.

The composition and percent coverage of epifauna was assessed from photographs of the seafloor taken with a drop camera system (Ramboll, 2020. Appendix E).

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% (Figure 4-13). Of the individual epibenthic organisms, Gastropoda sp. 2 (a cone shell) and crionids (featherstars) were the most abundant. Further analysis of epifauna from a grab samples at Artisan (representative of the spill EMBA) showed 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.

Based on the assessment of epifauna using seabed photographs, the general impression of the seafloor is of a unmodifed marine environment that supports a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians and sponges). This complex was highly patchy, covering 0.25 m^2 on average but could be found in patches of at least 0.4 m^2. A microscopic examination of a qualitative sample of this epibiota indicated that this complex of fauna provide microhabitat for a range of macrofauna such as amphipods, isopods, polychaete worms and molluscs. Such epifaunal habitats are known to provide refuge and other resources for benthic species (Jones, 2006). By comparison, there was a low abundance and diversity of infauna living within the sediment which reflects the coarse nature of the substrate. This type of substrate is highly mobile making it difficult for filter feeders and soft bodies invertebrates to survive and establish significant populations.

Ramboll (2020) summarise that the epibiota on the seabed in the vicinity of the Thylacine and Artisan gas fields 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 EPBC Act were observed.

The findings from Ramboll (2020) align with findings from the Otway Gas Development studies (CEE Consultants Pty Ltd, 2003; BBG, 2003) and Boreen et al., (1993) concerning the subsea features and biological communities likely to dominate the EMBA. In summary the seabed of the EMBA can be characterised as a carbonate mid shelf and deeper sections (60 – 70 m) of the shallow shelf with surficial sediments of carbonate rich coarse to medium sands with areas of exposed limestone substrate. The epifauna is dominated by low density, sessile sponge assemblages. Six basalt rises occur in the eastern and south-eastern section of the EMBA, the largest of which is the 'Big Reef'.

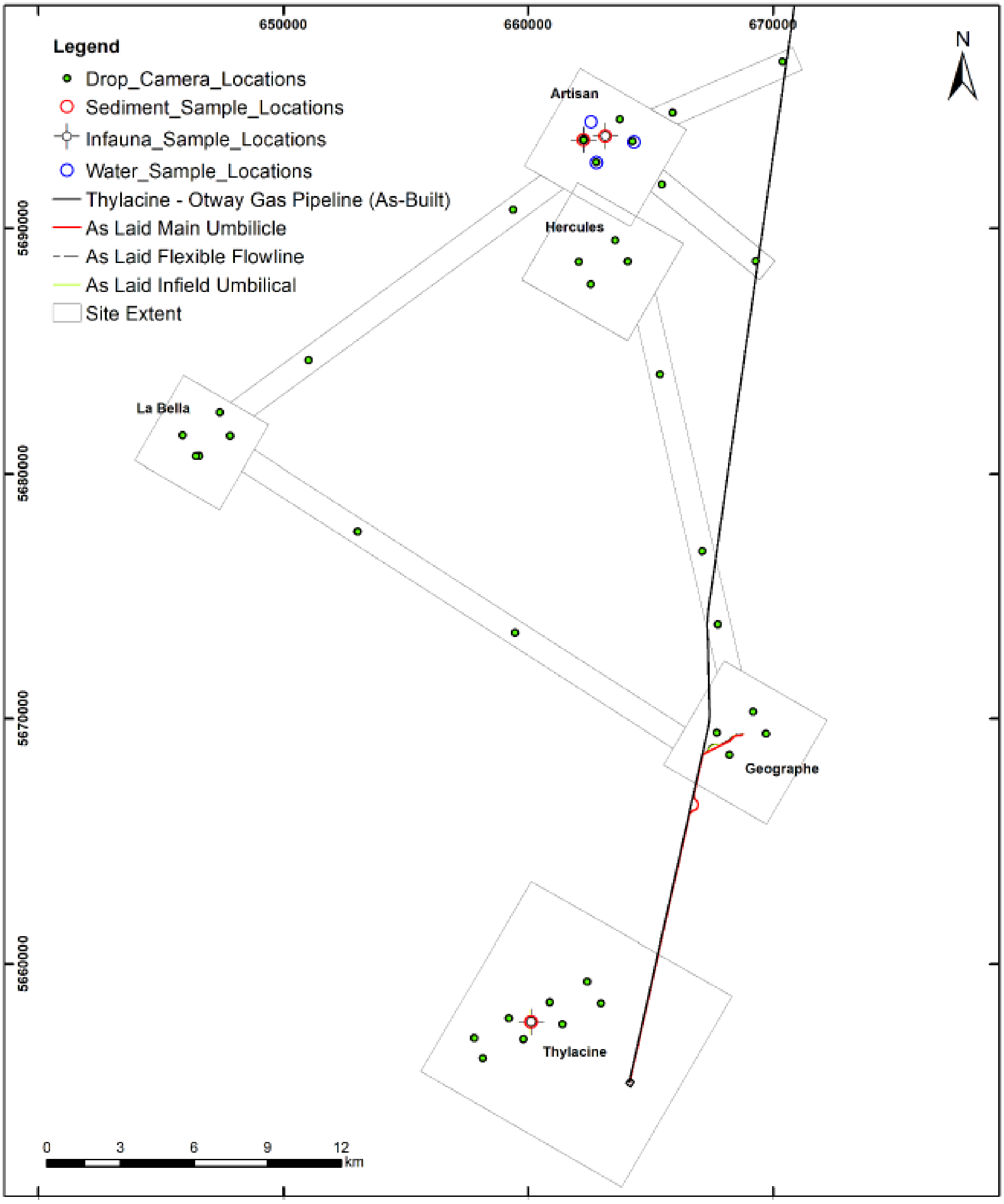


Figure 4-13: Location of the Otway Gas Development seabed site assessment

4.5.3 Otway assessments and surveys- Operational area

As detailed in Section 4.5.2, Beach commissioned a seabed site assessment for the Otway Gas Development, from November 2019 to January 2020, and in water depths ranging from 70 m to 104 m. The survey extent included the gas fields and infrastructure routes are shown in Figure 4-13.

The objective of the seabed site assessment was to determine suitable locations for anchoring and MODU placement for drilling operations and the installation of infrastructure to connect new production wells to the existing platform or pipeline. Information gathered is also relevant to the Phase 5 Early Dive Installation Campaign activities due to the locations surveyed. The geophysical survey comprised of multibeam bathymetry, side scan sonar, magnetometer and sub-bottom profiling. The geotechnical investigation comprised of cone penetration tests and seabed samples. In addition, sediment samples for infauna were collected at the Thylacine gas field and the composition and percent coverage of epifauna was assessed from photographs of the seafloor taken with a drop camera at several locations including the Thylacine gas field (Ramboll, 2020. Appendix E). The drop camera locations are shown in Figure 4-14. These investigation techniques were used to examine and describe the seabed and benthic biota, as well as identify possible hazards from manmade, natural and geological features.

The seabed site assessment for the Thylacine field (Fugro, 2020a; Ramboll, 2020) identified:

- The seabed depths vary ranging from 92 m to 115 m. LAT, with an overall southwestern slope.
- The seabed topography compromises of rocky outcrops of the regionally-dipping Port Campbell limestones.
- Sands are coarse (siliceous) calcareous medium sand.
- A local relief of up to 3 m is identified on the rocky scarp surfaces, which are separated by shallow depressions often with a transgressive sandy infill.
- The percentage epifauna cover from the eight drop camera sites ranged from zero to 65% with an average percentage cover of 14%.
- Predominantly hard seabed with coarse sand substrates that supports a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians and sponges).
- The epibiota on the seabed in the vicinity of the Thylacine gas fields 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.

Based on the information from the seabed site assessment for the Otway Gas Development, Condition 1 (d) of EPBC 2002/621 is met as information from the seabed site assessment was used to determine the final selection of the Thylacine and Geographe well locations. No high relief outcrops, reefs, sponge beds or historic shipwrecks were identified within the well locations.

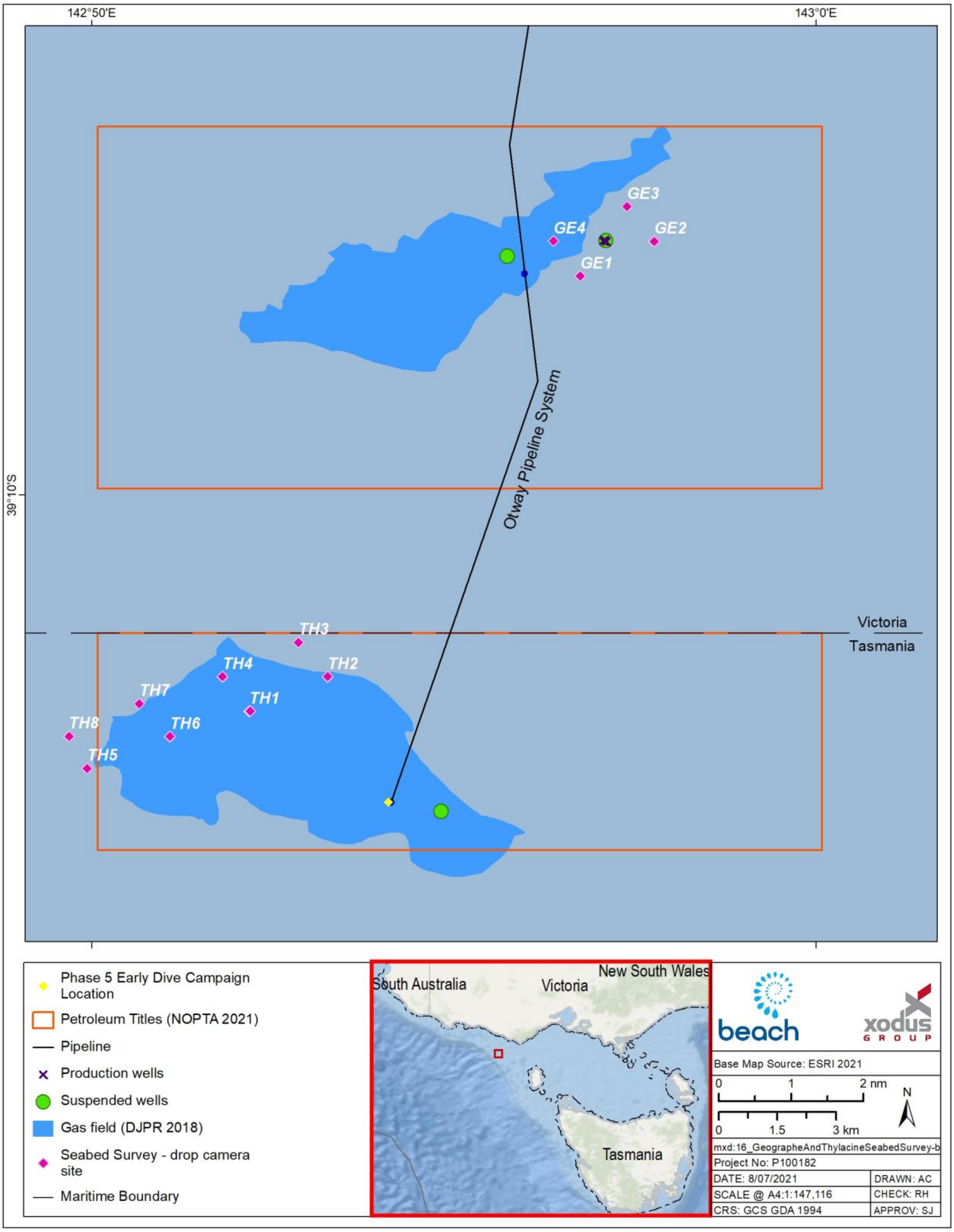


Figure 4-14: Drop camera locations within operational area

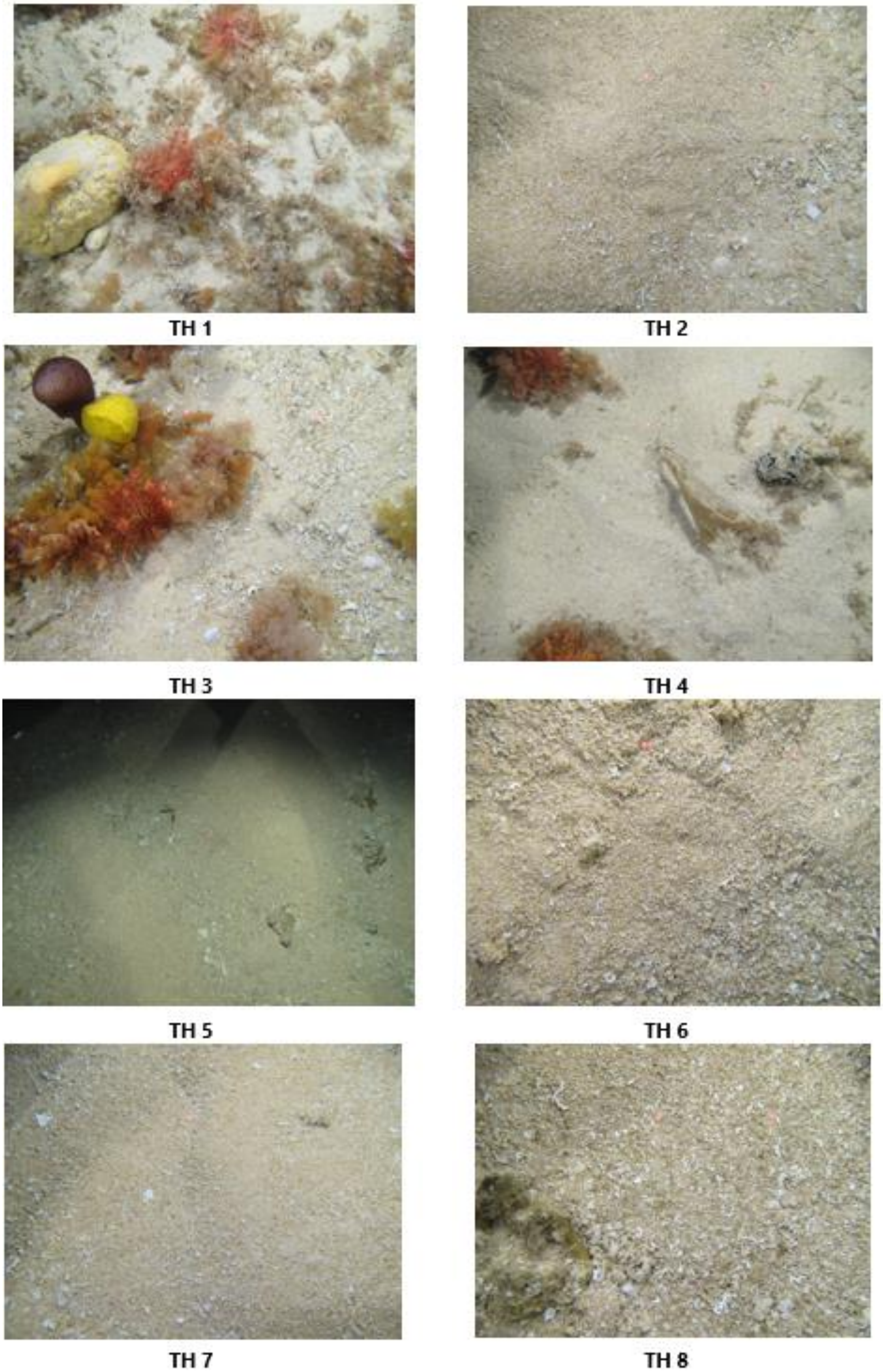


Figure 4-15: Drop camera images TH 1-8

4.5.4 Metocean conditions

4.5.4.1 Climate

The area is typical of a cool temperate region with cold, wet winters and warm dry summers. The regional climate is dominated by sub-tropical high-pressure systems in summer and sub-polar low pressure systems in winter. The conditions are primarily influenced by weather patterns originating in the Southern Ocean. The low-pressure systems are accompanied by strong westerly winds and rain-bearing cold fronts that move from south-west to north-east across the region, producing strong winds from the west, north-west and south-west.

The day-to-day variation in weather conditions is caused by the continual movement of the highs from west to east across the Australian continent roughly once every 10 days.

4.5.4.2 Winds

Bass Strait is located on the northern edge of the westerly wind belt known as the Roaring Forties. In winter, when the subtropical ridge moves northwards over the Australian continent, cold fronts generally create sustained west to south-westerly winds and frequent rainfall in the region (McInnes and Hubbert, 2003). In summer, frontal systems are often shallower and occur between two ridges of high pressure, bringing more variable winds and rainfall.

Winds in this section of the Otway basin and western Bass Strait generally exceed 13 knots (23.4 km/h) for 50% of the time. Winds contribute to the predominant moderate to high wave-energy environment of area and are predominantly south-westerly cycling to north-westerly. September is the windiest month, with average wind speeds of 29 km/h (Figure 4-16).

4.5.4.3 Tides

Tides are semi-diurnal with some diurnal inequalities (Jones and Padman, 1983), generating tidal currents along a north-east/south-west axis, with speeds generally ranging from 0.1 to 2.5 m/s (Fandry, 1983). The maximum range of spring tides in western Bass Strait is approximately 1.2 m. Sea level variation in the area can arise from storm surges and wave set up (Santos, 2004).

4.5.4.4 Ocean currents

The East Australian Current is one of the four major currents known to heavily influence on the conditions and biodiversity in Australian oceans and coastal environments. There are also a number of smaller and more complex current systems. All these ocean features can change from season to season, and may be more or less extensive and energetic, depending on climate factors.

Ocean currents in Bass Strait are primarily driven by tides, winds and density-driven flows (Figure 4-17). During winter, the South Australian current moves dense, salty warmer water eastward from the Great Australian Bight into the western margin of the Bass Straight. In winter and spring, waters within the straight are well mixed with no obvious stratification, while during summer the central regions of the straight become stratified.

Furthermore, during winter, the Bass Strait cascade occurs, a wintertime downwelling caused by cooling of the shallow waters of Bass Strait in the Gippsland Basin. Downwelling currents that originate in the shallow eastern waters of Bass Strait flow down the continental slope to depths of several hundred meters or more into the Tasman Sea. Lateral flushing within the strait results from inflows from the South Australian Current, East Australian Current, and sub-Antarctic surface waters. The importance of this phenomenon is recognised through the designation of the seasonal Bass Cascade KEF.

Surface currents within the permit area have been modelled by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2009 – 2013 inclusive to produce monthly surface currents. These show a rotational aspect because of inflow and outflow to Bass Strait. Although unimodal the currents are stronger from the west in all months excepting February when the currents from the east are the strongest. Minimum currents have been derived as 0.2-0.4 m/s and maximum currents as 0.8-2.0 m/s, with the strongest currents during the months July to October.

4.5.4.5 Waves

Bass Strait is a high-energy environment exposed to frequent storms and significant wave heights. The Otway coast has a predominantly south-westerly aspect and is highly exposed to swell from the Southern Ocean.

There are two principal sources of wave energy in the Otway Basin:

- from the westerly swell from the Great Australian Bight and Southern Ocean.
- from locally generated winds, generally from the west and east.

The Otway area is fully exposed to long period 13 second average south-westerly swell from the Southern Ocean as well as periodic shorter 8 second average period waves from the east. Wave heights from these winds generally range from 1.5 m to 2 m, although waves heights to 10 m can occur during storm events and a combination of wind forcing against tidal currents can cause greater turbulence. The largest waves are associated with eastward-moving low pressure and frontal systems that cross the site every 4 to 6 days in winter.

4.5.4.6 Sea temperature

The waters have average surface temperatures ranging from 14°C in winter to 21°C in summer. However, subductions of cooler nutrient-rich water (upwellings) occur along the seafloor during mid to late summer, though this is usually masked in satellite images by a warmer surface layer.

The upwelled water is an extension of the regional Bonney coast upwelling system, which affects southern Australia because of south-east winds forcing surface water offshore thus triggering a compensatory subduction along the bottom. If the wind is strong enough the water sometimes shoals against the coast. The water originates from a subsurface water flow called the Flinders current and has the characteristics of reheated Antarctic Intermediate Water (Levings and Gill, 2010).

During winter and spring onshore winds cycling from the southwest to northwest mound the surface layer against the land and cause a south-easterly flow along the coast that fills the shelf from the shore outwards to a depth of 500 m deep. Shelf water temperatures at these times range from between 18°C to 14°C with seafloor temperatures warmer in winter than in summer.

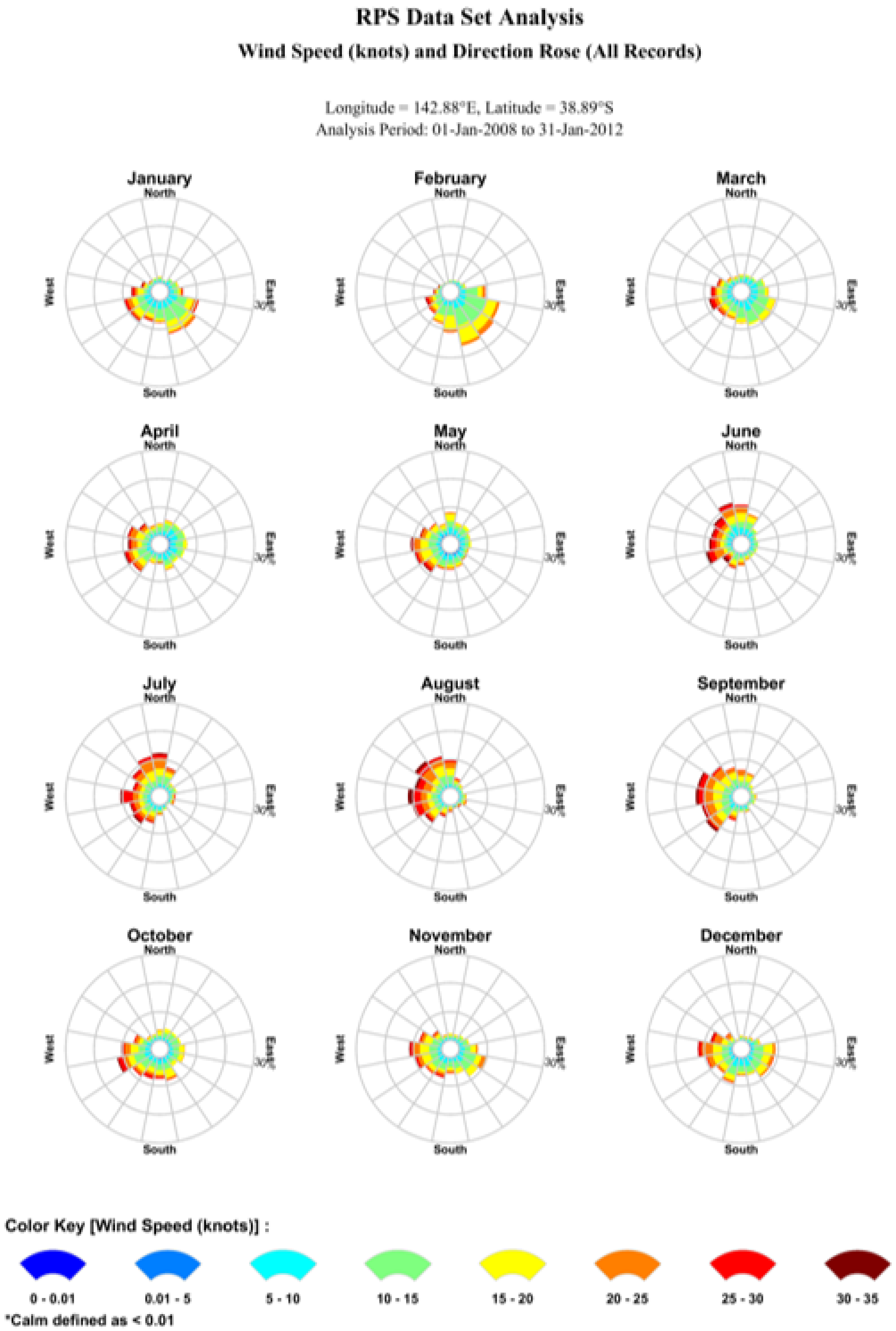


Figure 4-16: Modelled monthly wind rose distributions (RPS, 2019)

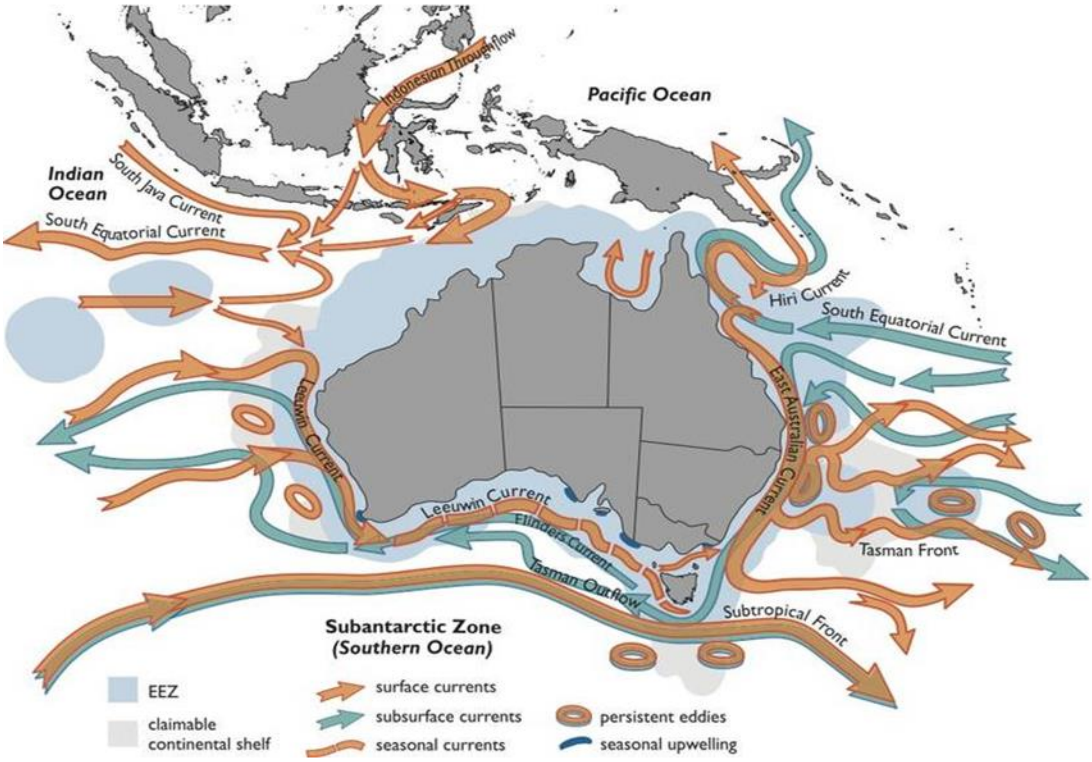


Figure 4-17: Australian ocean currents

4.5.5 Ambient sound levels

McCauley and Duncan (2001) undertook a desktop review of natural and man-made sea sound sources likely to be encountered in the Otway Basin. They concluded that natural sea sound sources are dominated by wind noise, but also include rain noise, biological noise and the sporadic noise of earthquakes. Man-made underwater sound sources in the region comprise shipping and small vessel traffic, petroleum production and exploration drilling activities and sporadic petroleum seismic surveys.

Between 2009 and 2016 the Integrated Marine Observing System (IMOS) has been recording underwater sound south of Portland, Victoria (38°32.5' S, 115°0.1'E). Prominent sound sources identified in recordings include blue and fin whales at frequencies below 100 Hz, ship noise at 20 to 200 Hz and fish at 1 to 2 kHz (Erbe et al., 2016). In the broader region, primary contributors to background sound levels were wind, rain and currents-and waves-associated sound at low frequencies under 2 kHz (Przeslawski et al., 2016). Biological sound sources including dolphin vocalisations were also recorded (Przeslawski et al., 2016).

Ambient sound levels in the Otway Basin have been measured as part of impact assessment activities for the petroleum industry.

To gain an understanding of the existing marine acoustic environment to inform the impact assessment for the Otway Gas Development acoustic monitoring was undertaken by Woodside (2003). During April-May 2001 two underwater noise loggers were placed (5.1 km and 2.9 km south-west of an exploration petroleum drilling vessel at the Thylacine site) to measure underwater noise before, during and after drilling activity. Only one of the loggers (5.9 km) was able to be recovered. A further logger was placed in the shipping lane approximately 60 km due south of Port Fairy to measure ambient noise produced by physical, man-made and biological sources between late November 2001 and early March 2002.

The following features were noted with respect to underwater noise environment at the Thylacine location:

- The Thylacine site was relatively quiet with only the passage of several boats (about ten) evident.

- The rig tender and drill rig noise show clearly from 13:00 on the 3 May 2001.
- Drill rig noise was evident as sharp tones.
- Rig tender noise was evident either at a low but persistent level for days or in short bursts of high level noise for several hours associated with manoeuvring, use of thrusters or as a close passage by the receiver.
- The horizontal banding characteristic of persistent calling by pygmy blue whales was not evident, rather these call types occurred infrequently and at low levels indicating the respective sources were at long range.
- Evidence of low-level, distant evening fish choruses only.

The following features were noted with respect to underwater noise environment at the shipping lane location:

- Regular passages of boats evident.
- Regular evening fish choruses, there were also dawn choruses and persistent low level calling by these sources over daytime.
- Blue whale calling persisted over many hours, an example is the first close passage for the season just before midday on 4 January 2002 followed by several more animals a day later.
- Evidence of calling from at least three other whale species.
- Baseline broadband underwater noise for the period was in the order of 93 to 97 dB re 1 µPa with shipping raising the averaged noise level above 105 dB re 1 µPa for 6% of the deployment time.

An acoustic monitoring program was also undertaken during exploratory drilling of the Casino-3 well. A sound logger located 28.03 km from the drill site did not detect drilling noise and recorded ambient noise that ranged between 90 and 110 dB re 1 µPa (McCauley, 2004). Passive acoustic monitoring commissioned by Origin from April 2012 to January 2013, 5 km offshore from the coastline east of Warrnambool, identified that ambient underwater noise in coastal areas are generally higher than further offshore, with a mean of 110 dB re 1 µPa and maximum of 161 dB re 1 µPa (Duncan et al., 2013).

More recently, JASCO Applied Sciences (Australia), JASCO, completed a monitoring study for Beach in relation to exploration drilling activities at the Artisan-1 well with the aim of completing an acoustic characterisation of the drilling and associated vessel activity within the Otway Basin. McPherson et al. (2021) details the monitoring program and results. Four recorders were deployed in February and retrieved in early April 2021 with Stations 1 through 4 deployed at distances of 0.336, 1.13, 5.11, and 25 km from the Ocean Onyx drill rig.

The results for Station 4, the furthest from the drill rig, were a median broadband ambient noise of 104.5 dB re 1 µPa, a mean of 118.3 dB re 1 µPa, a minimum of 86.6 dB re 1 µPa, and a maximum of 153.6 dB re 1 µPa. This is both quieter and louder than those for Casino 3. The mean levels at Station 4 are 8.3 dB higher than those recorded 5 km offshore of Warrnambool, while the maximum recorded at Station 4 is lower by 7.4 dB. For Station 4 contributors to the soundscape were weather, shipping, and marine mammals. Local variations in ambient noise and received levels can depend upon water depth and the proximity to contributors. In this case, the shipping lanes and the frequency and proximity of vessel passes are strong drivers of the ambient noise at Station 4. The quieter levels reported at Thylacine in Lattice Energy (2017) are likely due to the placement of the monitoring station at a distance from the shipping lanes, which limited their contributions to the data set and thus resulted in a lower reported range of received sound levels.

4.5.6 Water quality

Marine water quality considers chemical, physical and biological characteristics with respect to its suitability to support marine life, or for a purpose such as swimming or fishing. Marine water quality can be measured by several factors, such as the concentration of dissolved oxygen (DO), the salinity, the amount of material suspended in the water (turbidity or total suspended solids) as well as the concentration of contaminants such as hydrocarbons and heavy metals.

The Otway Basin is characterised by high wave energy and cold temperature waters subject to upwelling events (Bonney coast upwelling) around the continental shelf margin (Origin, 2015). Significant upwelling of colder, nutrient rich deep water during summer can cause sea surface temperatures to decrease by 3°C compared with offshore waters (Butler et al., 2002).

The Bass Strait and Otway Basin are known for a complex, high energy wave climate and strong ocean currents (Origin, 2015), and therefore water column turbidity on the Victorian coastline is subject to high natural variability. Weather conditions in the coastal environment around Port Campbell and Port Ferry are known to influence offshore hydrodynamic conditions and are a driver of sediment dynamics, impacting benthic and pelagic habitats and changing water column turbidity. Wave-driven sediment resuspension generates high turbidity levels within coastal zones, commonly exceeding 50 mg/L (Larcombe et al. 1995, Whinney 2007, Browne et al., 2013), but coastal communities appear generally well adapted to deal with these extrinsic stresses.

An environmental survey was undertaken from November 2019 to January 2020 for the Otway Gas Development (Ramboll, 2020. Appendix E). Water samples were collected at two of the gas fields, Artisan and Thylacine.

In-situ measurements were taken for DO, pH and oxidation-reduction potential (ORP) and 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.

DO 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.

Laboratory analyses for a suite of analytes were undertaken and compared to the ANZECC (2000) 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 the level of reporting (LOR) for all samples. Only one sample contained a concentration of nitrate-nitrite, NO_{-3}, TKN and TN above the LOR, however, none of the measurements exceeded ANZECC trigger values. Concentrations of TP were recorded in all samples, but all measurements were well below ANZECC trigger values. TSS was typically within the range expected for unmodified marine waters.

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) 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 small degree by human activity.

BTEXs and PAHs were below the detection limit in all water samples. Very low traces of Total Recoverable Hydrocarbon (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.

In summary, the water quality at the Thylacine and Artisan survey areas indicated an undisturbed mid-depth environment.

It is expected that water quality within the operational area and spill EMBA will be typical of the offshore marine environment of the Otway Basin, which is characterised by high water quality with low background concentrations of trace metals and organic chemicals.

4.5.7 Sediment quality

An environmental survey was undertaken from November 2019 to January 2020 for the Otway Gas Development (Ramboll, 2020. Appendix E). Sediment samples were collected at two of the gas fields, Artisan and Thylacine using a Double Van Veen grab sampler. Three replicate sediment samples were to be collected at each of the fields, 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 sediment within all samples and, therefore at both fields, 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 fraction. There were no discernible trends based on the location of sample collection.

The ORP or oxidation reduction potential of sediments within the samples was measured and 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.

There was a notable degree of variability in the nutrient samples collected in the Thylacine field, however the small number of samples means that a trend or pattern is not discernible. Nitrate-nitrite was not detected in any samples. Total organic content 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.

Of the inorganic compounds tested, Cd, Cu, Pb, Hg, Ni and Sn were below the limit of reporting in all sediment samples. The concentration of Cr in sediments was low, and well below the Interim Sediment Quality Guidelines 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.

BTEXs, PAHs, PCBs and TRHs were either below the LOR or at levels of no concern.

In summary, sediments had a high ORP and low or undetectable levels of toxicants indicating an unmodified seabed environment.

It is expected that sediment quality within the operational area and spill EMBA will be typical of the offshore marine environment of the Otway Basin.

4.5.8 Air quality

Historical air quality data for the region is available from the Environment Protection Authority (EPA) Victoria air quality monitoring stations, and Cape Grim Baseline Air Pollution Station on Tasmania's west coast, which is one of the three premier baseline air pollution stations in the World Meteorological Organisation-Global Atmosphere Watch (WMO-GAW) network, measuring greenhouse and ozone depleting gases and aerosols in clean air environments.

The Victorian air quality data is collected at 15 performance monitoring stations representing predominantly urban and industrial environments in the Port Phillip and Latrobe Valley regions of Victoria. Results are assessed against the requirements of the National Environment Protection (Ambient Air Quality) Measure for the pollutants carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), particles less than 10 micrometres in diameter (PM10) and particles less than 2.5 micrometres in diameter (PM2.5). The most recent annual air monitoring report shows Victoria's air quality in 2015 was generally good with AAQ NEPM (Ambient Air Quality National Environmental Protection Measure) goals and standards being met for carbon monoxide (CO), nitrogen dioxide (NO_2), Ozone (O_3) and sulphur dioxide (SO_2). There were some exceedances for particles.

The Geelong monitoring station is the closest to the operational area; however, it is situated in an urban environment and is not representative of the clean air environment over the majority of the EMBA. The Cape Grim Baseline Air Pollution Station data is likely a more reliable point of reference for air quality in the operational area and spill EMBA as the air sampled arrives at Cape Grim after long trajectories over the Southern Ocean and is representative of a large area unaffected by regional pollution sources (cities or industry) (CSIRO, 2017). The Cape Grim station monitors greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and synthetic GHGs such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6).

Historical air quality data from Cape Grim show that most GHGs have shown continuous increases in concentration since the mid-to-late 1970s with carbon dioxide levels increasing by more than 15% since 1976, and concentrations of methane and nitrous oxide increasing by around 20% and 8% respectively since 1978. The increase in methane levels however has slowed recently and CFCs and halons are in decline. Increases have been attributed to anthropogenic causes, for example, fossil fuel consumption and agricultural practices (CSIRO, 2017).

4.5.9 Bonney coast upwelling

The Bonney coast upwelling is mainly driven by the frequent south-easterly winds during the austral summer (Lewis, 1981; Middleton and Bye, 2007; Nieblas et al., 2009; Schahinger, 1987). The frequent south-easterly winds are the result of southern migration of the subtropical ridge (Nieblas et al., 2009; Schahinger, 1987). The upwelling occurs via Ekman dynamics, where the ocean surface experiences a steady wind stress which results in a net transport of water at right angles to the left of the wind direction which brings cold, nutrient rich water to the sea surface.

Huang and Wang (2019) developed an image processing technique to map upwelling areas along the south-eastern coast of Australia. This study used monthly Moderate Resolution Imaging Spectroradiometer (MODIS) sea surface temperature (SST) composites between July 2002 and December 2016, which were generated from daily SST images with a spatial resolution of ~1 km. As upwelling in winter is unlikely to occur images during this period were not analysed. Upwelling reaching the surface often displays a colder SST signature than the adjacent area (e.g., Dabuleviciene et al., 2018; Gill et al., 2011; Kampf et al., 2004; McClatchie et al., 2006; Oke and Griffin, 2011; Oke and Middleton, 2001; Roughan and Middleton, 2002; Roughan et al., 2003; Willis and Hobday, 2007). This negative SST anomaly is the foundation of upwelling mapping using SST data (Huang and Wang 2019).

The spatial patterns of the mapped Bonney coast upwelling have been shown to follow a clear temporal pattern. When the upwelling season starts during late spring and early summer (November and December), the influence of the Bonney coast upwelling was found to be often restricted to the coast. During the mid-summer and early autumn (January to March) when the upwelling is the strongest, the upwelling influence often extended to the shelf break before retreating in April (Huang and Wang 2019).

Gill et al (2011) states that the Bonney coast upwelling generally starts in the eastern part of the Great Australian Bight and spreads eastwards to the Otway Basin. At the height of the Bonney coast upwelling during February and March, the upwelling's area of influence often exceeds 12,000 km^2, its SST anomaly often exceeds 1°C, and its chlorophyll-a concentrations are often >1.5 times of its adjacent areas (Huang and Wang 2019).

Variability

While the general characteristics of the Bonney coast upwelling are broadly understood virtually nothing is known of the longer-term variability of the phenomenon. Alongshore wind is the predominant mechanism in the upwelling, which is, therefore, directly impacted by any changes to the strength or frequency of these winds. However, not all favourable upwelling winds lead to an upwelling event. Huang and Wang (2019) state that each year for the period of 14 years (Sept 2002 to May 2016) of their study there was large variability in the distribution of the upwelling influence areas, month to month, season to season and year to year.

The El Niño – Southern Oscillation (ENSO) has been identified by some authors as a potential driver of upwelling strength along the south Australian coast. The ENSO is the dominant global mode of inter-annual climate variability, is a major contributor to Australia's climate and influences Australia's marine waters to varying degrees around the coast. The two phases of ENSO, El Niño and La Niña, produce distinct and different changes to the climate.

Middleton et al., (2007) examined meteorological and oceanographic data and output from a global ocean model. The authors concluded that El Niño events lead to enhanced upwelling along Australia's southern shelves. However, it has been found that relationships between ENSO events and upwelling and production indices off southern Australia are weak due to the high interannual and inter-seasonal variability in these indices.

Huang and Wang (2019) results indicate that the ENSO events are likely to have a low-to-moderate impact on the upwelling intensity although the El Nino events tend to strengthen upwelling intensity along the south-east coast of Australia with La Nina events tending to weaken upwelling intensity. Previous studies (Middleton and Bye, 2007; Middleton et al., 2007) indicated that the El Nino events would raise the thermocline (along the Australian margin) which effectively forms a colder and nutrient-rich pool at shallower depths. This is likely to enhance upwelling intensity, with higher SST and chlorophyll-a anomalies and a larger area of influence.

Ecological importance

The primary ecological importance of the Bonney coast upwelling is as a feeding area for the blue whale (*Balaenoptera musculus*). The upwelled nutrient-rich re-heated Antarctic intermediate water promotes blooms of coastal krill, *Nyctiphanes australis*, which in turn attracts blue whales to the region to feed.

The Bonney coast upwelling is one of only two identified seasonal feeding areas for blue whales in Australian coastal waters and is one of 12 known blue whale feeding aggregation areas globally. Sightings of the sei whale (*Balaenoptera borealis)* in the upwelling indicate this is potentially an important feeding ground for the species (Gill et al., 2015). There have also been sightings of the fin whale (*Balaenoptera physalus)*, which indicate this could potentially be an important feeding ground (Morrice et al., 2004)

The high productivity of the Bonney coast upwelling also leads to other attributes such as algal diversity and its productivity as a fishery. This productivity is also capitalised on by other higher predator species such as little penguins and fur-seals feeding on baitfish. Robinson et al. (2008) postulated that upwelling waters may bring fish prey of Australian fur-seals to surface waters, which are then flushed into Bass Strait within foraging range of seals.

Linkages between climate, upwelling strength and blue whale abundance

The complex interaction between climatic conditions, upwelling strength and seasonal blue whale distribution and abundance within the Bonney coast upwelling is currently poorly understood other than at a general level. Factors to be resolved to enable a more detailed understanding include observations that not all strong upwelling-favourable winds necessarily lead to strong upwelling events (Griffin et al. 1997) and that increased upwelling does not necessarily equate to increased productivity as conditions may be less optimal for plankton growth. Huang and Wang (2019) found a generally weak and unclear correlation between chlorophyll-a and SST. This weak correlation may be due to chlorophyll-a concentrations (a remote measure of plankton population) being influenced by other complex oceanographic and biological mechanisms such as grazing, seasonality and transportation

Further, an increase in plankton biomass does not necessarily coincide with the presence of the blue whales. Review of pygmy blue whale aerial observation data from Gill et al. (2011) from the 2001-02 to 2006-07 seasons, and additional surveys in the Otway Basin commissioned by Origin during February 2011 and November - December 2012 did not find a significant positive correlation between El Niño conditions and pygmy blue whale abundance. Such a positive correlation could be expected if El Niño conditions caused a stronger upwelling and a stronger upwelling led to increased planktonic productivity with an associate increase in blue whales.

Two of the six seasons subject to aerial surveys in the eastern section of the Otway Basin (Gill et al, 2011) were determined by the Bureau of Meteorology to demonstrate weak to moderate El Niño conditions. The remainder of the years were assessed to be neutral. The two El Niño seasons (2002-03 and 2006-07) corresponded with the lowest observation frequencies (sightings/1,000 km) for pygmy blue whales of all the yearly surveys.

Aerial surveys commissioned by Origin undertaken during February 2011 and November-December 2012 were undertaken during La Niña events classified by the Bureau of Meteorology (BOM) as very strong and strong respectively. Although observation frequencies are not available, the absolute numbers of pygmy blue whales observed was substantially higher than during the 2001-01 to 2006-07 surveys. Also, of note is that pygmy blue whales observed during February 2011 were congregated along the seaward edge of a plume of terrestrial runoff, potentially suggesting use of this plume as a feeding resource, which has no relationship to upwelling.

As such, the interactions between climate and ecology for this upwelling system are complex and no definitive linkages between climatic events, upwelling strength and blue whale abundance have yet been described. Given this, development of management strategies for petroleum activities in the area using prevailing climatic conditions as a predictor of seasonal blue whale abundance is not currently feasible.

Operational Setting

Mapping of the Bonney coast upwelling frequency by Huang and Wang (2019) identified that the occurrence of an upwelling event between 2002 and 2016 (measured by remote sensing of a combination of SST anomaly and chlorophyll-a) within the operational area was unlikely with an upwelling frequency for this area of <10%. The closest areas of increased frequency of upwelling events to the operational area (10-30% occasional/semi-seasonal) were small isolated areas situated in coastal areas (Figure 4-18) >35 km from the Thylacine-A wellhead platform. Areas of further increased frequencies of Bonney coast upwellings (30-50% seasonal) were found to the west >235 km of the operational area.

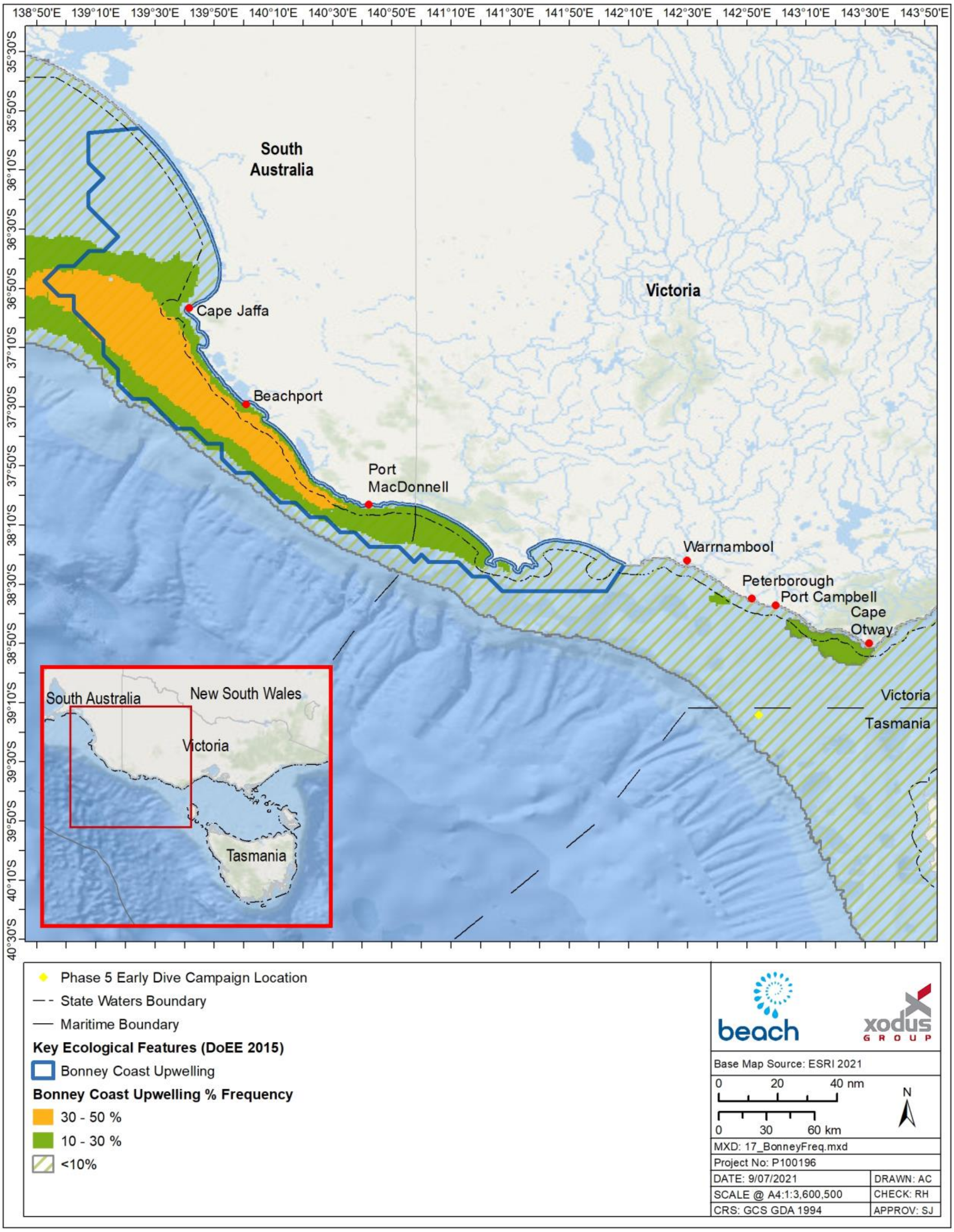


Figure 4-18: Bonney coast upwelling frequency (*Source: Huang and Wang 2019; Geoscience Australia 2020*).

4.6 Ecological environment

To characterise the ecological environment, a literature search and online resources and databases have been reviewed to identify and assess flora and fauna species known to be present or potentially present in the operational area and spill EMBA. The following information sources were reviewed to assure consistency with previous assessments and to develop an up-to-date overview of the existing environment.

- Online government databases, publications, and interactive mapping tools, such as the SPRAT database provided by the DAWE.
- The DAWE Protected Matters Search Tool (PMST) for Matters of National Environmental Significance (MNES) protected under the EPBC Act.
- Published observations, data and statistics on marine mammals.
- Reports from scientific experts and institutions, marine biologist and experts in blue whale and southern right whale populations in the Otway area.
- Seabed site assessment undertaken for the Otway Gas Development (Ramboll, 2020. Appendix E)
- Woodside's Otway Gas Project Environmental Effects Statement/Environmental Impact Assessment (EES/EIS) (2003) (Woodside, 2003).
- Santos Casino Gas Field Development Environmental Report (2004) (Santos, 2004).
- BHP Billiton's Minerva Environmental Impact Statement and Environmental Effects Statement and Associated Supplemental Environmental Monitoring published research papers (BHP Billiton, 1999).
- Origin Energy's Environment Plans for previous activities in the region.
- The National Conservation Values Atlas (Commonwealth of Australia, 2015).
- Relevant listings under the Victorian FFG Act 1988 (DELWP, 2017b).
- Relevant listings under the Tasmanian Threatened Species Conservation Act (1995) (TSC Act).
- Relevant environmental guidelines and publicly available scientific literature on individual species.

4.6.1 Benthic habitats and species assemblages

Benthic communities are biological communities that live in or on the seabed. These communities typically contain light-dependent taxa such as algae, seagrass and corals, which obtain energy primarily from photosynthesis, and/or animals such as molluscs, sponges and worms. Benthic habitats are the seabed substrates that benthic communities grow on or in; these can range from unconsolidated sand to hard substrates (e.g. limestone) and occur either singly or in combination.

The Otway continental margin is a swell-dominated, open, cool-water carbonate platform which can be divided into depth-related zones (Figure 4-10, Boreen et al., 1993):

- Shallow shelf: consisting of exhumed limestone substrates that host encrusting mollusc, sponge, bryozoan and red algae assemblages.
- Middle shelf: a zone of swell wave shoaling and production of mega-rippled bryozoan sands.
- Deep shelf: accumulations of intensely bioturbated, fine bioclastic sands.
- Shelf edge/top of Slope: nutrient-rich upwelling currents support extensive, aphotic bryozoan/sponge/coral communities.

The dominant benthic habitat throughout the area, as indicated by the seabed and benthic habitat studies detailed in Section 4.5.2 and 4.5.3, is medium to coarse carbonate sands with areas of low relief exposed limestone (Ramboll, 2020; Appendix E). Drop camera images of seabed at the Thylacine survey locations are shown in Figure 4-15. A series of basaltic rises occur in the south eastern corner of the spill EMBA.

The benthic species assemblages known or likely to be associated with these habitats are described in the following sections.

4.6.1.1 Soft Sediment

Unvegetated soft sediments are a widespread habitat in both intertidal and subtidal areas, particularly in areas beyond the photic zone. Factors such as depth, light, temperature and the type of sediment present can vary the biodiversity and productivity of soft sediment habitat.

The Middle Otway Shelf (70-130 m depth) is a zone of large tracts of open sand with little or no epifauna to characterise the area: infaunal communities and bivalves, polychaetes and crustaceans dominate in the open sand habitat. The Deep Otway Shelf (130 – 180 m) sediments consist of accumulations of intensely bioturbated, fine, bio clastic sands. The Upper Slope of Otway Shelf (>180 m) incorporates the edge/ top of the shelf which displays nutrient-rich upwelling currents support extensive, aphotic bryozoan/sponge/coral communities. The upper slope is dominated by bioturbated mixture of periplatform bioclastic debris and pelleted foraminiferal/nannofossil mud. Turbidites and resedimentation features are common. Bioturbation and shelf-derived skeletal content decrease progressively downslope and pelagic muds dominate below 500 m.

Scientific surveys have shown that some shallow Victorian sandy environments have the highest levels of animal diversity in the sea ever recorded (Parks Victoria, 2016a). Some of the larger animals found in these soft sediment environments in Victoria include smooth stingray (*Dayatis brevicaudata*), pipi (*Plebidonax deltoids*), dumpling squid (*Euprymna tasmanica*), common stargazer (*Kathetostoma laeve*) and heart urchin (*Echinocardium cordatum*) (Parks Victoria, 2016a).

4.6.1.2 Seagrass

Seagrasses are marine flowering plants, with around 30 species found in Australian waters (Huisman, 2000). While seagrass meadows are present throughout southern and eastern Australia, the proportion of seagrass habitat within the south-eastern sector is not high compared to the rest of Australia (in particular with parts of South Australia and Western Australia) (Kirkham, 1997).

Seagrass generally grows in soft sediments within intertidal and shallow subtidal waters where there is sufficient light and are common in sheltered coastal areas such as bays, lees of islands and fringing coastal reefs (McClatchie et al., 2006; McLeay et al., 2003). Known seagrass meadows within the spill EMBA include Corner Inlet, Port Phillip Bay and Western Port Bay. Seagrass meadows are important in stabilising seabed sediments, and providing nursery grounds for fish and crustaceans, and a protective habitat for the juvenile fish and invertebrates species (Huisman, 2000; Kirkham, 1997).

Within the spill EMBA, seagrass is present along the South Australian (SA) and Victorian coastline (Figure 4-19).

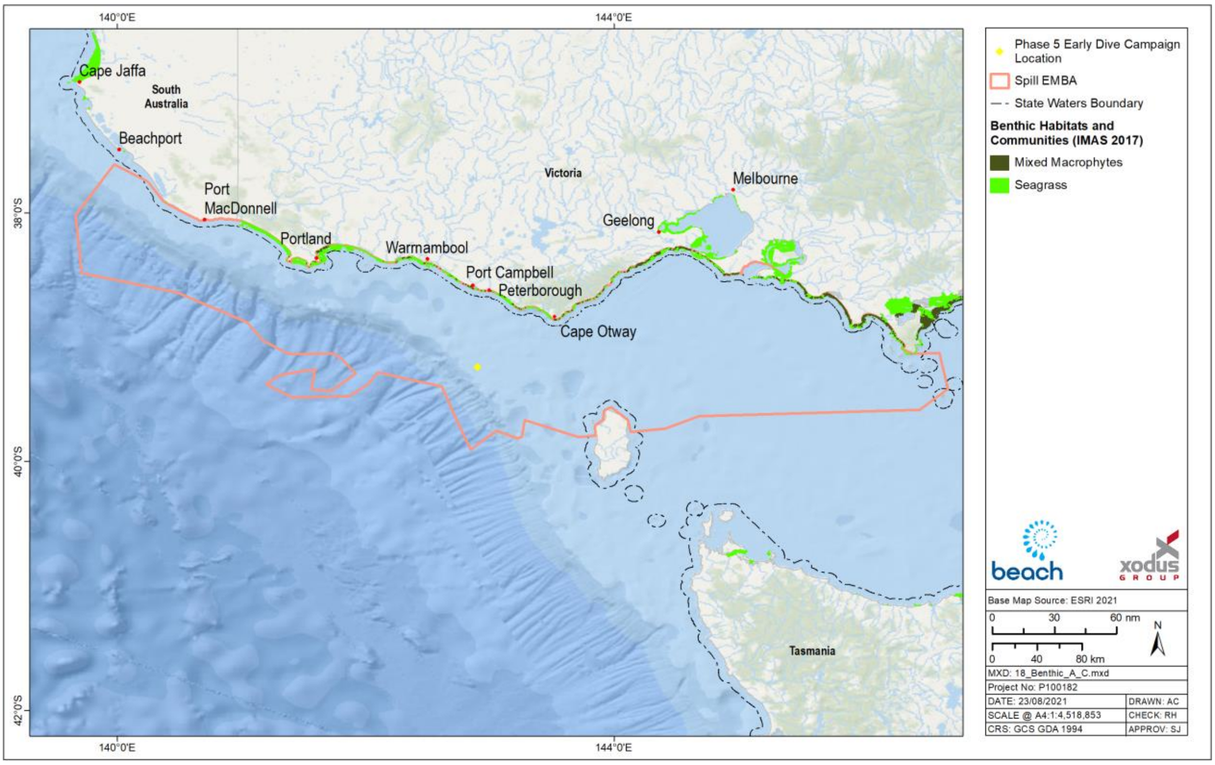


Figure 4-19: Presence of seagrass (and mixed macrophyte) habitat within the spill EMBA

4.6.1.3 Algae

Benthic microalgae are present in areas where sunlight reaches the sediment surface. Benthic microalgae are important in assisting with the exchange of nutrients across the sediment-water interface; and in sediment stabilisation due to the secretion of extracellular polymetric substances (Ansell *et al.*, 1999). Benthic microalgae can also provide a food source to grazers such as gastropod and amphipods (Ansell *et al.*, 1999).

Macroalgae communities occur throughout the Australian coast and are generally found on intertidal and shallow subtidal rocky substrates. Macroalgal systems are an important source of food and shelter for many ocean species; including in their unattached drift or wrack forms (McClatchie *et al.*, 2006). Macroalgae are divided into three groups: Phaeophyceae (brown algae), Rhodophyta (red algae), and Chlorophyta (green algae). Brown algae are typically the most visually dominant and form canopy layers (McClatchie *et al.*, 2006). The presence and growth of macroalgae are affected by the principal physical factors of temperature, nutrients, water motion, light, salinity, substratum, sedimentation and pollution (Sanderson, 1997). Macroalgae assemblages vary, but *Ecklonia radiata* and *Sargassum* sp. are typically common in deeper areas. Within the spill EMBA macroalgae is present along the South Australian (SA) and Victorian coastline from Beachport in SA to Philip Island (Figure 4-20).

4.6.1.4 Coral

Corals are generally divided into two broad groups: the zooxanthellate ('reef-building', 'hermatypic' or 'hard') corals, which contain symbiotic microalgae (zooxanthellae) that enhance growth and allow the coral to secrete large amounts of calcium carbonate; and the azooxanthellate ('ahermatypic' or 'soft') corals, which are generally smaller and often solitary (Tzioumis and Keable, 2007). Hard corals are generally found in shallower (<50 m) waters while the soft corals are found at most depths, particularly those below 50 m (Tzioumis and Keable, 2007).

Corals is not listed as a dominant habitat type within the operational area and spill EMBA (IMAS, 2017), however their presence has been recorded around areas such as Wilsons Promontory National Park and Cape Otway. Gorgonian corals (soft corals) were identified during the seabed survey at Thylacine (Ramboll 2022; Appendix E) as part of a patchy complex of branching epibiotic which makes up the low levels of reef development by hard corals does not occur further south than Queensland (Tzioumis and Keable, 2007). Soft corals are typically present in deeper waters throughout the continental shelf, slope and off-slope regions, to well below the limit of light penetration.

Reproduction methods for cold water corals are not as well understood as warm water corals such as those of the Great Barrier Reef, but it is likely that some are still broadcast spawners (like their tropical counterparts), while others brood and release formed larvae (Roberts *et al.*, 2009).

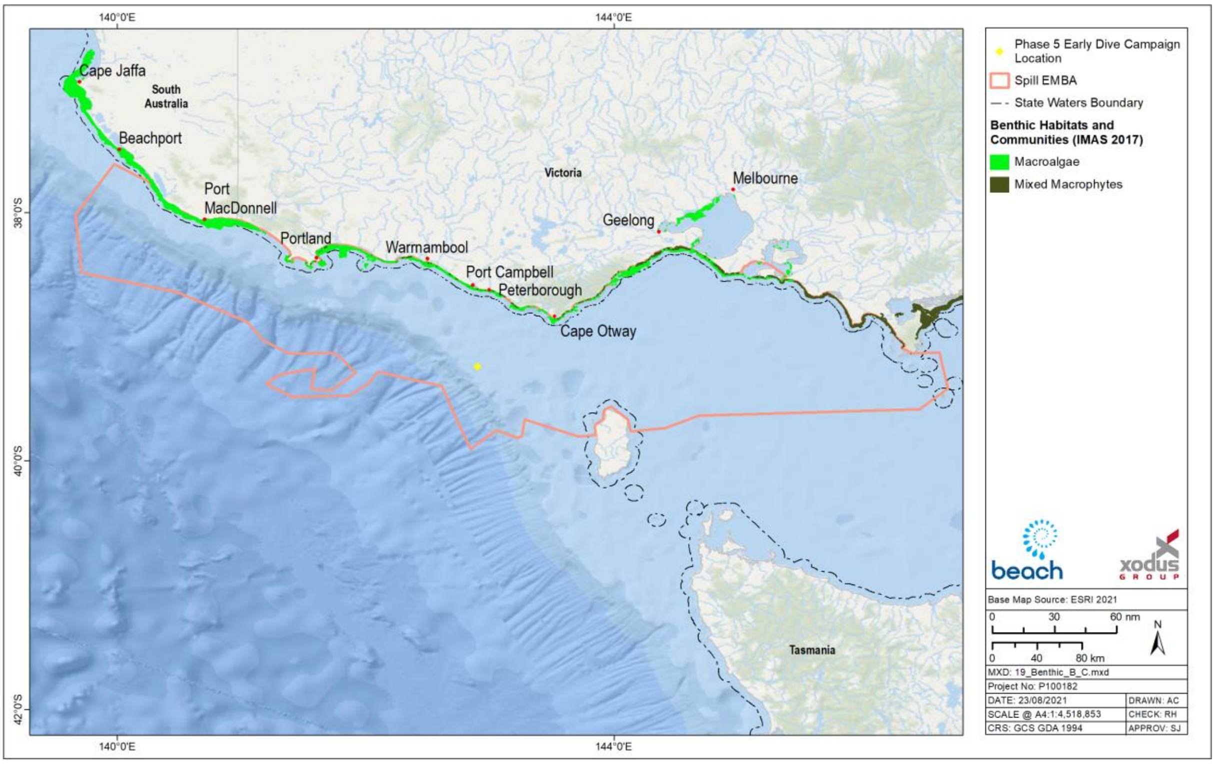


Figure 4-20: Presence of macroalgae (and mixed macrophyte) habitat within the spill EMBA

4.6.1.5 Carbonate sands and exposed limestone

Boreen et al., (1993) reported that carbonate sands in the Otway middle shelf support a benthic fauna dominated by bryozoans, infaunal echinoids and assemblages of sponges. Other components include bivalves (commonly *Mysella donaciformis* and *Legrandina bernardi*), *Chlamys* sp. scallops and small gastropods. The southern sand octopus (*Octopus kaurna*) also inhabits sandy sediments. This description is broadly supported by video footage of the Otway pipeline, which also indicates that hard substrates in mid shelf areas in the west of the operational support low to medium density sponge dominated communities.

Within the inner shelf, Boreen et al., (1993) reported that the benthic communities associated with hard limestone substrates were comprised of sponges, encrusting and branching coralline algae, peysonellid algae, bryozoa, benthic forams, robust serpulids, brachiopods, bivalves, gastropods, fleshy red algae and kelp.

A benthic survey of inner shelf sediments in the vicinity of the Minerva Gas Field development, found the seafloor was composed of course, well-sorted sand (Currie and Jenkins, 1994). This survey identified 196 species and a total of 5,035 individuals comprised of 63% crustaceans, 15% polychaetes, 8% molluscs and 5% echinoderms. The most abundant species were the bivalve *Katlysia* sp. (12.4 individuals/m^2), the sarconid (*Triloculina affinis)* (8.9 individuals/m^2), the tanaid isopod *Apsuedes* sp. (8.3 individuals/m^2) and the spionid polychaete (*Prionospio coorilla*) (4.8 individuals/m^2) (Currie, 1995).

Demersal fishes likely to be associated with carbonate sands on the middle and inner shelf include (LCC, 1993) eastern stargazer (*Kathetostoma laeve*), elephant shark (*Callorhynchus milli*), greenback flounder (*Rhombosolea tapirina*), gummy shark (*Mustelus antarcticus*), long-snouted flounder (*Ammotretis rostratus*), saw shark (*Pristiophorus nudipinnis*), southern sand flathead (*Platycephalus bassensis*) and southern school whiting (*Sillago bassensis*).

4.6.1.6 Basalt rises

There is no published information on the species assemblages of the basalt rises in the south east and east of the spill EMBA, other than general information on their importance as a southern rock lobster fishing area. Following the classification system of Hutchinson et al., (2010) these rises can be classified as deep reefs, defined as rocky habitat at depths greater than 20 m.

In general, deep reef biota is typified by invertebrate animals rather than algae, usually in the form of sessile, filter feeding fauna. Organisms such as sponges, octocorals, bryozoans and ascidians usually dominate rock faces on deep reefs (Hutchison et al., 2010). This is partly due to the ability of species such as sponges to survive in low light conditions that algae are unable to survive in. The most common algae present on deep reefs are encrusting coralline red algae which is able to tolerate low levels of penetrating light (Hutchison et al., 2010).

The distribution of fish fauna is governed by biologically formed habitat structure as well as by food. Fish assemblages typically begin to change at depths greater than 20 m, with the loss of the kelp- associated wrasses and leatherjackets, and the appearance of deeper water fishes such as boarfishes (family Pentacerotidae), splendid perch (*Callanthias australis*) and banded seaperch (*Hypoplectrodes nigroruber*). Schools of barber perch (*Caesioperca razor*) are replaced by the related butterfly perch (*Caesioperca lepidoptera*) (O'Hara et al., 1999). While fish present on shallow subtidal reefs include algavores, omnivores and carnivores, those on deep reefs are typically carnivorous as algae are typically not abundant at depth.

Although common on rocky reefs, sponges, hydrozoans, anthozoans, bryozoans, and ascidians are thought to be largely unpalatable to reef fish. It is therefore likely that fish at these depths are feeding on associated mobile invertebrate fauna. Edmunds et al. (2006) suggests that mobile invertebrate organisms play an ecologically significant role, providing food for carnivorous fishes on deep reefs in Port Phillip Bay, and are likely to include a variety of crustaceans and molluscs.

Information from the few specific studies of specific deep reef habitats in Bass Strait can be assessed to draw broad conclusions about the species assemblages likely to occur on the basalt rises, noting that assemblages of reef species are likely to differ based on geology, habitat structure, exposure to tidal and wave motion and nutrient availability. These studies are generally limited to one off video surveys with little or no temporal replication. More generally little is known about deep reefs in the Bass Strait, or the biology and ecology of organisms that live on them, due in part to difficulties associated with conducting observational work or manipulative experiments in situ.

Beaman et al. (2005) undertook video surveys of the New Zealand Star Bank in the eastern Bass Strait, approximately 600 km east of the operational area. This feature is comprised of granite outcrops between approximately 30 to 40 m water depth, rising from the surrounding relatively flat seabed of mainly unconsolidated quartz sands with variable amounts of shell debris.

Underwater video footage revealed a structurally complex surface of crevices and steep slopes, which is densely covered in erect large and small sponges and encrusting calcareous red algae. Encrusting red algae are usually the greatest occupier of space due to tolerance of low light conditions (< 1% of surface) found at these depths (Andrew, 1999). Mobile benthos observed were crinoids within crevices and the black sea urchin (*Centrostephanus rodgersii*) in low numbers on high slope surfaces and dense encrustations on low relief lower slopes. Underwater video showed a draughtboard shark (*Cephaloscyllium laticeps*) cruising above the crevices of high-relief granite outcrop as well as schools of butterfly perch feeding on plankton in the water column above the bank (Andrew, 1999).

This study demonstrated a significant difference between communities that live on hard-ground granite outcrops of the New Zealand Star Bank and those which exist on soft substrate surrounding the rocky bank. These granite outcrops support a diverse sessile fauna of large and small sponges, bryozoans, hydroids and ascidians which prefer stable attachment surfaces (Underwood et al., 1991; Andrew 1999; Andrew and O'Neill, 2000). It is likely that similar species assemblages occur within the spill EMBA between the flat carbonate sands of the seabed and the basalt rises.

Edmunds et al. (2006) investigated assemblages of benthic fauna at near shore deep reefs within Central Victoria (Point Addis and Wilsons Promontory) and Port Phillip Bay. The Port Phillip Bay deep reef assemblages were dominated by sponges, occupying 70 to 90% of the rocky substratum. The Point Addis assemblage was dominated by upright sponges (arborescent, massive and flabellate growth forms), but cnidarians including hydroids were entirely absent. Wilson’s Promontory had a low coverage of encrusting sponges and hydroids, with high abundances of red and brown algae and the gorgonian fan *Pteronisis* sp. The Port Phillip Heads assemblage was dominated by encrusting sponges, hydroids, ascidians and bryozoans.

In summary, the species assemblages associated with the basalt rises in the south-east and east of the spill EMBA are likely to be significantly different to the species assemblages of the surrounding flat seabed supporting carbonate sands. The depth of the basalt rises is likely to preclude significantly algal growth, with red algae likely to be most abundant. Sponges, hydrozoans, anthozoans, bryozoans, and ascidians are likely to occur though the relative abundances of these groups are not known. Targeting of the rises for rock lobster fishing indicates presence of this species in relatively high densities. The trophic effects of long term targeting of this species at these rises is not known. Site attached fishes are not likely to include kelp-associated wrasses and leatherjackets. Further statements cannot be made with sufficient confidence as site specific data for these rises are not available.

4.6.2 Mangroves

Mangroves grow in intertidal mud and sand, with specially adapted aerial roots (pneumatophores) that provide for gas exchange during low tide (McClatchie et al., 2006). Mangrove forests are important in helping stabilise coastal sediments, providing a nursery ground for many species of fish and crustacean, and providing shelter or nesting areas for seabirds (McClatchie et al., 2006).

The mangroves in Victoria are the most southerly extent of mangroves found in the world and are located mostly along sheltered sections of the coast within inlets or bays (MESA, 2015). There is only one species of mangrove found in Victoria, the white or grey mangrove (*Avicennia marina*), which is known to occur at Western Port and Corner Inlet within the spill EMBA. (Figure 4-21).

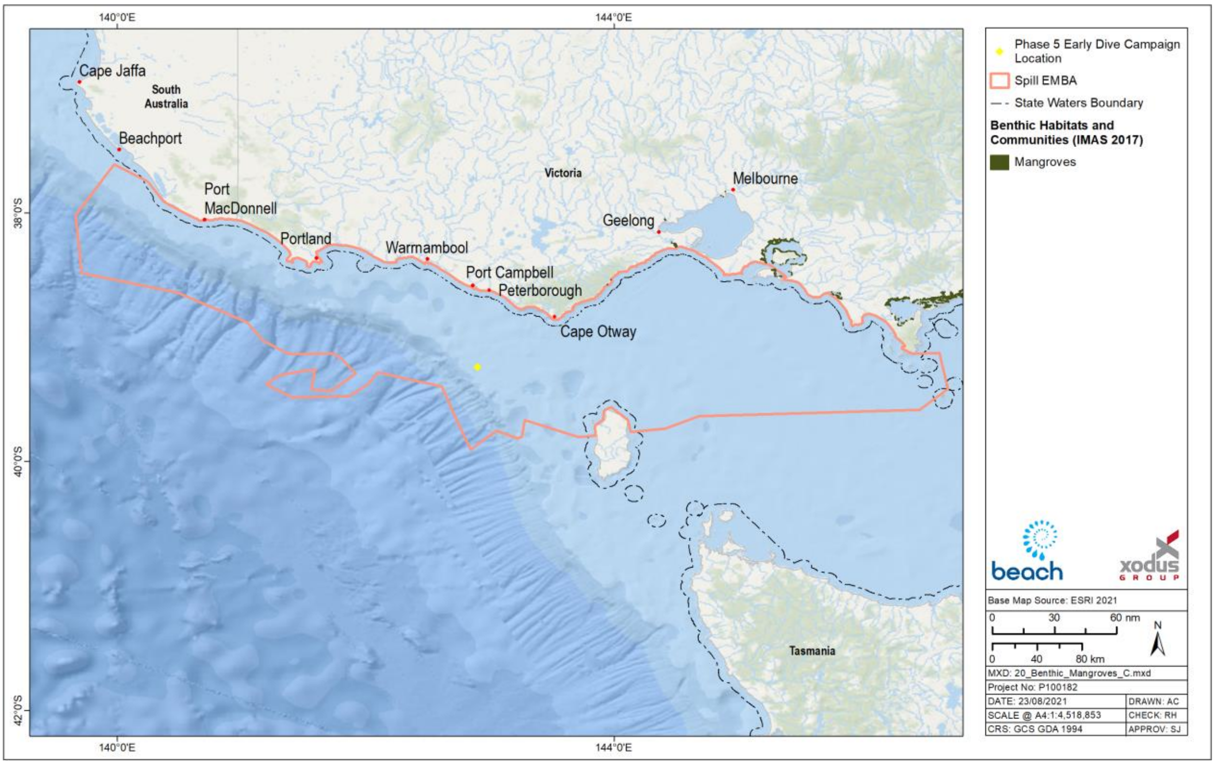


Figure 4-21: Presence of mangrove habitat within the spill EMBA.

4.6.3 Saltmarsh

Saltmarshes are terrestrial halophytic (salt-adapted) ecosystems that mostly occur in the upper-intertidal zone and are widespread along the coast. Saltmarshes are typically dominated by dense stands of halophytic plants such as herbs, grasses and low shrubs. In contrast to mangroves, the diversity of saltmarsh plant species increases with increasing latitude. The vegetation in these environments is essential to the stability of the saltmarsh, as they trap and bind sediments. The sediments are generally sandy silts and clays and can often have high organic material content. Saltmarshes provide a habitat for a wide range of both marine and terrestrial fauna, including infauna and epifaunal invertebrates, fish and birds.

Saltmarsh is found along many parts of the Victorian coast, although is most extensive in western Port Phillip Bay, northern Western Port, within the Corner Inlet-Nooramunga complex, and behind the sand dunes of Ninety Mile Beach in Gippsland (Figure 4-22) (Boon et al., 2011).

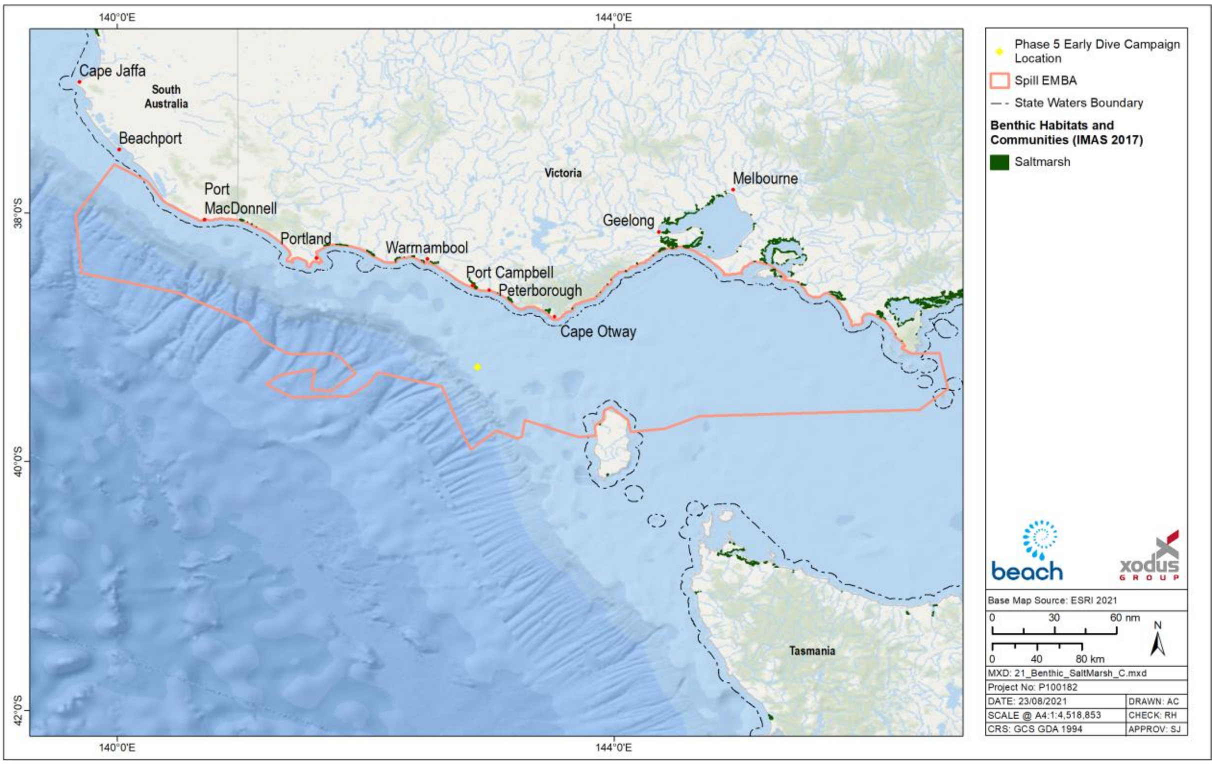


Figure 4-22: Presence of saltmarsh habitat within the spill EMBA

4.6.4 Plankton

Plankton species are the key component of the food web and support nearly all marine life. Copepods are the most common zooplankton and are some of the most abundant animals on earth. Plankton communities are highly diverse, with members from almost all phyla. Phytoplankton are photosynthetic organisms that drift with ocean currents and are mostly microscopic; however, some gelatinous plankton can be up to 2 m in diameter. Phytoplankton is grazed by zooplankton such as small protozoa, copepods, decapods, krill and gelatinous zooplankton.

The carrying capacity of marine ecosystems (the mass of fish resources) and recruitment of individual stocks is strongly related to plankton abundance, timing and composition. In the spill EMBA, the seasonal Bonney coast upwelling is a productivity hotspot, with high densities of zooplankton and are important for fish and whales. Of importance in the region is the coastal krill, *Nyctiphanes australis*, which swarms throughout the water column of continental shelf waters primarily in summer and autumn, feeding on microalgae and providing an important link in the blue whale food chain. The fisheries in this region account for half of Australia's total annual catch and the main fishery in the region is sardine, which feeds on plankton, which illustrates the interdependence of the fishing industry on plankton.

There have been relatively few studies of plankton populations in the Otway and Bass Strait regions, with most concentrating on zooplankton. Watson and Chaloupka (1982) reported a high diversity of zooplankton in eastern Bass Strait, with over 170 species recorded. However, Kimmerer and McKinnon (1984) reported only 80 species in their surveys of western and central Bass Strait.

Plankton distribution is dependent upon prevailing ocean currents including the East Australia Current, flows into and from Bass Strait and Southern Ocean water masses. Plankton distribution in the spill EMBA is expected to be highly variable both spatially and temporally and are likely to comprise characteristics of tropical, southern Australian, central Bass Strait and Tasman Sea distributions.

4.6.5 Invertebrates

There is a very large number of marine invertebrates in deep waters around Australia. Knowledge of the species in different habitats is extremely patchy; the number of deep-water benthic fauna is large but almost unknown. Throughout the region, a variety of seabed habits support a range of animal communities such as sparse sponges to extensive 'thickets" of lace corals and sponges, polychaete worms and filter feeders (Director of National Parks, 2013).

Characteristics of large species of crustacea, such as lobster, prawn and crab, which are significant commercial species in southern Australia, are well known. Mollusc species, such as oysters, scallops and abalone are also commercially fished, and their biology and abundance are well known. Major fisheries for the blacklip and to a lesser extent, greenlip abalone and scallops have been founded. The cooler waters of southern Australia also support the Maori octopus commercial fishery, which is one of the largest octopuses in Australia (with arm spans longer than 3 m and weighing more than 10 kg. Other molluscs are abundant in southern Australia and Tasmania such as the sea-slug with more than 500 species. Volutes and cowries represent a relic fauna in southern Australia, with several species being very rare and can be highly sought after by collectors.

Echinoderms, such as sea stars, sea urchins and sea cucumbers are also an important fauna species of the southern Australian and Tasmanian waters, with several species at risk of extinction (DPIPWE, 2016).

A microscopic examination of a qualitative sample of epibiota taken during the seabed surveys at Thylacine indicated that the complex of fauna found in the area 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. (Ramboll 2020; Appendix E)

Studies by the Museum of Victoria found that invertebrate diversity was high in southern Australian waters although the distribution of species was patchy, with little evidence of any distinct biogeographic regions (Wilson and Poore, 1987). Results of sampling in shallower inshore sediments reported high diversity and patchy distribution (Parry et al., 1990). In these areas, crustaceans, polychaetes and molluscs were dominant.

4.6.6 Threatened ecological communities

Threatened Ecological Communities (TECs) provide wildlife corridors or refugia for many plant and animal species, and listing a TEC provides a form of landscape or systems-level conservation (including threatened species). The spill EMBA PMST Report (Appendix A) identified the following TECs:

- Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community.
- Giant kelp marine forests of South East Australia.
- Grassy eucalypt woodland of the Victorian Volcanic Plain.
- Karst springs and associated alkaline fens of the Naracoorte Coastal Plain Bioregion
- Natural damp grassland of the Victorian Coastal Plains.
- Natural temperate grassland of the Victorian Volcanic Plain.
- Seasonal herbaceous wetlands (freshwater) of the temperate lowland plains

- Subtropical and temperate coastal saltmarsh.
- Tasmanian forests and woodlands dominated by black gum or Brookers fum (Eucalyptus ovata/ E. brookeriana).
- White box-yellow box-Blakely's red gum grassy woodland and derived native grassland.

Of the TECs listed above, only the assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community, the giant kelp marine forests of South East Australia and the subtropical and temperate coastal saltmarsh are marine/coastal features; the rest are terrestrial listings (Figure 4-23). No Threatened Ecological Communities were identified within the operational area.

4.6.6.1 Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community

This ecological community is the assemblage of native plants, animals and micro-organisms associated with the dynamic salt-wedge estuary systems that occur within the temperate climate, microtidal regime (< 2 m), high wave energy coastline of western and central Victoria. The ecological community currently encompasses 25 estuaries in the region defined by the border between South Australia and Victoria and the most southerly point of Wilsons Promontory (TSSC, 2018).

Salt-wedge estuaries are usually highly stratified, with saline bottom waters forming a 'salt-wedge' below the inflowing freshwater layer of riverine waters. The dynamic nature of salt-wedge estuaries has important implications for their inherent physical and chemical parameters, and ultimately for their biological structure and ecological functioning. Some assemblages of biota are dependent on the dynamics of these salt-wedge estuaries for their existence, refuge, increased productivity and reproductive success. The ecological community is characterised by a core component of obligate estuarine taxa, with associated components of coastal, estuarine, brackish and freshwater taxa that may reside in the estuary for periods of time and/or utilise the estuary for specific purposes (e.g. reproduction, feeding, refuge, migration) (TSSC, 2018).

4.6.6.2 Giant Kelp Marine Forests of South East Australia

Giant kelp (*Macrocystis pyrifera*) is a large brown alga that grows on rocky reefs in cold temperate waters off south east Australia. The kelp grows up from the sea floor 8 m below the sea surface and deeper, vertically toward the water surface. It is the foundation species of this TEC in shallow coastal marine ecological communities. The kelp species itself is not protected, rather, it is communities of closed or semi-closed giant kelp canopy at or below the sea surface that are protected (DSEWPaC, 2012).

Giant kelp is the largest and fastest growing marine plant. Their presence on a rocky reef adds vertical structure to the marine environment that creates significant habitat for marine fauna, increasing local marine biodiversity. Species known to shelter within the kelp forests include weedy sea dragons (*Phyllopteryx taeniolatus*), six-spined leather jacket (*Mesuchenia freycineti*), brittle stars (ophiuroids), sea urchins, sponges, blacklip abalone (*Tosia spp*) and southern rock lobsters (*Jasus edwardsii*). The large biomass and productivity of the giant kelp plants also provides a range of ecosystem services to the coastal environment.

Giant kelp requires clear, shallow water no deeper than approximately 35 m deep (Edyvane, 2003; Shepherd and Edgar, 2012; cited in DoE, 2012). They are photo-autotrophic organisms that depend on photosynthetic capacity to supply the necessary organic materials and energy for growth. O'Hara (in Andrew, 1999) reported that giant kelp communities in Tasmanian coastal waters occur at depths of 5-25 m.

Figure 4-23 shows that the largest extent of giant kelp marine forests are along the SA coastline with patches around the Victorian coastline.

Gillanders et al (2013) undertook extensive surveys of macroalgal communities along the Otway Shelf from Warrnambool to Portland in south-west Victoria. Sites were adjacent to shore or on offshore rocky reefs covering a depth range of 0 to 36 meters water depth. These surveys did not locate giant kelp at any site but identified that other brown algae species (*Durvillaea, Ecklonia, Phyllospora, Cystophora, and Sargassum*) are prolific to around 20 m water depth. Brown algae tend to be replaced by red algae in deeper waters.

Surveys of the Arches Marine Sanctuary (Edmunds et al. 2010) and Twelve Apostles Marine National Park (Holmes et al. 2007 cited in Barton et al., 2012) have not located giant kelp. The species has been recorded in Discovery Bay National Park forming part of a mixed brown algae community (Ball and Blake, 2007) (not part of the TEC), on basalt rocky reefs. An assemblage dominated by the species has been recorded from Merri Marine Sanctuary occupying a very small area (0.2 ha) of rocky reef (Barton et al., 2012).

4.6.6.3 Subtropical and Temperate Coastal Saltmarsh

The Subtropical and Temperate Coastal Saltmarsh TEC occurs in a relatively narrow strip along the Australian coast, within the boundary along 23°37’ latitude along the east coast and south from Shark Bay on the west coast (Threatened Species Scientific Committee, 2013). The community is found in coastal areas which have an intermittent or regular tidal influence. Figure 4-23 shows that from Corner Inlet to Marlo there is a substantial amount of subtropical and temperate coastal saltmarsh along the Victorian coastline.

The coastal saltmarsh community consists mainly of salt-tolerant vegetation including grasses, herbs, sedges, rushes and shrubs. Succulent herbs, shrubs and grasses generally dominate and vegetation is generally less than 0.5 m in height (Adam, 1990). In Australia, the vascular saltmarsh flora may include many species, but is dominated by relatively few families, with a high level of endism at the species level.

The saltmarsh community is inhabited by a wide range of infaunal and epifaunal invertebrates and low and high tide visitors such as fish, birds and prawns (Adam, 1990). It is often important nursery habitat for fish and prawn species. Insects are also abundance and an important food source for other fauna. The dominant marine residents are benthic invertebrates, including molluscs and crabs (Ross et al., 2009).

The coastal saltmarsh community provides extensive ecosystem services such as the filtering of surface water, coastal productivity and the provision of food and nutrients for a wide range of adjacent marine and estuarine communities and stabilising the coastline and providing a buffer from waves and storms. Most importantly, the saltmarshes are one of the most efficient ecosystems globally in sequestering carbon, due to the biogeochemical conditions in the tidal wetlands being conducive to long-term carbon retention. A concern with the loss of saltmarsh habitat is that it could release the huge pool of stored carbon to the atmosphere.

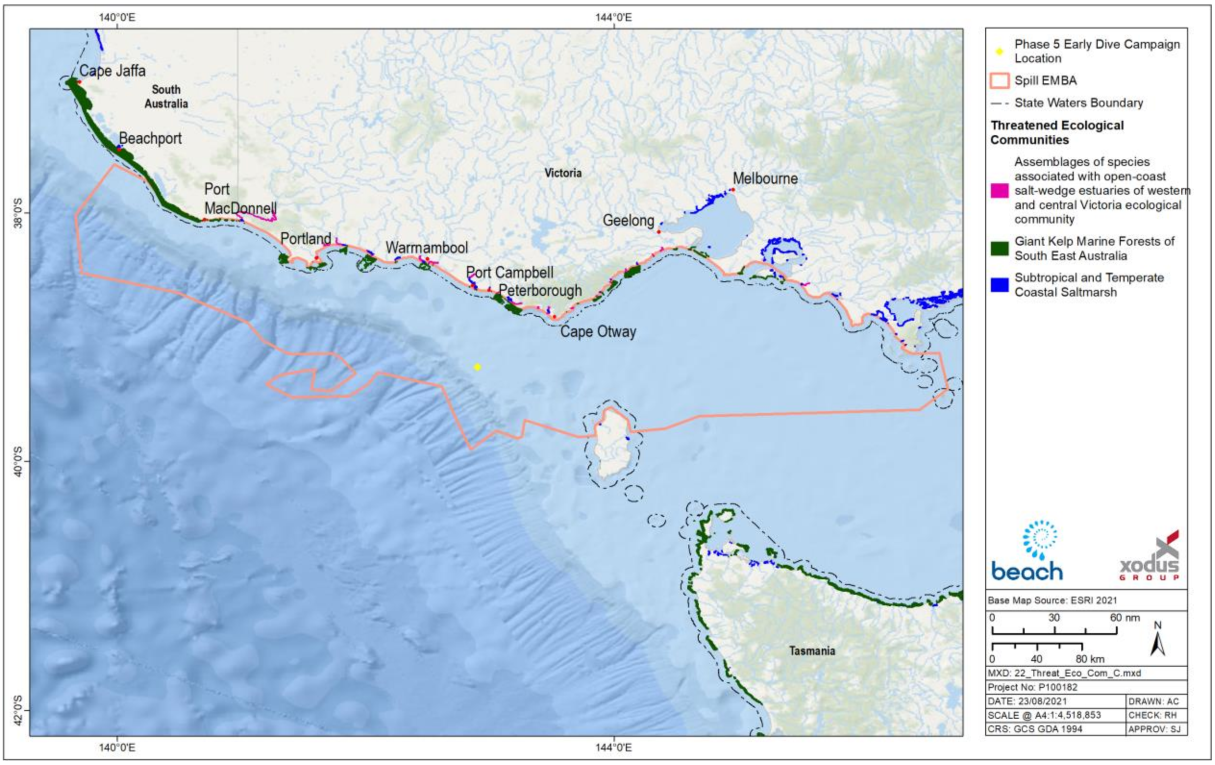


Figure 4-23: Threatened ecological communities within the spill EMBA

4.6.7 Threatened and Migratory species

PMST reports were generated for the operational area and spill EMBA to identify the listed Threatened and Migratory species that may be present (Appendix A).

A total of 32 Threatened species and 37 Migratory species were identified as potentially occurring within the operational area. There were also 119 marine species and 30 cetaceans identified as potentially occurring within the spill EMBA.

4.6.7.1 Marine Fauna of Conservation Significance

Under Part 13 of the EPBC Act, species can be listed as one, or a combination, of the following protection designations:

- Threatened (further divided into categories; extinct, extinct in the wild, critically endangered, endangered, vulnerable, conservation-dependent);
- Migratory;
- Whale or other cetaceans; and
- Marine.

Details of listed fauna and their likely presence in the operational area or spill EMBA are provided in the following sections.

For the purpose of the EP, only species listed as threatened or migratory under the EPBC Act likely to occur in the operational area or spill EMBA are considered to have conservation significance warranting further discussion. Likely occurrence was determined by the PMST report or through designation of important habitat (e.g. BIA).

4.6.7.2 Biologically Important Areas and Critical Habitat to the survival of the species

Biologically Important Areas (BIAs) are areas that are particularly important for the conservation of protected species and where aggregations of individuals display biologically important behaviour such as breeding, foraging, resting or migration. Their designation is based on expert scientific knowledge about species' distribution, abundance and behaviour. The presence of the observed behaviour is assumed to indicate that the habitat required for the behaviour is also present.

There is no habitat critical to the survival of listed species within the operational area or spill EMBA. BIAs within the operational area and spill EMBA are summarised in Table 4-9 with further details in the relevant species sections.

Table 4-9: BIAs identified within the operational area and spill EMBA

Receptor	***Operational area (1 km)***	***Spill EMBA***	***Type of BIA***
Birds			
Antipodean albatross	Overlap	Overlap	Foraging
Australasian gannet	>105 km	Overlap	Foraging
	>140 km	Overlap	Aggregation
Black-browed albatross	Overlap	Overlap	Foraging
Black-faced Cormorant	>90 km	Overlap	Breeding
	>80 km	Overlap	Foraging
Buller's albatross	Overlap	Overlap	Foraging
Campbell albatross	Overlap	Overlap	Foraging
Common diving-petrel	Overlap	Overlap	Foraging
	>120 km	Overlap	Breeding
Indian yellow-nosed albatross	Overlap	Overlap	Foraging
Little penguin	>80 km	Overlap	Foraging
	>90 km	Overlap	Breeding
Short-tailed shearwater	Overlap	Overlap	Foraging
Shy albatross	Overlap	Overlap	Foraging
Wandering albatross	Overlap	Overlap	Foraging
Wedge-tailed shearwater	Overlap	Overlap	Foraging
	>60 km	Overlap	Breeding
White-faced storm petrel	>70 km	Overlap	Foraging
	160 km	Overlap	Breeding

Receptor	Operational area (1 km)	Spill EMBA	Type of BIA
Fish			
White shark	Overlap	Overlap	Distribution
	>90 km	Overlap	Foraging
Pinnipeds			
Australian sea lion	>400 km	Overlap	Foraging
Cetaceans			
Southern right whale	>60 km	Overlap	Aggregation
	>57 km	Overlap	Migration and resting on migration
	Overlap	Overlap	Known core coastal range
	>90 km	Overlap	Connecting habitat
Blue and Pygmy blue whale	180 km	Overlap	Possible Foraging Area
	Overlap	Overlap	Foraging (annual high use area)
	>60 km	Overlap	Known Foraging Area
	Overlap	Overlap	Distribution

4.6.7.3 Fish

Fish species present in the operational area or spill EMBA are either pelagic (living in the water column), or demersal (benthic). Fish species inhabiting the region are largely cool temperate species, common within the SEMR. The spill EMBA PMST report (Appendix A) identified 29 listed fish species that potentially occur in the spill EMBA. Table 4-10 details the listed fish species identified in the spill EMBA and operational area PMST reports.

The following fish species were identified in the operational area PMST Report (Appendix A.2):

- White shark;
- Shortfin mako;
- Porbeagle, mackerel shark; and
- Pipefish, seahorse, seadragons.

Table 4-10: Listed fish species identified in the PMST report

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Fish						
Australian grayling	*Prototroctes maraena*	V	-	-	SHK	
Sharks and rays						
Porbeagle, mackerel shark	*Lamna nasus*	-	M	-	SHL	SHL
Shortfin mako	*Isurus oxyrinchus*	-	M	-	SHL	SHL
White shark	*Carcharodon carcharias*	V	M	-	FFK	SHK
Pipefish, seahorse, seadragons						
Australian long-snout pipefish	*Vanacampus poecilolaemus*	-	-	L	SHM	SHM
Australian smooth pipefish	*Lissocampus caudalis*	-	-	L	SHM	SHM
Bigbelly seahorse	*Hippocampus abdominalis*	-	-	L	SHM	SHM
Black pipefish	*Stigmatopora nigra*	-	-	L	SHM	SHM
Briggs' crested pipefish	*Histiogamphelus briggsii*	-	-	L	SHM	SHM
Brushtail pipefish	*Leptoichthys fistularius*	-	-	L	SHM	SHM
Bullneck Seahorse	*Hippocampus minotaur*	-	-	L	SHM	
Common seadragon	*Phyllopteryx taeniolatus*	-	-	L	SHM	SHM
Deep-bodied pipefish	*Kaupus costatus*	-	-	L	SHM	SHM
Hairy pipefish	*Urocampus carinirostris*	-	-	L	SHM	SHM
Half-banded pipefish	*Mitotichthys semistriatus*	-	-	L	SHM	SHM

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Javelin pipefish	*Lissocampus runa*	-	-	L	SHM	SHM
Knife-snouted pipefish	*Hypselognathus rostratus*	-	-	L	SHM	SHM
Leafy seadragon	*Phycodurus eques*	-	-	L	SHM	SHM
Mollison's pipefish	*Mitotichthys mollisoni*	-	-	L	SHM	
Mother-of-pearl pipefish	*Vanacampus margaritifer*	-	-	L	SHM	SHM
Port Phillip pipefish	*Vanacampus phillipi*	-	-	L	SHM	SHM
Pug-nosed pipefish	*Pugnaso curtirostris*	-	-	L	SHM	SHM
Red pipefish	*Notiocampus ruber*	-	-	L	SHM	SHM
Rhino pipefish	*Histiogamphelus cristatus*	-	-	L	SHM	SHM
Ring-backed pipefish	*Stipecampus cristatus*	-	-	L	SHM	SHM
Robust pipehorse	*Solegnathus robustus*	-	-	L	SHM	SHM
Sawtooth pipefish	*Maroubra perserrata*	-	-	L	SHM	SHM
Short-head seahorse	*Hippocampus breviceps*	-	-	L	SHM	SHM
Spiny pipehorse,	*Solegnathus spinosissimus*	-	-	L	SHM	SHM
Spotted pipefish	*Stigmatopora argus*	-	-	L	SHM	SHM
Trawl pipefish	*Kimblaeus bassensis*	-	-	L	SHM	
Tucker's pipefish	*Mitotichthys tuckeri*	-	-	L	SHM	SHM
Upside-down pipefish	*Heraldia nocturna*	-	-	L	SHM	SHM

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		

Listed Threatened	Likely Presence
V: Vulnerable	SHM: Species or species habitat may occur within area.
Listed Migratory	SHL: Species or species habitat likely to occur within area.
M: Migratory	SHK: Species or species habitat known to occur within area.
Listed Marine	BK: Breeding known to occur within area.
L: Listed	FFK: Foraging, feeding or related behaviour known to occur within area

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the other smaller EMBAs or operational area.

White shark

The white shark (*Carcharodon carcharias*) is widely distributed and located throughout temperate and sub-tropical waters with their known range in Australian waters including all coastal areas except the Northern Territory (DotEE, 2010). Studies of white sharks indicate that they are largely transient. However, individuals are known to return to feeding grounds on a seasonal basis (Klimley and Anderson, 1996). In the Australasian region, white sharks differ genetically from other populations and data suggest there are two populations: southwestern Australia and eastern Australia (Blower et al. 2012). A recent long-term electronic tagging study of juvenile white sharks off eastern Australia, indicated complex movement patterns over thousands of kilometres, including annual fidelity to spatially restricted nursery areas, directed seasonal coastal movements, intermittent areas of temporary nearshore residency and offshore movement into the Tasman Sea (Bruce et al., 2019). This study also supported the two-population model for the species in Australian waters with restricted east to west movements through Bass Strait. Bruce et al., (2019) observed seasonal movements of juvenile white sharks being in the northern region during winter– spring (June–November) and southern region during summer–autumn (December–May).

Observations of adult sharks are more frequent around fur-seal and sea lion colonies, including Wilsons Promontory and the Skerries. Juveniles are known to congregate in certain key areas including the Ninety Mile Beach area (including Corner Inlet and Lakes Entrance) in eastern Victoria and the Portland area of western Victoria).

The distribution BIA for the white shark intersects the spill EMBA and operational area (Figure 4-24). The known distribution is on the coastal shelf/upper slope waters out to 1000 m and the broader area where they are likely to occur extends from Barrow Island in WA to Yeppoon in New South Wales (NSW). They are more likely to be found between the 60–120 m depth contours than in the deeper waters. There is a known nursery area at Corner Inlet (outside of the spill EMBA), and they are known to forage in waters off pinniped colonies throughout the SEMR. It is likely that white sharks are present in the spill EMBA.

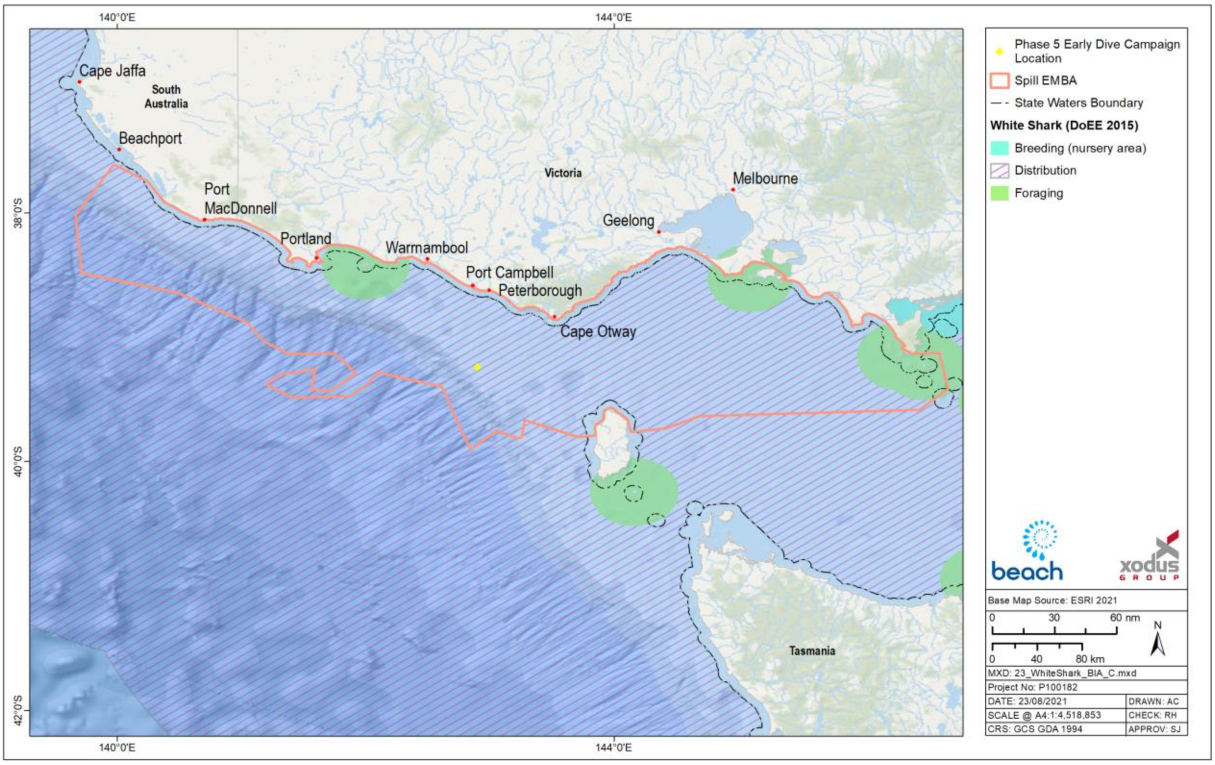


Figure 4-24: BIAs for the white shark within the spill EMBA

Shortfin mako shark

The shortfin mako shark (*Isurus oxyrinchus*) is a pelagic species with a circum-global oceanic distribution in tropical and temperate seas (Mollet et al., 2000). It is widespread in Australian waters, commonly found in water with temperatures greater than 16°C. Populations of the shortfin mako are considered to have undergone a substantial decline globally. These sharks are a common by-catch species of commercial fisheries (Mollet et al., 2000).

The use of dorsal satellite tags on 10 juvenile shortfin mako sharks captured in the Great Australian Bight (GAB) between 2008 and 2011 investigated habitat and migration patterns. It revealed GAB and south east of Kangaroo Island, near the northern extent of the Bonney coast upwelling region, to be areas of highest fidelity indicating critical habitats for juvenile shortfin mako (Rogers, 2011). The tagged sharks also showed migration to south west Western Australia, Victoria, Bass Strait and south west of Tasmania. Stomachs of shortfin mako sharks were also analysed from specimens collected by game fishing competitors in Port Mac Donnell, South Australia and Portland, Victoria from 2008 and 2010 found they specialise in larger prey including pelagic teleosts and cephalopods (Rogers, 2011). Due to their widespread distribution in Australian waters, shortfin mako sharks are likely to be present in the operational area and spill EMBA in low numbers.

Porbeagle shark

The porbeagle shark (*Lamna nasus*) is widely distributed in the southern waters of Australia including Victorian and Tasmanian waters. The species preys on bony fishes and cephalopods and is an opportunistic hunter that regularly moves up and down in the water column, catching prey in mid-water as well as at the seafloor. It is most commonly found over food-rich banks on the outer continental shelf, but does make occasional forays close to shore or into the open ocean, down to depths of approximately 1,300 m. It also conducts long-distance seasonal migrations, generally shifting between shallower and deeper water (Pade et al., 2009). The porbeagle shark is likely to be present in the spill EMBA in low numbers.

Australian grayling

The Australian grayling (*Prototroctes maraena*) is a dark brown to olive-green fish attaining 19 cm in length. The species typically inhabits the coastal streams of NSW, Victoria and Tasmania, migrating between streams and the ocean. Spawning occurs in freshwater, with timing dependant on many variables including latitude and temperature regimes. Most of its life is spent in fresh water, with parts of the larval or juvenile stages spent in coastal marine waters (Department of Sustainability and Environment, 2008a), though its precise marine habitat requirements remain unknown (Department of Sustainability and Environment, 2008b). They are a short-lived species, usually dying after their second year soon after spawning (a small proportion may reach four or five years) (Department of Sustainability and Environment, 2008a).

The Australian grayling has been recorded from the Gellibrand River (Department of Sustainability and Environment, 2008b), making it likely that it occurs in coastal waters. As marine waters are not part of the species' spawning grounds, the spill EMBA is not likely to represent critical habitat for the species.

Syngnathids

All of the marine ray-finned fish species identified in the Spill EMBA and operational area EPBC PMST Reports are syngnathids, which includes seahorses and their relatives (sea dragon, pipehorse and pipefish). The majority of these fish species are associated with seagrass meadows, macroalgal seabed habitats, rocky reefs and sponge gardens located in shallow, inshore waters (e.g., protected coastal bays, harbours and jetties) less than 50 m deep

(Fishes of Australia, 2015). They are sometimes recorded in deeper offshore waters, where they depend on the protection of sponges and rafts of floating seaweed such as sargassum.

Of the 33 species of syngnathids identified in the spill EMBA EPBC PMST Report, only one (*Hippocampus abdominalis*, big-belly seahorse) has a documented species profile and threats profile, indicating how little published information exists in general regarding syngnathids. The species profile and threats profiles indicate that the syngnathid species listed in the spill EMBA are widely distributed throughout southern, south-eastern and south-western Australian waters. It is possible that these species will be present in the coastal area of the spill EMBA where water depths are less than 50 m, however presence in the operational area is not expected.

4.6.7.4 Birds

A diverse array of seabirds and terrestrial birds utilise the Otway region and may potentially forage within or fly over the operational area and spill EMBA, resting on islands during their migration. Infrequently and often associated with storm events, birds that do not normally cross the ocean are sometimes observed over the Otway shelf, suggesting the birds have been blown off their normal course or are migrating.

Bird species listed in the PMST reports, as possibly or known to occur in the operational area and spill EMBA (this includes species or species habitat), are shown in Table 4-11. Threatened or migratory species that are likely or known to occur in the area or have an intercepting BIA with the operational area and spill EMBA are discussed in more detail.

Table 4-11: Listed bird species identified in the PMST report

* species BIA identified see Section 4.6.7.2 and Table 4-9 for information as to which species have identified BIAs within the operational area and spill EMBA

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Albatrosses						
Antipodean albatross*	*Diomedea antipodensis*	V	M	L	FL	FL
Black-browed albatross*	*Thalassarche melanophris*	V	M	L	FL	FL
Buller's albatross*	*Thalassarche bulleri*	V	M	L	FL	FL
Campbell albatross*	*Thalassarche impavida*	V	M	L	FL	FL
Chatham albatross	*Thalassarche eremita*	E	M	L	FL	
Gibson's albatross	*Diomedea antipodensis gibsoni* *Diomedea gibsoni*	V	-	L	FL	
Grey-headed albatross	*Thalassarche chrysostoma*	E	M	L	SHM	SHM
Northern buller's albatross	*Thalassarche bulleri platei*	V	-	-	FL	FL
Northern royal albatross	*Diomedea sanfordi*	E	M	L	FL	FL
Pacific albatross	*Thalassarche sp. nov.*	V	-	L	FL	FL
Salvin's albatross	*Thalassarche salvini*	V	M	L	FL	FL
Shy albatross*	*Thalassarche cauta*	E	M	L	FL	FL
Sooty albatross	*Phoebetris fusca*	V	M	L	SHL	SHL
Southern royal albatross	*Diomedea epomophora*	V	M	L	FL	FL

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Wandering albatross*	*Diomedea exulans*	V	M	L	FL	FL
White-capped albatross	*Thalassarche steadi*	V	M	L	FL	FL
Shearwaters						
Flesh-footed shearwater	*Ardenna carneipes*	-	M	L	SHK	FL
Short-tailed shearwater*	*Ardenna tenuirostris* *Puffinus tenuirostris*	-	M	L	BK	
Sooty shearwater	*Ardenna grisea* *Puffinus griseus*	-	M	L	SHM	SHM
Petrels						
Blue petrel	*Halobaena caerulea*	V	-	L	SHM	SHM
Common diving petrel*	*Pelecanoides urinatrix*	-	-	L	BK	
Gould's petrel	*Pterodroma leucoptera*	E	-	-	SHM	SHM
Great-winged petrel	*Pterodroma macroptera*	-	-	L	FK	
Northern giant-petrel	*Macronectes halli*	V	M	L	SHM	SHM
Soft-plumaged petrel	*Pterodroma mollis*	V	-	L	FL	SHM
Southern giant-petrel	*Macronectes giganteus*	E	M	L	FL	SHM
White-bellied storm-petrel	*Fregetta grallaria grallaria*	V	-	-	BK	
White-faced storm petrel*	*Pelagodroma marina*	-	-	L	BK	
Other						
Australasian bittern	*Botaurus poiciloptilus*	E	-	-	SHK	

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Australasian gannet*	*Morus serrator*	-	-	L	BK	
Australian fairy tern	*Sternula nereis nereis*	V	-	-	SHK	FL
Australian painted-snipe	*Rostratula australis*	E	-	-	SHK	
Bar-tailed godwit	*Limosa lapponica*	-	W	L	SHK	
Black currawong	*Strepera fuliginosa colei*	V	-	-	BL	
Black-eared cuckoo	*Chrysococcyx osculans*	-	-	L	SHK	
Black-faced cormorant*	*Phalacrocorax fuscescens*	-	-	L	BK	
Black-faced monarch	*Monarcha melanopsis*	-	T	L	SHK	
Black-tailed godwit	*Limosa limosa*	-	W	L	RK	
Broad-billed sandpiper	*Limicola falcinellus*	-	W	L	RK	
Cape gannet	*Morus capensis*	-	-	L	BK	
Caspian tern	*Hydroprogne caspia* *Sterna caspia*	-	M	L	BK	
Cattle egret	*Bubulcus ibis*	-	-	L	SHM	
Common greenshank	*Tringa nebularia*	-	W	L	SHK	
Common noddy	*Anous stolidus*	-	M	L	SHL	
Common sandpiper	*Actitius hypoleucos*	-	W	L	SHK	SHM
Crested tern	*Thalasseus bergii* *Sterna bergii*	-	W	L	BK	
Curlew sandpiper	*Calidris ferruginea*	CE	W	L	SHK	SHM
Double-banded plover	*Charadrius bicinctus*	-	W	L	RK	
Eastern curlew	*Numenius madagacariensis*	CE	W	L	SHK	SHM

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Eastern hooded plover	*Thinornis cucullatus cucullatus*	V	-	L	SHK	
Fairy prion	*Pachyptila turtur*	-	-	L	SHK	SHM
Fairy prion (southern)	*Pachyptila turtur subantarctica*	V	-	-	SHK	SHK
Fairy tern	*Sterna nereis*	-	-	L	BK	
Fork-tailed swift	*Apus pacificus*	-	M	L	SHL	
Great knot	*Calidris tenuirostris*	CE	W	L	RK	
Great skua	*Catharacta skua*	-	-	L	SHM	SHM
Greater sand plover	*Charadrius leschenaultii*	V	W	L	RK	
Green rosella *King Island)	*Platycercus caledonicus brownie*	V	-	-	SHL	
Grey falcon	*Falco hypoleucos*	V	-	-	SHL	
Grey plover	*Pluvialis squatarola*	-	W	L	RK	
Grey-tailed tattler	*Heteroscelus brevipes*	-	W	-	RK	
Hooded plover	*Thinornis rubricollis*		-	L	SHK	
Hooded plover (eastern)	*Thinornis cucullatus cucullatus* *Thinornis rubricollis rubricollis*	V	-	L	SHK	
Kelp gull	*Larus dominicanus*	-	-	L	BK	
King Island brown thornbill	*Acanthiza pusilla archibaldi*	E	-	-	SHL	
King Island scrubtit	*Acanthornis magna greeniana*	CE	-	-	SHK	

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Latham's snipe	*Gallinago hardwickii*	-	W	L	SHK	
Lesser sand plover	*Charadrius mongolus*	E	W	L	RK	
Little curlew	*Numenius minutus*	-	W	L	RL	
Little penguin*	*Eudyptula minor*	-	-	L	BK	
Little tern	*Sternula albifrons*	-	M	L	BK	
Magpie Goose	*Anseranas semipalmata*	-	-	L	SHM	
Marsh sandpiper	*Tringa stagnatilis*	-	W	L	RK	
Nunivak bar-tailed godwit	*Limosa lapponica baueri*	V	-	-	SHK	
Orange-bellied parrot	*Neophema chrysogaster*	CE	-	L	MK	
Osprey	*Pandion haliaetus*	-	W	L	SHK	
Pacific golden plover	*Pluvialis fulva*	-	W	L	RK	
Pacific gull	*Larus pacificus*	-	-	L	BK	
Painted honeyeater	*Grantiella picta*	V	-	-	SHK	
Painted snipe	*Rostratula benghalensis (sensu lato)*	E	-	L	SHK	
Pectoral sandpiper	*Calidris melanotos*	-	W	L	SHK	SHM
Pied stilt	*Himantopus himantopus*	-	-	L	RK	
Pin-tailed snipe	*Gallinago stenura*	-	W	L	RL	
Plains-wanderer	*Pedionomus torquatus*	CE	-	-	SHL	
Rainbow bee-eater	*Merops ornatus*	-	-	L	SHM	
Red knot	*Calidris canutus*	E	W	L	SHK	SHM
Red-capped plover	*Charadrius ruficapillus*	-	-	L	RK	

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Red-necked avocet	*Recurvirostra novaehollandiae*	-	-	L	RK	
Red-necked phalarope	*Phalaropus lobatus*	-	W	L	RK	
Red-necked stint	*Calidris ruficollis*	-	W	L	RK	
Regent honeyeater	*Anthochaera Phrygia*	CE	-	-	FL	
Ruddy turnstone	*Arenaria interpres*	-	W	L	RK	
Ruff (Reeve)	*Philomachus pugnax*	-	M	L	SHK	
Rufous fantail	*Rhipidura rufifrons*	-	T	L	SHK	
Sanderling	*Calidris alba*	-	W	L	RK	
Satin flycatcher	*Myiagra cyanoleuca*	-	T	L	BK	
Sharp-tailed sandpiper	*Calidris acuminata*	-	W	L	RK	SHM
Silver gull	*Larus novaehollandiae*	-	-	L	BK	
Sooty tern	*Sterna fuscata*	-	-	L	BK	
South-eastern Red-tailed Black-Cockatoo	*Calyptorhynchus banksii graptogyne*	E	-	-	SHK	
Swift parrot	*Lathamus discolour*	CE	-	L	SHK	
Swinhoe's snipe	*Gallinago megala*	-	W	L	RL	
Tasmanian azure kingfisher	*Ceyx azureus diemenensis*	E	-	-	SHL	
Tasmanian wedge-tailed eagle	*Aquila audax fleayi*	E	-	-	SHL	
Terek sandpiper	*Xenus cinereus*	-	W	L	RK	
Wandering tattler	*Heteroscelus incana*	-	W	-	RK	

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed Threatened	Listed Migratory	Listed marine		
Whimbrel	*Numenius phaeopus*	-	W	L	RK	
White-bellied sea-eagle	*Haliaeetus leucogaster*	-	-	L	BK	
White-faced storm-petrel	*Pelagodroma marina*	-	-	L	BK	
White-throated needletail	*Hirundapus caudacutus*	V-	T	L	SHK	
Wood sandpiper	*Tringa glareola*	-	W	L	RK	
Yellow wagtail	*Motacilla flava*	-	T	L	SHK	

Listed Threatened
- CE: Critically Endangered
- E: Endangered
- V: Vulnerable

Listed Migratory
- M: Migratory
- T: Migratory Terrestrial
- W: Migratory Wetlands

Listed Marine
- L: Listed

Likely Presence
- SHM: Species or species habitat may occur within area.
- SHL: Species or species habitat likely to occur within area.
- SHK: Species or species habitat known to occur within area.
- FL: Foraging, feeding or related behaviour likely to occur within area.
- RK: Roosting known to occur within area.
- ML: Migratory route likely to occur in area.
- BK: Breeding known to occur within area.

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the other smaller EMBAs or operational area.

Albatross and petrels

Albatrosses and giant-petrels are among the most dispersive and oceanic of all birds, spending more than 95% of their time foraging at sea in search of prey and usually only returning to land (remote islands) to breed. The National Recovery Plan for threatened albatross and giant petrels (DSEWPaC, 2011a). Only seven species of albatross and the southern and northern giant petrel are known to breed within Australia, which are protected under the National Recovery Plan for threatened albatross and giant petrels (DSEWPaC, 2011a). Breeding within Australian territory occurs on the isolated islands of Antarctica (Giganteus Island, Hawker Island and Frazier islands) and the Southern Ocean (Heard Island, McDonald Island, Macquarie Island, Bishop and Clerk Islands), as well as islands off the south coast of Tasmania and Albatross Island off the north-west coast of Tasmania in Bass Strait (DSEWPaC, 2011b). There are no islands with colonies of threatened marine seabirds within the operational area and spill EMBA. Albatross Island, supporting a breeding population of approximately 5,000 shy albatross (*Thalassarche cauta*), is the closest breeding colony of threatened seabirds to the spill EMBA.

Albatross and giant petrel species exhibit a broad range of diets and foraging behaviours, hence their at-sea distributions are diverse. Combined with their ability to cover vast oceanic distances, all waters within Australian jurisdiction can be considered foraging habitat, however the most critical foraging habitat is those waters south of 25 degrees where most species spend most of their foraging time. The Antipodean albatross, black-browed albatross, Buller's albatross, Campbell albatross, Indian yellow-nosed albatross, shy albatross and wandering albatross, have BIAs for foraging that overlap the operational area or spill EMBA (Figure 4-25 and Figure 4-26). These BIAs cover either most or all the SEMR (Commonwealth of Australia, 2015). Therefore, it is likely that these will be present and forage in the EMBA.

Both the common diving-petrel and the white-faced storm petrel are not listed as threatened species under the EPBC Act, and have large populations within Australia, accounting for 5% and 25% respectively of the global population (DoE, 2015b). The common diving-petrel breeds on islands off south-east Australia and Tasmania; there are 30 sites with significant breeding colonies (defined as more than 1,000 breeding pairs) known in Tasmania, and 12 sites in Victoria (including Seal Island, Wilson's Promontory and Lady Julia Percy Island) (DoE, 2015e). There are 15 sites with significant breeding colonies in Tasmania, and three sites with Victoria, for the white-faced storm petrel (DoE, 2015e). A BIA for foraging has been identified for the common diving-petrel that overlaps with the operational area and spill EMBA. The common-diving petrel also has a breeding BIA that overlaps the spill EMBA. The white-faced storm petrel has a foraging BIA that overlaps the operational area and spill EMBA. The white-faced storm petrel also has a breeding BIA that overlaps the spill EMBA.

Southern royal albatross forage from 36° to 63°. They range over the waters off southern Australia at all times of the year but especially from July to October (DSEWPaC, 2011b). The northern royal albatross is regularly recorded throughout the year around Tasmania and South Australia at the continental shelf edge and feeds frequently in these waters. Despite breeding colonies in New Zealand, the white capped and the Chatham albatross are common off the coast of south-east Australia throughout the year. During the non-breeding season, the Salvin's albatross occur over continental shelves around continents with a small number of non-breeding adults flying regularly across the Tasman Sea to south-east Australian waters (DSEWPaC, 2011b). Sooty albatrosses although rare are likely regular migrants to Australian waters mostly in the autumn to winter months and have been observed foraging in southern Australia (Thiele, 1977; Pizzey & Knight, 1999). The Pacific albatross (equivalent to the northern Buller's albatross) is a non-breeding visitor to Australian waters mostly limited to the Tasman Sea and Pacific Ocean, occurring over inshore, offshore and pelagic waters and off the east-coast of Tasmania (DSEWPaC, 2011b). Gibson's albatross has breeding colonies in New Zealand but has been known to forage in the Tasman Sea and South Pacific Ocean with individuals occurring offshore from Coffs harbour in the north to Wilson's Promontory in the south (EA, 2002; Marchant & Higgins 1990). Therefore, it is likely that these along with the Tasmanian shy albatross will be present and forage in the spill EMBA and potentially the operational area.

The white-bellied storm petrel breed on small offshore islets and rocks in Lord Howe Island and has been recorded over near-shore waters off Tasmania (Baker et al. 2002). The great-winged petrel breeds in the Southern

Hemisphere between 30° and 50° south, outside of the breeding season they are widely dispersed (Birdlife International, 2019)

Terns and shearwaters

The flesh-footed shearwater is a trans-equatorial migrant widely distributed across the south-western Pacific during breeding season (early September to early May) and is a common visitor to the waters of the continental shelf/slope and occasionally inshore waters. The species breeds in burrows on sloping ground in coastal forest, scrubland, shrubland or grassland. Thirty-nine of the 41 islands on which the species breeds lie off the coast of southern Western Australia, with the remaining two islands being Smith Island (SA) and Lord Howe Island. The flesh-footed shearwater feeds on small fish, cephalopod molluscs (squid, cuttlefish, nautilus and argonauts), crustaceans (barnacles and shrimp), other soft-bodied invertebrates (such as Velella) and offal. The species forages almost entirely at sea and very rarely on land. It obtains most of its food by surface plunging or pursuit plunging. It also regularly forages by settling on the surface of the ocean and snatching prey from the surface ('surface seizing'), momentarily submerging onto prey beneath the surface ('surface diving') or diving and pursuing prey beneath the surface by swimming ('pursuit diving'). Birds have also been observed flying low over the ocean and pattering the water with their feet while picking food items from the surface (termed 'pattering') (DotEE, 2014). This species is likely to be an uncommon visitor to the operational area or spill EMBA.

The short-tailed shearwater has foraging and breeding BIAs within the spill EMBA (Figure 4-27). The short-tailed shearwater is migratory, and breeding is restricted to southern Australia being most abundant in Victoria and Tasmania (Skira et al., 1996). Huge numbers arrive along the south and south-east coast of Australia from wintering grounds in the North Pacific and are observed in large numbers foraging the surrounding coastal and offshore waters (Marchant & Higgins, 1990). Short-tailed shearwaters have been identified as a conservation value in the temperate east and south-west marine areas.

The wedge-tailed shearwater has a foraging BIA within the operational area and spill EMBA (Figure 4-27 and Appendix A). A review of the DotEE Species Profile and Threats Database (SPRAT), Atlas of Living Australia and South-east Marine Region Profile did not provide any information on the Victorian Muttonbird Island wedge-tailed shearwater colony. The DotEE SPRAT profile does not show any locations for the wedge-tailed shearwater in Victoria and Beaver (2018) details Montague Island in NSW was the southernmost known colony, however, in 2017 breeding individuals of Wedge-tail shearwaters were discovered a couple of hundred kilometres further south on Gabo Island Lighthouse Reserve, Victoria near the NSW border.

Caspian tern is the largest turn in Australia, they inhabit both coastal and inland regions and breeding occurs widespread throughout Australia. In Victoria breeding sites are mostly along coastal regions with three significant regular breeding colonies, Corner Inlet, Mud Island and Mallacoota (Minton & Deleyev, 2001). Breeding occurs between September to December are resident and occur throughout the year at breeding sites. The Caspian tern usually forages in open wetlands and prefers shallow waters but is also found in open coastal waters, title channels and mud flaps. They can forage 60 km from their nesting site (Higgins & Davis, 1996). The little tern species is also widespread in Australia with three major sub populations, the northern population that breeds from Broome to Northern Territory. The eastern subpopulation breeds on the eastern and south eastern coast extending as far as western Victoria and the south-eastern parts of South Australia, to the northern and eastern coast of Tasmania. The third population migrate from breeding grounds in Asia to spend the spring and summer in Australia. The little tern has a naturally high rate of breeding failure due to the ground nets being exposed to adverse weather conditions, and native predators. The Australian fairy tern occurs along the coastline of Victoria, South Australia, Western Australia and Tasmania. Breeding habitat for the Caspian, little tern and Australian fairy tern vary from terrestrial wetlands, rocky islets or banks, low islands, beaches, cays and spits. Nest are present in the open sparse vegetation such as tussocks and other sand binding plants to sometimes near bushes and driftwood. Their diet also consists primarily of fish along with aquatic invertebrates, insects and eggs and the young of other birds (Higgins & Davis, 1996; Taylor & Roe, 2004; Van de Kam et al., 2004).

The sooty tern has a much larger foraging range, encompassing open shelf waters, shelf edge and deep water (DSEWPaC, 2012b). Main breeding colonies occur off Australia's west and east coast. Like the crested tern where distribution is widespread in Australia, but breeding occurs off islands in large colonies off Queensland and New South Wales (Higgins & Davis, 1996). Foraging diet consists of pelagic fish, cephalopods, crustaceans and insects.

Osprey and white bellied sea eagle

The white-bellied sea eagle is a large raptor generally seen singly or in pairs, distributed along the coastline of mainland Australia and Tasmania. Breeding records are patchily distributed mainly along the coastline especially the eastern coast extending from Victoria and Tasmania to Queensland. There are recorded breeding sites as far inland as the Murray, Murrumbidgee and Lachlan River in norther Victoria (Marchant & Higgins, 1993). There is no quantitative data available on area of occupancy, but it is believed that there could be a decline due to increased development of coastal areas. Estimations of 500 or more pairs in Australia account for 10-20% of the global population (Marchant & Higgins, 1993). Recorded decline in numbers have been recorded across Australia, with a decline numbers in Victoria recorded in Gippsland Lakes, Phillip Island and the Sunraysia district (Bilney & Emison, 1983; Quinn, 1969). White-bellied sea eagles feed on a variety of fish, birds, reptiles, mammals and crustaceans. They hunt from a perch and while in flight (circling slowly). Described as a breeding resident throughout much of its range in Australia, breeding is generally sedentary, and the home range can be up to 100 km^2 (Marchant & Higgins, 1993). White-bellied sea eagles are sensitive to disturbance particularly in the early stages of nesting, human activity may cause nests and young to be abandoned (Debus et al, 2014). Breeding is known to occur within the spill EMBA, so they are likely to be common visitor.

The osprey is a medium sized raptor extending around the northern coast of Australia from Albany, Western Australia to Lake Macquarie in New South Wales with an isolated breeding population on the coast of South Australia. Listed as migratory under the EPBC Act they are resident around breeding territories. They are found along coastal habitats and terrestrial wetlands and require open fresh or saltwater for foraging (Marchant & Higgins, 1993). Osprey feed mainly on fish, occasionally molluscs, crustaceans, mammals, birds, reptiles and insects. Generally, they search or prey by soaring, circling and quartering above water and dive directly into the water at their target prey (Clancy, 2005). This species is likely to be an uncommon visitor to the operational area or spill EMBA.

Orange-bellied parrot

The orange-bellied parrot (*Neophema chrysogaster*) (listed as critically endangered under the EPBC Act) breeds in Tasmania during summer, migrates north across Bass Strait in autumn and spends winters on the mainland. The migration route includes the west coast of Tasmania and King Island (Figure 4-28). Birds depart the mainland for Tasmania from September to November (Green, 1969). The southward migration is rapid (Stephenson, 1991), so there are few migration records. The northward migration across western Bass Strait is more prolonged (Higgins & Davies, 1996). The orange-bellied parrot is protected under the National Recovery Plan for the orange-bellied parrot (DELWP, 2016a). The parrot's breeding habitat is restricted to south-west Tasmania, where breeding occurs from November to mid-January mainly within 30 km of the coast. The species forage on the ground or in low vegetation (Loyn et al., 1986). During winter, on mainland Australia, orange-bellied parrots are found mostly within 3 km of the coast. In Victoria, they mostly occur in sheltered coastal habitats, such as bays, lagoons and estuaries. They are also found in low samphire herbland dominated by beaded glasswort (*Sarcocornia quinqueflora*), sea heath (*Frankenia pauciflora*) or sea-blite (*Suaeda australis*), and in taller shrubland dominated by shrubby glasswort (*Sclerostegia arbuscula*) (DotEE, 2019a). There are also non-breeding orange-bellied parrots on mainland Australia, between Goolwa in Australia and Corner Inlet in Victoria. The orange bellied parrot may overfly the coastal waters of the spill EMBA (Figure 4-29). However, parrots rarely land or forage out at sea.

Little penguin

The little penguin is the smallest species of penguin in the world and are permanent residents on a number of inshore and offshore islands. The Australian population is large but not thought to exceed one million birds (DoE, 2015a). Bass Strait has the largest proportion (approximately 60%) of the known breeding colonies in Australia; however, breeding populations are also found on the New South Wales coast. Individuals exhibit strong site fidelity, returning to the same breeding colony each year to breed in the winter and spring months (Gillanders *et al.*, 2013). The diet of a Little Penguin includes small school fish, squid and krill. Prey is typically caught with rapid jabs of the beak and swallowed whole. A BIA for breeding and foraging, has been identified for the Little Penguin within the spill EMBA (Figure 4-26). Their main breeding site within the spill EMBA is in Western Port Bay. Little penguins are also an important component of the Australian and New Zealand fur-seals' diet (Parliament of South Australia, 2011).

Australasian gannet

The Australasian gannet generally feeds over the continental shelf or inshore waters. Their diet is comprised mainly of pelagic fish, but also squid and garfish. Prey is caught mainly by plunge-diving, but it is also seen regularly attending trawlers. Breeding is highly seasonal (October–May), nesting on the ground in small but dense colonies (DoE, 2015a). Important breeding locations for the Australasian gannet within the Environment Sectors include Pedra Branca, Eddystone Rocks, Sidmouth Rocks, and Black Pyramid (Tasmania) and Lawrence Rocks (Victoria). A BIA, for foraging, has been established in the spill EMBA with substantial foraging sites within port Philip Bay and Port Fairy (Figure 4-25).

Other shorebirds

A number of species listed in Table 4-11 use coastal shoreline habitats such as Australian fairy tern, fairy prion, red knot, pectoral sandpiper, fork-tailed swift, sharp-tailed sandpiper, curlew sandpiper, eastern curlew, little curlew, yellow wagtail, Australasian bittern and species of plover. These species are commonly found on coastal shores including beaches and rocky shores and either feed at low tide on worms, crustaceans and molluscs or fish species or feed on aquatic biota (Parks Victoria, 2016). This species is unlikely to be present in the operational area or spill EMBA due to the distance offshore.

Many sandpipers including the common, marsh, terek, wood and the broad-billed sandpiper are widespread through Australia's coastline inhabiting saltwater and freshwater ecosystems. They migrate from the Northern Hemisphere in non-breeding months, favouring estuaries, saltmarshes, intertidal mudflats, swamps and lagoons and foraging on worms, molluscs, crustaceans, insects, seeds and occasionally rootlets and other vegetation (Marchant & Higgins, 1993; Higgins & Davies, 1996).

The Australian painted snipe is a stocky wading bird most commonly in eastern Australian wetlands. Feeding on vegetation, insects, worms, molluscs, crustaceans and other invertebrates. Latham's, Swinhoe's and pin-tailed snipe is a non-breeding visitor to Australia occurring at the edges of wetlands, shallow swamps, ponds and lakes (Marchant & Higgins, 1993). The wandering tattler and grey-tailed tattler migrate from the Northern hemisphere and inhabit rocky coasts with reefs and platforms, offshore islands and intertidal mudflats. Foraging on polychaete worms, molluscs and crustaceans and roosting on branches of mangroves and rocks and boulders close to water. The bar-tailed godwit and black-tailed godwit are large waders, migrating from the Northern hemisphere in the noon-breeding months to coastal habitat in Australia. The large waders are commonly found in sheltered bays, estuaries, intertidal mudflats, and occasionally on rocky coasts (Higgins & Davies, 1996).

Hooded and eastern hooded plovers are small beach nesting birds. They predominantly occur on wide beaches and are easily disturbed by human activity. The lesser sand and greater sand plover are migratory and inhabits intertidal sand and mudflats, forage on invertebrates and breed in areas characterised by high elevation. Breeding occurs outside Australia, but roosting occurs near foraging areas on beaches, banks, spits and banks (Pegler, 1983). The pacific golden and grey plover are widespread in coastal regions foraging on sandy beaches, spits, rocky points, exposed reef and occasional low saltmarsh and mangroves. Roosting usually occurs near foraging areas while breeding occurs in dry tundra areas away from the coast (Bransbury, 1985; Pegler, 1983; Marchant & Higgins, 1993). The double-banded plover is found in both coastal and inland areas with greatest numbers in Tasmania and Victoria. It breeds only in New Zealand and migrates to Australia.

Other waders including common noddy, ruddy turnstone, sanderling, red-necked stint, whimbrel, common greenshank, pied stilt, white-throated needletail, red-necked phalarope, ruff, red-necked avocet, rufous fantail and black-faced cormorant are common along Australia's coastline. The black-faced cormorant has a breeding and foraging BIA off King Island within the spill EMBA. Many of these waders are migratory travelling from the Northern Hemisphere in non-breeding months. Most inhabit intertidal mudflats, rocky islets, sand beaches, mangroves, rocky coastline and coral reefs. Roosting occurs in similar habitats and species are found feeding on fish, crustaceans, aquatic insects, as well as plants and seeds (Higgins & Davies, 1996). These species are unlikely to be present in the operational area due to the distance offshore. The plains wanderer is a unique bird that lives predominantly in grasslands in Victoria, South Australia, New South Wales and Queensland. The swift parrot is a small parrot breeding in colonies in Tasmania. The entire population migrates to the mainland during winter. The great knot is critically endangered migratory arriving in large numbers in Australia occurring in sheltered coastal habitats with large intertidal mudflats. Typically, they roost in large open areas at the water's edge to in shallow water close to foraging grounds (Higgins & Davies 1996). These species are critically endangered and may occur within the spill EMBA.

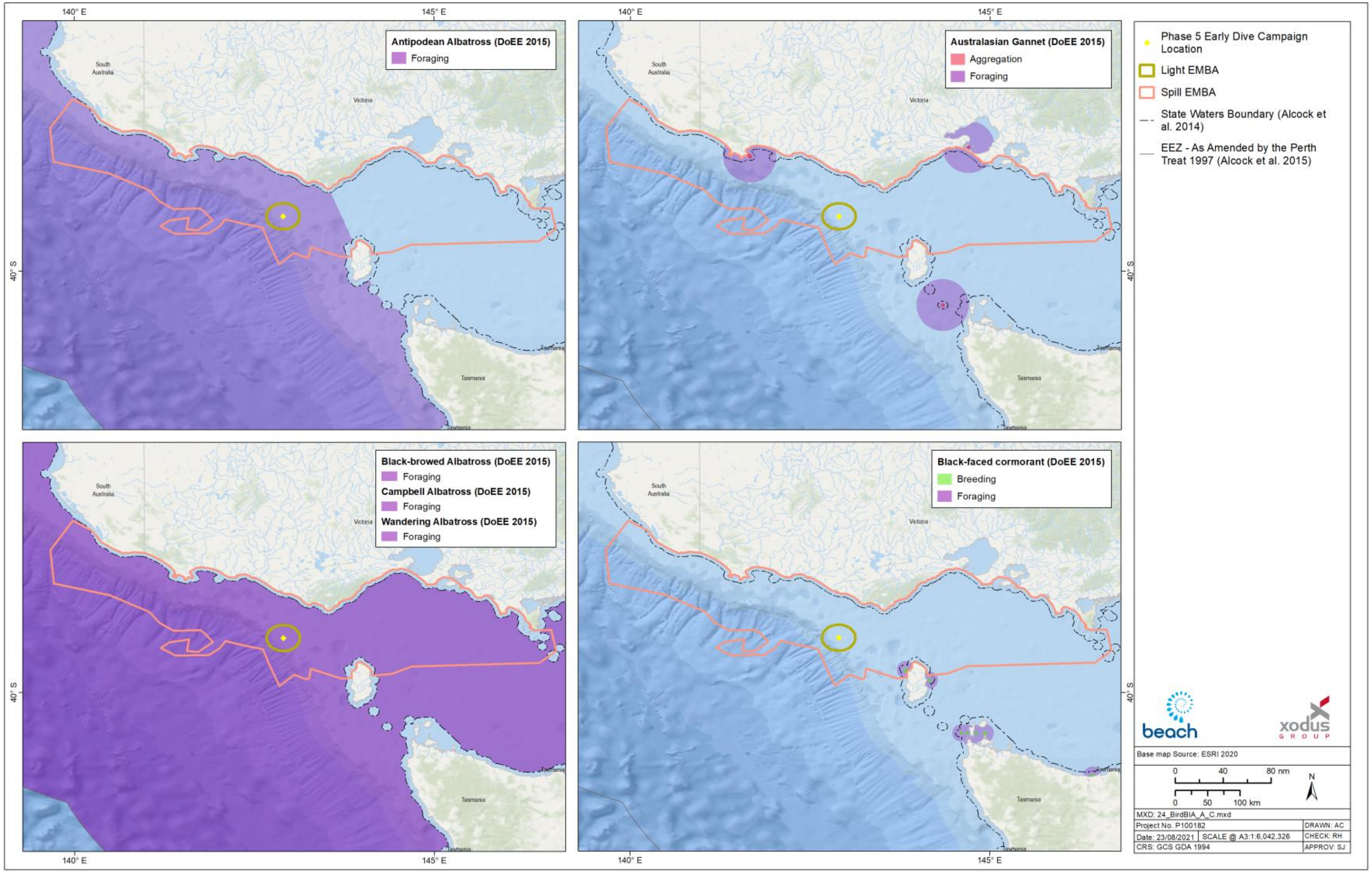


Figure 4-25: BIAs for antipodean albatross, Australasian gannet, black-browed albatross, Campbell albatross, wandering albatross and black-faced cormorant within the spill EMBA

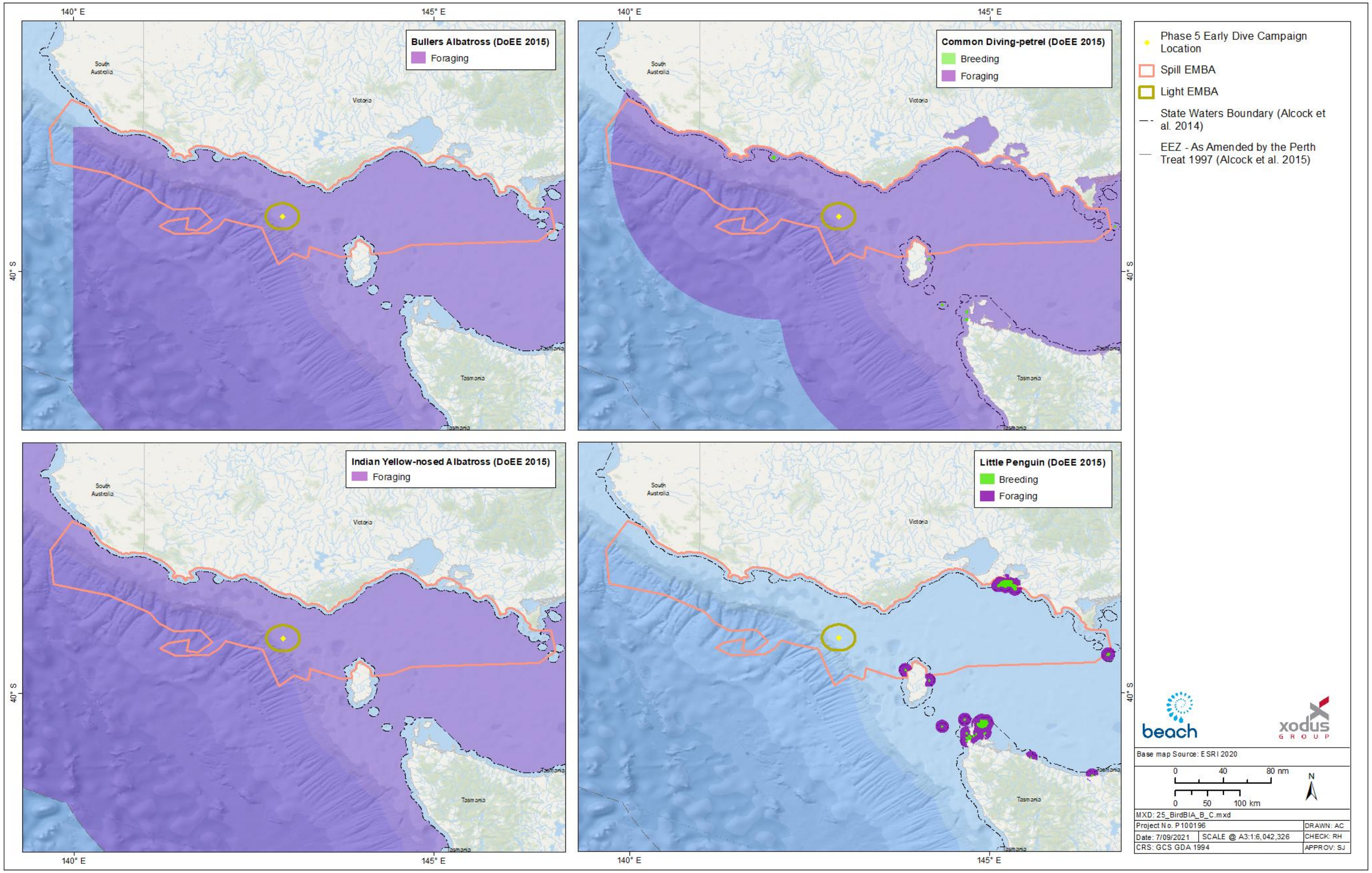


Figure 4-26: BIAs for the Buller’s albatross, common diving-petrel, Indian yellow-nosed albatross and little penguin within the spill EMBA

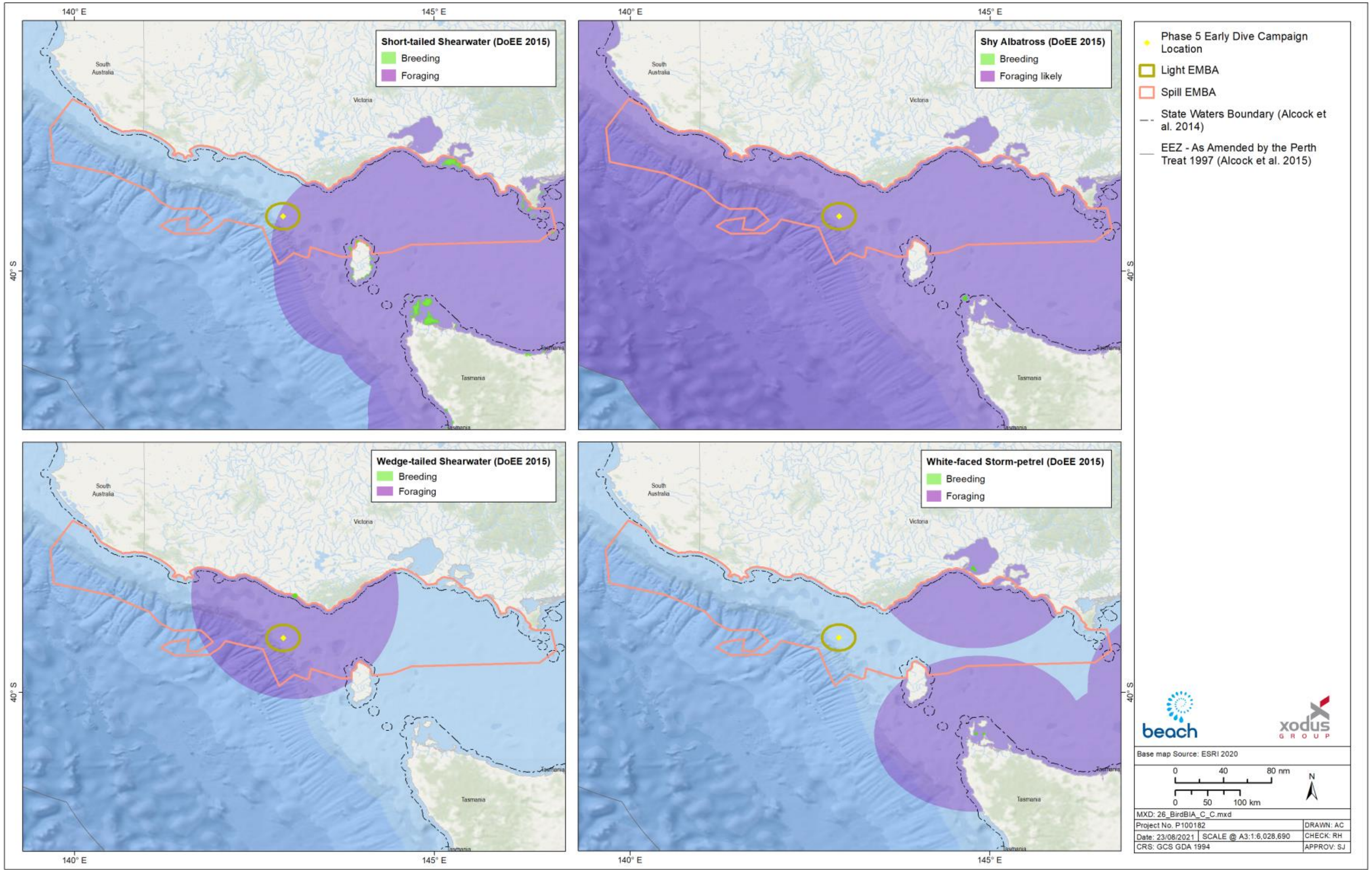


Figure 4-27: BIAs for short-tailed shearwater, shy albatross, wedge-tailed shearwater and white-faced storm petrel within the spill EMBA

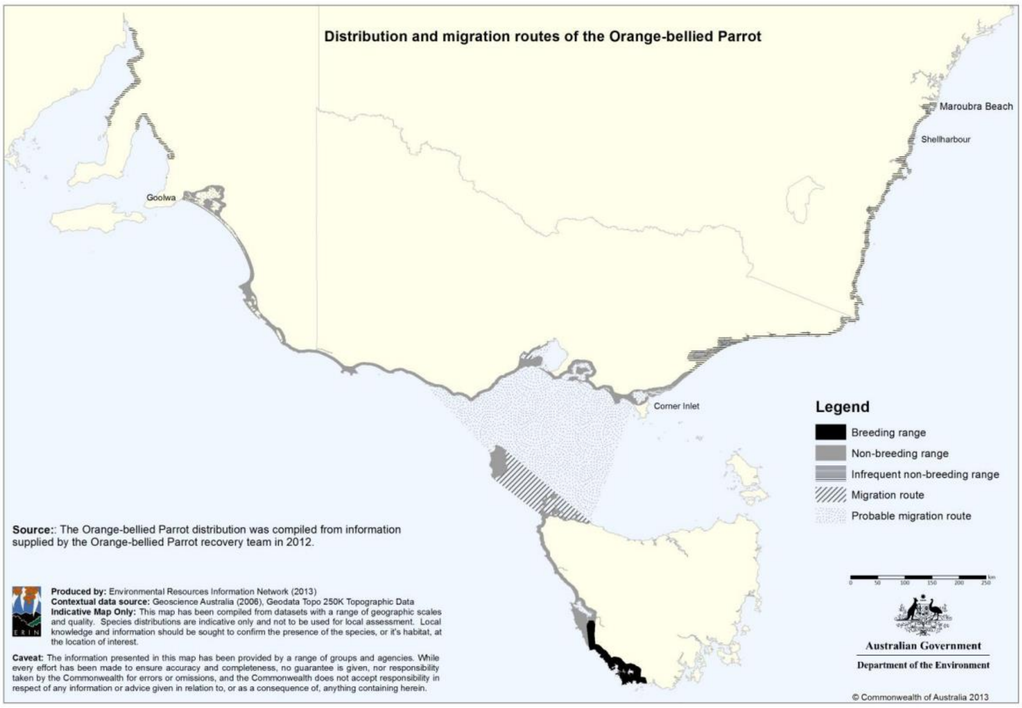


Figure 4-28: Migration routes and breeding ranges for the orange-bellied parrot (DELWP, 2016a)

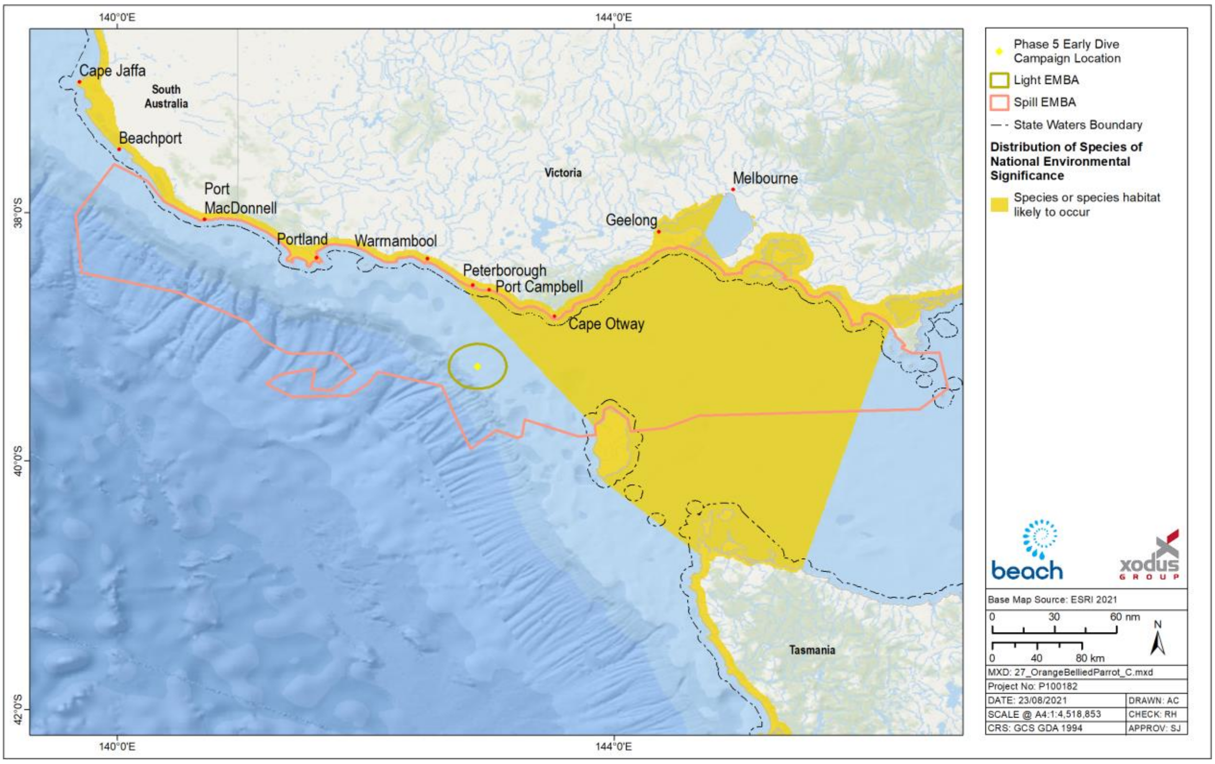


Figure 4-29: Distribution of the orange bellied parrot within the spill EMBA

4.6.7.5 Marine reptiles

The PMST reports for the operational area and spill EMBA identified three marine turtle species likely to occur (Table 4-12, Appendix A). All three species of marine turtles are protected by the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). The spill EMBA PMST report identifies that feeding is known to occur in the spill EMBA for all species. There are no identified BIAs for these reptiles in the operational area or spill EMBA.

Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) is globally distributed in tropical, sub-tropical waters and temperate waters. The loggerhead is a carnivorous turtle, feeding primarily on benthic invertebrates in habitat ranging from nearshore to 55 m depth (Plotkin et al., 1993).

The main Australian breeding areas for loggerhead turtles are generally confined to southern Queensland and Western Australia (Cogger et al., 1993). Loggerhead turtles will migrate over distances in excess of 1,000 km but show a strong fidelity to their feeding and breeding areas (Limpus, 2008). Loggerhead turtles forage in all coastal states and the Northern Territory, but are uncommon in South Australia, Victoria and Tasmania (Commonwealth of Australia, 2017b). Due to waters depths it is unlikely loggerhead turtles would be present in the spill EMBA.

Green turtle

Green turtles (*Chelonia mydas*) nest, forage and migrate across tropical northern Australia. They usually occur between the 20°C isotherms, although individuals can stray into temperate waters as vagrant visitors. Green turtles spend their first 5-10 years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with drift lines and floating rafts of sargassum. Green turtles are predominantly found in Australian waters off the Northern Territory, Queensland and Western Australian coastlines, with limited numbers in NSW, Victoria and South Australia. There are no known nesting or foraging grounds for green turtles offshore Victoria; they occur only as rare vagrants in these waters (DotEE, 2019m), therefore it is expected they would only be occasional visitors in the spill EMBA.

Leatherback turtle

The leatherback turtle (*Dermochelys coriacea*) is a pelagic feeder found in tropical, sub-tropical and temperate waters throughout the world. Unlike other marine turtles, the leatherback turtle utilises cold water foraging areas, with the species most commonly reported foraging in coastal waters between southern Queensland and central NSW, southeast Australia (Tasmania, Victoria and eastern SA), and southern WA (Commonwealth of Australia, 2017b). This species is an occasional visitor to the Otway shelf and has been sighted on a number of occasions during aerial surveys undertaken by the Blue Whale Study Group, particularly to the southwest of Cape Otway. It is mostly a pelagic species, and away from its feeding grounds is rarely found inshore (Commonwealth of Australia, 2017b). Adults feed mainly on soft-bodied organisms such as jellyfish, which occur in concentrations at the surface in areas of convergence and upwelling (Bone, 1998; Cogger, 1992). Bass Strait is one of three of the largest concentrations of feeding leatherbacks (DSE, 2009). The major threat to leatherback turtles is by-catch and habitat pollution. In the Bass Strait, leatherbacks are at risk of entanglement from crayfish and pot float lines, ingestion of marine debris as ocean currents and wind can accumulate floating debris where turtles feed (DSE, 2009).

No major nesting has been recorded in Australia, with isolated nesting recorded in Queensland and the Northern Territory. The leatherback turtle is expected to be only an occasional visitor in the spill EMBA.

Table 4-12: Listed turtle species identified in the PMST

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed threatened	Listed migratory	Listed marine		
Green turtle	*Chelonia mydas*	V	M	L	SHM	SHM
Leatherback turtle	*Dermochelys coriacea*	E	M	L	FK	SHL
Loggerhead turtle	*Caretta caretta*	E	M	L	FK	SHL
Listed Threatened E: Endangered V: Vulnerable Listed Migratory M: Migratory Listed Marine L: Listed		Likely Presence FK: Foraging, feeding or related behaviour likely to occur within area SHL: Species or species habitat likely to occur within area SHM: Species or species habitat may occur within area				

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the operational area.

4.6.7.6 Cetaceans

The PMST reports identified several cetaceans that potentially occur in the operational area and spill EMBA (Appendix A). Table 4-13 details cetaceans identified in the PMST reports. Threatened or migratory species that are likely or known to occur in the area or have an intercepting BIA with the operational area or spill EMBA are discussed in more detail in the sections below.

Gill et al., (2015) summarised cetacean sightings from 123 systematic aerial surveys undertaken over western Bass Strait and the eastern Great Australian Bight between 2002 and 2013. This paper does not include sighting data for blue whales, which has previously been reported in Gill et al., (2011) (See Section below on blue whales).

These surveys recorded 133 sightings of 15 identified cetacean species consisting of seven mysticete (baleen) whale species, eight odontocete (toothed) species and 384 sightings of dolphins (Table 4-14 and Table 4-15). Survey effort was biased toward coverage of upwelling seasons, corresponding with pygmy blue whales' seasonal occurrence (November to April; 103 of 123 surveys), and relatively little survey effort occurred during 2008–2011. Cetacean species sighted within the region are described in the following sections.

Gill et al., (2015) encountered southern right and humpback whales most often from May to September, despite low survey effort in those months. Southern right whales were not recorded between October and May. Fin, Sei, and Pilot whales were sighted only from November to May (upwelling season), although this may be an artefact of their relative scarcity overall and low survey effort at other times of year. Dolphins were sighted most consistently across years. The authors caution that few conclusions about temporal occurrence can be drawn because of unequal effort distribution across seasons and the rarity of most species.

Marine fauna observations in the period 2 February 2021 to 27 March 2021 were undertaken during the Artisan-1 drilling activity (located in the spill EMBA). Vessels also undertook activities at other project locations in within the Otway Gas Development, including Thylacine. The focus of the marine fauna observations was primarily based on the detection of blue whales as required in the accepted Artisan-1 EP. However, the MFOs were directed to collect data on other species wherever possible. In total, the marine fauna observers identified 207 cetaceans, of which the most commonly sighted were pygmy blue whale, short-beaked common dolphin and Australian fur seal. Sightings data is provided in Table 4-17 below.

The Bass Strait and the Otway Basin is considered an important migratory path for humpback, blue, southern right, and to some extent the fin and sei whales. The whales use the Otway region to migrate to and from the north-eastern Australian coast and the sub-Antarctic. Of environmental importance in the Otway is the Bonney coast upwelling, the eastward flow of cool nutrient rich water across the continental shelf of the southern coast of Australia that promotes blooms of krill and attracts baleen whales during the summer months.

Origin Energy conducted a survey for cetaceans focused on Origin operations and permit in the Otway basin from June 2012 through to March of 2013. Table 4-15 lists the species present in the area Origin surveyed.

Table 4-13: Listed cetacean species identified in the PMST report

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed threatened	Listed migratory	Listed marine		
Whales						
Andrew's beaked whale	*Mesoplodon bowdoini*	-	-	L	SHM	SHM
Antarctic minke whale	*Balaenoptera bonaerensis*	-	M	L	SHL	
Arnoux's beaked whale	*Berardius arnuxii*	-	-	L	SHM	SHM
Blainville's beaked whale	*Mesoplodon desirostris*	-	-	L	SHM	SHM
Blue whale	*Balaenoptera musculus*	E	M	L	FK	FK
Bryde's whale	*Balaenoptera edeni*	-	M	L	SHM	
Curvier's beaked whale	*Ziphius cavirostris*	-	-	L	SHM	SHM
Dwarf sperm whale	*Kogia simus*	-	-	L	SHM	SHM
False killer whale	*Pseudorca crassidens*	-	-	L	SHL	SHL
Fin whale	*Balaenoptera physalus*	V	M	L	FK	FL
Gray's beaked whale	*Mesoplodon grayi*	-	-	L	SHM	
Hector's beaked whale	*Mesoplodon hectori*	-	-	L	SHM	SHM
Humpback whale	*Megaptera novaeangliae*	V	M	L	SHK	SHL
Killer whale, orca	*Orcinus orca*	-	M	L	SHL	SHL
Long-finned pilot whale	*Globicephala melas*	-	-	L	SHM	SHM
Minke whale	*Balaenoptera acutorostrata*	-	-	L	SHM	SHM
Pygmy right whale	*Caperea marginata*	-	M	L	FL	FM
Pygmy sperm whale	*Kogia breviceps*	-	-	L	SHM	SHM
Sei whale	*Balaenoptera borealis*	V	M	L	FK	FL

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (1 km)
		Listed threatened	Listed migratory	Listed marine		
Shepherd's beaked whale	*Tasmacetus shepherdi*	-	-	L	SHM	
Short-finned pilot whale	*Globicephala macrorhynchus*	-	-	L	SHM	SHM
Southern bottlenose whale	*Hyperoodon planifrons*	-	-	L	SHM	
Southern right whale	*Eubalaena australis* *Balaena glacialis australis*	E	M	L	BK	SHK
Sperm whale	*Physeter macrocephalus*	-	M	L	SHM	SHM
Strap-toothed beaked whale	*Mesoplodon layardii*	-	-	L	SHM	SHM
True's beaked whale	*Mesoplodon mirus*	-	-	L	SHM	SHM
Dolphins						
Bottlenose dolphin	*Tursiops truncates*	-	-	L	SHM	SHM
Common dolphin	*Delphinus delphis*	-	-	L	SHM	SHM
Dusky dolphin	*Lagenorhynchus obscures*	-	M	L	SHL	SHM
Indian ocean bottlenose dolphin	*Tursiops aduncus*	-	-	L	SHL	
Risso's dolphin	*Grampus griseus*	-	-	L	SHM	SHM
Southern right whale dolphin	*Lissodelphis peronii*	-	-	L	SHM	SHM

Listed Threatened
E: Endangered
V: Vulnerable
Listed Migratory
M: Migratory
Listed Marine
L: Listed

Likely Presence
SHM: Species or species habitat may occur within area.
SHL: Species or species habitat likely to occur within area.
SHK: Species or species habitat known to occur within area.
FK: Foraging, feeding or related behaviour known to occur within area. FL: Foraging, feeding or related behaviour likely to occur within area
FM: Foraging, feeding or related behaviour may to occur within area.

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the operational area.

Table 4-14: Cetacean species recorded during aerial surveys 2002–2013 in southern Australia

Taxon	Common name	Species group*	Sightings	Individual	Mean group size (+/- SD)
Baleen whales					
Eubalaena australis	Southern right whale	SRW	12	52	4.2 +/- 4.2
Caperea marginata	Pygmy right whale		1	100	100
Balaenoptera physalus	Fin and like fin whale	ROR	7	8	1.1 +/- 0.4
B. borealis	Sei and like sei whale	ROR	12	14	1.3 +/- 0.5
B. acutorostrata	Dwarf minke whale	ROR	1	1	1
B. bonaerensis	like Antarctic minke whale	ROR	1	1	1
Megaptera novaeangliae	Humpback whale	ROR	10	18	1.8 +/- 1.0
Toothed whales					
Physeter macrocephalus	Sperm whale	ODO	34	66	1.9 +/- 2.2
Mesoplodon spp.	Unidentified beaked whales	ODO	1	20	20
Orcinus orca	Killer whale	ODO	6	21	3.5 +/- 2.8
Globicephala melas	Long-finned pilot	ODO	40	1853	46.3 +/- 46.7
Grampus griseus	Risso's dolphin	ODO	1	40	40
Lissodelphis peronii	Southern right whale dolphin	ODO	1	120	120
Tursiops spp.	Bottlenose dolphin	DOL	4	363	90.8 +/- 140.1
	Dolphins	DOL	384	22169	58 +/- 129.6
Unidentified large whales			3	3	1
Unidentified small whales			2	2	1

SRW = southern right whales; ROR = rorquals; ODO = other odontocetes; DOL = dolphins.

Table 4-15: Temporal occurrence across months of cetaceans sighted during aerial surveys from November 2002 to March 2013 in southern Australia

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Southern right whale	0	0	0	0	0	0	0	0	0.8	3.1	6.8	8.8
Pygmy right whale*	0	0	0	0	0	0	0	0	19.8	0	0	0
Fin whale	0	0.10	0.14	0.07	0.08	0	0	0	0	0	0	0
Sei whale	0	0.25	0.07	0.04	0.08	0.19	0	0.21	0	0	0	0
Minke whale*	0	0	0.02	0	0	0	0.12	0	0	0	0	0
Humpback whale	0	0.05	0.07	0	0	0	0	0.11	0.99	1.0	0	0.35
Sperm whale	1.7	1.2	0.23	0.53	0.08	0.13	0.75	0.85	0	0	0	0
Unidentified beaked whale*	0	0	0.47	0	0	0	0	0	0	0	0	0
Killer whale	0	0	0.19	0	0	5.0	0	6.0	0	0.68	0	0
Pilot whale	0	59.6	7.0	19.3	4.0	39.5	0	26.3	0	0	0	0
Southern right whale dolphin*	0	59.6	0	0	0	0	0	0	0	0	0	0
Risso's dolphin*	0	0	0	0	1.7	0	0	0	0	0	0	0
Bottlenose dolphin	0	1.5	7.7	0	0	0	0	0	0	0	0	1.1
Dolphins	545.1	120.3	105.0	151.8	105.6	233.4	26.9	257.6	155.8	2.7	0	0

*Species sighted 2 or fewer times.

Note: Numbers denote animals sighted per 1,000 km survey distance for each month, pooled for all years (i.e. the 12-month period from Oct–Sep).

Table 4-16: Observed cetaceans in the Otway Basin

Species	Jun	Jul	Aug	Sep *	Oct	Nov	Dec	Jan	Feb	Mar	Total
Blue whale	0	0	0	0	0	23	70	17	8	2	120
Southern right whale	2	0	12	13	0	0	0	0	0	0	39*
Humpback whale	3	2	0	1	0	1	0	0	0	0	7
Sperm whale	2	0	0	0	4	0	0	3	1	0	10
Pilot whale	0	0	0	0	0	70	0	0	55	0	125
Dolphins	13	298	0	33	54	620	80	672	1526	21	3317
Southern right whale	0	0	0	0	0	120	0	0	0	0	120

*September values averaged over two surveys on 1 and 11 September 2012. Totals include individuals from both September surveys

Table 4-17: Marine fauna observations at project locations during the Artisan-1 drilling activity

	Thylacine	***Total***
Blue whale	1 [2]	38 [57]
Unidentified whale	0	3 [3]
Bottlenose dolphin	0	16 [122]
Common dolphin	0	132 [3,976]
Unidentified dolphin	0	18 [128]
Total	1 [2]	207 [4,286]

Key: Approximate total number of individuals [Total number of detections]

Antarctic minke whale

The Antarctic minke whale (*Balaenoptera bonaerensis*) has been found in all Australian states except the Northern Territory and occupies cold temperate to Antarctic offshore and pelagic habitats between 21°S and 65°S (Bannister et al., 1996). In summer the species is found in pelagic waters from 55°S to the Antarctic ice edge. During winter the species retreat to breeding grounds between 10-30°S, occupying oceanic waters exceeding 600 m depth and beyond the continental shelf break (DotEE, 2019e). Mating occurs from June through December, with a peak in August and September and calving occurs during late May and early June in warmer waters north of the Antarctic Convergence (DotEE, 2019e). The species primarily feeds in the Antarctic during summer on Antarctic krill and does not appear to feed much while in the breeding grounds of lower latitudes (DotEE, 2019e).

The Antarctic minke whale has been observed within the region however there are no BIAs in the operational area or spill EMBA. Therefore, it is likely that they would be uncommon visitors in the spill EMBA.

Blue whale

The pygmy blue whale has a foraging (annual high use area) BIA within the operational area and spill EMBA (Figure 4-30).

Status

The blue whale (*Balaenoptera musculus*) is listed as an endangered species under the EPBC Act (1999) and the IUCN Red List. There are two subspecies of blue whales that use Australian waters (including Australian Antarctic waters), the pygmy blue whale (*B. m. brevicauda*) and the Antarctic blue whale (*B. m. intermedia*). Reference to blue whale unless otherwise specified is generally synonymous to both species. The blue whale has a recovery plan that identifies threats and establishes actions for assisting the recovery of blue whale populations using Australian waters (Commonwealth of Australia, 2015b).

Population

The Antarctic blue whale was extremely abundant until the early 20th century when they were hunted to near extinction. Approximately 341,830 blue whale takes were recorded by commercial whaling in the Antarctic and sub-Antarctic in the 20th century, of which 12,618 were identified as pygmy blue whales (Branch et al., 2004). The current global population of blue whales is uncertain but is plausibly in the range of 10,000 to 25,000, corresponding to about 3-11% of the 1911 estimated population size (Reilly et al., 2008). The Antarctic blue whale subspecies remains severely depleted from historic whaling and its numbers are recovering slowly. The Antarctic blue whale population is growing at an estimated rate of 7.3% per year, but it was hunted to such a low level that it remains at a tiny fraction of pre-whaling numbers (Branch et al., 2004). Recent studies suggest an updated rate of increase in population growth of 12.6 %, consistent with growth rates in waters off the south of Australia (McCauley et al., 2018). The updated abundance estimate uses acoustic chorus squared pressure levels to estimate growth rate off Portland (McCauley et al., 2018). This growth rate considers the number of whales calling assuming the range distribution of whales, source levels, sound propagation and calling behaviour were all similar between years.

Distribution

The blue whale is a cosmopolitan species, found in all oceans except the Arctic, but absent from some regional seas such as the Mediterranean, Okhotsk and Bering seas. Little is known about mating behaviour or breeding grounds. The pygmy blue whale is mostly found north of 55°S, while Antarctic blue whales are mainly sighted south of 60°S in Antarctic waters. Pygmy blue whales are most abundant in the southern Indian Ocean on the Madagascar plateau, and off South Australia and Western Australia, where they form part of a more or less continuous distribution from Tasmania to Indonesia. The Otway region is an important migratory and foraging area for blue whales, as shown by passive acoustic monitoring and aerial surveys (Gavrilov, 2012; McCauley et al., 2018; Gill et al., 2011).

Underwater acoustic monitoring programs have detected Antarctic and pygmy blue whale calls in the Otway Region. Acoustic detection of Antarctic blue whales indicates that they occur along the entire southern coastline of Australia (McCauley et al., 2018). Pygmy and Antarctic blue whales were acoustically detected by Origin Energy between February and October 2011 in the Otway Basin, east of the Thylacine-A wellhead platform. The presence of Antarctic blue whales in the area is considered rare (Gavrilov, 2012). However, recent acoustic studies have estimated an increase in the abundance of blue whales off Portland, Victoria (McCauley et al., 2018). From 2009-2016 Antarctic blue whale calls were received via deep sound channel propagation south of Portland and the maximum chorus levels occurred from late February to late June with yearly increases in chorus levels (McCauley et al., 2018).

Important foraging grounds for blue whales include the Great Australian Bight, South Australia and off Portland Victoria where blue whales visit between December and June to forage on the inshore shelf break (Figure 4-30). The time and location of the appearance of blue whales in the east generally coincides with the upwelling of cold water in summer and autumn along this coast (the Bonney Upwelling) and the associated aggregations of krill that they feed on (Gill and Morrice, 2003). The Bonney Upwelling generally starts in the eastern part of the Great Australian Bight in November or December and spreads eastwards to the Otway Basin around February as southward migration of the subtropical high-pressure cell creates upwelling favourable winds. Sighting data indicates that blue whales are seasonally distributed (Gill et al. 2011, McCauley et al., 2018).

Several aerial and noise studies of blue whales within the Otway Basin have been conducted and are summarised below.

Gill et al., (2011) undertook 69 seasonal aerial surveys for blue whales between Cape Jaffa and Cape Otway over six seasons (2001-02 to 2006-07). This study found that the general pattern of seasonal movement of blue whales is from west to east, with whales foraging in between the Great Australian Bight and Cape Nelson in November and spreading further east in December. Whales are typically widely distributed throughout Otway shelf waters from January through to April (Gill et al., 2011) (Figure 4-32 and Figure 4-33).

Blue whale encounter rates in the central and eastern study (Cape Nelson to Cape Otway) area by month is shown in Figure 4-31 with sighting and effort data presented geographically in Figure 4-32 and Figure 4-33. Data is pooled for all seasons, for central and eastern areas, overlaid on gridded aerial survey effort (10 km x 10 km squares), represented as minutes flown per grid square (key, upper right). Thick solid lines represent 50% and 95% probability contours for blue whale distribution from density kernel analysis. Dashed lines are central and eastern boundaries (Gill et al., 2011). The spill EMBA is within the central and eastern areas and the operational area on the outer edge of the eastern area.

There had been fewer than 50 sightings of blue whales in Bass Strait up to the year 1999, but since that time feeding blue whales have been more regularly observed in the Discovery Bay area and more generally along the Bonney coast from Robe to Cape Otway. Gill et al., (2011) found that across the eastern zone (Cape Nelson to Cape Otway), there were no blue whale sightings in November (2001-2007) despite significant effort (Figure 4-32).

Based on the pooled aerial survey data (2001-2007), encounter rates increased from 1.6 whales per 1,000 km in December, to 9.8 whales per 1,000 km in February, decreased slightly to 8.8 whales per 1,000 km in March, then declined sharply to a single sighting for May (0.4 whales per 1,000 km) (Gill et al., 2011). A mean blue whale group size of 1.3±0.6 was observed per sighting with cow-calf pairs observed in 2.5% of the sightings. Gill et al. (2011) also identified that 80% of blue whale sightings are encountered in water depths between 50 and 150 m; 93% of sightings occurred in water depths <200 m and 10% of sightings occurred within 5 km of the 200 m isobath in the eastern and central zones.

The data from Gill et al. (2011) shows:

- blue whales are typically widely distributed throughout central and eastern areas shelf waters from January through to April.
- blue whale numbers are significantly lower in November, December and January in the eastern area compared to the central area.
- no blue whales were sighted in the eastern area during November for any season despite significant effort. Pooled monthly encounter rates increased from 1.6 whales 1,000 km–1 in December, 5 whales 1,000 km–1 in January, peaked at 9.8 whales 1,000 km–1 in February, dropped slightly to 8.8 whales 1,000 km–1 in March, then declined sharply to a single sighting for May (0.4 whales 1,000 km–1).
- encounter rates in central and eastern zones peaked in February, coinciding with peak upwelling intensity and primary productivity.

From February to October 2011 Origin located an array of marine loggers east of the Thylacine platform to document nearby ambient marine noise, detect cetaceans and measure acoustics associated with the Origin 3D Bellerive Marine Seismic Survey. Pygmy and Antarctic blue whales were acoustically detected in the monitored area. Pygmy blue whales were observed from early February to early June being abundant from March to mid-May. Rare calls from Antarctic blue whales were observed in June.

Aerial surveys commissioned by Origin undertaken during 2011 and 2012 by the Blue Whale Study found that blue whales were common in the eastern upwelling zone during November-December 2012. In November, an estimated 21 individual blue whales were sighted, with most sightings near the 100 m isobath or deeper. December 2012 surveys identified 70 blue whales foraging along the edge of the continental shelf west of King Island. This was the largest recorded aggregation of blue whales during any aerial surveys of the Bonney coast upwelling since 1999. During five aerial surveys between 8 and 25 February 2011, 56 blue whales were sighted. Most of the sightings were at inshore areas between Moonlight Head to Port Fairy with whales apparently aggregating along and offshore of the boundary between the runoff plume from major flooding prevalent at the time and adjacent seawater.

From 2009-2016 Antarctic blue whale calls were received via deep sound channel propagation south of Portland and the maximum chorus levels occurred from late February to late June with yearly increases in chorus levels (McCauley et al., 2018). McCauley et al. (2018) suggests that acoustic detection of Antarctic blue whales indicate they predominantly occur along the entire southern coastline.

McCauley et al. (2018) analysed data from passive acoustic recorders that were located around Australia to look at blue whale presence, distribution and population parameters. The primary sites comprised central Bass Strait, western Tasmania, the southeast Australian coast and the Great Australian Bight area. Each study area had multiple receivers and may have had several sites sampled within the area. Temporal sampling focussed on the southern Australian site south west of Portland, Victoria. Data was used from 2004 to 2016. The study concluded:

- pygmy blue whales have three migratory stages around Australia; the "southbound migration stage" were predominantly between October to December (sometimes into January) whales travel from Indonesian waters down to the WA coast, the "southern Australian stage" where between January and June whales spread across the southern Australian waters, and the "northbound migration stage" where whales travel back up to Indonesia between April and August.
- the "southern stage" involves animals searching for feeding sites, feeding and then marking their way north towards June.
- along the southern Australian coastline pygmy blue whales are most frequently detected towards the east along the Bonney coast over late February to early June, utilising secondary productivity produced by a seasonal upwelling event.
- within a season it is difficult to predict whale numbers and their specific locations, but when correlated across seasons the strength and persistence of this upwelling event as given by time integrated water temperature south of Portland, significantly correlates with time integrated number of individual whales calling from the same site.
- the Bonney coast upwelling is a strong predicator of pygmy blue whale presence at Portland where whale presence in the area is linked to prey availability
- sea noise data was available from the Portland site from 2009 to early 2017 detailed:
    - in 2009 and 2011 pygmy blue whales arrived in November or December whereas in the other years, calls were not detected until January or February (Figure 4-32). There was substantial variation in presence within a season, with some whales remaining in the Portland detection area until mid-June each year.
    - there was considerable variability in whale persistence and presence within a season (Figure 4-33) with no consistent trend other than a peak in presence somewhere over February to June.

- it is difficult to predict numbers within a season but when correlated across seasons the strength and persistence of the Bonney coast upwelling, given by time integrated water temperature, significantly correlates with time integrated number of individual whales calling from the same site. The upwelling index explains 83% of the variability in blue whale calling presence across seasons when using seasonal whale counts (not corrected for population growth). When a growth rate of 4.3% is applied a correlation of 90% of the variance in seasonal occurrence is predicted by the upwelling index.

- the number of pygmy blue whale calling in Portland could be expected in increase yearly with whale population growth.

There were no confirmed sightings of blue whales during Origin's Speculant 3D Transition Zone marine seismic survey in November and December 2010, the Astrolabe 3D seismic survey undertaken in early November 2013 (RPS, 2014) or during the Enterprise 3D seismic survey undertaken in late October and early November 2014 (RPS, 2014). During the Beach Otway Development Seabed Survey (November 2019 to January 2020) there were four sightings of blue whales within 3.5 km of the Thylacine Platform in November 2019 and one sighting in January 2020 about 1 km from the Artisan well location. The whales were identified as swimming.

Möller et al. 2020 analysis data from the tags of 13 pygmy blue whales who were tagged in the Bonney upwelling region in January 2015 with tags transmitting up to March 2016. In summary:

- the whales' movements in the Great Southern Australian Coastal Upwelling System (GSACUS) ranged mostly from eastern South Australia, over the continental shelf south of Kangaroo Island, to between mainland Australia and Tasmania), with a few whales performing some movements to the continental slope and the deep-sea (Figure 4-34).

- in the GSACUS, most tagged whales remained over the continental shelf, utilising this region from at least January to July. This was the area of highest occupancy by the whales, with one whale returning to the Bonney Upwelling in January the year after and remaining there for at least three months. This timing coincides with the upwelling season, which generally occurs from November to March each year.

- a low probability of area restricted search (ARS) behaviour (i.e. high probability of transiting behaviour) was mainly observed between April and June, and then between November and December, suggesting that the pygmy blue whales were mainly migrating during those times.

- seascape correlates of ARS behaviour for these whales suggested the importance of sea surface temperature, sea surface height anomaly, wind speed and chlorophyll a concentration as proxies of upwelling productivity and presence of krill patches.

Beach commenced a 22 month drilling program in February 2021 in the Otway Development Area. The Blue Whale Study was engaged to undertaken aerial surveys from February to May 2021 to identify blue whale and krill surface swarms within the Otway Development Area and outside of this area. A preliminary data summary provided to Beach detailed:

- Nine aerial surveys were undertaken from 25 February to 21 May 2021.

- There were 34 blue whale sightings consisting of 43 individuals.

- Peak blue whale sightings was on 7 April with 19 blue whales sighted.

- First blue whale was sighted 25 February and final blue whale sighted 7 April.

- Blue whales and krill surface swarms were distributed throughout the area surveyed.

As detailed in Section 4.5.5, JASCO completed a monitoring study for Beach in relation to exploration drilling activities at the Artisan-1 well from the 1 Feb to 6 April 2021 (McPherson et al., 2021). Songs of pygmy blue whales were detected sporadically through February and the first half of March. By the end of March, the signals were present in almost every hour of recording. This pattern of occurrence was reflected across all recording stations. The data were too sparse to confirm anything about animal movements.

The seasonal distribution and abundance of blue whales are variable across years and influenced by climate variables. The time and location of the appearance of blue whales in the east generally coincides with the upwelling of cold water in summer and autumn along the coast (the Bonney coast upwelling) and the associated aggregations of krill that they feed on (Gill and Morrice, 2003). The Bonney coast upwelling generally starts in the eastern part of the Great Australian Bight in November or December and spreads eastwards to the Otway Basin around February as southward migration of the subtropical high-pressure cell creates upwelling favourable winds.

There are two known seasonal feeding aggregations areas in Australia, the Bonney Coast Upwelling KEF and adjacent waters off South Australia and Victoria (Figure 4-34), and the Perth Canyon KEF and adjacent waters in Western Australia. The abundance of pygmy blue whales varies within and between seasons, but they typically forage in the Otway region between January and April. Foraging of pygmy blue whales is known to occur in Bass Strait and the west coast of Tasmania where they have been recorded diving at depth presumably feeding (Commonwealth of Australia. 2015). McCauley et al. (2018) suggests that acoustic detection of pygmy blue whales indicate they predominantly occur west of Bass Strait (Figure 4-35). Acoustic detections of pygmy blue whales off Portland Victoria correlated with upwelling indicators in the Bonney coast upwelling in late summer to autumn (February-April) (McCauley et al., 2018). The two pygmy blue whale call types and the Antarctic blue whale call have been detected in central Bass Strait. One occasion all three types were detected between April and June with more commonly two calls present over this period during other years (Figure 4-35).

Pygmy blue whales have three migratory stages around Australia; the “southbound migration stage” where predominantly between October to December (sometimes into January) whales travel from Indonesian waters down to the WA coast, the “southern Australian stage” where between January and June whales spread across the southern Australian waters, and the “northbound migration stage” where whales travel back up to Indonesia between April and August. The “southern stage” involves animals searching for prey. The Bonney coast upwelling is a strong predicator of pygmy blue whale presence at Portland where whale presence in the area is linked to prey availability (McCauley et al., 2018). Passive acoustic monitoring in southern Australia during 2000-2017 focused on the distribution and population parameters of both subspecies of blue whales in southern and western Australia. In Portland sea noise data was available from 2009 to early 2017. In 2009 and 2011 pygmy blue whales arrived in November or December whereas in the other years, calls were not detected until January or February. There was substantial variation in presence within a season, with some whales remaining in the Portland detection area until mid-June each year. Acoustic loggers located east of the Thylacine platform from February to October 2011 detected pygmy blue whales between February and early June, with the greatest abundance from March to mid-May.

It is difficult to predict numbers within a season but when correlated across seasons the strength and persistence of the Bonney coast upwelling, given by time integrated water temperature, significantly correlates with time integrated number of individual whales calling from the same site. The upwelling index explains 83% of the variability in blue whale calling presence across seasons when using seasonal whale counts (not corrected for population growth). When a growth rate of 4.3% is applied a correlation of 90% of the variance in seasonal occurrence is predicted by the upwelling index. The number of pygmy blue whale calling in Portland could be expected in increase yearly with whale population growth (McCauley et al., 2018).

Photo identification, genetics and telemetry studies provide information on whale movements and connectivity. Photo identification and genomic studies suggest population exchange between the two feeding grounds of the Bonney coast upwelling and the Perth Canyon (Attard et al., 2018). A pygmy blue whale was tagged in 2014 north of the Perth Canyon and travelled a total distance of 506.3 km in 7.6 days, indicating the vast distances that the large marine mammals can travel in a short amount of time (Owen et al., 2016). While migrating the whale made dives at depths just below the surface which likely reduces energy expenditure but also increases the risk of ship strike greatly for longer periods than previously thought.

BIAs for pygmy blue whales have been identified around Australia with the foraging BIA intersecting the operational area and spill EMBA (Figure 4-36). Surveys data suggests that blue whales are most likely to first appear during December/January and reach peak number during February/March. The likelihood and extent of the interaction is dependent on broad scale environmental factors affecting the abundance and distribution of blue whale feeding resources.

Foraging

There are two known seasonal feeding aggregations areas in Australia, the Bonney Coast Upwelling KEF and adjacent waters off South Australia and Victoria and the Perth Canyon KEF and adjacent waters in Western Australia (Figure 4-30). Foraging of pygmy blue whales is known to occur in Bass Strait and the west coast of Tasmania where they have been recorded diving at depth presumably feeding (DoE, 2015d). Blue whales are known as 'constant foragers'; their ecology in feeding grounds consists of constantly searching for patchily distributed krill resources, preferably those that reward the effort involved in consuming them (Torres et al., 2020). They are physically well-adapted for rapid movement between widely separated foraging areas (Woodward et al., 2006), but when they enter areas where krill may occur, they carry out zig-zagging 'area-restricted searches' (ARS) patterns until either they find prey, or exhaust local possibilities, and move on to another possible foraging ground based on past experience (Abrahms et al., 2019). Based on this it is assumed that once the blues have finished feeding, they will move from the feeding area to commence searching for another area.

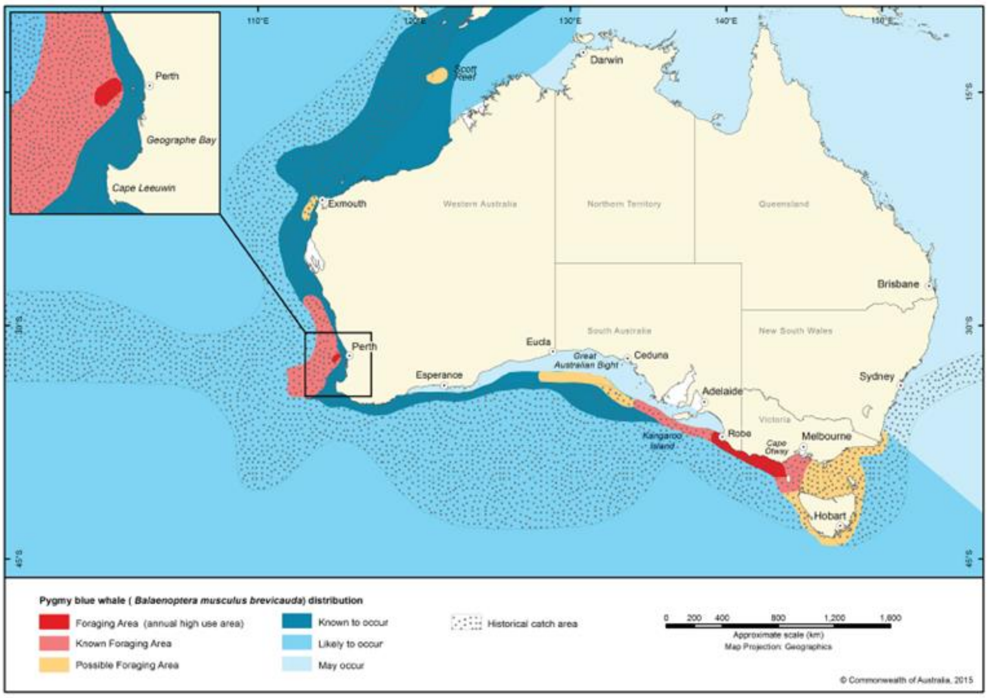
Diving behaviour of blue whales associated with feeding at depth was observed by Gill & Morris (2003) in the Otway region, who note that blue whales dived steeply, submerging for 1 – 4 minutes, then returned to the surface. Tagging of a pygmy blue whale at the Perth Canyon identified 1677 dives over the tag duration (7.6 days) (Owen et al., 2016). The duration of dives was:

- Feeding - mean of 7.6 minutes, maximum of 17.5 minutes;
- Migratory – mean of 5.2 minutes, maximum of 26.7 minutes; and
- Exploratory – mean of 8.6 minutes, maximum of 22.05 minutes.

Tagging of 13 pygmy blue whales (five of which had tags that monitored dive depth and duration) in the Bonney upwelling identified (Möller et al., 2015):

- Whales predominantly carried out area-restricted search (presumably foraging) with generally shallow and short dives. However, dives were generally deeper at night compared to during the day.
- Whales performed mostly square shaped dives that were shallow in depth and short in duration.
- Dives recorded to a maximum of 492 m (mean = 59.5 m ± 94.3), and for a maximum duration of 112 minutes (mean = 6.1 minutes ± 5.2).

Although the maximum recorded dive time was 112 minutes, the mean dive time of 6.1 minutes ± 5.2 provides confidence that the typical dive time is less than 30 minutes (Möller et al., 2015). Tagging of eight blue whales off California (Irvine et al., 2019) identified that dive durations were as long as 30.7 minutes and no feeding lunges were recorded during dives >20 minutes in duration.



Foraging Area (Annual high use area)	Blue whales are regularly observed feeding on a seasonal basis	Known to occur	Blue whales are known to occur based on direct observations, satellite tagged whales or based on acoustic detections
Known Foraging Area	Known foraging occurs in these areas but is highly variable both between and within seasons	Likely to occur	Blue whales are likely to occur based on occasional observations in the area and nearby areas
Possible Foraging Area	Evidence for feeding is based on limited direct observations or through indirect evidence, such as occurrence of krill in close proximity of whales, or satellite tagged whales showing circling tracks. Blue whales travel through on a seasonal basis, possibly as part of their migratory route	May occur	Evidence for the presence of blue whales through strandings or rare observations
		Historical catch area	Blue whales were caught during the whaling period based on whaling data

Figure 4-30: Pygmy blue whale foraging areas around Australia (Commonwealth of Australia, 2015b)

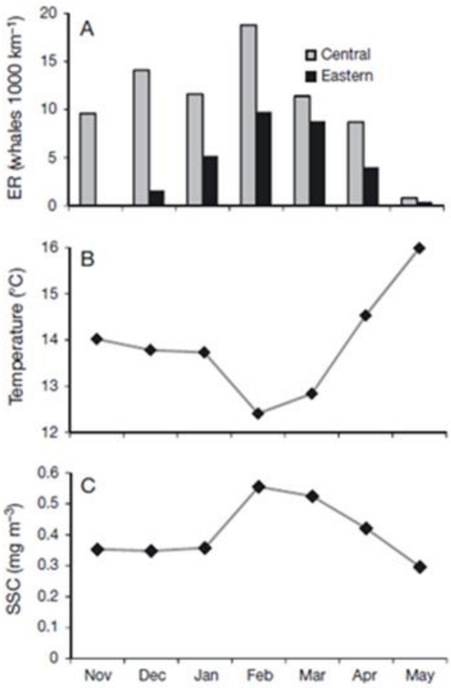


Figure 4-31: Blue whale encounter rates in the central and eastern study (Cape Nelson to Cape Otway) area by month (Gill et al., 2011)

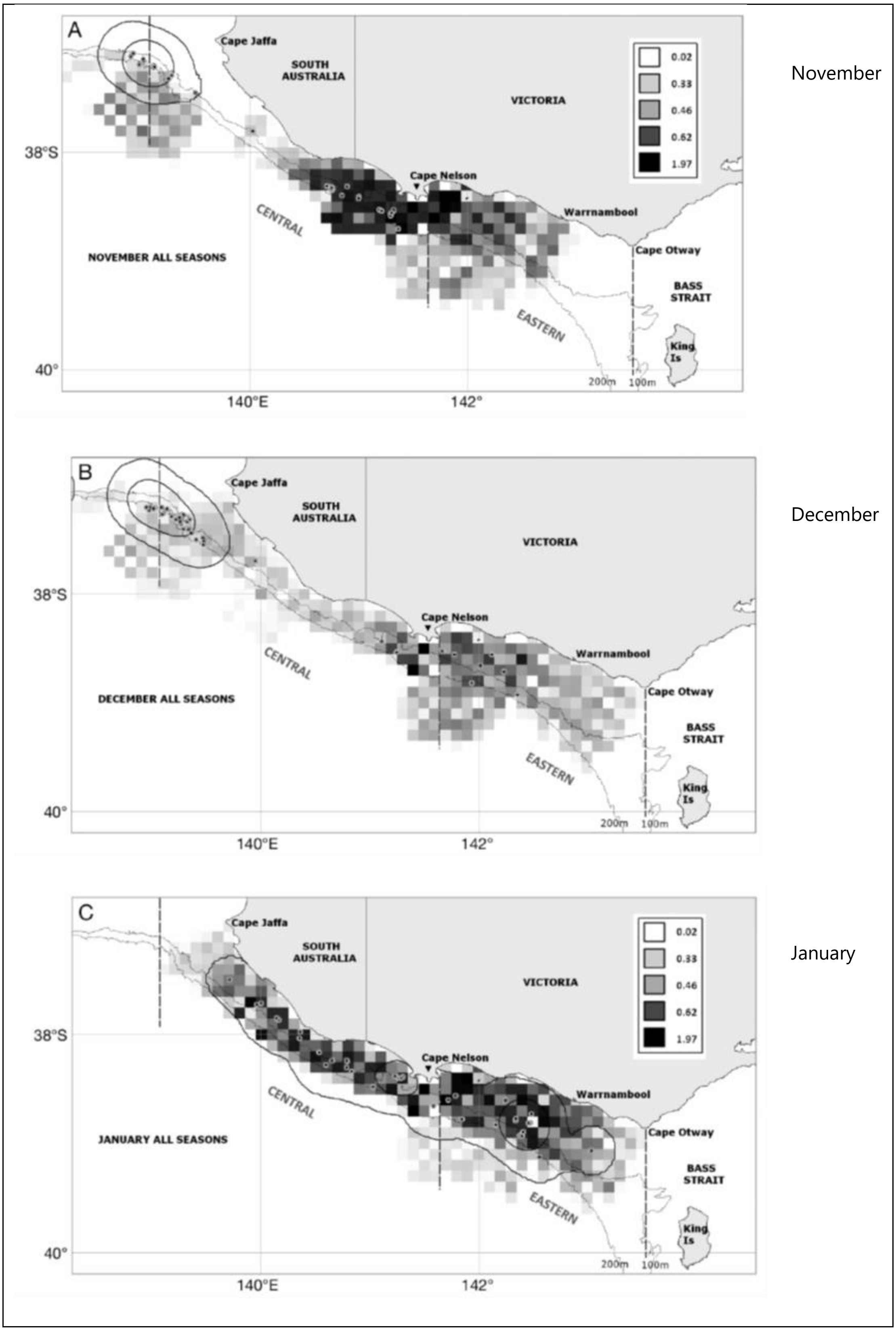


Figure 4-32: Blue whale sightings in the Otway Basin (Nov, Dec, Jan) (Gill et al., 2011)

Note: Dots represent blue whale sightings while squares are aerial survey effort (10 km x 10 km squares) represented as minutes flown per grid square (key, upper right corner of the November and January figures).

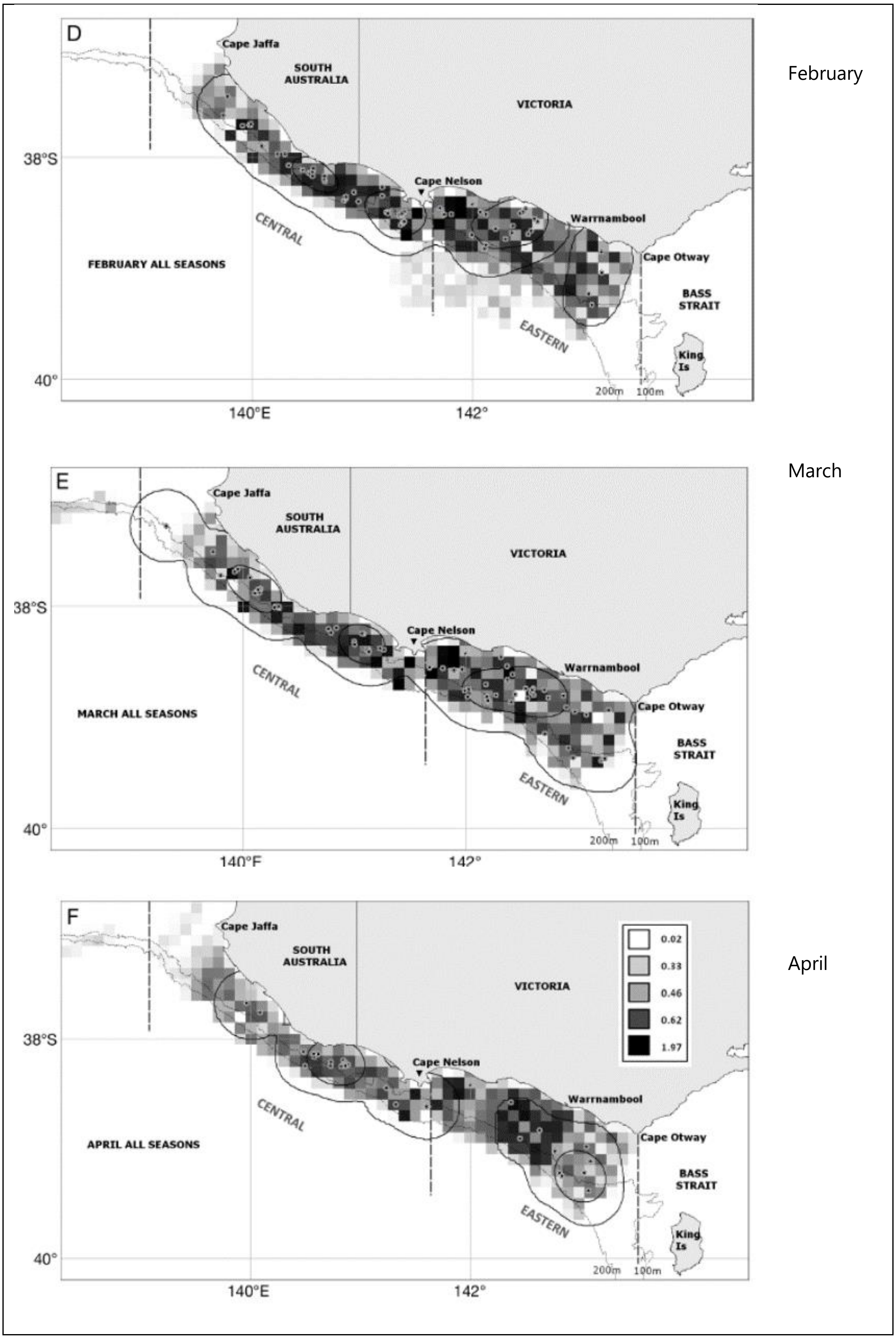


Figure 4-33: Blue whale sightings in the Otway Basin (Feb, Mar, Apr) (Gill et al., 2011)

Note: Dots represent blue whale sightings while squares are aerial survey effort (10 km x 10 km squares) represented as minutes flown per grid square (key, upper right corner of the April figure).

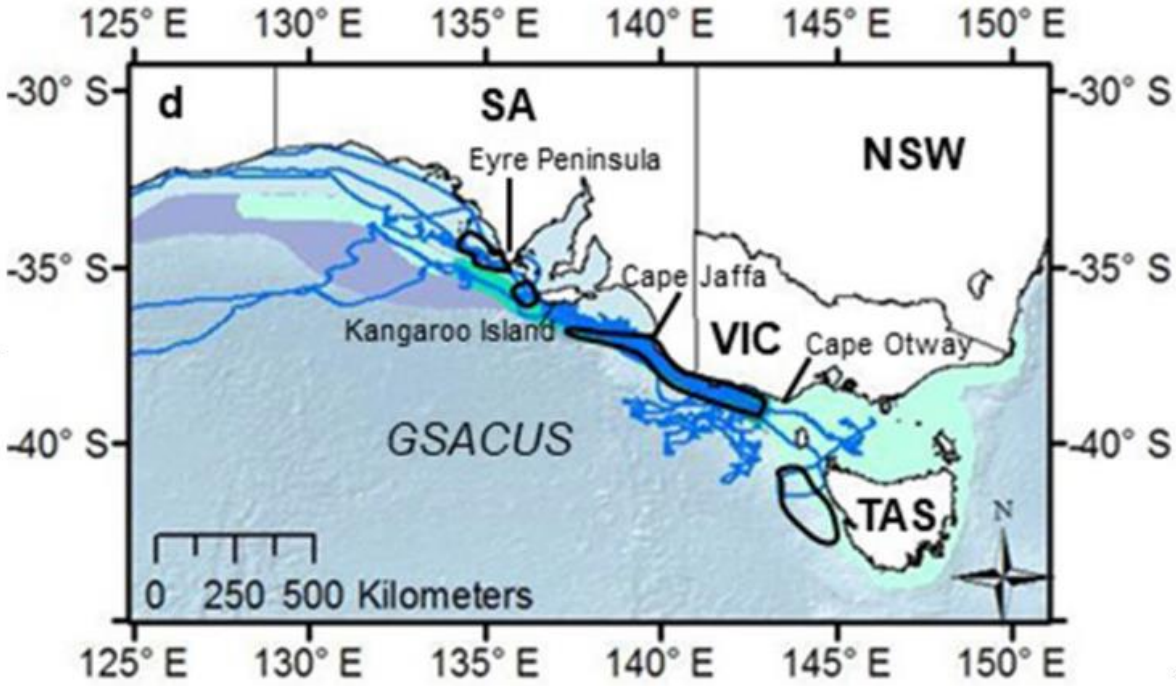


Figure 4-34: Tracks of 13 pygmy blue whales in the Great Southern Australian Coastal Upwelling System (GSACUS) (Möller et al. 2020)

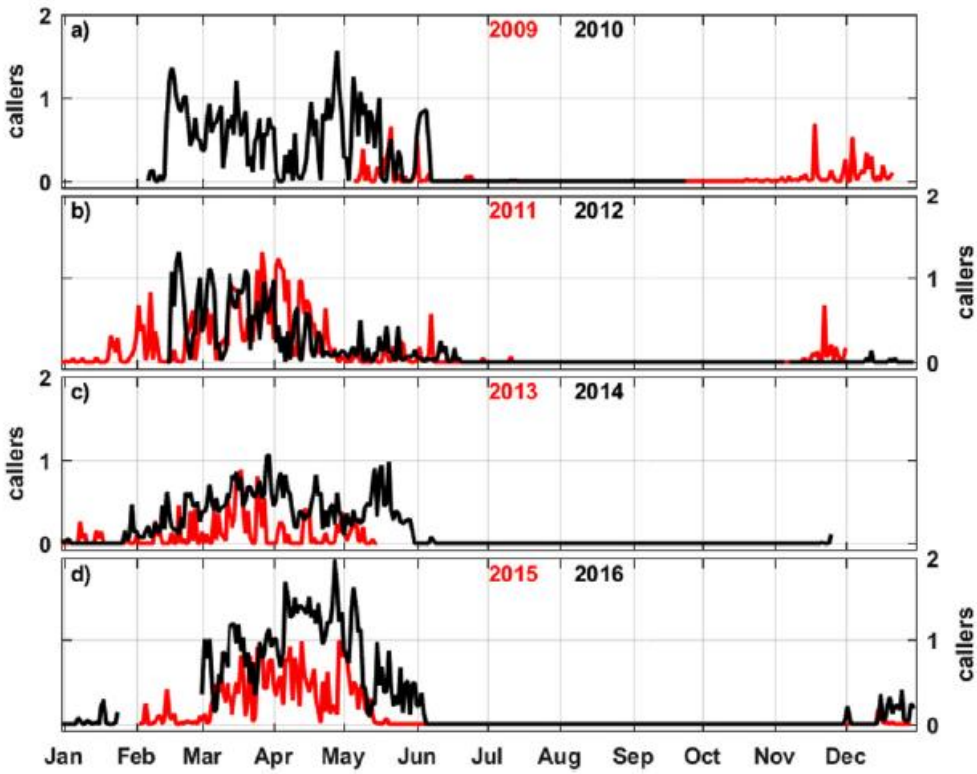


Figure 4-35: Mean number of individual pygmy blue whales calling (McCauley et al. 2018)

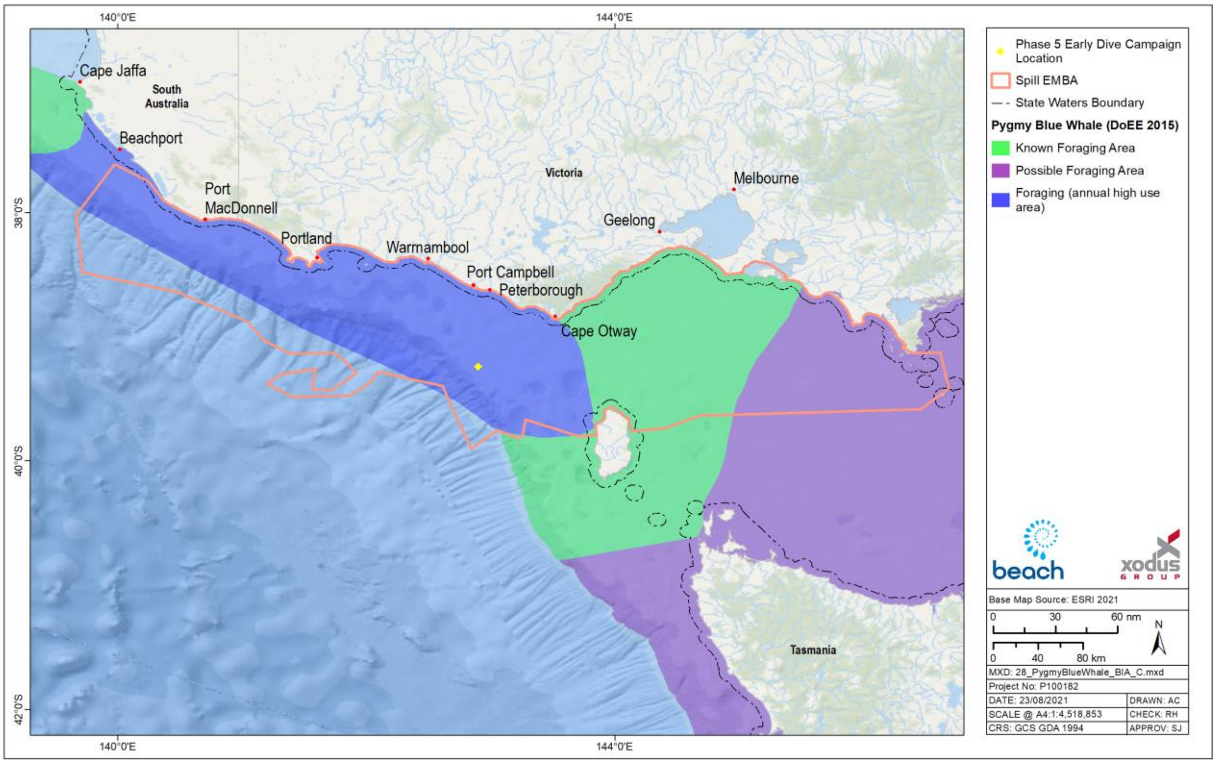


Figure 4-36: BIA for the pygmy blue whale within the spill EMBA.

Fin whale

Fin whales are considered a cosmopolitan species and occur from polar to tropical waters and are rarely in inshore waters. They show well defined migratory movements between polar, temperate and tropical waters. Migratory movements are essentially north–south with little longitudinal dispersion. Fin whales regularly enter polar waters. Unlike blue whales and minke whales, fin whales are rarely seen close to ice, although recent sightings have occurred near the ice edge of Antarctica.

There are stranding records of this species from most Australian states, but they are considered rare in Australian waters (Bannister et al., 1996). The fin whale has been infrequently recorded between November and February during aerial surveys in the region (Gill et al., 2015). Fin whales have been sighted inshore in the proximity of the Bonney coast upwelling, Victoria, along the continental shelf in summer and autumn months (Gill, 2002). Fin whales in the Bonney coast upwelling are sometimes seen in the vicinity of blue whales and sei whales.

Fin whales were sighted, and feeding was observed between November-May (upwelling season) during aerial surveys conducted between 2002-2013 in South Australia (Gill et al., 2015). This is one of the first documented records these whales feeding in Australian waters, suggesting that the region may be used for opportunistic baleen whale feeding (Gill et al., 2015). Fin whales have also been acoustically detected south of Portland, Victoria (Erbe et al., 2016). Aulich et al. (2019) recorded infrequent presence of fin whales in Portland between 2009 to 2016. This suggests that the area may not be a define migratory route however, calls recorded in July may be from whales migrating northward towards the east coast of NSW. Calls detected in late August and September may be indication of the presence of whales on their migration route back to Antarctica waters.

The sighting of a cow and calf in the Bonney coast upwelling in April 2000 and the stranding of two fin whale calves in South Australia suggest that this area may be important to the species' reproduction, perhaps as a provisioning area for cows with calves (Morrice et al., 2004). However, there are no defined mating or calving areas in Australia waters.

As there are no BIAs for the fin whale in the operational area or spill EMBA, they are likely to be uncommon visitors to the operational area and spill EMBA.

Humpback whale

Humpback whales (*Megaptera novaeangliae*) are present around the Australian coast in winter and spring. Humpbacks undertake an annual migration between the summer feeding grounds in Antarctica to their winter breeding and calving grounds in northern tropical waters. Along the southeast coast of Australia, the northern migration starts in April and May while the southern migration peaks around November and December (TSSC, 2015a). A discrete population of humpback whales have been observed to migrate along the west coast of Tasmania and through Bass Strait, and these animals may pass through the operational area. The exact timing of the migration period varies between years in accordance with variations in water temperature, extent of sea ice, abundance of prey, and location of feeding grounds (TSSC, 2015a). Feeding occurs where there is a high krill density, and during the migration this primarily occurs in Southern Ocean waters south of 55°S (TSSC, 2015a).

Humpback whales satellite-tagged off Australia's east coast were tracked during three austral summers in 2008/2009, 2009/2010 and 2010/2011 (Andrews-Goff et al., 2018). Of the thirty tagged humpbacks, 21 migrated south along the coastline across into Bass Strait during October. In November the whales then migrated along the east coast (12 whales) and west coast (1 whale) of Tasmania to Antarctic feeding grounds. The state space model used shows both search and transit behaviour revealing new temperate feeding grounds in Bass Strait, the east coast of Tasmania and in the eastern Tasman Sea.

There are no known feeding, resting or calving grounds for humpback whales in the spill EMBA, although feeding may occur opportunistically where sufficient krill density is present (Commonwealth of Australia, 2015) and anecdotal sightings of humpback whale have been made by Beach in the area. The nearest BIA which is important habitat for migrating humpback whales is Twofold Bay, a resting area off the NSW coast (DAWE, 2021).

During Origin's Enterprise 3D seismic survey undertaken during early November 2014, 16 humpback whales were sighted (RPS, 2014).

The recovery of humpback whale populations following whaling has been rapid. The Australian east coast humpback whale population, which was hunted to near-extinction in the 1950s and early 1960s, had increased to 7,090±660 (95% CI) whales by 2004 with an annual rate of increase of 10.6±0.5% (95% CI) between 1987–2004 (Noad et al., 2011). The available estimates for the global population total more than 60,000 animals, and global population is categorised on the IUCN Red List as Least Concern.

Killer whale

Killer whales (*Orcinus orca*) are thought to be the most cosmopolitan of all cetaceans and appear to be more common in cold, deep waters; however, they have often been observed along the continental slope and shelf particularly near seal colonies (Bannister et al., 1996). The killer whale is widely distributed from polar to equatorial regions and has been recorded in all Australian waters with concentrations around Tasmania. The only recognised key locality in Australia is Macquarie Island and Heard Island in the Southern Ocean (Bannister et al., 1996). The habitat of killer whales includes oceanic, pelagic and neritic (relatively shallow waters over the continental shelf) regions, in both warm and cold waters (DotEE, 2019d).

Killer whales are top-level carnivores. Their diet varies seasonally and regionally. The specific diet of Australian killer whales is not known, but there are reports of attacks on dolphins, young humpback whales, blue whales, sperm whales, dugongs and Australian sea lions (Bannister et al., 1996). In Victoria, sightings peak in June/July, where they have been observed feeding on sharks, sunfish, and Australian fur seals (Morrice et al., 2004; Mustoe, 2008).

The breeding season is variable, and the species moves seasonally to areas of food supply (Bannister et al., 1996; Morrice et al., 2004). Killer whales are frequently present in Victorian waters with sightings recorded along most of Victoria's coastline. Mustoe (2008) describes between 2002 and 2008 web-based casual sightings had an average of 13 killer whales sighted per year in Victoria and NSW, more than half in Victorian waters. This combined with the Atlas of Victorian Wildlife indicates a peak in killer whale sightings in June to July and September to November (Mustoe, 2008).

The killer whale has been observed within the region however there are no BIAs in the operational area or spill EMBA. Therefore, it is likely that they would be uncommon visitors in the operational area or spill EMBA.

Long-finned pilot whale

The long-finned pilot whale (*Globicephala melas*) is distributed throughout the northern and southern hemispheres in circumpolar oceanic temperate and subantarctic waters containing zones of higher productivity along the continental slope. They sometimes venture into the shallower waters of the shelf (<200 m) in pursuit of prey species. Stomach contents confirm that squid are the main prey of long-finned pilot whales in Australian waters, although some fish are also taken (DotEE, 2019f). No key localities have been identified in Australia (Bannister et al., 1996) however they are considered reasonably abundant (DotEE, 2019f).

There is some (inconclusive) evidence that suggests the species moves along the edge of the continental shelf in southern Australian waters (Bannister et al., 1996) in response to prey abundance at bathymetric upper slopes and canyons (DoE, 2016g). Records from Tasmania indicate mating occurs in spring and summer with 85% of calves born between September and March although births do occur throughout the year.

No calving areas are known in Australian waters (DotEE, 2019f).

The long-finned pilot whale has been identified in surveys over the Bass Strait and eastern Great Australian Bight; however, there are no BIAs in the operational area or spill EMBA. During works undertaken by Origin Energy, long-finned pilot whales have been seen sporadically, such as, a sighting of approximately 30 whales occurred during the 2014 Enterprise MSS. It is likely that they would be uncommon visitors to the operational area or spill EMBA.

Minke whale

The minke whale (*Balaenoptera acutorostrata*) is a widely distributed baleen whale that has been recorded in all Australian waters except the Northern Territory. The whales can be found inshore although they generally prefer deeper waters. In summer they are abundant feeding throughout the Antarctic south of 60°S but appear to migrate to tropical breeding grounds between 10°S and 20°S during the Southern Hemisphere winter (Kasamatru, 1998; Reilly et al., 2008). Although the exact location of breeding grounds is unknown, mating occurs between August to September with calving between May and July (Bannister et al., 1996). A few animals have been sighted during aerial surveys of the Bonney coast upwelling. The minke whale has been observed within the region however there are no BIAs in the operational area or spill EMBA. Therefore, it is likely that they would be uncommon visitors in the operational area or spill EMBA.

Pygmy right whale

The pygmy right whale (*Caperea marginata*) is a little-studied baleen whale species that is found in temperate and sub-Antarctic waters in oceanic and inshore locations. The species, which has never been hunted commercially, is thought to have a circumpolar distribution in the Southern Hemisphere between about 30°S and 55°S. Distribution appears limited by the surface water temperature as they are almost always found in waters with temperatures ranging from 5° to 20°C (Baker, 1985) and staying north of the Antarctic Convergence. There are few confirmed sightings of pygmy right whales at sea (Reilly et al., 2008). The largest reported group was sighted (100+) just south-west of Portland in June 2007 (Gill et al., 2008).

Species distribution in Australia is found close to coastal upwellings and further offshore it appears that the Subtropical Convergence may be important for regulating distribution (Bannister et al., 1996). Key locations include south-east Tasmania, Kangaroo Island (SA) and southern Eyre Peninsula (SA) close to upwelling habitats rich in marine life and zooplankton upon which it feeds (Bannister et al., 1996).

The pygmy right whale has been observed in surveys in the region however Origin Energy did not observe it during the 2010 Speculant MSS and 2014 Enterprise MSS. Also, there are no BIAs identified in the operational area or spill EMBA. Therefore, it is likely to be an uncommon visitor in the operational area or spill EMBA.

Sei whale

Sei whales are considered a cosmopolitan species, ranging from polar to tropical waters, but tend to be found more offshore than other species of large whales. They show well defined migratory movements between polar, temperate and tropical waters. Migratory movements are essentially north-south with little longitudinal dispersion. Sei whales do not penetrate the polar waters as far as the blue, fin, humpback and minke whales (Horwood, 1987), although they have been observed very close to the Antarctic continent.

Sei whales move between Australian waters and Antarctic feeding areas; subantarctic feeding areas (e.g. Subtropical Front); and tropical and subtropical breeding areas. The proportion of the global population in Australian waters is unknown as there are no estimates for sei whales in Australian waters.

Sei whales feed intensively between the Antarctic and subtropical convergences and mature animals may also feed in higher latitudes. Sei whales feed on planktonic crustaceans, in particular copepods and amphipods. Below the Antarctic convergence sei whales feed exclusively upon Antarctic krill (*Euphausia superba*).

In the Australian region, sei whales occur within Australian Antarctic Territory waters and Commonwealth waters, and have been infrequently recorded off Tasmania, NSW, Queensland, the Great Australian Bight, Northern

Territory and Western Australia (Parker 1978; Bannister et al., 1996; Thiele et al., 2000; Chatto and Warneke 2000; Bannister 2008a).

Sightings of sei whales within Australian waters includes areas such as the Bonney coast upwelling off South Australia (Miller et al., 2012), where opportunistic feeding has been observed between November and May (Gill et al., 2015).).

There are no known mating or calving areas in Australian waters. The sei whale is likely to be an uncommon visitor to the operational area or spill EMBA.

Southern right whale

The spill EMBA overlaps the southern right whale (*Eubalaena australis*) aggregation, connecting habitat and migration BIAs and current core coastal range (Figure 4-37). The operational area overlaps the known core coastal range BIA. The operational area is ~67 km from the aggregation BIA and ~90 km from the connecting habitat BIA (Figure 4-37).

The southern right whale is listed as endangered under the EPBC Act in Australia and as critically endangered on the Victorian Threatened Species Advisory List. Southern right whales were depleted to less than 300 individuals globally due to commercial whaling in the 19th and 20th centuries (Tormosov et al., 1998). They were protected from whaling in 1935 however, due to illegal whaling in the 1970s and because southern right whales have a slow rate of increase (7% per annum (p.a.)) compared to other marine mammals, their numbers remain low (IWC, 2013). Global abundance estimates are 13,000 for the species, across key wintering grounds in South Africa, Argentina, Australia and New Zealand.

The Australian population of southern right whales is divided into two sub-populations due to genetic diversity (Carroll et al., 2011; Baker et al., 1999) and different rates of increase (DSEWPaC, 2012a). The western sub-population occurs predominantly between Cape Leeuwin, Western Australia (WA) and Ceduna, South Australia (SA) This sub-population comprises most of the Australian population and is estimated at 3,200 individuals increasing at an annual rate of approximately 6% p.a. (Smith et al., 2019). The eastern sub-population can be found along the south-eastern coast, including the region from Tasmania to Sydney, with key aggregation areas in Portland and Warrnambool in Victoria. The eastern sub-population is estimated at less than 300 individuals and is showing no signs of increase (Bannister, 2017). A rate of around 7% p.a. is considered the maximum biological rate of increase for southern right whales (IWC, 2013). Connectivity between the two populations is unknown however, some limited movement between the two areas has been recorded (Burnell, 2001; Charlton, 2017; Pirzl et al., 2009).

Southern right whales are distributed in the Southern Hemisphere with a circumpolar distribution between latitudes of 16°S and at least 65°S. They migrate from southern feeding grounds in sub-Antarctic waters to Australia in between May and November to calve, mate and rest (Bannister et al., 1996). They are distributed across thirteen primary aggregation areas along the southern coast of Australia (Figure 4-38) (DSEWPaC, 2012a). In Australian coastal waters, they occur along the southern coastline of the mainland and Tasmania and generally extend as far north as Sydney on the east coast and Perth on the west coast (DSEWPaC, 2012a). There are occasional sightings further north, with the extremities of their range recorded at Hervey Bay and Exmouth (DSEWPaC, 2012a).

The largest established calving areas in Australia include Head of Bight in SA, and Doubtful Island Bay and Israelite Bay in WA. Smaller but established aggregation areas regularly occupied by southern right whales include Yokinup Bay in WA, Fowlers Bay in SA and the Warrnambool and Portland in Victoria. Emerging aggregation areas include Flinders Bay, Hassell Beach, Cheyne/Wray Bays, and Twilight Cove in WA, and sporadically occupied areas include Encounter Bay in SA (DSEWPaC, 2012a). Southern right whales generally occupy shallow sheltered bays within 2 km of shore and within water depths of less than 20 m (Charlton et al., 2019). A number of additional areas for southern right whales are emerging that might be of importance, particularly to the south-eastern population. In these areas, small but growing numbers of non-calving whales regularly aggregate for short periods of time. These areas include coastal waters off Peterborough, Port Campbell, Port Fairy and Portland in Victoria (DSEWPaC, 2012a).

Coastal connecting habitat, which may also serve a migratory function or encompass locations that will emerge as calving habitat as recovery progresses (some locations within connecting habitat are occupied intermittently but do not yet meet criteria for aggregation areas) (DSEWPaC, 2012a). A portion of the King Island connecting habitat BIA is within the spill EMBA.

There is variation in annual abundance on the coast of Australia due to the 3-year calving cycles (Charlton 2017). Female and calf pairs generally stay within the calving ground for 2–3 months (Burnell, 2001). Peak periods for mating in Australian coastal waters are from mid-July through August (DSEWPaC, 2012a). Pregnant females generally arrive during late May/early June and calving/nursery grounds are generally occupied until October (occasionally as early as April and as late as December) (Charlton et al., 2019). A study conducted by Stamation et al, (2020) shows that despite an increase in breeding females sighted in south-eastern Australian between 1985 and 2017, there is no evidence of an increase in annual numbers of mother-calf pairs.

As a highly mobile migratory species, southern right whales travel thousands of kilometres between habitats used for essential life functions. Movements along the Australian coast are reasonably well understood, but little is known of migration travel, non-coastal movements and offshore habitat use. Exactly where southern right whales approach and leave the Australian coast from, and to, offshore areas remain unknown (DSEWPaC, 2012a The Victorian and Tasmania coastal waters are known to include migrating habitat and SRW are known to arrive at the south eastern Australian coastline and travel west to established aggregation areas in South Australia such as the Head of the Great Australian Bight (Watson et al. 2021). There is one established calving ground for female and calf pairs in south eastern Australian at Logans Beach, Warrnambool, Victoria (Watson et al. 2021). A predominance of westward movements amongst long-range photo-identification re-sightings may indicate a seasonal westward movement in coastal habitat (Burnell, 2001). Direct approaches and departures to the coast have also been recorded through satellite telemetry studies (Mackay et al. 2015 cited in Charlton 2017).

Aerial surveys of western Bass Strait and eastern Great Australian Bight undertaken by Gill et al., (2015) detected southern right whales between May and September. A survey in early November 2010 did not observe any whales in the Warrnambool area and it was assumed that cows and calves had already left the calving and aggregation areas (M. Watson, pers. comm., 2010). No southern right whales were encountered during Origin's Enterprise 3D seismic survey undertaken during November 2014 (RPS, 2014), or during spotter flights of the coastline undertaken prior to the survey in late October 2014. Aerial surveys between Ceduna, SA and Sydney NSW (and included Tasmania) were undertaken in August of 2013 and 2014 and recorded a total of 34 southern right whale individuals (17 breeding females) in 2013 and 39 (11 breeding females) in 2014, respectively (Watson et al., 2015).

The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) reports that known and potential threats that may have individual or population level impacts to southern right whales include: entanglement in fishing gear, vessel disturbance, climate variability and change, noise interference, habitat modification and overharvesting of prey.

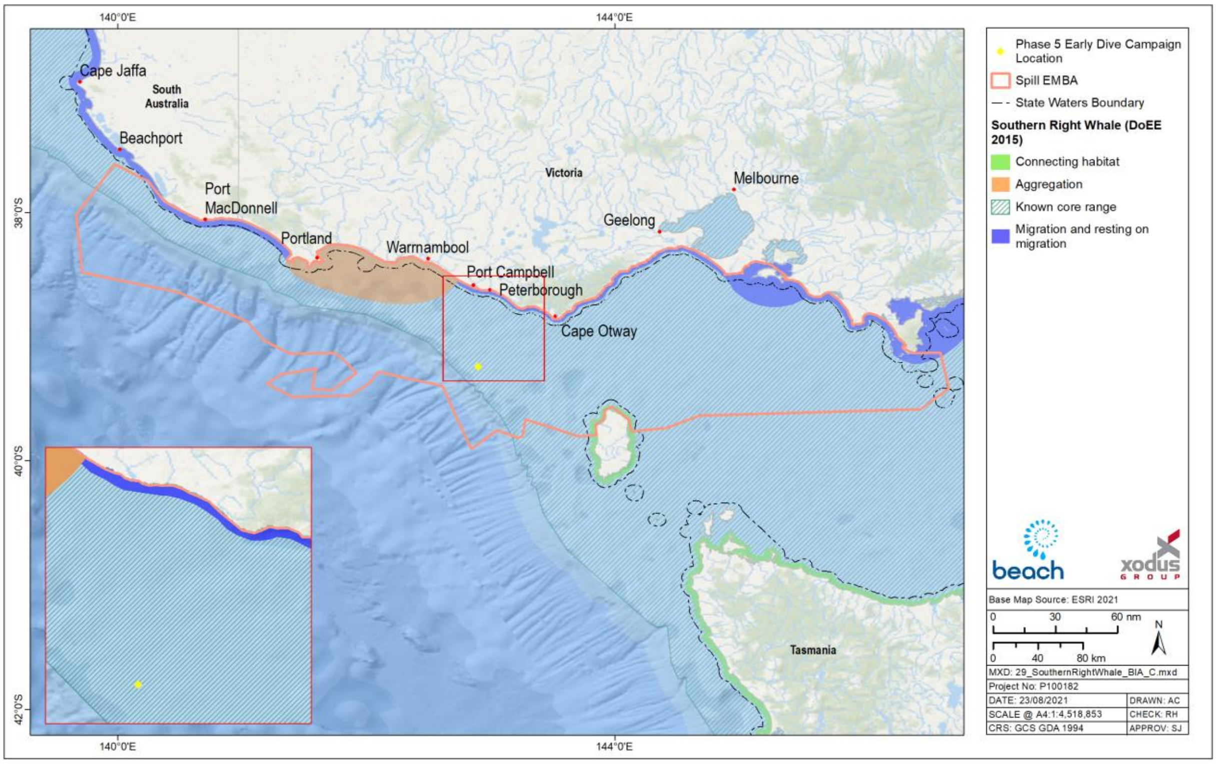


Figure 4-37: Southern right whale BIAs within the spill EMBA.

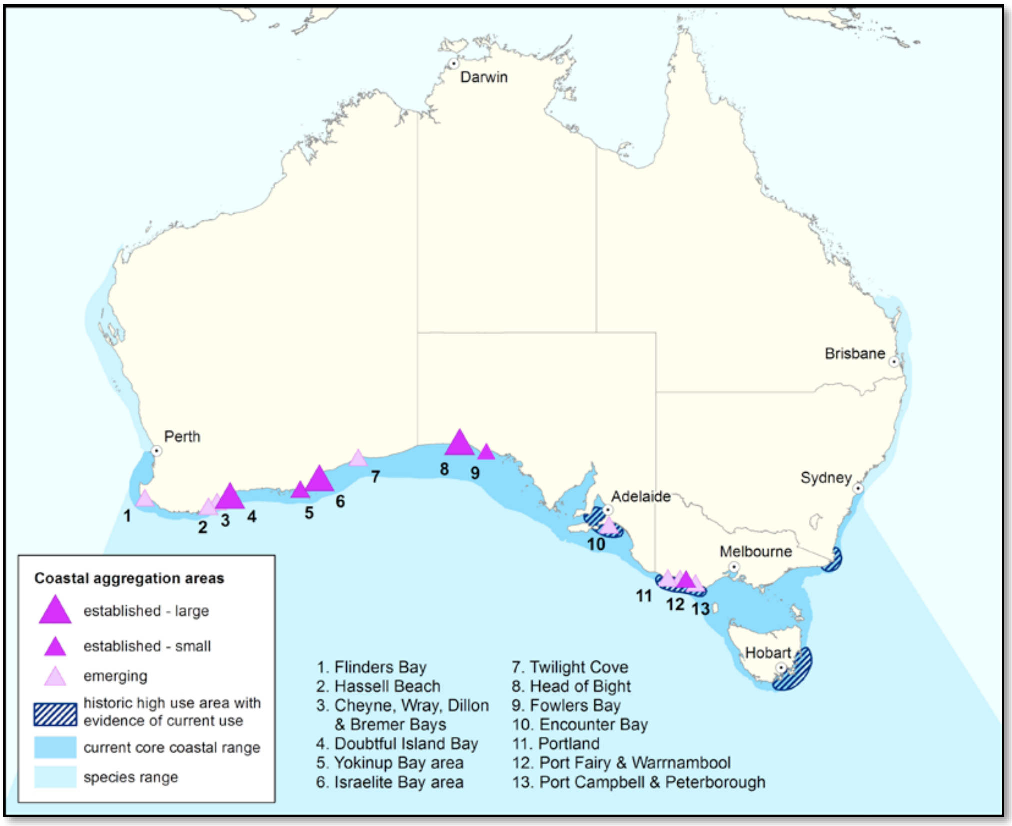


Figure 4-38: Aggregation areas for southern right whales (DSEWPaC, 2012a)

Sperm whale

The sperm whale (*Physeter macrocephalus*) has a worldwide distribution and has been recorded in all Australian states. Sperm whales tend to inhabit offshore areas with a water depth of 600 m or greater and are uncommon in waters less than 300 m deep (DotEE, 2019f). Key locations for the species include the area between Cape Leeuwin to Esperance (WA); southwest of Kangaroo Island (SA), deep waters of the Tasmanian west and south coasts, areas off southern NSW (e.g., Wollongong) and Stradbroke Island (Qld) (DotEE, 2019f). Concentrations of sperm whales are generally found where seabeds rise steeply from a great depth (i.e., submarine canyons at the edge of the continental shelf) associated with concentrations of food such as cephalopods (DotEE, 2019f).

Females and young males are restricted to warmer waters (i.e., north of 45oS) and are likely to be resident in tropical and sub-tropical waters year-round. Adult males are found in colder waters and to the edge of the Antarctic pack ice. In southern Western Australian waters sperm whales move westward during the year. For species in oceanic waters, there is a more generalised movement of sperm whales' southwards in summer and northwards in winter (DotEE, 2019f).

Sperm whales are prolonged and deep divers often diving for over 60 minutes (Bannister et al., 1996) however studies have observed sperm whales do rest at, or just below, surface for extended periods (>1 hr) (Gannier et al., 2002). In addition, female and juvenile sperm whales in temperate waters have been observed to spend several hours a day at surface resting or socialising (Hastie et al., 2003).

The sperm whale has been observed in the region, however the closest recognised BIA for foraging is further east near Kangaroo Island in South Australia. Therefore, it is likely they would be uncommon visitors in the operational area or spill EMBA.

Bottlenose dolphin

The bottlenose dolphin (*Tursiops truncates*) has a worldwide distribution from tropical to temperate waters. While the species is primarily coastal, they are also found inshore, on the shelf and open oceans.

They are associated with many types of substrate and habitats, including mud, sand, seagrasses, mangroves and reefs (DotEE, 2019j). Bottlenose dolphins are known to associate with several cetacean species such as pilot whales, white-sided, spotted, rough-toothed and Risso's dolphins, and humpback and right whales (DotEE, 2019j).

There are two forms of bottlenose dolphin, a nearshore form and an offshore form. The nearshore form occurs in Southern Australia including the Otway Basin area, while the offshore form is found north of Perth and Port Macquarie in NSW. Most populations are relatively discrete and reside in particular areas, such as individual resident populations in Port Phillip Bay, Westernport Bay, Spencer Gulf, Jervis Bay and Moreton Bay. There may be some migration and exchange between the populations, but it is likely that most encountered near the Victorian coasts are local residents.

The bottlenose dolphin has been observed in the region; however, no BIAs have been identified in the operational area or spill EMBA. Therefore, it is likely they would be uncommon visitors in the operational area or spill EMBA.

Common dolphin

The common dolphin (*Delphinus delphis*) is an abundant species, widely distributed from tropical to cool temperate waters, and generally further offshore than the bottlenose dolphin, although small groups may venture close to the coast and enter bays and inlets. They have been recorded in waters off all Australian states and territories, and have been recorded in abundance by marine fauna observers during activities in the Otway Development area.

Common dolphins are usually found in areas where surface water temperatures are between 10°C and 20°C, and in habitats also inhabited by small epipelagic fishes such as anchovies and sardines.

In many areas around the world common dolphins show shifts in distribution and abundance, suggesting seasonal migration. The reason for this seasonal migration is unknown however in New Zealand the shift appears to be correlated with sea surface temperature and in South Africa, the species occurrence appears to be correlated with the annual sardine run (DotEE, 2019k). They are abundant in the Bonney coast upwelling during the upwelling season, and very scarce outside the season.

Dusky dolphin

The dusky dolphin (*Lagenorhynchus obscures*) is rare in Australian waters and has been primarily reported across southern Australia from Western Australia to Tasmania with a handful of confirmed sightings near Kangaroo Island and off Tasmania (DotEE, 2019i). Only 13 reports of the dusky dolphin have been made in Australia since 1828, and key locations are yet to be identified (Bannister et al., 1996). The species is primarily found from approximately 55°S to 26°S, though sometimes further north associated with cold currents. They are considered to be primarily an inshore species but can also be oceanic when cold currents are present (DotEE, 2019i).

Indian Ocean bottlenose dolphin

The Indian Ocean bottlenose dolphins are found in tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific Region and the western Pacific Ocean bottlenose dolphins are distributed continuously around the Australian mainland, but the taxonomic status of many populations is unknown. Indian Ocean bottlenose dolphins have been confirmed to occur in estuarine and coastal waters of eastern, western and northern Australia and it has also been suggested that the species occurs in southern Australia (Kemper, 2004).

In south-eastern Australia, inshore Indian Ocean bottlenose dolphins show a high degree of site fidelity to some local areas and appear to belong to relatively small communities or populations (Möller et al., 2002).

Risso's dolphin

The Risso's dolphin (*Grampus griseus*) is a widely distributed species found in deep waters of the continental slop and outer shelf from the tropics to temperate regions. The species prefer warm temperate to tropical waters with depths greater than 1,000 m, although they do sometimes extend their range into cooler latitudes in summer (Bannister et al., 1996). They are thought to feed on cephalopods, molluscs and fish. The Risso's dolphin has been observed in the region, however no BIAs have been identified in the operational area or spill EMBA. Therefore, it is likely they would be uncommon visitors in the operational area or spill EMBA.

Southern right whale dolphin

The southern right whale dolphin (*Lissodelphis peronii*) is a pelagic species found in Southern Australian waters but generally well offshore in deep water or on the outer edges of the continental shelf between the subtropical and subantarctic convergence (DotEE, 2019h). No key localities have been identified in Australian waters however preferred water temperatures range from approximately 2-20°C (DotEE, 2019h). Of the limited southern right whale dolphin stomachs examined, myctophids and other mesopelagic fish, squid and crustaceans have been recorded, and euphausiids are also thought to be potential prey (DotEE, 2019h). It is unknown whether the southern right whale dolphin is a surface or deep-layer feeder (Bannister et al., 1996).

Calving areas are not known, however there is evidence that the calving season occurs between November to April (DotEE, 2019h).

The southern right whale dolphin has been observed in the region; however, no BIAs have been identified in the operational area or spill EMBA. Therefore, it is likely they would be uncommon visitors in the operational area or spill EMBA.

4.6.7.7 Pinnipeds

The PMST reports identified three pinnipeds that potentially occur in the operational area and spill EMBA (Appendix A). The spill EMBA overlaps a foraging BIA for the Australian sea lion.

Table 4-18: Listed pinniped species identified in the PMST search

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (500 m)
		Listed threatened	Listed migratory	Listed marine		
New Zealand fur-seal	*Arctocephalus forsteri*	-	-	L	SHM	SHM
Australian fur-seal	*Arctocephalus pusillus*	-	-	L	BK	SHM
Australian sea lion	*Neophoca cinereal*	E	-	L	SHK	
Listed Threatened E: Endangered Listed Marine L: Listed		Likely Presence SHM: Species or species habitat may occur within area. SHK: Species or species habitat known to occur within area. BK: Breeding known to occur within area				

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the operational area.

Australian sea lion

The Australian sea lion is the only endemic, and least abundant, pinniped that breeds in Australia (DoE, 2013b). All current breeding populations are outside of the spill EMBA and are located from the Abrolhos Islands (Western Australia) to the Pages Islands (South Australia). The Australian sea lion uses a variety of shoreline types but prefer the more sheltered side of islands and typically avoid rocky exposed coasts (Shaughnessy, 1999).

The spill EMBA overlaps an Australian sea lion foraging BIA (Figure 4-39). The Australian sea lion is a specialised benthic forager; i.e. it feeds primarily on the sea floor (DSEWPaC, 2013). The Australian sea lion feeds on the continental shelf, most commonly in depths of 20–100 m, with adult males foraging further and into deeper waters (DSEWPaC, 2013). They typically feed on a range of prey including fish, cephalopods (squid, cuttlefish and octopus), sharks, rays, rock lobster and penguins (DSEWPC, 2013) They typically forage up to 60 km from their colony but can travel up to 190 km when over shelf waters (Shaughnessy, 1999).

New Zealand fur-seal

New Zealand fur-seal (*Arctocephalus forsteri*) are found in the coastal waters and offshore islands of South and Western Australia, Victoria, NSW and New Zealand. Population studies for New Zealand fur-seal in Australia carried out in 1990 estimated an increasing population of about 35,000. The species breeds in southern Australia at the Pages Islands and Kangaroo Island, which produces about 75% of the total pups in Australia. Small populations are established in Victorian coastal waters including at Cape Bridgewater near Portland, Lady Julia Percy Island near Port Fairy and, Kanowna Island (near Wilsons Promontory) and The Skerries in eastern Victoria.

Figure 4-40 illustrates the known breeding colonies of New Zealand fur-seal (Kirkwood et al., 2009). These colonies are typically found in rocky habitat with jumbled boulders. Colonies are typically occupied year-round, with greater activity during breeding seasons. Pups are born from mid-November to January, with most pups born in December (Goldsworthy, 2008). Known sites for New Zealand Fur-seal breeding colonies within the spill EMBA include Seal Rocks (off King Island) and Judgement Rocks (Kent Group Islands) (Figure 4-40).

Australian fur-seal

Australian fur-seals (*A. pusillus*) breed on islands of the Bass Strait but range throughout waters off the coasts of South Australia, Tasmania, Victoria and NSW. Numbers of this species are believed to be increasing as the population recovers from historic hunting (Hofmeyr et al., 2008). The species is endemic to south-eastern Australian waters.

In Victorian State waters they breed on offshore islands, including Lady Julia Percy Island, Seal Rocks in Westernport Bay, Kanowna and Rag Islands off the coast of Wilson’s Promontory and The Skerries off Wingan Inlet in Gippsland (Figure 4-41). There are important breeding sites on Lady Julia Percy Island and Seal Rocks, with 25% of the population occurring at each of these islands. Their preferred breeding habitat is a rocky island with boulder or pebble beaches and gradually sloping rocky ledges.

Haul out sites with occasional pup births are located at Cape Bridgewater, at Moonlight Head, on various small islands off Wilsons Promontory and Marengo Reef near Apollo Bay. Australian fur-seals are present in the region all year, with breeding taking place during November and December.

Research being undertaken at Lady Julia Percy Island indicates that adult females feed extensively in the waters between Portland and Cape Otway, out to the 200 m bathymetric contour. Seal numbers on the island reach a maximum during the breeding season in late October to late December. By early December, large numbers of lactating females are leaving for short feeding trips at sea and in late December there is an exodus of adult males. Thereafter, lactating females continue to alternate between feeding trips at sea and periods ashore to suckle their pups. Even after pups begin to venture to sea, the island remains a focus, and at any time during the year groups may be seen ashore resting (Robinson et al., 2008; Hume et al., 2004; Arnould & Kirkwood, 2007).

During the summer months, Australian fur-seals travel between northern Bass Strait islands and southern Tasmania waters following the Tasmanian east coast, however, lactating female fur-seals and some territorial males are restricted to foraging ranges within Bass Strait waters. Lactating female Australian fur-seals forage primarily within the shallow continental shelf of Bass Strait and Otway on the benthos at depths of between 60 – 80 m and generally within 100 – 200 km of the breeding colony for up to five days at a time.

Male Australian fur-seals are bound to colonies during the breeding season from late October to late December, and outside of this they time forage further afield (up to several hundred kilometres) and are away for long periods, even up to nine days (Kirkwood et al., 2009; Hume et al., 2004).

As there are breeding and haul out sites within the spill EMBA it is likely that Australian fur-seal would be present in the spill EMBA and operational area.

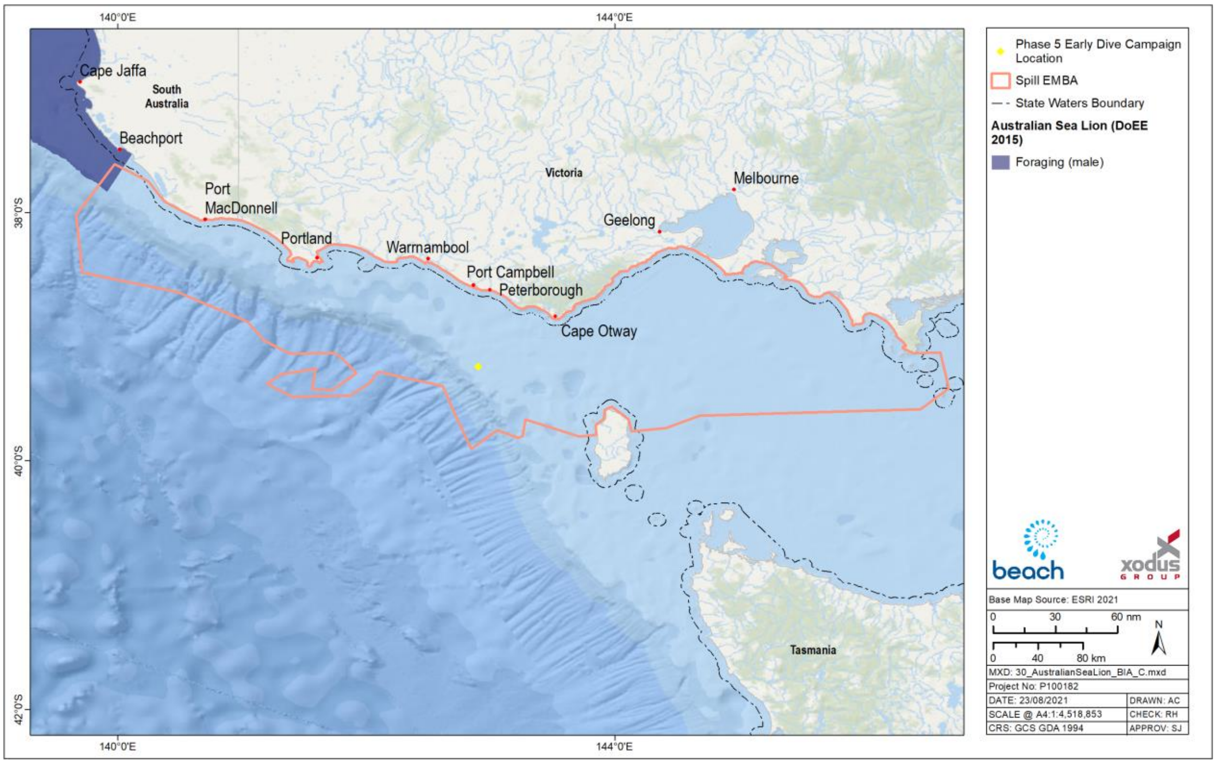


Figure 4-39: Australian sea lion foraging BIA within the spill EMBA

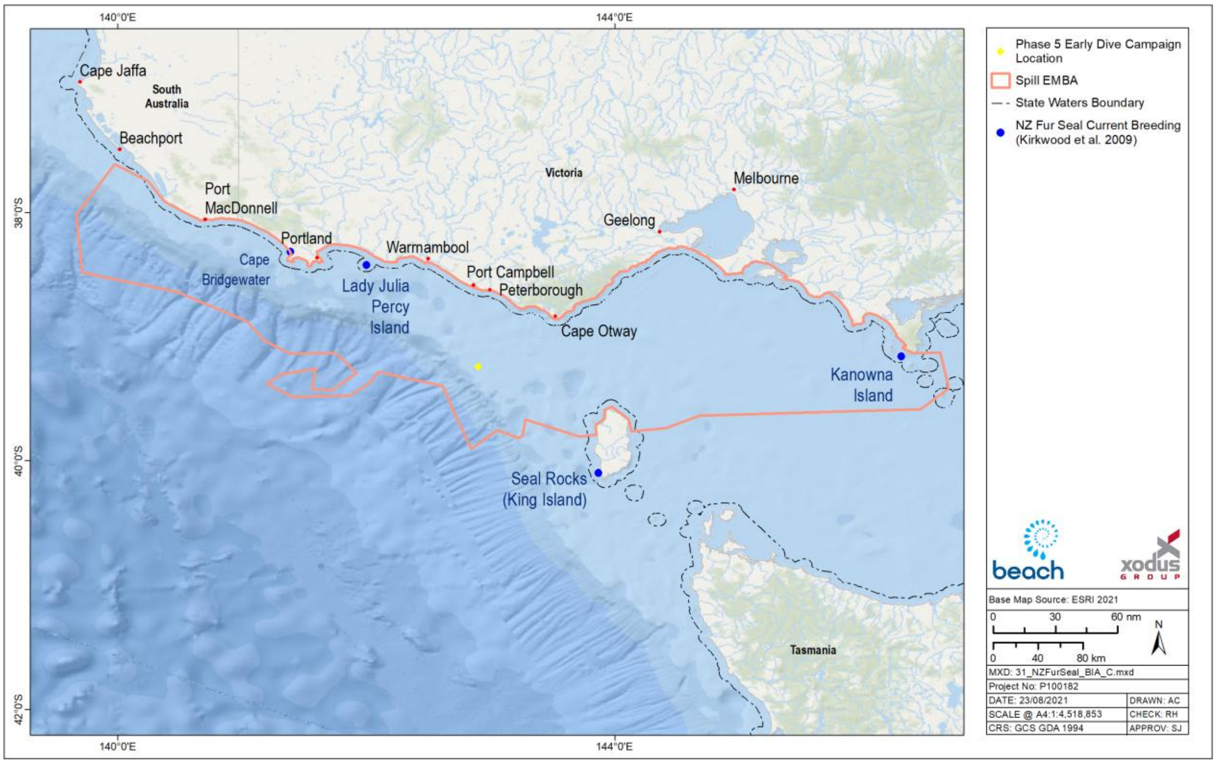


Figure 4-40: Locations of New Zealand fur-seal breeding colonies (Kirkwood et al., 2009).

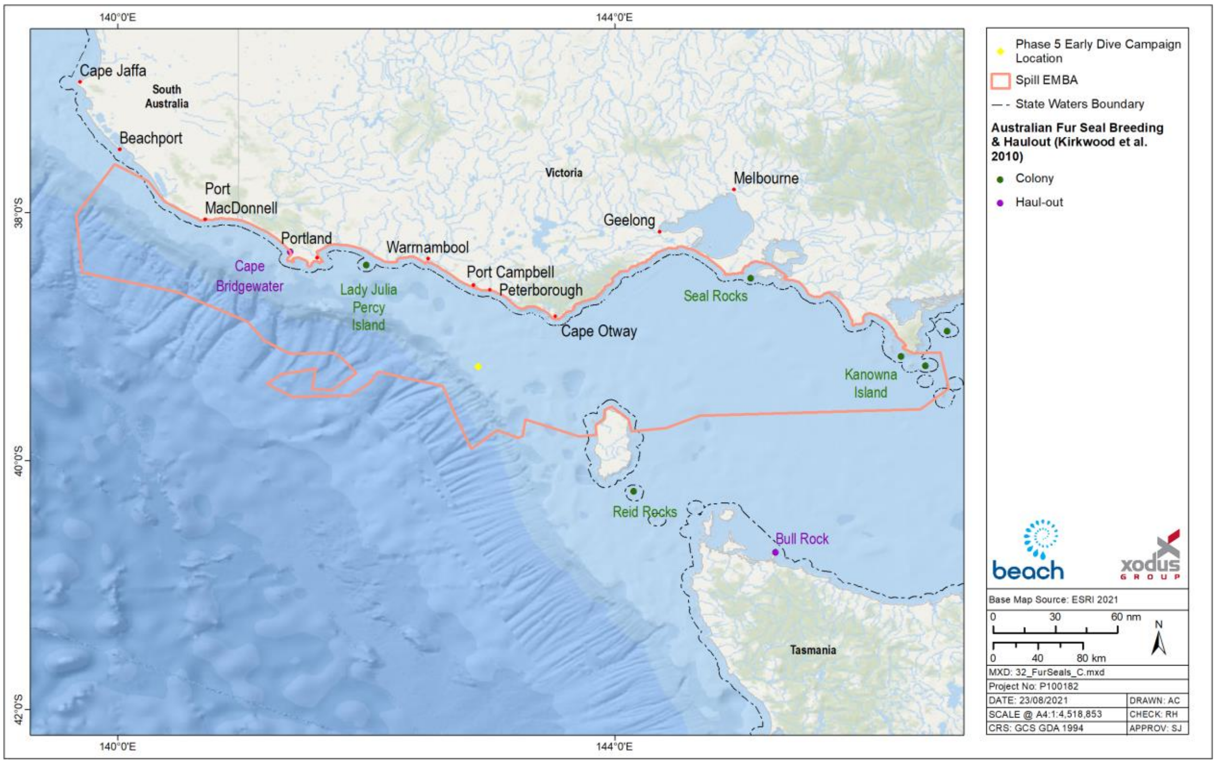


Figure 4-41: Locations of Australian fur-seal breeding colonies and haul out sites (Kirkwood et al., 2010)

4.6.7.8 Pest species

Invasive marine species (IMS) are marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish. More than 200 non-indigenous marine species including fish, molluscs, worms and a toxic alga have been detected in Australian coastal waters.

It is widely recognised that IMS can become pests and cause significant impacts on economic, ecological, social and cultural values of marine environments. Impacts can include the introduction of new diseases, altering ecosystem processes and reducing biodiversity, causing major economic loss and disrupting human activities (Brusati & Grosholz, 2006).

In the South-east Marine Region, 115 marine pest species have been introduced and an additional 84 have been identified as possible introductions, or 'cryptogenic' species (NOO, 2002). Several introduced species have become pests either by displacing native species, dominating habitats or causing algal blooms.

Key known pest species in the South-East Marine Region include (NOO, 2001):

- Northern pacific sea star (*Asterias amurensis*).
- Fan worms (*Sabella spallanzannii* and Euchone sp).
- Bivalves (*Crassostrea gigas* (Pacific oyster) Corbulagibba and Theorafragilis).
- Crabs (*Carcinus maenas* (European shore crab) and *Pyromaia tuberculata*).
- Macroalgae (*Undaria pinnatifida* (Japanese giant kelp) and *Codium fragile tormentosoides*).
- The introduced New Zealand screw shell (*Maoricolpus roseus*).

Other introduced species tend to remain confined to sheltered coastal environments rather than open waters (Hayes et al. 2005).

The Marine Pests Interactive Map (DotEE, 2019) indicates that the ports likely to be used for the survey (Warrnambool, Apollo Bay or Port Fairy) do not currently harbour any marine pests.

4.6.7.9 Viruses

A virus, the Abalone Viral Ganglioneuritis (AVG), has been detected in wild abalone populations in southwest Victoria and was confirmed as far east as White Cliffs near Johanna, and west as far as Discovery Bay Marine Park (DPI, 2012). The virus can be spread through direct contact, through the water column without contact, and in mucus that infected abalone produce before dying. The last confirmation of active disease in Victoria was from Cape Otway lighthouse in December 2009 (Victoria State Government, 2016).

Strict quarantine controls need to be observed with diving or fishing activities in south-west Victoria when the virus has been detected in the area. Given the lack of detected AVG in Victorian State waters, controls outlined in the Biosecurity Control Measures for AVG: A Code of Practice (Gavine et al., 2009) are not active.

4.7 Socio-economic environment

This section describes the socio-economic environment within the operational area and spill EMBA.

4.7.1 Coastal settlements

There are no coastal settlements within the operational area.

Australian's have a strong affinity to the coast, with over 80% of the population living within 50 km of the coast. The coastal settlements that lie within the EMBA and are subject to potential impact are (from west to east) Discovery Bay, Cape Nelson, Portland, Port Fairy, Warrnambool, Peterborough, Childers Cove, Bay of Islands, Port Campbell, Princetown, Moonlight Head, Cape Otway, Apollo Bay, Cape Patton, Lorne, Anglesea, Torquay, Port Phillip, Mornington Peninsula, Western Port, French Island, Kilcunda, Venus Bay, Cape Liptrap, Waratah Bay, Wilsons Promontory, Corner Inlet and Eurobodalla. All settlements are within Victoria, apart from Eurobodalla in NSW. These settlements are administered by different councils, with some of the larger councils including the Glenelg Shire Council (Portland), Moyne Shire Council (Port Fairy, Peterborough), Warrnambool City Council, Shire of Corangamite (Port Campbell, Princetown) and the Shire of Colac Otway (Apollo Bay).

The largest settlement within the spill EMBA is Mornington Peninsula, with a population just under 300,000 (Table 4-19). The Warrnambool, Peterborough, Childers Cove, Bay of Islands, Port Campbell, Princetown, Moonlight Head, Cape Otway, Apollo Bay, Cape Patton, Lorne and Anglesea settlements are along the Great Ocean Road, a National Heritage listed stretch along the Victorian coastline, with Warrnambool marking the western end. Warrnambool is another large settlement within the EMBA, with a population just under 30,000 (Table 4-19) and is a former port for the state of Victoria. The Port of Warrnambool has a breakwater and yacht club and provides shelter for commercial fishing boats. Portland and Port Fairy are the next largest centres with populations of 9,712 and 3,340, respectively (Table 4-19). Portland is Victoria's western-most commercial port and is a deep-water port with breakwaters sheltering a marina and boat ramp. Port Fairy has both harbour and fish processing facilities, but is not suitable for use by large vessels, nor is Port Campbell.

The coastal settlements within the EMBA all provide services to the commercial and recreational fishing industries in south-west Victoria and rely on fishing and tourism to contribute to their economies through income and employment. In Portland and Princetown, the largest employment industries are the agriculture, forestry and fishing industries, accounting for 59 and 28%, respectively (Table 4-19). In all but the two largest centres, accommodation and food services (which are heavily reliant on tourism) is either the first or second largest employment industry (Table 4-19).

Table 4-19: Coastal settlement population estimates and employment figures

Settlement	Population[1]	% of employment in industries relevant to potential impacts[2]	
		Agriculture, forestry & fishing	Accommodation & food services
Discovery Bay	N/A	N/A	N/A
Cape Nelson	N/A	N/A	N/A
Portland	9,712	2.8	8.8
Port Fairy	3,340	6.5	12.8
Warrnambool	29,661	2.1	9.1
Peterborough	247	6.7	13.3
Childers Cove	N/A	N/A	N/A
Bay of Islands	N/A	N/A	N/A
Port Campbell	478	28.4	16.6
Princetown	241	59.3	10.5
Moonlight Head	N/A	N/A	N/A
Cape Otway	15	N/A	N/A
Apollo Bay	1,598	3.6	27.9
Cape Patton	N/A	N/A	N/A
Lorne	1,114	0	0
Anglesea	2,545	0	4.8
Torquay	13,258	0	0
Port Phillip	100,872	0	0
Mornington Peninsula	289,142	0	0
Western Port	N/A	N/A	N/A
French Island	119	N/A	N/A
Kilcunda	396	0	0
Venus Bay	944	0	0
Cape Liptrap	N/A	N/A	N/A
Waratah Bay	56	N/A	N/A
Wilsons Promontory	13	N/A	N/A

[1] Data from Australian Bureau of Statistics 2016 census, available at www.censusdata.abs.gov.au

[2] Data from Australian Bureau of Statistics 2016 census, available at www.censusdata.abs.gov.au

4.7.2 Petroleum exploration

Petroleum exploration has been undertaken within the Otway Basin since the early 1960s. Gas reserves of approximately 2 trillion cubic feet (tcf) have been discovered in the offshore Otway Basin since 1995, with production from five gas fields using 700 km of offshore and onshore pipeline. Up to 2015, the DEDJTR reports that 23 PJ of liquid hydrocarbons (primarily condensate) has been produced from its onshore and offshore basins, with 65 PJ remaining, while 85 PJ of gas has been produced (Victoria and South Australia), with 1,292 PJ remaining.

From a review of the NOPSEMA website and engagement with other oil and gas exploration companies a summary of exploration activities that may occur within the Otway Basin are detailed in Table 4-20. There is no overlap of known seismic surveys with the operational area and the nearest survey is 11 km away (Figure 4-42).

Table 4-20: Petroleum exploration potentially in close proximity to the operational area

Titleholder	Activity	Timing and Duration	Proximity to development well locations
TGS (Previously Spectrum Geo Australia Pty Ltd	Otway Deep Marine Seismic Survey	October 2020 to end February 2021 October 2021 to end February 2022 120 days	Figure 4-42 shows the Spectrum acquisition area is ~17 km from the operational area. TGS confirmed they have not committed to undertaking the survey in 2021/2022 and are looking at 2022/2023 season. (See Stakeholder Record TGS 30).
ConocoPhillips Australia SH1 Pty Ltd and 3D Oil T49P Pty Ltd	Sequoia 3D Marine Seismic Survey	1 August to 31 October 2021 31 days	Figure 4-42 shows that the Sequoia 3D Marine Seismic Survey acquisition area is 29 km from the operational area.

4.7.3 Petroleum production

There is no non-Beach oil and gas infrastructure within the operational area. The Cooper Energy Casino and Henry gas fields and Casino-Henry pipeline and the Minerva gas field and pipeline are within the northern portion of the spill EMBA.

Beach is undertaking or planning the following development activities over the next two years:

- Development drilling and well abandonment programme in the Geographe and Thylacine fields in 2021-2022. The closest well to the operational area, TN-1, is scheduled to commence in Q4 2021 and last for approximately 50 days.
- Tie in of the G-4 and G-5 production wells in 2021 (within the Geographe field, Figure 4-42).
- Tie-in of the Thylacine subsea wells in 2021 (within the Thylacine field, Figure 4-42).

Operation of the Otway Gas Development, including operation of the Thylacine-A wellhead platform, Geographe subsea facilities, Otway Pipeline System and IMR activities are ongoing. Thylacine and Geographe fields and the Otway Pipeline System are shown in Figure 4-42.

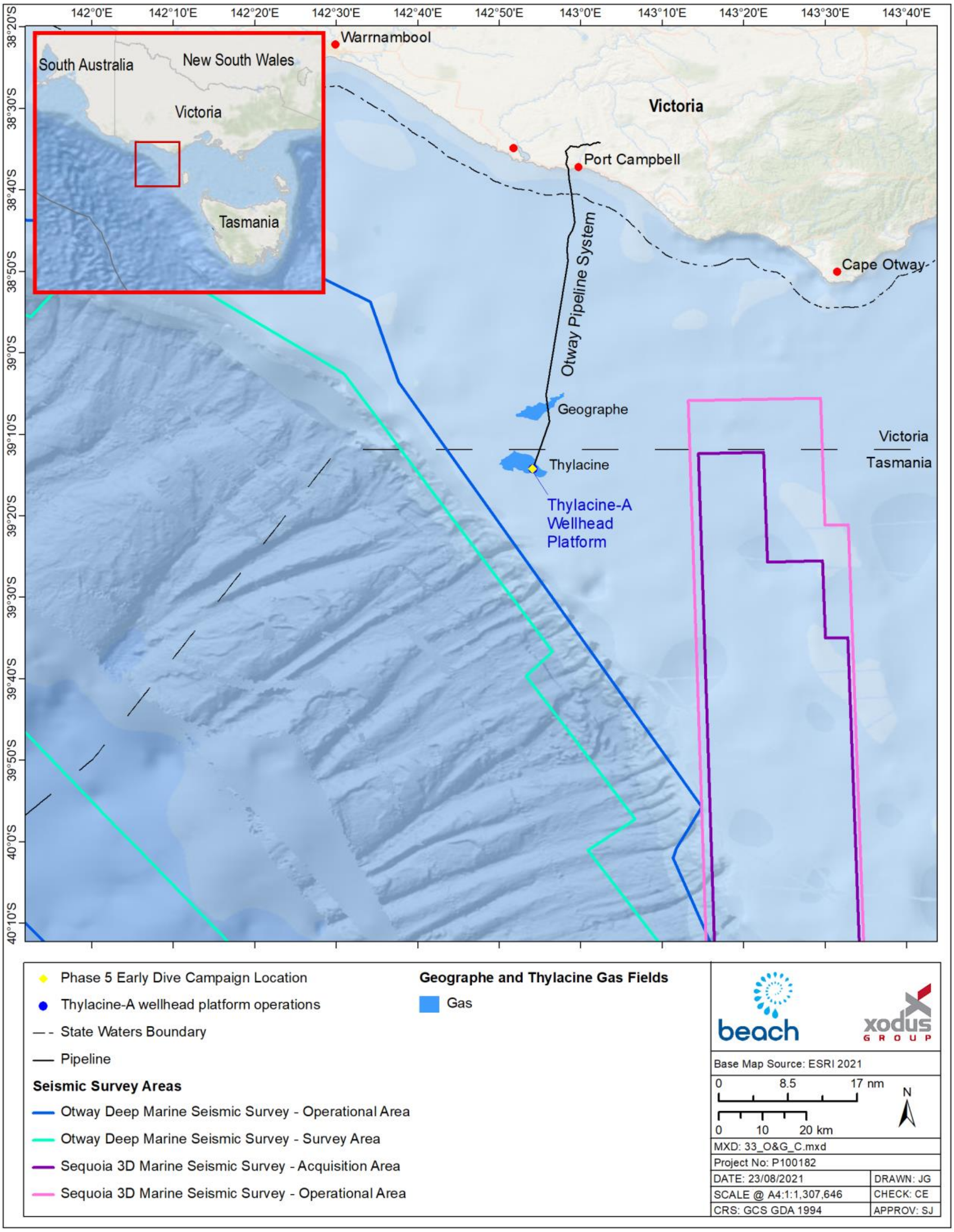


Figure 4-42: Oil and gas exploration and production

4.7.4 Shipping

The SEMR is one of the busiest shipping regions in Australia and Bass Strait is one of Australia's busiest shipping routes (Figure 4-43). Commercial vessels use the route when transiting between ports on the east, south and west coasts of Australia, and there are regular passenger and cargo services between mainland Australia and Tasmania.

Ports Australia (2019) provide statistics for port operations throughout Australia's main commercial ports. Based on the latest information (2018 – 2019 financial year) the majority of commercial shipping traffic transiting to and from Victorian ports were bulk liquid carriers (696,261), bulk gas (445,230), other cargo (3,800), container (1,057), general cargo (716), car carrier (384) and livestock (36).

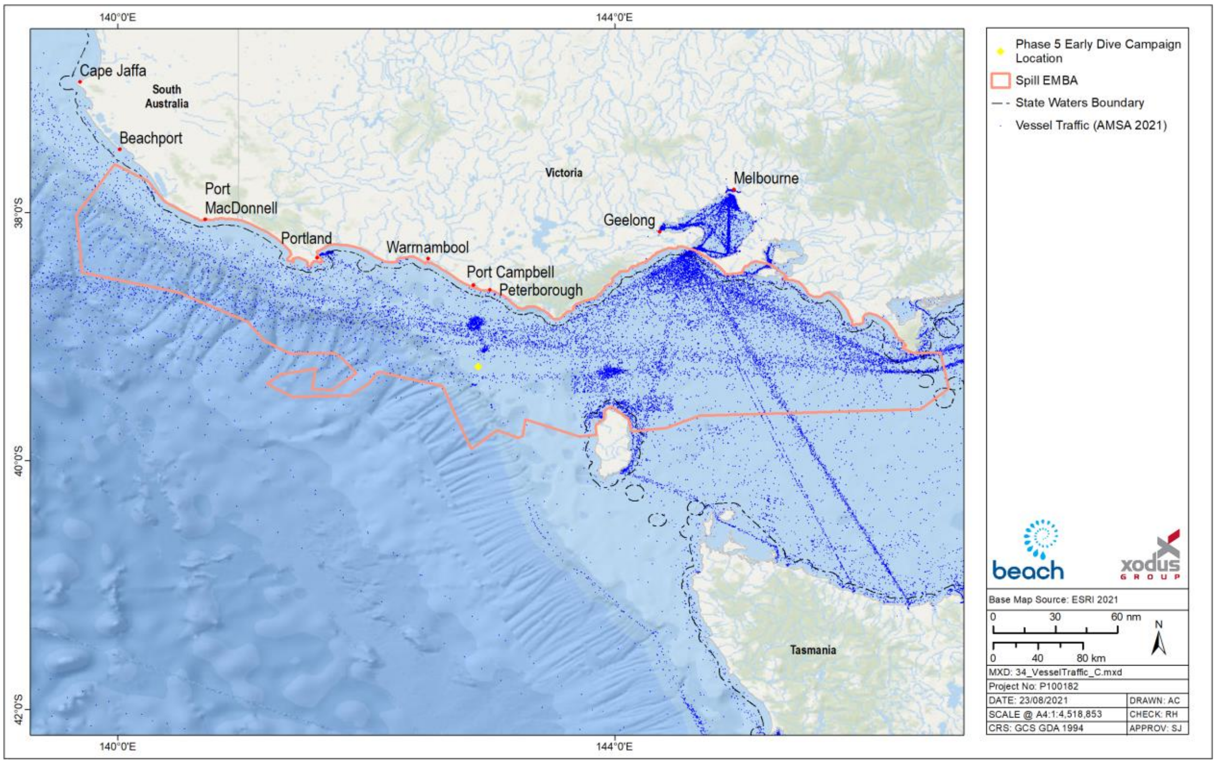


Figure 4-43: Vessel traffic within the spill EMBA and operational area

4.7.5 Tourism

Consultation has identified that the key areas of tourism in the region include land-based sightseeing from the Great Ocean Road and lookouts along that road, helicopter sightseeing, private and chartered vessels touring into the Twelve Apostles Marine Park, diving and fishing. Land-based tourism in the region peaks over holiday periods and in 2011, Tourism Victoria reported a total of approximately 8 million visitors to the Great Ocean Road region.

Local vessels accessing the area generally launch from Boat Bay in the Bay of Islands or from Port Campbell. Given the available boat launching facilities in the area (Peterborough and Port Campbell), and the prevailing sea-state of the area, vessel-based tourism is limited.

4.7.6 Recreational diving

Recreational diving occurs along the Otway coastline. Popular diving sites near Peterborough include several shipwrecks such as the Newfield, which lies in 6 m of water and the Schomberg in 8 m of water. Peterborough provides several good shore dives at Wild Dog Cove, Massacre Bay, Crofts Bay and the Bay of Islands. In addition, there is the wreck of the Falls of Halladale (4-11 m of water) which can be accessed from shore or via boat.

Consultation with local vessel charterers and providers of SCUBA tank fills has confirmed that diving activity is generally concentrated around The Arches Marine Sanctuary and the wreck sites of the Loch Ard and sometimes at the Newfield and Schomberg shipwrecks. Diving activity peaks during the rock lobster season with the bulk of recreational boats accessing the area launching from Boat Bay at the Bay of Islands or Port Campbell.

4.7.7 Recreational fishing

Recreational fishing is popular in Victoria and is largely centred within Port Phillip Bay and Western Port, although beach- and boat-based fishing occurs along much of the Victorian coastline.

The recreational fisheries that occur within the spill EMBA are:

- Rock lobster.
- Finfish (multiple species are targeted, including sharks).
- Abalone.
- Scallops.
- Squid.
- Pipi.

Of these, active recreational fishing for rock lobster, abalone, finfish and sharks is likely to occur within the EMBA. Recreational fishing for tuna has been observed by Beach in the area during Artisan-1 drilling activities, and recreational fishing vessels are regularly sighted within close proximity to the Thylacine-A wellhead platform. Recreational scallop and squid fishing primarily occurs within Port Phillip Bay and Western Port and as such fishing for these species is unlikely within the EMBA. Pipi harvesting occurs in Venus Bay, in the eastern portion of the EMBA, but due to high levels of toxins in pipis at that location the public is currently advised that they are unsafe for human consumption.

Information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery is included in Table 4-21.

Table 4-21: Recreational fisheries within the spill EMBA

Fishery	Target species	Description	Fishing activity
Rock lobster	Southern rock lobster	Recreational catch is taken by hand from coastal inshore reefs in waters less than about 20 m deep. A daily bag limit of 2 lobster applies.	Yes
Finfish	Snapper King George whiting Salmon Flathead Bream Tuna Sharks	Recreational fishing occurs along the Victorian coastline from beaches, jetties and vessels (privately owned and chartered). Artificial reefs have also been established in Port Phillip Bay and offshore from Torquay, to enhance recreational fishing opportunities.	Yes

Fishery	Target species	Description	Fishing activity
Scallops	Commercial scallops Doughboy scallops	Scallops are collected by hand by recreational fishers while diving. Most recreational catch occurs within Port Phillip Bay.	Unlikely
Abalone	Blacklip abalone Greenlip abalone	A permanent closure is in place for greenlip abalone in Port Phillip Bay, and for both green- and blacklip abalone from the intertidal to 2 m water depth in all of Victoria. The central zone (which overlaps with the EMBA) is open to recreational abalone take only on nominated days between November and April.	Yes
Squid	Gould's squid	Recreational squid fishing predominantly occurs in Port Phillip Bay and Western Port, but also in other sheltered waters such as at Portland. Fishing is generally from jetties such as at Queenscliff (Port Phillip Bay) and Flinders (Mornington Peninsula, Western Port) or from boats.	Unlikely
Pipi	Pipi	Pipi are harvested from the intertidal zone. Currently the only recreational harvest occurs in Venus Bay, although the Victorian Fisheries Authority has advised that high levels of toxins are present in pipis and advises that they are unsafe for human consumption.	Unlikely (due to toxins)

4.7.8 Commonwealth managed fisheries

A review of the Australian Fisheries Management Authority (AFMA) website identified that the following Commonwealth managed fisheries overlap the spill EMBA:

- Bass Strait Central Zone Scallop Fishery (Bass Strait CZSF).
- Eastern Tuna and Billfish Fishery (ETBF).
- Skipjack Tuna Fishery.
- Small Pelagic Fishery (SPF).
- Southern Bluefin Tuna Fishery (SBTF).
- Southern and Eastern Scalefish and Shark Fishery (SESSF).
- Southern Squid Jig Fishery.

Of these fisheries, the Bass Strait CZSF, ETBF, SBTF, SESSF and Southern Squid Jig Fishery have catch effort within the spill EMBA and SESSF and Southern Squid Jig Fishery have catch effort within the operational area based on ABARES reports data for fishing years 2013 – 2019 (Patterson et al. 2020, 2019, 2018, 2017, 2016, 2015 and Georgeson et al. 2014). The Skipjack Fishery is not currently active and management arrangements for the fishery are under review.

Information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery is included in Table 4-22. Detailed mapping is provided where there is overlap between recent fishing intensity and the spill EMBA (Figure 4-44 to Figure 4-47).

Engagement with AFMA was undertaken in relation to providing licensing information for any Commonwealth fishers who are active within the operational area which includes the operational area.

Table 4-22: Commonwealth managed fisheries within the spill EMBA

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Bass Strait Central Zone Scallop Fishery	Scallops	Fishery operates in the Bass Strait between the Victorian and Tasmanian and starts at 20 nm from their respective coastlines. Commercial scallops in the Bass Strait Central Zone Scallop Fishery are mainly found at depths of 35 - 100 m and are caught using a steel dredge that is towed by the vessel along muddy to coarse sand substrates. Fishing effort is concentrated around King and Flinders Islands. Currently 12 active boats using towed dredges. Fishing season is 1 April to 31 December. Actual catch in 2019 was 2,931 tonnes. The major landing ports in Victoria are Apollo Bay and Queenscliff. Total fishery value in 2016 was A$6.3 million. Fishing mortality: not subject to overfishing. Biomass: Not over fished. There has been fishing effort in the spill EMBA based on ABARES data for 2013 – 2019. There has been no fishing effort in the operational area based on ABARES data for 2013 – 2019. Figure 4-47 shows the total area fished with the highest fishing intensity occurring around King Island.	No	Yes
Eastern Tuna and Billfish Fishery	Albacore tuna Bigeye tuna Yellowfin tuna Broadbill swordfish Striped marlin	A longline and minor line fishery that operates in water depths > 200 m from Cape York to Victoria. Fishery effort is typically concentrated along the NSW coast and southern Queensland coast. No Victorian ports are used. In 2017 there was some fishing effort in Victoria at low levels. The number of active vessels has decreased within the fishery from around 152 in 1999 to 37 in 2019. Actual catch in the 2019 season was 4,341 tonnes. Total fishery value in 2019 was A$32.1 million. Fishing mortality: not subject to overfishing. Biomass: Over fished – striped marlin. All other species not overfished. There has been fishing effort within the spill EMBA in 2017 based on ABARES data for 2013 – 2019. There has been no fishing effort in the operational area based on ABARES data for 2013 – 2019.	No	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Skipjack Tuna Fishery (Eastern)	Skipjack tuna	The Skipjack Tuna Fishery is not currently active and the management arrangements for this fishery are under review. There has been no catch effort in this fishery since the 2008 -2009 season.	No	No
Small Pelagic Fishery (Western sub-area)	Jack mackerel Blue mackerel Redbait Australian sardine	The Small Pelagic Fishery extends from the southern Queensland to southern Western Australia. Fishers use midwater trawls and purse seine nets. Geelong is a major landing port. Total retained catch of the four target species was 16,093 tonnes in the 2019-20 season. Fishery effort generally concentrated in the near-shore Great Australian Bight to the west and south of Port Lincoln. Fishing mortality: not subject to overfishing. Biomass: Not over fished. There has been no fishing effort in the EMBA based on ABARES data for 2013 – 2019/2020. There has been no fishing effort in the operational area based on ABARES data 2013 – 2019/2020.	No	No

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Southern and Eastern Scalefish and Shark Fishery (SESSF) (Commonwealth Trawl Sector and Scalefish Hook Sector)	Blue-eye trevalla Blue grenadier Blue warehou Deepwater sharks Eastern school whiting Flathead Gemfish Gulper shark Jackass morwong John dory Mirror dory Ocean jacket Ocean perch Orange roughy Smooth oreodory Pink ling Red fish Ribaldo Royal red prawn Silver trevally Silver warehou	The Southern and Eastern Scalefish and Shark Fishery stretches south from Fraser Island in southern Queensland, around Tasmania, to Cape Leeuwin in southern Western Australia. The EMBA is within the Commonwealth Trawl Sector and Scalefish Hook Sector. A multi-sector, multi-species fishery that uses a range of gear year-round. Fishing is generally concentrated along the 200 m bathymetric contour. Total retained catch of the target species was 13,148 tonnes in the 2019-20 season. No value is provided for 2019-20 season. In 20118-19, the fishery value was A$49.47 million. Fishing mortality: some species subject to overfishing. Biomass: some species over fished. There has been fishing effort in the spill EMBA based on ABARES data for 2013 – 2019/20. There has been fishing effort in the operational area based on ABARES data for 2013 – 2019/20 (Figure 4-44 to Figure 4-46). The shark hook and trawl sectors have no fishing intensity within the operational area (Figure 4-45 and Figure 4-46), while the shark gillnet sector has high to medium fishing intensity closer to the shore but within the operational area (Figure 4-44).	Yes	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Southern Bluefin Tuna Fishery (SBTF)	Southern bluefin tuna	The SBTF covers the entire sea area around Australia, out to 200 nm from the coast. Southern bluefin tuna are also commonly caught off the NSW coastline. In this area, fishers catch these fish using the longline fishing method. A pelagic longline and purse seine fishery that was worth $43.41 million in 2018-19 (actual catch was 6,074 tonnes). The fishery operates year-round. Fishery effort is generally concentrated in the Great Australian Bight and off the southern NSW coast. Fishing mortality: not subject to overfishing. Biomass: Over fished. There has been fishing effort within the spill EMBA in 2017 based on ABARES data for 2013 – 2019. There has been no fishing effort in the operational area based on ABARES data for 2013 – 2019.	No	Yes
Southern Squid Jig Fishery	Gould's squid (arrow squid)	A single species fishery that operates year-round. Portland and Queenscliff are the major Victorian landing ports. Jigging typically occurs midwater at depths between 50 and 100m at night using large lights that illuminate the waters around a boat. In 2018-19, the actual catch of 722 tonnes was worth A$2.89 million. In 2019 there were eight active vessels in the fishery. Fishing mortality: not subject to overfishing. Biomass: Not over fished. There has been fishing effort in the spill EMBA based on ABARES data for 2013 – 2019. There has been fishing effort in the operational area based on ABARES data for 2013 – 2019. Figure 4-48 shows the total area fished with squid jig in 2019 within the operational area with the highest fishing intensity occurring on the East coast of Tasmania.	Yes	Yes

Data/information sources: Australian Fisheries Management Authority (www.afma.gov.au), ABARES Fishery Status Reports 2014 to 2020.

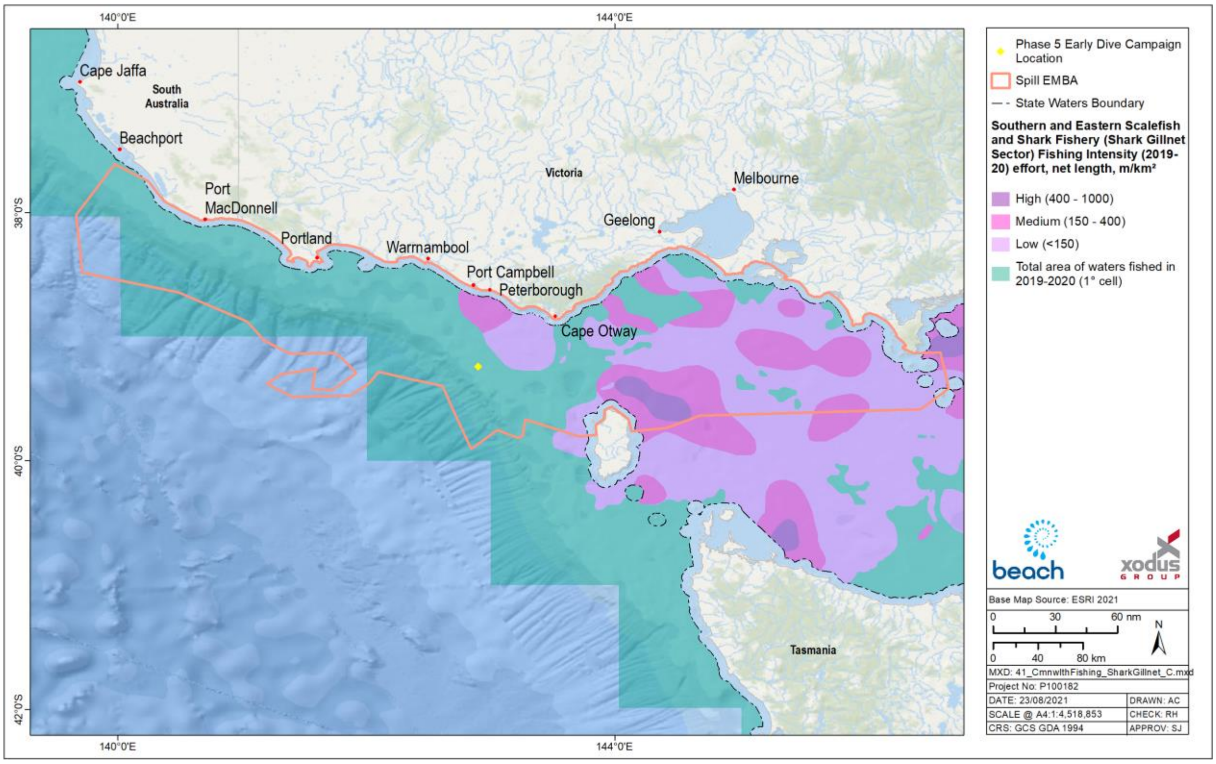


Figure 4-44: Southern and Eastern Scalefish and Shark Fishery (Shark Gillnet Sector) Fishing Intensity (effort, net length, m/km^2)

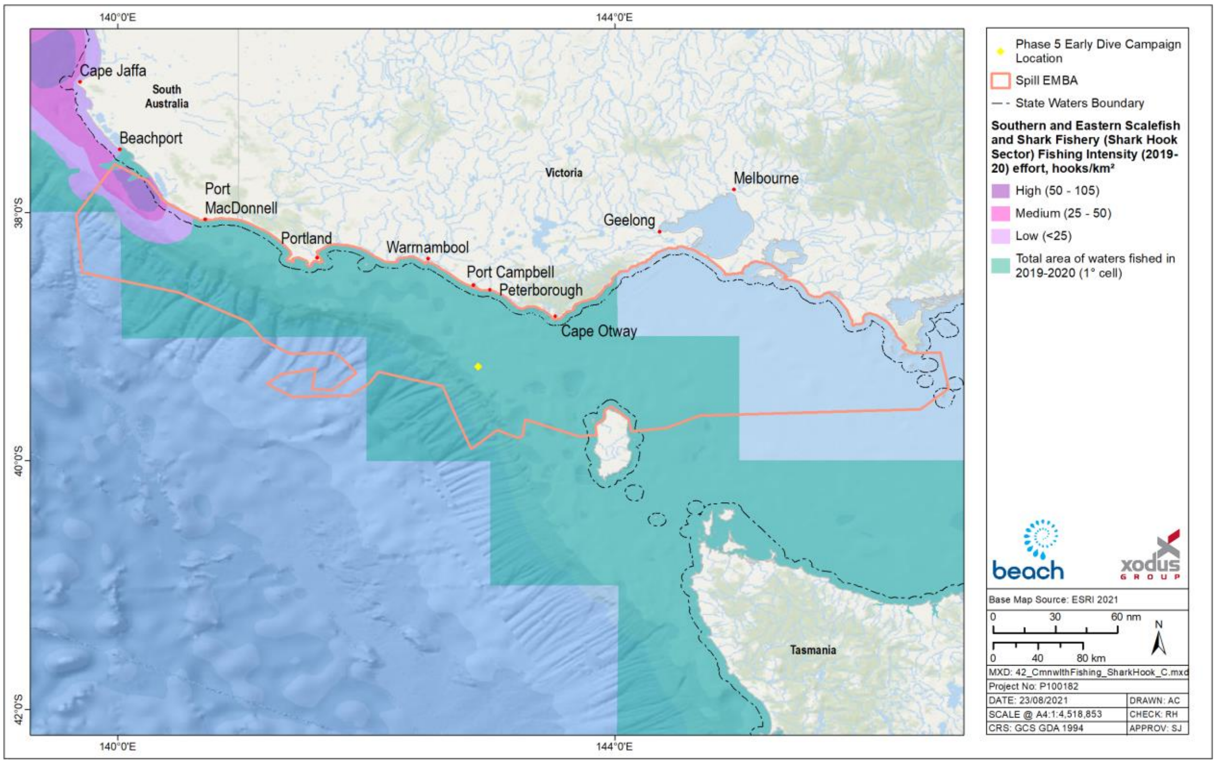


Figure 4-45: Southern and Eastern Scalefish and Shark Fishery (Shark Hook Sector) Fishing Intensity (effort, net length, m/km^2)

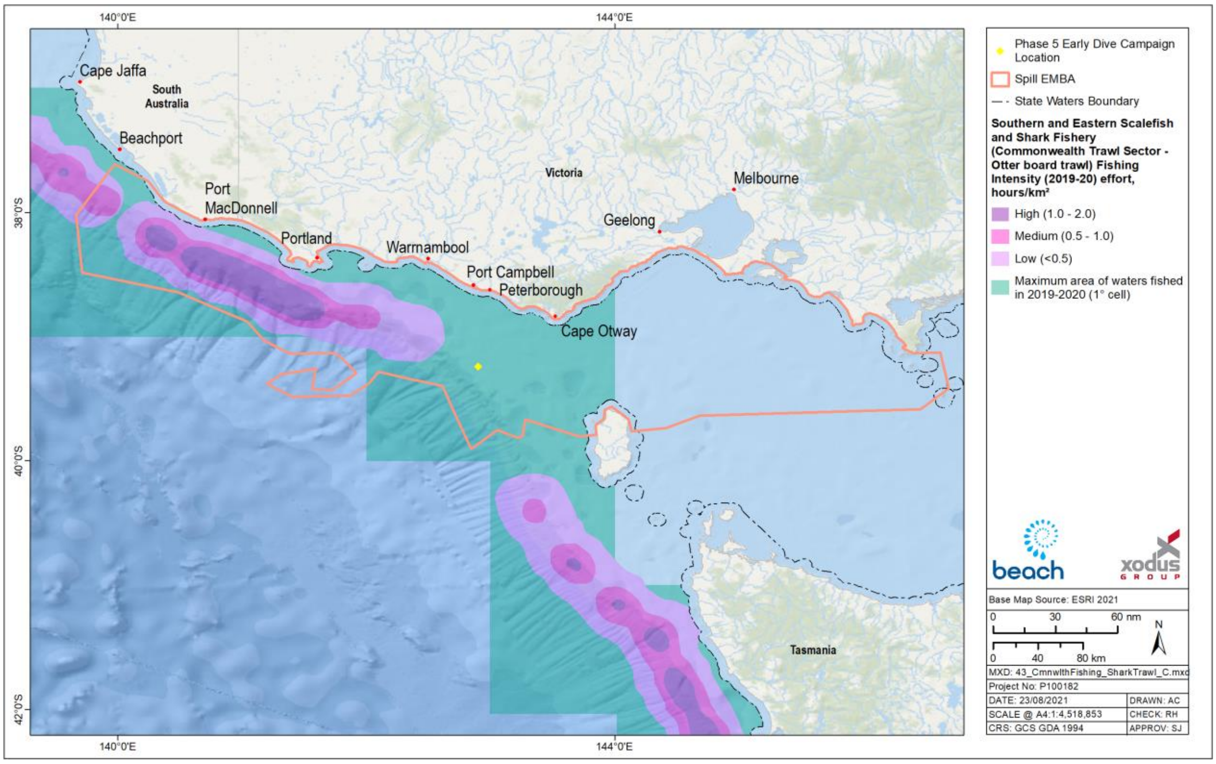


Figure 4-46: Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector) Fishing Intensity (effort, net length, m/km²)

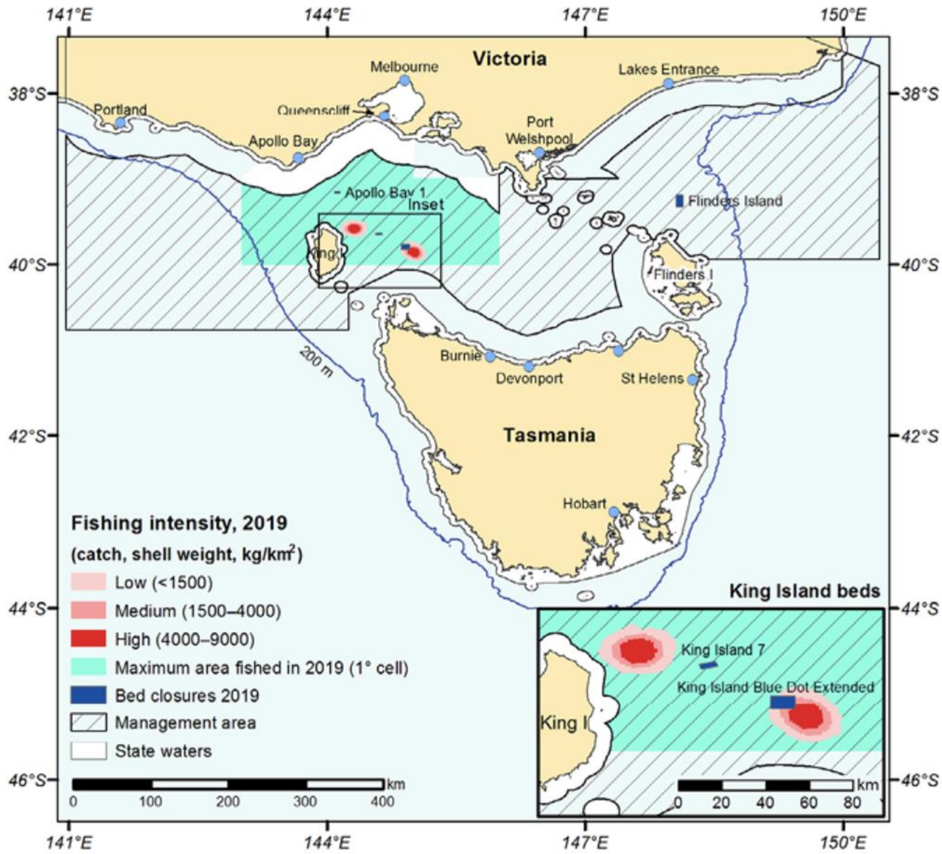


Figure 4-47: Jurisdiction of and fishing intensity of the Bass Strait Central Zone Scallop Fishery

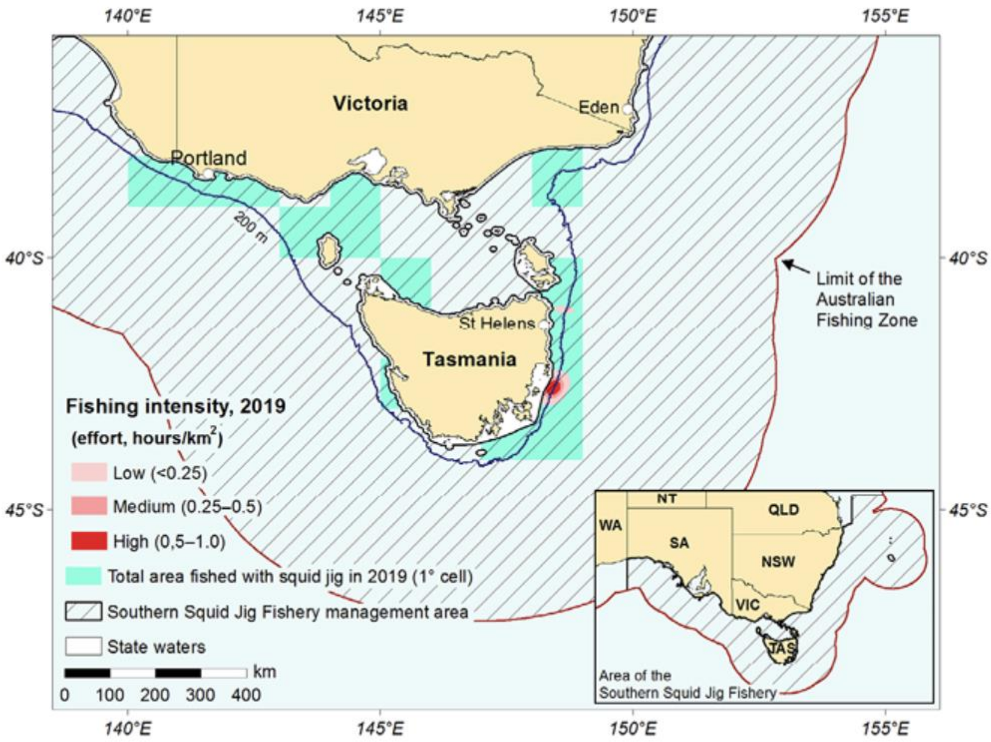


Figure 4-48: Jurisdiction of and fishing intensity of the Southern Squid Jig Fishery

4.7.9 Victorian managed fisheries

There are ten Victorian state-managed fisheries that overlap the spill EMBA:

- Abalone Fishery
- Bays and Inlet Fisheries
- Giant Crab Fishery
- Eel Fishery
- Octopus Fishery
- Pipi Fishery
- Rock Lobster Fishery
- Scallop (Ocean) Fishery
- Shark Fishery
- Snapper Fishery (Ocean fishery trawl)
- Wrasse (Ocean) Fishery

A description of these fisheries is detailed in Table 4-23.

Data was requested from VFA for the following grids. The grid numbers requested was based on where the operational area and spill EMBA lies within the grids.

- G10; G11; G12; G13
- H10; H11; H12; H13
- J10; J11; J12; J13
- K10; K11; K12; K13
- L10; L11; L12; L13
- M10; M11; M12; M13

A description of the fisheries that overlap the spill EMBA and operational area are detailed in Table 4-23 along with a description for the following fisheries that have monthly catch effort data within the operational area; fish (eel, snapper and wrasse fishers), octopus, shark, southern rock lobster and giant crab. Figure 4-49 to Figure 4-53 show the catch effort based on the maximum number of fishers in that area for each year from 2016-2020.

Table 4-23: Victorian managed fisheries in the spill EMBA

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Abalone Fishery (western zone)	Blacklip abalone Greenlip abalone	A highly valuable fishery (A$20 million in 2014-15) that operates along most of the Victorian shoreline, generally to 30 m depth. Abalone are harvested by divers. Total allowable commercial catch limits of blacklip abalone for the western zone are considerably less than the central and eastern zone (for 2017-18 season, 63.2 tonnes compared with 274.0 and 352.5 tonnes, respectively). There are 14 licences in the western zone. The water depths where abalone are fished are close to shore within the spill EMBA. No fishing effort was identified in the operational area.	No	Yes
Bays and Inlet Fisheries	Multi-species	Multi-species, multi gear fishery utilising octopus, fish and crab traps plus line fishing, seine nets mussel rakes and underwater breathing apparatus. Fisheries within Western Port and Port Phillip Bay are within the spill EMBA.	No	Yes
Eel Fishery	Eel	Target species are the short-finned eel (*Anguilla australis*) and long-finned eel (*A. reinhardtii*). Commercial fishers are only permitted to use fyke nets. Total catch for both species in 2016 was ~60 tonnes. Species spend the majority of their life cycle in fresh water or estuaries but travel to the ocean to spawn once before dying. Estuaries and migration routes are within the spill EMBA. Beach obtained fishing data from VFA for the years from 2016 – 2020. Figure 4-51 shows there is fishing effort within the spill EMBA and operational area. The wrasse, snapper and eel fishery have been combined in Figure 4-51. The catch data from VFA shows that the eel fishery is only present in grid G11 which is outside the operational area.	No	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Giant Crab Fishery	Giant crab	A small fishery operating in western Victoria and closely linked with the Rock Lobster Fishery. Most vessels are used primarily for rock lobster fishing with giant crab taken as by-product. Fishing effort is concentrated on continental shelf edge (~200 m deep). Giant crabs inhabit the continental slope at approximately 200 m depth and are most abundant along the narrow band of the shelf edge. Closed seasons operate for male (15 September to 15 November) and female (1 June to 15 November) giant crabs. Total landed catch in 2015-16 was 10 tonnes. Beach obtained fishing data from VFA for the years from 2016 – 2020. Figure 4-50 shows there is fishing effort within the spill EMBA and operational area. Within both the spill EMBA and operational area there is only a maximum of one giant crab fisher. The grids that show consistency with fishing data for all of the years from 2016-2020 are grids M12 and L11 which are outside of the operational area. Within the operational area L12, there has been a maximum of one giant crab fisher for August 2017, May 2018, June 2018 and December 2018.	Yes	Yes
Octopus Fishery	Pale octopus Maori octopus Gloomy octopus	The octopus fishery (Eastern Zone) is a new fishery harvesting mainly pale octopus (Octopus pallidus) in East Gippsland. The fishery may also catch maori octopus (*Macroctopus maorum*) and gloomy octopus (*Octopus tetricus*). Octopus are caught using purpose-built unbaited traps. The fishery commenced on 1st August 2020. Three fishery locations have been established for this new fishery; Eastern, Central and Western octopus zones. The Eastern zone is where the majority of commercial octopus takes place with the Central and Western zones are less established but are being managed by VFA through exploratory, temporary permits. Beach obtained fishing data from VFA for the years from 2016 – 2020. Figure 4-52 shows there is fishing effort within the spill EMBA and operational area. Most catch effort for the octopus fishery occurs along the coastline near Peterborough and Port Campbell (Figure 4-52), with presence every year from 2016-2020, however this fishery has declined in maximum number of fishers from 2016 in both grids G12 and G13. No fishing has been recorded in Grid L12 where the operational area is located.	No	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Pipi Fishery	Pipi	Main commercial harvesting area is Discovery Bay with limited activity in Venus Bay. Harvested in the high impact beach zone using traditional dip nets. Total annual catches in 2016–17 and 2017–18 were 42 tonnes each year. Discovery Bay and Venus Bay are within the spill EMBA	No	Yes
Rock Lobster Fishery (western zone)	Southern rock lobster	Victoria's second most valuable fishery with a production value of A$24 million in 2014-15. Since 2009/10, annual quotas have been set at between 230 and 260 tonnes and have been fully caught each year. In the western zone, most catch is landed through Portland, Port Fairy, Warrnambool, Port Campbell and Apollo Bay. Closed seasons operate for male (15 September to 15 November) and female (1 June to 15 November) lobsters. Southern rock lobsters are found to depths of 150 m, with most of the catch coming from inshore waters less than 100 m deep. Beach obtained fishing data from VFA for the years from 2016 – 2020. Figure 4-49 shows there is fishing effort within the spill EMBA and operational area. The data shows that this fisheries presence has declined since 2016 with the maximum number of fishers close to the coastline (Figure 4-49). For grid L12 where the operational area is located there has been a maximum of one fisher in 2017 and 2019.	Yes	Yes
Scallop (Ocean) Fishery	Scallops	Extends the length of the Victorian coastline from high tide mark to 20 nm offshore. Fishers use a scallop dredge. Temporary closures occur when stocks are low to allow scallop beds to recover. Total allowable commercial catch for 2015-16 was set at 135 tonnes. Scallops are mostly fished from Lakes Entrance and Welshpool. Fishing data from VFA for 2016 – 2020 did not identify scallop fishing effort within the grids provided which included the operational area. Based on the fishery location scallop fishing effort may occur within the spill EMBA.	No	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Shark Fishery	Gummy shark School shark Port Jackson shark Dog shark One-finned shark Broadnose shark	The wrasse, inshore trawl, southern rock lobster and giant crab fisheries are able to catch gummy shark (*Mustelus antarcticus*) and school sharks (*Galeorhinus galeus*) as part of their fishery. The combined catch limit for the gummy and school shark has been increased to 5 with no more than 1 shark being a school shark. Other shark species that may be caught is the Port Jackson shark (*Heterodontus portusjacksoni*), dog shark (*Squalus acanthias*), one-finned shark (*Heptranchias perlo*) and the broadnose shark (*Notorynchus cepedianus*). Beach obtained fishing data from VFA for the years from 2016 – 2020. Figure 4-53 shows there is fishing effort within the spill EMBA and operational area. The shark fishery has most of their recorded catch effort near the coastline. No effort has been recorded in the operational area (Grid L12).	No	Yes
Snapper Fishery (western stock) (Ocean fishery trawl (inshore) licence)	Snapper	Snapper are caught using lines, nets and haul seine. Over 90% of the catch is from Port Phillip Bay, and around 5% from coastal waters. In 2014-15, 147 tonnes were landed at a value of A$1.38 million. Beach obtained fishing data from VFA for the years from 2016 – 2020. Figure 4-51 shows there is fishing effort within the spill EMBA and operational area. The wrasse, snapper and eel fishery have been combined in Figure 4-51. The catch data obtained from VFA shows that the fish fishery is mostly along the coast surrounding Port Campbell and Peterborough. The snapper fishery has a high presence along the Peterborough coastline from 2016-2020 (grids G11 and G12). No effort has been recorded in the operational area (Grid L12).	No	Yes
Wrasse (Ocean) Fishery	Bluethroat wrasse Purple wrasse Small catches of rosy wrasse, senator wrasse and southern Maori wrasse	Extends the length of the Victorian coastline from high tide mark to 20 nm offshore. Fishers mostly use hook and line. Limited entry fishery with 22 current licences. Total annual catches in 2014-15 and 2015-16 were ~30 tonnes. Beach obtained fishing data from VFA for the years from 2016 – 2020. Figure 4-51 shows there is fishing effort within the spill EMBA and operational area. The wrasse, snapper and eel fishery have been combined Figure 4-51. The catch data obtained from VFA shows that the fish fishery is mostly along the coast surrounding Port Campbell and Peterborough. No effort has been recorded in the operational area (Grid L12).	No	Yes

Data/information sources: Victorian Fisheries Authority (www.vfa.vic.gov.au), DoEE (2015), State Govt of Victoria (2015a, b)

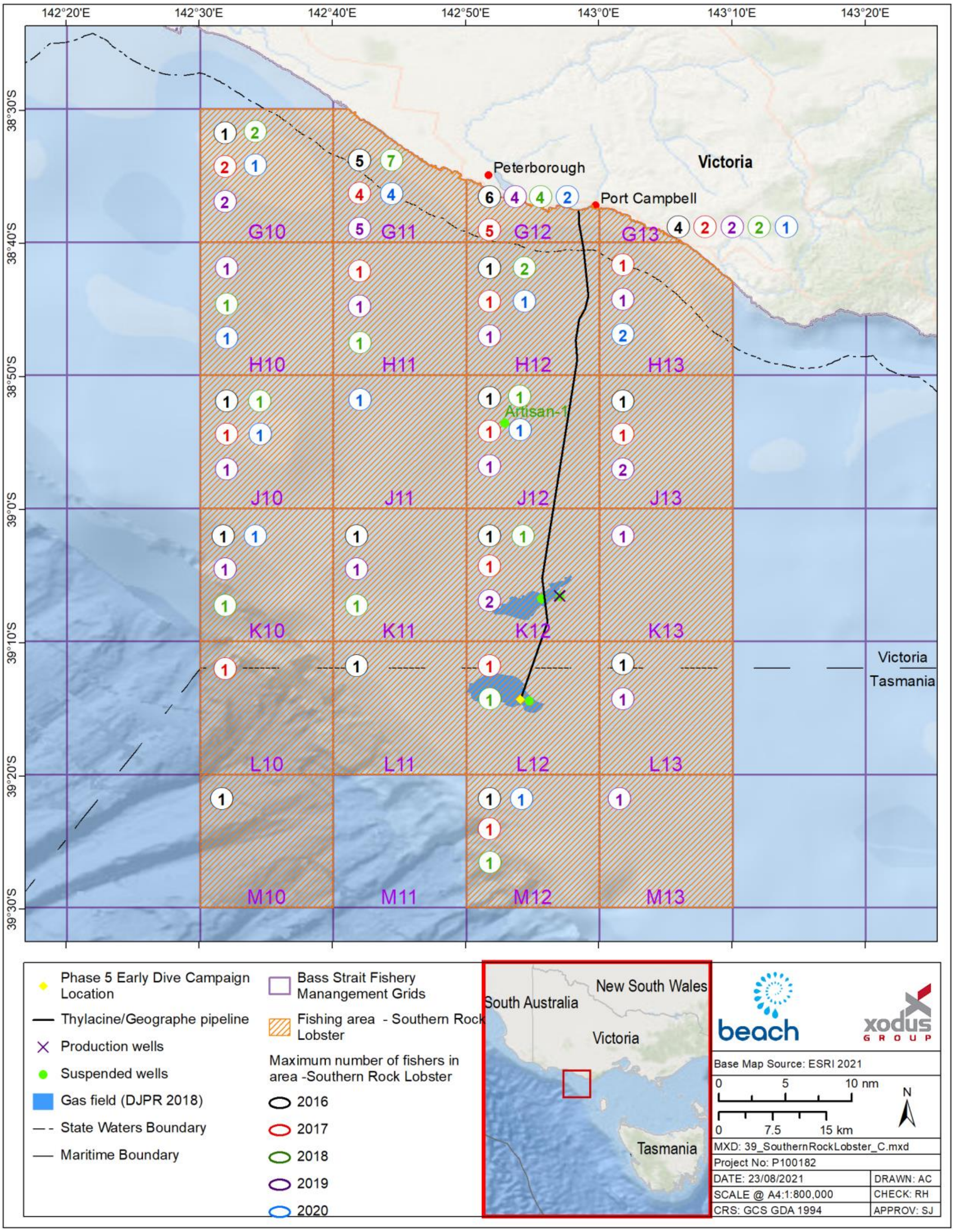


Figure 4-49: Maximum number of southern rock lobster fishers in the Otway region from 2016-2020. Data obtained from VFA, 2021.

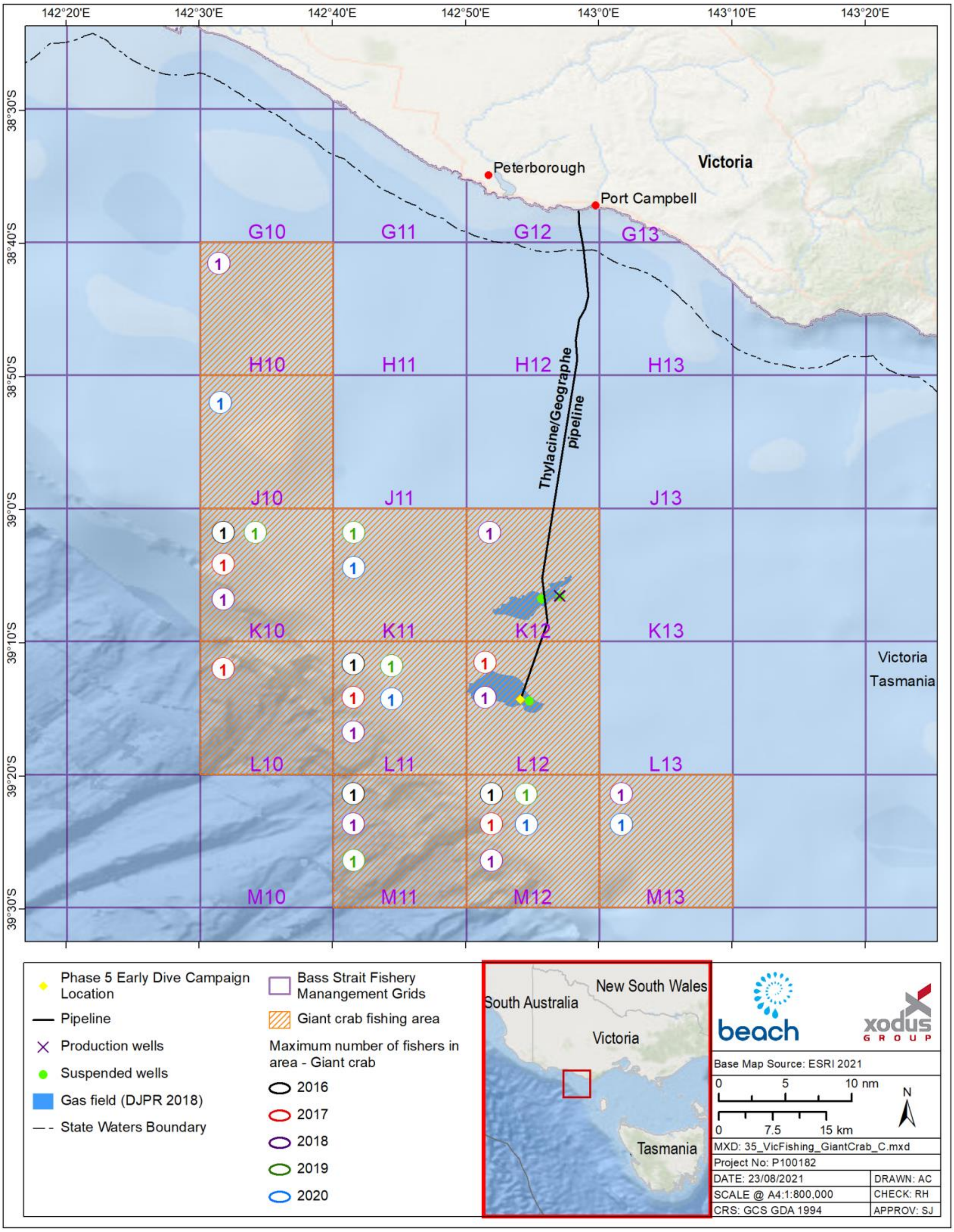


Figure 4-50: Maximum number of giant crab fishers in the Otway region from 2016-2020. Data obtained from VFA, 2021.

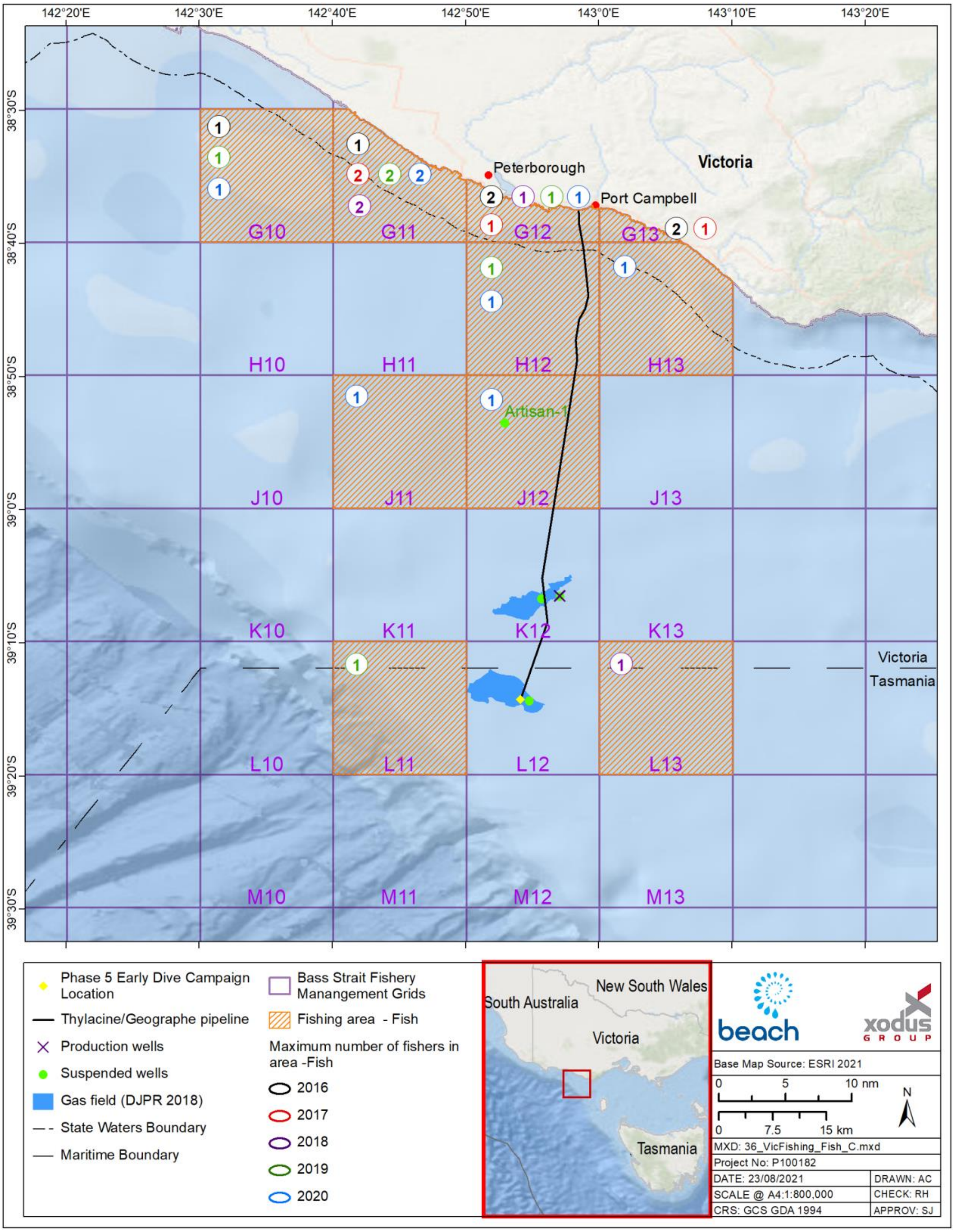


Figure 4-51: Maximum number of fish fishers (eel, snapper and wrasse fisheries) in the Otway region from 2016-2020. Data obtained from VFA, 2021.

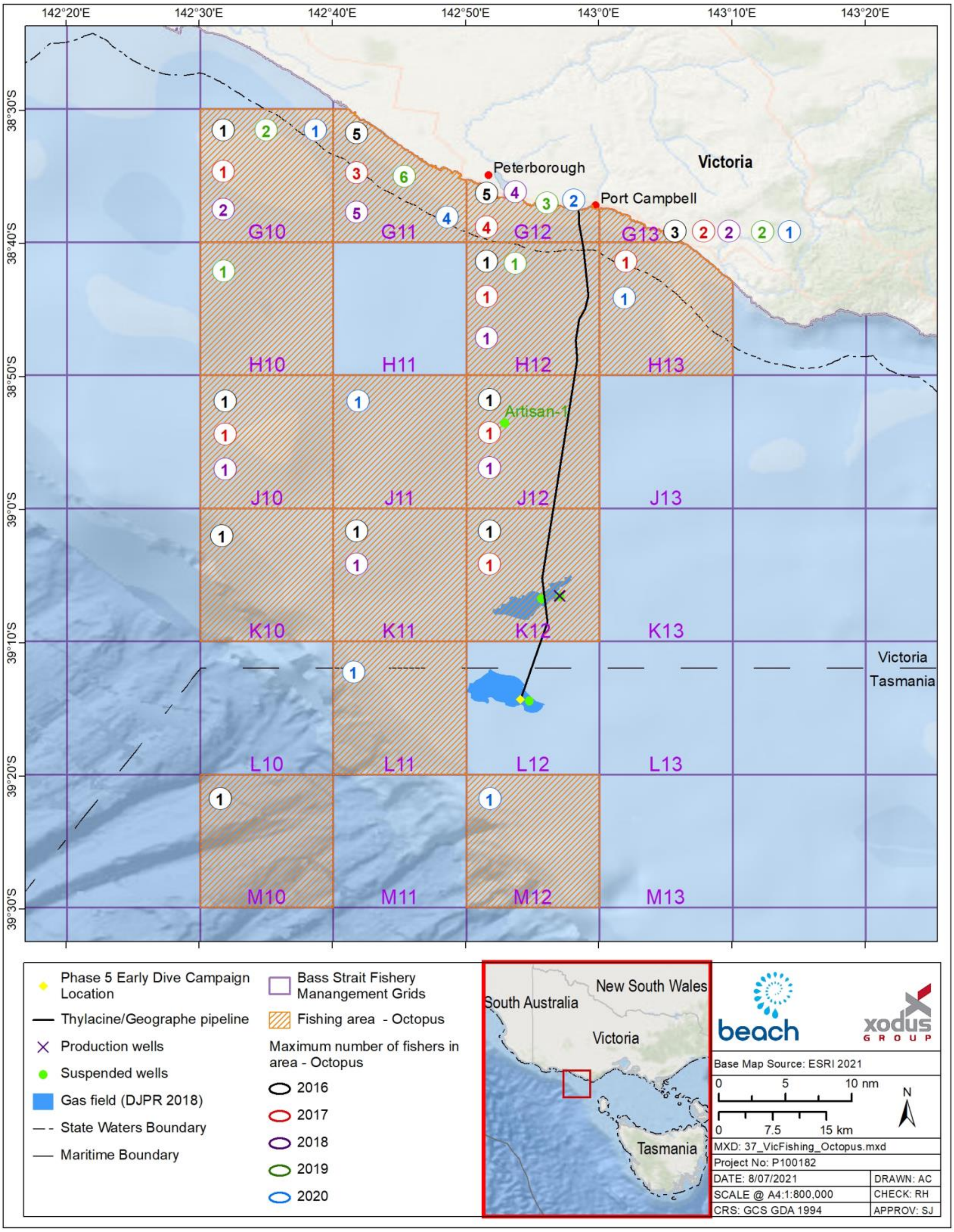


Figure 4-52: Maximum number of octopus fishers in the Otway region from 2016-2020. Data obtained from VFA, 2021.

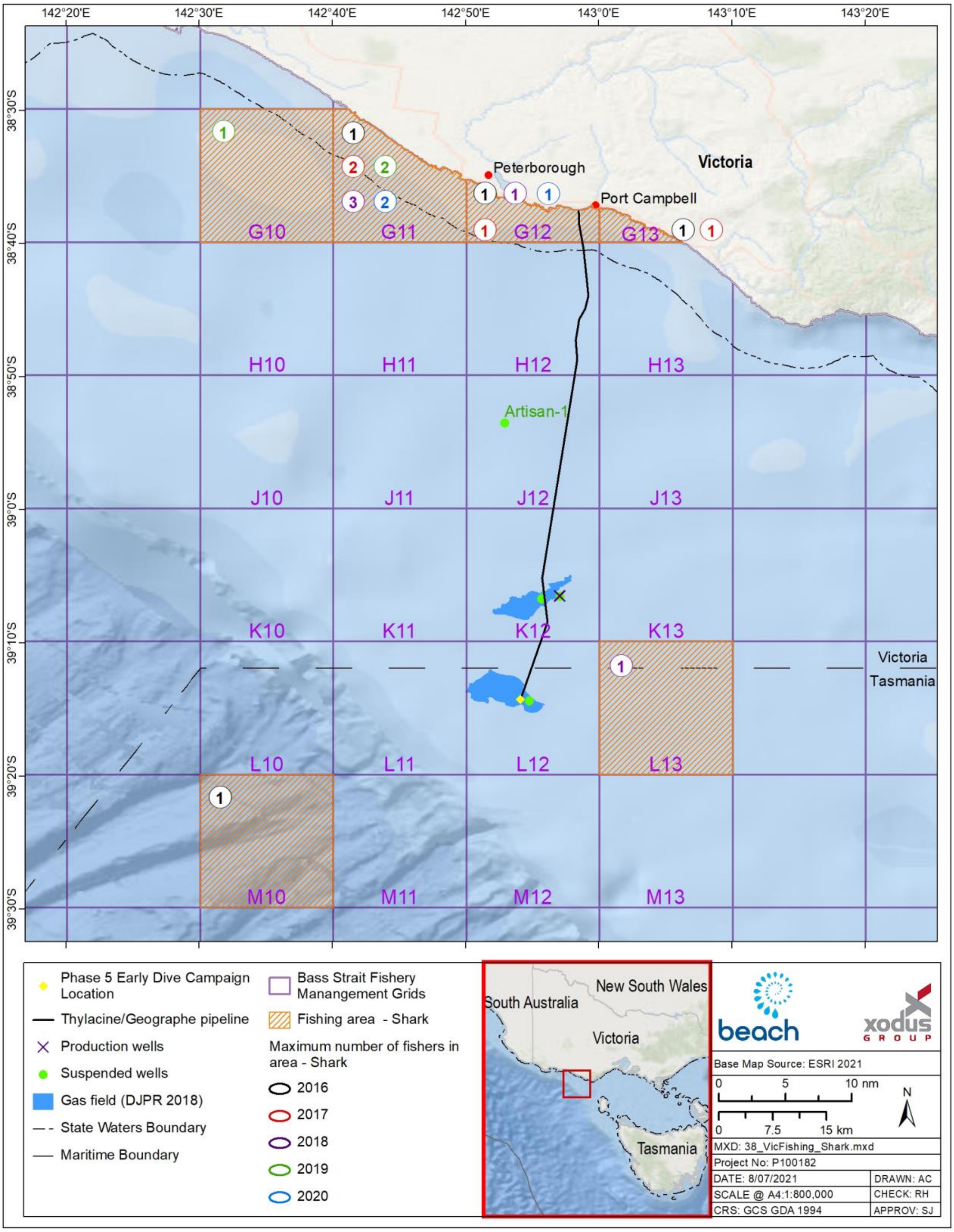


Figure 4-53: Maximum number of shark fishers in the Otway region from 2016-2020. Data obtained from VFA, 2021.

4.7.10 Tasmanian managed fisheries

No Tasmanian fisheries were identified within the operational area.

There are eight Tasmanian state managed commercial fisheries that occur within the spill EMBA:

- Abalone Fishery
- Commercial Dive Fishery
- Giant Crab Fishery
- Rock Lobster Fishery
- Scalefish Fishery
- Scallop Fishery
- Seaweed Fishery
- Shellfish Fishery

A description of these fisheries is in Table 4-24.

Historic catch assessments indicate that Commercial Dive, Scallop and Shellfish Fisheries activities are unlikely to occur in the spill EMBA, with fishing effort located in other areas of these fisheries. The Rock Lobster and Abalone Fisheries, which are by far the most productive and economically important Tasmanian fisheries accounting for 95% of the total value, are both expected to be active within the spill EMBA. Giant Crab, Scalefish, Scallop and Seaweed Fisheries are also likely to be active within the spill EMBA to varying degrees.

The jurisdictional area of the Seaweed Fishery extends to the limit of Tasmanian State waters coastal waters (3 nm). The jurisdictional area for the Scallop Fishery extends from the high water mark to 20 nm from Tasmanian state waters into the Bass Strait and out to the limits of the Australian Fishing Zone (200 nm) off the rest of the state, as defined in the 1986 Offshore Constitutional Settlement (OCS) arrangements for scallop stock. The Abalone, Rock Lobster, Giant Crab, Commercial Dive, Scalefish and Shellfish Fisheries apply throughout Tasmanian State waters as defined in the 1996 OCS arrangements for invertebrates and finfish stock.

Table 4-24: Tasmanian managed fisheries in the spill EMBA

Fishery	Target species	Description	Fishing Effort Spill EMBA
Abalone Fishery (Northern and Bass Strait Zones)	Black lip (*Haliotis rubra*) and greenlip abalone (*H. laevigata*)	Largest wild abalone fishery in the world (providing ~25% of global production) and a major contributor to the local economy. Abalone are hand-captured by divers in depths between 5-30 m. Blacklip abalone are collected around on rocky substrate around the Tasmanian shoreline and are the main focus of the fishery. Greenlip abalone are distributed along the north coast and around the Bass Strait islands and usually account for around 5% of the total wild harvest. Total landings were 1018.5 t for 2020, comprising 934.5 t of blacklip and 84 t of greenlip abalone. The spill EMBA intersects the Northern Zone (waters around King Island) and Bass Strait Zone (waters in the Northern Bass Strait Region) of the Abalone Fishery.	Yes
Commercial Dive Fishery (Northern Zone)	White sea urchin (*Heliocidaris urethrograms*), black sea urchin (*Centrostephanus rodgersii*) and periwinkles (*Lunella undulate*)	Dive capture fishery that targets several different species; the main species collected being sea urchins and periwinkles. In 2020-2021 approximately 180 t of sea urchins and 2.07 t of periwinkles were harvested. Sea urchins and periwinkles accounting for 63% and 37% of the total respectively. Jurisdiction encompasses all Tasmanian State waters (excluding protected and research areas), although licence holders largely operate out of small vessels (<10 m) and effort is concentrated on the south and east costs of Tasmania around ports. The spill EMBA intersects the Northern Zone of the Commercial Dive Fishery at King Island and in the northern Bass Strait. The Northern Zone of the fishery is defined as the area of Tasmanian State waters on the east coast bounded by the line of latitude 42°20'40"S in the south and extending north to the line of latitude 41°00'26"S (from the southern point of Cape Sonnerat to Red Rocks).	Yes
Giant Crab Fishery	Giant crab (*Pseudocarcinus gigas*)	The giant crab fishery is a comparatively small fishery with the total allowable catch for 2019-20 at 19.18 t. The fishery has been commercially targeted since the early 1990s moving from open access to limited entry. The area of the fishery includes waters surrounding the state of Tasmania generally south of 39º12 out to 200 nm. Within the area of the fishery, most effort takes place on the edge of the continental slope in water depths between 140 m and 270 m. CPUE has declined continually since the inception of the fishery in the early 1990s indicating that it has been overfished. The TAC has been reduced to 20.7 t for 2019/120 and 2021/2022 to address the issue. The spill EMBA potentially overlaps the area where giant crabs are fished for on the continental slope.	Yes

Fishery	Target species	Description	Fishing Effort Spill EMBA
Rock Lobster Fishery	Southern rock lobster (*Jasus edwardsii*)	Southern rock lobster are the other major wild-caught Tasmanian fishery. For 2020-21 the Total Allowable Catch has declined to 990.56 t. The quota for the year remains at 1050.7 t. Rock lobster made up a volume of 1,047 t or 25% percent of total fisheries production in 2015/16. Production value was $89 million or 51% of total fisheries value in 2014/15 (up 7% from 2013/14). Southern rock lobsters are found to depths of 150 m with most of the catch coming from inshore waters less than 100 m deep throughout state waters. There are 209 vessels active in the fishery. The spill EMBA potentially overlaps the Rock Lobster Fishery.	Yes
Scalefish Fishery (northwest coast)	Numerous species, but the majority of effort is on # species	Complex multi-species fishery harvesting a range of scalefish, shark and cephalopod species. Fourteen different fishing methods are used. The total catch was around 270 t in 2014/15, a decline of 20 t compared to the previous season. Due to the fishery being undercaught by 26.7% in the previous season 2020/21, the Total Allowable Catch for the 2021/22 season has increased to 30 kg quota unit. The spill EMBA potentially overlaps the Scalefish Fishery.	Yes
Scallop Fishery	Commercial scallop (*Pecten fumatus*)	Fishery area extends 20 nm from the high water mark of Tasmanian state waters into Bass Strait and out to 200 nm offshore from the remainder of the Tasmanian coastline. Eight vessels are active in the fishery. Fishers use a scallop dredge. Scallop beds are generally found along the east coast and Bass Strait in depths between 10-20 m but may occur in water deeper than 40 m in the Bass Strait. Scallop habitat is protected through a ban on dredging in waters less than 20 m and a network of dredge-prohibited areas around the state. There is high variability in abundance, growth, mortality, meat yield and condition of scallop stock in the fishery and recruitment is sporadic and intermittent. Managed using an adaptable strategy where surveys are undertaken to estimate abundance and decision rules are used to open an area (or areas) to fishing. When open the scallop fishery contributes significantly to total fisheries production. In 2015 the scallop fishing season ran from July to October and the catch was 781 t. At present the Tasmanian Commercial Scallop fishery remains closed. The spill EMBA does not overlap the area of effort for the Scallop Fishery.	No

Fishery	Target species	Description	Fishing Effort Spill EMBA
Seaweed Fishery	Bull kelp (*Durvillea Pototorum*), Japanese kelp (*Undaria pinnatifida*)	Components of this fishery include collection of cast bull kelp and harvesting of Japanese kelp, an introduced species. The majority of cast bull kelp is collected from King Island. The right to harvest and process kelp on King Island was granted exclusively to Kelp Industries Pty Ltd in the mid-1970s. About 80 to 100 individuals collect cast bull kelp and transport it to the Kelp Industries plant in Currie. An average annual harvest above 3000 t (dried weight) has been produced in recent years, accounting for about 5% of the world production of alginates (i.e. the end product of dried bull kelp). The cast bull kelp harvesting on King Island generates about $2 million annually. Comparatively minor cast bull kelp collection also occurs at two centres of operation on Tasmania's West Coast: around Bluff Hill Point and at Granville Harbour. Japanese kelp is harvested by divers only along Tasmania's east coast where it is already well established. The spill EMBA potentially overlaps the Seaweed Fishery.	Yes
Shellfish Fishery	Katelysia cockles (*Katelysia scalarina*), Venerupis clam (*Venerupis largillierti*), native oyster (*Ostrea angasi*), Pacific oyster (*Crassostrea gigas*)	Comprises specific shellfish species hand captured by divers in defined locations on the east coast of Tasmania, namely Angasi oysters in Georges Bay, Venerupis clams in Georges Bay and Katelysia cockles in Ansons Bay. The taking of Pacific oysters, an invasive species, is also managed as part of the fishery but no zones apply. Pacific oysters can be collected throughout all State waters (which includes areas within the spill EMBA), as the aim of harvesting these animals is to deplete the wild population. The estimated total value of the shellfish fishery based on landings from 2001-2005 was $345,538. The spill EMBA does not overlap the Shellfish Fishery.	No

Data/information sources: Department of Primary Industries, Water and Environment (DPIPWE, 2021). Australian fisheries and aquaculture statistics 2014-15 (Patterson et al, 2016), Department of the Environment and Energy (DotEE, 2017c), Fish Research and Development Corporation (FRDC, 2017)

4.8 Cultural environment

4.8.1 Maritime archaeological heritage

Shipwrecks over 75 years old are protected within Commonwealth waters under the *Underwater Cultural Heritage Act 2018* (Cth), in Victorian State waters under the *Victorian Heritage Act 1995* (Vic) and in Tasmanian waters under the *Historic Cultural Heritage Act 1995*. Some historic shipwrecks lie within protected zones of up to 800 m radius, typically when the shipwreck is considered fragile or at particular risk of interference. In Tasmania, the Historic Heritage Section of the Parks and Wildlife Service is the government authority responsible for the management of the State's historic shipwrecks and other maritime heritage sites.

Within the spill EMBA is a 130 km stretch of coastline known as the 'Shipwreck Coast' because of the large number of shipwrecks present, with most wrecked during the late nineteenth century. The strong waves, rocky reefs and cliffs of the region contributed to the loss of these ships. More than 180 shipwrecks are believed to lie along the Shipwreck Coast (DELWP, 2016b) and well-known wrecks include Loch Ard (1878), Thistle (1837), Children (1839), John Scott (1858) and Schomberg (1855).

The wrecks represent significant archaeological, educational and recreational (i.e. diving) opportunities for locals, students and tourists (Flagstaff Hill, 2015).

There are over 200 historic wrecks in the spill EMBA. Only one of these wrecks, the *SS Alert*, has a protection zone that is within the spill EMBA. There is no identified aircraft wreckage within the operational area.

Beach commissioned a seabed site assessment for the Otway Gas Development (Fugro, 2020a; Fugro, 2020b). The survey extent, including the Thylacine gas field and infrastructure, are shown in Figure 4-13. As part of the seabed site assessment a sub-bottom profiler was used to identify any buried objects. The penetration of the sub-bottom profiler was limited to a maximum of ~100 cm, with the average thickness of the sand patches being ~20-30 cm; precluding burial of a shipwreck.

4.8.2 Aboriginal heritage

Aboriginal groups inhabited the southwest Victorian coast as is evident from the terrestrial sites of Aboriginal archaeological significance throughout the area. During recent ice age periods (the last ending approximately 12,000-14,000 years ago), sea levels were significantly lower, and the coastline was a significant distance seaward of its present location, enabling occupation and travel across land that is now submerged.

Coastal Aboriginal heritage sites include mostly shell middens, some stone artefacts, a few staircases cut into the coastal cliffs, and at least one burial site. The various shell middens within the Port Campbell National Park and Bay of Islands Costal Park are close to coastal access points that are, in some cases, now visitor access points (Parks Victoria, 2006b).

Aboriginal people have inhabited Tasmania for at least 35,000 years. At the end of the last ice age the sea level rose, and Tasmania became isolated from the mainland of Australia. They survived in the changing landscape partly due to their ability to harvest aquatic resources, such as seals and shellfish.

Following conflict between the European colonists and the Tasmanian Aboriginal peoples, leading to the relocation of people to missions on Bruny Island, Flinders Island and other sites, and finally to Oyster Cove, their numbers diminished drastically. The Aboriginal Heritage Register (AHR), lists over 13,000 sites; however, there is no searchable database to identify any sites in the operational area. It must be assumed that sites will be scattered along the coast of King Island within the spill EMBA.

4.8.3 Native title

A search of the National Native Title Tribunal (NNTT) database identifies two claims have been accepted for registration over the adjacent coastal shoreline (and terrestrial component of the spill EMBA). One claim is by the Eastern Maar people (VC2012/001), registered in 2013, and extends seaward 100 m from the mean low-water mark of the coastline (NNTT, 2016). There is currently no determination registered over the area of the claim (still active) in the National Native Title Register. There is also a registered claim (2014/001) over Wilson's Promontory by the Gunaikurnai people. There are no registered claims in Tasmania.

5 Environmental Impact and Risk Assessment Methodology

5.1 Overview

This section outlines the environmental impact and risk assessment methodology used for the assessment of the program activities. The methodology is consistent with the Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000:2018, *Risk Management – Principles and Guidelines*). Figure 5-1 outlines this risk assessment process.

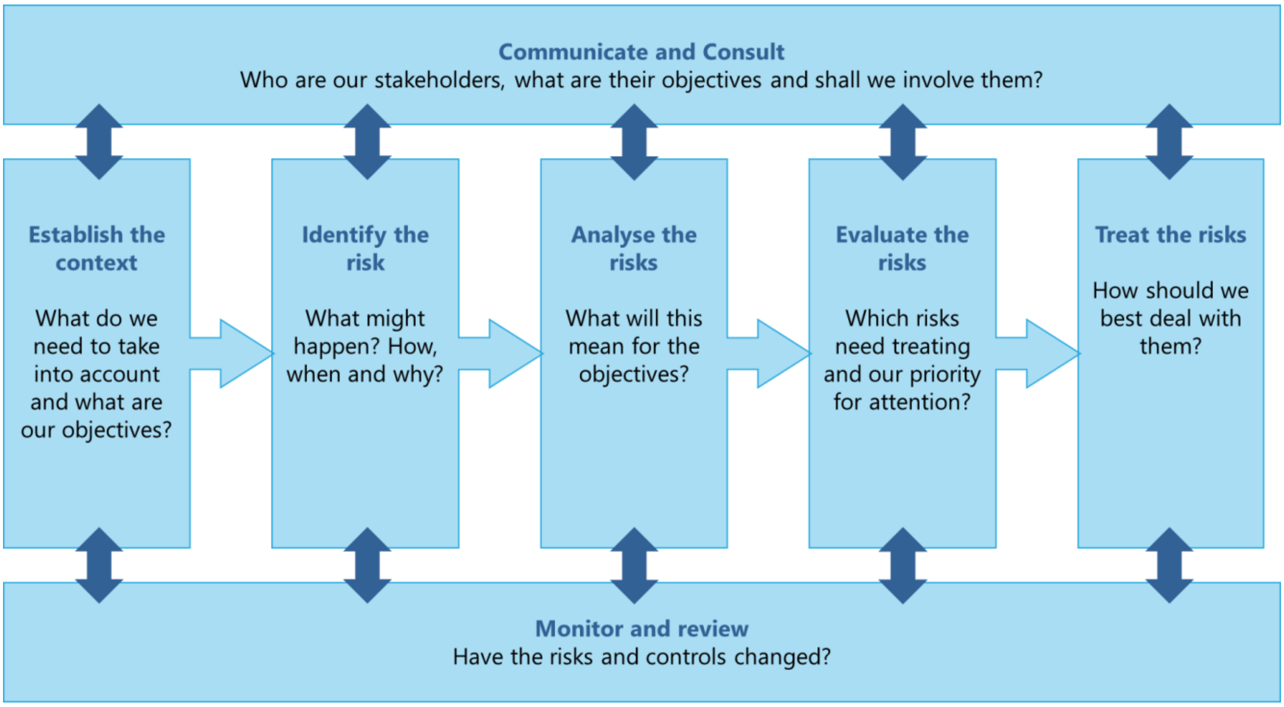


Figure 5-1: Risk assessment process

5.1.1 Definitions

Definitions of the term used in the risk assessment process are detailed in Table 5-1.

Table 5-1: Risk assessment process definitions

Term	Definition
Activity	Refers to a 'petroleum activity' as defined under the OPGGS(E)R as: • petroleum activity means operations or works in an offshore area undertaken for the purpose of: a. exercising a right conferred on a petroleum titleholder under the Act by a petroleum title; or, b. discharging an obligation imposed on a petroleum titleholder by the Act or a legislative instrument under the Act.
Consequence	The consequence of an environmental impact is the potential outcome of the event on affected receptors (particular values and sensitivities). Consequence can be positive or negative.
Control measure	Defined under the OPGGS(E)R as a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks.
Emergency condition	An unplanned event that has the potential to cause significant environmental damage or harm to MNES. An environmental emergency condition may, or may not, correspond with a safety incident considered to be a Major Accident Event.
Environmental aspect	An element or characteristic of an operation, product, or service that interacts or can interact with the environment. Environmental aspects can cause environmental impacts.
Environmental impact	Defined under the OPGGS(E)R as any change to the environment, whether adverse or beneficial, that wholly or partially results from an activity.
Environmental performance outcome	Defined under the OPGGS(E)R as a measurable level of performance required for the management of environmental aspects of an activity to ensure that environmental impacts and risks will be of an acceptable level.
Environmental performance standard	Defined under the OPGGS(E)R as a statement of the performance required of a control measure.
Environmental risk	An unplanned environmental impact has the potential to occur, due either directly or indirectly from undertaking the activity.
Likelihood	The chance of an environmental risk occurring.
Measurement criteria	A verifiable mechanism for determining control measures are performing as required.
Residual risk	The risk remaining after control measures have been applied (i.e. after risk treatment).

5.2 Communicate and consult

In alignment with Regulation 11A(2) of the OPGGS(E)R, during the development of this EP, Beach has consulted with relevant person(s) (stakeholders) to obtain information in relation to their activities within the operational area and potential impacts to their activities. This information is used to inform the EP and the risk assessment undertaken for the activity. Stakeholder consultation is an iterative process that continues throughout the development of the EP and for the duration of a petroleum activity as detailed in Section 8.

5.3 Establish the context

Context for the risk assessment process is established by:

- understanding the regulatory framework in which the activity takes place (described in Section 2, 'Applicable Requirements');
- identifying the environmental aspects of the activity (and associated operations) that will or may cause environmental impacts or may present risks to the environment (based upon the 'Activity Description' in Section 3);
- identifying the environment that may be affected, either directly or indirectly, by the activity (based upon the 'Existing Environment' as described in Section 4.1); and
- understanding the concerns of stakeholders and incorporating those concerns into the design of the activity where appropriate (outlined in Section 8, 'Stakeholder Consultation').

5.4 Identify the potential impacts and risks

Potential impacts (planned) and risks (unplanned) associated with the environmental aspects of the activity are identified in relation to the EMBA, either directly or indirectly, by one or multiple aspects of the activity i.e., identifying the cause-effect pathway by which environmental and social receptors may be impacted. Table 6-1 details the aspects identified for the activity.

5.5 Analyse the potential impacts and risks

Once impacts and risks have been identified, an analysis of the nature and scale of the impact or risk is undertaken. This involves determining the possible contributing factors associated with the impact or risk. Each possible cause should be identified separately, particularly where controls to manage the risk differ. In this way, the controls can be directly linked to the impact or risk.

5.5.1 Establish environmental performance outcomes

Environmental performance outcomes (EPOs) are developed to provide a measurable level of performance for the management of environmental aspects of an activity to ensure that environmental impacts and risks will be of an acceptable level. EPOs have been developed based on the following:

- ecological receptors: EPBC Act MNES: Significant Impact Guidelines 1.1 to identify the relevant significant impact criteria. The highest category for the listed threatened species or ecological communities likely to be present within the EMBA is used, for example: endangered over vulnerable. Where appropriate species recovery plan actions and/or outcomes.
- commercial fisheries: Victorian Fishing Authority core outcome of sustainable fishing and aquaculture (https://vfa.vic.gov.au/about).
- marine users: OPGGS Act 2006 (Cth) Section 280.

5.6 Evaluate and treat the potential impacts and risks

The following steps are undertaken using the Beach OEMS Element 8, BSTD 8.1 Risk Management Standard, Risk Matrix (Table 5-2) to evaluate the potential impacts and risks:

- identify the consequences of each potential environmental impact, corresponding to the maximum credible impact;
- for unplanned events, identify the likelihood (probability) of unplanned environmental impacts occurring;
- for unplanned events, assign a level of risk to each potential environmental impact using the risk matrix.

- identify control measures to manage potential impacts and risks to as low as reasonably practicable (ALARP) (Section 5.7) and an acceptable level (Section 5.8); and
- establish environmental performance standards for each of the identified control measures.

Table 5-2: Environmental risk assessment matrix

CDN 14740489 Beach Risk Matrix & Risk Management Quick Reference Guide

Risk Matrix

CONSEQUENCE	CONSEQUENCE CATEGORY					LIKELIHOOD					
	PEOPLE	**ENVIRONMENT**	**REPUTATION**	**FINANCIAL**	**LEGAL**	**A. Remote**	**B. Highly Unlikely**	**C. Unlikely**	**D. Possible**	**E. Likely**	**F. Almost Certain**
	Impact to Beach or contracting personnel	**Natural environment**	**Community safety, reputation/social licence. media, items of cultural significance.**	**Financial impact (e.g. due to loss of revenue, business interruption, asset loss etc.)**	**E.G. Breach of law, prosecution, civil action**	<1% chance of occurring within the next year. Requires exceptional circumstances, unlikely event in the long-term future. Only occur as a 100-year event	> 1% chance of occurring within the next year. May occur but not anticipated. Could occur years to decades	> 5% chance of occurring within the next year. May occur but not for a while. Could occur within a few years	>10% chance of occurring within the next year. May occur shortly but a distinct probability it won't. Could occur within months to years	>50% chance of occurring within the next year. Balance of probability will occur. Could occur within weeks to months	99% chance of occurring within the next year. Impact is occurring now. Could occur within days to weeks
6 Catastrophic	Multiple fatalities >4 or severe irreversible disability to large group of people (>10)	Catastrophic offsite or onsite release or spill; long-term destruction of highly significant ecosystems; significant effects on endangered species or habitats; irreversible or very long-term impact	Multiple community fatalities; complete loss of social licence; prolonged negative national media; complete loss of items of cultural significance	> AUD$500m	Prolonged and complex civil and/or regulatory litigation; potential jail terms and/or very high fines and/or damages claim	HIGH	HIGH	SEVERE	SEVERE	EXTREME	EXTREME
5 Critical	1-3 fatalities or serious irreversible disability (>30%) to multiple persons (<10)	Significant offsite or onsite release or spill; eradication or impairment of the ecosystem; significant impact on highly valued species or habitats; widespread long-term impact	Community fatality; significant loss of social licence; negative national media for 2 or more days; significant damage to items of cultural significance	>AUD$100m & ≤ $500m	Civil and/or regulatory litigation; potential significant fines and/or damages claim	MEDIUM	MEDIUM	HIGH	SEVERE	SEVERE	EXTREME
4 Major	Serious permanent injury/ illness or moderate irreversible disability (<30%) to one or more persons	Major Offsite or onsite release or spill; very serious environmental effects, such as displacement of species and partial impairment of ecosystem; major impact on highly valued species or habitats; widespread medium and some long-term impact	Serious permanent injury to community member; major damage to social licence; negative national media; major damage to items of cultural significance	>AUD$10m & ≤ $100m	Civil and/or regulatory litigation; potential major fine and damages claim	MEDIUM	MEDIUM	MEDIUM	HIGH	SEVERE	SEVERE
3 Serious	Serious reversible/ temporary injury/illness; Lost Time Injury >5 days or Alternate/Restricted Duties > 1 month	Minor offsite or onsite release or spill; serious short-term effect to ecosystem functions; serious impact on valued species or habitats; moderate effects on biological or physical environment	Serious reversible injury to community member; serious damage to social licence; negative state media; serious damage to items of cultural significance	>AUD$1m & ≤$10m	Serious potential breach of law; report and investigation by regulator; possible prosecution or regulatory notice (e.g. improvement notice or equivalent), or possible civil litigation and serious damages claim	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	SEVERE
2 Moderate	Reversible temporary injury/ illness requiring Medical Treatment; Lost Time Injury ≤5 days or Alternate/Restricted Duties for ≤ 1 month	Event contained within site; short-term effects but not affecting ecosystem functions; some impact on valued species or habitats; minor short-term damage to biological and/or physical environment	Moderate injury to community member; moderate impact to social licence; negative local media; moderate damage to items of cultural significance	>AUD$100,000 & ≤ $1m	Potential Breach of law or non-compliance; inquiry by a regulator leading to Low-level legal issues; possible civil litigation and moderate damages claim	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH
1 Minor	First Aid Injury/illness	Spill limited to release location; minor effects but not affecting ecosystem functions; no impact on valued species or habitats; low-level impacts on biological and physical environment	Minor injury to community member, public concern restricted to local complaints, minor damage to items of cultural significance	≤AUD$100,000	Minor potential breach of law; not reportable to a regulator; on the spot fine or technical non-compliance	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM

5.7 Demonstration of ALARP

Beach's approach to demonstration of ALARP includes:

- Systematically identify and assess all potential environmental impacts and risks associated with the activity;
- Where relevant, apply industry 'good practice' controls to manage impacts and risks;
- Assess the effectiveness of the controls in place and determine whether the controls are adequate according to the 'hierarchy of control' principle; and
- For higher order impacts and risks, undertake a layer of protection analysis and implement further controls if both feasible and reasonably practicable to do so.

NOPSEMA's EP decision making guideline (NOPSEMA, 2021) states that in order to demonstrate ALARP, a Titleholder must be able to implement all available control measures where the cost is not grossly disproportionate to the environmental benefit gained from implementing the control measure.

For this EP, the guidance provided in NOPSEMA's EP decision making guideline (NOPSEMA, 2021) has been applied, whereby the level of ALARP assessment is dependent upon the:

- Residual impact and risk level (high versus low); and
- The degree of uncertainty associated with the assessed impact or risk.

The following section details how the guidance provided in NOPSEMA's EP decision making guideline (NOPSEMA, 2021) have been applied.

5.7.1 Residual impact and risk levels

Lower-order environmental impacts and risks

NOPSEMA defines lower-order environmental impacts and risks as those where the environment or receptor is not formally managed, less vulnerable, widely distributed, not protected and/or threatened and there is confidence in the effectiveness of adopted control measures.

Impacts and risks are considered to be lower-order and ALARP when, using the environmental risk assessment matrix, the impact consequence is rated as 'minor' or 'moderate' or risks are rated as 'low', 'medium' or 'high.' In these cases, applying 'good industry practice' (as defined in Section 5.7.2.1) is sufficient to manage the impact or risk to ALARP.

Higher-order environmental impacts and risks

All other impacts and risks are defined by NOPSEMA as higher-order environmental impacts and risks (i.e., where the environment or receptor is formally managed, vulnerable, restricted in distribution, protected or threatened and there is little confidence in the effectiveness of adopted control measures).

Impacts and risks are considered to be higher-order when, using the environmental risk assessment matrix (Table 5-2), the impact consequence is rated as 'serious', 'major', 'critical' or 'catastrophic', or when the risk is rated as 'severe' or 'extreme'. In these cases, further controls must be considered as per Section 5.7.2.

An iterative risk evaluation process is employed until such time as any further reduction in the residual risk ranking is not reasonably practicable to implement. At this point, the impact or risk is reduced to ALARP. The determination of ALARP for the consequence of planned operations and the risks of unplanned events is outlined in Table 5-3.

Table 5-3: ALARP determination for consequence (planned operations) and risk (unplanned events) (derived from NOPSEMA, 2021)

Consequence ranking	Minor	Moderate	Serious	Major	Critical	Catastrophic
Planned operation	Broadly acceptable	Tolerable if ALARP		Intolerable		
Residual impact category	Lower order impacts		Higher order impacts			
Risk ranking	Low	Medium	High	Severe	Extreme	
Unplanned event	Broadly acceptable	Tolerable if ALARP		Intolerable		
Residual risk category	Lower order risks			Higher order risks		

5.7.2 Uncertainty of impacts and risks

In addition to the evaluation of residual impacts and risks as described above, the relative level of uncertainty associated with the impact or risk is also used to inform whether the application of industry good practice is sufficient to manage impacts and risks to ALARP, or if the evaluation of further controls is required.

Beach have adapted the approach developed by Oil and Gas UK (OGUK) (OGUK, 2014) for use in an environmental context to determine the assessment technique required to demonstrate that potential impacts and risks are ALARP (Figure 5-2). Specifically, the framework considers impact severity and several guiding factors:

- Activity type;
- Risk and uncertainty; and
- Stakeholder influence.

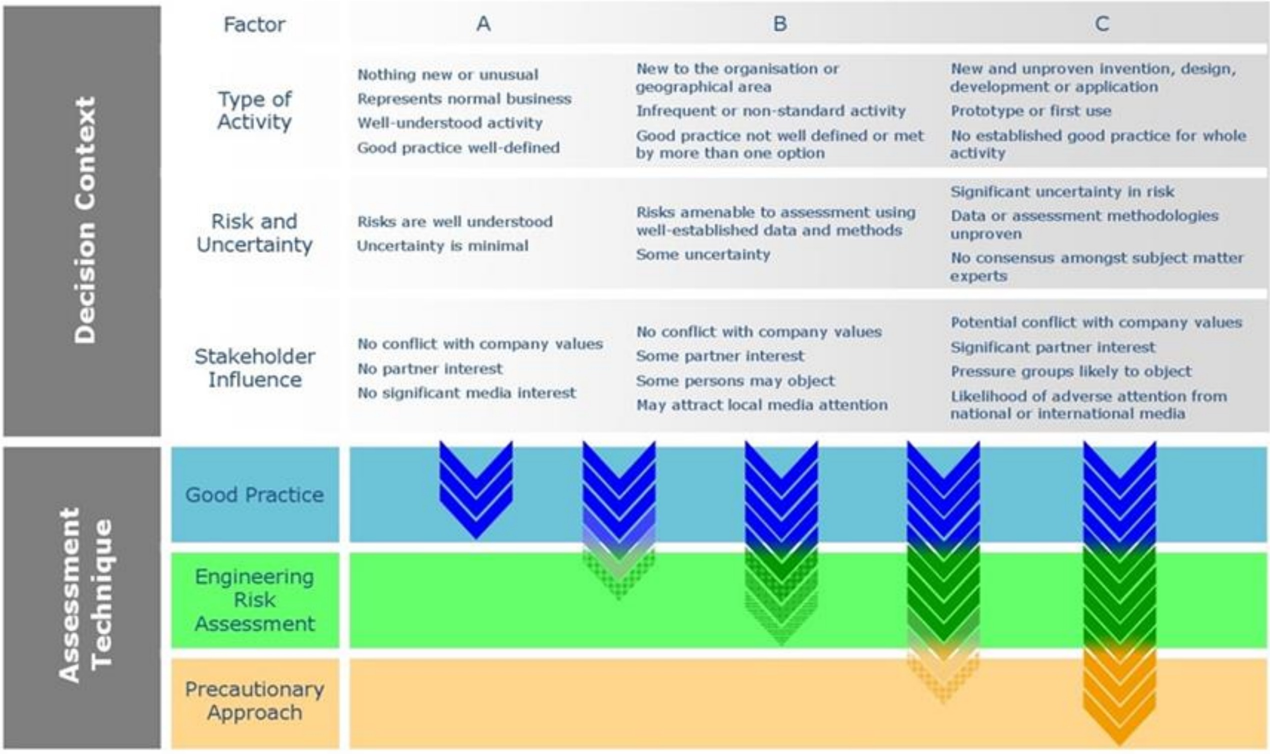


Figure 5-2: OGUK (2014) decision support framework

A **Type A** decision is made if the risk is relatively well understood, the potential impacts are low, activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. However, if good practice is not sufficiently well-defined, additional assessment may be required.

A **Type B** decision is made if there is greater uncertainty or complexity around the activity and/or risk, the potential impact is moderate, and there are no conflict with company values, although there may be some partner interest, some persons may object, and it may attract local media attention. In this instance, established good practice is not considered sufficient and further assessment is required to support the decision and ensure the risk is ALARP.

A **Type C** decision typically involves sufficient complexity, high potential impact, uncertainty, or stakeholder influence to require a precautionary approach. In this case, relevant good practice still must be met, additional assessment is required, and the precautionary approach applied for those controls that only have a marginal cost benefit.

In accordance with the regulatory requirement to demonstrate that environmental impacts and risks are ALARP, Beach has considered the above decision context in determining the level of assessment required.

The levels of assessment techniques considered include:

- Good practice;
- Engineering risk assessment; and
- Precautionary approach.

5.7.2.1 Good practice

OGUK (2014) defines 'good practice' as the recognised risk management practices and measures that are used by competent organisations to manage well-understood impacts and risks arising from their activities.

'Good practice' can also be used as the generic term for those measures that are recognised as satisfying the law. For this EP, sources of good practice include:

- Requirements from Australian legislation and regulations;
- Relevant Australian policies;
- Relevant Australian Government guidance;
- Relevant industry standards and/or guidance material; and
- Relevant international conventions.

If the ALARP technique is determined to be 'good practice', further assessment ('engineering risk assessment') is not required to identify additional controls. However, additional controls that provide a suitable environmental benefit for an insignificant cost are also identified at this point.

5.7.2.2 Engineering risk assessment

All potential impacts and risks that require further assessment are subject to an 'engineering risk assessment'. Based on the various approaches recommended in OGUK (2014), Beach believes the methodology most suited to this activity is a comparative assessment of risks, costs, and environmental benefit. A cost–benefit analysis should show the balance between the risk benefit (or environmental benefit) and the cost of implementing the identified measure, with differentiation required such that the benefit of the control can be seen and the reason for the benefit understood.

5.7.2.3 Precautionary approach

OGUK (2014) states that if the assessment, considering all available engineering and scientific evidence, is insufficient, inconclusive, or uncertain, then a precautionary approach to impact and risk management is needed. A precautionary approach will mean that uncertain analysis is replaced by conservative assumptions that will result in control measures being more likely to be implemented.

That is, environmental considerations are expected to take precedence over economic considerations, meaning that a control measure that may reduce environmental impact is more likely to be implemented. In this decision context, the decision could have significant economic consequences to an organisation.

5.8 Demonstration of acceptability

Regulation 13(5)(c) of the OPGGS(E)R requires demonstration that environmental impacts and risks are of an acceptable level.

Beach considers a range of factors when evaluating the acceptability of environmental impacts and risks associated with its activities. This evaluation works at several levels, as outlined in Section 5.8.1 which is based on Beach's interpretation of the NOPSEMA EP content requirements (NOPSEMA, 2019).

5.8.1 Acceptability Criteria

Beach has defined a set of criteria to determine acceptability of an impact or risk, following risk mitigation. Where an impact or risk is not considered acceptable, further control measures are required to lower the risk, or alternative options will be considered. The Beach acceptability criteria considers:

- Principles of Ecological Sustainable Development (ESD);
- Internal Context;
- External Context; and
- Other requirements.

These criteria are described in the following sections and are consistent with NOPSEMA EP content requirements (NOPSEMA, 2019).

5.8.1.1 Principles of Ecologically Sustainable Development

Section 3A of the EPBC Act defines ESD, which is based on Australia's National Strategy for Ecological Sustainable Development (1992) that defines ESD as:

> *'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased.'*

Relevant ESD principles and how they are applied by Beach:

- Decision making processes should effectively integrate both long term and short term economic, environmental, social and equitable considerations. This principle is inherently met through the EP development process, as such this principal is not considered separately for each acceptability evaluation.
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. If there is, the project shall assess whether there is significant uncertainty in the evaluation, and if so, whether the precautionary approach should be applied.
- The principle of inter-generational equity — that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. The EP risk assessment methodology ensures that potential impacts and risks are ALARP, where the potential impacts and risks are determined to be serious or irreversible the precautionary principle is implemented to ensure the environment is maintained for the benefit of future generations. Consequently, this principal is not considered separately for each acceptability evaluation.
- The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making. Beach considers if there is the potential to affect biological diversity and ecological integrity through the risk assessment process.

To meet this acceptance criteria, the activity must be carried out in a manner consistent with the relevant ESD principles above.

5.8.1.2 Internal Context

Beach's OEMS includes Elements and Standards relevant to the way Beach operates.

At the core of the OEMS are 11 Elements (see Section 7.1) which detail specific performance requirements for the implementation of Beach's Environmental Policy and management of potential HSE impacts and risks

Elements and Standards in the OEMS which are relevant to either the activity, impact, control or receptor will be described within the internal context and contribute towards the assessment of acceptability.

To meet this acceptance criteria, the impact or risk must be compliant with the objectives of Beach's Environment Policy. Where specific internal procedures, guidelines, expectations are in place for management of the impact or risk in question, acceptability is demonstrated.

5.8.1.3 External Context

External context considers stakeholder expectations, obtained from stakeholder consultation.

Beach has undertaken stakeholder consultation, which is described in detail in Section 8. Where objections or claims have been raised, these are considered in the assessment of acceptability of related impacts and risks.

To meet this acceptance criteria, the merits of claims or objections raised by a relevant stakeholder must have been adequately assessed and additional controls adopted where appropriate.

5.8.1.4 Other Requirements

Aside from internal and external context, other requirements must be considered in the assessment of acceptability. These include:

- Environmental legislation (described in Section 2);
- Policies and guidelines (described in Section 2);
- International agreements (described in Section 2);
- EPBC Management Plans (described in Section 2.1); and
- Australian Marine Park designations (described in Section 4.4.2).

This acceptance criteria is met when: compliance with specific laws or standards is demonstrated; management of the impact or risk is consistent with relevant industry practices; and the proposed impact or risk controls, environmental performance objectives and standards are consistent with the nature of the receiving environment based upon formal management plans.

5.9 Monitoring and review

Monitoring and review activities are incorporated into the impact and risk management process to ensure that controls are effective and efficient in both design and operation. This is achieved through the environmental performance outcomes, environmental performance standards and measurement criteria that are described for each environmental impact or risk. Monitoring and review are described in detail in the Implementation Strategy (Section 7).

6 Environmental Impact and Risk Assessment

6.1 Overview

In alignment with Regulation 13 (5) of the OPGGS(E)R this section of the EP details the potential environmental impacts and risks associated with the activity and provides an evaluation of all the impacts and risks appropriate to the nature and scale of each impact or risk. This evaluation includes impacts and risks arising directly or indirectly from the activity and includes potential oil pollution emergencies and the implementation of oil spill response strategies and oil spill monitoring.

In addition, this section details the control measures (systems, procedures, personnel or equipment) that will be used to reduce potential impacts and risks to ALARP and acceptable levels. Environmental performance outcomes (EPOs), environmental performance standards (EPSs) and measurement criteria associated with each of the identified control measures are provided in Section 6.16.

For oil spill response options aspects associated with the use of vessels are as per vessel operations in Table 6-1. Other related impacts and risks are described in Sections 6.15.

Table 6-1: Activity – Aspect Relationship

ACTIVITIES	ASPECT	Light emissions	Atmospheric emissions	Underwater sound emissions	Physical presence	Benthic disturbance	Planned marine discharges- Vessels	Planned marine discharges – pre-commissioning	Establishment of IMS	Disturbance to marine fauna	Unplanned Marine Discharge (Solids)	Loss of Containment
Installation of new subsea infrastructure												
Lowering of infrastructure into position				X		X						
T-DIS installation						X						
Rigid spool installation				X		X						
Pre-commissioning philosophy								X				
Support Operations												
Vessel operations		X	X	X	X		X		X	X	X	X

6.2 Light emissions

6.2.1 Hazards

During Otway Phase 5 Early Dive Installation Campaign, vessel-based activities will be undertaken 24 hours a day. Therefore, lighting is required at night for navigation and to ensure safe operations when working on the CSV.

Light emissions from the CSV will result in a change in ambient light.

6.2.2 Predicted environmental impacts

The predicted environmental impacts from light emissions are:

- Changes in ambient light leading to changes in fauna behaviour, through attraction of light-sensitive species.

6.2.3 EMBA

The EMBA for light emissions is based on the National Light Pollution Guidelines for Wildlife (the Guidelines) (Commonwealth of Australia 2020). The guidelines recommend undertaking a light impact assessment where important habitat for list species sensitive to light are located within 20 km of the light source. The 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15-18 km and fledgling seabirds grounded in response to artificial light 15 km away (Commonwealth of Australia 2020). Seabird grounding, as described in Rodriguez et al (2014), relates to impacts of onshore fixed light sources such as streetlights and buildings and the effect this can have on young fledgling birds making their first flight from their nests to the open ocean. Subsequently, the 20 km light EMBA adopted here is considered to be highly conservative.

The guidelines identify marine turtles, seabirds and migratory shorebirds as potentially being impacted by artificial light to a level significant enough to require assessment. Other species such as fish are discussed in the guidelines but have not been identified in the guidelines as requiring assessment and thus this is taken as impacts to them are not likely to be of a level that requires further assessment.

The guidelines detail that important habitats are those areas necessary for an ecologically significant proportion of a listed species to undertake important activities such as foraging, breeding, roosting or dispersal. For this assessment a distance of 20 km from the operational area was used to identify any areas where turtles, shorebirds and seabirds may be foraging, breeding, roosting or migrating. This area (20 km around the operational area) is called the light EMBA. The EPBC Protected Matters Report for the light EMBA is in Appendix A.3.

Table 6-2 details the shorebirds and seabirds that may be foraging, breeding, roosting or migrating within the light EMBA. These were identified from the light EMBA PMST Report (Appendix A) and BIAs from the National Conservation Values Atlas. No roosting or breeding behaviours have been identified within the light EMBA.

Table 6-2: Light sensitive receptors within the light EMBA

Receptor	Biologically Important Behaviour
Albatross	
Antipodean albatross	Foraging, feeding or related behaviour likely to occur within area
	Foraging BIA
Black-browed albatross	Foraging, feeding or related behaviour likely to occur within area
	Foraging BIA

Receptor	Biologically Important Behaviour
Buller's albatross	Foraging, feeding or related behaviour likely to occur within area
	Foraging BIA
Campbell albatross	Foraging, feeding or related behaviour likely to occur within area
	Foraging BIA
Indian yellow-nosed albatross	Foraging BIA
Northern Buller's albatross	Foraging, feeding or related behaviour likely to occur within area
Northern royal albatross	Foraging, feeding or related behaviour likely to occur within area
Salvin's albatross	Foraging, feeding or related behaviour likely to occur within area
Shy albatross	Foraging, feeding or related behaviour likely to occur within area
	Foraging BIA
Southern royal albatross	Foraging, feeding or related behaviour likely to occur within area
Wandering albatross	Foraging, feeding or related behaviour likely to occur within area
	Foraging BIA
White-capped albatross	Foraging, feeding or related behaviour likely to occur within area
Other	
Common diving-petrel	Foraging BIA
Short-tailed shearwater	Foraging BIA
Wedge-tailed shearwater	Foraging BIA

Artificial light can disrupt turtle nesting and hatching behaviours. Artificial light is listed as a key threat in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). Three listed turtle species may occur within the light EMBA, however, no biologically important behaviours, BIAs or habitat critical to survival for marine turtles were identified. Therefore, impacts to turtles from light emissions is not predicted.

Therefore, the light-sensitive receptors that may occur within the light EMBA are:

- Seabirds and migratory shorebirds.

6.2.4 Consequence evaluation

For the light impact assessment, the process outlined in the guidelines is used. The aim of the guidelines is that artificial light will be managed so wildlife is:

1. Not disrupted within, nor displaced from, important habitat; and
2. Able to undertake critical behaviours such as foraging, reproduction and dispersal.

Identification of light-sensitive receptors was undertaken through definition of a 20 km light EMBA. No seabird and migratory shorebird coastal habitats for nesting or roosting are within the 20 km light EMBA.

The light EMBA PMST Report (Appendix A) identified likely foraging behaviour for a number of albatrosses in the light EMBA. Some of these species have foraging BIAs that the light EMBA overlaps (Table 6-2). These BIAs are shown in Figure 4-25 to Figure 4-27. Light emissions are not identified as a threat in National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). Albatrosses forage most actively during daylight and are less active at night because their ability to see and capture prey from the air is reduced (Phalan et al. 2007). Thus, impacts within the small area of overlap with albatross foraging BIAs are not predicted based on these species forage most actively during daylight.

The common diving-petrel was not identified in the light EMBA PMST Report (Appendix A). This species is listed as marine and does not have a recovery plan or conservation advice. The light EMBA overlaps a foraging BIA within the SEMR (Figure 4-26). Brooke (2004) cited on Animal Diversity Web (2020) details that common diving petrels spend the night in burrows during the breeding season and seem to forage mainly during the day, although they also forage at night on vertically migrating plankton. They are thought to be fairly sedentary, remaining more or less in the area of their breeding colony year-round, although they may venture into the open ocean to forage outside of the breeding season and some studies suggest seasonal movements (Brooke, 2004 cited on Animal Diversity Web, 2020). Based on this information, common diving-petrels may forage at night within the light EMBA.

The short-tailed shearwater was identified in the light EMBA PMST Report as foraging likely within the light EMBA. The light EMBA overlaps a foraging BIA within the SEMR (Figure 4-27). This species is listed as marine and migratory and does not have a recovery plan or conservation advice. No BIAs or habitat critical for the survival of the species occur within the light EMBA. Impacts to this species from light emissions are not predicted as the short-tailed shearwater returns to the colonies at dark after feeding at sea during the day (AAD, 2020).

The wedge-tailed shearwater was not identified in the light EMBA PMST Report (Appendix A). The light EMBA overlaps a foraging BIA within the SEMR. The foraging BIA directly intersected by the light EMBA is a buffer around Muttonbird Island, Victoria (Figure 4-27). This species is listed as marine and migratory and does not have a recovery plan or conservation advice. Light has not been identified as a threat to this species (DoEE, 2020d). A review of the DoEE Species Profile and Threats Database (SPRAT), Atlas of Living Australia and South-east Marine Region Profile did not provide any information on the Victorian Muttonbird Island wedge-tailed shearwater colony. The DoEE SPRAT profile does not show any locations for the wedge-tailed shearwater in Victoria and Beaver (2018) details Montague Island in NSW was the southernmost known colony, however, in 2017 breeding individuals of wedge-tail shearwaters were discovered a couple of hundred kilometres further south on Gabo Island Lighthouse Reserve, Victoria near the NSW border. However, impacts to this species from light emissions are not predicted as Warham, (1996) cited in Beaver (2018) details that the wedge-tailed shearwater forms large aggregations referred to as "rafts" just offshore from their breeding colony just on dusk and enter and leave the colony at night to avoid predators.

The extent of the area of potential impact is predicted to be up to 20 km from the operational area with a maximum duration of 21 days.

The severity (with no controls) is assessed as minor based on:

- Light will be generated by a single vessel during they activity which may take up to 21 days.
- Of the seabirds that may potentially forage within the light EMBA only the common diving-petrel was identified as foraging at night.
- There are no roosting or breeding behaviours, or BIAs identified within the light EMBA.

6.2.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Light emissions	
ALARP decision context and justification	**ALARP Decision Context: Type A** Impacts from light emissions are relatively well understood though there is the potential for uncertainty in relation to the level of impact. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. Additional controls may be required to ensure impacts can be managed to an acceptable level.
Adopted Control Measures	**Source of good practice control measures**
CM#2: MO 30: Prevention of collisions	AMSA MO 30: Prevention of collisions requires that onboard navigation, radar equipment, and lighting meets the International Rules for Preventing Collisions at Sea (COLREGs) and industry standards.
CM#1: Light Management Procedure	The National Light Pollution Guidelines provide management options for mitigating the effect of light to seabirds. A review of the management options relevant to the activity is provided in the additional controls section with the following to be adopted: CSV will have and implement a Light Management Procedure as per the National Light Pollution Guidelines (Commonwealth of Australia, 2020). Once safety navigational lighting requirements are met (as per vessel class), the Light Management Procedure will detail additional mitigations to manage light based on the information in the Seabird Light Mitigation Toolbox and at a minimum will implement: • Screens, blinds or window tinting on windows to contain light inside the CSV. • Outdoor/deck lights when not necessary for human safety or navigation will be turned off. • Lights will be directed onto work areas. • Program for handling grounded birds. • Reporting requirements.

Additional controls assessed		
Control	**Cost/Benefit Analysis**	**Control Implemented?**
Seasonal timing	The following seasonal timings were identified for the species that may be active at night within the light EMBA: • Common diving petrel: year round (NCVA, 2021). Controls have been identified to ensure lighting is reduced to that for safe operations. As common diving petrel may be present all year round, no benefit is gained from adjusting the activity timing with the seasons. Other species are present all year round or do not forage at night thus restricting the period when activities will occur does not afford any benefit to these species.	No
Implement management actions during the breeding season. Light management should be implemented during the	The light EMBA is >70 km from islands or a coast where nesting and fledglings may be located. As no impact to nesting or fledglings is predicted the control does not have an environmental benefit.	No

nesting and fledgling periods.		
Maintain a dark zone between the rookery and the light sources	The light EMBA is > 70 km from islands or a coast where rookeries may occur, therefore a dark zone between the and potential rookeries and the light sources will be maintained.	Yes
Turn off lights during fledgling season.	The light EMBA is >70 km from islands or a coast where rookeries may be located. As no impact to fledglings is predicted the control does not have an environmental benefit.	No
Use curfews to manage lighting such as extinguish lights around the rookery during the fledgling period by 7 pm as fledglings leave their nest early in the evening.		
Aim lights downwards and direct them away from nesting areas.	The light EMBA is >70 km from islands or a coast where nesting may occur. As no impact to nesting areas is predicted the control does not have an environmental benefit.	No
CM#1: Light Management Procedure Prevent indoor lighting reaching outdoor environment.	Use of fixed window screens, blinds or window tinting on windows to contain light inside buildings has the environmental benefit of reducing light emissions from the activity.	Yes
CM#1: Light Management Procedure Reduce unnecessary outdoor, deck lighting on the CSV and permanent and floating oil and gas installations in known seabird foraging areas at sea.	Extinguishing outdoor/deck lights when not necessary for human safety and restrict lighting at night to navigation lights has the environmental benefit of reducing light emissions from activity.	Yes
CM#1: Light Management Procedure CSV working in seabird foraging areas during breeding season should implement a seabird management plan to prevent seabird landings on the ship, manage birds appropriately and report the interaction.	As the activities will take place when birds may be foraging within the Light EMBA, a vessel Light Management Procedure will be developed and implemented as per the National Light Pollution Guidelines (Commonwealth of Australia, 2020) which will detail mitigations to manage light based on the information in the Seabird Light Mitigation Toolbox.	Yes
CM#1: Light Management Procedure Use flashing/intermittent lights instead of fixed beam. Use motion sensors to turn lights on only when needed.	Mitigations to manage light, including appropriate use and types of lights, will be reviewed as part of the Light Management Procedure (detailed above). Where the Light Management Procedure identifies changes to vessel lighting that has a cost/benefit these mitigations will be implemented.	Yes – where appropriate

Avoid lights containing short wavelength violet/blue light. Avoid white LEDs. Avoid high intensity light of any colour.		
CM#1: Light Management Procedure Design and implement a rescue program for grounded birds.	A rescue program will not prevent birds grounding, but as it has proven useful to reducing mortality of seabirds it has an environmental benefit. The program will be developed as part of the Light Management Plan (CM#1) and will include advice detailed in the International Association Antarctic Tour Operators Seabirds Landing on Ships documents and cover: • Handling of birds. • Releasing of birds • Reporting to DAWE in the case of protected species.	Yes – where appropriate

Consequence rating	Minor (1) with no controls, remaining Minor (1) with identified controls implemented.
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Light emissions were assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding light emissions.
Other requirements	Light emissions will be managed in accordance with the National Light Pollution Guidelines (Commonwealth of Australia, 2020). Light emissions are not identified as a threat in National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). There are no recovery plans, conservation advice or listing advice for the common diving-petrel, short-tailed shearwater or wedge-tailed shearwater.
Monitoring and reporting	Impacts associated with light emissions are for a short duration (21 days), over small area and not predicted to have long term impacts to fauna in the area. Therefore, the monitoring of light emissions is not proposed.
Acceptability outcome	**Acceptable**

6.3 Atmospheric emissions

6.3.1 Hazards

Atmospheric emissions are generated from combustion engines used on vessels. The CSV will be powered by diesel (marine diesel oil (MDO)).

6.3.2 Predicted environmental impacts

The predicted environmental impacts from atmospheric emissions are:

- Atmospheric emissions leading to a change in air quality and an increase in greenhouse gas emission.

6.3.3 EMBA

Predicted impacts from atmospheric emissions will be limited to the operational area. Receptors which may be affected by atmospheric emissions within the operational area include:

- Air quality
- Seabirds
- Coastal settlements

6.3.4 Consequence evaluation

The combustion of MDO can create continuous or discontinuous plumes of particulate matter (soot or black smoke) and the emission of non-GHG, such as sulphur oxides (SOX) and nitrous oxides (NOX). Inhaling this particulate matter can cause or exacerbate health impacts to humans exposed to the particulate matter, such as offshore project personnel or residents of nearby towns (e.g., respiratory illnesses such as asthma) depending on the amount of particles inhaled. Similarly, the inhalation of particulate matter may affect the respiratory systems of fauna.

As the operational area is away from coastal settlements and given the limited extent of reduced air quality, adverse impact on local or regional biodiversity, ecological integrity, social amenity or human health is not predicted.

The operational area overlaps foraging BIAs for several albatrosses, the wedge-tailed shearwater, common diving-petrel and short-tailed shearwater. No habitat critical to the survival of birds occur within the operational area. As it is unlikely that seabirds would remain close to the emission source for an extended period impacts are not predicted.

Diesel combustion will result in gaseous emissions of GHG such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). While these emissions add to the atmospheric GHG load, which adds to global warming potential, they are very small on a global scale, representing an insignificant contribution to overall GHG emissions. These emissions are not considered to have a determinable local-scale impact and therefore impacts are considered to be low.

The extent of the area of potential impact is predicted to be close to the emission source for the duration of the emission (21 days) with a consequence level of minor based on:

- The low level of emissions.

- The open ocean environment and prevailing winds of the Otway Basin atmospheric emissions will rapidly disperse to background levels close to the emission source.
- Impacts to seabirds and coastal communities are not predicted.

6.3.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Atmospheric emissions	
ALARP decision context and justification	**ALARP Decision Context: Type A** Impacts from atmospheric emissions are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to air emissions. As the impact consequence is rated as Minor (1) applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#3: MO 97: Marine Pollution Prevention – Air Pollution	The CSV will comply with Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution (appropriate to vessel class) for emissions from combustion of fuel including: • Hold a valid International Air Pollution Prevention (IAPP) certificate and a current international energy efficiency certificate. • Have a Ship Energy Efficiency Management Plan (SEEMP) as per MARPOL 73/78 Annex VI. • Engine NOx emission levels will comply with Regulation 13 of MARPOL 73/78 Annex VI. • Sulphur content of diesel/fuel oil complies with Marine Order Part 97 and Regulation 14 of MARPOL 73/78 Annex VI.
CM#4: Preventative Maintenance System	Combustion equipment shall be maintained in accordance with the preventative maintenance system (or equivalent) to ensure efficient operation.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Air emissions were assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding air emissions.

Other requirements	Air emissions are not identified as a threat in National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). Air emissions will be managed in accordance with the applicable legislative requirements.
Monitoring and reporting	Impacts associated with air emissions are over a small area and not predicted to have long term impacts to receptors in the area.
Acceptability outcome	Acceptable

6.4 Underwater Sound Emissions

6.4.1 Hazards

Underwater sound emissions will be generated by:

- Subsea positioning equipment (USBL) used during positioning of new infrastructure on the seabed;
- Cutting tools (if required) to prepare the production J-tube for connection to the new production spool; and
- Vessel operations of the CSV and HRV.

Subsea positioning equipment (USBL) will be used during installation. This equipment consists of a number of transducers and receivers positioned on the infrastructure and installation vessel hull near the sea surface.

Cutting tools, such as diamond wire cutter or disk cutter, may be used during installation.

Vessels generate continuous sound from propeller cavitation, thrusters, hydrodynamic flow around the hull, and operation of machinery and equipment.

6.4.2 Predicted environmental impacts

Underwater sound emissions will be continuous (vessel operations) and impulsive (subsea positioning equipment i.e. USBL). In all cases the sound source will be on the sea surface.

Potential impacts of underwater noise emissions from the Otway Phase 5 Early Dive Installation Campaign are:

- Behavioural changes; and
- Auditory impairment, permanent threshold shift (PTS) and temporary threshold shift (TTS).

6.4.3 EMBA

The noise EMBA is the area where noise levels are predicted to be above the noise behaviour criteria. Sound modelling undertaken to determine the EMBA is described below; in summary the largest spatial extent of impacts is predicted to be:

- Behavioural effect: 6.5 km.
- TTS: 1.5 km.

Specific impact thresholds for each species and / or hearing group are described in the section below.

The EPBC Protected Matters Report for the noise EMBAs are in Appendix A.5.

Underwater sound emissions may impact biological receptors within the noise EMBAs such as:

- Fish (with and without swim bladders) including commercial species such as sharks and scalefish;
- Marine reptiles; and
- Marine mammals.

6.4.4 Consequence evaluation

Vessel Operations

Underwater sound emissions will be generated by vessel dynamic position (DP), and to a lesser extent machinery, pumps and generators on the CSV (Erbe et al., 2013). Throughout the activity, the HRV will be on standby outside of the operational area and will be moving slowly.

Subsea Positioning Equipment

Subsea positioning systems will typically emit short pulses of medium to high frequency sound, normally within the range of 15 to 40 kHz. Typical operating energy output is between 166 and 196 dB re 1 µPa 1 m peak level, depending on the environmental conditions (Bai and Bai 2010).

Austin et al. (2012) calculated the distances to SPL isopleths for a comparable USBL system in open water and found the distance to 160 dB re 1 µPa (SPL) to be 36 m. Positioning equipment will be retrieved as soon as possible from the seabed, limiting the potential exposure. As continuous sound from vessel activities and combined activities presents the worst-case impact distances, the assessment is based on continuous sound exposure.

Cutting Tools

Pangerc et al. (2016) described the underwater sound measurement data during an underwater diamond wire cutting of a 32” conductor (10 m above seabed in ~80 m depth) and found that at lower frequencies, the operation was generally indistinguishable above the background noise; however, the sound that could be associated with the diamond wire cutting was primarily detectable above the background noise at the higher acoustic frequencies (above around 5 kHz). The background noise levels were substantially higher at lower frequencies; therefore, it is likely that the spectra of the noise peaks at lower frequencies, which has been approximated between 2.5 and 20 kHz.

6.4.4.1 Underwater sound level modelling – Continuous sound emissions

JASCO Applied Sciences (JASCO) performed a modelling study of underwater sound levels associated with the Beach Energy Otway Development (Koessler and McPherson 2021 Appendix F), to supplement drilling and construction results previously presented in Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021). The results from these previous modelling studies have been revised due to a better understanding of the propagation loss in the region gained through the validation monitoring of drilling operations at Artisan-1 (McPherson et al. 2021). Modelled scenarios considered all upcoming activities undertaken by Beach, including those covered by this EP, and therefore the modelling is directly applicable to this assessment.

The underwater sound level modelling considered several locations; Artisan and Thylacine, as representative of all locations within the Otway operations. For the purposes of this EP, results from scenarios modelled at the Thylacine location will be used.

The modelling study assessed distances from activities where underwater sound levels reached exposure criteria corresponding to various levels of potential impact to marine fauna. The marine fauna considered was based on a review of receptors that may be impacted by continuous sound, these were marine mammals, turtles, and fish. The exposure criteria selected for the modelling and the impact assessment were selected as they have been accepted by regulatory agencies and because they represent current best available science (Koessler et al. 2020, Matthews et al. 2020).

Table 6-3 summarised the modelling scenarios applicable to Phase 5 Early Dive Campaign activities. As the sound pressure level (SPL) metric does not depend on the duration of the operation, these estimates are valid for both stationary (CSV) and moving (HBV) vessel activities. Note the modelling study by Koessler and McPherson (2021) (Appendix F) details results for other scenarios such as drilling that are not relevant to this EP.

Table 6-3 Modelled underwater sound scenarios

#	***Activity***	***Modelled Scenario***
7	CSV installation	Vessel stationary, operating at 20% MCR. Located at Thylacine North-1 well location (close to the operational area).
21	Combined drilling, platform and installation activities	Drilling at Thylacine North-1, Thylacine Wellhead platform and installation activities within the Early Dive Campaign operational area.
31	Combined vessel operations and ROV cutting tool	Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (June)*

* ROV cutting tool modelled at the Geographe-4 location presents a worst-case distance compared to ROV cutting tool modelled at the Thylacine-A wellhead platform location and is therefore a conservative representative of the potential sound impacts during this activity.

6.4.4.2 Marine Mammals

Exposure Criteria - PTS and TTS

The US National Marine Fisheries Service (NMFS 2018) reviewed available literature to determine exposure criterion for the onset of temporary hearing TTS and PTS for marine mammals based on their frequency hearing range. NMFS (2018) details that after sound exposure ceases or between successive sound exposures, the potential for recovery from hearing loss exists, with PTS resulting in incomplete recovery and TTS resulting in complete recovery.

The NFMS (2018) exposure criteria are based on a cumulative SELs over a period of 24 h. Table 6-4 details the criteria and furthest modelled distances to them for each scenario.

The PTS and TTS 24 h criteria are only relevant to those receptors that are likely to be present in the area of ensonification for a period of 24 h. For this assessment the PTS and TTS 24 h criteria was applied to marine mammals that may be undertaking biologically important behaviours, such as calving, foraging, resting or migration (as defined by Commonwealth of Australia, 2015c), that could result in them being within the ensonification area above the PTS and TTS criteria for a period of 24 h or greater.

Exposure Criteria - Behaviour

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. The current interim NFMS (NOAA 2019) criterion of 120 dB re 1 µPa for non-impulsive sound sources such as vessels is used as the marine mammal behavioural criteria for this assessment as it represents a conservative criterion as Southall et al. (2007) reviewed extensive literature and studies in relation to marine mammal behavioural response to impulsive (seismic, pile driving) and non-impulsive (drilling, vessels) and found that most marine mammals exhibited varying responses between 140 and 180 dB re 1 µPa.

Table 6-4 details the furthest modelled distance to the NOAA (2019) exposure criteria for each scenario.

Table 6-4: Cetacean PTS, TTS and behaviour sound criteria and predicted furthest distances and areas

Hearing group	***SEL24h threshold (LE,24h; dB re 1 µPa²·s)***	***CSV installation***		***Combined drilling, platform and installation activities***		***Combined vessel operations and ROV cutting tool***	
		Rmax (km)	***Area (km²)***	***Rmax (km)***	***Area (km²)***	***Rmax (km)***	***Area (km²)***
PTS							
LF cetaceans	199	0.06	0.01	0.06	0.01	0.10	0.03
MF cetaceans	198	0.02	0.001	0.04	0.001	0.02	0.001
HF cetaceans	173	0.09	0.03	0.26	0.16	0.16	0.08
Phocid seals	201	0.02	0.001	0.04	0.001	0.02	0.002
Otariid seals	219	–	–	–	–	-	-
TTS							
LF cetaceans	179	0.60	1.04	0.65	1.10	0.95	2.39
MF cetaceans	178	0.07	0.02	0.16	0.06	0.13	0.05
HF cetaceans	153	0.84	2.02	1.15	3.26	1.17	3.55
Phocid seals	181	0.19	0.12	0.18	0.09	0.27	0.22
Otariid seals	199	0.02	0.001	0.04	0.001	0.03	0.003
Behaviour							
Marine mammals	120	2.71		4.85		3.29	

Note: a dash indicates the level was not reached within the limits of the modelling resolution (20 m).

Phocid seals

For Phocid seals the furthest distance to the PTS criteria is reached at 40 m and the furthest distance to the TTS criteria is 270 m during combined vessel operations and ROV cutting tool activities. From the PMST Reports Phocid seals were not identified within the operational area (1 km around the T-DIS location) and thus PTS and TTS are not assessed further.

The distances to the behavioural threshold ranged from 2.71 – 4.85 km. No Phocid seals where identified within the Sound Behaviour EMBA (5 km) PMST report (Appendix A.5) thus behaviour impacts are not assessed further.

Otariid seals

For Otariid seal the PTS criteria is not reached and the furthest distance to the TTS criteria is 40 m during combined drilling, platform and installation activities. The Australian and New Zealand fur seal may occur within the operational area (1 km) but no biologically important behaviours or biologically important areas where identified within the operational area thus PTS and TTS are not assessed further.

The distances to the behavioural threshold ranged from 2.71 – 4.85 km. The PMST Report (Appendix A.5 Sound Behaviour EMBA 5 km) identified that the Australian and New Zealand fur seal may occur within the Sound Behaviour EMBA (5 km). Impacts are predicted to be temporary avoidance. The consequence is assessed as Minor (1) as there are no biologically important behaviours, biologically important areas, aggregation areas or haul-out area identified within the predicted ensonified area.

High-frequency cetaceans

The furthest distance to the high-frequency cetacean PTS criteria is 260 m and the TTS criteria is 1.17 km. The PMST Report (Appendix A.4 Sound 24 hr TTS EMBA 1.5 km) identified that high-frequency cetaceans such as pygmy and dwarf sperm whales may occur within the Sound 24 hr TTS EMBA (1.5 km), however, no biologically important areas or behaviours were identified within the area of ensonification and therefore they are not assessed further.

The distances to the behavioural threshold ranged from 2.71 – 4.85 km. The PMST Report (Appendix A.5 Sound Behaviour EMBA 5 km) identified that that high-frequency cetaceans such as pygmy and dwarf sperm whales may occur within the Sound Behaviour EMBA (5 km). Impacts are predicted to be temporary avoidance. The consequence is assessed as Minor (1) as there are no biologically important behaviours or biologically important areas identified within the predicted ensonified area.

Mid-frequency cetaceans

The furthest distance to the mid-frequency cetacean PTS criteria is 40 m and the TTS criteria is 160 m. The PMST Report (Appendix A.4 Sound TTS 24 hr EMBA 1.5 km) identified several dolphin species, beaked and toothed whales, however, no biologically important areas or behaviours were identified within the area of ensonification and therefore they are not assessed further.

The distances to the behavioural threshold ranged from 2.71 – 4.85 km. The PMST Report (Appendix A.5 Sound Behaviour EMBA 5 km) identified several dolphin species, beaked and toothed whales that may occur within the Sound Behaviour EMBA (5 km). Impacts are predicted to be temporary. The consequence is assessed as Minor (1) as there are no biologically important behaviours or biologically important areas identified within the predicted ensonified area.

Low-frequency cetaceans

The furthest distance to the low-frequency cetacean PTS criteria is 100 m and the TTS criteria is 950 km. Table 6-5 details the low-frequency cetaceans that have biologically important areas and/or biologically important behaviours within the Sound TTS 24 hr EMBA (1.5 km) as identified from the Sound TTS 24 hr EMBA PMST Report (Appendix A.4) and Table 4-9.

The distances to the behavioural threshold ranged from 2.71 – 4.85 km. Table 6-5 details the low-frequency cetaceans that have biologically important areas or biologically important behaviour within the Sound Behaviour EMBA (5 km) as identified from the Sound Behaviour EMBA (5 km) PMST Report (Appendix A.5) and Table 4-9.

Table 6-5: Low-frequency cetaceans with biologically important behaviours within the PTS and TTS ensonification area

Species	***Biologically Important Behaviour***
Blue whale	Foraging, feeding or related behaviour known to occur within area.
	High density foraging BIA
Fin whale	Foraging, feeding or related behaviour likely to occur within area.
	No BIAs
Pygmy right whale	Foraging, feeding or related behaviour may to occur within area.
	No BIAs
Sei whale	Foraging, feeding or related behaviour likely to occur within area.
	No BIAs
Southern right whale	Cow and calf pairs may move through the current core coastal range.
	Known core coastal range BIA

Blue whales

Foraging behaviour for blue whales has been identified in the area where the PTS, TTS and behavioural criteria is reached. As detailed in Section 4.6.7.6 cetacean foraging within the Otway shelf, and hence the area where the PTS, TTS and behavioural criteria is reached, is typically from January to April though whales maybe present from November to June which overlaps the period when Phase 5 Early Dive Installation Campaign activities will occur (activities could occur year round).

The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) details that anthropogenic noise in BIAs will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area.

The severity is assessed as moderate and is of an acceptable level based on:

- A conservative approach has been taken in applying the sound modelling and results such as the furthest distance to the PTS and TTS criteria for the scenarios modelled to assess potential impacts.
- The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) details that shipping and industrial noise are classed as a minor consequence for which the definition is: individuals are affected but no affect at a population level.
- The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) details that "It is the high intensity signals with high peak pressures received at very short range that can cause acute impacts such as injury and death." As vessel noise is continuous noise sources and do not have high intensity signals it is unlikely that they would cause injury to foraging pygmy blue whales.
- The short duration of activities (21 days).

- Though activities may occur during the period when pygmy blue whales are likely to be foraging within the BIA, the largest area of potential impact within the pygmy blue whale high density foraging BIA (35,627 km^2) is very small (2.39 km^2), which represents 0.007% of the high density foraging BIA for up to 21 days.
- Displacement from the high density foraging BIA is not predicted as the foraging BIA covers a broad area (35,627 km^2) and is not restricted and the area where behavioural avoidance may occur is 0.007% providing >99.9% of the foraging BIA for foraging.
- Adopted controls as detailed in Section 6.4.5 will prevent possible PTS, TTS and displacement impacts to pygmy blue whale that may be foraging.
- The ensonification area is ~75 km from the Bonney coast upwelling KEF which is a known feeding aggregation area (Gill et al. 2011; McCauley et al. 2018). The ensonification area is within an area where the occurrence of an upwelling event between 2002 and 2016 was assessed as very unlikely with an upwelling frequency of <10% (Huang and Wang 2019 see Section 4.5.9 Bonney coast upwelling). Thus, blue whale foraging is likely to be opportunistic within the ensonification area. Attard et al. (2017) showed that pygmy blue whales travel widely between the two known foraging areas (Bonney coast upwelling and Perth Canyon) and that records suggest that this population of blue whales may visit diverse, widespread areas for feeding during the austral summer, including perhaps the southern Indian Ocean and sub-Antarctic region, and travel to winter breeding grounds in the Indonesian region where they may also feed.

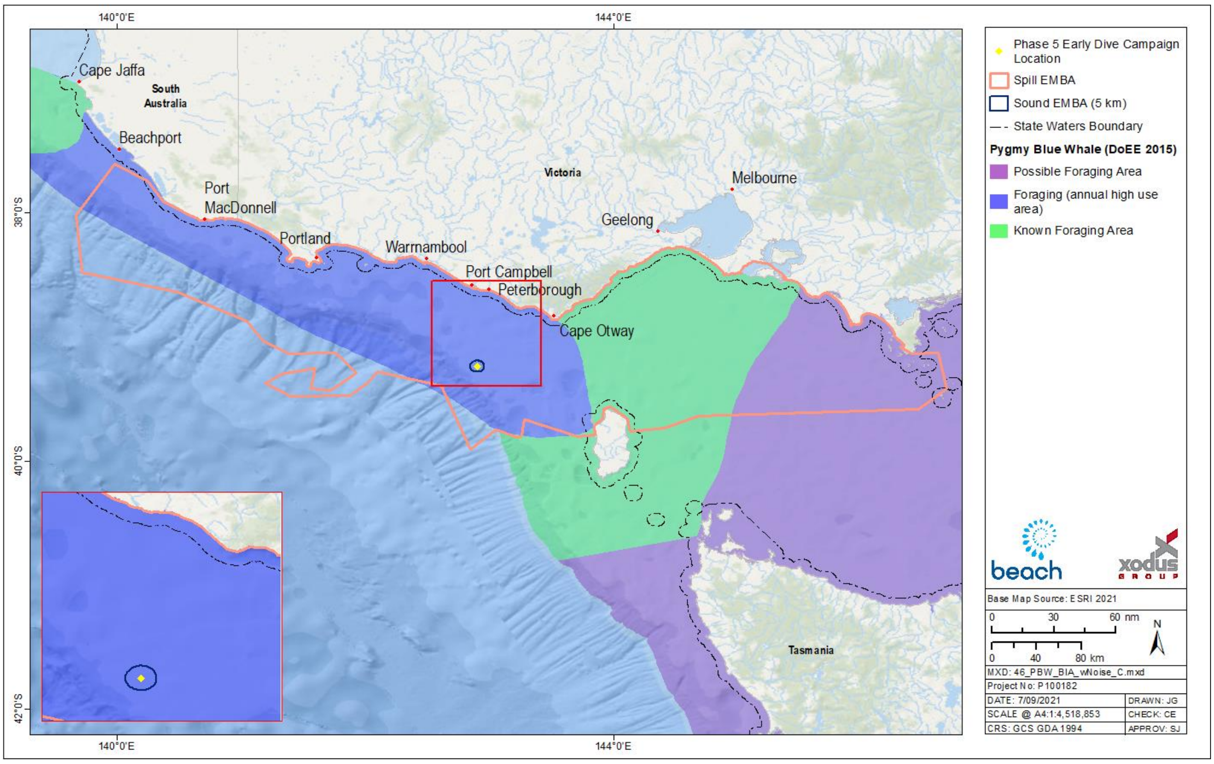


Figure 6-1: Pygmy blue whale BIAs and sound EMBA

Southern right whales

For southern right whales the following areas are within the predicted ensonified area:

- Current core coastal range is within the area where the PTS, TTS and behavioural criteria is reached.
- Southern right whale emerging aggregation area is not within the area where the PTS, TTS and behavioural criteria is reached (Table 6-4).

As detailed in Section 4.6.7.6, there is the potential for southern right whales to be within the Victorian coastal migration and resting on migration BIA and emerging aggregation area from late May/early June till October and transiting through the area during May-June and September-November as they move to and from coastal aggregation areas.

The severity is assessed as moderate and is of an acceptable level based on:

- A conservative approach has been taken in applying the sound modelling and results such as the furthest distance to the PTS and TTS criteria for the scenarios modelled to assess potential impacts.
- The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) identifies shipping and industrial noise as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level.
- Though activities may occur during the period when southern right whales are within the core coastal area, the largest area of potential impact within the core coastal area (217,825 km^2) is very small (2.39 km^2), which represents 0.001% of the core coastal area for up to 21 days
- PTS and TTS impacts are not predicted to southern right whales, by themselves or with calf, that may be moving through the core coastal area to and from coastal aggregation and migration areas based on mean recorded swims speeds for southern right whales are between 3 – 3.3 km/hr (Mate et al. 2011; Mackay et al. 2015 cited in Charlton 2017). As the furthest distance to the PTS or TTS criteria is 950 m southern right whales, by themselves or with calf, would move out of the ensonified area before PTS or TTS could occur.
- Avoidance behaviour may be exhibited if southern right whales are within the area where the behavioural criteria is reached. Disturbance on the behaviour of the mothers that could increase their energy expenditure will result in a reduction of energy available for their calf and for their return migration (Christiansen et al. 2014b). Based on an average swim speed of 3 km/hr (Charlton 2021 per com) energetic costs would be low if avoidance behaviour and thus not predicted to impact the fitness of mothers or calves moving between calving and feeding areas.
- Southern right whales may avoid the area where the behavioural criteria is reached but there is no impediment to them continuing to and from coastal aggregation and migration areas. Southern right whales are a highly mobile migratory species that travel thousands of kilometres between habitats used for essential life functions (DSEWPaC, 2012a). Along the Australian coast, individual southern right whales use widely separated coastal areas (200–1,500 km apart) within a season, indicating substantial coast-wide movement. The longest movements are undertaken by non-calving whales, though calving whales have also been recorded at locations up to 700 km apart within a single season (DSEWPaC, 2012a). As such, avoidance of the ensonified area is unlikely to prevent or hinder them from undertaking their seasonal migrations.
- PTS, TTS or behavioural criteria are not reached at the Victorian coastal migration and resting on migration BIA or southern right whale emerging aggregation area.
- Adopted controls as detailed in Section 6.4.5 will prevent possible PTS, TTS and displacement impacts to southern right whales.

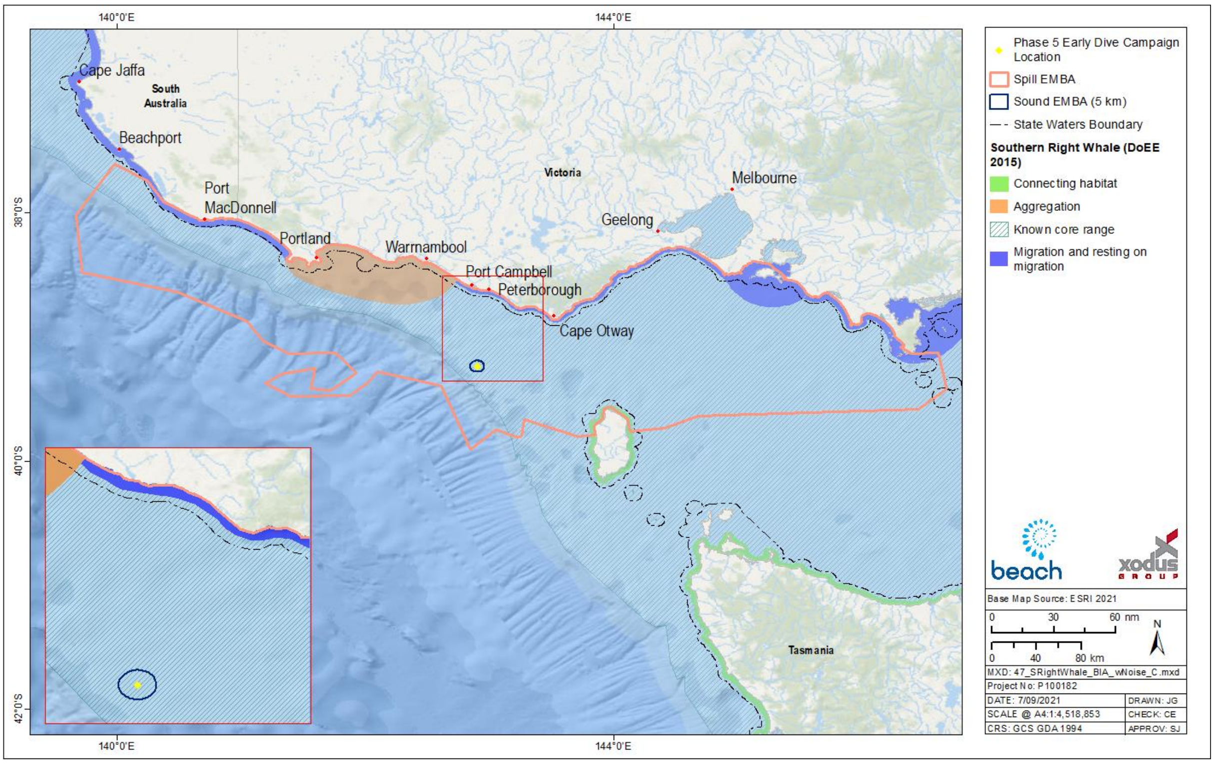


Figure 6-2: Southern right whale BIAs, current core coastal range and sound EMBA

Other whales

Foraging behaviour for fin, pygmy right and sei whales has been identified in the area where the PTS, TTS and behavioural criteria is reached. As detailed in Section 4.6.7.6 cetacean foraging within the Otway shelf, and hence the area where the PTS, TTS and behavioural criteria is reached, is typically from January to April though whales maybe present from November to June which overlaps the period when Phase 5 Early Dive Installation Campaign activities will occur (activities could occur year round).

The fin, pygmy right and sei whales do not have conservation management plans. The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016g) which both identify anthropogenic noise as a threat with the conservation and management actions of:

- Once the spatial and temporal distribution (including biologically important areas) of sei whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.
- If required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.

The severity is assessed as moderate and is of an acceptable level based on:

- The fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor with the extent over which the threat may operate as moderate-large. There is no conservation advice for the pygmy right whale and the Species Profile and Threats Database (DotEE, 2020a) does not identify anthropogenic noise and acoustic disturbance as a threat.

- The fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor with the extent over which the threat may operate as moderate-large.
- The pygmy right whale Species Profile and Threats Database (DotEE, 2020a) in lieu of no conservation advice, does not identify anthropogenic noise and acoustic disturbance as a threat.
- Low numbers of fin, sei and pygmy right whales are predicted within the PTS, TTS and behaviour ensonification area based on the following:
  - the PTS and TTS ensonification area is ~75 km from the Bonney coast upwelling KEF which is known as feeding aggregation area (Gill et al. 2011; McCauley et al. 2018).
  - the PTS and TTS ensonification area is within an area with a historical frequency <10% of an upwelling occurring (Huang and Wang 2019).
  - no biologically important areas were identified for these species.
  - aerial surveys in the Otway region (2002 – 2013) recorded seven fin whale sightings consisting of 8 individuals, 12 sei whale sightings consisting of 14 individuals and one pygmy right whale sighting consisting of 100 individuals (Gill et al. 2015). Gill et al. (2015) did observer feeding behaviour for sei and fin whales but noted that it is at least an opportunistic feeding area for these species.

Marine Turtles

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) identifies noise interference as a threat to turtles. It details that exposure to chronic (continuous) loud noise in the marine environment may lead to avoidance of important habitat.

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to develop sound exposure criteria for fish and turtles. The Working Group developed guidelines with specific thresholds for different levels of effects for several species groups including turtles (Popper et al. 2014).

Popper et al. (2014) details that there is no direct evidence of mortality or potential mortal injury to sea turtles from ship sound emissions.

Popper et al. (2014) found that there was insufficient data available to propose a quantitative exposure guideline or criteria for marine turtles for continuous sound such as those generated by vessels and instead suggested general distances to assess potential impacts. Using semi-quantitative analysis, Popper et al. (2014) suggests that there is a low risk to marine turtles from shipping and continuous sound except for TTS near (10s of metres) to the sound source, and masking at near, intermediate (hundreds of metres) and far (thousands of metres) distances and behaviour at near and intermediate distances from the sound source. Based on this information avoidance behaviour may occur within the operational area.

Finneran et al. (2015) presented revised thresholds for turtle PTS and TTS for continuous sound. Table 6-6 details the criteria and modelled distances to them (Koessler et al. 2021. Appendix F). The 24 hr PTS criteria was reached within 30 m during combined drilling, platform and installation activities. The 24 hr TTS criteria was reached within 150 m.

Table 6-6: Finneran turtle SEL24h thresholds and modelled distances

Marine Turtles	***SEL24h threshold***	***CSV installation***	***Combined drilling, platform and installation activities***	***Combined vessel operations and ROV cutting tool***
		Rmax (km)	Rmax (km)	Rmax (km)
PTS	220 dB re 1 $\mu Pa^2 \cdot s$	20 m	30 m	20 m
TTS	200 dB re 1 $\mu Pa^2 \cdot s$	80 m	80 m	150 m

Three marine turtle species may occur within the operational area (1 km) though no BIAs or habitat critical to the survival of the species were identified.

The extent of the area of impact is predicted to be within the operational area. The severity is assessed as minor (1) based on:

- The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) details that exposure to chronic (continuous) loud noise in the marine environment may lead to avoidance of important habitat and no marine turtle important habits are located within the area that maybe impacted.
- Thresholds for turtle PTS and TTS over 24 hrs were predicted to occur with a maximum distance of 80 m within the operational area where no marine turtle important habits are located.
- Avoidance behaviour may occur within the operational area where no marine turtle important habits are located.
- Low numbers of marine turtles are predicted in the operational area and therefore impacts would be limited to a small number of individuals.

Fish

Popper et al. (2014) details that there is no direct evidence of mortality or potential mortal injury to fish from ship sound emissions. Popper et al., (2014) details that risks of mortality and potential mortal injury, and recoverable injury impacts to fish with no swim bladder (sharks) or where the swim bladder is not involved in hearing is low and that TTS in hearing may be a moderate risk near (tens of metres) the vessel. For fish with a swim bladder involved in hearing risks of mortality and potential mortal injury impacts is low. However, some evidence suggests that fish sensitive to acoustic pressure show a recoverable loss in hearing sensitivity, or injury when exposed to high levels of sound and Popper et al. (2014) details SPL criteria for fish with a swim bladder involved in hearing. Table 6-7 details the criteria and modelled distances to them (Koessler et al. 2021. Appendix F).

Table 6-7: SPL criteria for fish with a swim bladder involved in hearing and modelled distances

Fish: Swim bladder involved in hearing	***SPL (Lp; dB re 1 µPa)***	***CSV installation***	***Combined drilling, platform and installation activities***	***Combined vessel operations and ROV cutting tool***
		Rmax (km)	***Rmax (km)***	***Rmax (km)***
Recoverable injury	170 dB SPL for 48 h	Not reached	Not reached	Not reached
TTS	158 dB SPL for 12 h	30 m	40 m	50 m

No cumulative impacts are expected as there are no habitats likely to support site-attached fish in the operational area.

The recoverable injury threshold was not reached for any scenario. The 12 hr TTS criteria was reached within 50 m of combined activities. As there are no habitats likely to support site-attached fish in the operational area it is also unlikely that fish species would be present for a period of 12 hours. Thus, TTS impacts are not predicted.

Behavioural impacts are more likely such as moving away from the vessel. There are no habitats or features within the operational area that would restrict fish and sharks from moving away from the vessel.

The operational area is within a distribution BIA for the white shark though no habitat critical to the survival of the species or behaviours were identified. The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify sound as a threat.

Low levels of commercial fishing for fish species were identified within the operational area. Thus, temporary avoidance may occur during activities.

The extent of the area of impact is predicted to be within the operational area for the duration of vessel activities. The severity is assessed as minor based on:

- The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify sound impacts as a threat.
- Avoidance behaviour may occur within the operational area, however, no habitats likely to support site-attached fish have been identified within the operational area.
- Temporary avoidance behaviour may occur within the operational area (1 km) for commercial fish, however recovery would occur once the activity had finished. Based on the small area of impact, low fishing activity and that displaced fish would still being available to be caught outside of the operational area, impacts to commercial fishing are not predicted.

6.4.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Underwater sound emissions	
ALARP decision context and justification	**ALARP Decision Context: Type B** Impacts from sound emissions are relatively well understood though there is the potential for uncertainty in relation to the level of impact. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. Additional controls may be required to ensure impacts can be managed to an acceptable level.
Adopted Control Measures	**Source of good practice control measures**
CM#5: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans describes strategies to ensure whales and dolphins are not harmed during offshore interactions with vessels and helicopters. The CSV will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. These regulations stipulate a safe operating distance of 300 m. Helicopters will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans.
CM#6 Whale Management Procedure	The Whale Management Procedure details the controls to prevent possible PTS, TTS and displacement impacts to foraging blue whale and southern right whales that maybe present in the core coastal area and migration and resting on migration BIA. The procedure assumes that once an activity is underway whales within the pre-activity survey zone are not displaced and that only PTS and TTS need to be managed. Prior to an activity commencing a pre-activity survey will be undertaken of the observation zone for the activity (5 km around the activity location). The observation zone is based on the distance to the modelled behaviour criteria and have been rounded up to take into account accuracy of estimation of distance at sea. On advice from the Blue Whale Study, a conservative approach will be adopted whereby it is assumed that all whales present on the Otway shelf are conducting biologically important behaviours (e.g., foraging blue whales). All whales will also include southern right whales with or without a calf. Surveys will be undertaken for 30 min prior to the activity commencing. If a whale is sighted within the pre-activity survey zone the activity will not commence until: • No whales are observed for 30 min within the observation zone; or • Whales are observed leaving the observation zone. MMOs currently contracted to the Otway drilling campaign have stated that from a vessel bridge height of ~20 m, observations are possible up to 7 km. Given that the CSV has a

	bridge height above sea level of ~24 m, MMO viewing distance will be able to cover the observation zone especially as the vessel will be moving during the pre-survey. The period of 30 min is deemed as sufficient time to observed deep diving whales such as blue whales based on blue whale foraging behaviour and dive duration detailed in the blue whale section in Section 4.6.7.6. Once the activity has commenced observations will be undertake within this activity shutdown zone (1.5 km). The shutdown zone is based on the distance to the modelled PTS/TTS criteria and have been rounded up to take into account accuracy of estimation of distance at sea. If a whale is sighted within the shutdown zone the CSV will continue operations until the earliest point is reached at which operations can be safely suspended (i.e., the 'safe point'). On suspension of operations, the vessel will adopt the most favourable heading in order to reduce propulsion noise and then increase separation to whales if safe to do so. The activity can recommence once: • No whales are observed for 30 min within the activity shutdown zone; or • Whales are observed leaving the activity shutdown zone. Activities can commence at night or in low visibility conditions (i.e., when observations cannot be undertaken) if no more than three whales have been seen in the PTS/TTS zone in the preceding daylight hours. The no more than three whales criterion is acceptable for blue whales because it indicates the krill stock at the location has been diminished. More than three whales within the previous daylight hours may indicate a large krill supply and more whales could be expected. The daylight hours is justified because it is the longest possible continuous observation period (i.e., one full day of observations). Three southern right whales would be an indication that there is an increased likelihood of a southern right whale within the PTS/TTS zone during the period that observations cannot be undertaken.
CM#6 Whale Management Procedure Marine Mammal Observers	A trained and experienced MMO will undertake observation and shutdown zone observations. In addition, vessel crew who act as Officer of the Watch will receive training from the MMO in whale observation and distance estimation to assist the MMO during daylight hours.
CM#4: Preventative Maintenance System	Power generation and propulsion systems on the CSV will be operated in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation.

Additional controls assessed

Control	Cost/Benefit Analysis	Control Implemented?
Seasonal timing	Pygmy blue whales are potentially in the foraging BIA within the Otway shelf waters from November through to June. Southern right whales may travel through the operational area to and from coastal aggregation and migration areas during May-June and September-November and be present in the coastal aggregation and migration areas between June to October. Thus,	No

	there is no period when there is not a whale undertaking a biologically important behaviour within the Otway region. The implementation of additional controls above the legislative requirements of the EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans will be implemented to manage potential impacts to whales undertaking biologically important behaviour.	
Anchoring of the CSV	This is not feasible at the site of installation activities as anchoring may damage existing subsea infrastructure. In addition, minor adjustments to the vessel position are required throughout the installation of subsea infrastructure. The vessel must also be able to react to an errant vessel, man overboard or other safety issues. Thus, anchoring of the CSV is not a feasible option while installing equipment. However, in the event of a whale-instigated shutdown, the vessel would shutdown the DP, where safe to do so, and move to a safe location away from subsea infrastructure.	No
Shut down zones	Implemented with safety controls. Shutting down the CSV DP system during installation activities could lead to the vessel drifting and colliding with another vessel, potentially resulting in a safety risk to personnel or an MDO spill. It may lead to damage to subsea equipment if the equipment is suspended by a crane in the air or in the water at the time of shutdown or, as a worst case, result in damage to existing subsea equipment. It could also result in a vessel strike to the whales that shutting down the propulsion system is meant to protect.	No
Passive acoustic monitoring (PAM)	PAM is most useful in the detection of odontocetes such as sperm whales, dolphins and porpoise known to emit regular distinctive clicks and high frequency calls during long dives. PAM has limited utility in detecting lower frequency calls of baleen whales (such as blue whales, southern right whales) especially when in the presence of constant background low frequency sound such as that generated by the vessel towing the PAM system. Given the very low utility and associated unreliability of using PAM to inform mitigation decision making, any additional cost is considered disproportionate to the benefit gained.	No
Dedicated monitoring vessel	An additional dedicated monitoring vessel is not considered to represent an ALARP solution as monitoring activities can effectively be carried out by an MMO situated on the CSV because the extent of the shutdown zone is 1.5 km, which can be easily monitored from the bridge of the CSV. MMOs contracted to the Otway drilling campaign state that the viewing distance from a support vessel bridge is 7 km. Additional vessels may increase the risk of vessel strike with cetaceans, increase underwater sound impacts and other vessel-related impacts and risks. The cost to implement this control measure is disproportionate to marginal environmental benefit and may actually contribute to increased environmental risk.	No

Aerial surveillance	Flights in small aircraft over open water introduce significant safety risks, and there is no guarantee that whales will be spotted. Previous spotter flights undertaken in the Otway have identified that the ability to detect cetaceans can be severely limited during: • Choppy sea states, when white caps make it extremely difficult to spot tell-signs of whale presence, • Calm conditions, when glare from the water can significantly reduce the ability to detect any features on the sea surface, and • Mists and fogs, which can severely reduce visibility. The speed and turning time of the aircraft make positive identification of potential sightings very challenging. Spotter flights are also unable to detect cetaceans that are not active on the ocean surface. Undertaking aerial spotter flights has a low likelihood of success and involves taking a high safety risk. This, combined with the high costs of spotter flights, means the risks and costs associated with this control are disproportionately high when considering the minor' residual impact consequence for cetaceans. Aerial flights will be undertaken as part of the Otway Offshore Drilling Campaign. Information from these flights will be provided to the MMO onboard the CSV.	No
Consequence rating	Moderate (2)	
Likelihood of occurrence	NA	
Residual risk	Low	
Acceptability assessment		
To meet the principles of ESD	Sound emissions were assessed as having a moderate consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.	
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).	
External context	There have been no stakeholder objections or claims regarding noise emissions.	
Other requirements	Sound emissions will be managed in accordance with legislative requirements. Sound emissions will: • Not impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • Be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area (Commonwealth of Australia, 2015b). • Not impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • Not impact southern right whale established or emerging aggregation BIAs or the migration and resting on migration BIA (Commonwealth of Australia 2015b).	

	• Not impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • Not impact the recovery of the white shark as per the Recovery Plan for the White Shark (DSEWPaC, 2013a). Actions from the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) applicable to the activity in relation to assessing and addressing anthropogenic noise have been addressed as per: • Assessing the effect of anthropogenic noise on blue whale behaviour. Section 6.4 assesses the effects of anthropogenic noise from the activity on blue whale behaviour. • 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. Section 6.4 demonstrates that the activity can be conducted in a manner that is consistent with the conservation management plan and will not result in injury or displacement of pygmy blue whales from a foraging BIA.
Monitoring and reporting	Cetacean sightings will be recorded using the DAWE sighting sheets as detailed in Section 7.12.6.
Acceptability outcome	Acceptable

6.5 Physical presence

6.5.1 Hazards

Physical presence of the Otway Phase 5 Early Dive Installation Campaign includes:

- 500 m safety exclusion zone around the CSV when undertaking installation activities.

Once installed, infrastructure will be managed under the Otway Operations EP, which considered impacts related to physical presence of the infrastructure.

6.5.2 Predicted environmental impacts

The physical presence of the vessel operating within the operational area can result in the displacement of other marine users.

6.5.3 EMBA

Predicted impacts from the physical presence of vessel activities will be limited to the operational area (1 km).

Other marine user identified to occur within the operational area are:

- Recreation and tourism
- Commercial shipping
- Petroleum activities
- Commercial fishing

6.5.4 Consequence evaluation

6.5.4.1 Recreation and tourism

Recreation and tourism could be affected by restricted access to an area (i.e. due to the presence of the safety zone), particularly if the area is of interest due to fishing opportunities or presence of marine fauna. Impacts to recreational fishing and tourism are not predicted due to the distance that the operational area is offshore (~70 km) and the absence of emergent features within the operational area.

6.5.4.2 Commercial shipping

The operational area is located within an area of major shipping traffic (Section 4.7.4) however, vessel activities associated with the Otway Gas Development have been ongoing for over 10 years and to date there has been no interactions or incidents.

Vessel undertaking activities within the operational area will not be anchored, and any disturbance to commercial vessels will be minor disturbance only.

The extent of the area of impact is predicted to be the operational area. The severity is assessed as minor based on the area of impact is small, duration is short (21 days) and the exclusion is required for safe operations of the vessel.

6.5.4.3 Petroleum activities

Beach-managed petroleum activity may be undertaken within the operational area as part of the Otway Offshore Development, however there are no other petroleum activities managed by other titleholders planned within the operational area.

Petroleum activities managed by other titleholders will be required to avoid the safety exclusion zone for the duration of the activity (21 days). Displacement of other petroleum activities is therefore not predicted.

6.5.4.4 Commercial fishing

The Commonwealth SESSF and Southern Squid Jig Fishery have catch effort within the operational area based on ABARES reports 2014 – 2020 (Patterson et al. 2018, 2017, 2016, 2015 and Georgeson et al. 2014). The Skipjack Fishery is not currently active and management arrangements for the fishery are under review.

AFMA detailed that there are currently no active vessels in Commonwealth fisheries within the operational area.

Based on Victorian Fishing Association data from 2016 to 2020 the catch effort in the fishing grids surrounding the operational area is low, with a vast majority of the fishing effort congregated around the shoreline as described in Section 4.7.9.

During stakeholder consultation for previous Beach activities up to six fishers have identified they may fish in the broader Otway Offshore Development area which includes the operational areas of the development wells (Section 8).

A report commissioned by Beach and developed by South East Trawl Fishing Industry Association (SETFIA) on Trawl and Gillnet fishing activity (October 2019) found:

- Trawl fishing in the Southern and Eastern Scalefish and Shark Fishery Commonwealth Trawl Sector board trawl sub-sector does not occur in the Otway Offshore Project area as the grounds appear too rough for trawl fishing in its current form.
- Gillnet fishing in the Southern and Eastern Scalefish and Shark Fishery Gillnet Hook and Trap Sector does not seem to occur within the Otway Offshore Project area.
- There is no Southern and Eastern Scalefish and Shark Fishery Commonwealth Trawl Sector Danish seine sub-sector fishing in the Otway Offshore Project area.

There is a clear separation of these commercial fishers and the Offshore Project area. Therefore, no interaction is anticipated between trawl or gill net fishers and the Otway Phase 5 Early Dive Installation Campaign.

During stakeholder consultation for previous Beach activities stakeholders have raised concerns in relation to displacement of their fishing activities in relation to new PSZs. No comments were received in relation to displacement of fishers during stakeholder consultation undertaken for Phase 5 Early Dive Installation Campaign activities.

The extent of displacement is the 500 m safety exclusion zone for the duration of the activity (21 days). The severity is assessed as minor based on:

- Small area of displacement (0.79 km^2) within the safety exclusion zone
- Short duration (21 days)
- No trawl or gill net fishing occurs in the operational area.

- Limited fishing has been identified within the operational area.

6.5.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Physical Presence	
ALARP decision context and justification	**ALARP Decision Context: Type A** Impacts from physical displacement are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. Though objections and claims have been raised by stakeholders, via consultation in relation to development activities in the Otway Development Area, in relation to trawl and gillnet snagging risks on subsea wells subsequent data identified that there is no trawl or gillnet fishing in the operational area. No objections or claims were raised from fishers from consultation undertaken for the development of this EP. As the impact consequence is rated as minor (1) applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#7: Ongoing consultation	Consultation will continue with relevant stakeholders as detailed in Section 8.8
CM#8: Beach Fair Ocean Access Procedure	Beach's Fair Ocean Access Procedure (Appendix D) is being developed with input from commercial fishing industry organisations (Bass Strait Scallop Industry Association, Scallop Fisherman's Association of Tasmania, South East Trawl Fishing Industry Association and Tasmanian Seafood Industry Council. The procedure details the process whereby a commercial fisher can claim compensation for an economic loss associated with Beach's offshore activities where impacts cannot be avoided. An information sheet on the procedure is available in Appendix D.
CM#2: MO 30: Prevention of collisions	AMSA MO 30: Prevention of collisions requires that onboard navigation, radar equipment, and lighting meets the International Rules for Preventing Collisions at Sea (COLREGs) and industry standards.
CM#9: MO 27: Safety of navigation and radio equipment	AMSA MO 27: Safety of navigation and radio equipment gives effect to SOLAS regulations regarding radiocommunication and safety of navigation and provides for navigation safety measures and equipment and radio equipment requirements.
Consequence rating	Minor (1)

Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Physical displacement was assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	The merits of claims or objections raised by a relevant stakeholder have been adequately assessed and additional controls adopted where appropriate.
Other requirements	Physical displacement will be managed in accordance with the applicable legislative requirements.
Monitoring and reporting	Monitoring of potential impacts is undertaken via stakeholder engagement.
Acceptability outcome	Acceptable

6.6 Benthic disturbance

6.6.1 Hazards

Benthic disturbance can occur as a result of activities which interact with the seabed, including (footprints in brackets):

- Placement of positioning equipment on the seabed (< 5 m^2).
- Temporary wet-parking of infrastructure and equipment on the seabed (up to ~150 m^2).
- Installation of the T-DIS (47 m^2) and rigid spools (~70 m^2), including the pipe handling frame (~6 m^2 per frame).
- Spool span rectification via jetting
- Installation of stabilisation mattresses (198 m^2) and grout bag / cement bags.

The footprint of all activities will be within the operational area.

Vessel anchoring will not occur during the activity.

6.6.2 Predicted environmental impacts

Benthic disturbance can impact on benthic habitats and fauna through smothering and alteration of habitat and localised and temporary increases in suspended sediments near the seabed.

6.6.3 EMBA

Predicted impacts from benthic disturbance will be limited to the operational area. Receptors which may be affected by benthic disturbance within the operational area include:

- Benthic habitats and species assemblages.

6.6.4 Consequence evaluation

As detailed in Section 4.5.2 and 4.5.3 a seabed site assessment was undertaken over the Otway Development gas fields and proposed infrastructure corridors. This included the Thylacine field. In relation to benthic habitat within the Thylacine field and broader area the following was identified:

- The seabed topography is dominated by exposed rock on the seabed.
- Small patches of very thin transgressive coarse sand are present across the survey area.
- The seabed showed a scattered sessile biota on a sandy seafloor.
- No rocky reefs or outcrops were identified.
- The sandy substrates described for Thylacine gas field are consistent with the reported description for the broader Otway Development area of unconsolidated seabed sediments made up of carbonate sands.
- Based on the assessment of epifauna using seabed photographs, the general impression of the seafloor is of an 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 m^2 on average but could be found in patches of at least 0.4 m^2.

- 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.
- The epibiota on the seabed in the vicinity of the Thylacine field 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 EPBC Act were observed.

The Shelf Rocky Reefs and Hard Substrates KEF is not spatially defined and may occur within the operational area. No threatened ecological communities or habitats critical to the survival of the species were identified within the operational area. The Shelf Rocky Reefs and Hard Substrates KEF is in all areas of the South-east Marine Region continental shelf including Bass Strait, from the sub-tidal zone shore to the continental shelf break.

The seabed site assessment identified a hard substrate within the operational area but did not identify rocky reefs (Ramboll, 2020. Appendix E). The seafloor supported a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians and sponges) which is characteristic of the hard grounds associated with the hard substrates' component of the Shelf Rocky Reefs and Hard Substrates KEF (Section 4.4.13). However, the hard substrate and associated biota characteristic of the hard substrate component of the Shelf Rocky Reefs and Hard Substrates KEF is not unique to the operational area based on Commonwealth of Australia (2015c) stating that the hard grounds associated with the Shelf Rocky Reefs and Hard Substrates KEF are located in all areas of the South-east Marine Region continental shelf including Bass Strait. This is support by the seabed site assessment (Ramboll, 2020. Appendix E), that identified that the epibiota on the seabed in the vicinity of the Thylacine gas field is representative of what is expected at depths around 70-100 m, and also previous surveys within the Otway Basin, as detailed below, that identified hard substrate with similar biota to that in the operational areas.

The total disturbance footprint from the Phase 5 Early Dive Installation Campaign is expected to be ~400 m^2, which in the context of T/L2 and the marine bioregion occupies a very small area of the seabed. The activity may result in the mortality of sessile fauna within this very small footprint and potentially the mortality of benthic infauna associated with the habitat. However, it is considered that potentially impacted benthic habitats and associated biota are well represented in the region. Therefore, any disturbance and loss of habitat will represent a very small fraction of the widespread available habitat and abundance of benthic fauna in the region. Following removal of the temporarily positioned equipment and pipe handing frames, the soft sediments will be left disturbed. However, benthic habitats will remain viable and are expected to recolonise through the recruitment of new colonists from planktonic larvae in adjacent undisturbed areas. In addition, the installation of the subsea infrastructure will generate hard substrate in an area of otherwise relatively featureless seabed. This will act as an anchoring point for some benthic organisms and contribute to a localised increase in biodiversity following the activity.

Displacement of sediments may occur during subsea equipment deployment and installation, and during jetting for span rectification. This will result in temporary, localised plumes of suspended sediment and subsequent deposition of sediment, potentially resulting in smothering of marine benthic habitat and benthic communities in the immediate vicinity. Given the limited amount of subsea equipment to be installed, the displacement of sediments and creation of silt plumes in the water column are not expected to significantly impact benthic communities in the activity area because they are likely to be dispersed by oceanic currents.

The extent of the area of impact is predicted to be small for a duration of up to months to years while the disturbed area recolonises. The severity is assessed as minor based on:

- No threatened ecological communities, critical habitats, sensitive or protected benthic habitat or species, including commercial invertebrate species, have been identified in the area of impact (operational area).
- Though the operational area overlap hard substrate similar to that described for the Shelf Rocky Reefs and Hard Substrates KEF this feature, and associated biota are not unique to the operational area based on Commonwealth of Australia (2015c) stating that the hard grounds associated with the Shelf Rocky Reefs and Hard Substrates KEF are located in all areas of the South-east Marine Region continental shelf including Bass Strait, and on surveys within the Otway Basin that identified hard substrate with similar biota to that in the operational areas.
- Due to the small area of disturbance and that the hard substrate habitat and associated biota is not unique to the operational area the benthic disturbance will not modify, destroy, fragment, isolate or disturb a substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results.
- There is no impediment to the disturbed areas recolonising as the benthic habitat and associated biota is not unique within the operating area.

6.6.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Benthic disturbance	
ALARP decision context and justification	**ALARP Decision Context: Type A** Impacts from benthic disturbance are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to benthic disturbance. As the impact consequence is rated as minor (1) applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#10: As-left survey	An ROV survey will be undertaken at the completion of the activity to confirm temporary equipment, including any temporarily 'wet parked' equipment and infrastructure, has been removed from the activity area and the location of subsea infrastructure is recorded.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Benthic disturbance was assessed as having a minor consequence which is not considered as having the potential to result in serious or

	irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding benthic disturbance.
Other requirements	No other requirements were identified in relation to benthic disturbance.
Monitoring and reporting	Impacts associated with benthic disturbance are over a small area and not predicted to have long term impacts to protected or commercially important receptors. Therefore, the monitoring is not proposed.
Acceptability outcome	Acceptable

6.7 Planned marine discharges – Vessels

6.7.1 Hazards

The vessel will have planned marine discharges within the operational area such as cooling water, brine, bilge water, deck drainage, putrescible waste, sewage and grey water.

6.7.2 Predicted environmental impacts

Planned marine discharges can result in changes in water quality such as increased temperature, salinity, nutrients, chemicals and hydrocarbons which can lead to toxic effects to marine fauna.

Putrescible waste discharges can result in changes in fauna behaviour if result in fauna habituate to this food source.

6.7.3 EMBA

Predicted impacts from planned marine discharges from the vessel will be limited to the operational area. Receptors potentially affected include water quality and marine fauna.

6.7.4 Consequence evaluation

6.7.4.1 Planned marine discharges

The consequence evaluation considers the potential cumulative impacts from:

- Planned marine discharges of waste waters and putrescible wastes from the vessel when undertaking petroleum activities within the operational area.

These discharges will result in:

- Nutrients levels may be intermittently elevated within 500 m of a vessel when sewage, greywater and putrescible waste discharged.
- Water temperature may be elevated within 100 m of the of a vessel from the constant discharge of cooling water.
- Hydrocarbon levels may be intermittently elevated within 100 m of a vessel when bilge waster is discharged.

Cumulative impacts may occur from the vessel discharges if work scopes overlap, such as if early dive installation campaign activities (this EP) overlap with drilling activities at Thylacine North-1. However, the small additional volume that one additional vessel will discharge and intermittent nature of the discharges, except for cooling water which has a predicted area of impact of 100 m, would be unlikely to significantly increase the impact extent beyond 500 m or the impacts to water quality and marine receptors while concurrent activities are occurring.

For the consequence evaluation, it is assumed that all wastewater discharges will dissipate within the operational area (1 km).

Though plankton may be sensitive to some aspects of marine discharges such as increased temperatures (Huertas et al. 2011) this is typically for prolonged exposure. In view of the high level of natural mortality and the rapid replacement rate of many plankton species (Richardson et al, 2017) impacts from short term exposure to marine discharges of low toxicity that will rapidly dilute is unlikely to have lethal effects to plankton that area ecologically significant.

Fish species, including commercial species maybe present within the operational area. There are no BIAs or protected habitats and commercial fishing for fish species has not been identified within the operational area. No features have been identified where site attached species would be present. As fish species would be transient in the operational area, toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

The operational area overlaps the distribution BIA for white shark although no critical habitats or behaviours are known to occur. The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify vessel discharges or equivalent as a threat. As these species would be transient in the operational area toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

No turtle BIAs are located within the operational area though turtle species may occur. Chemical and terrestrial discharge is identified as a threat to turtles in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) though not specifically from vessels and is focus on long term exposure. As these species would be transient in the operational area toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

The operational area overlaps the pygmy blue whale high density foraging BIA. The Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) does not identify discharges from vessels as a threat to the recovery of these species. It does identify that marine pollution can have a variety of possible consequences for blue whales at an individual and population level, or indirectly through harming their prey or the ecosystem. The conservation plan identifies acute chemical discharge (oil or condensate spill) as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level. Given that chemicals associated with a spill is classed as a minor consequence impacts from low toxicity discharges that would rapidly dilute would be expected to be the same or a lower consequence,

The operational area overlaps the southern right whale current core coastal range. The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) does not identify discharges from vessels as a threat to the recovery of these species but does identify chemical pollution in the form of sewage and industrial discharges as a threat more likely in coastal aggregation areas. The conservation plan identifies acute chemical discharge as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level. Given that the conservation plan identifies acute chemical discharge as a threat more likely in coastal aggregation areas it would be expected that chemical discharges in an offshore area which would rapidly dilute would be the same or lower consequence.

The South-east Marine Region Profile (Commonwealth of Australia, 2015c) details that the oceanography of the South-east Marine Region contributes to enhanced areas of primary productivity, including:

- Spring and autumn phytoplankton blooms in the Subtropical Convergence Zone (south of Tasmania).
- Primary productivity associated with the Bass Cascade and upwelling of cool nutrient-rich waters along the mainland coast north-east of Bass Strait.
- Localised seasonal upwellings along the Bonney coast.

The closest of these high productivity areas to the Phase 5 Early Dive Campaign activities is the Bonney coast upwelling KEF. Figure 4-18 shows that the Bonney coast upwelling KEF is ~ 75 km from the operational area. The Bonney coast upwelling KEF is an area of high productivity and aggregations of marine life, of importance as feeding grounds to blue, sei and fin whales and higher predatory species, typically in summer and autumn months. However, based on the large distance between the operational area and the Bonney coast upwelling KEF impacts to water quality and therefore productivity impacts are not predicted.

The extent of impact, including any cumulative impacts, is predicted to be 500 m from a vessel. The severity is assessed as minor based on:

- Marine discharges will be of low toxicity with controls such as treatment and chemical assessment in place.
- Marine discharges are not predicted to have lasting effects on either the biological or physical environment in the operational area with no specific value when compared with surrounding waters.
- The operational area overlap with the white shark distribution BIA is small; and the Recovery Plan for the White Shark (DSEWPaC, 2013a) does not identify vessel discharges or equivalent as a threat.
- The operational area overlap with the pygmy blue whale foraging BIA is small; and the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) identifies acute chemical discharge (oil or condensate spill) as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level.
- The operational area overlap with the southern right whale current core coastal range is small; and the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) identifies acute chemical discharge as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level.
- Marine discharges do not interfere with wind-generated upwelling events, nor are they likely to impact marine fauna attracted to the area by regional upwelling events.
- Potential impacts to plankton are not expected to result in impacts to foraging marine species given the overall abundance of food resources within the region.
- As the discharges are discharged into an open oceanic environment they are predicted to mix rapidly with the surrounding waters and impacts to sediments and benthic biota including invertebrates is not predicted.
- Given the anticipated rapid dilution of low concentration of hydrocarbons and chemicals within the water column, there is no identified potential for decreases in water quality that may impact on marine fauna attracted to regional upwelling events.

6.7.4.2 Putrescible waste

The operational area where the vessel would discharge putrescible waste overlaps foraging BIAs for several albatross species, common diving-petrel, and short-tailed and wedged-tailed shearwater (Figure 4-25, Figure 4-26 and Figure 4-27). No habitat critical to the survival of seabirds occur within the operational area. Marine pollution is identified as a threat in the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a); however, vessel food waste discharge would be sporadic and for a short duration thus would not result in seabirds habituating to this food source. The common diving-petrel (listed as marine) and wedged-tailed shearwater (listed as marine and migratory) do not have a recovery plan or conservation advice.

Fish may also become attracted to the food waste but as for seabirds the sporadic nature of vessel food waste discharge would not lead to fish habituating to this food source.

Periodic discharge of macerated food waste to the marine environment will result in a temporary increase in nutrients in the water column that is expected to be localised to waters surrounding the discharge with no lasting effects to either the biological or physical environment.

The extent of the impact is predicted to be 500 m from the vessel while undertaking activities in the operational area. The severity is assessed as minor based on:

- Food waste discharges are sporadic and for a short duration thus would not result in fauna habituating to this food source.
- Food waste will rapidly disperse in the marine environment.
- The nutrients within putrescible waste are to be discharged within an area of regionally elevated nutrient levels created by seasonal upwelling events, therefore additional nutrients loading is not likely detrimental to marine fauna.

6.7.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Planned marine discharges – vessels	
ALARP decision context and justification	**ALARP Decision Context: Type A** Impacts from planned marine discharges are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims were raised by stakeholders in relation to planned marine discharges As the impact consequence is rated as minor (1) applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#11: Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and Marine Order 96 (Marine pollution prevention — sewage) 2018 giving effect to MARPOL Annex IV.	This Act regulates Australian regulated vessels with respect to ship-related operational activities and invokes certain requirements of the MARPOL Convention relating to discharge of noxious liquid substances, sewage, putrescible waste, garbage, air pollution etc.
CM#4: Preventative Maintenance System	Equipment to treat marine discharges such as bilge water, slops from deck drainage, sewage and food waste are operated in accordance with the preventative maintenance system (or equivalent) to ensure efficient operations.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Planned marine discharges were assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding planned marine discharges.

Other requirements	Planned marine discharge will be managed in accordance with legislative requirements. Planned marine discharges will not: • impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • impact the recovery of the white shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a). • impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • impact sei, fin whale or humpback whales, covered by conservation advice.
Monitoring and reporting	Impacts associated with planned marine discharges are over a small area and not predicted to have long term impacts to protected or commercially important receptors. The control measures adopted ensure water quality remains within internationally recognised and acceptable parameters therefore, monitoring is not proposed.
Acceptability outcome	Acceptable

6.8 Planned marine discharges – pre-commissioning

6.8.1 Hazards

During the activity, pre-commissioning discharges will include small volumes (< 1m^3) of inhibited seawater and MEG released during:

- MEG manifold isolation verification
- Spool installation (including discharges from production riser)
- T-DIS installation

The base plan is to pressure test within a closed-system; however, it is possible that flushing will be required. In this case, a total of 11 m^3 of flushing fluid (MEG and inhibited seawater) would be discharged to sea, likely from the T-DIS location.

In the event that the MEG riser has to be depressurised, a maximum volume of 60 m^3 of MEG would be discharged at the base of the Thylacine MEG riser for system testing, flushing and contingency purposes.All chemicals that will be or have the potential to be discharged to the marine environment must be assessed prior to use to ensure the lowest toxicity, most biodegradable and least accumulative chemicals are selected which meet the technical requirements of the application.

6.8.2 Predicted environmental impacts

Planned discharges of pre-commissioning fluid can result in changes in water quality which can lead to toxic effects to marine fauna.

6.8.3 EMBA

Predicted impacts from planned marine discharges of pre-commissioning fluid will be limited to the operational area. Receptors potentially affected include water quality and marine fauna.

6.8.4 Consequence evaluation

MEG has a low toxicity, is readily biodegradable and is rated as posing little or no risk to the environment (PLONOR) and 'E' (non-CHARM) in the OCNS rankings. The fluid proposed for use in the HFL function test (MacDermid Oceanic 443) is a water-based fluid that is ranked "D" in the OCNS ranking and has a substitution ("SUB") warning, indicating that alternative products should be used where possible. The substitution warning is triggered by a non-biodegradable fluorescent leak tracer dye at <150ppm in the whole product. The dye is non-toxic and does not have a potential to bioaccumulate.

The consequence of the subsea discharges to the physical and biological environment are expected to have minor consequences because of the:

- Low toxicity of the products to be discharged;
- Low volumes associated with the discharges (likely discreet discharges of <1 m^3, contingency maximum 71 m^3);
- Temporary nature of the discharges;
- High dilution and dispersal factor in open waters; and

- Absence of sensitive habitats in the activity area.

6.8.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Planned marine discharges – pre-commissioning	
ALARP decision context and justification	**ALARP Decision Context: Type A** Impacts from planned marine discharges are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to marine discharges of hydraulic control fluids or other operational discharges. As the impact consequence is rated as minor (1) applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP. As the risk is rated as low applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#12: Beach Chemical Management Plan	All chemicals that could be discharged to the marine environment must be assessed prior to use to ensure the lowest toxicity, most biodegradable and least accumulative chemicals are selected which meet the technical requirements of the application.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Planned marine discharges were assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding planned marine discharges.

Other requirements	Planned marine discharge will be managed in accordance with legislative requirements.
Monitoring and reporting	Impacts associated with planned marine discharges are over a small area and not predicted to have long term impacts to protected or commercially important receptors. The control measures adopted ensure water quality remains within acceptable parameters given the chemicals are assessed to internationally recognised standards, therefore, monitoring is not proposed.
Acceptability outcome	Acceptable

6.9 Establishment of invasive marine species

6.9.1 Hazards

The introduction of marine pests could occur during vessel operations as a result of:

- Discharge of ballast water containing foreign species.
- Translocation of species through biofouling of the vessel hull, anchors and/or niches (e.g. sea chests, bilges and strainers).
- Disposal of contaminated waste and materials.

Successful IMS invasion requires the following three steps:

- Colonisation and establishment of the marine pest on a vector (e.g., vessel hull) in a donor region (e.g., home port).
- Survival of the settled marine species on the vector during the voyage from the donor to the recipient region (e.g., project area).
- Colonisation (e.g., dislodgement or reproduction) of the marine species in the recipient region, followed by successful establishment of a viable new local population.

6.9.2 Predicted environmental risks

IMS or pathogens may become established where conditions are suitable, and these species may have impacts on local ecological and economic values. However, establishment of introduced marine species is mostly likely to occur in shallow waters in areas where large numbers of vessels are present and are stationary for an extended period.

If the risk of establishment of IMS is realised, the following known and potential environmental impacts may occur:

- Change in ecosystem dynamics.
- Changes to the functions, interests or activities of other users.

Change in ecosystem dynamics may include reduction in native marine species diversity and abundance, displacement of native marine species, socio-economic impacts on commercial fisheries, and changes to conservation values of protected area.

6.9.3 EMBA

Predicted impacts from the risk of establishment of IMS will be limited to the operational area. Receptors potentially affected include marine invertebrates and benthic habitats, and commercial fisheries.

6.9.4 Consequence evaluation

IMS or pathogens may become established where conditions are suitable, and these species may have impacts on local ecological and economic values. Establishment of introduced marine species is most likely to occur in shallow waters in areas where large numbers of vessels are present and are stationary for an extended period.

In the event of an IMS being introduced to the marine environment, successful colonisation is dependent upon suitable substrate availability. The operational area does not present a location conducive to marine pest survival because it is located in deep waters (greater than 70 m).

IMS introduced during the activity has the potential to impact ecosystem dynamics. As a result of a change in ecosystem dynamics, further impacts may occur, which include change in the functions, interests or activities of other users.

Receptors potentially impacted by a change in ecosystem dynamics include:

- Marine invertebrates
- Benthic habitat (soft sediment, macroalgae, soft corals)
- Commercial fisheries.

Given the distance from planned activities, no impacts to Australian Marine Parks are predicted.

Marine invertebrates and benthic habitats

IMS are likely to have little or no natural competition or predators, thus potentially outcompeting native species for food or space, preying on native species, or changing the nature of the environment. It is estimated that Australia has more than 250 established marine pests, and that approximately one in six introduced marine species becomes a pest (Department of the Environment, 2015). Once established, some pests can be difficult to eradicate (Hewitt et al., 2002) and therefore there is the potential for a long-term or persistent change in habitat structure. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open-water environments, where the number of dilutions and the degree of dispersal are high (Paulay et al., 2002).

The chances of successful colonisation in the Otway region are considered small given:

- The Fugro seabed survey (2019) identified that the seabed is dominated by exposed rock with very thin transgressive coarse sand and no rocky reefs or outcrops. This type of habitat is not conducive to the establishment of IMS and is outside of coastal waters where the risk of IMS establishment is considered greatest (BRS, 2007).
- The activity is geographically isolated from other subsea or surface infrastructure which might be suitable for colonisation.
- The offshore location of the activity does not present a location conducive to marine pest survival because it is located in deep waters with the operational area in water greater than 70 m.
- Areas of higher value or sensitivity are located away from the operational area with Twelve Apostles Marine National Park on the Victorian coast over 70 km away from the operational area. While unlikely, if an IMS was introduced, and if it did colonise an area, it is expected that any colony would remain fragmented and isolated, and only within the vicinity of the activity (i.e. it would not be able to propagate to nearshore environments, and protected marine areas present in the wider region).

Given the impact of a successful IMS colonisation has the ability to significantly impact local species and thus change local epifauna and infauna populations permanently, the consequences have been evaluated as Serious. However, it is considered such an event is Remote due to the unfavourable conditions within the operational area required for colonisation. As outlined in Section 6.9.5 Beach has demonstrated that the acceptability criteria is met and therefore, the residual risk is considered low.

Commercial fisheries

The introduction of IMS has the potential to result in changes to the functions, interest or activities of other users, including commercial fisheries. Marine pest species can deplete fishing grounds and aquaculture stock, with between 10% and 40% of Australia's fishing industry being potentially vulnerable to marine pest incursion. For example, the introduction of the Northern Pacific Seastar (*Asterias amurensis*) in Victorian and Tasmanian waters was linked to a decline in scallop fisheries (DSE, 2004). However, areas suitable for commercial scallop fishing are not expected near the well locations; commercially suitable scallop aggregations occur in the waters of eastern Victoria (Koopman et al. 2018).

AFMA have confirmed there is no fishing effort for Commonwealth fisheries within the operational area. There is some fishing effort from the Rock Lobster Fishery,

Whilst it has been assessed that the introduction of an IMS would have a Serious impact on state and Commonwealth fisheries the likelihood has been assessed as Remote. Beach has demonstrated that the acceptability criteria is met and therefore, the residual risk is considered low.

6.9.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Establishment of invasive marine pests	
ALARP decision context and justification	**ALARP Decision Context: Type B** On the basis of the impact assessment completed, Beach considers the control measures described are appropriate to manage the impacts associated with the risk of introduction and establishment of IMS. The Victorian DJPR have expressed interest in the management of IMS in Victorian State waters.
Adopted Control Measures	**Source of good practice control measures**
CM#13: Beach IMS Management Plan	All vessels mobilised from domestic waters to undertake offshore petroleum activities within the operational area must complete the Beach Domestic IMS Biofouling Risk Assessment Process as detailed in the Beach Introduced Marine Species Management Plan (S400AH719916) prior to the initial mobilisation into the operational area. The Beach Domestic IMS Biofouling Risk Assessment Process: • Validates compliance with regulatory requirements (Commonwealth and State) in relation to biosecurity prior to engaging in petroleum activities within the operational area; • Identifies the potential IMS risk profile of vessels and submersible equipment prior to deployment within the operational area; • Identifies potentially deficiency of IMS controls prior to entering the operational area; • Identifies additional controls to manage IMS risk; and

	• Prevents the translocation and potential establishment of IMS into non-affected environments (either to or from the operational area).

Additional controls assessed

Control	Control Type	Cost/Benefit Analysis	Control Implemented?
Only use vessels that are based in Victoria to reduce the potential for introducing IMS.	Equipment	A specialised installation vessel is required to undertake the activity. Using a vessel that is based in Victoria (if available) may reduce the likelihood of introducing an IMS but this would depend on the IMS risk level of the port where the vessel is based. The control measures that are to be implemented are required to be undertaken for vessels from any port in Victoria or Australia. Thus, there is limited environmental benefit associated with implementing this response.	Not selected

Consequence rating	Serious (3)
Likelihood of occurrence	Remote (1)
Residual risk	Low

Acceptability assessment

To meet the principles of ESD	The risk of the establishment of IMS was assessed as low and the consequence was assessed as serious which has the potential to result in serious or irreversible environmental damage. However, this is assessed as acceptable based on: There is little uncertainty associated with this aspect as the activities are well known, the cause pathways are well known, and activities are well regulated and managed. No impacts to MNES are predicted. The implementation of controls makes it a remote likelihood that IMS will be introduced from the activity resulting in a low residual risk. It is not considered that there is significant scientific uncertainty associated with this aspect. Therefore, the precautionary principle has not been applied.

Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding the introduction or establishment of invasive marine pests in relation to the activity.
Other requirements	The impact will be managed in accordance with legislation requirements and guidance, including: • Offshore Installations - Biosecurity Guide (DAWR 2019) • National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009) • Australian Ballast Water Management Requirements (Commonwealth of Australia, 2020) with gives effect to the Biosecurity Act 2015; International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention) and relevant guidelines or procedures adopted by the Marine Environment Protection Committee of the International Maritime Organization (IMO) • IMO Biofouling Guidelines There are no EPBC management plans (management plans, recovery plans or conservation advice) which relate specifically to IMS introduction and establishment as a threat. The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013) identifies IMS and diseases translocated by shipping, fishing vessels and other vessels as a threat to the AMP network. The implementation of the controls makes it unlikely that IMS will be introduced from the activity and spread to nearby AMPs.
Monitoring and reporting	Impacts as a result of the introduction of marine invasive species will be monitored and reported in accordance with the Section 7.10.
Acceptability outcome	Acceptable

6.10 Disturbance to marine fauna

6.10.1 Hazards

Disturbance to marine fauna could occur as a result of activities within the operational area, through:

- Vessel operations resulting in collision with marine fauna.

Disturbance from sound emissions is assessed in Section 6.4.

6.10.2 Potential environmental impacts

Disturbance to marine fauna can result in injury or death.

Disturbance to fauna from underwater noise emissions is addressed in Section 6.4.

6.10.3 EMBA

Predicted impacts resulting from the risk of disturbance to marine fauna will be limited to the operational area. Receptors include marine fauna, specifically slow moving marine fauna and seabirds.

6.10.4 Consequence evaluation

Marine fauna species most susceptible to vessel strike are typically characterised by one or more of the following characteristics:

- Commonly dwells at or near surface waters;
- Often slow moving or large in size;
- Frequents areas with a high levels of vessel traffic; and
- Fauna population is small, threatened, or geographically concentrated in areas that also correspond with high levels of vessel traffic.

The National Strategy for Mitigating Vessel Strike of Marine Mega-fauna (Commonwealth of Australia, 2017a) identifies cetaceans and marine turtles as being vulnerable to vessel collisions.

Three marine turtle species may occur within the operational area, though no BIAs or critical habitat to the survival of the species were identified. The Recovery Plan for Marine Turtles in Australia (DotEE, 2017d) identified vessel strike as a threat.

Three species of pinniped may occur within the operational area; the New Zealand fur-seal and the Australian fur-seal. No BIAs or habitat critical to the survival of the species were identified for pinnipeds.

Five whale species (or species habitat) may occur within the operational area. Foraging behaviours were identified for some species (sei, blue, fin and pygmy right whales); no other important behaviours were identified. The operational area intersects the current core coastal range for the southern right whale and a foraging BIA for the pygmy blue whale. The Conservation Management Plan for the blue whale and the southern right whale and Conservation Advice for the sei whale, fin whale and humpback whale identify vessel strike as a threat.

Protected species vulnerable to vessel strikes are identified as being transient in the area except for pygmy blue whales within the foraging BIA. Pygmy blue whales are likely to be foraging within the BIA (November to June) which overlaps the period of the activity (March – July). The Conservation Management Plan for the Blue Whale

(Commonwealth of Australia 2015b) detail that collisions will impede the recovery of blue whale populations if a sufficient number of individuals in the population lose reproductive fitness or are killed.

The occurrence of vessel strikes is very low with no incidents occurring to date associated with Beach's activities in the Otway or Bass Strait region. During the activity the CSV will predominantly be holding position and is unlikely to be moving at speeds or over distances which could result in collision with marine fauna.

The extent of the area where disturbance to marine fauna may occur is within the operational area and the risk could occur while the activity is undertaken. The severity is assessed as moderate and likelihood as remote based on:

- Within the operational area the CSV will be slow moving to stationary.
- The short duration of the activity (21 days).
- The occurrence of vessel strikes is very low with no incidents occurring to date associated with Beach's activities in the Otway or Bass Strait region.
- If an incident occurred, it would be restricted to individual fauna.

6.10.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Disturbance to marine fauna	
ALARP decision context and justification	**ALARP Decision Context: Type A** The risk of disturbance to marine fauna is well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to air emissions. As the risk is rated as low applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#5: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans describes strategies to ensure whales and dolphins are not harmed during offshore interactions with vessels.
CM# 14: Vessel speed restrictions	The National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna 2017(Commonwealth of Australia, 2017a) identifies that speed is a concern when considering collision risk and the outcome and that slower moving vessels provide greater opportunity for both fauna and vessel to avoid collision. Large, high-speed vessels, in particular, have become a major concern as they are capable of travelling at speeds of up to 35 to 40 knots, which correlates to an increase in collisions (Weinrich 2004; Ritter 2010 cited in Commonwealth of Australia, 2017a). The National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna 2017(Commonwealth of

	Australia, 2017a) does not make any recommendations in relation to a maximum vessel speed, but case studies within the strategy have implemented a 10 knot speed limit in sensitive areas. Furthermore, the strategy details, according to Laist et al. (2001), 89 % of incidences where the whale was severely hurt or killed occurred at vessel travelling speeds greater than 14 knots and were most serious in large vessels (> 80 m). Based on this information vessel speeds within the operational area will be restricted to 10 knots.
Consequence rating	Moderate (2)
Likelihood of occurrence	Remote (1)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	The risk of disturbance to marine fauna was assessed as low and the consequence was assessed as moderate which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding disturbance to marine fauna.
Other requirements	Disturbance to marine fauna will be managed in accordance with legislative requirements. Disturbance to marine fauna if it occurred will not: • Impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • Impact the recovery of the white shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a). • Impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • Impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). Actions from the recovery plan applicable to vessel collision will be implemented.

	• Impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • Impact the recovery of sei, fin whale or humpback whales, covered by conservation advice. Actions from the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) applicable to the activity to minimise vessel collisions have been addressed as per: • Ensure all vessel strike incidents are reported in the National Ship Strike Database. Vessel collision with protected marine fauna are required to be reported as detailed in Section 7.12 • Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented. Section 6.10 details the impact assessment and mitigation measures (controls) to be implemented to ensure impacts are of an acceptable level and ALARP.
Monitoring and reporting	Disturbance to protected marine fauna area required to be reported as detailed in Section 7.12.
Acceptability outcome	Acceptable

6.11 Unplanned marine discharges - solids

6.11.1 Hazards

Solids which may be accidentally discharged include:

- Waste maybe accidently blown overboard off the vessel.

6.11.2 Predicated environmental impacts

Solids accidently released to the marine environment may lead to injury or death to individual marine fauna through ingestion or entanglement.

6.11.3 EMBA

Impacts resulting from the risk of unplanned marine discharge (solids) will be limited to the operational area.

6.11.4 Consequence evaluation

The Threat Abatement Plan for the impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean (Commonwealth of Australia, 2018) details harmful marine debris impacts on a range of marine life, including protected species of birds, sharks, turtles and marine mammals. Harmful marine debris refers to all plastics and other types of debris from domestic or international sources that may cause harm to vertebrate marine wildlife. This includes land sourced plastic garbage (e.g. bags, bottles, ropes, fibreglass, piping, insulation, paints and adhesives), derelict fishing gear from recreational and commercial fishing activities and ship-sourced, solid non-biodegradable floating materials lost or disposed of at sea.

Solids accidently released to the marine environment may lead to injury or death to individual marine fauna through ingestion or entanglement. Impacts will be restricted in exposure and quantity and will be limited to individual fauna.

The operational area overlaps foraging BIAs for several albatross species, the wedge-tailed shearwater, common diving-petrel and short-tailed shearwater. No habitat critical to the survival of birds occur within the operational area. Marine debris is identified as a threat in the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a).

Three marine turtle species (or species habitat) may occur within the operational area though no BIAs or critical habitat to the survival of the species were identified. The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) identified marine debris as a threat.

Three species of pinniped (or species habitat) may occur within the operational area; the New Zealand fur-seal, the Australian fur-seal and the Australian sea lion. A foraging BIA for the Australian sea lion is present within the EMBA.

Five whale species (or species habitat) may occur within the operational area. Foraging behaviours were identified for some species (sei, blue, fin and pygmy right whales); no other important behaviours were identified. The operational area intersects a foraging BIA for the pygmy blue whale and the current core coastal range for the southern right whale.

The Conservation Management Plan for the blue whale and for the southern right whale and Conservation Advice for the sei whale, fin whale and humpback whale do not identify marine debris as threat.

The extent of the area of where the risk of unplanned waste being discharged to the marine environment is within the operational area and the risk could occur at any time. The severity is assessed as Minor and remote as unplanned release of waste is uncommon; if waste was lost overboard impacts would be restricted in exposure and quantity and would be limited to individual fauna.

6.11.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Unplanned marine discharges - Solids	
ALARP decision context and justification	**ALARP Decision Context: Type A** The risk of an unplanned marine discharge of solids impacts to marine fauna is well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation unplanned marine discharge of solids. As the risk is rated as low applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#15: MO 95: Marine Pollution Prevention – Garbage	Marine Order Part 95 (Marine pollution prevention — garbage gives effect to MARPOL Annex V. MARPOL is the International Convention for the Prevention of Pollution from Ships and is aimed at preventing both accidental pollution, and pollution from routine operations. Specifically, MARPOL Annex V requires that a garbage / waste management plan and garbage record book is in place and implemented.
Consequence rating	Minor (1)
Likelihood of occurrence	Remote (1)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	The risk of a marine fauna injury or death from unplanned discharge of solids was assessed as low and the consequence was assessed as minor which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).

External context	There have been no stakeholder objections or claims regarding marine fauna injury or death from unplanned discharge of solids
Other requirements	Waste on board the CSV will be managed in accordance with legislative requirements. Marine fauna injury or death from unplanned discharge of solids if occurred will not: • Impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • Impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • Impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • Impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • Impact the recovery of sei, fin whale or humpback whales, covered by conservation advice.
Monitoring and reporting	Unplanned discharge of solids is required to be reported as per Section 7.12.6.
Acceptability outcome	Acceptable

6.12 Loss of Containment – Minor Release of Hazardous Substances

6.12.1 Hazards

Several loss of containment scenarios of minor releases of hazardous substances have been identified as credible during Phase 5 Early Dive Campaign. These are described in Table 6-8.

There is no refuelling of the vessel within the operational area.

Table 6-8 Credible Loss of Containment (hazardous substances) scenarios

Scenario	Description
Loss of Containment – hazardous substances stored on the vessel	Routine operation of CSV includes handling, use and transfer of chemicals with the following were identified as potentially leading to a loss of containment event: • Use, handling and transfer of chemicals on board • Hydraulic line failure from equipment
Loss of Containment – hose failure	Hose failure during transfer of hazardous substances could occur as a result of equipment damage, resulting in a loss of containment of the hose volume.
Loss of containment – MEG	Loss of MEG could occur due to: • Failure in infrastructure system as a result of equipment damage, dropped object or human error. • Loss of containment during flushing activities

6.12.2 Predicted environmental impacts

The predicted environmental impacts of a loss of containment (hazardous substances) are:

- Change in water quality

As a result of a change in water quality, further impacts may occur, which include:

- Injury / mortality to fauna
- Change in fauna behaviour
- Change in ecosystem dynamics
- Changes to the functions, interests or activities of other users

6.12.3 EMBA

Impacts resulting from the risk of a loss of containment of hazardous substances will be limited to the operational area.

6.12.4 Consequence evaluation

An evaluation of the types of minor spill events was completed to determined indicative volumes associated with each type of event. Both hydraulic line failure and use of hazardous materials onboard were associated with small volume spill events – with the maximum volume based upon the loss of an intermediate bulk container ~1 m^3. Loss of containment of MEG could result in a maximum release of the flushing volume ~11 m^3

The potential consequence of a loss of containment of hazardous substances within the operational area would be limited to a localised and temporary change in water quality in the vicinity of the release, and the potential change to fauna behaviour within surface waters affected by the spill, such as avoidance. As such, the consequence of this scenario has been evaluated as Minor (1) given there is unlikely to be a lasting effect to biological and physical environment in an area that is not formally managed.

6.12.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Loss of Containment – hazardous substances	
ALARP decision context and justification	**ALARP Decision Context: Type A** The risk of a minor spill is well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to minor spills during the activity. As the risk is rated as low applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#16: Spill containment	Vessel management system includes provision to maintain spill containment aboard the vessel and clean spills aboard the vessel to prevent release to the marine environment.
CM#18: Crane handling and transfer procedure	The crane handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects.
Consequence rating	Minor (1)
Likelihood of occurrence	Unlikely (3)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	The risk of a loss of containment (hazardous substances) was assessed as low and the consequence was assessed as minor which is not considered as having the potential to result in serious or irreversible environmental

	damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding loss of containment (hazardous substances).
Other requirements	Loss of containment (hazardous substances) will be managed in accordance with legislative requirements. Loss of containment (hazardous substances) will not: • impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • impact the recovery of the white shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a). • impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • impact the recovery of sei, fin whale or humpback whales, covered by conservation advice.
Monitoring and reporting	Loss of containment (hazardous substances) are required to be reported as per Section 7.10.
Acceptability outcome	Acceptable

6.13 Loss of Containment – damage to existing subsea infrastructure

6.13.1 Hazards

There is the potential for damage to existing subsea petroleum infrastructure from the accidental loss of an object from the CSV during the activity. For this activity, dropped objects may include ROV baskets, production spools, flying lead deployment frames and any unsecured equipment (e.g., tools and hardware) that may be accidentally dropped overboard during crane lifting and hoisting operations.

No planned lifts or crane operations will be undertaken directly over the production export pipeline and MEG pipeline, which are located to the west of the Thylacine-A wellhead platform.

6.13.2 Predicted environmental impacts

The predicted environmental impacts of a dropped objects on existing subsea petroleum infrastructure are:

- Change in water quality

As a result of a change in water quality, further impacts may occur, which include:

- Injury / mortality to fauna
- Change in fauna behaviour
- Change in ecosystem dynamics
- Changes to the functions, interests or activities of other users

6.13.3 EMBA

Impacts resulting from the risk of dropped objects on existing subsea petroleum infrastructure will be limited to the operational area.

6.13.4 Consequence evaluation

In the event of a dropped object to the marine environment, potential environmental effects would be limited to localised physical impacts on benthic habitats and communities. If the dropped object is recovered, this impact will be temporary in nature. If the object cannot be recovered, then the impact may be longer.

There is no risk of a well blowout within the activity area because there are no wells within the operational area. As such, a catastrophic loss of hydrocarbons will not occur.

No planned lifting or crane activities will occur directly over the production export pipeline or MEG line. These pipelines are also entirely covered in stabilisation mattresses, which act as protection from dropped objects. There is therefore no risk of an uncontrolled release from the pipeline or MEG line.

The potential consequence of a damage to existing infrastructure within the operational area would be limited to a localised and temporary change in water quality in the vicinity of the release, and the potential change to fauna behaviour within surface waters affected by the spill, such as avoidance. As such, the consequence of this scenario has been evaluated as Minor (1) given there is unlikely to be a lasting effect to biological and physical environment in an area that is not formally managed.

6.13.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: damage to existing infrastructure	
ALARP decision context and justification	**ALARP Decision Context: Type A** The risk of damage to existing infrastructure is well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to damage to existing infrastructure during the activity. As the risk is rated as low applying good industry practice (as defined in Section 5.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#18: Crane handling and transfer procedure	The crane handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects.
Consequence rating	Minor (1)
Likelihood of occurrence	Unlikely (3)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	The risk of damage to existing infrastructure was assessed as low and the consequence was assessed as minor which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	There have been no stakeholder objections or claims regarding damage to existing infrastructure.
Other requirements	Damage to existing infrastructure will be managed in accordance with legislative requirements. Damage to existing infrastructure will not:

	• impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • impact the recovery of the white shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a). • impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • impact the recovery of sei, fin whale or humpback whales, covered by conservation advice.
Monitoring and reporting	Any loss of containment (hazardous substances) resulting from damage to existing infrastructure are required to be reported as per Section 7.10.
Acceptability outcome	Acceptable

6.14 Loss of Containment - diesel

6.14.1 Hazards

MDO is used in offshore vessels. A collision between a Beach contracted vessel (i.e. the CSV) and third-party vessel has the potential to result in a spill of fuel. The following events have the potential to result in a spill of fuel:

- A collision between the CSV and third-party vessel.

No refuelling will occur during Phase 5 Early Dive Installation Campaign.

A vessel collision typically occurs as a result of:

- Mechanical failure/loss of DP
- Navigational error, or
- Foundering due to weather.

Grounding is not considered credible due to the water depths typically being greater than 10 m and absence of submerged features in the operational area.

6.14.1.1 Characteristics of diesel oils

Diesel oils are generally considered to be low viscosity, non-persistent oils, which are readily degraded by naturally occurring microbes.

Diesel oils are considered to have a higher aquatic toxicity in comparison to many other crude oils due to the types of hydrocarbon present and their bioavailability. They also have a high potential to bio-accumulate in organisms.

Marine diesel is a medium-grade oil (classified as a Group II oil) used in the maritime industry. It has a low density, a low pour point and a low dynamic viscosity (Table 6-9), indicating that this oil will spread quickly when spilled at sea and thin out to low thicknesses, increasing the rate of evaporation.

Due to its chemical composition, approximately 40% will generally evaporate within the first day, with the remaining volatiles evaporating over 3-4 days depending upon the prevailing conditions. Diesel shows a strong tendency to entrain into the upper water column in the presence of moderate winds and breaking waves (>12 knots) but floats to the surface when conditions are calm, which delays the evaporation process. Table 6-10 shows the boiling point ranges for the diesel used in the spill modelling.

Table 6-9: Physical characteristics of marine diesel oil

Parameter	***Characteristics***
Density (kg/m3)	829 at 15oC
API	37.6
Dynamic viscosity (cP)	4.0 at 25oC
Pour point (°C)	-14
Oil category	Group II
Oil persistence classification	Light-persistent oil

Table 6-10: Boiling point ranges of marine diesel oil

Characteristic	***Volatiles (%)***	***Semi-volatiles (%)***	***Low volatiles (%)***	***Residual (%)***
Boiling point (°C)	<180	180 – 265	265 – 380	>380
Marine diesel oil	6.0	34.6	54.4	5
	Non-Persistent			Persistent

On release to the marine environment, diesel would evaporate and decay and be distributed over time into various components. Of these components, surface hydrocarbons, entrained hydrocarbons (non-dissolved oil droplets that are physically entrained by wave action) and dissolved aromatics (principally the aromatic hydrocarbons) have the most significant impact on the marine environment. These are discussed in further detail below.

6.14.2 Quantitative hydrocarbon spill modelling

Beach commissioned RPS Australia West Pty Ltd (RPS) to conduct quantitative spill modelling (Appendix A) for a credible, yet hypothetical, worst-case hydrocarbon release scenario.

Scenario 1: a 300 m^3 surface release of marine diesel oil (MDO) over 6 hours.

This scenario represents a loss of inventory from the largest fuel tank on the CSV due to a hypothetical vessel collision incident. The calculation of discharge volume and timing aligns with the methodology recommended in the AMSA Technical guidelines for preparing contingency plans for marine and coastal facilities (Commonwealth of Australia, January 2015).

The spill modelling was undertaken at the Artisan-1 well location. To develop the diesel spill EMBA the low threshold boundary for the vessel spill modelling at the Artisan-1 well location was duplicated and repositioned over the Phase 5 Early Dive Installation Campaign location.

6.14.2.1 Hydrocarbon exposure thresholds

In the event of an oil pollution incident, the environment may be affected in several ways, depending on the concentration and duration of exposure of the environment to hydrocarbons. The hydrocarbon exposure thresholds presented in Table 6-11 are considered appropriate to:

- Predict potential hydrocarbon contact at conservative (low exposure) concentrations and inform the description of the environment (Section 3), inform the EPBC Protected Matters Search (Appendix A) and identify the AMP, Marine National Parks MNP, Marine Parks (MP), and Ramsar wetlands that may require monitoring in the event of a worst-case discharge based upon conservative (low exposure) in-water thresholds;
- Inform the oil spill impact and risk evaluation; and
- Inform oil spill response planning based upon potentially actionable concentrations of hydrocarbons (see OPEP) and potential monitoring requirements (see Section 7.9.4 and OSMP).

Table 6-11: Hydrocarbon exposure thresholds

Exposure type	***Exposure threshold***		
	Low exposure	**Moderate exposure**	**High exposure**
Surface	0.5 g/m^2	10 g/m^2	25 g/m^2
Shoreline	10 g/m^2	100 g/m2	1,000 g/m^2
Entrained*	10 ppb	100 ppb	1,000 ppb
Dissolved*	6 ppb	50 ppb	400 ppb

* In-water (entrained & dissolved) hydrocarbon thresholds are based upon an instantaneous (1 hr) hydrocarbon exposure

Beach also applies a time-based exposure (ppb.hrs) for in-water hydrocarbons to evaluate the potential consequences associated with hydrocarbon contact at various concentrations, considering potential exposure pathways for various receptor types. Time-based exposure is not used to inform the outer geographical extent of potential hydrocarbon contact to various receptors.

The quantitative spill modelling assessment was completed for two distinct periods, defined by the unique prevailing wind and general current conditions; summer (November–April) and winter (May–October).

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 modelling study was carried out in several stages. Firstly, a five-year current dataset (2008–2012) that includes the combined influence of ocean currents from the HYCOM model and tidal currents from the HYDROMAP model was developed. Secondly, high-resolution local winds from the Climate Forecast System Reanalysis model and detailed hydrocarbon characteristics were used as inputs in the three-dimensional oil spill model (SIMAP) to simulate the drift, spread, weathering and fate of the spilled oils.

As spills can occur during any set of wind and current conditions, modelling was conducted using a stochastic (random or non-deterministic) approach, which involved running 100 spill simulations per season for each scenario initiated at random start times, using the same release information (spill volume, duration and composition of the oil). This ensured that each simulation was subject to different wind and current conditions and, in turn, movement and weathering of the oil.

6.14.3 Extent of potential hydrocarbon exposure

The extent of possible exposure to hydrocarbons is based upon a hypothetical worst-case 300 m^3 surface release of MDO over 6 hours at the Artisan-1 well location with results derived from the Artisan-1 Exploration Well Oil Spill Modelling, RPS 2019 (Appendix B). The extent of potential hydrocarbon exposure at moderate thresholds (including 48-hour time-based in-water dissolved and entrained) for a marine diesel spill scenario is presented in Figure 6-3.

Potential extent of hydrocarbon exposure to Australian Marine Parks

Whilst Apollo AMP could potentially be exposed to moderate (instantaneous) thresholds of entrained hydrocarbons (up to 7% summer and 16% winter), spill modelling indicates there in no potential for Apollo AMP to be impacted by moderate or high time-based in-water exposure thresholds.

No AMPs are predicted to be exposed to high (instantaneous or time-based) thresholds of dissolved or entrained hydrocarbons.

Potential extent of hydrocarbon exposure to surface waters

During summer conditions, moderate (10 g/m^2) exposure to surface hydrocarbons were predicted to travel a maximum distance of 12 km from the release location. During winter, moderate exposure of surface hydrocarbons extended to a maximum distance of 10 km from the release location.

None of the receptors identified within the modelling report were exposed at or above the moderate or high (>25 g/m^2) thresholds. However, spill modelling indicates potential summer and winter exposure to surface waters up to a maximum of 6 km from the release location of 48% and 41% probability respectively.

Potential extent of hydrocarbon exposure to shorelines

No shoreline contact above the minimum threshold (>10 g/m^2) was predicted for any of the seasons modelled.

Potential extent of in-water dissolved hydrocarbon exposure

The averaged dissolved hydrocarbon concentrations over 48 hours was highest within open ocean surrounding the release location registered 8 ppb and 9 ppb during summer and winter conditions, respectively based upon a 1% probability of exposure in open waters surrounding the release location. No identified receptors were exposed at or above the low 48-hour time-based dissolved hydrocarbon exposure threshold.

Based on the 1-hour (instantaneous) exposure window, the greatest predicted dissolved hydrocarbon concentration was 76 ppb during summer and 59 ppb during winter. Open waters surrounding the release location recorded a probability of 2% and 3% during the summer and winter conditions, respectively, based on the moderate instantaneous threshold. There was no predicted exposure to identified receptors at either moderate or high instantaneous thresholds.

Potential extent of in-water 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. While there is potential (1-2% probability) of low

(10 ppb) exposure (over a 48-hour window) in open waters surrounding the release location, none of the identified receptors were exposed at or above the moderate (10-100 ppb) or high (>1,000 ppb) thresholds.

Within the 0-10 m depth layer, the maximum entrained hydrocarbon exposure (over 1 hour) for the open waters surrounding the release location was 5,933 ppb and 5,046 ppb, during summer and winter conditions, respectively. For identified receptors, 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 MNP) to 16% (Apollo AMP) during winter conditions. No receptors were exposed at or above the high threshold (>1,000 ppb).

6.14.4 Predicted environmental impacts

The known and potential environmental impacts of a diesel spill are:

- Change in water quality

As a result of a change in water quality, further impacts may occur, which include:

- Injury / mortality to fauna
- Change in fauna behaviour
- Change in ecosystem dynamics
- Changes to the functions, interests or activities of other users

6.14.5 Consequence evaluation

The potential environmental impacts to receptors within the EMBA are discussed in Table 6-12 to Table 6-15.

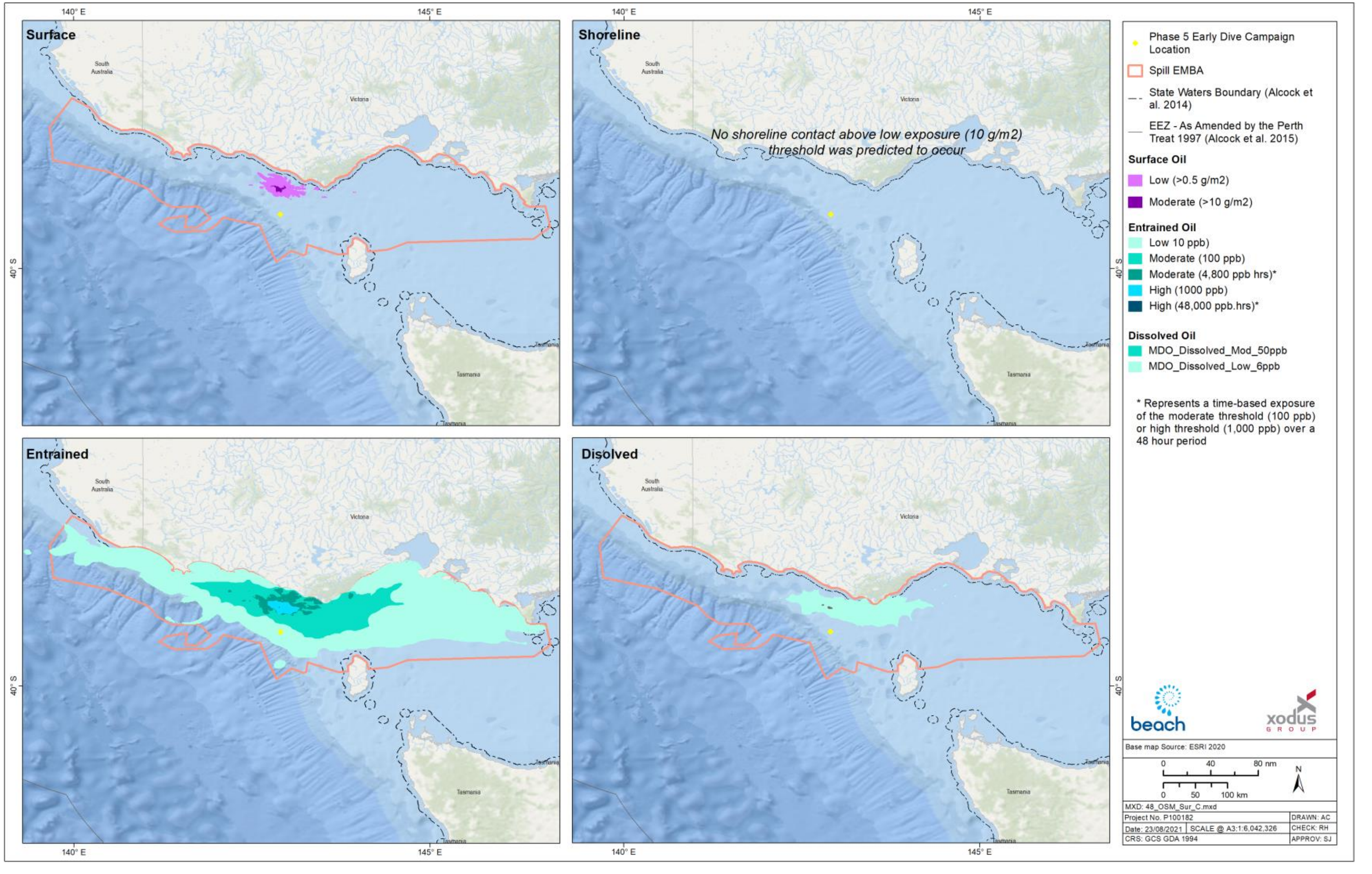


Figure 6-3: Environment potentially exposed to hydrocarbons from a hypothetical 300 m^3 diesel spill at Artisan-1 over 6 hours

Table 6-12: Consequence evaluation to ecological receptors within the EMBA – sea surface

Receptor Group	***Receptor Type***	***Impact***	***Exposure Evaluation***	***Consequence Evaluation***
Marine fauna	Seabirds	Change in fauna behaviour Injury / mortality to fauna	Several listed Threatened, Migratory and/or listed marine species have the potential to be rafting, resting, diving and feeding within 12 km of the release location predicted to be exposed to moderate levels of surface hydrocarbons. Foraging BIAs for several albatross species, the wedge-tailed shearwater, common diving-petrel and short-tailed are present in the area Figure 4-26 and Figure 4-27) predicted to be above threshold. Foraging and breeding BIAs for little penguins are within the EMBA (Figure 4-26), however are well beyond the predicted area of surface exposure at >10 g/m2, Colonies of little penguins, without defined BIAs, are known to along parts of Port Campbell Bay area; therefore, it is possible that little penguins may be present in the area exposed to surface hydrocarbon >10g/m2.	When first released, diesel has higher toxicity due to the presence of volatile components. Individual birds making contact close to the spill source at the time of the spill (i.e. areas of concentrations >10 g/m^2 out to 12 km from the release location) may be impacted; however, it is unlikely that many birds will be affected as volatile surface hydrocarbons are expected to evaporate over 3-4 days. Seabirds rafting, resting, diving or feeding at sea have the potential to encounter areas where hydrocarbons concentrations are greater than 10 g/m2 and due to physical oiling may experience lethal surface concentrations. As such, acute or chronic toxicity impacts (death or long-term poor health) to birds are possible but unlikely for a diesel spill because of the limited period of exposure above 10 g/m2. Sea surface oil >10 g/m2 (10 µm) is only predicted for the first 36 hrs limiting the period when oiling may occur. Therefore, potential impact would likely be limited to individuals, however, impacts to aggregations may occur. Consequently, the potential consequence to seabirds is considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 6.14.6.
	Marine reptiles	Change in fauna behaviour	There may be marine turtles in the area predicted to be exposed to surface oil. However, there are no BIAs or habitat critical	Marine turtles are vulnerable to the effects of oil at all life stages. Marine turtles can be exposed to surface oil externally (i.e. swimming through oil slicks) or internally (i.e. swallowing the oil). Ingested oil

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
		Injury / mortality to fauna	to the survival of the species within this area (Section 4.6.7.5).	can harm internal organs and digestive function. Oil on their bodies can cause skin irritation and affect breathing. The number of marine turtles that may be exposed to surface diesel is expected to be low as there are no BIAs or habitat critical to the survival of the species present; however, turtles may be transient within the EMBA. Sea surface oil >10 g/m2 (10 µm) is only predicted for the first 36 hrs limiting the period when oiling may occur. Therefore, potential impact would likely be limited to individuals, with population impacts not anticipated. Consequently, the potential consequence to marine turtles are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value Refer to management advice and evaluation of acceptability in Section 6.14.6.
	Pinnipeds (seals and sea lions)	Change in fauna behaviour Injury / mortality to fauna	The Australian and New Zealand fur-seals may occur within the area predicted to be exposed to surface hydrocarbons >10 g/m2. No BIAs, breading colonies or haul outs areas are within the area of exposure (Section 4.6.7.7). There is a foraging BIA for the Australian sea-lion but it is outside of the predicted area of surface exposure at >10 g/m2.	Seals are vulnerable to sea surface exposures given they spend much of their time on or near the surface of the water, as they need to surface every few minutes to breathe. Exposure to surface oil can result in skin and eye irritations and disruptions to thermal regulation. Fur seals are particularly vulnerable to hypothermia from oiling of their fur. The number of seals that may be exposed to surface diesel at >10 g/m2 is expected to be low as there are no BIAs or habitat critical to the survival of the species present; however, seals may be transient in low numbers within areas of potential surface exposure at >10 g/m2 (Section 4.6.7.7). Sea surface oil >10 g/m2 (10 µm) is only

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				predicted for the first 36 hrs limiting the period when oiling may occur. Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Consequently, the potential consequence to pinnipeds are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value Refer to management advice and evaluation of acceptability in Section 6.14.6.
	Cetaceans (whales)	Change in fauna behaviour Injury / mortality to fauna	Several threatened, migratory and/or listed marine species have the potential to be within the area predicted to be exposed to surface hydrocarbons of >10 g/m2. Surface exposure of >10 g/m2 is expected to extend out 12 km from the release location i.e., a relatively small areas compared to the overall distribution area of cetaceans. BIAs for foraging for pygmy blue whales and distribution for southern right whale are within the area predicted to be exposed to surface hydrocarbons >10 g/m2 (Section 4.6.7.6).	Geraci (1988) found little evidence of cetacean mortality from hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur. While this reduces the potential for physiological impacts from contact with hydrocarbons, active avoidance of an area may displace individuals from important habitat, such as foraging. If whales are foraging at the time of the spill, a greater number of individuals may be present in the area where sea surface oil is present, however sea surface oil >10 g/m2 (10 µm) is only predicted for the first 36 hrs limiting the period when oiling may occur. Also, the area exposed by moderate levels of surface hydrocarbons (12 km from the release location) is relatively small compared to the overall distribution area of cetaceans. Given this is a relatively small area of the total foraging BIA for pygmy blue whales and current core coastal range for southern right whales, the risk of displacement to whales is considered low.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				There is potential for interaction with southern right whales given the activity window overlaps with the northern migration period of May-June, and the peak breeding (July-August) (Section 4.6.7.6). The activity timing overlaps with the blue whale season for migration and foraging in the operational area and EMBA. Visual and acoustic surveys suggest that blue whales are present in the Otway region between November to June, peaking in February and March (Section 4.6.7.6). There is no population estimate for blue whales globally or in Australia and they are EPBC listed as endangered and migratory. Blue whales are highly mobile and widespread across the world's oceans. Aerial surveys in the Otway region recorded mean Blue whale group size of 1.3±0.6 per sighting with cow-calf pairs observed in 2.5% of the sightings (Gill et al. 2011). However, acknowledging there is scientific uncertainty with specific whale numbers within the vicinity of the Phase 5 Early Dive Campaign location, and given activities may occur during upwelling events, it is expected that foraging whales would be present in the area. As such in the event of a spill potential hydrocarbon exposure could possibly affect aggregations of blue or other foraging whale species. Consequently, the potential consequence to cetaceans are considered to be Moderate, as they could be expected to result in localised short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 6.14.6.
	Cetaceans (dolphins)	Change in fauna behaviour	There may be dolphins in the area predicted to be exposed to surface oil (>10 g/m2 - 12 km from the release location). However,	Dolphins surface to breathe air and may inhale hydrocarbon vapours or be directly exposed to dermal contact with surface hydrocarbons. Direct contact with oil can result in direct impacts to the animal, due

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
		Injury / mortality to fauna	there are no BIAs or habitat critical to the survival of the species (Section 4.6.7.6).	to toxic effects if ingested, damage to lungs when inhaled at the surface, and damage to the skin and associated functions such as thermoregulation (AMSA 2010). Dolphins are highly mobile and are considered to have some ability to detect and avoid oil slicks. Direct surface hydrocarbon contact may pose little problem to dolphins due to their extraordinarily thick epidermal layer which is highly effective as a barrier to the toxic, penetrating substances found in hydrocarbons. The number of dolphins exposed is expected to be low. If dolphins are foraging at the time of the spill, a greater number of individuals may be present in the area where sea surface oil is present, however due to the short duration of the surface exposure above the impact threshold (approximately 36 hours), this is not likely. Consequently, the potential consequence to dolphins are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 6.14.6.

Table 6-13: Consequence evaluation to socio-economic receptors within the EMBA – sea surface

Receptor Group	***Receptor Type***	***Impact***	***Exposure Evaluation***	***Consequence Evaluation***
Human systems	Recreation and tourism (including recreational fisheries)	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in impacts to marine-based tourism from reduced visual aesthetic. The modelling predicts (visible surface rainbow sheen) surface sheens (0.5 g/m2) may occur up to 93 km from the release location. This oil may be visible as a rainbow sheen on the sea surface during calm conditions.	Visible surface hydrocarbons (i.e. a rainbow sheen) have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. However, the relatively short duration means there may be short-term and localised consequences, which are ranked as Moderate. Refer also to: • Cetaceans (whales) Refer to management advice and evaluation of acceptability in Section 6.14.6.
	Industry (shipping)	Displacement of other marine users	Shipping occurs within the area predicted to be exposed to surface hydrocarbons >10 g/m2 (12 km from the release location).	Vessels may be present in the area where sea surface oil is present, however, due to the short duration of the surface exposure (approximately 36 hours) deviation of shipping traffic would be unlikely.
	Industry (oil and gas)	Displacement of other marine users	There are no oil and gas operations or activities within the area predicted to be exposed to surface hydrocarbons >10 g/m2 (12 km from the release location).	No impact as there are no non-Beach oil and gas platforms located within the area predicted to be exposed to surface hydrocarbons.

Table 6-14: Consequence evaluation to physical and ecological receptors within the EMBA – in water

Receptor Group	***Receptor Type***	***Impact***	***Exposure Evaluation***	***Consequence Evaluation***
Habitat	Algae	Change in habitat	Macroalgae communities may be within the overall area potentially exposed to moderate levels of in-water entrained hydrocarbons. Video surveys confirmed the presence of high density macroalgae dominated epibenthos in waters shallower than 20 m, however, it is not a dominant habitat feature in eastern Victoria (Section 4.6.1.3). Note that the greater wave action and water column mixing within the nearshore environment will also result in rapid weathering of the MDO residue.	Smothering, fouling and asphyxiation are some of the physical effects that have been documented from oil contamination in marine plants (Blumer 1971; Cintron et al. 1981). The effect of hydrocarbons however is largely dependent on the degree of direct exposure, and the presence of morphological features (e.g. a mucilage layer and/or fine 'hairs') will directly influence the amount of hydrocarbon that will adhere to the algae. Generally, the effects of oil on macroalgae, such as kelp and many other species which dominate hard substrata in shallow waters is small due to their mucilaginous coating that resists oil absorption. Hydrocarbons may contact the intertidal shores as the tide ebbs, but it would be expected that this would be flushed with each flood tide. Natural flushing is more likely to reduce impacts in exposed areas of shoreline. Consequently, the potential consequence to algae are considered to be Minor, as they could be expected to result in localised low-level impacts.
	Soft Coral	Change in water quality Change in habitat	Corals do not occur as a dominant habitat type within the EMBA, however their presence has been recorded around areas such as Wilsons Promontory National Park and Cape Otway (Section 4.6.1.4). In-water exposure (entrained) is only predicted to occur within intertidal or shallow nearshore waters. Note that the greater wave action and water column mixing within the nearshore	Exposure of entrained hydrocarbons to shallow subtidal corals has the potential to result in lethal or sublethal toxic effects, resulting in acute impacts or death at moderate to high exposure thresholds (Shigenaka, 2001). Contact with corals may lead to reduced growth rates, tissue decomposition, and poor resistance and mortality of sections of reef (NOAA, 2010). However, given the lack of coral reef formations, no predicted dissolved in-water hydrocarbon exposure and the sporadic cover of hard or soft

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			environment will also result in rapid weathering of the hydrocarbon.	corals in mixed nearshore reef communities along the Otway coast, such impacts are considered to be limited to smothering of isolated corals. Hydrocarbons may contact the intertidal shores as the tide ebbs, but it would be expected that this would be flushed with each flood tide. Natural flushing is more likely to reduce impacts in exposed areas of shoreline. Consequently, the potential consequence to corals are considered to be Minor, as they could be expected to result in localised low-level impacts.
	Seagrass	Change in habitat	In-water exposure (entrained) is only predicted to occur within the surface layers with the potential to contain seagrasses. Note that the greater wave action and water column mixing within the nearshore environment will also result in rapid weathering of the MDO. Seagrass may be present within the area predicted to be exposed to in-water hydrocarbons (e.g. seagrass is known to occur within Twelve Apostles Marine Park) (Section 4.6.1.2). Exposure in nearshore and intertidal areas is predicted to only be at moderate thresholds (e.g. instantaneous exposure >100 ppb for entrained hydrocarbons only).	There is the potential that entrained in-water hydrocarbon exposure could result in sub-lethal impacts from smothering, more so than lethal impacts, possibly because much of seagrasses' biomass is underground in their rhizomes (Zieman et al., 1984). Given the restricted range of exposure (shallow nearshore and intertidal waters only), no predicted dissolved in-water hydrocarbon exposure and the predicted moderate concentrations of entrained hydrocarbons expected to be in these waters, any impact to seagrass is not expected to result in long-term or irreversible damage. Consequently, the potential consequence to seagrass are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to habitat of recognised conservation value.
Marine fauna	Plankton	Injury/Mortality to fauna	Plankton are likely to be exposed to entrained hydrocarbons. Effects will be greatest in the upper 10 m of the water column and areas close	Relatively low concentrations of hydrocarbon are toxic to both plankton [including zooplankton and ichthyoplankton (fish eggs and larvae)]. Plankton risk exposure through ingestion, inhalation and dermal contact. Impacts would predominantly result from exposure to dissolved fractions,

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			to the spill source where hydrocarbon concentrations are likely to be highest.	as larval fish and plankton are pelagic, and are moved by seawater currents. Potential impacts would largely be restricted to planktonic communities, which would be expected to recover rapidly following a hydrocarbon spill. Plankton are numerous and widespread but do act as the basis for the marine food web, meaning that an oil spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level Section 4.6.4). Once background water quality conditions have re-established, the plankton community may take weeks to months to recover (ITOPF, 2011a), allowing for seasonal influences on the assemblage characteristics. Additionally, with the elevated nutrient loading expected during seasonal upwelling events within the Otway region (November to April), plankton are likely to recover more rapidly than when upwelling of nutrient-rich waters is less prevalent. Consequently, given the limited area exposed by moderate levels of dissolved hydrocarbons, the potential consequence to plankton are considered to be Minor, as they could be expected to result in localised low-level short-term and recoverable impacts.
	Marine invertebrates	Injury/Mortality to fauna	In-water invertebrates of value have been identified to include squid, crustaceans (rock lobster, crabs) and molluscs (scallops, abalone). Impact by direct contact of in-water hydrocarbons to benthic species in the deeper areas of potential exposure are not expected. Species located in shallow nearshore or intertidal	Acute or chronic exposure through contact and/or ingestion can result in toxicological risks. However, the presence of an exoskeleton (e.g. crustaceans) reduces the impact of hydrocarbon absorption through the surface membrane. Invertebrates with no exoskeleton and larval forms may be more prone to impacts. Localised impacts to larval stages may occur which could impact on population recruitment that year.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			waters may be exposed to in-water hydrocarbons. Several commercial fisheries for marine invertebrates are within the area predicted to be exposed to moderate levels of entrained in-water hydrocarbons.	Tainting of recreation or commercial species is considered unlikely to occur given exposure is limited to entrained hydrocarbons, however if it did it is expected to be localised and low level with recovery expected. Consequently, the potential consequence to invertebrates, including commercially fished invertebrates are considered to be Moderate, as they could be expected to result in localised short-term impacts to species of value.
	Fish	Injury/Mortality to fauna	Entrained hydrocarbon droplets can physically affect fish exposed for an extended duration (weeks to months). Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest. Several fish communities in these areas are demersal and therefore more prevalent towards the seabed, which is not likely to be exposed). Therefore, any impacts are expected to be highly localised. The Australian grayling spends most of its life in fresh water, with parts of the larval or juvenile stages spent in coastal marine waters, therefore it is not expected to be present in offshore waters in large numbers. There is a known distribution and foraging BIA for the white shark in the EMBA, however, it is not expected that this species spends a large	Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2011a). Subsurface hydrocarbons could potentially result in acute exposure to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. Consequently, the potential consequence to fish, including those commercially fished, are considered to be Moderate, as they could be expected to result in localised low-level short-term impacts to species of value. Impacts on fish eggs and larvae entrained in the upper water column are not expected to be significant given the temporary nature of the resulting change in water quality. As egg/larvae dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will rapidly replace any oil affected populations.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			amount of time close to the surface where thresholds may be highest.	Consequently, the potential consequence to eggs/larva are considered to be Minor, as they could be expected to result in localised low-level short-term impacts. Refer to management advice and evaluation of acceptability in Section 6.14.6.
	Pinnipeds (seals and sea lions)	Injury/Mortality to fauna Change in fauna behaviour	The PMST report identified three pinnipeds that potentially occur in the EMBA (Australian sea lion, Australian and New Zealand fur-seal) (Section 4.6.7.7). There are no identified BIAs for seals within the EMBA. Known breeding colonies for Australian fur-seals are on islands off the coast; Kanowna Island, Rag Island, West Moncoeur Island, Lady Julia Percy Island and Seal Rocks (Vic). Cape Bridgewater is also a known haul out site. Seal Rocks on King Island is also a New Zealand fur-seal breeding colony. A foraging BIA for the Australian sea-lion is located west and north-west of Beachport within the EMBA. This BIA overlaps both South Australian State waters and the Bonney Coast Upwelling KEF, therefore the predicted hydrocarbon exposure to these areas is likely to also contact with the foraging BIA. There is no predicted exposure to the Bonney Coast Upwelling KEF at the low (48-hour) threshold exposure. A maximum entrained hydrocarbon exposure for a 1-hour window is predicted to be	Exposure to moderate effect levels of hydrocarbons in the water column or consumption of prey affected by the oil may cause sub-lethal impacts to pinnipeds. Due to the temporary and localised nature of the spill, their widespread nature, the low-level exposure zones and rapid loss of the volatile components of diesel in choppy and windy seas (such as that of the area exposed by moderate in-water hydrocarbon thresholds), the potential consequence to pinnipeds are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 6.14.6.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			98 ppb with a 22% probability of low instantaneous exposure to the KEF. There is no predicted dissolved exposure to South Australian State waters and the maximum time entrained hydrocarbon exposure for a 48-hour window is 31 ppb and 26 ppb for a 1-hour window based upon a 2% probability of contact. Known breeding colonies of Australian fur-seals are unlikely to be exposed to moderate in-water exposure thresholds, and the foraging BIA for the Australian Sea-lion is not within the predicted area of moderate in-water exposure. Given the mobility of pinnipeds, there may be small numbers of seals and sea-lions in the areas predicted to be temporarily exposed to moderate concentrations of in-water hydrocarbons in the water column, noting that in-water exposure (dissolved or entrained) is only predicted to occur within the upper layers of the water column.	
	Cetaceans (whales and dolphins)	Injury/Mortality to fauna Change in fauna behaviour	Several threatened, migratory and/or listed marine cetacean species have the potential to be migrating, resting or foraging within an area predicted to be exposed to in-water hydrocarbons.	Cetacean exposure to entrained hydrocarbons can result in physical coating as well as ingestion (Geraci and St Aubin, 1988). Such impacts are associated with ‘fresh’ hydrocarbon; the risk of impact declines rapidly as the MDO weathers. The potential for impacts to cetaceans and dolphins would be limited to a relatively short period following the release and would need to coincide

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			Known BIAs are present for foraging for pygmy blue whales and distribution for southern right whale in area exposed to moderate in-water thresholds, i.e. >50 ppb for dissolved and >100 ppb for entrained.	with seasonal foraging or aggregation event to result in exposure to a large number of individuals, as may be the case during seasonal upwelling events within the Otway region. However, such exposure is not anticipated to result in long-term population viability effects. A proportion of the foraging or distributed population of whales could be affected in the relatively localised area and water depth of the total foraging BIA for pygmy blue whales and current core coastal range for southern right whales. Consequently, the potential consequence to cetaceans are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 6.14.6.

Table 6-15: Consequence evaluation to socio-economic receptors within the EMBA – in water

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Human system	Commercial and recreational fisheries	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	In-water exposure to entrained diesel may result in a reduction in commercially targeted marine species, resulting in impacts to commercial fishing and aquaculture.	Any acute impacts are expected to be limited to small numbers of juvenile fish, larvae, and planktonic organisms, which are not expected to affect population viability or recruitment. Impacts from entrained exposure are unlikely to manifest at a fish population viability level. Any exclusion zone established would be limited to the immediate vicinity of the release point, and due to the rapid weathering of diesel

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			Actual or potential contamination of seafood can affect commercial and recreational fishing and can impact seafood markets long after any actual risk to seafood from a spill has subsided (NOAA, 2002) which can have economic impacts to the industry. Several commercial fisheries operate in the EMBA and overlap the spatial extent of the water column hydrocarbon predictions (Section4.7.8, Section 4.7.9 and Section 4.7.10).	would only be in place 1-3 days after release, therefore physical displacement to vessels is unlikely to be a significant impact. Consequently, the potential consequence to commercial and recreational fisheries are considered to be Minor, as they could be expected to result in localised low-level short-term impacts. Refer to management advice and evaluation of acceptability in Section 6.14.6
	Recreation and tourism	Change in ecosystem dynamics Changes to the functions, interests or activities of other users Change in aesthetic value Change in water quality	Tourism and recreation are also linked to the presence of marine fauna (e.g. whales), particular habitats and locations for recreational fishing. The area between Cape Otway and Port Campbell is frequented by tourists. It is a remote stretch of coastline dominated by cliffs with remote beaches subject to the high energy wave action. Access to the entire coastline is via a 7 to 8-day walking track from Apollo Bay ending at the Twelve Apostles. Recreation is also linked to the presence of marine fauna and direct	Any impact to receptors that provide nature-based tourism features (e.g. whales) may cause a subsequent negative impact to recreation and tourism activities. Refer also to: • Fish • Birds • Pinnipeds • Cetaceans (whales and dolphins) • Marine invertebrates • Recreational fisheries Any impact to receptors that provide nature-based tourism features (e.g. fish and cetaceans) may cause a subsequent negative impact to recreation and tourism activities. However, impacts would be localised and for a short duration (21 days).

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			impacts to marine fauna such as whales, birds, and pinnipeds can result in indirect impacts to recreational values. It is important to note that the impact from a public perception perspective may be even more conservative. This may deter tourists and locals from undertaking recreational activities. If this occurs, the attraction is temporarily closed, economic losses to the business are likely to eventuate. The extent of these losses would be dependent on how long the attraction remains closed.	Consequently, the potential consequence to recreation and tourism are considered to be Moderate, as they could be expected to result in localised short-term impacts. Refer to management advice and evaluation of acceptability in Section 6.14.6
Natural system	State Marine Protected Areas	Change in ecosystem dynamics Change in aesthetic value Change in water quality	State marine protected areas (e.g. Twelve Apostles Marine Park) occur within the area predicted to be exposed to in-water hydrocarbons at the instantaneous screening level of 100 ppb (entrained). Conservation values for these areas include high marine fauna and flora diversity, including fish and invertebrate assemblages and benthic coverage (sponges, macroalgae).	Refer to: • Marine invertebrates • Macroalgae The consequence to conservation values within the Twelve Apostles Marine Park is assessed as localised and short term and ranked as Moderate. Refer to management advice and evaluation of acceptability in Section 6.14.6.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
	Australian Marine Parks	Change in ecosystem dynamics Change in aesthetic value Change in water quality	Stochastic modelling indicates in-water hydrocarbons at the instantaneous screening level of 100 ppb (entrained) may extend to within the boundaries of the Apollo Marine Park (Section 4.4.2). Conservation values for Apollo Marine Park include foraging habitat for seabirds, dolphins, seals and white sharks, and blue whales migrate through Bass Strait. A reduction in water quality will lead to a breach in management objectives for AMPs.	Refer to: • Seabirds • Cetaceans and pinnipeds • Fish • Plankton The concentration at which the water column within Apollo Marine Park may be exposed is within the moderate thresholds for entrained hydrocarbons. Given the nature of the exposure to foraging habitats, and transient nature of migrating and foraging marine fauna, the consequence is ranked as Moderate. Refer to management advice and evaluation of acceptability in Section 6.14.6.
Conservation Values and sensitivities	Key Ecological Features	Change in water quality Injury / mortality to fauna Change in fauna behaviour. Change in ecosystem dynamics.	The KEFs that overlap the spill EMBA are described in Section 4.4.13, however, the Bonney Coast Upwelling is the only KEF predicted to be exposed to in-water hydrocarbons from a potential MDO spill. MDO is classified as a light persistent oil, has a low specific gravity (and will therefore tend to remain afloat) and has a high proportion (~95%) of volatile components and only a small (5%) residual component. Due to this volatility most of this oil will	Stochastic modelling indicates potential low-level and very short-term hydrocarbon exposure to the Bonney Coast Upwelling KEF resulting in a low-level reduction in water quality. This contact is predicted to be below the conservative environmental impact threshold for pelagic species i.e. moderate thresholds (refer Section 6.14.2) At the low instantaneous entrained exposure thresholds predicted, there is potential for chronic-level exposure to juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes (see Appendix B). Given the seasonal upwelling event supports regionally high productivity and high species diversity along the Bonney coast extending between Cape Jaffa, South Australia and Portland, Victoria.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			evaporate from the water surface; depending on wind conditions the proportion of evaporated oil may vary between approximately 40% within the first day, with the remaining volatiles evaporating over 3-4 days depending upon the prevailing conditions. Under moderate winds, oil will begin to entrain into the water column. Entrained oil can persist for extended periods of time, however if it re-floats it is subject to evaporation and is also subject to dissolution and natural degradation within the water column. There is no predicted surface or dissolved hydrocarbon exposure to any KEF from an MDO spill. The maximum time-entrained hydrocarbon exposure for a 48-hour window is predicted to be 125 ppb at the Bonney Coast Upwelling KEF with no predicted low (48-hour) threshold exposure. The maximum entrained hydrocarbon exposure for a 1-hour window is predicted to be 98 ppb at the Bonney Coast Upwelling KEF with a 22%	(DoE, 2015a) and the potential exposure is limited to low threshold contact to the eastern boundary of the Bonney Coast Upwelling KEF, some localised short-term impairment of ecosystem functioning during an upwelling event could occur. Consequently, the consequence of short-term effects including a potential regional decline in water quality during the upwelling season associated with the Bonney Coast KEF are considered to be Moderate, as they could be expected to result in localised short-term impacts to an area of recognised conservation value. Given the details above, Refer to management advice and evaluation of acceptability in Section 6.14.6.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			probability of low instantaneous exposure.	
	Wetlands	Change in water quality Change in ecosystem dynamics	Marine waters adjacent to the Port Phillip Bay and Bellarine Peninsula Ramsar site may be exposed to maximum time-entrained (for a 48-hour window) of 7 ppb with no exposure at low thresholds, and a maximum instantaneous exposure of 10 ppb with a 1% probability of exposure at low thresholds. No other Wetlands of International importance identified within the EMBA are predicted to be exposed to hydrocarbons from an MDO spill at any threshold. Nationally important wetlands, with a coastal interface, also occur within the EMBA and may be exposed to in-water hydrocarbons above low thresholds.	There is predicted low probabilities of low-level in-water hydrocarbon contact with marine waters adjacent to some wetlands (including both internationally important (Ramsar) and national important sites). Specifically, there is potential for a temporary decline in water quality that may impact on the ecological character of the following Ramsar sites: Port Philip Bay (Western shoreline) and Bellarine Peninsula. Wetland habitat can be of particular importance for some species of birds, fish and invertebrates. As such, in addition to direct impacts on wetland vegetation communities, oil that reaches wetlands may also affect these fauna utilising wetlands during their life cycle. Refer to other to receptor evaluations for in-water hydrocarbons, including: • Seagrass • Fish • Marine invertebrates At the predicted low exposure levels for dissolved and entrained in-water contact there is unlikely to be lethal ecological impacts on any of the values (receptors) that contribute to the ecological character of wetlands, however, a conservative consequence of Moderate has been applied given the cultural significance and International and National Importance of the wetlands (Ramsar-listed wetlands) and there may be localised minor short-term impacts to some of these receptors in closer

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				proximity to the release location where they may be exposed to moderate in-water hydrocarbon thresholds. Refer to management advice and evaluation of acceptability in Section 6.14.6

6.14.6 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Loss of Containment - diesel	
ALARP decision context and justification	**ALARP Decision Context: Type B** Vessels have been used for activities within the Otway Offshore Development including operations for over a decade with no major incident. Vessel activities are well regulated with associated control measures, well understood, and are implemented across the offshore industry. During stakeholder engagement, no concerns were raised regarding the acceptability of impacts from these events. However, if a diesel spill occurred from a vessel collision this could attract public and media interest. Consequently, Beach believes that ALARP Decision Context B should be applied.
Adopted Control Measures	**Source of good practice control measures**
CM#7: Ongoing consultation	Under the *Navigation Act 2012*, the Australian Hydrographic Office (AHO) are responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications such as Notices to Mariners. AMSA also issue radio-navigation warnings. Relevant details in relation to the vessel activity will be provided to the AHO and AMSA and to relevant stakeholders to ensure the presence of the vessel is known in the area. See Section 8.8 (Ongoing Stakeholder Consultation).
	Under the *OPGGS Act 2006* there is provision for ensuring that petroleum activities are carried out in a manner that doesn't interfere with other marine users to a greater extent than is necessary or the reasonable exercise of the rights and performance of the duties of the titleholder. Beach ensures this is achieved by conducting suitable consultation with relevant stakeholders. Consultation with potentially affected fisheries ensures the risk of interaction with these users is limited.
CM#17: SMPEP or SOPEP (appropriate to class)	In accordance with MARPOL Annex I and AMSA MO 91 [Marine Pollution Prevention – oil], a Shipboard Marine Pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (SOPEP) (according to class) is required to be developed based upon the Guidelines for the Development of Shipboard Oil Pollution Emergency Plans, adopted by IMO as Resolution MEPC.54(32) and approved by AMSA. To prepare for a spill event, the SMPEP/SOPEP details: • response equipment available to control a spill event; • review cycle to ensure that the SMPEP/SOPEP is kept up to date; and • testing requirements, including the frequency and nature of these tests. • in the event of a spill, the SMPEP/SOPEP details: • reporting requirements and a list of authorities to be contacted; • activities to be undertaken to control the discharge of hydrocarbon; and • procedures for coordinating with local officials. Specifically, the SMPEP/SOPEP contains procedures to stop or reduce the flow of hydrocarbons to be considered in the event of tank rupture.

CM#19: MO 21: Safety and emergency arrangements	AMSA MO 21: Safety and emergency arrangements gives effect to SOLAS regulations dealing with life-saving appliances and arrangements, safety of navigation and special measures to enhance maritime safety.		
CM#2: MO 30: Prevention of collisions	AMSA MO 30: Prevention of collisions requires that onboard navigation, radar equipment, and lighting meets the International Rules for Preventing Collisions at Sea (COLREGs) and industry standards.		
CM#20: MO 31: SOLAS and non-SOLAS certification	All vessels contracted to Beach will have in date certification in accordance with AMSA MO 31: SOLAS and non-SOLAS certification		
CM#9: MO 27: Safety of navigation and radio equipment	AMSA MO 27: Safety of navigation and radio equipment gives effect to SOLAS regulations regarding radiocommunication and safety of navigation and provides for navigation safety measures and equipment and radio equipment requirements.		
CM#21: NOPSEMA and DJPR accepted OPEP	Under the OPGGS(E)R, NOPSEMA require that the petroleum activity have an accepted Oil Pollution Emergency Plan (OPEP) in place before the activity commences. In the event of a LOC, the OPEP will be implemented. The Offshore Victoria – Otway Basin OPEP was developed to support all Beach activities within the Otway Basin and includes response arrangements for a worst-case LOC scenario from a development well. The OPEP also includes Tactical Response Plans (TRPs) for identified protection priority areas within the region.		
CM#22: NOPSEMA accepted OSMP	Under the OPGGS(E)R, NOPSEMA require that the Implementation Strategy of the Environment Plan provides for monitoring of an oil pollution emergency. The Beach OSMP details: • operational monitoring to inform response planning; and • scientific monitoring to inform the extent of impacts from hydrocarbon exposure and potential remediation requirements.		
Additional controls assessed			
Control	**Control Type**	**Cost/Benefit Analysis**	**Control Implemented?**
Eliminate or substitute the use of diesel.	Equipment	The use of diesel for fuel for vessels and machinery cannot be eliminated. Substituting for another fuel, i.e. Heavy Fuel Oil or bunker fuel oil, would have a higher environmental impact than diesel. There are other options for power generation, such as LNG or electrically powered vessels, which eliminate the need for fuel oil such as MDO to be stored and used. However, there are currently no vessels with the specifications required to undertake this scope of work which offer this option.	No
Consequence rating	Moderate (2)		
Likelihood of occurrence	Highly Unlikely (2) based upon AMSA Annual Report 2017-18 (serious incident reports)		

Residual risk	Medium
Acceptability Assessment	
To meet the principles of ESD	The risk of a loss of containment resulting in a diesel spill was assessed as medium and the highest consequence assessed as moderate which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	No objections or claims have been raised during stakeholder consultation regarding the potential for diesel spills.
Other Requirements	• Vessel activities undertaken during Phase 5 Early Dive Installation Campaign will adhere to relevant legislative requirements as detailed in the controls section. • The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013) identifies oil pollution associated with shipping, other vessels and offshore mining operations as a pressure or source of pressure on the conservation values of the South-east Marine Reserves Network. No AMPs are predicted to be exposed to surface, high (instantaneous) thresholds for entrained hydrocarbons or moderate or high thresholds for dissolved hydrocarbons. Only the Apollo AMP is predicted to be exposed to moderate (instantaneous) thresholds of entrained hydrocarbons (up to 7% summer and 16% winter). Impacts to Apollo AMP major conservation values for fauna (blue, fin, sei and humpback whales, black-browed and shy albatross, Australasian gannet, short-tailed shearwater, and crested tern) are assessed as short-term and recoverable based on the majority of the exposure being to moderate level of dissolved hydrocarbons for a short period of time. Impacts to Apollo AMP major conservation values for ecosystems, habitats, communities and cultural and heritage sites are not predicted as in-water hydrocarbons are only predicted within 0 – 30 m of the water column which does not intersect with these values. • The following Conservation Advices / Recovery Plans identify pollution as a key threat: o Conservation Advice *Balaenoptera borealis* (sei whale) (TSSC 2015g) o Conservation Advice *Balaenoptera physalus* (fin whale) (TSSC 2015f) o Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b), identified as acute chemical discharge (oil pollution) o Conservation Advice *Calidris ferruginea* (curlew sandpiper) (DoE, 2015f) identified as Habitat degradation/ modification (oil pollution) o National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPC 2011a) o Conservation Advice for *Sterna nereis nereis* (fairy tern) (DSEWPC, 2011c) • The following Conservation Advices / Recovery Plans identify habitats degradation/modification as threat, which may be consequence of accidental release of hydrocarbon:

	○ Conservation Advice Calidris canutus (red knot) (TSSC 2016d) ○ Conservation Advice Limosa lapponica baueri (bar-tailed godwit (western Alaskan)) (TSSC 2016a) ○ Conservation Advice for Numenius madagascariensis (eastern curlew) (DoE 201e) • These Conservation Advices and Recovery Plan identify the following conservation actions: ○ Minimise chemical and terrestrial discharge. Controls have been identified and will be implemented to minimise the risk of minimise chemical discharges. ○ Ensure spill risk strategies and response programs include management for turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs. No habitats for turtles are identified within the diesel spill EMBA. OPEP and OSMP cover management of response to oiled turtles. ○ Ensure appropriate oil-spill contingency plans are in place for the subspecies' breeding sites which are vulnerable to oil spills. OPEP and OSMP cover response strategies for management breeding sites vulnerable to oil spills. ○ Implement measures to reduce adverse impacts of habitat degradation and/or modification. Controls have been identified and will be implemented to reduce adverse impacts of habitat degradation and/or modification.
Monitoring and reporting	Loss of containment resulting in a diesel spill is required to be reported as per Section 7.10. Impacts as a result of a loss of containment resulting in a diesel spill will be monitored and reported in accordance with the OSMP.
Acceptability outcome	**Acceptable**

6.15 Oil spill response

This section presents the risk assessment for oil spill response options as required by the OPGGS(E)R.

6.15.1 Response option selection

Not all response options and tactics are appropriate for every oil spill. Different oil types, spill locations, and volumes require different response options and tactics, or a combination of response options and tactics, to form an effective response strategy.

Table 6-16 provides an assessment of the available oil spill response options, their suitability to the potential spill scenarios and their recommended adoption for the identified events.

6.15.2 Hazards

The following activities have been identified for responding to a spill event:

- mobilisation, use and demobilisation of spill response personnel, plant and equipment; and
- handling, treatment and/or relocation of affected fauna (oiled wildlife response).

Response option feasibility, effectiveness, capability needs analysis and capability assessment is detailed in Table 6-16.

Table 6-16: Response option feasibility, effectiveness, ALARP identified risks and capability needs analysis

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness & ALARP Analysis	Net Environmental Benefit	Capability Needs Analysis (See OPEP and OSMP for details)	Capability Assessment
Monitor and Evaluate	Visual – aerial and vessel	MDO	Effective - MDO rapidly spreads to thin layers on surface waters. Monitoring used to inform both response planning and monitoring requirements. Aerial surveillance is considered more effective than vessel to inform spill response and identify if oil has contacted shoreline or wildlife. Vessel surveillance limited in effectiveness in determining spread of oil. Scientific monitoring implemented to inform extent of impact and remediation requirements. Both vessel and aerial monitoring capability in place. Trained aerial observers available via AMOSC Core Group and available for deployment. Vessel and aircraft contracts in place. No further benefit gained by having additional monitoring capability.	Yes	Actionable on-water hydrocarbon thresholds limited to immediate vicinity of well site. Up to 8 km of coastline subject to moderate oiling. 1 x plane & observer required and/or 1 x vessel & observer and / or 5 x vessels and OSMP study teams Remote oil spill trajectory modelling (OSTM)	As detailed in OPEP: · fixed wing contract in place · aerial observers available via AMOSC · vessel contract in place · OSTM contract in place and available via AMOSC · environmental monitoring consultants accessible Implement response as per OPEP and under direction of the State Control Agency (if in State waters) Capability in place and sufficient to implement timely response.
Source Control	Right stricken vessel Transfer MDO to secure tank	MDO	Effective – primary response strategy for all spills in accordance with vessel SMPEP/SOPEP. For MDO source control in Commonwealth waters, AMSA is the Control Agency and has access to NatPlan resources, therefore no further controls are considered. For MDO source control in Victorian state waters, Department of Jobs, Precincts and Regions (DJPR) is the Control Agency. Upon establishment of incident control by DJPR, Beach shall continue to provide planning and resources as required by the EMT Leader. Beach will make available to DJPR an Emergency Management Liaison Officer (EMLO) who can mobilise to the incident control centre. Equipment within the respective port region will be utilised as per the Maritime Emergencies (NSR) Plan through Vic DJPR Emergency Management Branch (EMB) In the event of a cross-jurisdictional response (i.e. where a response is required in State and Commonwealth waters), Beach and DJPR will establish a Joint Strategic Coordination Committee (as per the DJPR guidance) to facilitate effective co-ordination between DJPR and AMSA.	Yes	Contract vessels	Vessel contract in place Capability available at request of AMSA as Control Agency
Offshore Containment and Recovery	Booms and skimmers	MDO	Not feasible. MDO spreads rapidly to less than 10 g/m^2 and suitable thicknesses for recovery are only present for the first 36 hours for a large offshore spill, and there is insufficient mobilisation time to capture residues. In general, this method only recovers approximately 10-15% of total spill residue, creates significant levels of waste, requires significant manpower and suitable weather conditions (calm) to be deployed.	N/A	N/A	N/A
Protection and Deflection	Booms and skimmer	MDO	Potentially feasible. MDO spreads rapidly to less than 10 µm and suitable thicknesses for recovery are only present for the first ~ 36 hours for a worst-case spill. There may be insufficient mobilisation time to capture residues prior to hydrocarbons reaching the shore. In addition, corralling of surface hydrocarbons close to shore may not be effective for MDO depending on sea surface conditions. However, if operational monitoring indicates river mouths and inlets are potentially exposed to actionable levels of hydrocarbons and accessible to response personnel and equipment, protection and deflection may be an effective technique for reducing oil within these inland water ways.		Response personnel Booms & skimmers Waste facilities	As detailed in OPEP: · Core responders and equipment available via AMOSC · NRT and NRST available via Control Agency request under NatPlan. · Environmental monitoring providers accessible · Waste contracts in place Tactical Response Plans developed for: · Aire River; · Princetown; · Port Campbell Bay; and · Curdies Inlet

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness & ALARP Analysis	Net Environmental Benefit	Capability Needs Analysis (See OPEP and OSMP for details)	Capability Assessment
						Implement response as per OPEP and under direction of the State Control Agency Capability in place and sufficient to implement timely response
Shoreline Clean-up	The active removal and/or treatment of oiled sand and debris	MDO	Feasible. May be effective at reducing shoreline loading where access to the shoreline is possible. If operational monitoring indicates shorelines are potentially exposed to actionable levels of hydrocarbons and accessible to response personnel and equipment, protection and deflection may be an effective technique for reducing shoreline loadings.	Subject to operational Net Environmental Benefit Analysis (NEBA) – unlikely to present net benefit	Based up a clean-up rate of 1 m^3 per day per person, a single clean-up team (10 persons) could clean 10 m^3 / day. Based on a waste generation (bulking) factor of 10:1, waste clean-up and recovery could take up to 1 month for a team of 10 people. This assumes that all 33 m^3 of stranded hydrocarbon is both accessible and retrievable. In reality, the total retrievable volume (if any) would be smaller.	As detailed in OPEP: · Core Group responders and equipment available via AMOSC · NRT and NRST available via Control Agency request under NatPlan. · Waste contracts in place Tactical Response Plans developed for: · Aire River; · Princetown; · Port Campbell Bay; and · Curdies Inlet Implement response as per OPEP and under direction of the State Control Agency Capability in place and sufficient to implement timely response
Oiled Wildlife Response (OWR)	Capture, cleaning and rehabilitation of oiled wildlife.	MDO	Feasible. Effective. Unlikely to require shoreline oiled wildlife response given no predicted shoreline loading. Potential that individual birds could become oiled in the offshore environment.	Yes	Personnel Equipment Triage and waste facilities	As detailed in OPEP: · Core Group responders and equipment available via AMOSC · NRT and NRST available via Control Agency request under NatPlan. DELWP are the State agency responsible for responding to wildlife affected by a marine pollution emergency in Victorian waters. DELWP's response to oiled wildlife is undertaken in accordance with the Victorian Wildlife Response Plan for Marine Pollution Emergencies. The Tasmanian Oiled Wildlife Response Plan (WildPlan) is administered by the Resource Management and Conservation Division of the DPIPWE. If an incident occurs in Commonwealth waters which affects wildlife, AMSA may request support from DELWP or DPIPWE to assess and lead a response if required. Both DELWP & DPIPWE have a number of first strike kits as well as access to AMOSC oiled wildlife equipment. Capability in place and sufficient to implement timely response
Chemical Dispersant Application	Application of chemical dispersants either surface or subsea	MDO	Feasible. Although "conditional" for Group II oil, the size of potential spill volume and the natural tendency of spreading into very thin films is evidence that dispersant application will be an ineffective response. The dispersant droplets will penetrate through the thin oil layer and cause 'herding' of the oil which creates areas of clear water and should not be mistaken for successful dispersion (see ITOPF – Technical Information Paper No. 4: The Use of Chemical Dispersants to Treat Oil Spills).	No	N/A	N/A

6.15.3 Oil Spill Response activities

6.15.3.1 Known and potential environmental impacts

Impacts and risks associated with monitoring and evaluation, source control and protection and deflection response strategies (in responding to a hydrocarbon spill) are similar to those discussed for vessel and ROV operations in Section 6. This section covers detailed impact and risk evaluations for source control, oiled wildlife response, shoreline protection and clean-up and the application of chemical dispersants.

Oiled wildlife response

Untrained resources capturing and handling native fauna may cause distress, injury and death of the fauna. AMSA as the Control Agency for a vessel spill in Commonwealth waters will managed any OWR and Beach will only undertake OWR if directed by AMSA. Potential impacts are:

- injury/Mortality of fauna
- change in fauna behaviour

Shoreline protection and clean up

Sensitive/protected shoreline habitats may be degraded, or marine fauna and flora and other users of the land may be disturbed due to movement of human responders and removal of oiled material on shorelines. Potential impacts are:

- change in fauna behaviour
- injury/Mortality of fauna
- change in habitat
- changes to the functions, interests or activities of other users

6.15.3.2 Consequence evaluation

This section assesses the impacts and risks specific to OWR and shoreline clean spill response strategies.

Oiled wildlife response

OWR includes pre-emptive techniques such as hazing, capturing and relocating of un-oiled fauna as well as post-oiling techniques such cleaning and rehabilitation. Deliberate disturbance of wildlife from known areas of ecological significance (e.g. resting, feeding, breeding or nesting areas) to limit contact of individuals with hydrocarbons may result in inhibiting these species from accessing preferred habitats or food sources. This approach may also result in additional disturbance/handling stress to the affected species with little benefit as many species tend to display site fidelity and return to the location from which they have been moved.

The incorrect handling of oiled fauna has also the potential to result in increased stress levels which has may result in increased fauna mortality. Although fauna interactions from oiled wildlife response and shoreline clean-up techniques are expected to be limited to the duration of the response, there is the potential that these effects may result in longer term impacts to local populations where a large proportion of the local population may be exposed to oil and subsequently oiled wildlife response.

Oiled wildlife preparedness and response shall be undertaken in accordance with the relevant EPOs and EPSs detailed within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (CDN/ID S4100AH717907).

Oiled wildlife surveillance and wildlife impact studies are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908).

Shoreline protection and clean up

Damage or removal of habitat (such as sand from beaches) from shoreline protection and clean-up techniques may expose shorelines to erosion processes or decrease in fauna and flora. Damage to intertidal shoreline habitats and communities may have indirect effects on ecosystem dynamics through impacts on food chains of the macrofauna communities which they support.

Shoreline clean-up or protection actions could affect significant stretches of coastline, with prolonged effects on areas and populations located with increased response effort (such as tourism sites). The presence of accumulated hydrocarbons on shorelines as well as the presence of clean-up operations will necessitate the implementation of exclusion zones (e.g. beach closures). The exclusion of local residents and tourists from coastal areas has the potential to impact local tourism businesses and local settlements. As exclusion zones may be in place for the entire duration of the spill and beyond to account for clean-up periods once the spill has been contained, impacts to tourism and local residents may last for extended periods of time.

The movement of spill response personnel, vehicles and equipment through coastal areas has the potential to disturb or damage artefacts or sites of cultural heritage significance. Adverse effects are expected to be localised to the area of disturbance. For known recognised sites, relocation of artefacts or implementation of exclusion zones may be considered as part of the operational NEBA. There is a potential to affect the internationally significant Ramsar wetlands at localised locations. Shoreline clean up and protection will endeavour to prevent impact to the ecological characteristics of Ramsar sites.

Shoreline protection and Clean up preparedness and response shall be undertaken in accordance with the relevant EPOs and EPSs detailed within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (CDN/ID S4100AH717907).

Hydrocarbon on shorelines and shoreline sediment impacts studies are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908).

6.15.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: oil spill response			
ALARP decision context and justification	**ALARP Decision Context: B** The purpose of implementing spill response activities is to reduce the severity of impacts from an oil spill to the environment. However, if the strategies do more harm than good (i.e. they are not having a net environmental benefit) then the spill response is not ALARP.		
Control measures	**Source of good practice control measures**		
All spill response control measures and associated Environmental Performance Outcomes (EPOs) and Environmental Performance Standards (EPSs) are detailed within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (CDN/ID S4100AH717907).			
All relevant operational and scientific monitoring studies are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908).			
Additional controls assessed			
Control	**Control type**	**Cost/benefit analysis**	**Control implemented?**
Monitor and evaluate: AUVs	Engineering Risk Assessment	This control measure is not expected to provide significant environmental benefit as the activity is located in close proximity to shore (70 km), and	No

		mobilisation of in-field monitoring, or aerial surveillance may be implemented rapidly via existing contracts.	
Monitor and evaluate: Night-time monitoring – infrared	Engineering Risk Assessment	Side looking airborne radar, systems are required to be installed on specific aircraft or vessels. The costs of sourcing such vessels/aircraft is approximately $20,000 per day. Infrared may be used to provide aerial monitoring at night-time, however the benefit is minimal given trajectory monitoring (and infield monitoring during daylight hours) will give good operational awareness. In addition to this, satellite imagery may be used at night to provide additional operational awareness.	No
OWR: Pre-positioning of oiled wildlife response resources.	Precautionary approach	Oiled wildlife response equipment containers for first strike activities are positioned in Geelong. Positioning the equipment any closer to the potential spill area is not considered to provide a considerable environmental benefit considering that any visible shoreline contact is not predicted until day 3 of the spill, therefore there is adequate time to deploy equipment positioned in Geelong. Additionally, spill modelling indicates potential (hypothetical) areas of exposure to hydrocarbons, post-spill operational monitoring would be required to predict actual or likely exposure locations, therefore determining an area to pre-position equipment may be inaccurate pre-spill.	No
Shoreline protection and clean up: Tactical Response Plans	Precautionary approach	Identified areas for priority protection have pre-populated tactical response plans to reduce response planning timeframes in the event of potential shoreline exposure. Refer to OPEP for TRPs. CM#21: NOPSEMA accepted Oil Pollution Emergency Plan (OPEP)	Yes
Chemical Dispersant: Pre-positioning of dispersant and application equipment.	Precautionary approach	No clear benefit identified as stockpiles of dispersant already available in Melbourne and elsewhere in Australia. Application equipment and dispersant can be readily mobilised to site, with no identified restriction on logistics pathways or response timing.	No

Consequence rating	Moderate (2)
Residual impact category	Low
Acceptability assessment	
To meet the principles of ESD	The activities were evaluated as having the potential to result in a Moderate (2) consequence thus is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required. While some response strategies may pose additional risk to sensitive receptors, to not implement response activities may potentially result in greater negative impact to the receiving environment and a longer recovery period. Response activities will be undertaken in accordance with controls which reduce and/or prevent additional risks. The mutual interests of responding and protecting sensitive receptors from further impact due to response activities will be managed using a NEBA during response strategy planning in preparedness arrangements, as well as during a response. Proposed response activities are consistent with industry practice. No impact to KEFS, Ramsar Wetlands, BIAs or state marine protected areas are expected during spill response.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the SCCP including relief well plan, OPEP, Tactical Response Plans and OSMP.
External context	No stakeholder concerns have been raised with regards to impacts of the spill response activities on relevant persons. During any spill response, a close working relationship with key regulatory bodies (Control Agencies) will occur and thus there will be ongoing consultation with relevant persons during response operations.
Other requirements	Response has been developed in accordance with: • OPGGS Act; • AMSA Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA, 2015); and NOPSEMA (2017). • South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013) • The following Conservation Advices / Recovery Plans identify pollution as a key threat: o Conservation Advice *Balaenoptera borealis* (sei whale) (TSSC 2015g) o Conservation Advice *Balaenoptera physalus* (fin whale) (TSSC 2015f) o Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b), identified as acute chemical discharge (oil pollution) o Conservation Advice *Calidris ferruginea* (curlew sandpiper) (DoE, 2015f) identified as habitat degradation/ modification (oil pollution)

	○ National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPC 2011a) ○ Conservation Advice for *Sterna nereis nereis* (fairy tern) (DSEWPC, 2011c) • The following Conservation Advices / Recovery Plans identify habitats degradation/modification as threat, which may be consequence of accidental release of hydrocarbon: ○ Conservation Advice *Calidris canutus* (red knot) (TSSC 2016d) ○ Conservation Advice *Limosa lapponica baueri* (bar-tailed godwit (western Alaskan) (TSSC 2016a) ○ Conservation Advice for *Numenius madagascariensis* (eastern curlew) (DoE 2015e) • These Conservation Advices and Recovery Plans identify the following conservation actions: ○ minimise chemical and terrestrial discharge. ○ ensure spill risk strategies and response programs include management for turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs. ○ ensure appropriate oil-spill contingency plans are in place for the subspecies' breeding sites which are vulnerable to oil spills. ○ implement measures to reduce adverse impacts of habitat degradation and/or modification; or ○ no explicit relevant management actions; oil pollution is recognised as a threat. In regard to oil spill response, activities associated with Phase 5 Early Dive Installation Campaign will not be conducted in a manner inconsistent with the objectives of the respective zones of the AMPs, and the principles of the IUCN Area Categories applicable to the values of the AMPs.
Monitoring and reporting	Impacts will be monitored in accordance with Section 7.9.3.
Acceptability outcome	Acceptable

6.16 Environmental Performance Outcomes, Standards and Measurement Criteria

Beach uses EPOs, EPSs and measurement criteria to demonstrate it is managing its environmental impacts and risks. Outcomes have been developed for each of the identified environmental impacts and risks and have been based around the key identified controls from the control assessment and are aligned with Beach's HSE Policy (refer Figure 7-2). For each EPO and EPS has been developed in conjunction with measurement criteria. The EPOs, EPSs and measurement criteria are provided in Table 6-17.

Table 6-17: Environmental performance outcomes, standards and measurement criteria

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
EPO1: No death or injury to fauna, including listed threatened or migratory species, from the activity. **EPO2:** Noise emissions in BIAs will be managed such that any whale, including blue whales, continues to utilise the area without injury, and is not displaced from a foraging area. **EPO3:** Biologically important behaviours within a BIA or outside a BIA can continue while the activity is being undertaken. **EPO4:** No substantial reduction of air quality within local airshed caused by atmospheric emissions produced during the activity.	CM#1: Light Management Procedure	• CSV will have a Lighting Management Procedure (or equivalent) to minimise light spill by: o keeping lights off when not needed. o directing lighting onto work areas. o screening interior lights with curtains and blinds. o developing a program for handling grounded birds. o reporting requirements.	Lighting Management Procedure (or equivalent) Vessel inspection	Vessel Master
	CM#2: MO 30: Prevention of collisions	• CSV shall meet the navigation equipment, watchkeeping, radar and lighting requirements of AMSA MO 30.	Vessel inspection	Vessel Master
	CM#3: MO 97: Marine Pollution Prevention – Air Pollution	• Use of very low sulphur fuel oil (VLSFO) (e.g. maximum 0.50% S VLSFO-DM, maximum 0.50% S VLSFO-RM). • Vessels with diesel engines>130 kW must be certified to emission standards (e.g. International Air Pollution Prevention [IAPP]). • CSV shall implement their Ship Energy Efficiency Management Plan to monitor and reduce air emissions (as appropriate to vessel class).	Bunker receipts Ship Energy Efficiency Management Plan (SEEMP) records Certification documentation Vessel inspection	Vessel Master
	CM#4: Preventative Maintenance System	• Power generation and propulsion systems on the CSV will be operated in accordance with preventative maintenance system (or equivalent) to ensure efficient operation.	PMS records Vessel inspection	Vessel Master
	CM#5: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	• Vessel operators shall adhere to the distances and vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with dolphins specifically: i. Do not approach a dolphin. ii. Maintain a distance of 150 m from a dolphin. iii. If a dolphin approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal. • Vessel operators shall adhere to the distances and vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with whales, specifically: i. Do not approach a whale. ii. Maintain a distance of 300 m from a whale. iii. If a whale approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal.	Project induction DAWE cetacean sighting sheets	Vessel Master

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#6 Whale Management Procedure	• Prior to an activity commencing a observation survey will be undertaken of the observation survey zone for the activity (5km). • Surveys will be undertaken for 30 min prior to the activity commencing. If a whale is sighted within the observation zone the activity will not commence until: o No whales are observed for 30 min within the observation zone; or o Whales are observed leaving the observation zone. • Once the activity has commenced observations will be undertaken within the activity shutdown zone (1.5 km) • On advice from the MMO that a whale has been sighted within the shutdown zone (1.5 km), the CSV will continue operations until the earliest point is reached at which operations can be safely suspended (i.e., the 'safe point'). On suspension of operations, the vessel will adopt the most favourable heading in order to reduce propulsion noise and then increase separation to whales if safe to do so. • The CSV will not re-continue installation activities in the activity area until such time as: o No whales are observed for 30 minutes within the shutdown zone; or o Whales are observed leaving the shutdown zone. • Activities can commence at night or in low visibility conditions (i.e., when observations cannot be undertaken) if no more than three whales have been seen in the PTS/TTS zone in the preceding daylight hours.	Daily report MMO report Review of whale data	Vessel Master
	CM#14: Vessel speed restrictions	• Vessel speeds within the operational area will be restricted to 10 knots.	Project induction Vessel log	Vessel Master
EPO5: No impact to water quality or sediment quality at a distance > 500 m from planned activities from planned marine discharges. **EPO6:** Seabed and associated biota disturbance will be within the operational area.	CM#10: As-left survey	• An ROV survey will be undertaken at the completion of the activity to confirm temporary equipment has been removed from the activity area and the location of subsea infrastructure is recorded.	ROV survey footage	Project Manager
	CM#11: *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and Marine Order 96 (Marine pollution prevention — sewage) 2018 giving effect to MARPOL Annex IV.	• Oil contaminated water shall be treated via a MARPOL (or equivalent) approved oily water separator and only discharge if oil content less than 15 ppm. • Sewage discharged at sea shall be treated via a MARPOL (or equivalent) approved sewage treatment system. • Food waste only discharged when macerated to ≤25 mm and at distance greater than 3 nm from land.	Oil record book MARPOL certification Garbage record book Vessel inspection	Vessel Master
	CM#4: Preventative Maintenance System	• Equipment used to treat planned discharges shall be maintained in accordance with manufacturer's specification as detailed within the preventative maintenance system.	PMS records Vessel inspection	Vessel Master
	CM#12: Beach Chemical Management Plan	• Chemicals that will be or have the potential to be discharged to the marine environment will meet the chemical acceptance criteria as per Section 7.11.2.	Completed and approved chemical assessment Register of approved chemicals	Vessel Master
EPO7: Undertake the activity in a manner that will not interfere with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted.	CM#7: Ongoing consultation	• Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 8 (Stakeholder Consultation).	Notification records Communication records	Project Manager
	CM#8: Beach Fair Ocean Access Procedure	• The Beach Fair Ocean Access Procedure (Appendix D for overview) shall be implemented with Fishers who have identified they fish in the area and have a commercial loss due to Beach's activities.	Communication records	Community Manager

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
EPO8: No introduction of a known or potential invasive marine species	CM#13: Beach IMS Management Plan	A pre-qualification is undertaken for the CSV against Beach's IMS Management Plan ((IMSMP) S4000AH719916) as per Section 8.22 of this EP to: • validate compliance with regulatory requirements (Commonwealth and State) in relation to biosecurity prior to engaging in petroleum activities within the operational area; • identify the potential IMS risk profile of CSV prior to deployment within the operational area; • identify potentially deficiency of IMS controls prior to entering the operational area; • identify additional controls to manage IMS risk; and • prevent the translocation and potential establishment of IMS into non-affected environments (either to or from the operational area).	Vessel contractor pre-qualification audit report verifies the vessel meets the requirements outlined in the IMSMP.	Project Manager
EPO9: No unplanned discharge of waste to the marine environment.	CM#15: MO 95: Marine Pollution Prevention – Garbage	• Waste with potential to be windblown shall be stored in covered containers.	Vessel inspection Garbage record book Incident report	Vessel Master
EPO10: No spills of chemicals or hydrocarbons to the marine environment.	CM#16: Spill containment	• Materials and equipment that have the potential to spill onto the deck or marine environment shall be stored within a contained area.	Vessel inspection.	Vessel Master
	CM#17: SMPEP or SOPEP (appropriate to class)	CSV shall have a SMPEP (or equivalent appropriate to class) which is: • implemented in the event of a spill to deck or marine environment. • tested as per the vessel test schedule. • spill response kits shall be available and routinely checked to ensure adequate stock is maintained.	Vessel SMPEP Vessel inspection Vessel exercise schedule	Vessel Master
	CM#18: Crane handling and transfer procedure	• The crane handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects. • The crane operators are trained to be competent in the handling and transfer procedure to prevent dropped objects.	Vessel inspection.	Vessel Master
	CM#7: Ongoing consultation	• Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 8 (Stakeholder Consultation).	Notification records Communication records	Project Manager
	CM#19: MO 21: Safety and emergency arrangements	• CSV shall meet the safety measures and emergency procedures of the AMSA MO 21.	Vessel inspection	Vessel Master
	CM#2: MO 30: Prevention of collisions	• CSV shall meet the navigation equipment, watchkeeping, radar and lighting requirements of AMSA MO 30.	Vessel inspection	Vessel Master
	CM#20: MO 31: SOLAS and non-SOLAS certification	• CSV will meet survey, maintenance and certification of regulated Australian vessels as per AMSA MO 31.	Vessel certification	Vessel Master
	CM#9: MO 27: Safety of navigation and radio equipment	• CSV shall meet the safety of navigation and radio equipment requirements of AMSA MO 27.	Vessel inspection	Vessel Master
	CM#21: NOPSEMA accepted Oil Pollution Emergency Plan (OPEP)	• Emergency spill response capability is maintained in accordance with the OPEP	Outcomes of internal audits and tests demonstrate preparedness	Senior Crisis, Emergency & Security Advisor
		• Implement spill response in accordance with relevant EPOs and EPSs in the accepted OPEP.	EMT log	Beach EMT
	CM#22: NOPSEMA accepted Operational and Scientific Monitoring Plan (OSMP)	• Operational and scientific monitoring capability is maintained in accordance with the OSMP.	Outcomes of internal audits and tests demonstrate preparedness	Senior Crisis, Emergency & Security Advisor

7 Implementation Strategy

Regulation 14 of the OPGGS(E)R requires that the EP must contain an implementation strategy for the activity.

The Beach Operations Excellence Management System (OEMS) will be used to govern the activity. The OEMS provides guidance on how Beach will meet the requirements of its Environmental Policy (Figure 7-2). The Beach OEMS has been developed considering Australian/New Zealand Standard ISO 14001:2016 Environmental Management Systems. The OEMS is an integrated management system and includes all HSE management elements and procedures.

The Implementation Strategy described in this section provides a summary of the OEMS elements and how they will be applied to effectively implement the control measures detailed in this EP. Specifically, it describes:

- the OEMS;
- environment-specific roles and responsibilities;
- arrangements for monitoring, review and reporting of environmental performance;
- preparedness for emergencies; and
- arrangements for ongoing consultation.

7.1 Operations Excellence Management System

he OEMS documents the Environmental Policy, the 11 OEMS Elements and 30 OEMS Standards. It provides a management framework for achieving the requirements in a systematic way but allows flexibility to achieve this in a manner that best suits the business. The OEMS is aligned with the requirements of recognised international and national standards including:

- ISO 14001 (Environmental Management);
- OHSAS 18001 (Occupational Health and Safety);
- ISO 31000 (Risk Management); and
- AS 4801 (Occupational Health and Safety Management Systems).

At the core of the OEMS are 11 elements and associated standards that detail specific performance requirements that incorporate all the requirements for the implementation of the Environmental Policy (Figure 7-2) and management of potential HSE impacts and risks (Figure 7-1, Table 7-1). The Elements, via the nominated expectations, sponsor 30 Beach OEMS Standards, which provide more granular minimum compliance rule sets under which the company operates. At the business level, the system is complemented by asset and site procedures and plans such as this EP.

Whilst Beach is the titleholder for the activity, the vessel contractor maintains operational control as per the requirements of their management system. The application of OEMS Elements and Standards relevant to the activity are described in the following sections.

Figure 7-1: Beach OEMS

Table 7-1: Beach OEM Elements and Standards

Element		***Standard***
1	Partners, Leadership and Authority	Leadership Standard
		Technical Authority Standard
		Joint Venture Management Standard
2	Financial Management and Business Planning	Integrated Planning Standard
		Phase Gate Standard
		Hydrocarbon Resource Estimation and Reporting Standard
		Financial Management Standard
3	Information Management and Legal Requirements	Regulatory Compliance Standard
		Document Management Standard
		Information Management Standard
4	People, Capability and Health	Training and Competency Standard
		Health Management Standard
5	Contracts and Procurement	Contracts and Procurement Standard
		Transport and Logistics Standard

Element		*Standard*
6	Asset Management	Asset Management Standard
		Maintenance Management Standard
		Well Integrity Management Standard
		Well Construction Management Standard
		Project Management Standard
7	Operational Control	Operational Integrity Standard
		Process Safety Standard
		Management of Change Standard
8	Risk Management and Hazard Control	Risk Management Standard
		Safe Systems of Work
		Emergency and Security Management Standard
9	Incident Management	Incident Management Standard
10	Environment and Community	Environment Management Standard
		Community Engagement Standard
11	Assurance and Reporting	Sustainability Standard
		Assurance Standard

Environment Policy

Objective

Beach is committed to conducting operations in an environmentally responsible and sustainable manner.

Strategy

To achieve this, Beach will:

- Comply with relevant environmental laws, regulations, and the Beach Health, Safety and Environment Management System which is the method by which Beach identifies and manages environmental risk.
- Establish environmental objectives and targets, and implement programs to achieve them that will support continuous improvement;
- Identify, assess and control environmental impacts of our operations by proactive management of activities and mitigation of impacts;
- Ensure that incidents, near misses, concerns and complaints are reported, investigated and lessons learnt are implemented;
- Inform all employees and contractors of their environmental responsibilities including consultation and distribution of appropriate environmental management guidelines, regulations and publications for all relevant activities;
- Efficiently use natural resources and energy, and engage with stakeholders on environmental issues; and
- Publicly report on our environmental performance.

Application

This policy applies to all personnel associated with Beach activities.

Matt Kay
Managing Director and CEO
December 2019

Figure 7-2: Beach's Environmental Policy

7.2 Element 1 – Partners, Leadership and Authority

Element 1 focuses on ensuring the organisation is equipped, structured and supported to ensure a healthy, efficient and successful company. Communications with internal and external bodies, including joint venture partners, is essential to delivering successful projects and operations. The leadership styles and actions demonstrated within Beach will influence the performance of all staff and contractors. Clear levels of authority are necessary to remove organisational ambiguity and to support effective decision making.

The Beach Energy CEO has the ultimate responsibility for ensuring that Beach Energy has the appropriate organisation in place to meet the commitments established within this EP. However, the Otway Operations Manager has the responsibility and delegated authority to ensure that adequate and appropriate resources are allocated to comply with OEMS and this EP.

The roles responsibilities for the implementation, management and review of this EP are detailed in Table 7-2.

Responsibility in the event of an oil pollution emergency is dependent on the response category level. For a Level 1 (or vessel) spill, the Vessel Master has the immediate responsibility. Roles and responsibilities for an oil pollution emergency response are clearly described in the OPEP.

Table 7-2: Roles and responsibilities

Role	Responsibilities
Chief Executive Officer	Ensure: • Beach has the appropriate organisation in place to be compliant with regulatory and other requirements and this EP. • OEMS continues to meet the evolving needs of the organisation.
Beach Otway Project Manager	Ensure: • Compliance with regulatory and other requirements and this EP. • Records associated with the activity are maintained as per Section 7.4.2. • Personnel who have specific responsibilities pertaining to the implementation of this EP or Oil Pollution Emergency Plan (OPEP) know their responsibilities and are competent to fulfil their designated role. • Environmental impacts and risks associated with the activity have been identified and any new or increased impacts or risks are managed via the Management of Change process detailed in Section 7.8.1. • Incidents are managed and reported as per Section 7.10. • EP report is submitted to NOPSEMA not more than three months after the anniversary date of the EP acceptance. • Changes to equipment, systems and documentation where there may be a new or change to an environmental impact or risk or a change that may impact the EP are assessed Management of Change process detailed in Section 7.8.1. • Oil spill response arrangements for the activity are tested as per Section 12.2 of the OPEP. • Audits and inspections are undertaken in accordance with Section 7.12.2.
Beach Principal Environment Advisor	Ensures: • Environmental and regulatory requirements are communicated to those who have specific responsibilities pertaining to the implementation of this EP or OPEP. • The environmental component of the activity induction is prepared and presented. • Environmental incidents are reported and managed as per Section 7.10. • The monthly and end-of-activity EP environmental performance report are prepared and submitted.

Role	Responsibilities
	• Environmental impacts and risks associated with the activity have been identified and any new or increased impacts or risks are managed via the Management of Change process detailed in Section 7.8.1. • That audits and inspections are undertaken as detailed in Section 7.12 and any actions from non-conformances or improvement suggestions tracked. • Reviews and revisions to the EP are made as per the requirements in Section 7.12.
Beach Community Relations Manager	• Undertake stakeholder consultation for the activity. • Record and report to the Activity Manager and Environment Advisor any objections or claims raised by relevant stakeholders. • Maintain a stakeholder consultation log.
Vessel Master	Ensure: • Vessel operations are carried out in accordance with regulatory requirements and this EP. • Vessel adheres to the distances and vessel management practices for whales and dolphins as per the EPBC Regulations (Part 8). • Environmental incidents are reported to the Otway Operations Manager within required timeframes as per Section 7.10. • Oil spill response arrangements are in place and tested as per the vessel's SMPEP or equivalent.
Vessel personnel	• Complete project induction. • Report hazards and/or incidents via company reporting processed. • Stop any task that they believe to be unsafe or will impact on the environment.

7.3 Element 2 – Financial Management and Business Planning

Element 2 seeks to ensure robust and achievable business plans are developed and supported by a consistent and realistic understanding of facility constraints. It drives robust analysis and accountable decision-making to deliver assets that maximise lifecycle value, providing clear cost control throughout the life of an asset.

There are four standards (Table 7-1) and ten outcomes to be delivered under this element.

This EP does not cover the risks involved in financial management and impact on the activity. The relevant impacts of financial and business planning risks are managed under the other OEMS elements described in this chapter.

7.4 Element 3 – Information Management and Legal

Element 3 describes the measures Beach must take to ensure ongoing compliance with regulatory and legal obligations in order to protect the Company's value and reputation, and to maintain Beach's licences to operate. Beach's ability to safely perform its duties in line with its legal obligations relies on robust management of documents and information.

There are three standards (Table 7-1) and seven outcomes to be delivered under this element. The standards relevant to the implementation of this EP are described below.

7.4.1 Standard 3.1 – Regulatory Compliance Standard

Standard 3.1 describes the responsibilities of each stakeholder and the processes for identifying, maintaining, managing and reporting Beach's regulatory compliance obligations. The Standard details the minimum requirements of a system to ensure effective Regulator engagement can be maintained across all its activities including permissions, project execution, operating and reporting.

Chapter 2 of this EP details the key environmental legislation applicable to the activity. The acceptability discussion for each aspect is assessed in Chapter 6 and specifically details the legislation pertaining to each aspect.

7.4.2 Standard 3.2 – Document Management Standard

Standard 3.2 specifies the minimum requirements to ensure that all Beach documents and records are managed in alignment with legal, regulatory and stakeholder requirements. It requires documents to be classified, developed, authorised, published, stored, accessed, reviewed and disposed consistently and in a manner that complies with company and statutory obligations. The document management system will clearly support the safe and efficient operations of the Company.

In accordance with Regulations 27 and 28 of the OPGGS(E), documents and records relevant to the implementation of this EP are stored and maintained in the Beach document control system for a minimum of five years. These records will be made available to regulators in electronic or printed form upon request.

7.4.3 Standard 3.3 – Information Management Standard

Standard 3.3 ensures that Beach implements appropriate Information Management practices to ensure information is managed as a corporate asset, enabling it to be exploited to support corporate objectives as well as satisfying Beach's legal and stakeholder requirements.

7.5 Element 4 – People, Capability and Health

Element 4 focuses on ensuring the people within the business are fully equipped with the competencies required to perform their assigned duties and are physically and mentally prepared. This element is important in protecting workers' health and is closely aligned with Standard 8.1 (Risk Management) and Standard 8.2 (Safe Systems of Work).

There are two standards (Table 7-1) and four outcomes to be delivered under this element. Standard 4.1 is discussed below, noting that the health management standard is not relevant to the EP.

7.5.1 Standard 4.1 – Training and Competency Standard

Standard 4.1 describes the minimum company requirements to ensure peoples training requirements are identified and meet the tasks they are required to perform, and that verification of competency is carried out where necessary. The Standard defines the responsibilities for ensuring suitable training programmes are available and for ensuring peoples levels of capability are maintained at the required level.

Each employee or contractor with responsibilities pertaining to the implementation of this EP shall have the appropriate competencies to fulfil their designated role.

To ensure that personnel are aware of the EP requirements for the activity all offshore personnel will complete an induction, as a minimum. Records of completion of the induction will be recorded and maintained as per Section 7.4.2. The induction will at a minimum cover:

- description of the environmental sensitivities and conservation values of the operational area and surrounding waters.
- controls to be implemented to ensure impacts and risks are ALARP and of an acceptable level.

- requirement to follow procedures and use risk assessments/ job hazard assessments to identify environmental impacts and risks and appropriate controls.
- requirements for interactions with fishers and/or fishing equipment.
- requirement for responding to and reporting environmental hazards or incidents.
- overview of emergency response and spill management plans.
- fauna sighting and vessel interaction procedures.
- noise controls to be implemented to ensure impacts and risks are ALARP and of an acceptable level and the importance of reporting whale sightings to the vessel MMO immediately.

In addition to the activity-specific induction, each employee or contractor with specific responsibilities pertaining to the implementation of this EP shall be made aware of their responsibilities, and the specific control measures required to maintain environmental performance and legislative compliance.

7.5.2 Communications

The Vessel Master and Beach Offshore Representative are jointly responsible for keeping the vessel crew informed about HSE issues, acting as a focal point for personnel to raise issues and concerns and consulting and involving all personnel in the following.

The meetings are used to identify and communicate:

- Issues associated with implementation of the EP;
- Any proposed changes to equipment, systems or methods of operation of equipment, where these may be HSE implications; and
- Any proposals for the continuous improvement of environmental protection, including the setting of environmental objectives and training schemes.

7.6 Element 5 – Contracts and Procurement

Element 5 addresses the acquiring of external services and materials, and the transportation of those materials. It ensures Beach's business interests are met while maintaining compliance with all legal obligations and retaining HSE performance as the top priority. Element 5 also documents requirements for management of land transport risks.

There are two standards (Table 7-1) and four outcomes to be delivered under this element.

Beach undertakes a pre-qualification of all contractors in which their HSE systems are reviewed to ensure that the contractor's HSE management system (HSEMS) is adequate for meeting their legal obligations and has identified the significant risks and control measures related to the scope of work being undertaken for Beach. This process includes verifying evidence of HSEMS implementation.

Training and competency of contractor personal engaged to work on the activity shall be managed in accordance with the contractor's HSEMS (or equivalent).

Section 7.12.2 details how the contractors will be assessed to ensure they have the capabilities and competencies to implement the control measures identified in Section 6.16.

7.7 Element 6 – Asset Management

The focus of Element 6 is the design, build and operation of assets. The underpinning standards reflect the importance of inherent safety in design, recognising that hazards and risk are to be reduced to ALARP in the design phase of an asset. The standards define the minimum requirement for the monitoring and assurance processes that support the ongoing safe and reliable management of an asset throughout its lifecycle. Element 6 draws heavily on the principles of process safety and is closely aligned with Elements 7 (Operational Control) and Element 8 (Risk Management).

There are five standards (Table 7-1) and eight outcomes to be delivered under this element.

Equipment that have been identified as a control measure for the purpose of managing potential environmental impacts and risks from the activity have an associated EPS that details the performance required as detailed in Section 6.

7.8 Element 7 – Operational Control

Element 7 focuses on the definition of parameters, practices and procedures required to ensure adequate controls and safe execution of work at operating assets. It deals with the ongoing management of barrier integrity throughout asset lifecycle, ensuring good process safety practices are consistently deployed, and that facility changes manage holistic risk.

There are three standards (Table 7-1) and ten outcomes to be delivered under this element. The standard of relevance to this EP Management of Change is discussed below.

7.8.1 Standard 7.3 – Management of Change Standard

Standard 7.3 defines the minimum planning and implementation requirements for technical and organisational change at Beach. It details the requirement for holistic assessment of the change, the requirement for consultation with stakeholder's dependent upon the nature of the change, and the need for clear accountability for the change. Risk associated with change is mitigated by ensuring change is appropriately approved, effectively implemented, formally assured and closed out upon completion. Any changes must be classified as either temporary or permanent.

The intent of the Management of Change (MoC) Standard is that all temporary and permanent changes to the organisation, personnel, systems, procedures, equipment, products and materials are identified and managed to ensure HSE risks arising from these changes remain at an acceptable level.

Changes to equipment, systems and documentation are managed in accordance with the MoC Standard to ensure that all proposed changes are adequately defined, implemented, reviewed and documented by suitably competent persons. This process is managed using an electronic tracking database (called 'Stature'), which provides assurance that all engineering and regulatory requirements have both been considered and met before any change is operational. The MoC process includes not just plant and equipment changes, but also documented procedures where there is an HSE impact, regulatory documents and organisational changes that impact personnel in safety critical roles.

Not all changes require a MoC review. Each change is assessed on a case-by-case basis. The potential environmental impacts and/or risks are reviewed by a member of the Beach Environment Team to determine whether the MoC review process is triggered.

Where risk and hazard review processes nominated in Section 7.9 identify a change in impacts, risks or controls (compared to those described and assessed in Chapter 6), and triggers a regulatory requirement to revise this EP, the revision shall be defined, endorsed, completed and communicated in accordance with the MoC Standard.

7.9 Element 8 – Risk Management and Hazard Control

The identification, assessment and treatment of risk is central to maintaining control of assets. Element 8 defines the means by which Beach manages all types of risk to the business. This element includes general risk management, the Safe Systems of Work by which site activities are controlled and executed, and the emergency and security arrangements in place to protect the Company from unplanned events or the attempts of others to do harm to the business.

There are three standards (Table 7-1) and seven outcomes to be delivered under this element. The standards of relevance to this EP are discussed below.

7.9.1 Standard 8.1 – Risk Management Standard

Standard 8.1 defines Beach's requirements to mitigate and manage risk at all levels within the business. It defines the Risk Management Framework for identifying, understanding, managing and reporting risks. The framework defines the documents, training, tools and templates to be used, and the accountabilities to be applied in support of effective risk management. Risks to people, the environment, Beach's reputation, financial position and any legal risks are assessed through the framework. The Standard defines the purpose and use of risk assessments and risk registers. The environmental risk management framework applied to the activity is described in Chapter 5 and applied to all the aspects assessed in Chapter 6 of this EP.

As described in Section 7.12.3, Beach will undertake a review of this EP if required in order to ensure that any changes to the activity, controls, regulatory requirements and information from research, stakeholders, industry bodies or any other sources to inform the EP are assessed using the risk management tools nominated. The review will ensure that the environmental impacts and risks of the activity continue to be reduced to ALARP and an acceptable level.

If revision of this EP is trigged though a change in risk or controls, the revision process shall be managed in accordance with the MoC process outlined in Section 7.8.1.

7.9.2 Standard 8.3 – Emergency and Security Management Standard

Standard 8.3 defines the minimum performance requirements to effectively manage credible emergency and security events, and to enable an efficient recovery to normal operations following such an event. The Standard defines the prevention, preparedness, response and recovery principles to be applied, the organisational structures to support emergency and security measures, and the training and testing protocols that must be in place to assure Beach maintains a state of readiness.

The emergency response framework to be applied to the activity is outlined below.

Emergency Response Framework

The Beach Crisis and Emergency Management Framework consists of a tiered structure whereby the severity of the emergency triggers the activation of emergency management levels. The emergency response framework contains three tiers based on the severity of the potential impact, as outlined in Figure 7-3. This framework is described in the Beach Emergency Management Plan (EMP) (CDN/ID 128025990).

The responsibilities of the Emergency Response Team (ERT), Emergency Management Team (EMT) and Crisis Management Team (CMT) are outlined in Table 7-3

The key emergency response arrangements for the activity are outlined herein.

Emergency Response Plan

Beach will prepare a bridging emergency response plan (ERP) that bridges to the emergency response measures in the vessel contractor's vessel-specific ERP to ensure that all emergency management functions are accounted for.

The Bridging ERP will describe the emergency roles and responsibilities for those on the vessel and outline the actions to be taken for potential activity-specific scenarios (e.g., loss of containment, vessel collision, fire, man overboard, fatality, etc). The Bridging ERP will define the communication requirements to notify both the company and external bodies of the incident so as to obtain assistance where needed and to fulfil reporting obligations.

The Bridging ERP will be supported by the Beach EMP. The EMP provides the standard mechanism for the EMT to operate from and includes guidance on effective decision-making for emergency events, identification, assessment and escalation of events and provides training and exercise requirements. The EMP provides information on reporting relationships for command, control and communications, together with interfaces to emergency services specialist response groups, statutory authorities and other external bodies. The roles and responsibilities are detailed for onshore and offshore personnel involved in an emergency, including the response teams, onshore support teams, visitors, contractors and employees. The EMP details the emergency escalation protocol depending on the nature of the emergency.

Associated with the EMP are the Emergency Response Duty Roster and Contact Lists. These documents constitute a suite of emergency response documents that form the basis for Beach's response to an emergency situation.

Where a third-party contractor (TPC) company is required to work under its own HSE management system while on the construction vessel, the Bridging ERP will detail the clear reporting lines between the TPC representatives and Beach personnel.

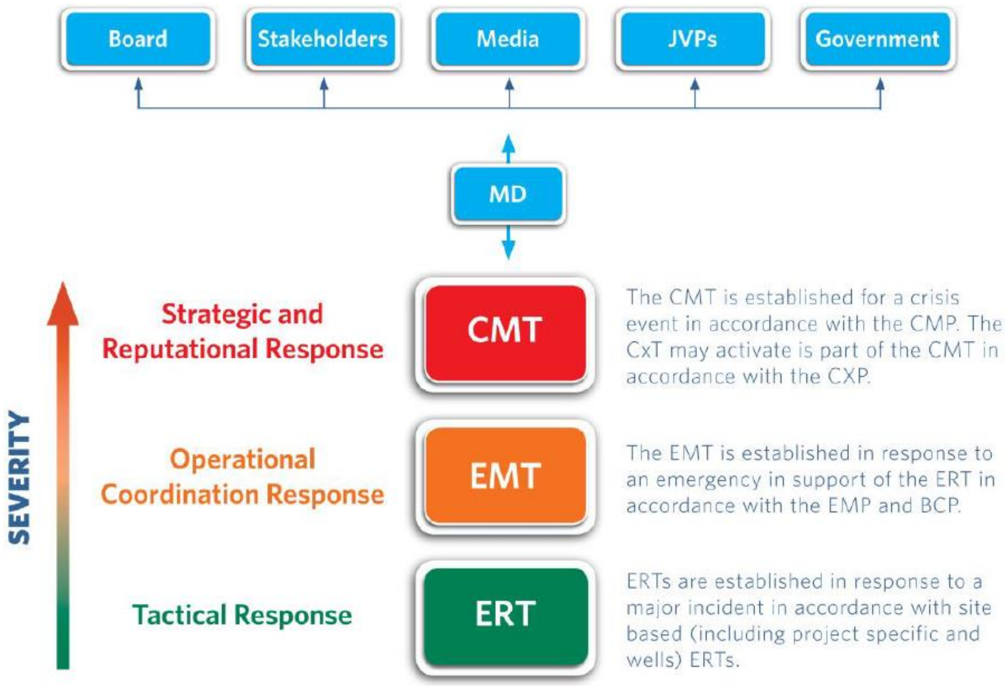


Figure 7-3: Beach Crisis and Emergency Management Framework

Prior to commencing the activity, office and vessel-based personnel will participate in an activity-specific desktop emergency response exercise to test the emergency response arrangements. The outcomes of the test will be documented to assess the effectiveness of the exercise against its objectives and to record any lessons and actions, and the outcomes will be communicated to participants. Actions will be recorded and tracked to completion. This emergency response exercise may be combined with a test of spill response arrangements (see Section 7.4).

Table 7-3: Responsibilities of the Beach Crisis and Emergency Management Teams

Team	Base	Responsibilities
CMT	Adelaide head office	• Strategic management of Beach's response and recovery efforts in accordance with the Crisis Management Plan. • Provide overall direction, strategic decision-making as well as providing corporate protection and support to activated response teams. • Activate the Crisis Management Team (CMT) if required.
EMT	Adelaide, Melbourne	• Provide operational management support to the Emergency Response team to contain and control the incident. • implement the Business Continuity Plan. • Liaise with external stakeholders in accordance with the site-specific Emergency Response Plan. • Regulatory reporting.
ERT	Site Vessel	• Respond to the emergency in accordance with the site-specific ERP.

7.9.3 Oil Pollution Emergency Plan

Oil spill response arrangements associated with Phase 5 Early Dive Installation Campaign are detailed within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (OPEP) (CDN/ID S4100AH717907).

The COVID-19 pandemic has resulted in restrictions or measures being implemented to address the pandemic. These restrictions or measures can potentially impact oil spill response arrangements. For all Beach activities within the Otway Development area, which includes the Phase 5 Early Dive Installation Campaign, the environmental risk profile has been reviewed with respect to the commitments in EPs and the Otway Offshore OPEP.

Section 7.12.2 Audits and Assessments and the Otway Offshore OPEP Section 12 On-Going Preparedness and Exercises detail the processes that Beach will complete to ensure that oil spill response requirements can be met during project activities.

7.9.4 Operational and Scientific Monitoring Plan

Operational and scientific monitoring arrangement associated with Phase 5 Early Dive Installation Campaign are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) (CDN/ID S4100AH717908) and Phase 5 Early Dive Installation Campaign OSMP Addendum (CDN/ID S4111AF725810).

Table 7-4 and **Error! Reference source not found.** detail particular values and sensitivities that may require monitoring in the event of a worst-case discharge, using Artisan-1 well location as a proxy indicator for the activity location and based upon conservative (low exposure) in-water thresholds, specifically: AMP, MNP, Marine Park (MP) and RAMSAR wetlands. There was shoreline contact at low exposure thresholds predicted for condensate release, but no intersection with RAMSAR wetlands; there was no shoreline contact predicted for the diesel release. Surface exposure was typically restricted to the immediate vicinity of the release location, however a low probability (1%) of exposure to the Apollo MP was predicted for the diesel release, and a low probability (3%) of exposure to the Twelve Apostles Marine National Park was predicted for the condensate release. These identified values and sensitivities are not exhaustive, as other receptors may also require monitoring in the event of a Level 2 or Level 3 hydrocarbon spill but provide an indication of the potential extent of hydrocarbon contact to formally managed areas.

7.9.5 Testing of spill response arrangements

Section 12.2 of the OPEP details the oil spill response testing arrangements.

Table 7-4: Environment potentially exposure to low in-water thresholds – diesel release from Artisan-1 well location

		Summer				Winter			
		Probability (%) of instantaneous dissolved >6ppb	Maximum instantaneous dissolved hydrocarbon exposure (ppb)	Probability (%) of instantaneous entrained >10ppb	Maximum instantaneous entrained (ppb)	Probability (%) of instantaneous dissolved >6ppb	Maximum instantaneous dissolved hydrocarbon exposure (ppb)	Probability (%) of instantaneous entrained >10ppb	Maximum instantaneous entrained (ppb)
Receptor type	**Receptor name**								
AMP	Apollo	3	22	25	406	5	24	54	501
	Beagle	-	-	-	-	-	-	2	11
MNP	Discovery Bay	-	-	3	25	-	-	-	-
	Point Addis	-	-	-	-	-	-	2	17
	Port Philip Heads	-	-	-	-	-	-	4	19
	Twelve Apostles	-	-	26	278	-	-	15	283
	Wilsons Promontory	-	-	-	-	-	-	3	16
MP	Lower South East	-	-	2	22	-	-	-	-
RAMSAR	Port Philip Bay and Bellarine Peninsula	-	-	-	-	-	-	1	10

7.10 Element 9 – Incident Management

Element 9 defines how Beach classifies, investigates, reports and learns from incidents. An incident is any unplanned event or change that results in potential or actual adverse effects or consequences to people, the environment, assets, reputation, or the community.

There is one standard (Table 7-1) and five outcomes to be delivered under this element, with the standard discussed below.

7.10.1 Standard 9.1 – Incident Management Standard

Standard 9.1 defines the requirement for incident reporting and subsequent investigation requirements. It ensures that incident classification is applied consistently across the company, and that the appropriate level of investigation and approval authority is implemented. The standard describes the requirement for identifying and assigning remedial actions, and for communicating key learnings throughout the business. As such, the standard also defines the requirement for adequate training for those persons involved in performing investigations.

The incident management standard requires that all HSE incidents, including near misses, are reported, investigated and analysed to ensure that preventive actions are taken, and learnings are shared throughout the organisation.

Incident reports and corrective actions are managed using the CMO Incident Management System.

Notification and reporting requirements for environmental incidents to external agencies are provided in Table 7-5.

Table 7-5: Regulatory incident reporting

Requirement	Timing	Contact	Responsible Person
Recordable incident As defined within the OPGGS(E)R a recordable environmental incident is a breach of an EPO or EPS in the EP that applies to the activity that is not a recordable incident.			
As a minimum, the written monthly recordable report must include a description of: • all recordable incidents which occurred during the calendar month; • all material facts and circumstances concerning the incidents that the operator knows or is able to reasonably find out; • corrective actions taken to avoid or mitigate any adverse environmental impacts of the incident; and • corrective actions that have been taken, or may be taken, to prevent a repeat of similar incidents occurring. Regulation 26B of the OPGGS(E)R requires a recordable incident report to	Before the 15th day of the following calendar month	• NOPSEMA – submissions@nopsema.gov.au	Offshore Project Manager

Requirement	Timing	Contact	Responsible Person
be submitted if there is a recordable incident, thus nil reports are not required.			
Reportable incident As defined within the OPGGS(E)R, a reportable incident is an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage. In the context of the Beach Environmental Risk Matrix moderate to significant environmental damage is defined as any incident of actual or potential consequence category Serious (3) or greater. These risks include: • pipeline or well loss of containment. • vessel collision resulting in a loss of containment or otherwise. • introduction of marine pests to the operational area			
Verbal notification The notification must contain: • all material facts and circumstances concerning the incident; • any action taken to avoid or mitigate the adverse environmental impact of the incident; and • the corrective action that has been taken or is proposed to be taken to stop control or remedy the reportable incident.	Within two hours of becoming aware of incident	• NOPSEMA – 1300 674 472 • NOPSEMA – submissions@nopsema.gov.au • DJPR – marine.pollution@ecodev.vic.gov.au (0409 858 715) • NOPTA – reporting@nopta.gov.au	Offshore Project Manager
Written notification Verbal notification of a reportable incident to the regulator must be followed by a written report. As a minimum, the written incident report will include: • the incident and all material facts and circumstances concerning the incident; • actions taken to avoid or mitigate any adverse environmental impacts; • the corrective actions that have been taken, or may be taken, to prevent a recurrence of the incident; and • the action that has been taken or is proposed to be taken to prevent a similar incident occurring in the future.	Within 3 days of notification of incident	• NOPSEMA – submissions@nopsema.gov.au	Offshore Project Manager

Requirement	Timing	Contact	Responsible Person
Written incident reports to be submitted to NOPTA and DJPR (for incidents in Commonwealth waters).	Within 7 days of written report submission to NOPSEMA	• DJPR – marine.pollution@ecodev.vic.gov.au • NOPTA – reporting@nopta.gov.au	Offshore Project Manager
Vessel spill to marine environment All discharges /spills or probable discharges/spills to the marine environment of oil or oily mixtures, or noxious liquid substances in the marine environment from vessels. Reporting info: http://www.amsa.gov.au/forms-and-publications/AMSA1522.pdf.	Verbal notification ASAP	Immediate notification by the Vessel Master to AMSA. Follow-up with Marine Pollution Report (POLREP). • Ph: 1800 641 792 • Email: rccaus@amsa.gov.au • AMSA POLREP: https://amsa-forms.nogginoca.com/public/	Vessel Master
AMP – in the event an AMP may be exposed to hydrocarbons	Verbal notification ASAP	• Marine Park Compliance Duty Officer – 0419 293 465 Notification must be provided to the Director of National Parks and include: • titleholder details; • time and location of the incident (including name of marine park likely to be affected); • proposed response arrangement; • confirmation of providing access to relevant monitoring and evaluation reports when available; and • contact details for the response coordinator.	EMT Lead (or delegate)
Vessel strike with cetacean	Within 72 hours	• DAWE – online National Ship Strike Database https://data.marinemammals.gov.au/report/shipstrike	Vessel Master
	ASAP for cetacean injury assistance	• Department of Environment, Land, Water and Planning (Whale and Dolphin Emergency Hotline) – 1300 136 017 • Seals, Penguins or Marine Turtles 136 186 (Mon-Fri 8am to 6pm) or AGL Marine Response Unit 1300 245 678.	Vessel Master / Environment Advisor
Injury to or death of EPBC Act-listed species	Within seven days	• DAWE – 1800 803 772 • EPBC.Permits@environment.gov.au	Environment Advisor

Requirement	Timing	Contact	Responsible Person
Suspected or confirmed Invasive Marine Species introduction	Verbal notification ASAP	• Department of Environment, Land, Water and Planning – 136 186	Environment Advisor
Identification of any historic shipwrecks, aircraft or relics	Written notification within 1 week	• written notification via the notification of discovery of an historic shipwreck or relic online submission form.	Offshore Project Manager

7.11 Element 10 – Environment and Community

Element 10 focuses on the measures the organisation must take to ensure that it upholds its reputation as a responsible and ethical company and continues its open and transparent engagements with its communities and stakeholders. Beach operates in environmentally sensitive areas, in close proximity to communities, with potential impacts on stakeholders. Beach has an obligation to ensure that potential impacts from its activities are clearly identified, minimised to ALARP and mitigated where there is an economic loss to a stakeholder directly impacted by Beach activities.

There are two standards (Table 7-1) and three outcomes to be delivered under this element, with the standards discussed below.

7.11.1 Standard 10.1 – Environment Management Standard

Standard 10.1 ensures that Beach implements appropriate plans and procedures to conduct its operations in an environmentally responsible and sustainable manner. The standard defines the requirement to assess environmental impacts and risks that may result from the company's operations and for site-specific management plans to protect the environment from harm. The standard covers land disturbance, reinstatement and rehabilitation activities, and defines obligations for management of biodiversity, water systems, air quality, noise and vibration, amenities and waste.

This EP provides the key means of satisfying this HSEMS standard. Three process identified as controls in Section 6 are described below.

7.11.2 Whale Management Procedure

A daily cetacean strategy meeting involving the MMO, Beach Offshore Representative and the vessel operator will be held at the start and/or end of each day shift. The meeting will review cetacean observations from the previous 24 hours and discuss implications for the following day's operations. In accordance with Part A of EPBC Policy Statement 2.1, the cetacean sighting data report will be submitted to DAWE within three months of the activity completion.

The controls outlined in Section 6.4.5are summarised in a flowchart presented in Figure 7-4. This flowchart will be provided to the MMO in order to implement these measures throughout the activity.

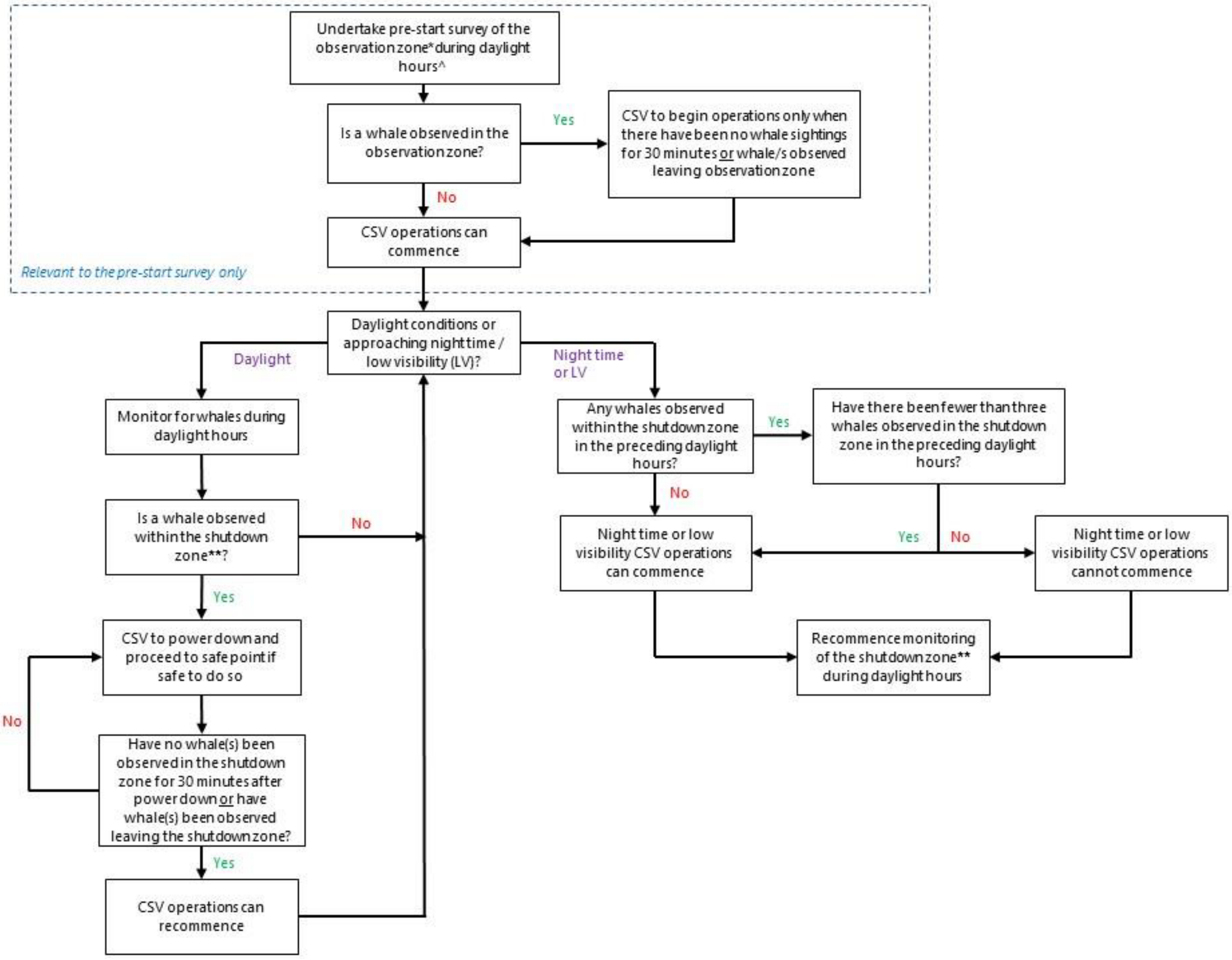


Figure 7-4 whale management procedure

7.11.3 Chemical Management Plan

The Hazardous Materials and Secondary Containment Directive addresses the management of hazardous substances and dangerous goods (termed “hazardous materials”) on Beach controlled sites/facilities.

The Beach Chemical Management Plan (S400AD719917) is used to assess chemicals that could be discharged to the marine environment to ensure that the impacts and risks associated with offshore discharge are reduced to ALARP. It considers aquatic toxicity, bioaccumulation and persistence data, along with the discharge concentration, duration, frequency, rate, and volume to assess chemicals that may or will be discharged to the marine environment. The assessment and outcome is recorded on the Offshore Chemical Register.

Figure 7-5 provides a summary of the offshore chemical environmental risk assessment process.

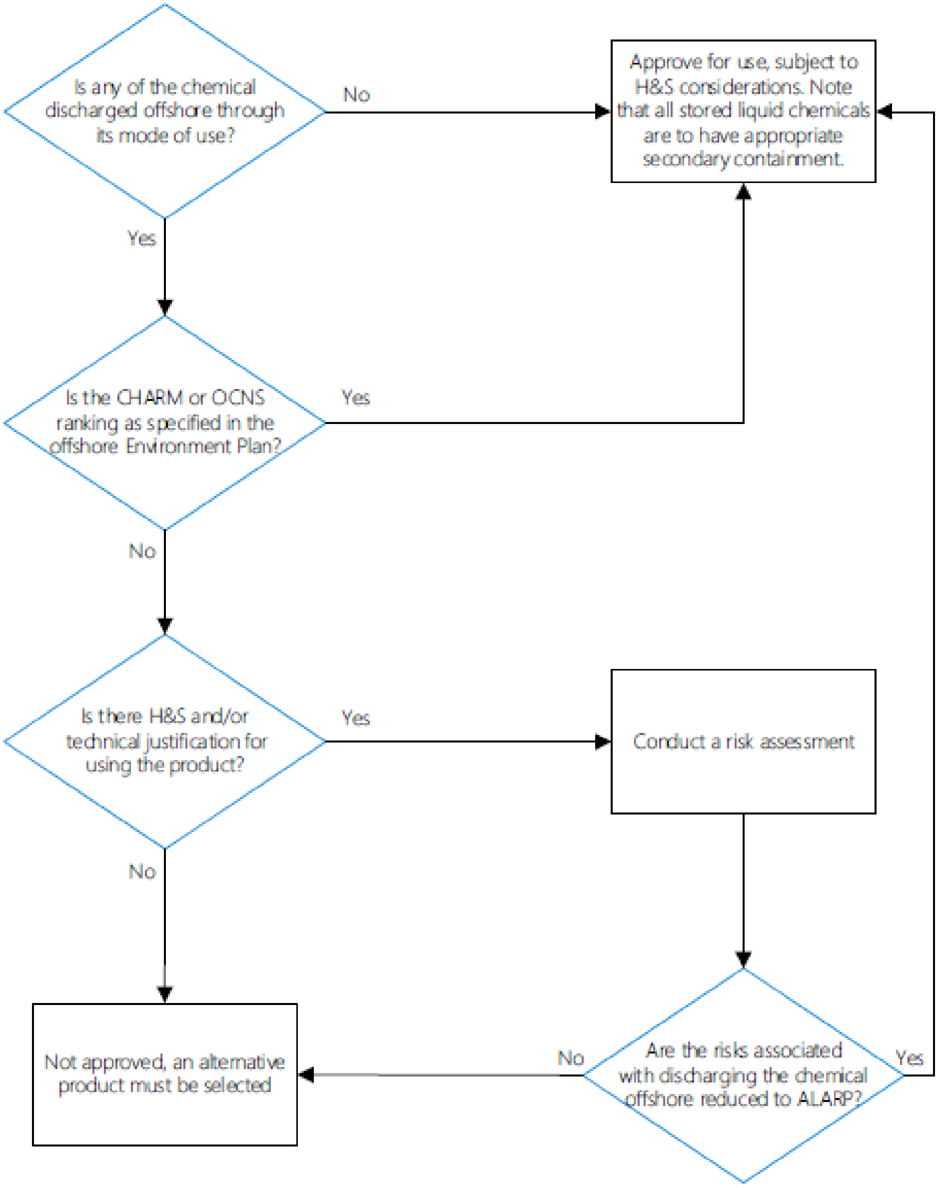


Figure 7-5: Beach offshore chemical environmental risk assessment process summary

7.11.4 Beach Energy Domestic IMS Biofouling Risk Assessment Process

Scope

All vessels mobilised from domestic waters to undertake offshore petroleum activities within the operational area must complete the Beach Domestic IMS Biofouling Risk Assessment Process as detailed in the Beach Introduced Marine Species Management Plan (S400AH719916) prior to the initial mobilisation into the operational area.

This domestic IMS biofouling risk assessment process does not include an evaluation of potential risks associated with ballast water exchange given all vessel operators contracted to Beach must comply with the most recent version of the Australian Ballast Water Management Requirements.

Purpose

- Validate compliance with regulatory requirements (Commonwealth and State) in relation to biosecurity prior to engaging in petroleum activities within the operational area;
- Identify the potential IMS risk profile of vessels prior to deployment within the operational area;
- Identify potential deficiencies of IMS controls prior to entering the operational area;
- Identify additional controls to manage IMS risk; and
- Prevent the translocation and potential establishment of IMS into non-affected environments (either to or from the operational area).

Screening Assessment

Prior to the initial mobilisation of the vessels to the operational area, a screening assessment must be undertaken considering:

- All relevant IMO and regulatory requirements under the Australian Biosecurity Act 2015 and/or relevant Australian State or Territory legislation must be met;
- If mobilising from a high or uncertain risk area, the vessel must have been within that area for fewer than 7 consecutive days or inspected and deemed low-risk by an independent IMS expert, within 7 days of departure from the area;
- Vessels must have valid antifouling coatings based upon manufacturers specifications;
- Vessels must have a biofouling control treatment system in use for key internal seawater systems; and
- Vessels must have a Biofouling Management Plan and record book consistent with the International Maritime Organization (IMO) 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (IMO Biofouling Guidelines).

Where relevant criteria have been met, no further management measures are required, and the vessel may be deployed into the operational area.

Where relevant criteria have not been met, or there is uncertainty if these criteria have been met, Beach must engage an independent IMS expert to undertake a detailed biosecurity risk assessment, and the vessel must be deemed low-risk prior to mobilisation into the operational area.

Basis of Detailed IMS Biofouling Risk Assessment

The basis by which an independent IMS expert evaluates the risk profile of a vessel includes:

- The age, type and condition of the vessel;
- Previous cleaning and inspection undertaken and the outcomes of previous inspections;
- Assessment of internal niches with potential to harbour IMS;
- The vessel history since previous inspection;
- The origin of the vessel including potential for exposure to IMS;

- Translocation risk based upon source location in relation to activity location – both in relation to the water depth / proximity to land at the point of origin and the potential survivorship of IMS from the point of origin to the operational / project area;
- The mobilisation method – whether dry or in-water (including duration of low-speed transit through high or uncertain risk areas);
- For vessels, the application, age and condition of antifouling coatings;
- presence and condition of internal seawater treatment systems;
- Assessment of Biofouling Management Plan and record book against IMO Biofouling Guidelines; and
- Where appropriate, undertake in-water inspections.

7.11.5 Standard 10.2 – Community Engagement Standard

Standard 10.2 defines the minimum requirements for the conduct of Beach and its staff within the community, and the commitments to plan and execute effective community engagement in the course of its business. Beach staff will conduct themselves as ambassadors for the company and engage positively and respectfully with the community.

The standard describes the obligation of the company to proactively engage with the community at the outset of any activity that may have an impact on that community, and to develop a stakeholder engagement plan to manage that engagement.

Stakeholder consultation specific to the activity is discussed in Section 8 of this EP.

7.12 Element 11 – Assurance and Reporting

Element 11 establishes that the company must apply the requirements of relevant policies, and the commitments detailed in the OEMS standards throughout its activities. An assurance process therefore exists to systematically quantify compliance with those commitments, and with the underlying procedures and systems. This Element also documents Beach's approach to sustainability and reporting company performance using established sustainability performance metrics.

There are two standards (Table 7-1) and four outcomes to be delivered under this element, with the standards relevant to the activity discussed below.

7.12.1 Standard 11.2 – Assurance Management Standard

Standard 11.2 describes the "Three Lines of Defence" assurance model employed by Beach to govern its activities and ensure compliance with its commitments and standards. The standard defines Beach's requirements for the establishment and management of risk-based assurance activities at all levels within the company. The assurance process establishes the adequacy and effectiveness of Beach's risk controls and quantifies the status of compliance against our obligations. It ensures the organisation proactively closes any gaps in performance so it can address those issues before harm is manifested. As such, the assurance programme identifies improvement opportunities in business processes and risk controls.

The Standard describes the need to have assurance plans across the business, and for the assurance activities to take place on multiple levels of the organisation. This approach collectively ensures the operational activities Beach perform are compliant with its procedures, standards and ultimately with governing policies and legislative obligations. The holistic results of the assurance programme are reportable to the Board and Committees.

7.12.2 Audits and Inspections

Environmental performance will be reviewed in several ways to ensure:

- EPSs to achieve the EPOs are being implemented and reviewed.
- potential non-compliances and opportunities for continuous improvement are identified.
- environmental monitoring and reporting requirements have been met.

A pre-mobilisation audit will be undertaken at least two weeks prior to commencement of vessel operations, of the EPOs and EPSs in this EP and the requirements detailed in the implementation strategy. The audit will inform the annual performance report submitted to the relevant regulator as per Section 7.12.5.

For offshore activities undertaken by the vessel the following will be undertaken:

- premobilisation inspection of each vessel (desktop or site) to confirm the requirements of the EP will be met.

Non-compliances and opportunities for improvements identified via audits, inspections or other means are communicated to the appropriate supervisor and/or manager to report and action in a timely manner. Tracking of non-compliances and audit actions will be undertaken using Beach's incident management system which includes assigning a responsible person for ensuring the action is addressed and closed out.

7.12.3 Environment Plan Review

Beach may determine that a review of the EP is required when one or more of the following occurs:

- changes to impacts and risks and/or controls identified during the activity.
- annual environmental performance reporting identifies issues in the EP that require review and/or updating.
- implementation of corrective actions to address internal audits findings or external inspection recommendations.
- an environmental incident and subsequent investigation identify issues in the EP that require review and/or updating.
- a modification of the activity is proposed that is not significant but needs to be documented in the EP.
- changes to risk and controls identified through the Risk Management Processes as per Section 7.9.
- new information or changes in information from stakeholders, research and studies, protected species, legal and other requirements. This shall be achieved by:
    - subscription to regulator and relevant industry distribution lists (such as APPEA and IOGP);
    - subscription to the NOPSEMA website to identify any new petroleum activities within the Otway Basin that may overlap with the Otway Operations locations and timings;
    - annual review of the EP inclusive of relevant regulatory requirements (when in force for longer than 12 months); and
    - ongoing Stakeholder communications.

Where the EP is revised the changes are to be logged in the EP Revision Change Register in Appendix C. Any revisions to the EP are to be assessed against the criteria for submission of a revised EP to NOPSEMA as detailed in Table 7-6 and Management of Change as per Section 7.8.1 shall be evaluated.

7.12.4 Environment Plan Revision

In accordance with Regulation 17 of the OPGGS(E)R, a revision of this EP shall be submitted to NOPSEMA as per the regulatory requirements in Table 7-6.

Table 7-6: Regulatory requirements for submission of a revised EP

OPGGS(E)R	EP Revision Submission Requirements
17(1)	With the regulator's approval before the commencement of a new activity.
17(5)	Before the commencement of any significant modification or new stage of the activity that is not provided for in the EP as currently in force.
17(6)	Before, or as soon as practicable after, the occurrence of any significant new or significant increase in environmental impact or risk; or The occurrence of a series of new or a series of increases in existing environmental impacts or risks which, taken together, amount to the occurrence of a significant new or significant increase in environmental impact or risk.
17(7)	A change in titleholder that results in a change in the manner in which the environmental impacts and risks of an activity are managed.

7.12.5 Annual Performance Report

In accordance with OPGGS(E) Regulation 14(2), Beach will submit a report on the environmental performance of the activity to NOPSEMA. Performance will be measured against the EPOs and EPSs described in this EP. The report will be submitted not more than three months after the anniversary date of the EP acceptance by NOPSEMA. The interval between reports will not be more than one year.

7.12.6 Emissions and Discharge Records

In accordance with OPGGS(E) Regulation 14(7), emissions and discharges shall be recorded for the duration of the activity. Table 7-7 details the types of emissions and discharges that shall be recorded including the monitoring method and frequency of reporting.

Table 7-7: Emissions and discharges monitoring requirements

Emission / Discharge	Monitoring parameter	Recording method	Reporting frequency	Responsibility
Pre-commissioning fluid	Chemical name Volume discharged	Daily report	Monthly	Offshore Project Manager
Vessel				
Fuel	Volume used	Daily report	Monthly	Vessel Operator
Bilge	Volume discharged	Oil record Book	As required	Vessel Operator
Sewage	Volume discharged	Garbage record book	As required	Vessel Operator

Emission / Discharge	Monitoring parameter	Recording method	Reporting frequency	Responsibility
Putrescible food	Volume discharged	Garbage record book	As required	Vessel Operator

8 Stakeholder Consultation

Stakeholder consultation was undertaken in line with current NOPSEMA guidelines on consultation requirements under the OPGGS(E)R.

Beach is committed to open, on-going and effective engagement with the communities in which it operates and providing information that is clear, relevant and easily understandable. Beach welcomes feedback and is continuously endeavouring to learn from experience in order to manage our risks.

8.1 Regulatory requirements

Section 280 of the OPGGS Act states that a person carrying out activities in an offshore permit area should not interfere with other users of the offshore area to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.

In relation to the content of an EP, more specific requirements are defined in the OPGGS (E) Regulation 11(A). This regulation requires that the Titleholder consult with 'relevant persons' in the preparation of an EP. A relevant person is defined as:

a) each Department or agency of the Commonwealth to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant;

b) each Department or agency of a State or the Northern Territory to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant;

c) the Department of the responsible State Minister, or the responsible Northern Territory Minister;

d) a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the environment plan, or the revision of the environment plan;

e) any other person or organisation that the titleholder considers relevant.

Regulation 9(8) of the OPGGS(E)R requires all sensitive information (if any) in an environment plan, and the full text of any response by a relevant person to consultation under regulation 11A in the course of preparation of the plan, must be contained in the sensitive information part of the plan and not anywhere else in the plan.

Regulation 9AB of the OPGGS(E)R requires the Regulator must publish (the EP) on the Regulator's website.

Regulation 14(9) of the OPGGS(E)R also defines a requirement for ongoing consultation to be incorporated into the Implementation Strategy. In addition, Regulation 16(b) of the OPGGS(E)R requires that the EP contain a summary and full text of this consultation. It should be noted that the full text is not made publicly available for privacy reasons.

8.2 Stakeholder consultation objectives

The objectives of Beach's stakeholder consultation in preparation of the EP were to:

- identify all relevant persons for stakeholder consultation.
- engage with stakeholders and the community in an open, transparent, timely and responsive manner.
- minimise community and stakeholders concern where practicable.
- build and maintain trust with stakeholders and the local community.

- demonstrate that stakeholders have been consulted in line with the requirements of the relevant regulations.

The objectives were achieved by:

- identifying stakeholders whose functions, interests or activities may be affected by the activity.
- confirming, through consultation, 'relevant persons' (stakeholders) and engaging them at the earliest opportunity.
- providing sufficient information to allow relevant persons to make an informed assessment of the possible consequences of the activity on their functions, interests or activities.
- ensuring relevant persons are informed about the process for consultation and their feedback is considered in the development of the EP.
- ensuring that issues raised by relevant persons are adequately assessed, and where requested or relevant, responses to feedback are communicated back to them.
- providing a copy of this EP to NOPSEMA for publication on the NOPSEMA website as per regulation 11B of the OPGGS(E)R.
- ensuring that relevant person sensitive information is not made publicly available.

8.3 Consultation approach

The approach Beach has undertaken for consultation for the entire Beach Otway Offshore Project, including this EP is:

- identify stakeholders that may be potentially affect by the activities by reviewing its stakeholder database and consulting with existing stakeholders to identify other relevant stakeholders. Beach, previously as Lattice Energy, has operated in the area since the early 2000s, and has built an extensive database of stakeholders from ongoing engagement in relation to the current Operating assets and in executing the Otway Offshore Project including the Otway Offshore Drilling program and subsea connections.
- determine the possible consequences of the activities on each stakeholders' functions, interests or activities from previous knowledge, reviewing any public statements by the stakeholder as to how they want to be engaged by oil and gas companies and/or consulting with stakeholders.
- provide sufficient information, based on possible consequences and the way they would like to be consulted, for the stakeholder to be able to make an informed assessment of the possible consequences of the activity on their functions, interests or activities.
- allow a reasonable period of time for the stakeholder to review and respond to any information provided, typically two to four weeks.
- provide further information requested by the stakeholder or that became available during the consultation period and allowed a reasonable time for the stakeholder to review and respond. Depending on the information provided this was between one to four weeks.
- ensure relevant stakeholders were informed about the consultation process and how their feedback, questions and concerns were considered in the EP.

8.4 Fair Ocean Access Procedure

The Fair Ocean Access Procedure was developed by Beach after consultation with stakeholders in particular SETFIA and BSSIA, the stakeholder records can be found in the Prion 3D Marine Seismic Survey EP.

The procedure supersedes Beach's Commercial Fisher Operating Protocol. The Fair Ocean Access Procedure Information Sheet can be found in Appendix D.

8.5 Stakeholder identification

Relevant stakeholders were identified by reviewing:

- social receptors identified in the existing environment section.
- existing stakeholders within Beach's stakeholder register.
- reviewing consultation record for previous Otway Basin activities undertaken by Beach and Lattice.
- Commonwealth and State fisheries jurisdictions and fishing effort in the region.
- the Australian Government Guidance Offshore Petroleum and Greenhouse Gas Activities: Consultation with Australian Government agencies with responsibilities in the Commonwealth Marine Area.

The Otway Development commenced production in late February 2008. Woodside Energy, the titleholder at the time, undertook significant consultation with the community, non-government organisations and Government departments. Consultation has been ongoing through the change of titleholders to Origin and then Lattice and now Beach.

Lattice also undertook three marine seismic surveys between 2014 and early 2017 and had regular and detailed engagement with both fishing industry associations and individual fishers over this period. In 2017 Lattice commenced consultation in relation to the Otway Development Phase 4 and associated seabed assessment and drilling activities. Beach then commenced consultation with stakeholders in early 2019 when they decided to progress with the Otway Development Phase 4. Consequently, Beach consider that they have effectively identified relevant stakeholders and have a good understanding of issues and areas of concern within the Otway Development area. Table 8-1 details the relevant stakeholders identified and groups them by the categories listed under OPGGS(E) Regulation 11A. It should be noted that no fishing effort by Tasmanian fisheries was identified within the operational area.

8.6 Provision of information

The OPGGS(E)R require titleholders to give each relevant person sufficient information to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person.

To determine the type of information to provide to a stakeholder an Information Category was developed and is detailed in Table 8-2.

8.7 Summary of stakeholder consultation

Table 8-4 provides a summary of the stakeholder consultation undertaken as part of the development of the EP. The summary provides details of the information sent to stakeholders and any response received. It also details the assessment undertaken of any objection or claims. Where an objection or claim was substantiated via evidence such as publicly available credible information and/or scientific or fishing data, this were assessed as per the risk assessment process detail in section 5 and controls applied where appropriate to ensure impacts and risks are managed to ALARP and an acceptable level.

Where an objection or claim was raised by a stakeholder, they were provided feedback as to whether the objection or claim was substantiated, how it was assessed and if any additional controls were required to manage the impact or risk to ALARP and an acceptable level or if not substantiated why.

On 28th June 2021 an email containing the Otway Offshore Project 2021-2023 Program, the Otway Offshore Project 2021-2023 Summary Information Sheet's along with the Drilling Locations and Timings of the Otway Offshore Project was sent to the stakeholders identified in Table 8-1. The information sheet is provided in Appendix G. Table 8-4 provides any stakeholder responses received during the consultation and details any objections and claims made.

Along with consultation completed on 28th June 2021, consultation has been ongoing since 2019 for the Otway Offshore Project and will continue on as required via one-on-one communications, mail outs and provision of information on the Beach website. Emails sent to stakeholders in early 2019, including Commonwealth and State government departments and commercial fisheries associations, specifically included subsea infrastructure installation as one of the activities to be undertaken during the Otway development activities.

Table 8-4 provides any stakeholder responses received during the consultation and details any objections and claims made.

Table 8-1: Relevant stakeholders for the activity (refer to Table 8-2 for information category definition)

Stakeholder	**Relevance**	**Information category**
Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant		
Australian Fisheries Management Authority (AFMA)	Australian Government agency responsible for the efficient management and sustainable use of Commonwealth fish resources. Activity is within a Commonwealth fishery area. AFMA expects petroleum operators to consult directly with fishing operators or via their fishing association body about all activities and projects which may affect day to day fishing activities.	1
Australian Hydrological Office (AHO)	Australian Government agency responsible for issuing notices to mariners.	2
AMSA Joint Rescue Coordination Centre (JRCC)	Australian Government agency responsible for maritime safety, adherence to advice, protocols, regulations. Issue radio-navigation warnings.	1
Parks Australia – Director of National Parks	Australian Government agency responsible for MNES and Australian Marine Parks	1
Department of Agriculture, Water and Environment-Biosecurity	Australian Government agency responsible for preventing, responding and recovering pests and diseases that threatened the economy and environment.	1
Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP may be relevant		
Victorian Fishery Authority	Activity is within a Victorian fishery area or will impact or potentially impact a Victorian fishery area or resource.	1

Stakeholder	Relevance	Information category
The Department of the Responsible State or Northern Territory Minister		
Tasmanian DPIPWE EPA Tasmania	Regulatory body for oil and gas activities in Tasmanian waters. Required to be notified of reportable incidents. Commencement and cessation notifications are only required for drilling and seismic surveys.	2
DJPR - Earth Resources Regulation	Regulatory body for oil and gas activities in Victorian waters. Required to be notified of reportable incidents. Commencement and cessation notifications are only required for drilling and seismic surveys.	2
DJPR – Marine Pollution	Regulatory body ensuring Victoria is adequately prepared for and effectively responds to a marine pollution incident in State coastal waters up to three nautical miles offshore.	2
A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP		
Australian Southern Bluefin Tuna Industry (SBTF) Association	Peak body representing Southern Bluefin Tuna companies in Australia. The SBTF overlaps the operational area.	1
Blue Whale Study	Primary research into the ecology of endangered pygmy blue whales in south-east Australia. The operational area BIAs for the pygmy blue whale.	1
Commonwealth Fisheries Association (CFA)	Peak association representing commercial fishing in Commonwealth fisheries. Industry Association for the following Commonwealth fisheries that have catch effort within the operational area: • SESSF (Commonwealth South East Trawl Sector, Scalefish Hook Sector and the Shark Hook and Shark Gillnet Sectors). • Southern Squid Jig Fishery.	1
Department of Defence (DoD)	After reviewing the DoD's website it was noted that in the Bass Strait and Otway regions there could possibly be unexploded Ordnance (UXO) in the Otway region.	1
Port Campbell Professional Fisherman's Association	Association representing Port Campbell fishers, primarily rock lobster around Port Campbell and Peterborough. Engagement via SIV. s	1
Portland Professional Fishermen's Association	Association representing Portland fishermen.	1
South East Trawl Fishing Industry Association (SETFIA)	SETFIA represents businesses with a commercial interest in the SETF and the East Coast Deepwater Trawl Sector. SETFIA represent the following fisheries that have catch effort within the operational area: • SESSF (Commonwealth South East Trawl Sector, Scalefish Hook Sector and the Shark Hook, Shark Gillnet Sectors and small pelagic fishery).	1
Seafood Industries Victoria (SIV)	Peak body representing professional fishing, seafood processors and exporters in Victoria. SIV primary contact for State fishers.	1
Southern Rock Lobster Limited	Associations representing state-based commercial rock lobster fishers. Associations are represented by one consultancy and are therefore grouped.	1

Stakeholder	Relevance	Information category
South Australian Rock Lobster Advisory Council Inc. South Eastern Professional Fishermen's Association Inc. Tasmanian Rock Lobster Fishermen's Association		
Victorian Fisheries Authority	Independent statutory authority established to effectively manage Victoria's fisheries resources.	1
Victorian Rock Lobster Association (VRLA)	VRLA represents Victorian rock lobster licence holders. Engagement via SIV as VRLA no longer functions as a separate association and now operates as a committee of SIV.	1
Any other person or organisation that the titleholder considers relevant		
Abalone Victoria Central Zone	Represent the views and interests of its members and to ensure appropriate governance of member resources. No impact to stakeholders' functions, interests or activities due to the distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Alcatel Submarine Networks	They installed the sub-sea fibre optic cable south of Yolla Platform within the Bass Strait. No impact to stakeholders' functions, interests or activities. However, Beach maintain engagement in relation to activities within the Otway area.	3
Australian Petroleum Production and Exploration Association (APPEA)	APPEA is the voice of the oil and gas industry on the issues that matter, working collaboratively with industry and the community.	3
ConocoPhillips	Operator with current permit areas within the EMBA. No impact to stakeholders' functions, interests or activities. However, Beach maintain engagement in relation to activities within the Otway area.	3
Cooper Energy	Operator with current permit areas within the EMBA. No impact to stakeholders' functions, interests or activities However, Beach maintain engagement in relation to activities within the Otway area.	3
Corangamite Shire Council	The Otway Gas Plant is within the Corangamite Shire. The activity does not overlap shoreline receptors. However, Beach maintain engagement in relation to activities within the Otway area.	3
Crab and Shark Fisher	This stakeholder has acknowledged concern in the past during consultation. Beach maintain engagement in relation to activities within the Otway area.	3
Deakin University – School of Life and Environmental Sciences	Beach provide information as have ongoing engagement in relation to marine studies within their operating areas. No impact to stakeholders' functions, interests or activities.	3

Stakeholder	Relevance	Information category
Department of Agriculture and Water Resources	Ensuring Australia's agriculture, fisheries, food and forestry industries remain competitive, profitable and sustainable. No impact to stakeholders' functions, interests or activities. Beach maintain engagement in relation to activities within the Otway area.	3
Fishwell Consulting	Provide expert research advice and consulting services to encourage and promote sustainable fishing practices to the commercial fishing industry within Australia. Beach provide information as have ongoing engagement in relation to marine studies within their operating areas. No impact to stakeholders' functions, interests or activities.	3
Institute for Marine and Antarctic Studies (IMAS) - University of Tasmania	No impact to stakeholders' functions, interests or activities. Beach provide information as have ongoing engagement in relation to seismic survey impacts to commercial fisheries.	3
Lochard Energy	Owns and operates the Iona Gas Plant and the associated facilities located near Port Campbell in the state of Victoria. Offshore activities do not impact on the stakeholder's activities, interests or functions. Beach send information on offshore activities to stakeholder for their information only.	3
Ocean Racing Club of Victoria	Club which conducts regular offshore racing including the Melbourne to Hobart and the Melbourne to Launceston yacht races. However, no impact to stakeholders' functions, interests or activities due to distance offshore.	3
Otway Gas Plant Community Reference Group	Community Reference Group established for the Otway Gas Plant. No impact to stakeholders' functions, interests or activities due to distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Peterborough Residents Association Port Campbell Community Group Port Campbell Progress Group Port Campbell Visitor Centre	No impact to stakeholders' functions, interests or activities, because offshore activities do not have an impact. However, Beach maintain engagement in relation to activities within the Otway area.	3
Port Campbell Surf Life Saving Club Port Campbell Board Riders Association	No impact to stakeholders' functions, interests or activities, because of the distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Schlumberger	Schlumberger have no planned activities within the Otway region, therefore there will be no impact to stakeholders' functions, interests or activities. However, Beach maintain engagement in relation to activities within the Otway area.	3
SCUBA Divers Federation of Victoria	No impact to stakeholders' functions, interests or activities, because of the distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3

Stakeholder	Relevance	Information category
Surf Rider Association	Registered not for profit sea-roots organisation dedicated to the protection of Australia's waves and beaches through conservation, activism, research and education. No impact to stakeholders' functions, interests or activities due to distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Tasmanian Abalone Council Limited	Peak industry body representing divers, processors and quota holders and represents the views and needs of all stakeholders and allied interests alike. No impact to stakeholders' functions, interests or activities due to distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Tasmanian Seafood Industry Council (TSIC)	The TSIC is the peak body representing the interests of wild capture fishers, marine farmers and seafood processors in Tasmania. The operational area does not overlap any Tasmanian fisheries where there is catch effort. However, Beach maintain engagement in relation to activities within the Otway area.	3
TGS	Proposing to undertake the Otway Deep three-dimensional (3D) marine seismic survey (MSS) in the Commonwealth waters of the Otway Basin, which is outside of the operational area. No impact to stakeholders' functions, interests or activities. However, Beach maintain engagement in relation to activities within the Otway area.	3
Timboon Action Group	No impact to stakeholders' functions, interests or activities, because offshore activities do not have an impact. However, Beach maintain engagement in relation to activities within the Otway area.	
Tuna Australia - ETBF Industry Association	Represents statutory fishing right owners, holders, fish processors and sellers, and associate members of the Eastern and Western tuna and billfish fisheries of Australia. The operational area does not overlap any Eastern and Western tuna and billfish fishery areas. However, Beach maintain engagement in relation to activities within the Otway area.	3
Twelve Apostles Tourism and Business Group	No impact to stakeholders' functions, interests or activities, because offshore activities do not have an impact. However, Beach maintain engagement in relation to activities within the Otway area.	3
Victorian Scallop Fishermen's Association	Represents the interests of scallop fishermen operating within Australia's south east waters. No impact to stakeholders' functions, interests or activities due to distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3

Table 8-2: Information category to determine information provided stakeholder

Information Category	Description	Information Type
1	Organisations or individuals whose functions, interests or activities may be impacted by the activity. Relevant government agencies Representative body for fishers who provide information to their members.	Information Sheet and/or provision of information as per organisations consultation guidance Provision of further information where required Meeting or phone call where required

Information Category	Description	Information Type
2	Organisation who receive activity commencement and cessation notices.	Commencement and cessation notices.
3	Organisations or individuals whose functions, interests or activities will not be impacted by the activity but are kept up to date with Beach's activities in the Otway area.	Information Sheet

8.8 Ongoing stakeholder consultation

Beach will continue to consult with stakeholders to keep them informed as information becomes available. This will be done via ongoing consultation including updates in relation to the activity and broader Otway Offshore Gas Development project via one-on-one communications, mail outs and provision of information on the Beach website.

Any objections or claims raised from ongoing consultation will be managed as per Section 8.8.2 Management of Objections and Claims.

Records of ongoing stakeholder engagement will be maintained as per Section 8.8.2 Records Management.

8.8.1 Ongoing Identification of Relevant Persons

New or changes to relevant persons will be identified through ongoing consultation with stakeholders including peak industry bodies and the environment plan review process detailed in Section 7.12.3. Should new relevant persons be identified they will be contacted and provided information about the activity relevant to their functions, interests or activities. Any objections or claims raised will be managed as per Section 8.8.2.

8.8.2 Management of objections and claims

If any objections or claims are raised during ongoing consultation these will be substantiated via evidence such as publicly available credible information and/or scientific or fishing data. Where the objection or claim is substantiated it will be assessed as per the risk assessment process detail in Section 5 and controls applied where appropriate to manage impacts and risks to ALARP and an acceptable level. Stakeholders will be provided with feedback as to whether their objection or claim was substantiated, and if not why, and if it was substantiated how it was assessed and if any controls were put in place to manage the impact or risk to ALARP and an acceptable level. If the objection or claim triggers a revision of the EP this will be managed as per Section 7.12.3 and 7.12.4. This will also be communicated to the stakeholder.

Table 8-3: Ongoing stakeholder consultation requirements

Stakeholder	Ongoing stakeholder requirement	Timing
Relevant stakeholders	Ongoing engagement including: • stakeholder communication of information and addressing queries and concerns via email, phone or meeting; and • updates to Beach website.	As required

Stakeholder	Ongoing stakeholder requirement	Timing
Relevant stakeholders listed in Table 8-2 under category 1	Stakeholder notification of activity commencement. Notification to include: • type of activity; • location of activity, coordinates and map; • timing of activity: expected start and finish date and duration; • sequencing of locations if applicable; • vessel details including call sign and contact; • any safety exclusion zones required; and • Beach contact details. Note: coordinates to be provided as degrees and decimal minutes referenced to the WGS 84 datum.	2 weeks prior to activity commencing
AHO	Vessel Contractor to issue notification of activity for publication of notice to mariners. Information provided should detail: • type of activity; • geographical coordinates of the well location; • any exclusion zones required; • period that NTM will cover (start and finish date); • vessel details including name, Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), contact details and call signs; and • Beach and vessel Contractor contact details. Update AHO of progress, changes to the intended operations including if activity start or finish date changes.	4 weeks prior to activity commencing
AMSA - JRCC	Vessel Contractor to issue notification of activity for promulgation of radio navigation warnings. Information provided should detail: • type of activity; • area of operation: geographical coordinates of the well location; • any exclusion zones required; • period that warning will cover (start and finish date); • vessel details including name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone numbers), contact details and calls signs; • any other information that may contribute to safety at sea; and • Beach and vessel Contractor contact person. Update AMSA JRCC of progress, changes to the intended operations including if activity start or finish date changes.	48 – 24 hrs prior to activity commencing
NOPSEMA	Regulatory notification of start of activity.	10 days prior to activity commencing

Stakeholder	Ongoing stakeholder requirement	Timing
Relevant stakeholders who have requested vessel location information.	SMS or email messaging undertaken where requested by stakeholder.	During activity
NOPSEMA	Regulatory notification of cessation of activity.	Within 10 days of activity completion

Table 8-4: Summary of stakeholder consultation records and Beach assessment of objections and claims

Stakeholder name	Date	Record #	Description	Assessment of objection or claim
Australian Hydrographic Office (AHO)	28/06/2021	AHO 09	AHO responded to Beach's email. It was an acknowledgement that the AHO had received and registered Beach's correspondence.	No concerns raised.
Australian Maritime Safety Authority	06/08/2021	AMSA 06	AMSA notified Beach that they need to ensure AMSA-JRCC will be contacted by the vessel master via the contact AMSA JRCC provided 24-48 hours prior to moving and Beach will notify the AHO no later than 4 weeks before operations will commence.	Table 8-3Table 7-6 updated to include notifications to AMSA JRCC 24-48 hours prior to operations and no later than 4-weeks notification to AHO before operations commence.
Department of Agriculture, Water and Environment (DAWE) - Biosecurity	28/06/2021	DAWE-Bio 03	DAWE Biosecurity emailed Beach a receipt of confirmation they have received the email.	No concerns raised.
Director of National Parks	02/07/2021	DNP 09	Director of National Parks acknowledged that they had received Beach's correspondence	No concerns raised.
Petuna Sealord Deepwater Fishing	29/06/2021	PSDF 15	Petuna Sealord Deepwater Fishing notified Beach of a new primary contact to use.	Beach have updated their internal stakeholder systems with the new contact details.
South East Trawl Fishing Industry Association (SETFIA)	06/08/2021	SETFIA_117	Beach asked SETFIA to confirm timing for notification to SETFIA for activities such as well inspections and the Otway basin activities including drill rig moves and installation of subsea infrastructure. SETFIA replied for smaller jobs (non-seismic) pipelines etc 1 or 2 weeks, with a follow up at 1-3 days.	SETFIA's 2 week requirement aligns with the notification timing for stakeholders in Table 8-3.
Seafood Industry Victoria	28/06/2021	SIV 82	SIV notified Beach that they will distribute the information provided to them to their website.	No concerns raised.
Victorian Fisheries Association	18/03/2021	VFA_79	Beach emailed VFA notifying them that Beach are currently reviewing their exploration and development planning and therefore their stakeholder assessments. As such, Beach requested the latest fishing activity data in the area of their operations, given Beach's last data request was in 2019, for which Beach received data from 2014 – 2018. Beach requested for an up-to-date report of monthly catch by species from the last 5 years (Jan 2016- Nov 2020) for the following fishing blocks: • G10; G11; G12; G13 • H10; H11; H12; H13 • J10; J11; J12; J13 • K10; K11; K12; K13 • L10; L11; L12; L13 • M10; M11; M12; M13	Data was obtained for January 2016 - November 2020. Based on the updated fishery data Section 4.7.9 was updated.

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Appendix A EPBC Act Protected Matters Search Reports

A.1: Spill EMBA

Australian Government

Department of Agriculture, Water and the Environment

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.

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Coordinates

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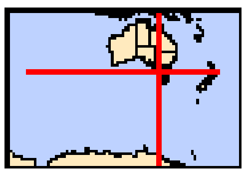

Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	2
Wetlands of International Importance:	6
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	10
Listed Threatened Species:	106
Listed Migratory Species:	74

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:	5
Commonwealth Heritage Places:	3
Listed Marine Species:	119
Whales and Other Cetaceans:	30
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	4

Extra Information

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

State and Territory Reserves:	39
Regional Forest Agreements:	3
Invasive Species:	56
Nationally Important Wetlands:	10
Key Ecological Features (Marine)	2

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

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 10km of Ramsar
Piccaninnie ponds karst wetlands	Within Ramsar site
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
Karst springs and associated alkaline fens of the Naracoorte Coastal Plain Bioregion	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 likely to occur within area
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (Eucalyptus ovata / E. brookeriana)	Critically Endangered	Community may occur within area
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
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 may 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 known to 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

Name	Status	Type of Presence
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat 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 Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route 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 may 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 known 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

Name	Status	Type of Presence
		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 Eastern Hooded Plover, 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 known to 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
Nannoperca variegata Variegated Pygmy Perch, Ewens Pygmy Perch, Golden Pygmy Perch [26178]	Vulnerable	Species or species habitat known 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

Name	Status	Type of Presence
		habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Vulnerable	Species or species habitat 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	Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area
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 known 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 likely to occur within area
Caladenia colorata Coloured Spider-orchid, Small Western Spider-orchid, Painted Spider-orchid [54999]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Caladenia hastata Melblom's Spider-orchid [16118]	Endangered	Species or species habitat likely to occur within area
Caladenia orientalis Eastern Spider Orchid [83410]	Endangered	Species or species habitat known 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
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat may 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
Lepidium aschersonii Spiny Pepper-cress [10976]	Vulnerable	Species or species habitat likely to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat known to 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
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

Name	Status	Type of Presence
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 known 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 macrocarpus Large-fruit Fireweed, Large-fruit Groundsel [16333]	Vulnerable	Species or species habitat likely to 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, Native 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 likely 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	Species or species habitat may 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	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species

[Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		

Name	Threatened	Type of Presence
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat known to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		to occur within area
[Thalassarche steadi](#) White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
[Balaena glacialis australis](#) Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
[Balaenoptera bonaerensis](#) Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
[Balaenoptera borealis](#) Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Balaenoptera edeni](#) Bryde's Whale [35]		Species or species habitat may occur within area
[Balaenoptera musculus](#) Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
[Balaenoptera physalus](#) Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Caperea marginata](#) Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	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
[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

Name	Threatened	Type of Presence
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 known to 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
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 known to occur within area

Name	Threatened	Type of Presence
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 Greater 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 -
Commonwealth Land - Australian Maritime Safety Authority
Defence - HMAS CERBERUS
Defence - WARRNAMBOOL TRAINING DEPOT
Defence - WEST HEAD GUNNERY RANGE

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
HMAS Cerberus Marine and Coastal Area	VIC	Listed place
Historic		
Cape Northumberland Lighthouse	SA	Listed place
Sorrento Post Office	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 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
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

Name	Threatened	Type of Presence
		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 known 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 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

Name	Threatened	Type of Presence
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 may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
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 known to 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 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
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pelecanoides urinatrix Common Diving-Petrel [1018]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
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

Name	Threatened	Type of Presence
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting 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 known to occur within area
Sterna albifrons Little Tern [813]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		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		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
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

Name	Threatened	Type of Presence
		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 habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence
		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	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

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

Name	Status	Type of Presence
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed 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)

Name	Label
Zeehan	Multiple Use 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
Cape Liptrap Coastal Park	VIC
Cape Nelson	VIC
Christmas Island	TAS
Deen Maar	VIC
Dingley Dell	SA
Discovery Bay Coastal Park	VIC
Douglas Point	SA
East Moncoeur Island	TAS
Edna Bowman N.C.R.	VIC
Great Otway	VIC
Lady Julia Percy Island W.R.	VIC
Lake Connewarre W.R	VIC
Latrobe B.R.	VIC
Lawrence Rocks W.R.	VIC
Lily Pond B.R.	VIC
Marengo N.C.R.	VIC
Mornington Peninsula	VIC
Nene Valley	SA
New Year Island	TAS
Phillip Island Nature Park	VIC
Piccaninnie Ponds	SA
Point Nepean	VIC
Porky Beach	TAS
Port Campbell	VIC
Princetown W.R	VIC
Rodondo Island	TAS
Southern Wilsons Promontory	VIC
Stony Creek (Otways)	VIC
Unnamed C0293	VIC
Ventnor B.R.	VIC
West Moncoeur Island	TAS
Wilsons Promontory	VIC
Wilsons Promontory Islands	VIC
Yambuk F.F.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 Resouces 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
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 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

Name	Status	Type of Presence
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 habitat likely to occur within area
Anredera cordifolia		
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

Name	Status	Type of Presence
		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
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		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 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

Name	Status	Type of Presence
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
Lower Aire River Wetlands	VIC
Lower Merri River Wetlands	VIC
Piccaninnie Ponds	SA
Powlett River Mouth	VIC
Princetown Wetlands	VIC
Shallow Inlet Marine & Coastal Park	VIC
Western Port	VIC
Yambuk Wetlands	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
West Tasmania Canyons	South-east

Caveat

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

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

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

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

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-39.132377 146.409671,-39.125665 146.624473,-39.414305 146.691599,-39.582119 146.463372,-39.636 144.684809,-39.733589 144.4157,-39.760735 144.135974,-39.660631 144.11256,-39.563037 143.978651,-39.584884 143.920774,-39.660631 143.911104,-39.710592 143.846639,-39.787951 143.853085,-39.801605 143.714836,-39.665572 143.283079,-39.798648 143.259421,-39.813434 143.223934,-39.749933 143.053388,-39.904322 142.845299,-39.396464 142.614744,-39.337319 142.345636,-39.279653 142.098706,-39.372806 142.023297,-39.472613 141.872478,-39.481484 141.402277,-39.375024 141.19601,-39.299614 141.315778,-39.255256 141.593019,-39.417164 141.561968,-39.430472 141.717223,-39.29296 141.921272,-39.1865 141.821466,-39.128733 141.749257,-39.13565 141.382633,-39.02919 141.176366,-38.87599 141.040755,-38.640082 140.485935,-38.481258 139.710531,-38.018091 139.663543,-37.608625 139.972321,-37.744389 140.243008,-37.907165 140.370328,-38.040922 140.625703,-38.036439 140.836563,-38.062243 141.000214,-38.147489 141.205536,-38.263913 141.361364,-38.353469 141.447339,-38.389292 141.517193,-38.391083 141.628243,-38.319438 141.599585,-38.258926 141.703376,-38.247793 141.812729,-38.285094 141.946487,-38.393322 142.196927,-38.360186 142.279767,-38.348096 142.370219,-38.380784 142.493359,-38.566468 142.807913,-38.619452 143.005622,-38.753339 143.361162,-38.786923 143.45027,-38.85826 143.510664,-38.735016 143.686244,-38.472579 144.033284,-38.279809 144.432258,-38.273276 144.550636,-38.3322 144.738541,-38.478625 144.888996,-38.457719 145.034746,-38.430707 145.051629,-38.38459 145.126769,-38.408126 145.235016,-38.488153 145.360801,-38.51723 145.386749,-38.520607 145.364802,-38.536223 145.373243,-38.532358 145.435739,-38.584749 145.5244,-38.654824 145.56064,-38.678882 145.654761,-38.651916 145.685602,-38.638785 145.725246,-38.686901 145.791089,-38.746622 145.854863,-38.831925 145.899194,-38.860792 145.910956,-38.879785 145.915598,-38.896668 145.937546,-38.880207 146.007609,-38.841377 146.000012,-38.822384 146.015206,-38.811775 146.03823,-38.81141 146.06501,-38.823865 146.116145,-38.876831 146.195006,-38.935498 146.246076,-38.976016 146.26929,-39.038129 146.326714,-39.071713 146.34888,-39.078578 146.321626,-39.132377 146.409671

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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A.2: Operational Area – 1 km

Australian Government
Department of Agriculture, Water and the Environment

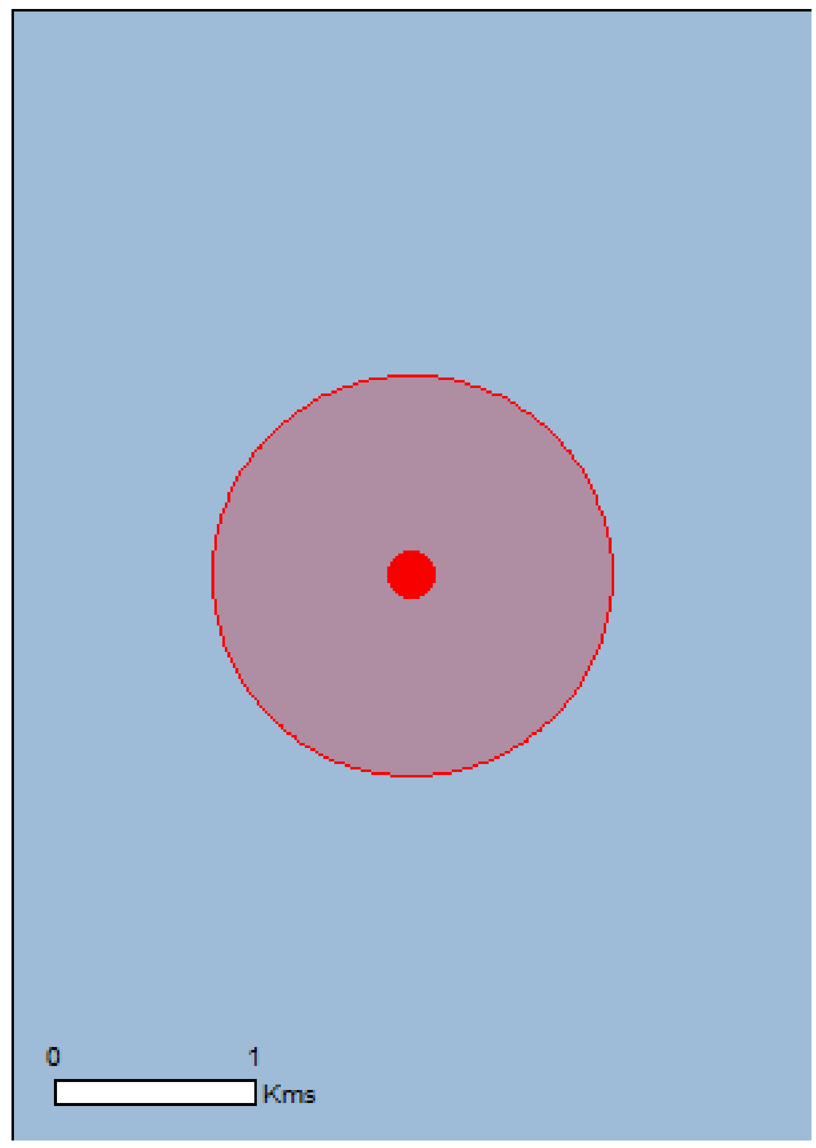
EPBC Act Protected Matters Report

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.

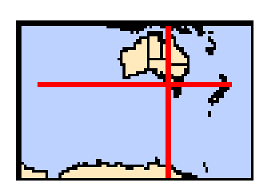
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 02/08/21 20:35:28



Coordinates
Buffer: 1.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	37

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	26
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

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

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

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

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area

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

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

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

Name	Threatened	Type of Presence
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche sp. nov.		
Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps		
Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus briggsii		
Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus		
Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus		
Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus		
Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius		
Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis		
Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa		
Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata		
Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus		
Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri		
Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber		
Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques		
Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus		
Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely

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

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

Extra Information

Caveat

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

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

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

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

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-39.23732 142.90154

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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A.3: Light EMBA – 20 km

Australian Government

Department of Agriculture, Water and the Environment

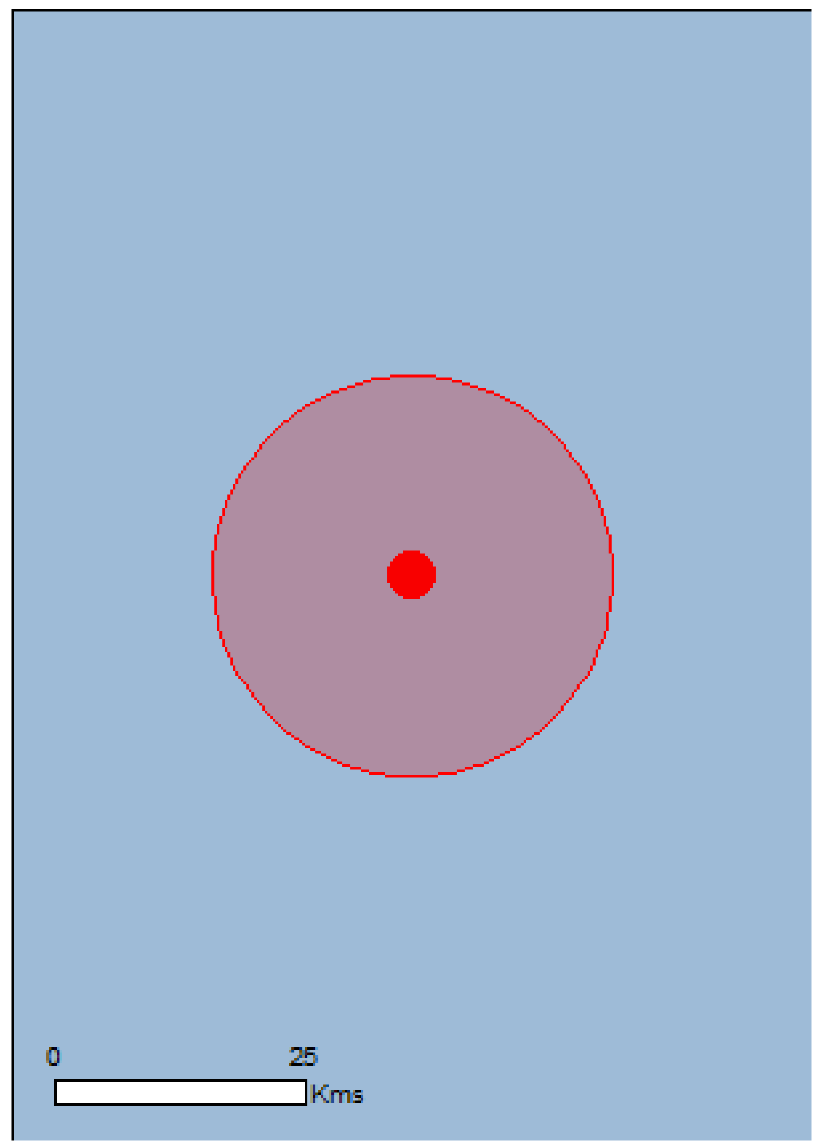
EPBC Act Protected Matters Report

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.

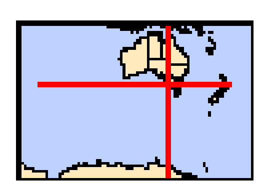
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 09/07/21 13:23:54



Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	38

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

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

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea		
Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli		
Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

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

Listed Migratory Species

[Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area

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

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

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

Name	Threatened	Type of Presence
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea		
Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli		
Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur		
Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca		
Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis		
Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus		
Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri		
Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma		
Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov.		
Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps		
Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus briggsii		
Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus		
Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus		
Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus		
Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius		
Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis		
Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa		
Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata		
Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus		
Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri		
Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber		
Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques		
Leafy Seadragon [66267]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

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

Name	Status	Type of Presence
		area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common 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
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area

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

Extra Information

Key Ecological Features (Marine) [Resource Information]

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

Name	Region
West Tasmania Canyons	South-east

Caveat

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

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

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

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

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-39.23732276 142.9015365

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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Australian Government

Department of Agriculture, Water and the Environment

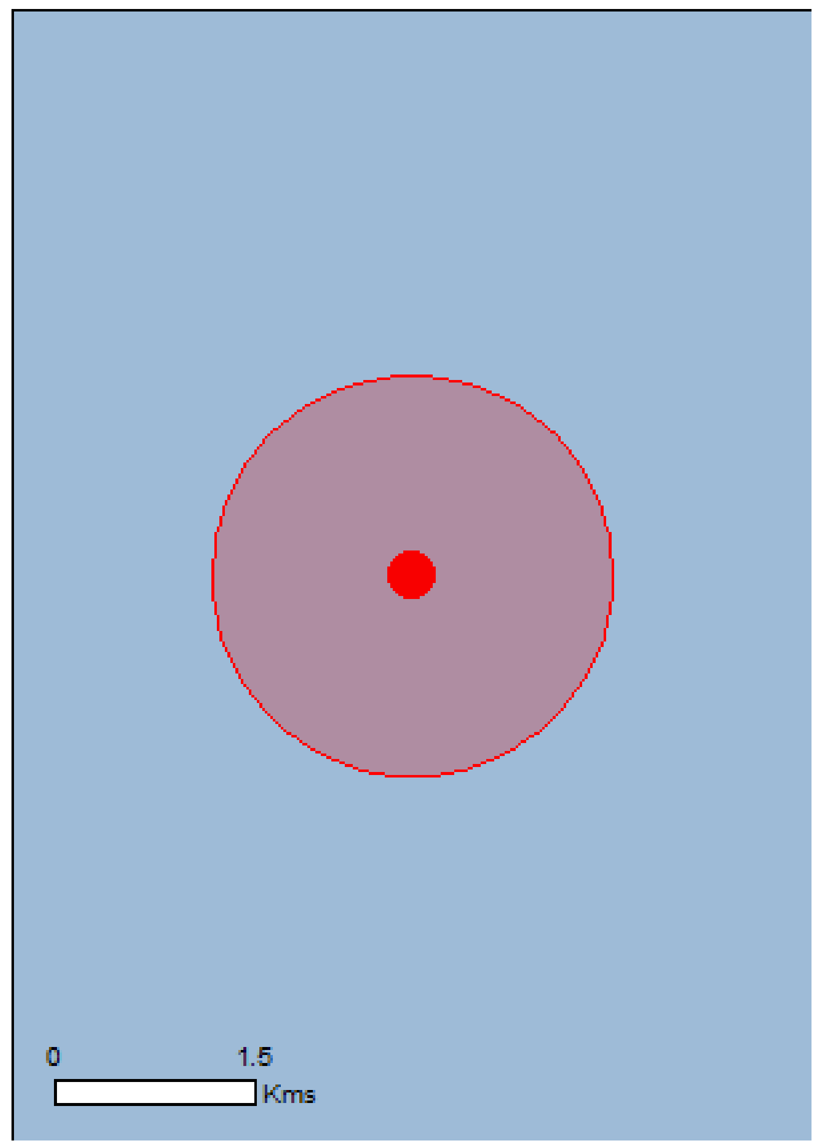
EPBC Act Protected Matters Report

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.

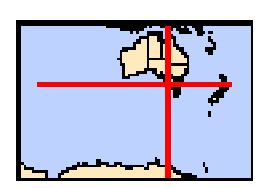
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 03/08/21 04:05:34



Coordinates

Buffer: 1.5Km



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:	58
Whales and Other Cetaceans:	26
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

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

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

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

Listed Migratory Species

[Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area

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

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

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

Name	Threatened	Type of Presence
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely

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

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

Extra Information

Caveat

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

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

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

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

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-39.23732 142.90154

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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A.5: Noise Behaviour EMBA– 5 km

Australian Government

Department of Agriculture, Water and the Environment

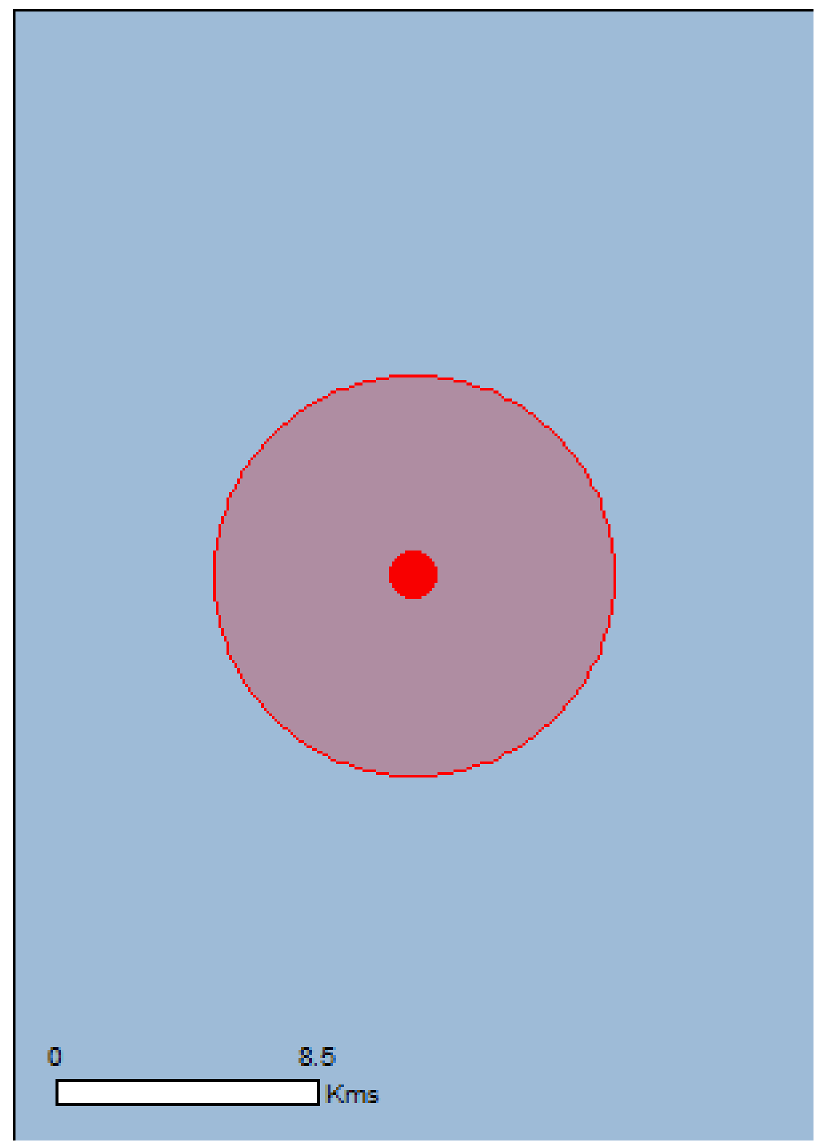
EPBC Act Protected Matters Report

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.

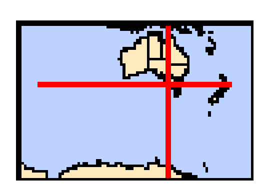
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 03/08/21 04:04:49



Coordinates

Buffer: 6.5Km



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:	58
Whales and Other Cetaceans:	26
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

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

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

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

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area

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

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

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

Name	Threatened	Type of Presence
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche sp. nov.		
Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps		
Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus briggsii		
Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus		
Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus		
Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus		
Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius		
Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis		
Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa		
Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata		
Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus		
Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri		
Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber		
Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques		
Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus		
Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely

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

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

Extra Information

Caveat

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

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

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

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

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-39.23732 142.90154

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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Appendix B RPS APASA Artisan-1 Spill Model Report

Report

13 JUNE 2019

Beach Energy Artisan-1 Exploration Well

Oil Spill Modelling

Document status

Version	Purpose of document	Authored by	Reviewed by	Review date
Draft	Draft issued for internal review	Jeremie Bernard	Nathan Benfer	27 May 2019
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Approval for issue

Name	Signature	Date
Dr. Sasha Zigic	S. Zigic	13 June 2019

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Approved: Dr Sasha Zigic
No.: MAQ0828J
Version: Rev0
Date: 13 June 2019

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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 m^3 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 configurated 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/m^3 (API of 37.6), a low pour point (-14ºC) 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/m^3 at 15ºC) 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%).

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Key Findings

Scenario: 300 m^3 surface release of marine diesel oil

Sea surface exposure

- No shoreline contact above the minimum threshold (>10 g/m^2) was predicted for any of the seasons modelled.
- During summer conditions, low (0.5 g/m^2) and moderate (10 g/m^2) 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/m^2) 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.

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

Sea surface exposure

- During summer conditions, low (0.5 -10 g/m^2) and moderate (10 - 25 g/m^2) 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 m^3 and 33 m^3, during summer and winter conditions, respectively, while the maximum length of shoreline contacted above the low threshold (10 – 100 g/m^2) was 7.0 km and 11.0 km, respectively. Note, no shoreline loading was predicted for the high threshold (above 1,000 g/m^2).
- 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

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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.

- 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 Energy[1] 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 m^3 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.

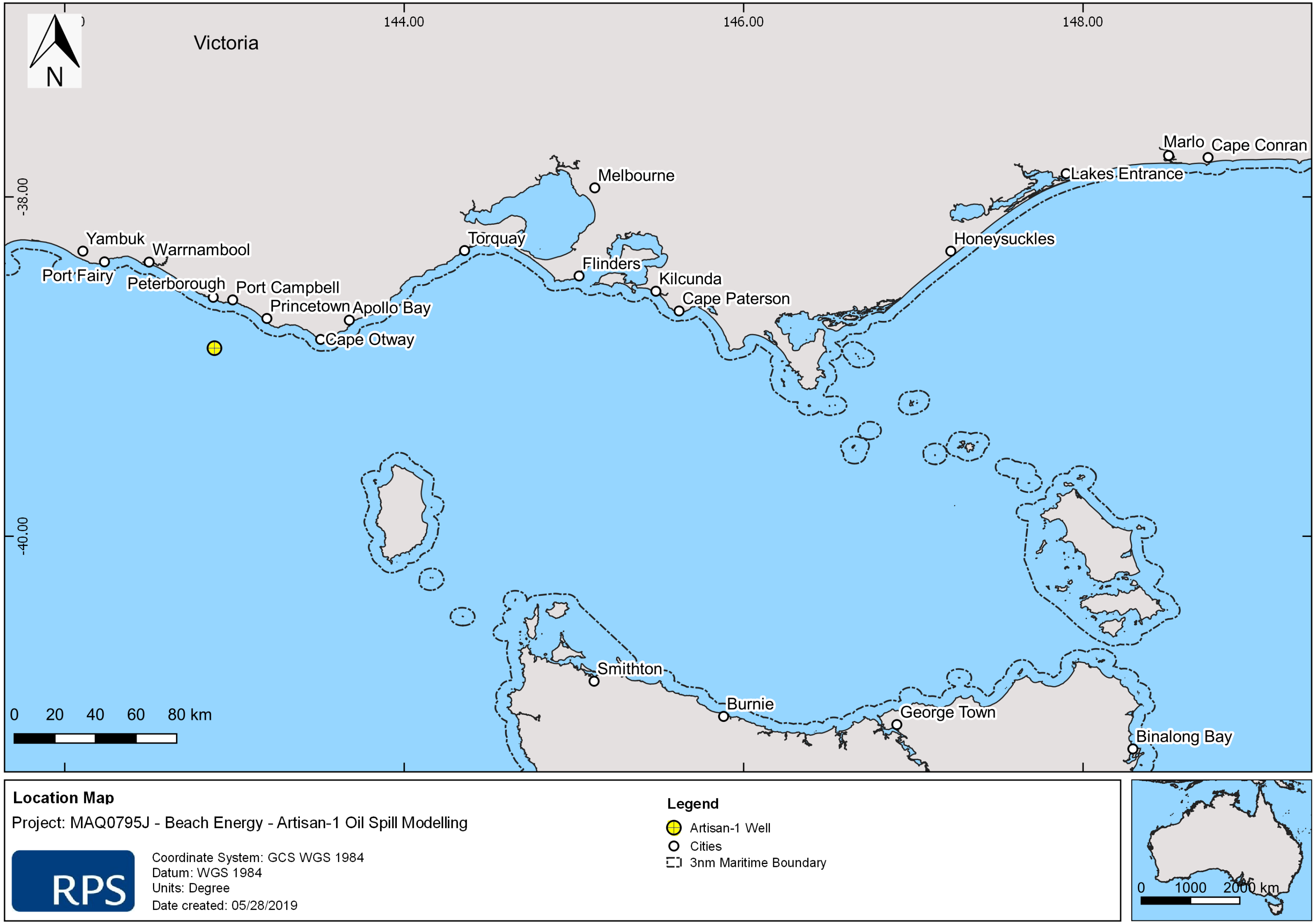

Figure 1 Locality map of the Artisan-1 exploration well.

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.

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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 straight 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 though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward 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.

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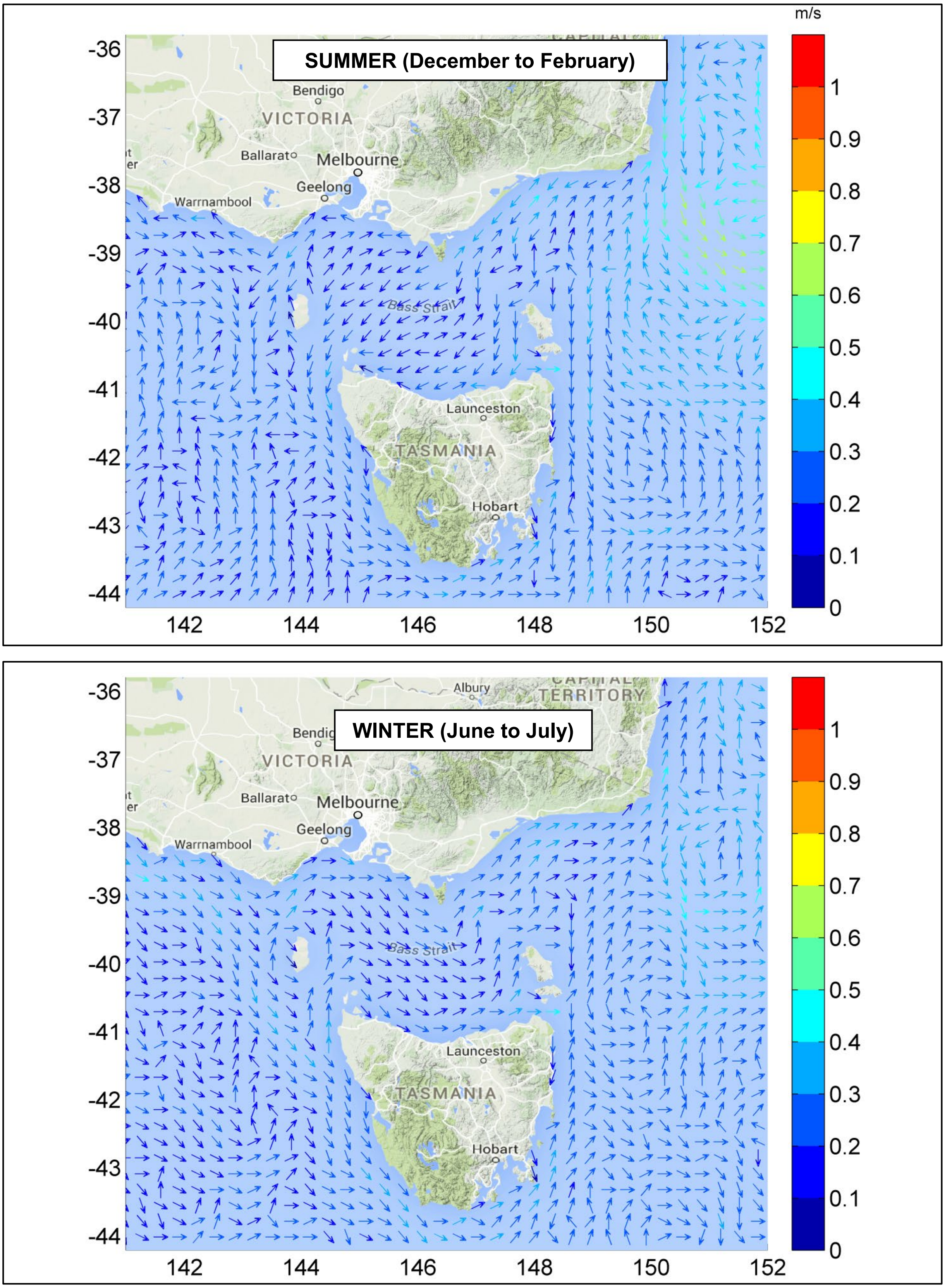

Figure 2 HYCOM averaged seasonal surface drift currents during summer and winter.

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).

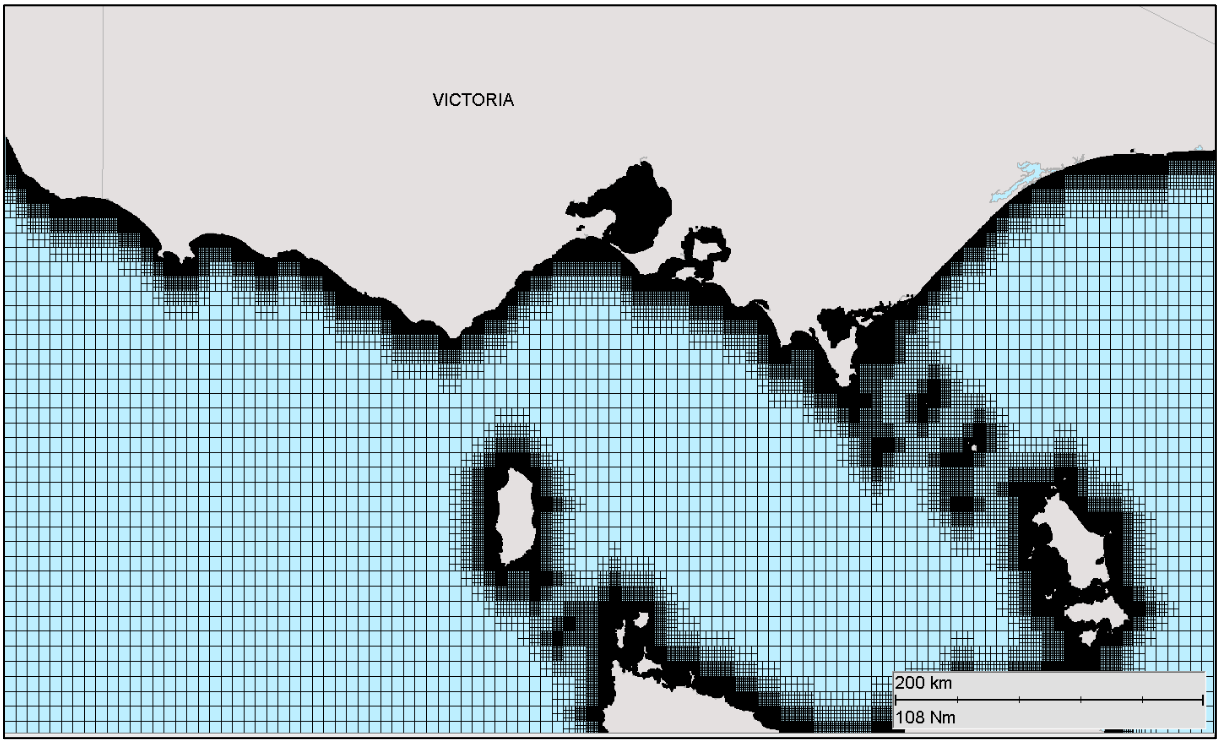

Figure 3 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

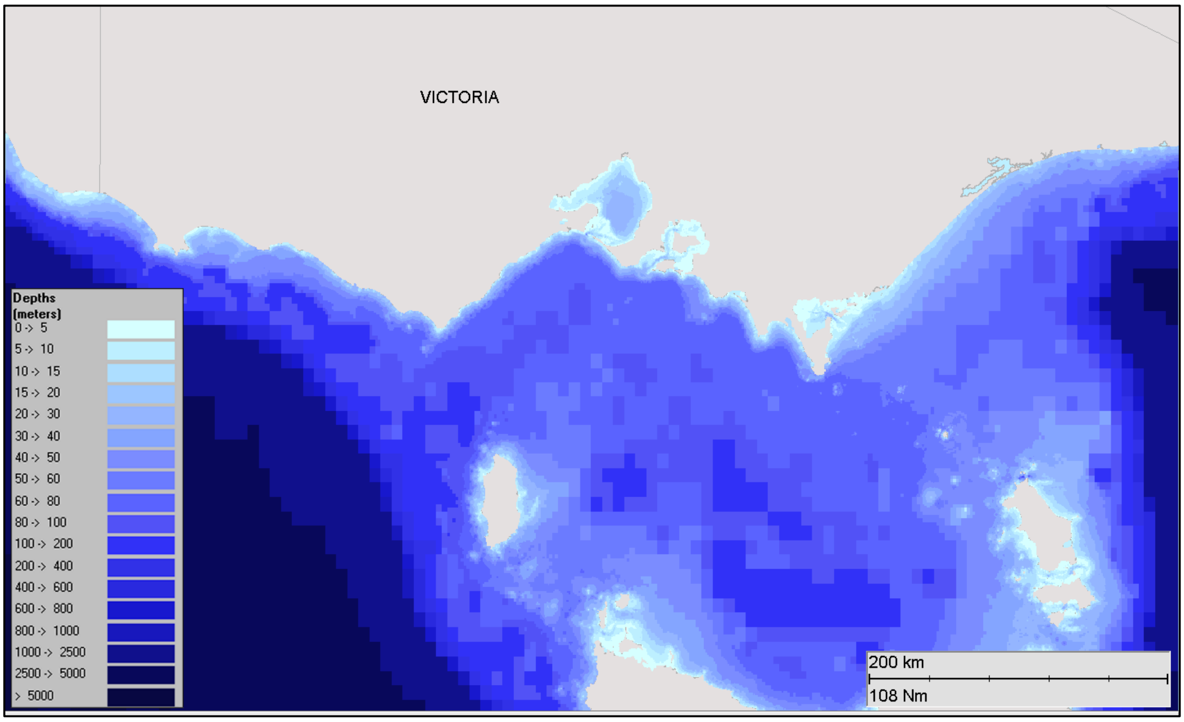

Figure 4 Bathymetry defined throughout the tidal model domain.

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:

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

Where: N = Number of observations

P_i = Model predicted surface elevation

O_i = Observed surface elevation

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

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: X_{model} = Model predicted surface elevation

X_{obs} = Observed surface elevation

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

Figure 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

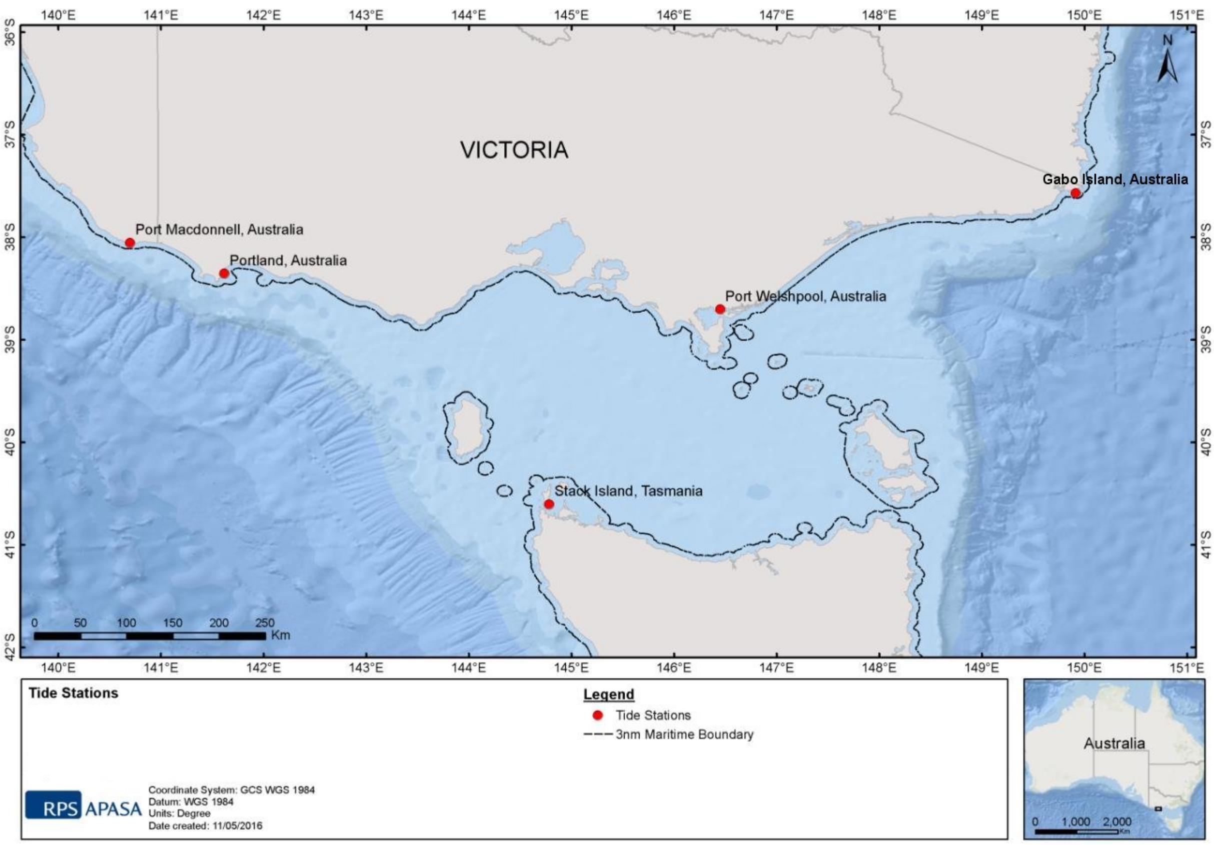

Figure 5 Tide stations used to calibrate surface elevation within the model.

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

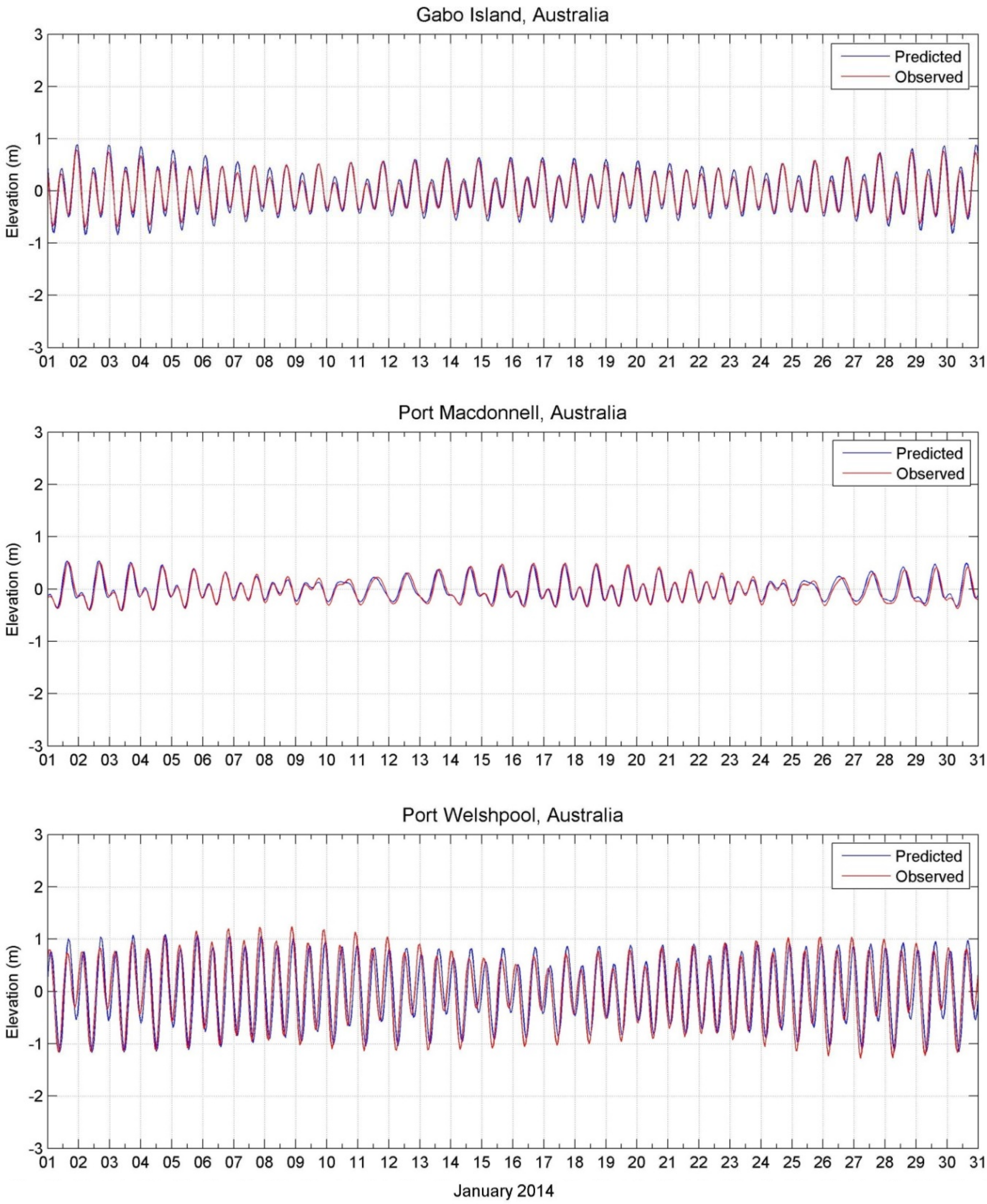

Figure 6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).

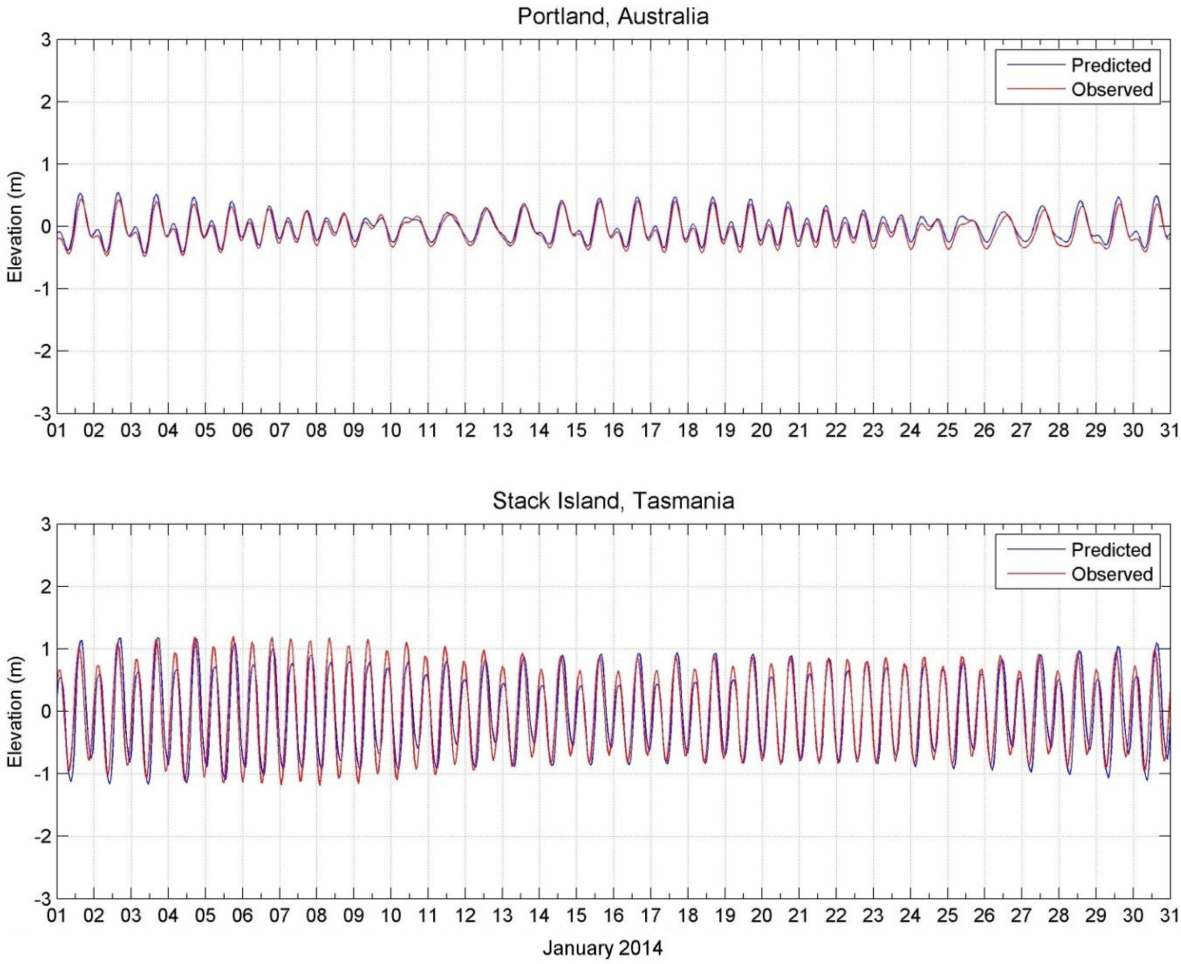

Figure 7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).

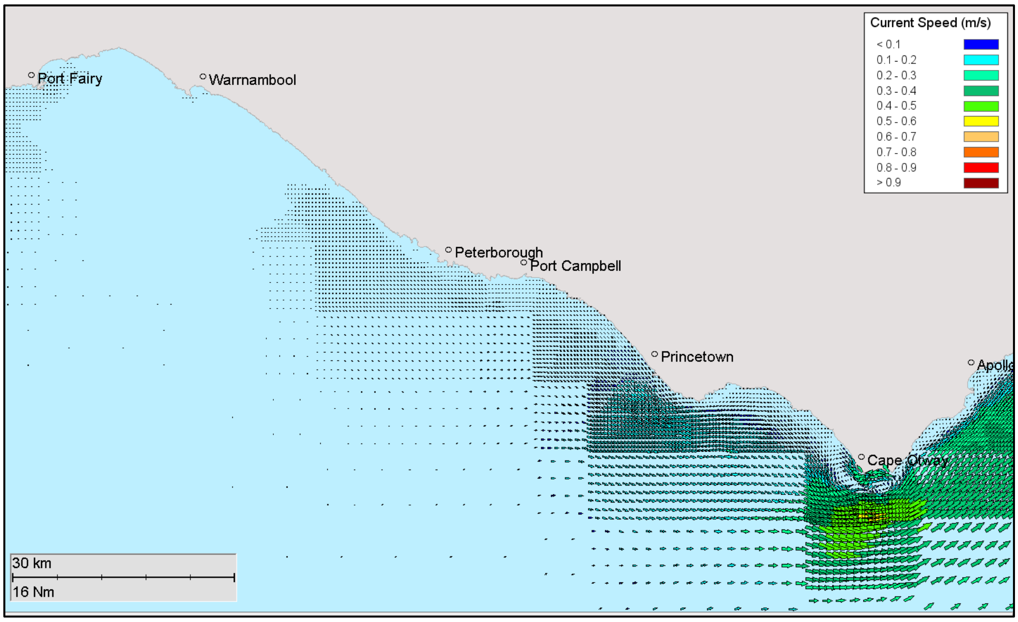

Figure 8 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and sholas.

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).

RPS

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**	

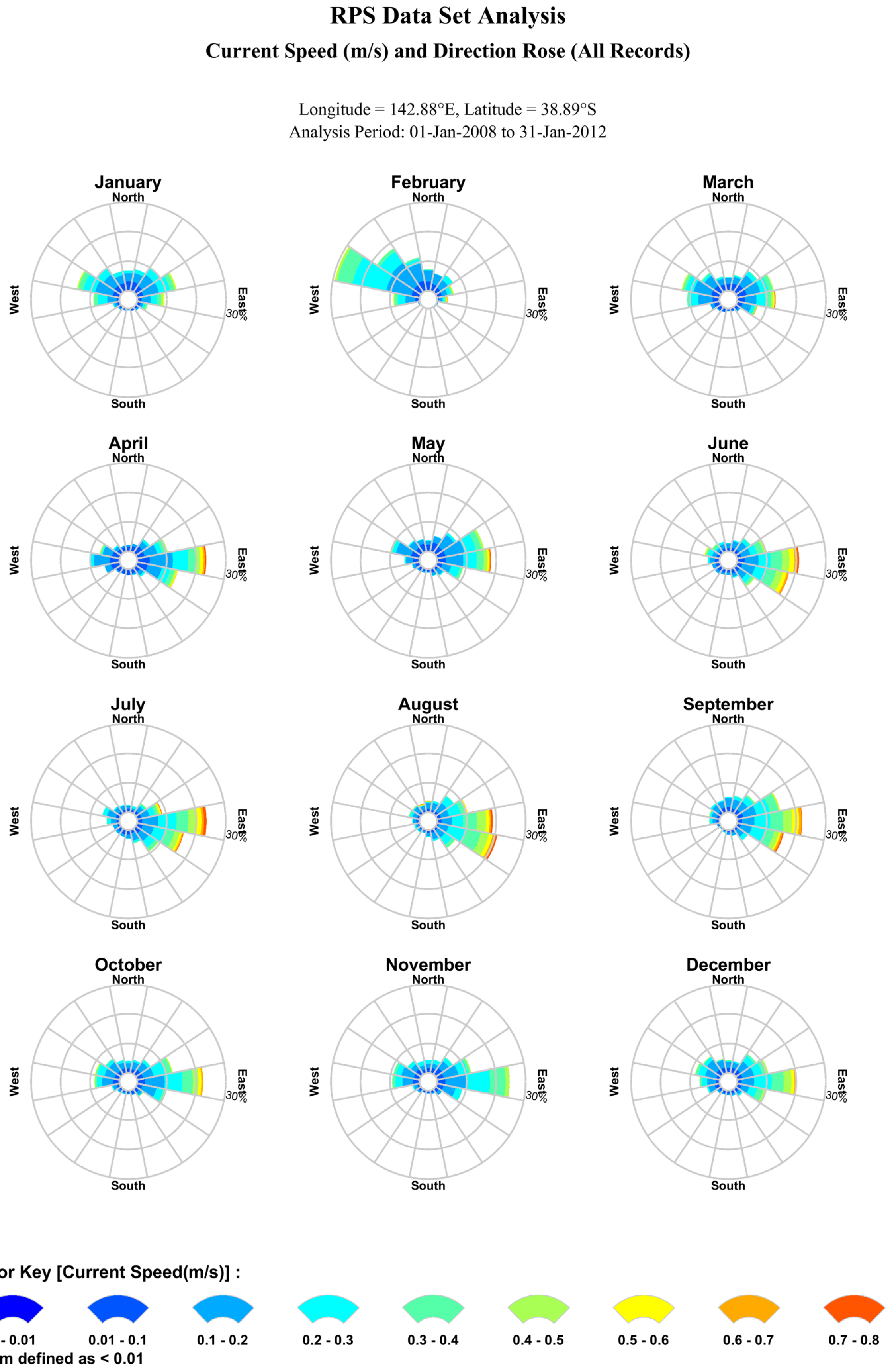

Figure 9 Monthly surface current rose plots near the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive).

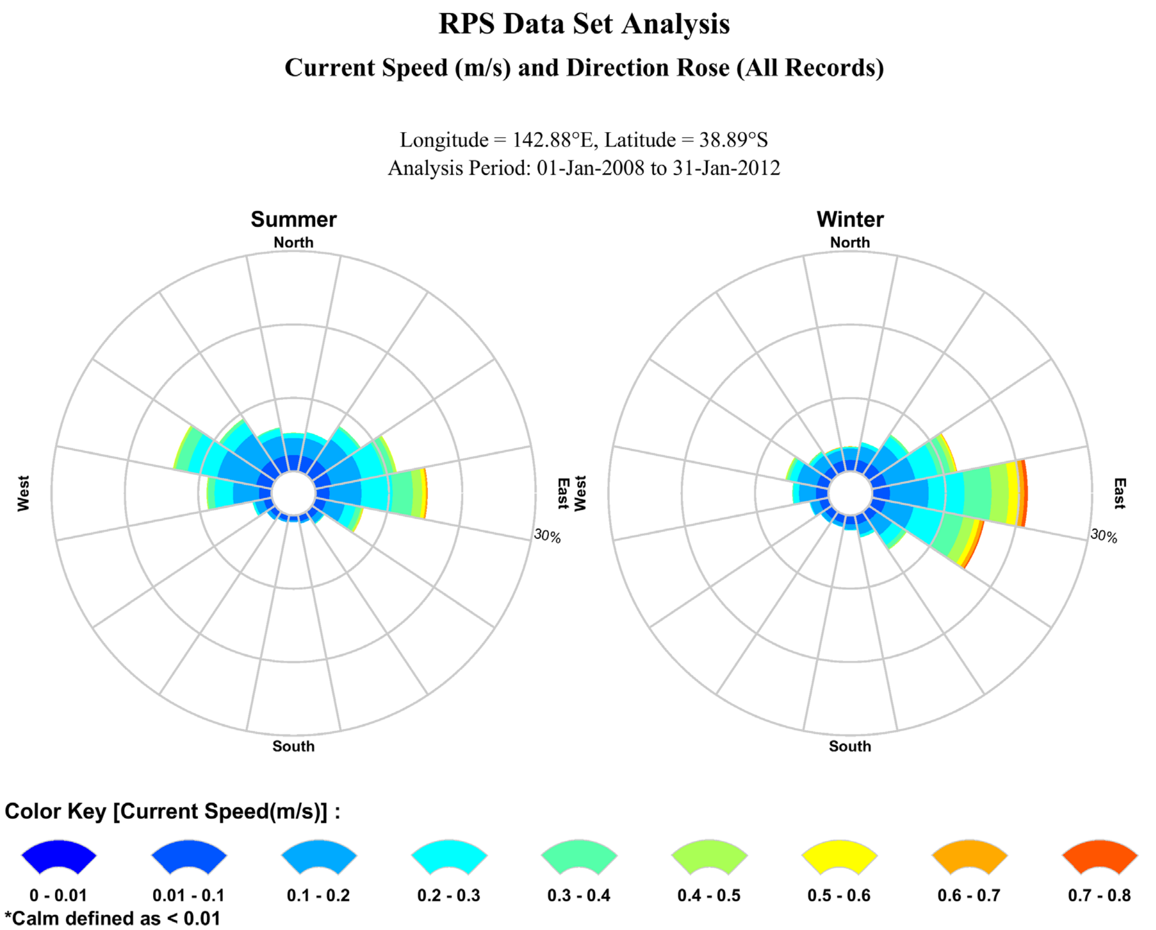

Figure 10 Seasonal surface current rose plots near the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive).

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 CFSR 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 ¼ 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 CFSR 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.

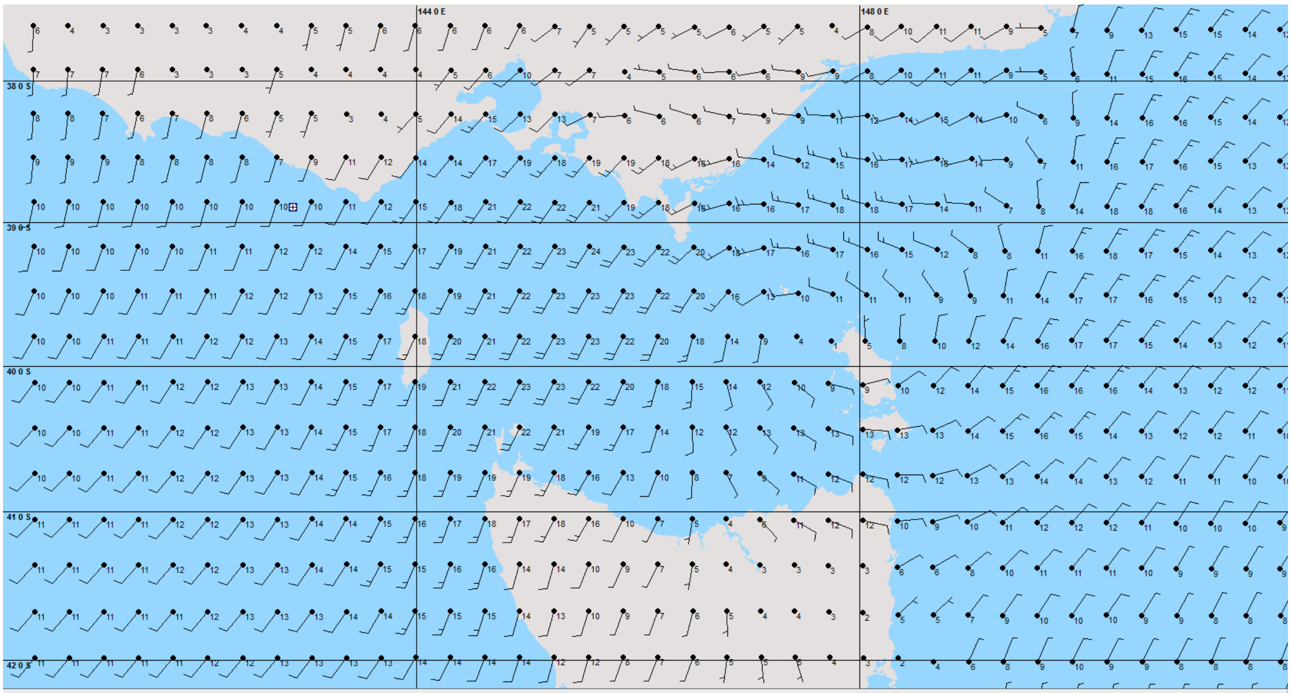

Figure 11 Image showing the CFSR modelled wind nodes.

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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**	

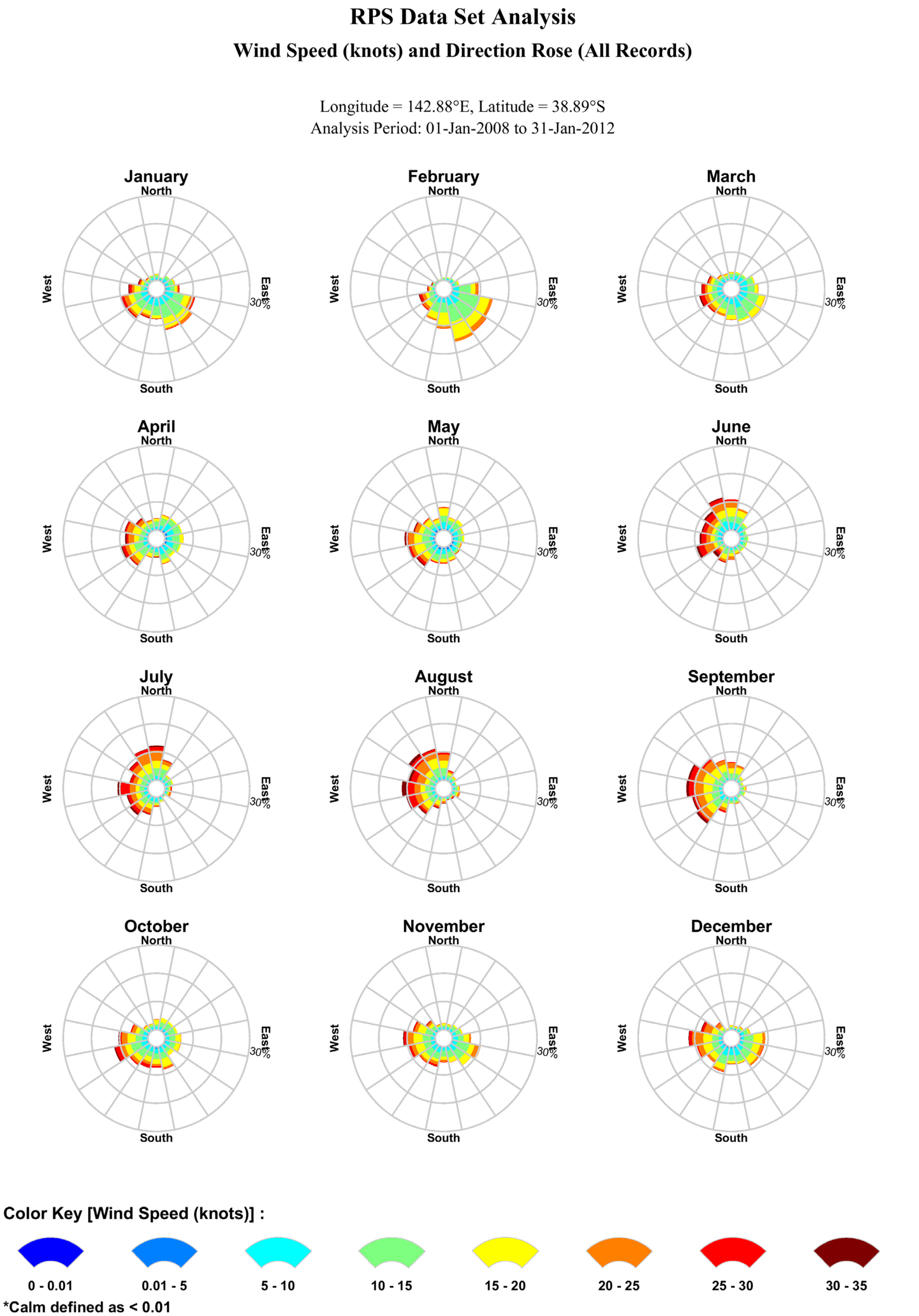

Figure 12 **Monthly wind rose distributions derived from the CFSR hindcast model from 2008–2012 (inclusive), for the nearest wind node to the release location.**

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

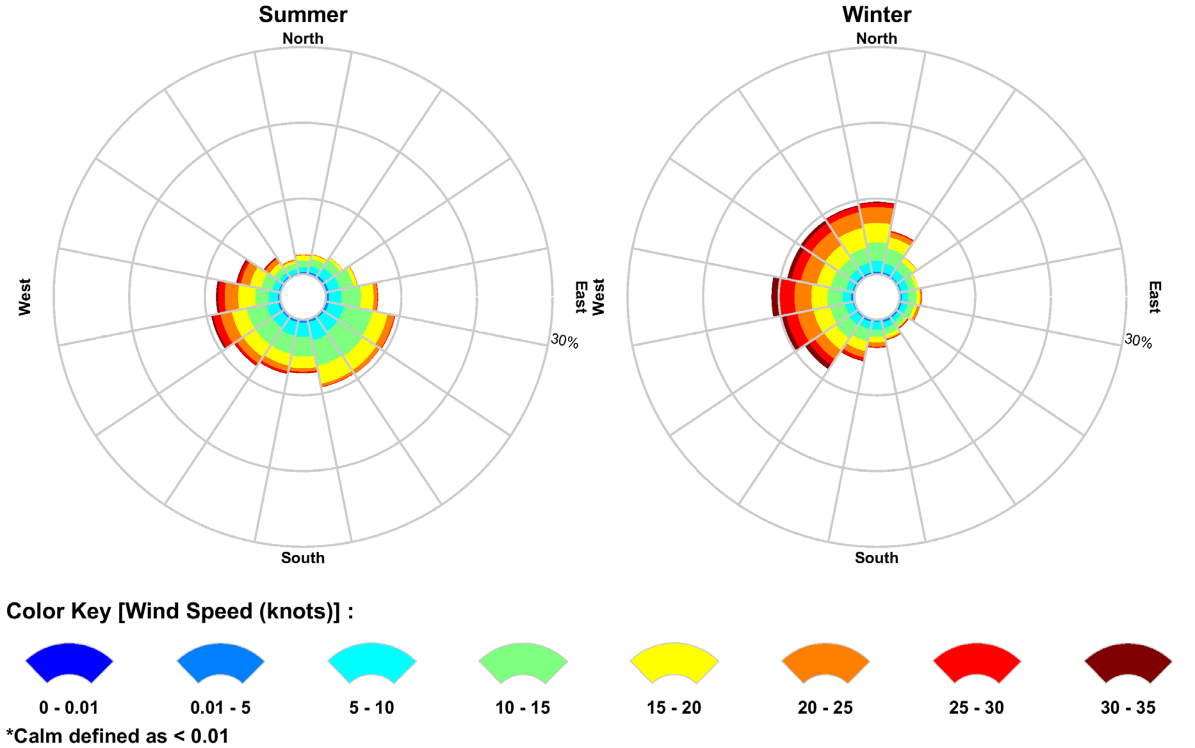

Figure 13 Seasonal wind rose distributions derived from the CFSR hindcast model from 2008–2012 (inclusive), for the nearest wind node to the release location.

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

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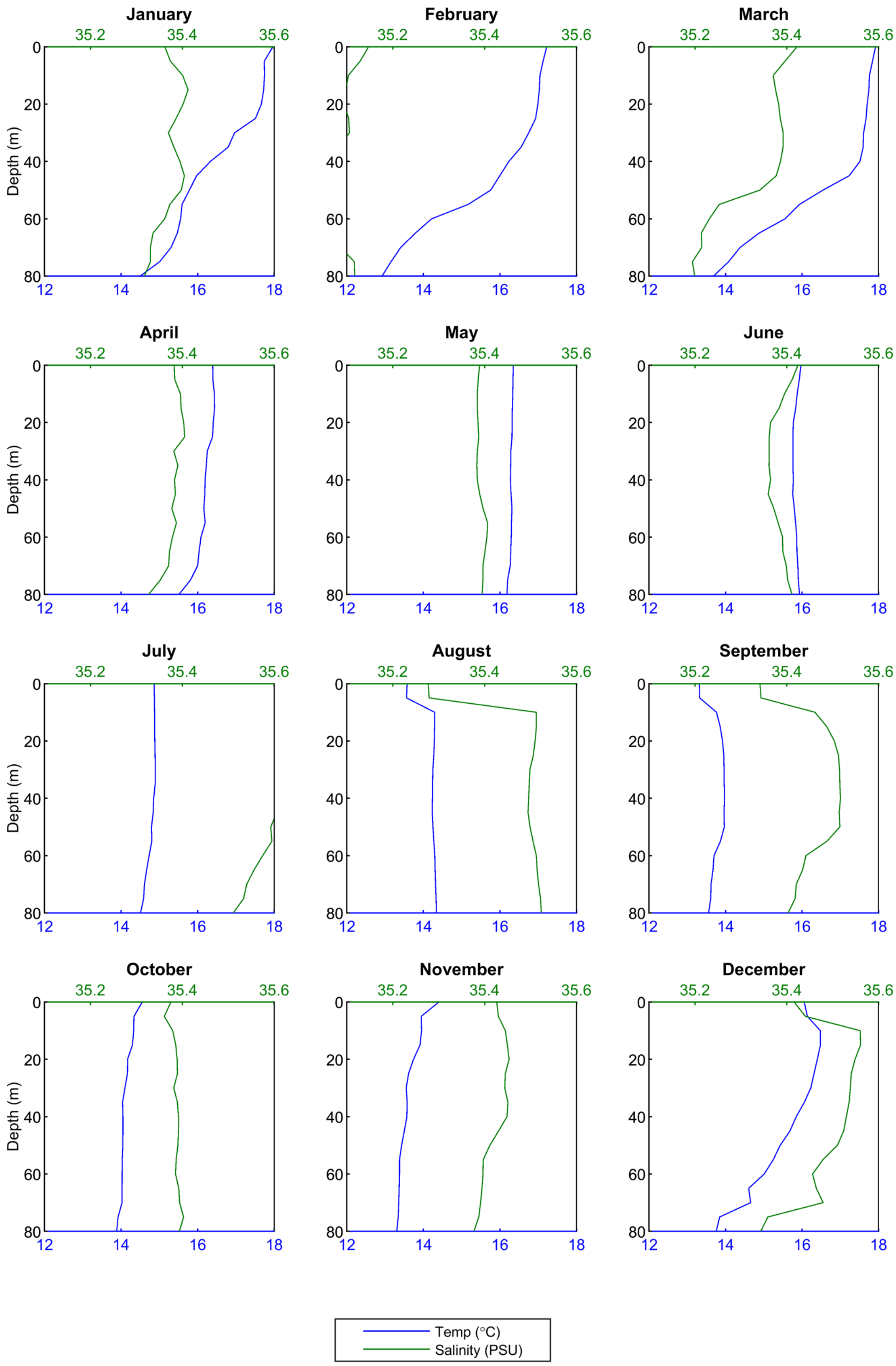

Figure 14 Monthly water temperature and salinity profiles near the release location.

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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 (°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

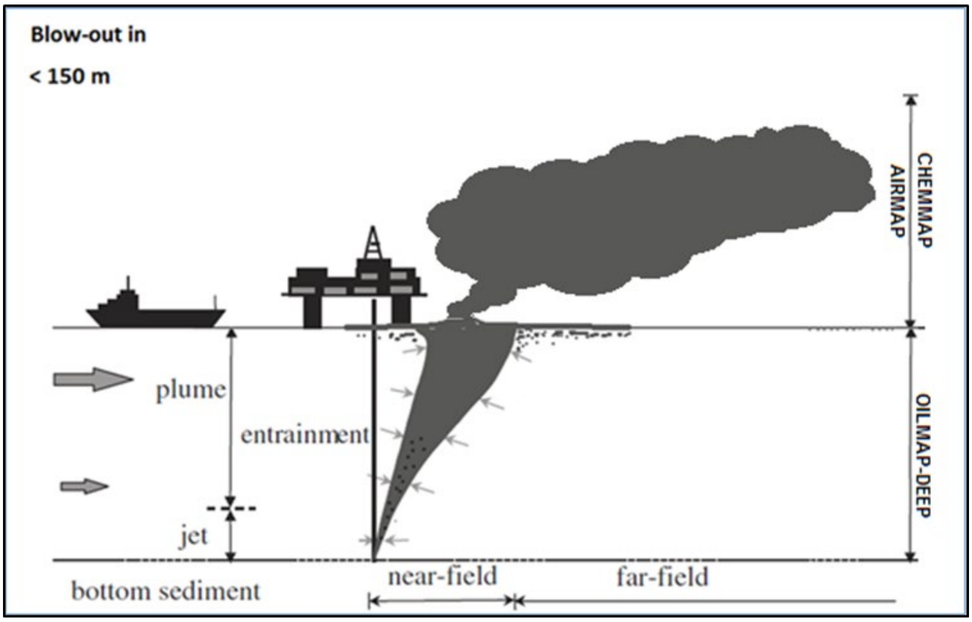

Figure 15 Example of a blowout plume illustrating the various stages of the plume in the water column (Source: Applied Science Associates, 2011).

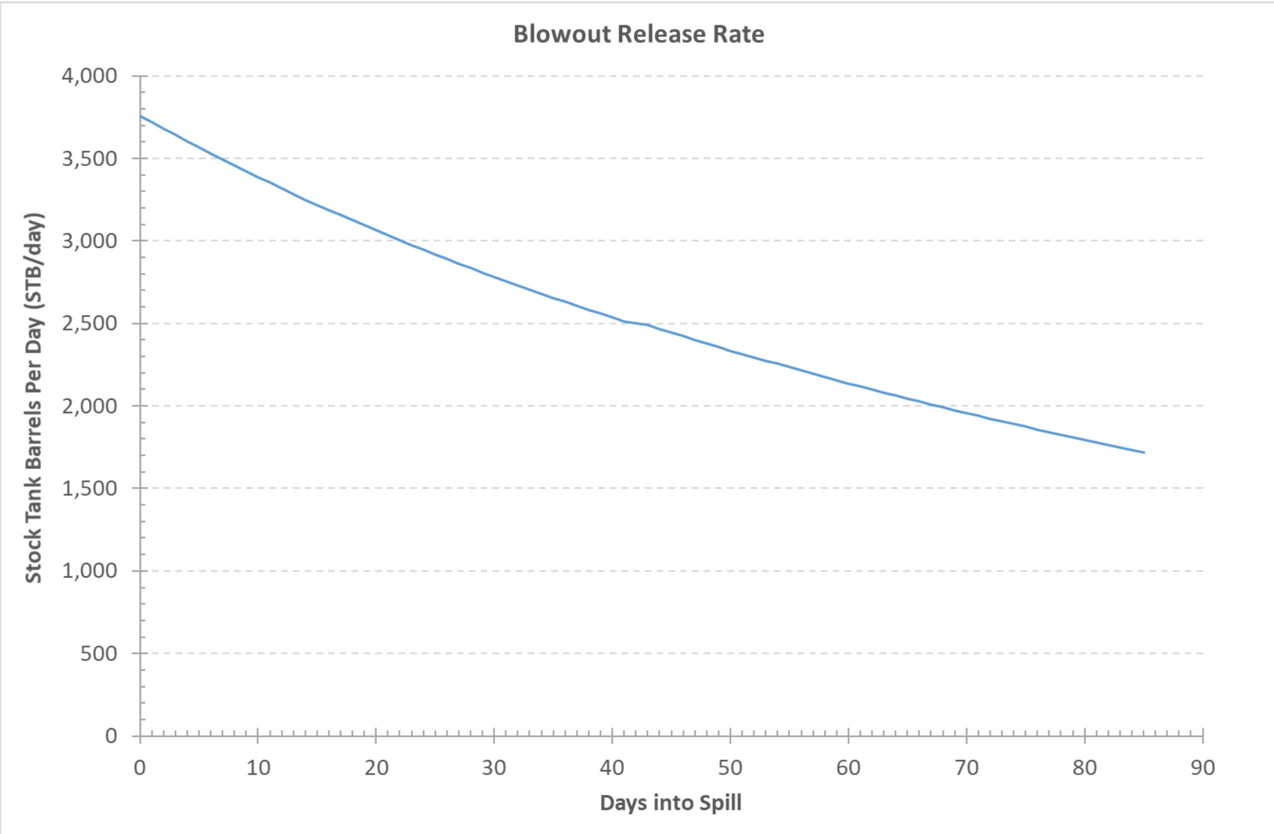

Figure 16 Depleting release rate used for the LOWC scenario

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

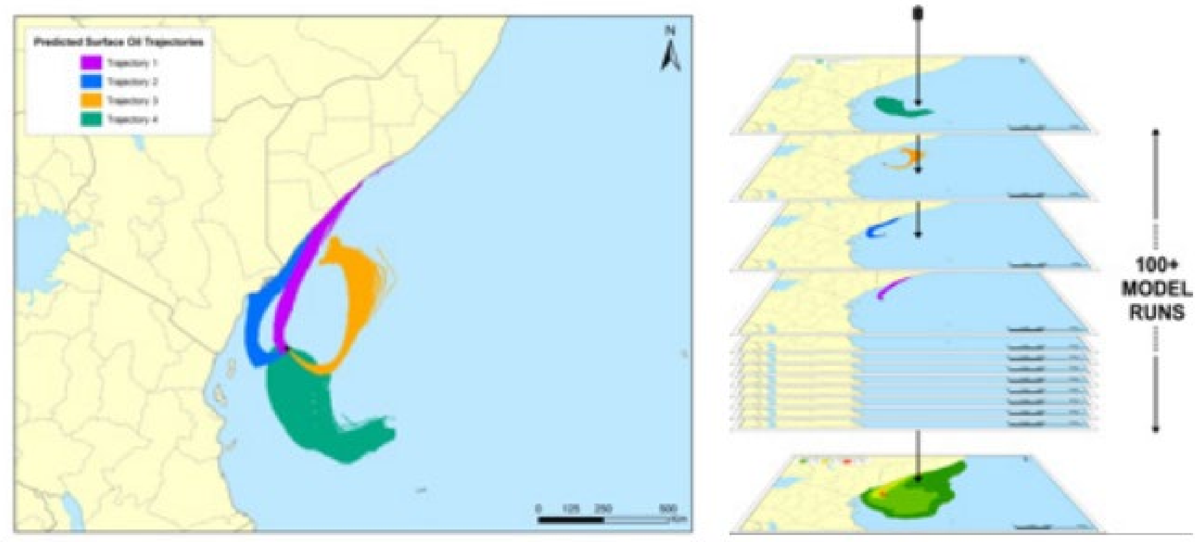

Figure 17 Predicted movement of four single oil spill simulations predicted by SIMAP for the same scenario (left image). All model runs are overlain (shown as the stacked runs on the right) and the number of times that trajectories contact a given location at a concentration is used to calculate the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

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7.2.1 Sea Surface Exposure Thresholds

The minimum sea surface reporting level for each spill simulation was 0.5 g/m^2, 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/m^2 (a film thickness of approximately 10 µm or 0.01 mm) according to French et al. (1996) and French-McCay (2009) as this level of fresh oiling has been observed to mortally impact some birds through adhesion of oil to their feathers, exposing them to secondary effects such as hypothermia. The appearance at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009). Concentrations above 10 g/m^2 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/m^2 (or greater), would be harmful for all birds that have landed in an oil film due to potential contamination of their feathers, with secondary effects such as loss of temperature regulation and ingestion of oil through preening. The appearance of oil at this thickness is also described as metallic sheen (Bonn Agreement, 2009).

The sea surface reporting thresholds applied in this study were 0.5–10 g/m^2 (low), 10–25 g/m^2 (moderate) and above 25 g/m^2 (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 –>

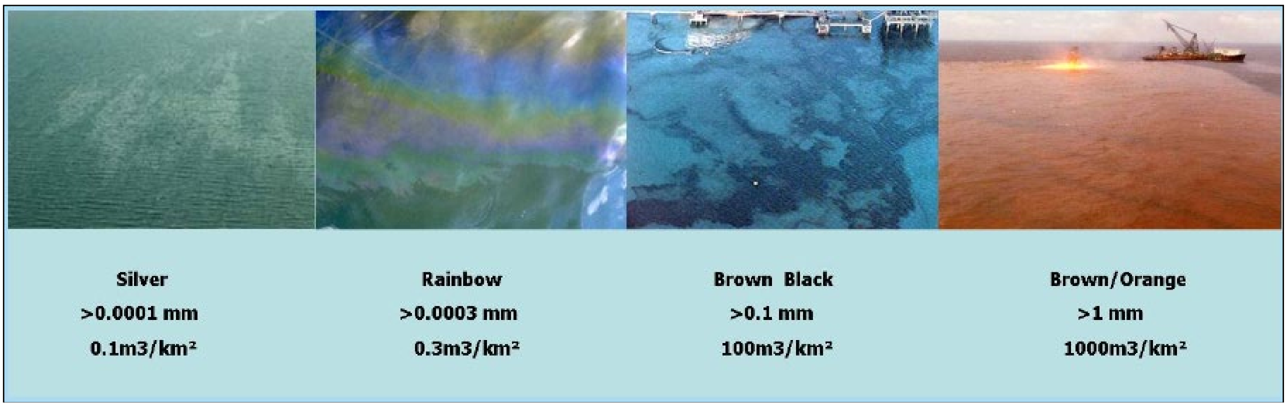

Figure 18 Photograph showing the difference between oil appearance on the sea surface (source: OilSpillSolutions.org, 2015).

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/m^2 (~25 um). 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/m^2 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/m^2, 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/m^2, 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/m^2, 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/m^2, 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 Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m^2 of oil during the growing season

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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/m^2 (low), 100–1,000 g/m^2 (moderate) and above 1,000 g/m^2 (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 (LC_{50}) 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/m^3 (API of 37.6) and a low pour point (-14^{o}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 m^3 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

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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/m^3 at 15ºC) 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 (ºC)	< 180	180 - 265	265 - 380	>380
MDO	6.0	34.6	54.4	5.0
Thylacine condensate	64.0	19.0	16.0	1

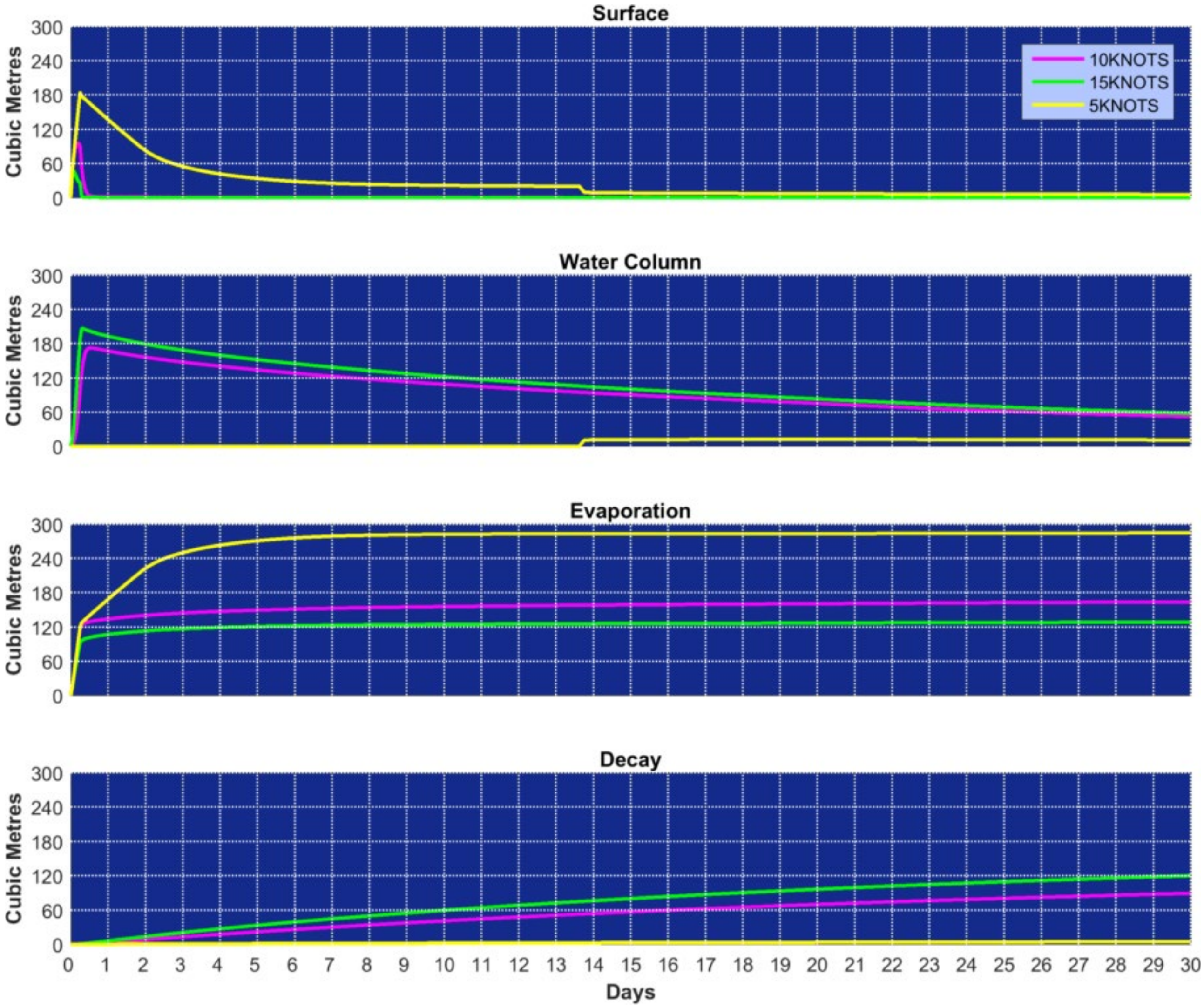

Figure 19 Weathering of a 300 m³ surface release of MDO over 6 hours (tracked for 30 days) under three static winds conditions (5, 10 and 15 knots).

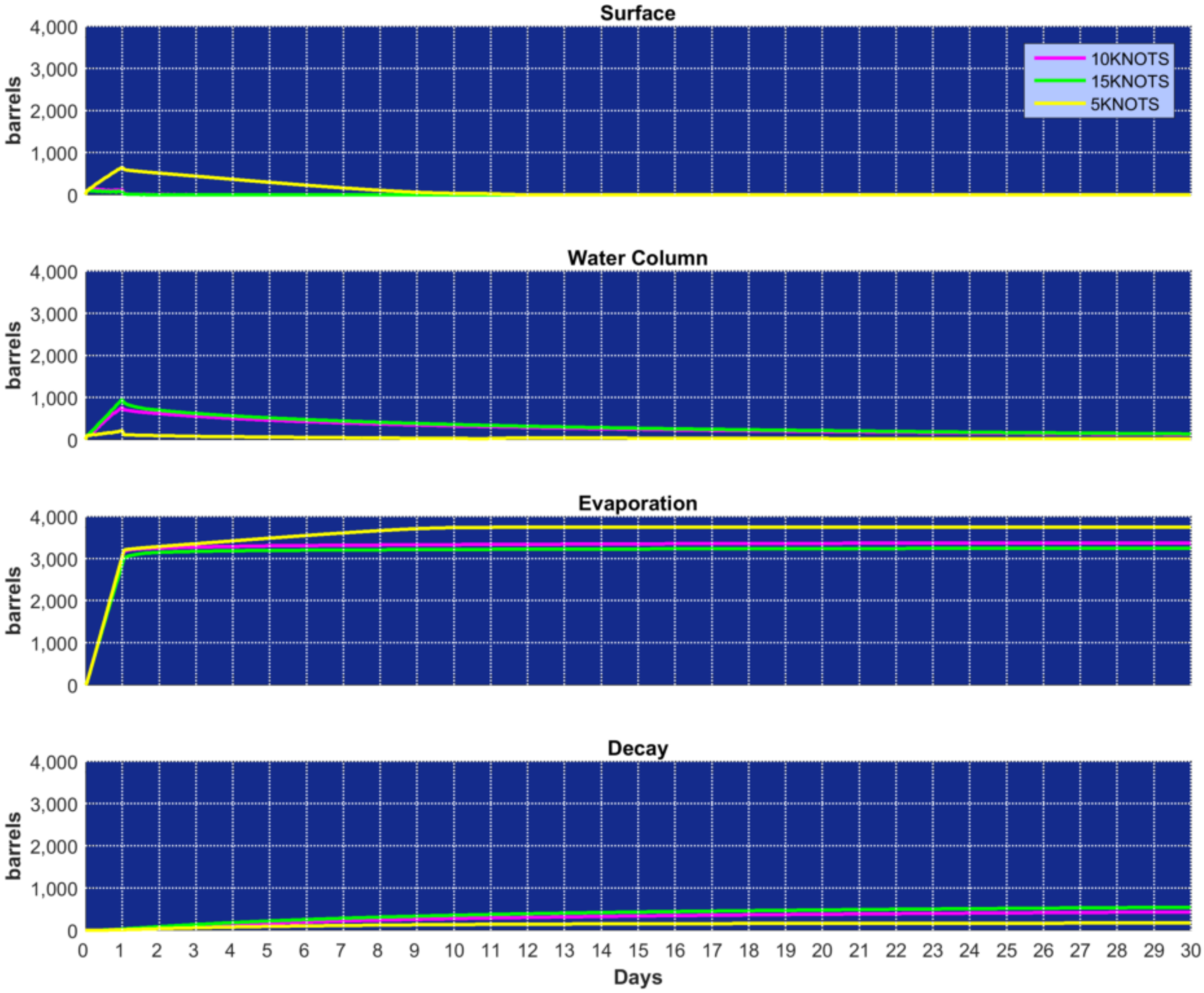

Figure 1 Weathering of 3,758 bbl subsea release of Thylacine condensate over 24 hours (tracked for 30 days) under three static wind speeds (5,10 and 15 knots).

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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 m^3 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	
Scenario description	Subsea Loss of Well Control	Loss of Containment from a Vessel
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). *These thresholds were assessed for 1 hour and 48-hour exposure windows.*	6 ppb, potential low exposure 50 ppb, potential moderate exposure 400 ppb, potential high exposure	
Entrained hydrocarbon exposure to assess the potential exposure (ppb). *These thresholds were assessed for 1 hour and 48-hour exposure windows.*	10 ppb, potential low exposure 100 ppb, potential moderate exposure 1,000 ppb, potential high exposure	

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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	✓	✓	✓

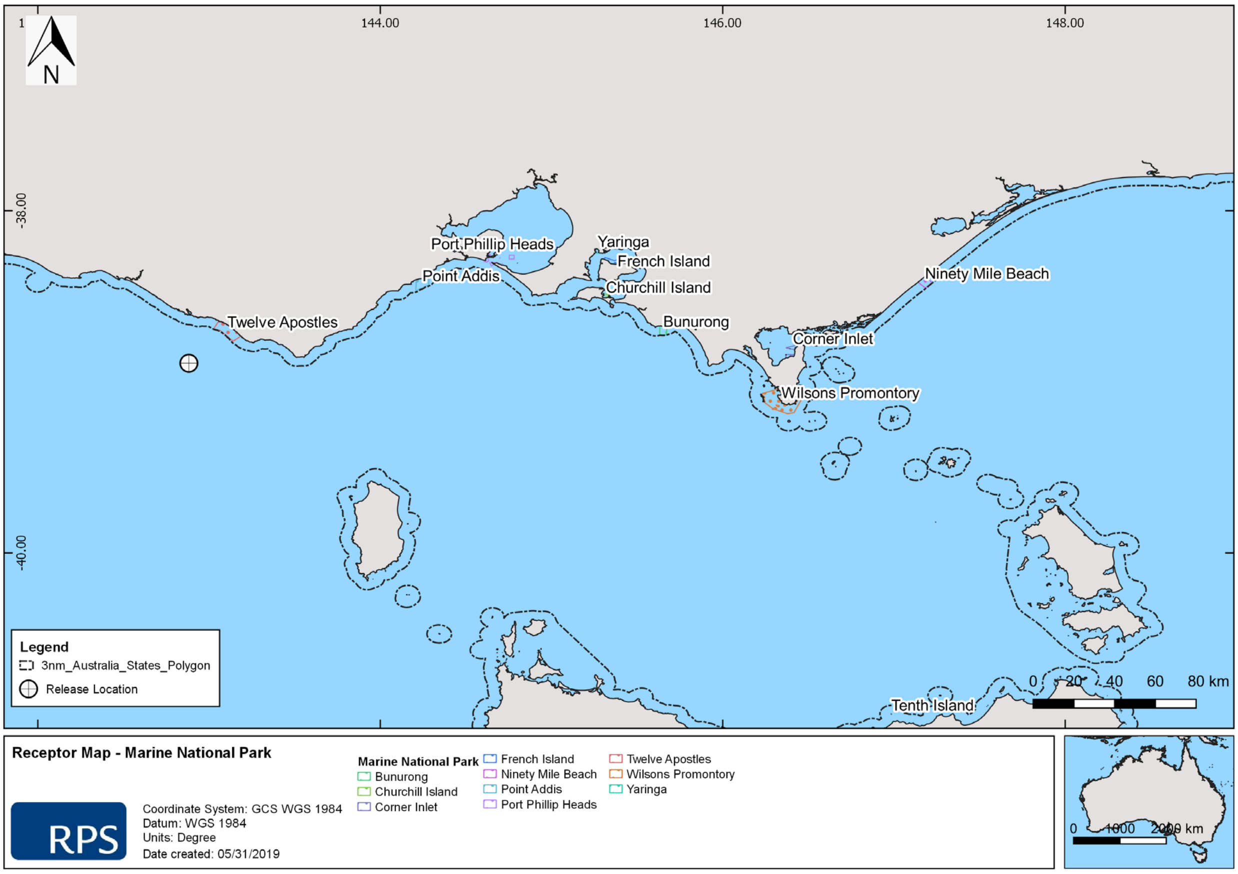

Figure 20 Receptor map for Marine National Parks.

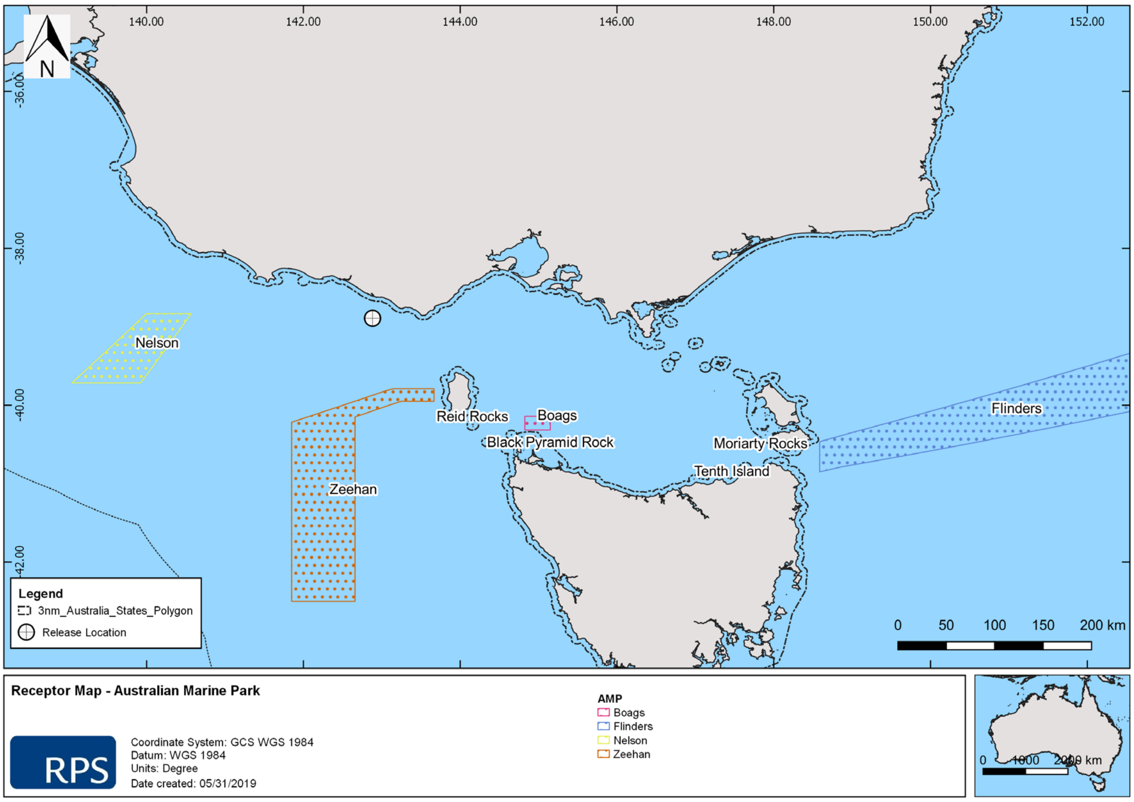

Figure 21 Receptor map for Australian Marine Parks.

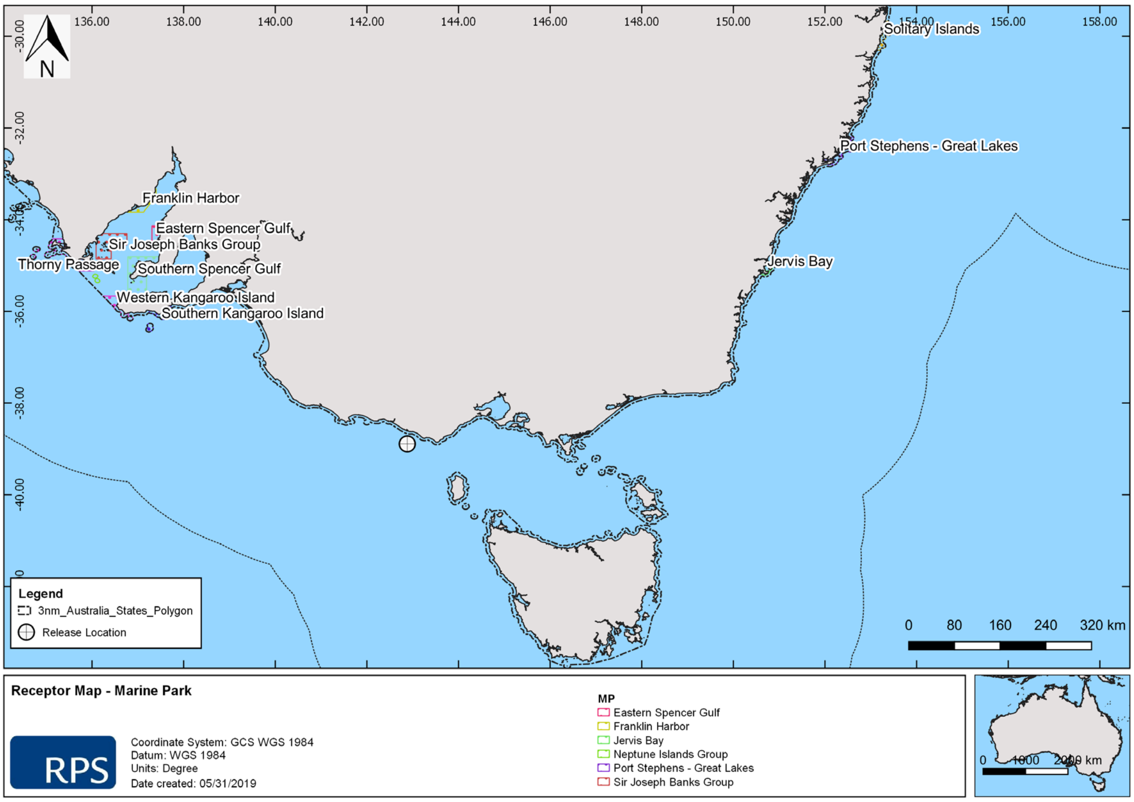

Figure 22 Receptor map for Marine Parks.

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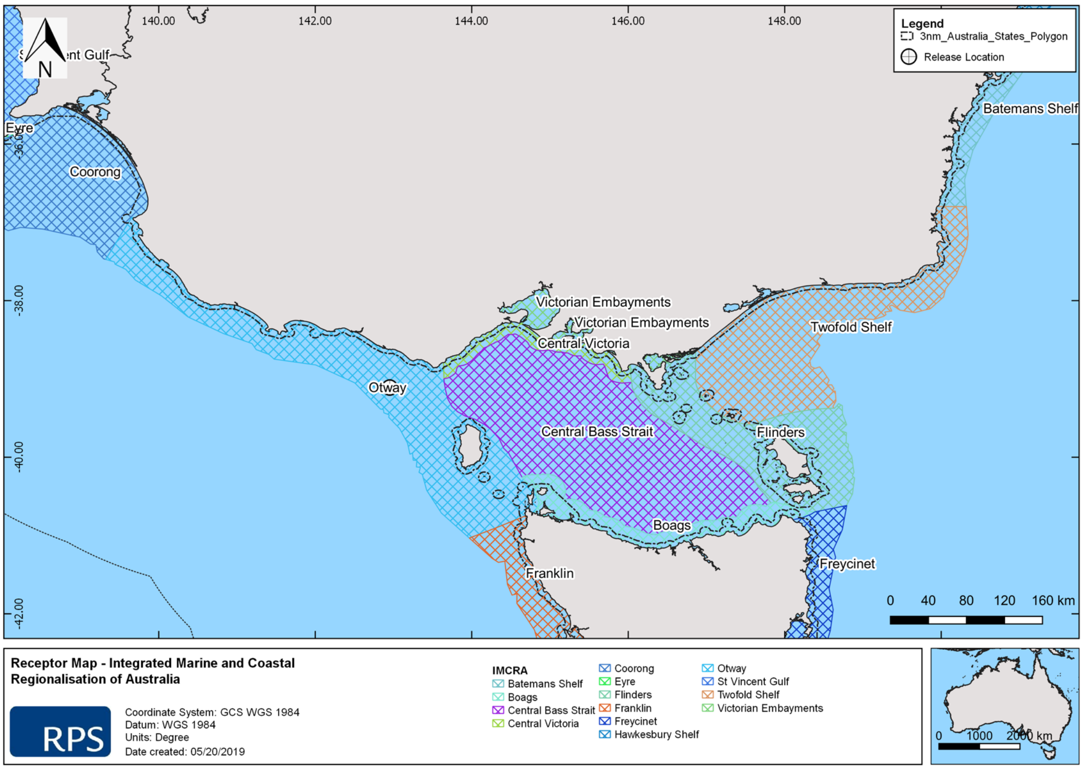

Figure 23 Receptor map illustrating the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) receptors.

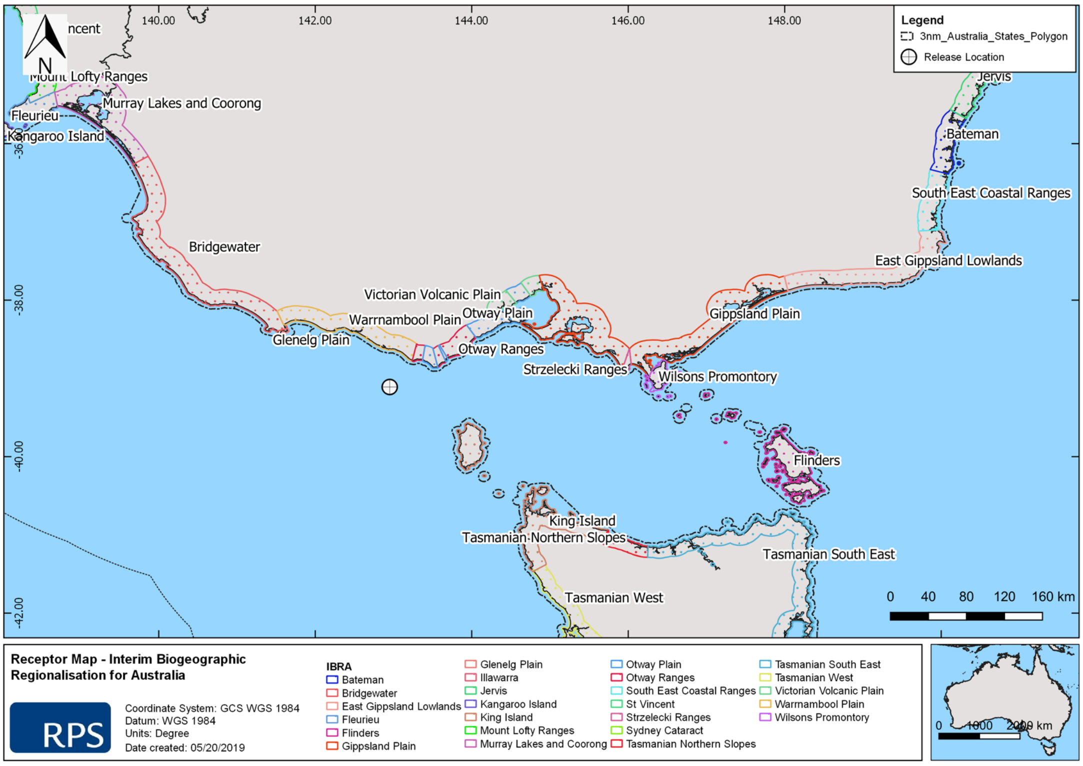

Figure 24 Map illustrating the Interim Biogeographic Regionalisation of Australia (IBRA) receptors.

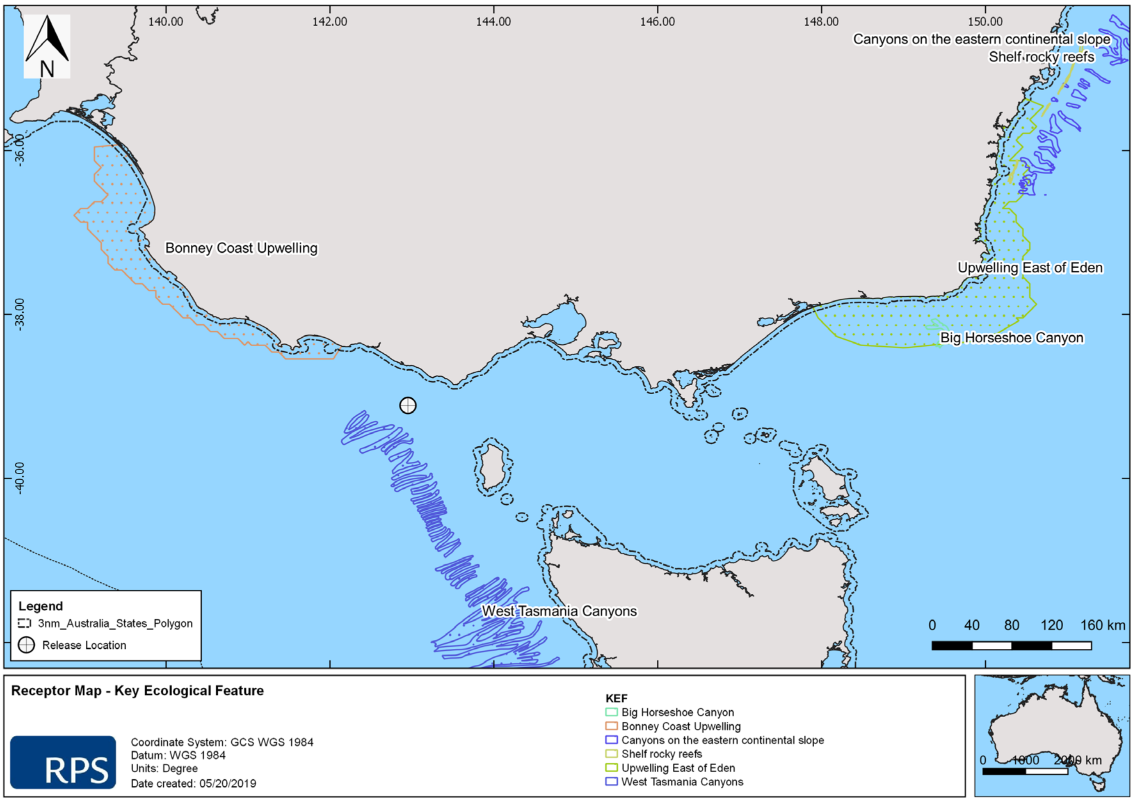

Figure 25 Receptor map of Key Ecological Features (KEF)

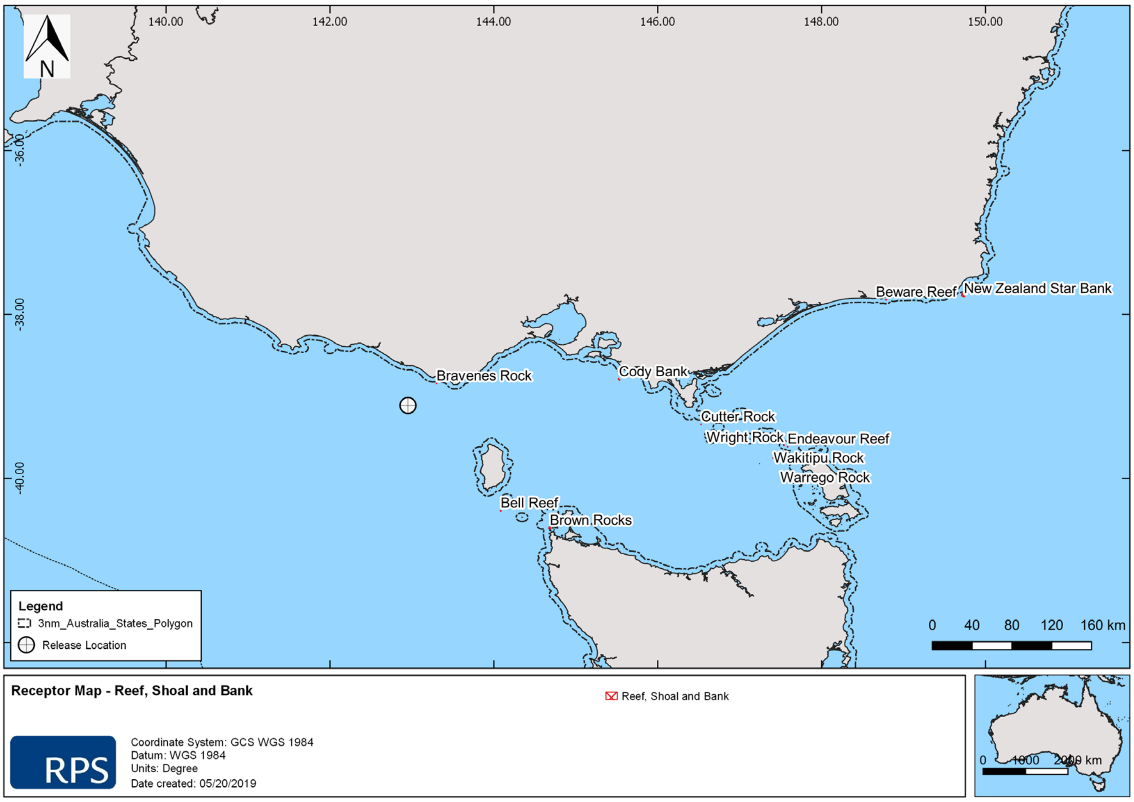

Figure 26 Receptor map of Reefs, Shoals and Banks (RSB)

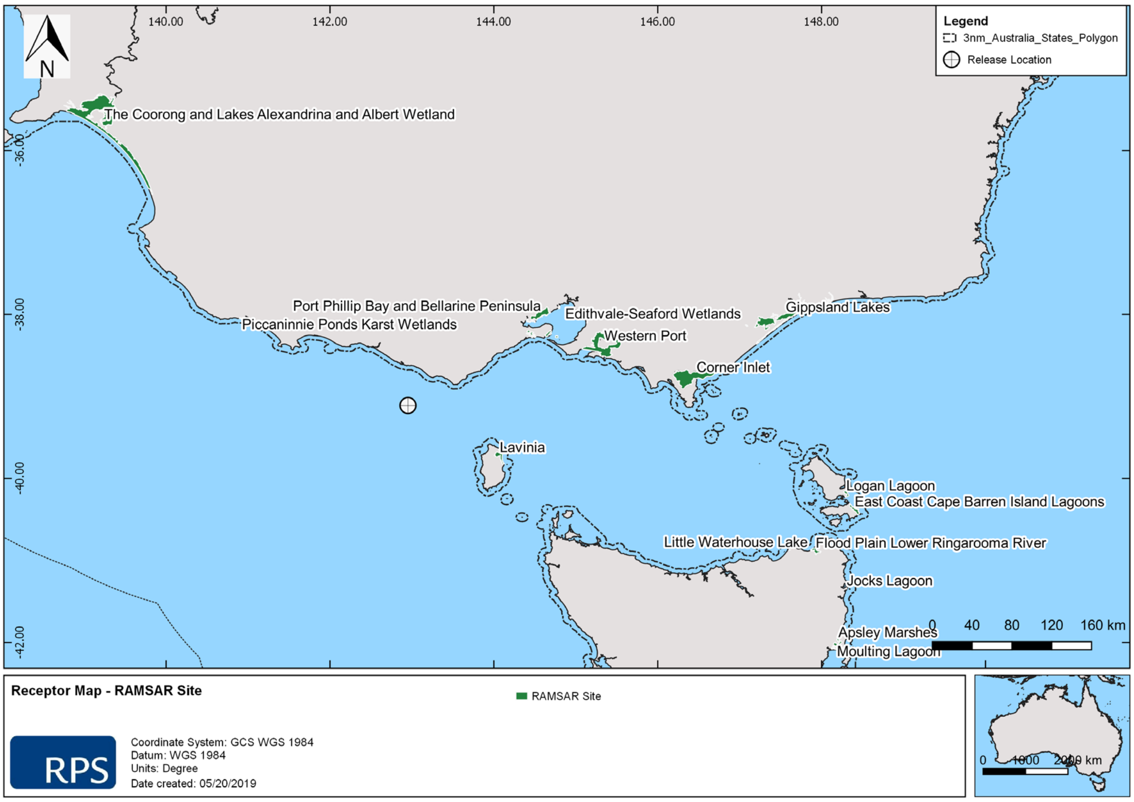

Figure 27 Receptor map of RAMSAR sites

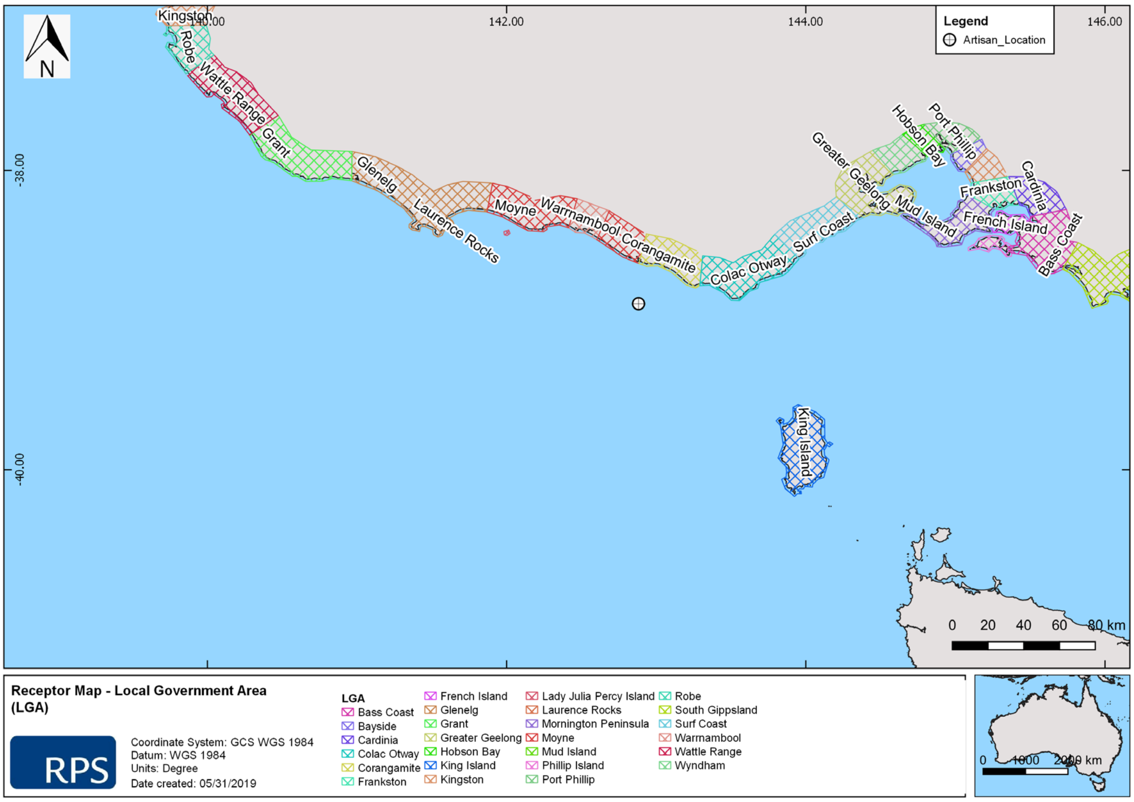

Figure 28 Receptor map of Local Government Areas (LGA) (1/3)

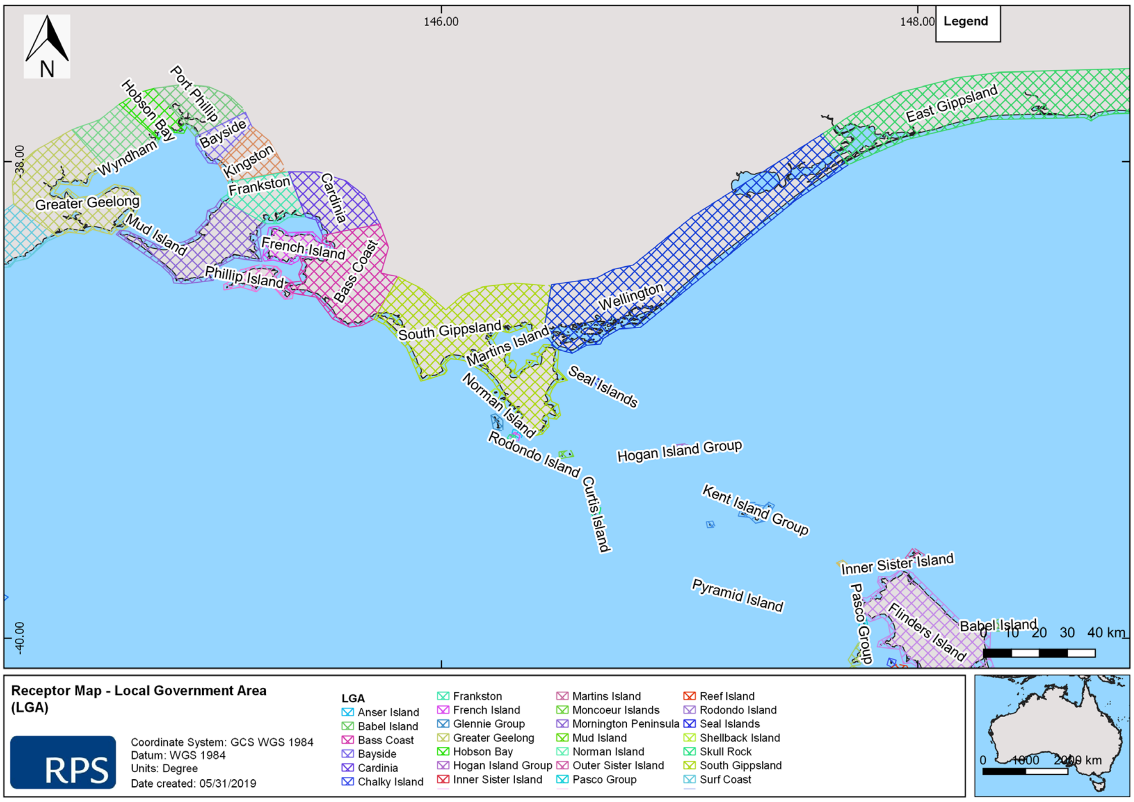

Figure 29 Receptor map of Local Government Areas (LGA) (2/3)

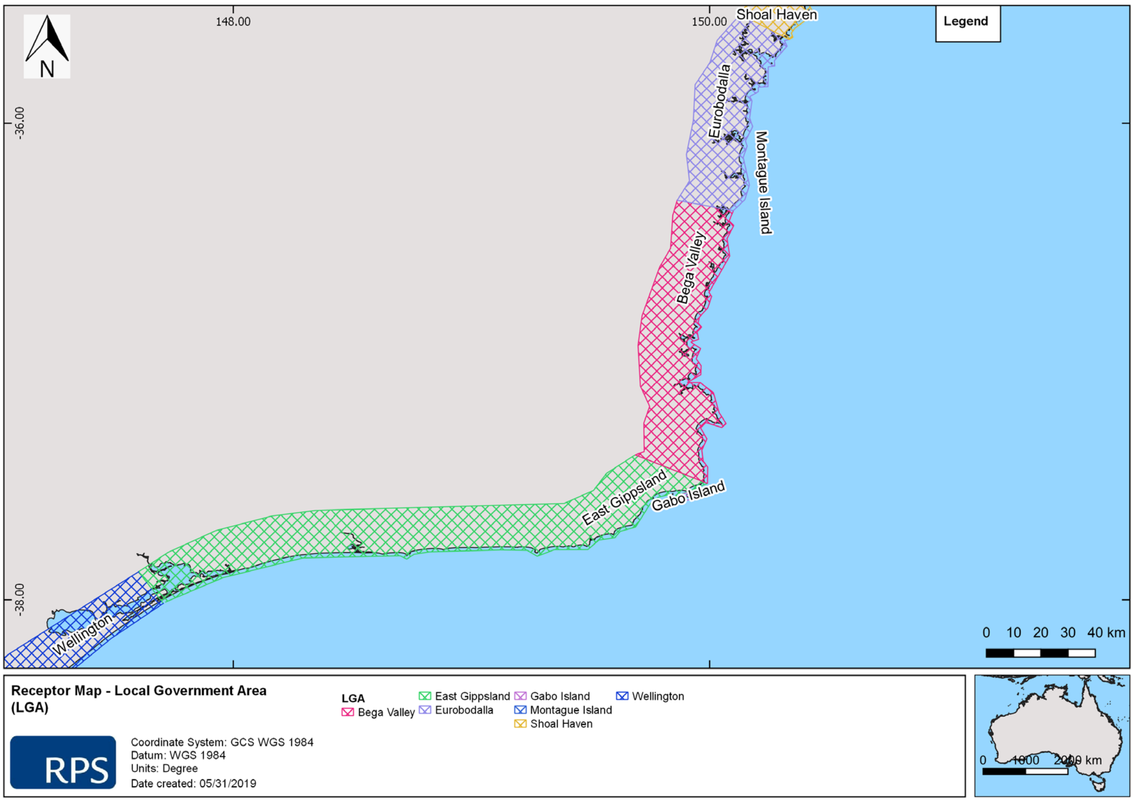

Figure 30 Receptor map of Local Government Areas (LGA) (3/3)

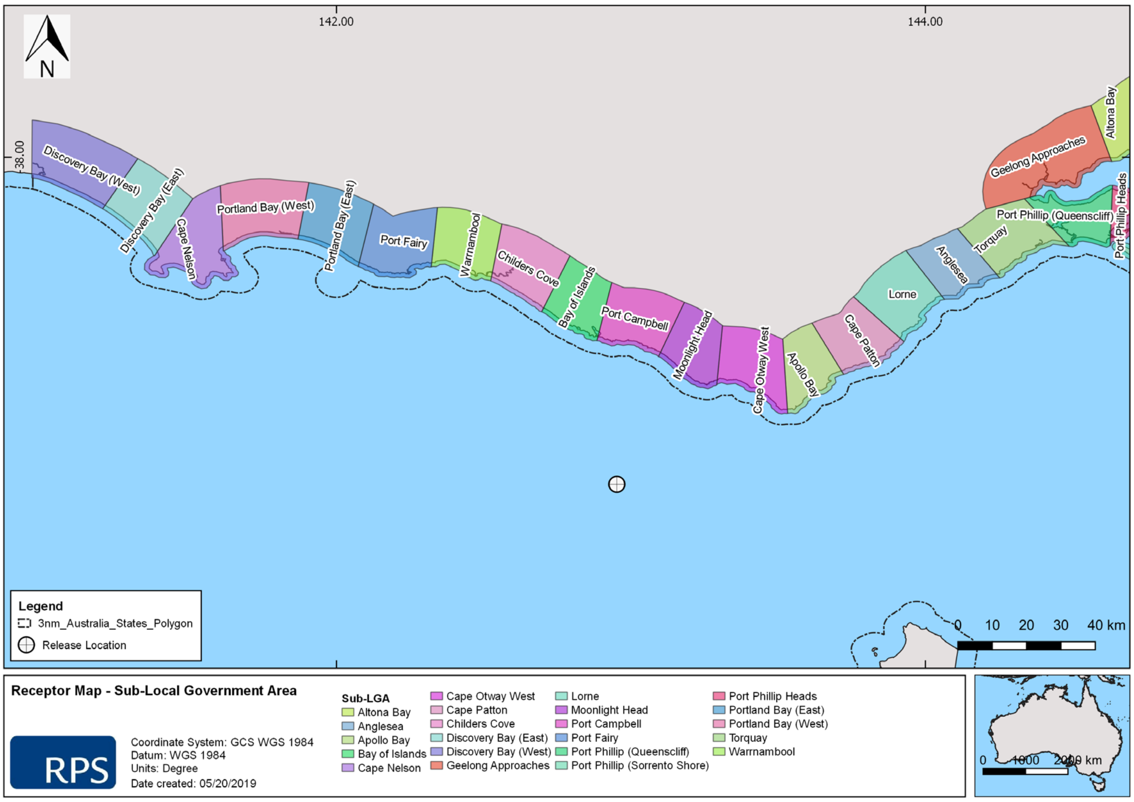

Figure 31 Receptor map of Sub-Local Government Areas (Sub-LGA) (1/3)

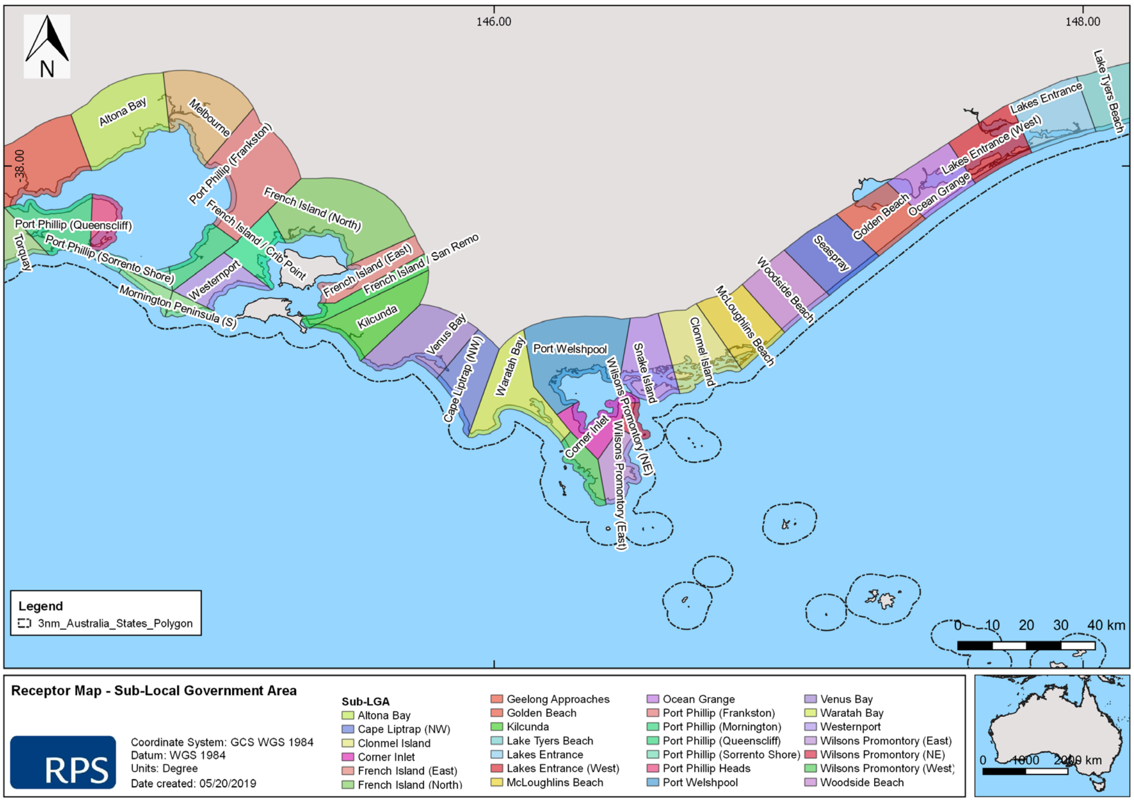

Figure 32 Receptor map of Sub-Local Government Areas (Sub-LGA) (2/3)

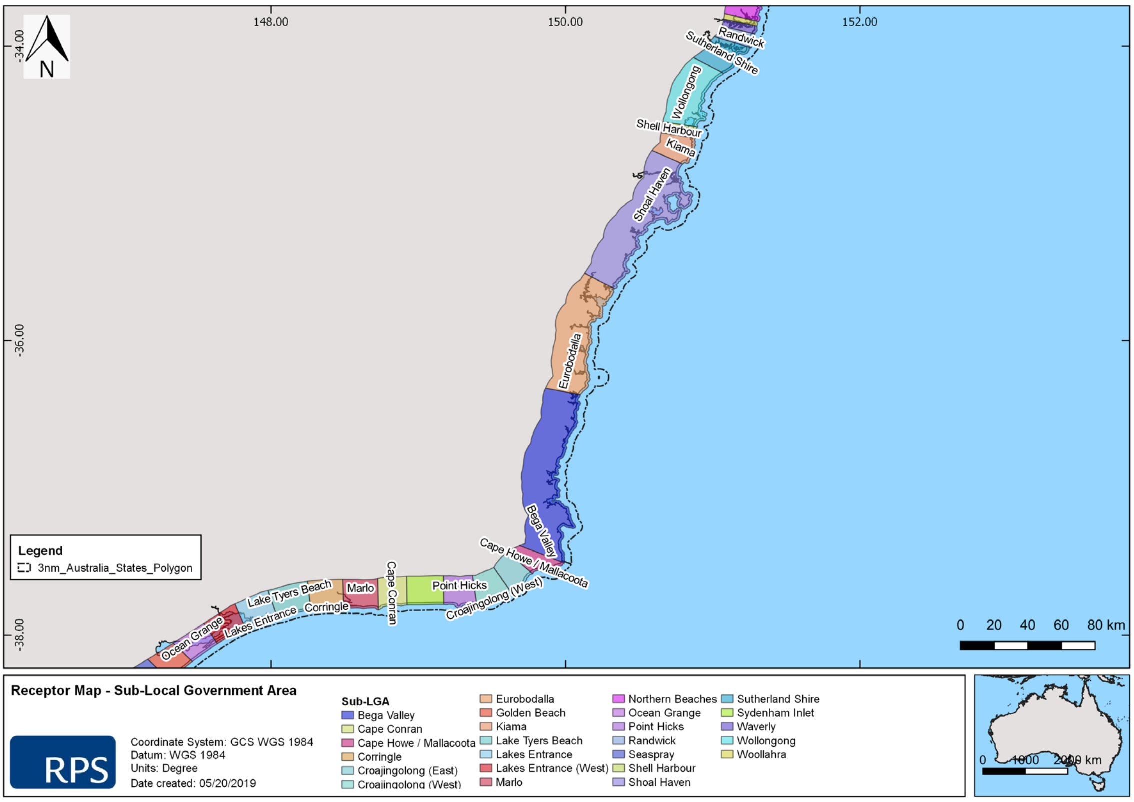

Figure 33 Receptor map of Sub-Local Government Areas (Sub-LGA) (3/3)

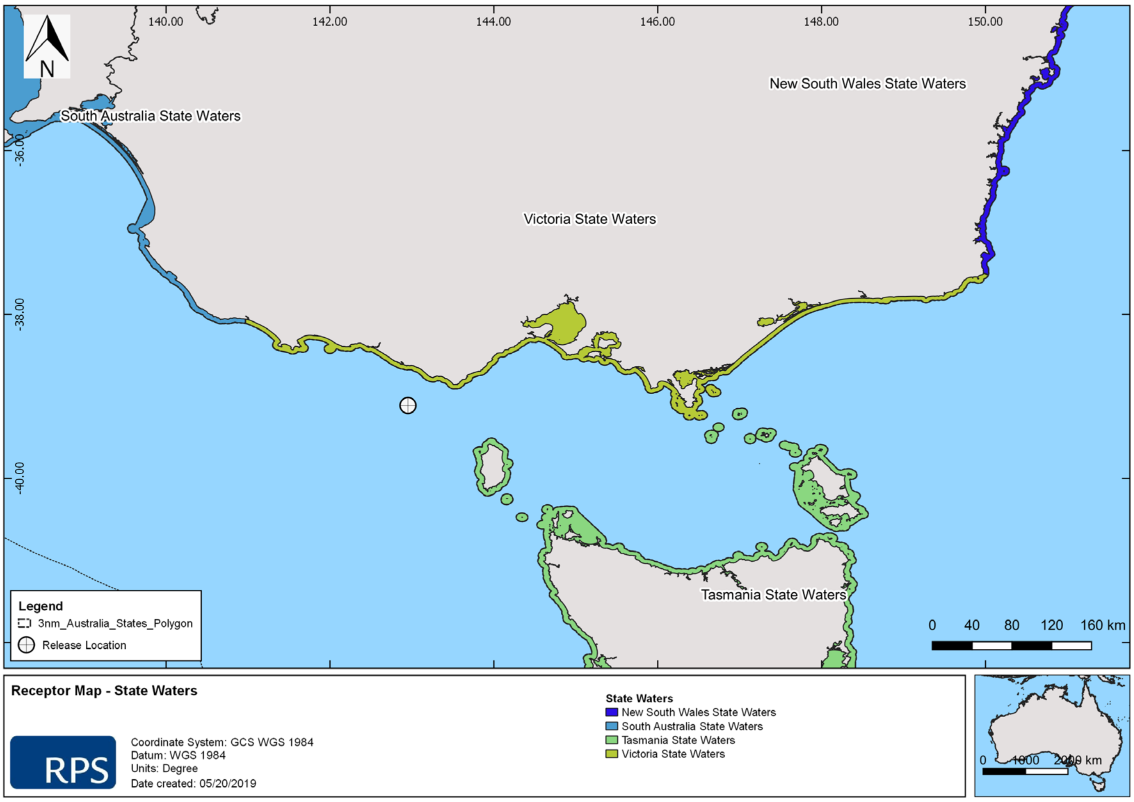

Figure 34 Receptor map of state waters.

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9 RESULTS: 300 M^3 SURFACE RELEASE OF MARINE DIESEL OIL

The scenario examined a 300 m^3 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/m^2), moderate (10-25 g/m^2) and high (>25 g/m^2) 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. Th 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) (99th percentile)	35	11	6
	Direction	E	NNE	E
Winter	Max. distance from release location (km)	93	10	6
	Max distance from release location (km) (99th percentile)	56	10	6
	Direction	E	WNW	ENE

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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: Low	Moderate	High	Minimum time before oil exposure on the sea surface (hours) for each threshold: 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.

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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	-	-

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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	Moderat e	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.

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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	-
IBRA	Glenelg Plain	58	-	-	-	33	9	-	-
	Bridgewater	58	-	-	-	31	5	-	-
	Warrnambool Plain	317	-	-	-	228	25	4	-
	Otway Ranges	254	-	-	-	218	25	2	-
	Otway Plain	284	-	-	-	208	28	3	-
	Gippsland Plain	39	-	-	-	21	1	-	-
	Wilsons 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	-	-
	Wilsons 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	-	-

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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	-	-
IMCRA	Twofold Shelf	5	-	-	-	10	1	-	-
	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	-	-

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	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	-	-
LGA	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	-	-
	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	-
SUB-LGA	Wilsons Promontory (West)	18	-	-	-	21	2	-	-
	Waratah Bay	12	-	-	-	13	1	-	-
	Cape Liptrap (NW)	13	-	-	-	15	1	-	-

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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.

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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/m^2), moderate (10-25 g/m^2) and high (>25 g/m^2) 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 m^3 and 33 m^3, during summer and winter conditions, respectively, while the maximum length of shoreline contacted above the low threshold (>10 g/m^2) was 7.0 km and 11.0 km, respectively. Note, no shoreline loading above 1,000 g/m^2 was predicted.

The Otway IMCRA shoreline was the only receptor to record of contact above 100 g/m^2 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.

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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) (99th percentile)	34	4	NA
	Direction	E	E	NA
Winter	Max. distance from release site (km)	53	3	NA
	Max distance from release site (km) (99th percentile)	49	3	NA
	Direction	NNW	W	NA

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

			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (hours)		
Season		Receptor	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	-	-

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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)	-	-

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

		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)		
Season	**Receptor**	**>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	-

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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.

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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 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	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	Wilsons 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	Wilsons 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	-	-

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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	-

	Port Phillip Heads	1	-	-	-	15	8	-	-
	Twelve Apostles	16	6	-	-	155	100	18	-
	Wilsons Promontory	5	-	-	-	66	23	1	-
NP	Bunurong Marine Park	1	-	-	-	24	8	-	-
	Wilsons 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	-	-

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	Laurence Rocks	1	-	-	-	19	2	-	-
State Waters	Tasmania State Waters	1	-	-	-	15	3	-	-
	Victoria State Waters	34	16	-	-	289	100	57	-
SUB-LGA	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	-	-
	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.

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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	-	-
	Wilsons 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	-
	Wilsons 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	-	-
	Wilsons Promontory Marine Park	23	-	-	-	27	8	-	-
RAMSAR	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	-	-
	Wilsons Promontory (East)	11	-	-	-	14	17	-	-
	Wilsons 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.

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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	-	-
	Wilsons 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	-	-
SUB-LGA	Eurobodalla	6	-	-	-	9	-	-	-
	Corner Inlet	10	-	-	-	12	10	-	-
	Wilsons Promontory (East)	22	-	-	-	27	56	-	-
	Wilsons 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	-	-
	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	-

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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Appendix C EP Revision Change Register

Any changes to the EP should be assessed against the OPGGS(E)R revision submission criteria detailed in Table 7-6.

Date	EP Revision	Section Revised	Changes	MOC No.	EP Submission Required

Appendix D Fair Ocean Access Information Sheet

Fair Ocean Access

Minimising fishing impacts from offshore operations

Information Sheet | May 2021

Introduction

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

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

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

Safety

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

Environmental Protection

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

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

Genuine consultation

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

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

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

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

Economic loss

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

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

Acting in good faith

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

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

Making a claim

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

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

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

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

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

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

Resolving disagreements

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

We welcome your questions and feedback

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beachenergy.com.au

beach

Appendix E Environmental Survey – Otway Basin

SUPPLIER DOCUMENT COVER PAGE

Project Title	Beach Otway Offshore Wellsite Survey Services		
Supplier Name	Ramboll		
Contract/PO No	TBC		
Document Title	Infauna Laboratory Testing and Factual Report		
Fugro Document Number	135846-V01-05-REP-001	**Revision**	B
Client Document Number	S4100RU718410	**Revision**	A
Supplier Document Number	3180000803	**Revision**	B
Sub-Supplier Document Number		**Revision**	
VDRL Code			
Tag No			

Supplier/Contractor Internal Approvals (Supplier/Contractor use only)					
Date	**Rev**	**Reason for Issue**	**Prepared By**	**Checked By**	**Supplier/Contractor Approval**
17/03/20	A	Issued for Review	E Jones	D McClary	J Miragliotta
23/04/20	B	Issued for Review	E Jones	D McClary	J Miragliotta

Review Status (Fugro use only)		
Tick Box	**Code**	**Review Status Description**
☐	Code 1	Approved – Certified Final
☐	Code 2	Approved as noted – Revise and resubmit as final revision, work may/may not proceed
☐	Code 3	Not accepted – Revise and resubmit for review
☐	Code 4	Information only – Review not required
☐	Code 5	No Comments – Submit certified final
☐	Code 6	As Built

Acceptance in any of these categories in no way relieves the Supplier/Contractor of their responsibility for the due and proper performance of the works in accordance with the Contract/Purchase Order with Fugro.

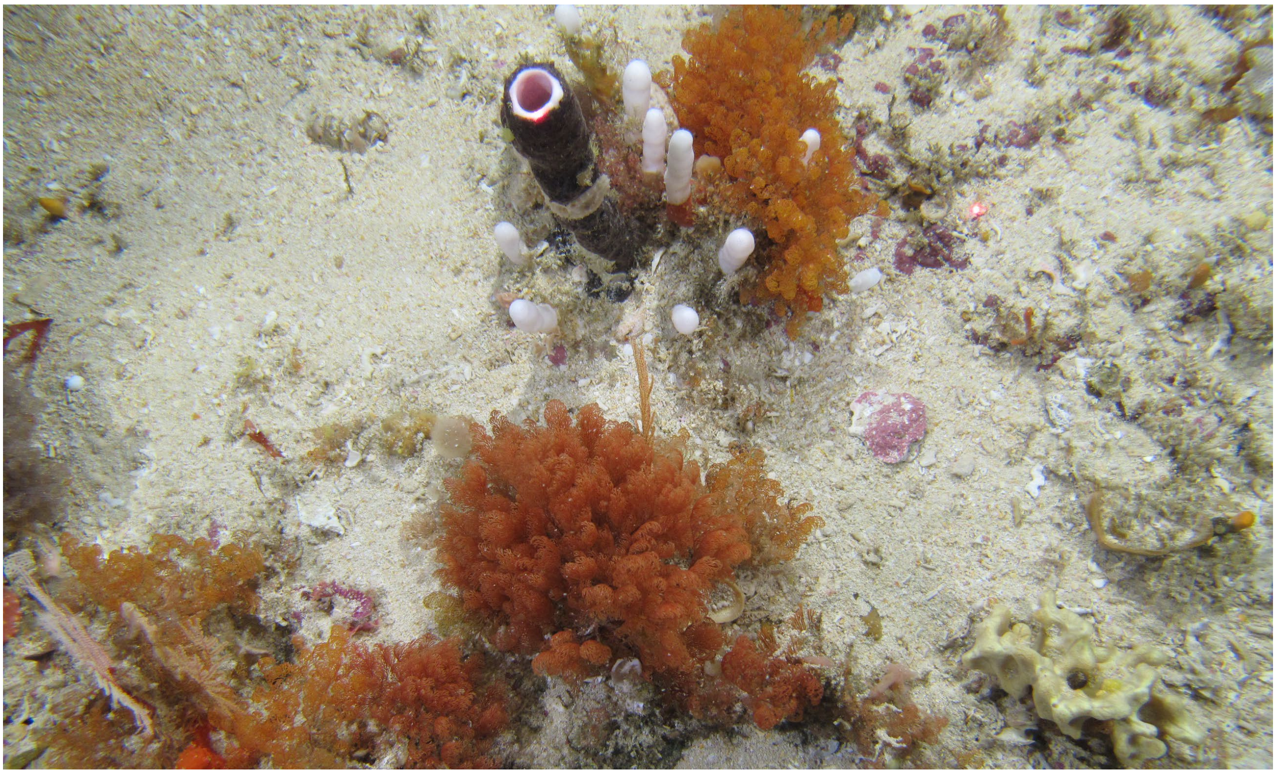
Fugro Approval	
Name	
Signature	
Date	

Intended for
Fugro Australia Pty Ltd

Document type
Report

Date
March 2020

ENVIRONMENTAL SURVEY
OTWAY BASIN



RAMBOLL Bright ideas. Sustainable change.

ENVIRONMENTAL SURVEY
OTWAY BASIN

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

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1. INTRODUCTION

1.1 Background

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

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

1.2 Objective

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

1.3 Report Scope

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

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

Water quality assessments included laboratory analyses for:

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

Sediment quality assessments included laboratory analyses for:

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

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

2. SURVEY LOCATIONS

These investigations were based around five survey areas including:

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

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

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

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

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

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

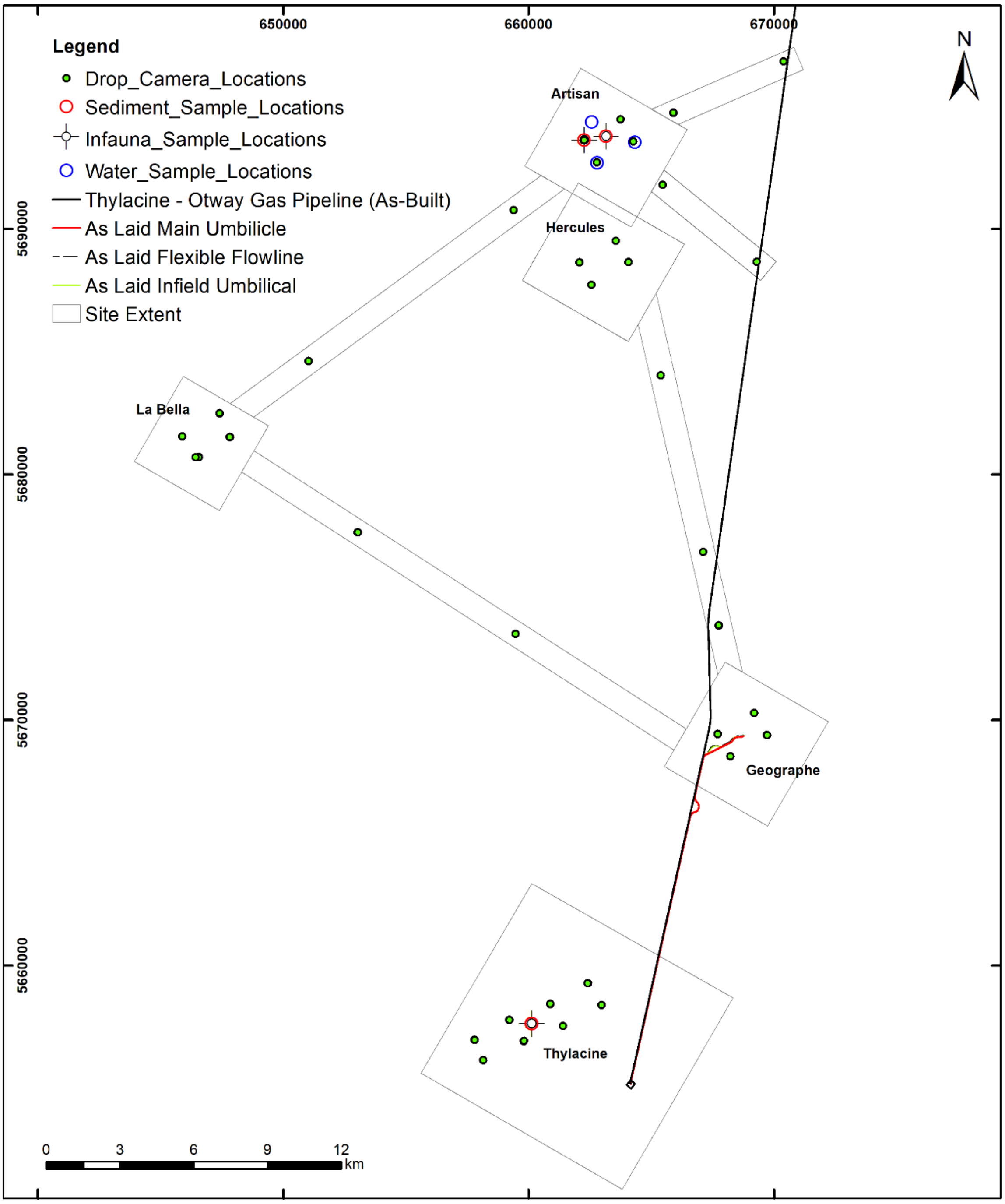


Figure 1 Locations of environmental survey site extents in Otway Basin. Provided by Fugro, April 2020.

3. METHOD

3.1 Survey Operations

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

3.2 Water Quality

3.2.1 Sample Collection

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

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

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

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

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

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

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

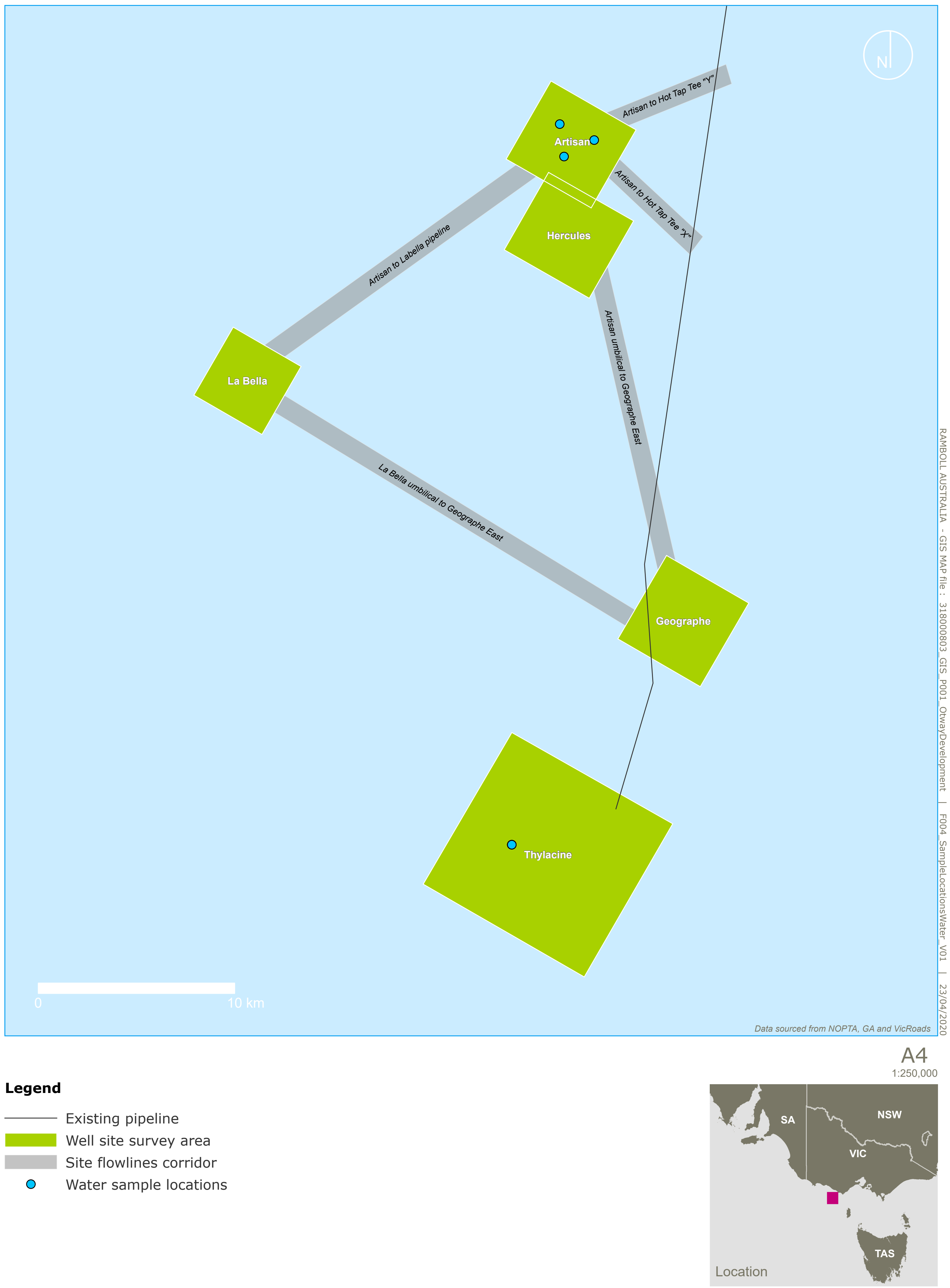


FIGURE 2 | Water sampling locations for Thylacine and Artisan survey areas.

3.2.2 Sample Processing and Analysis

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

The water samples were subsampled as follows:

- 1 x 500 mL plastic bottle with no preservative
- 1 x 200 mL glass bottle with no preservative
- 1 x 60 mL plastic bottle with sulphuric acid
- 1 x 60 mL plastic bottle with nitric acid
- 2 x 40 mL glass vials with hydrogen chloride

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

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

The following measurements were then taken using a YSI EcoSense handheld meter from the remaining water sample:

- pH
- Dissolved oxygen (DO)
- Oxidation-reduction potential (ORP)
- Temperature (˚C)

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

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

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

- Total suspended solids (TSS);
- Nutrients including total nitrogen (N), total Kjeldahl nitrogen (TKN), nitrogen oxides (NOx), nitrate (NO^{-}_3), ammonia (NH_3), total phosphorus (TP), and total reactive phosphorus (TRP);
- Chlorophyll *a*;
- Metals/metalloids including arsenic (As), cadmium (Cd), cobolt (Co), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), and zinc (Zn); and
- Hydrocarbons including total recoverable hydrogens (TRH), benzene, toluene, ethylbenzene and xylene compounds (BTEX), and polycyclic aromatic hydrocarbons (PAH).

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

3.3 Sediment Quality

3.3.1 Sample Collection

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

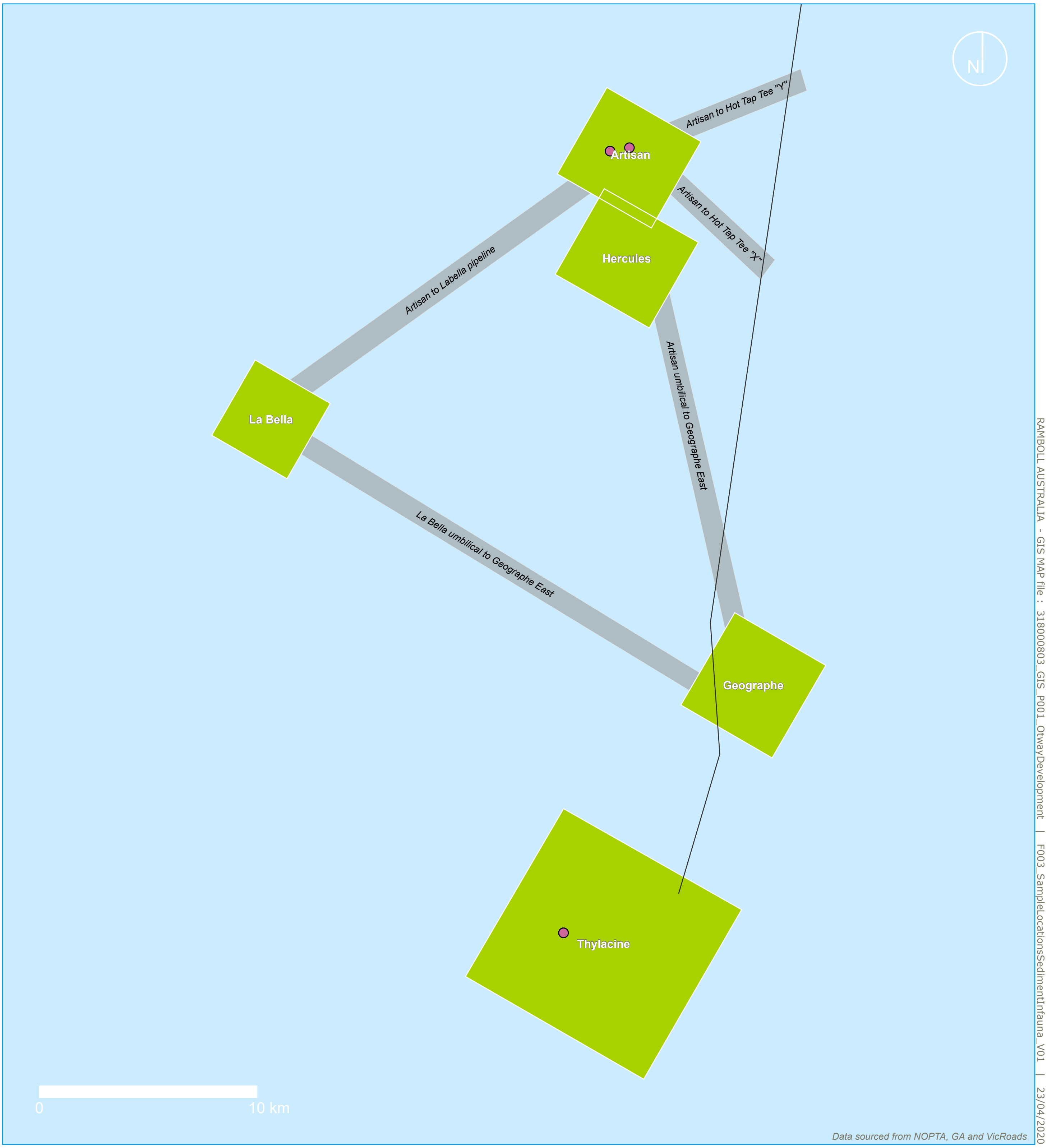
Prior to deployment, the jaws of both grabs were opened and fixed into position using a tension-based catch. The grab sampler was then winched over the stern of the vessel and lowered at a slow, steady rate to prevent the catch from being released too early. When the jaws made contact with the bottom,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

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

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

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

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



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Legend

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

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

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

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

3.3.2 Sample Processing and Analysis

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

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

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

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

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

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

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

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

3.4 Infauna Ecology

3.4.1 Sample Collection

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

3.4.2 Sample Processing and Analysis

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

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

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

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

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

3.5 Epibenthic Ecology

3.5.1 Sample Collection

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

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

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

3.5.2 Sample Processing and Analysis

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

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

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

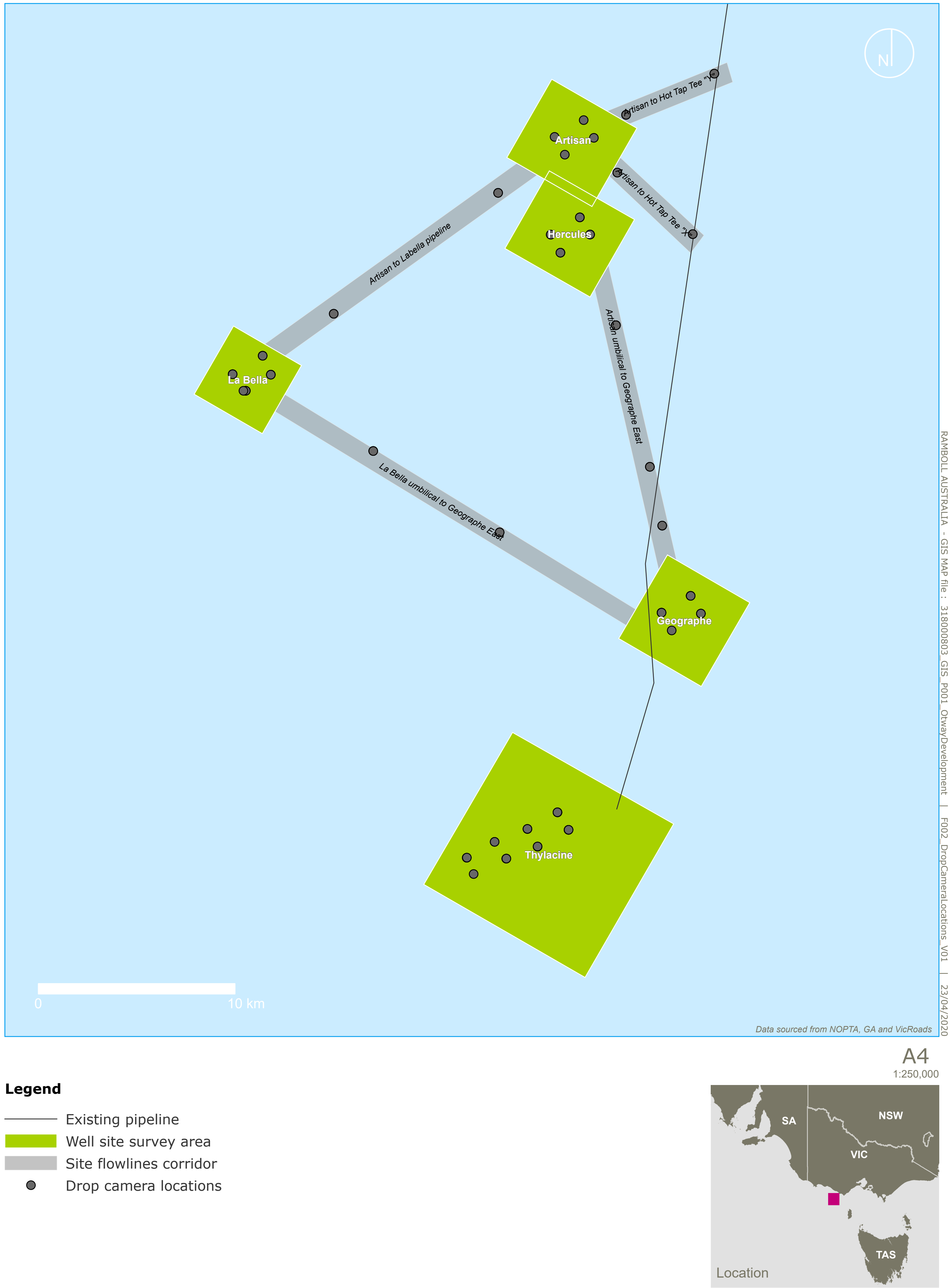

FIGURE 4 | Drop camera locations for all survey areas.

4. RESULTS

4.1 Water Quality

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

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

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

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

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

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

The concentration of ammonia, nitrite and reactive phosphorus was at or below LOR for all samples. Only one sample contained a concentration of nitrate-nitrite, NO^-_3, TKN and TN above the LOR. This was replicate Thylacine_1_3; however, none of the measurements exceeded ANZECC trigger values. Concentrations of TP were recorded in all samples, but all measurements were well below ANZECC trigger values. TSS was typically within the range expected for unmodified[1] marine ecosystems.

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

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

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

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

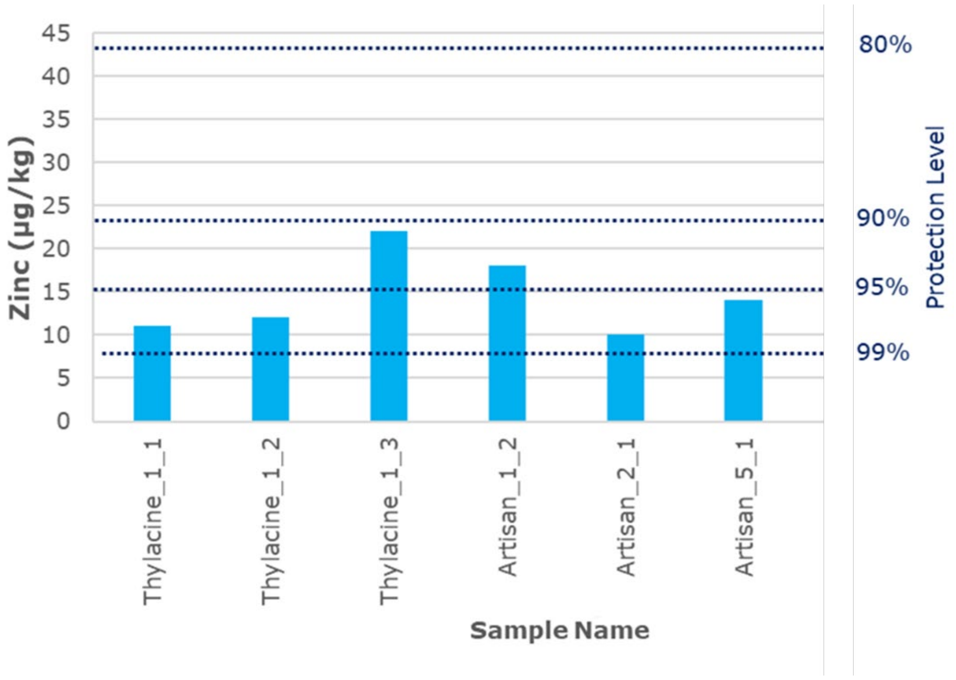

Figure 5 Concentration of Zn in water samples from Thylacine and Artisan survey areas.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.2 Sediment Quality

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

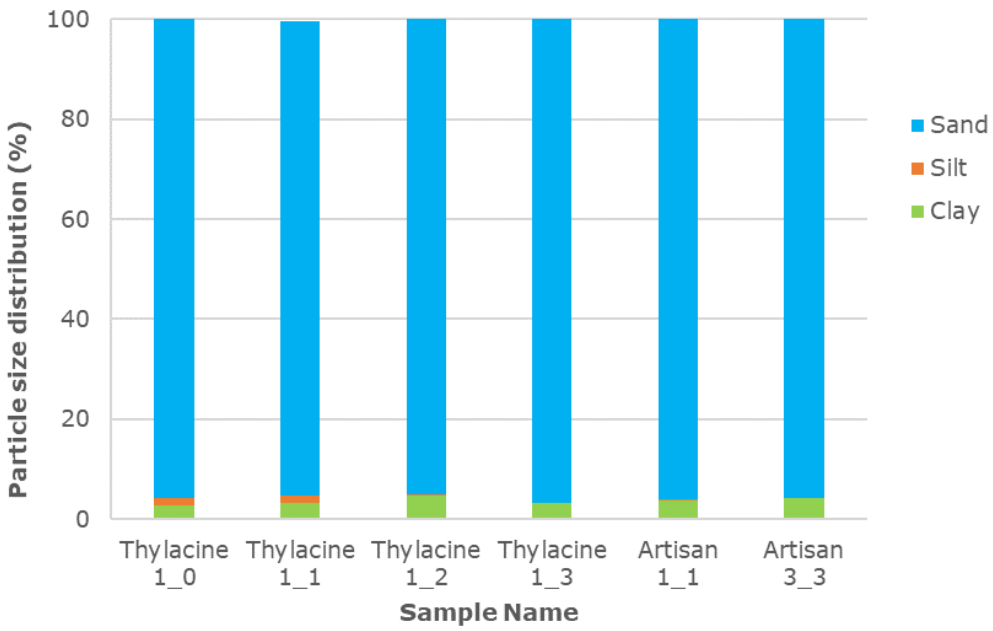

Figure 6 Particle size distribution (%) in sediment samples collected at Thylacine and Artisan survey areas.

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

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

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

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

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

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

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

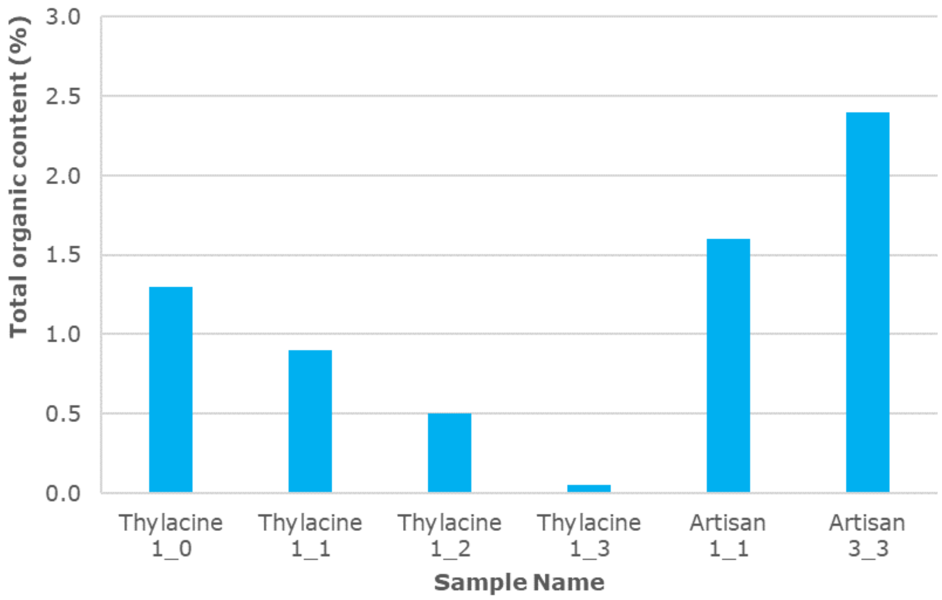

Figure 7 Total organic content (%) in sediment samples collected at Thylacine and Artisan survey areas.

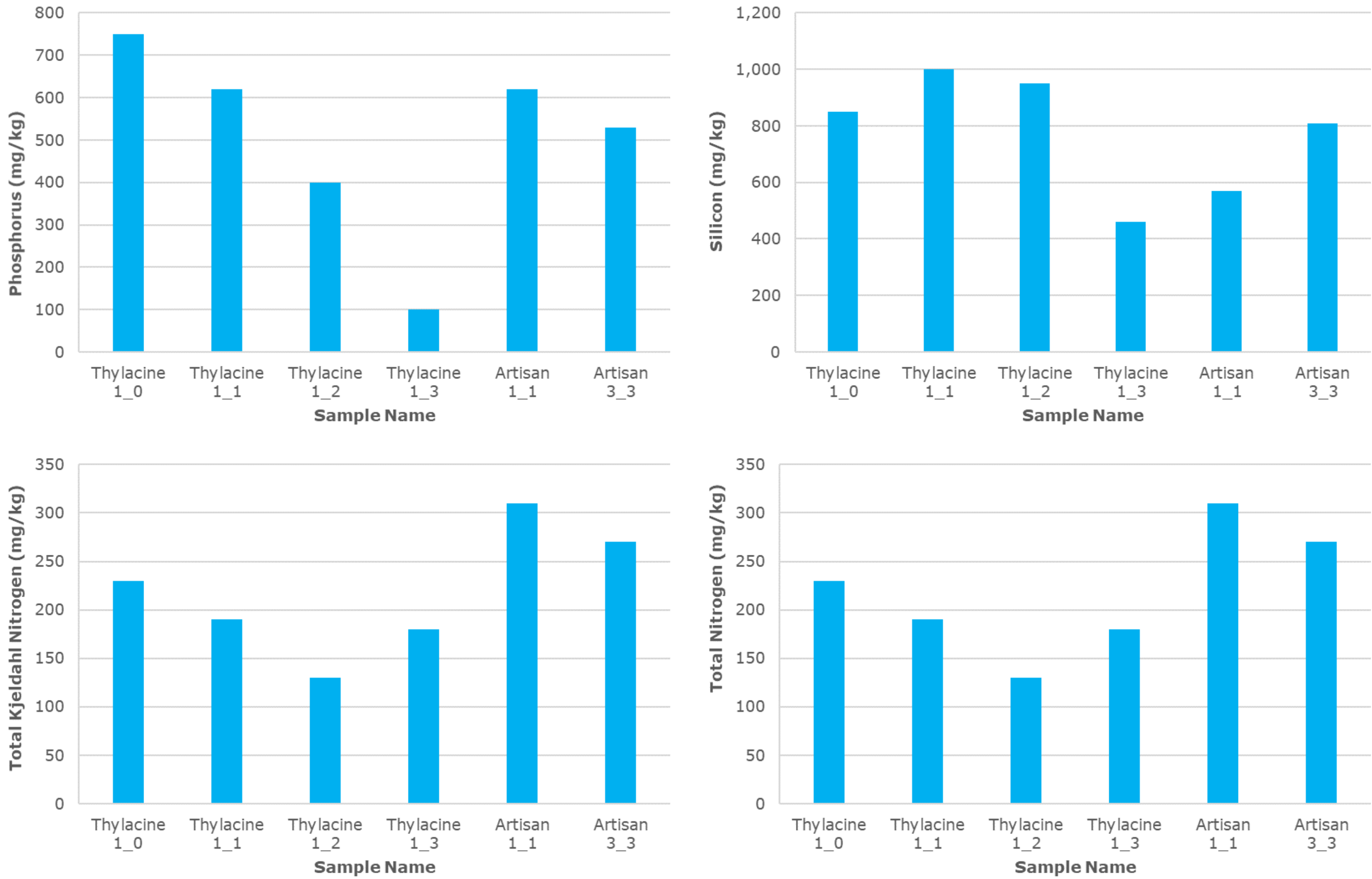

Figure 8 Nutrient concentrations (mg/kg) in sediment samples collected at Thylacine and Artisan survey areas, including phosphorus (top left), silicon (top right), total Kjeldahl nitrogen (bottom left) and total nitrogen (bottom right).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.3 Infauna Ecology

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

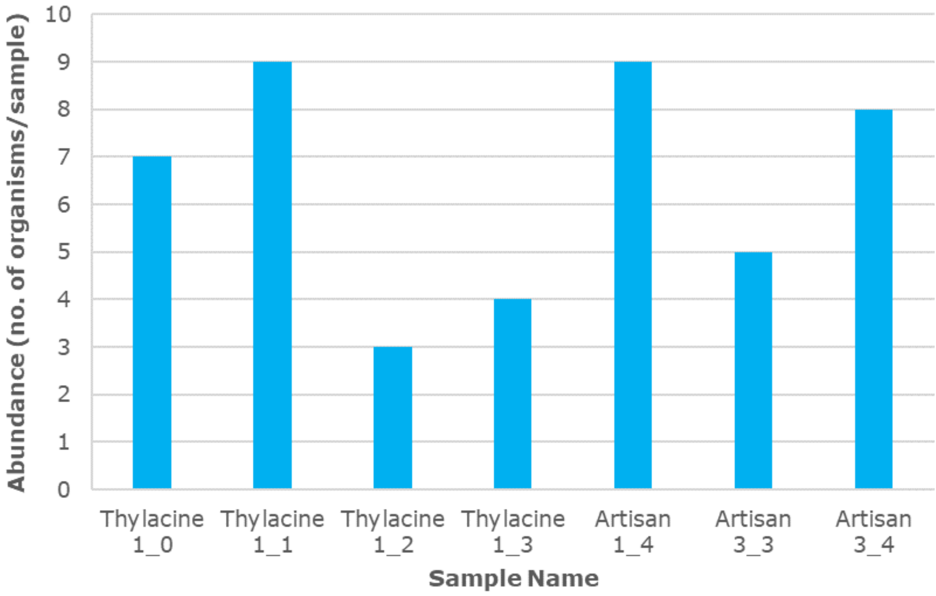

Figure 9 Abundance of benthic infauna in grab samples at Thylacine and Artisan survey areas.

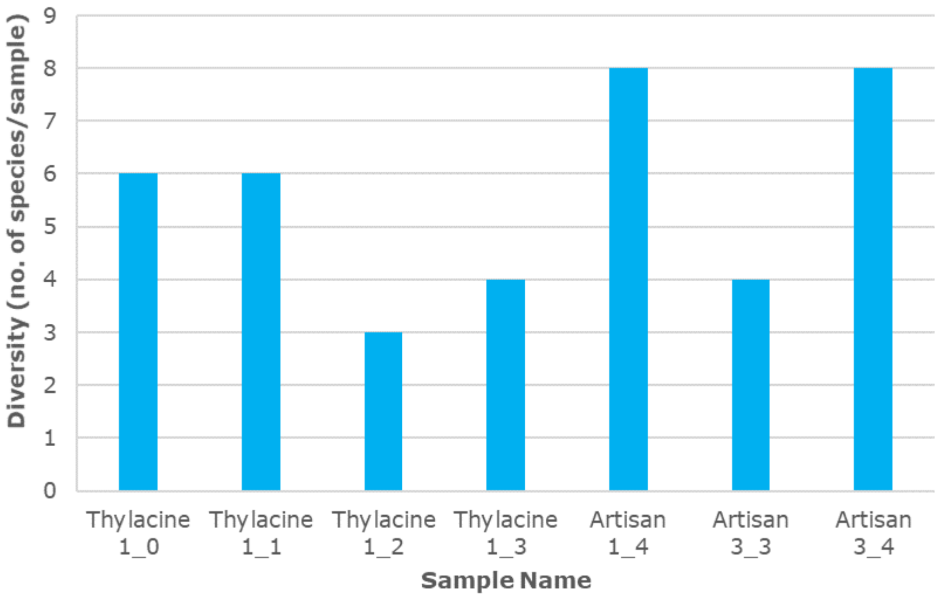

Figure 10 Diversity of benthic infauna in grab samples at Thylacine and Artisan survey areas.

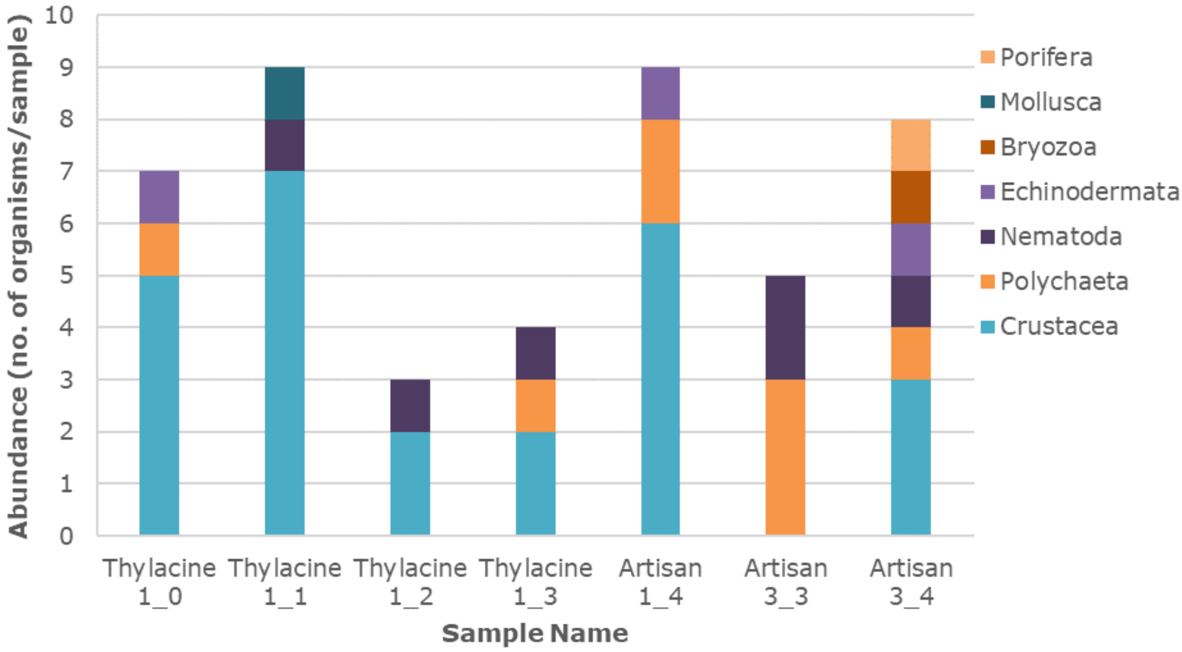

Figure 11 Abundance of benthic infauna by taxonomic group in grab samples at Thylacine and Artisan survey areas.

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

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

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

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

4.4 Epibenthic Ecology

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

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

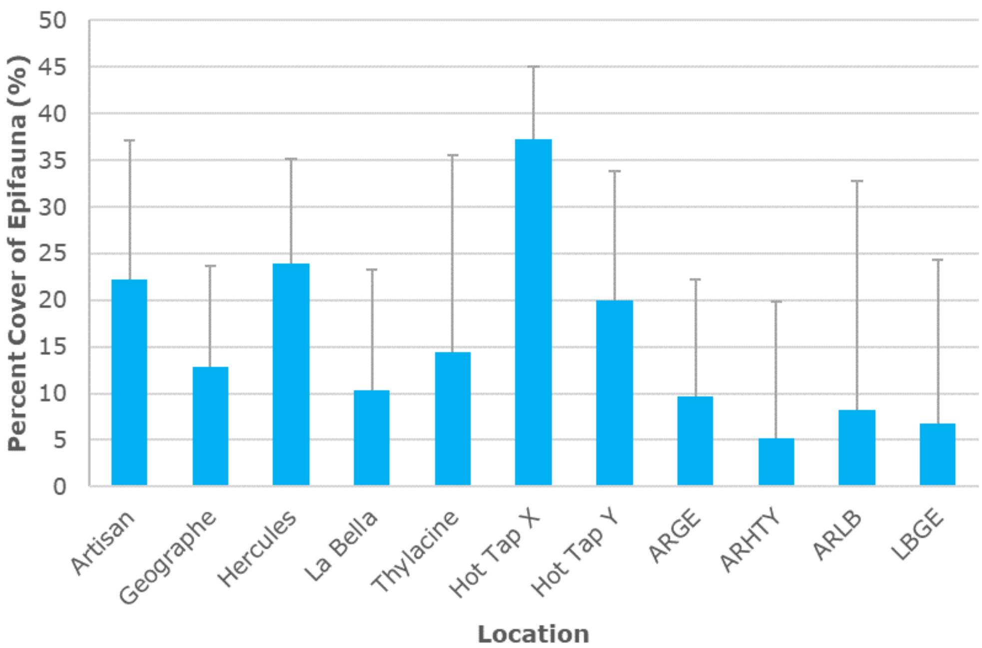

Figure 12 Percent cover of epifauna at drop camera location in Otway Basin.

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

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

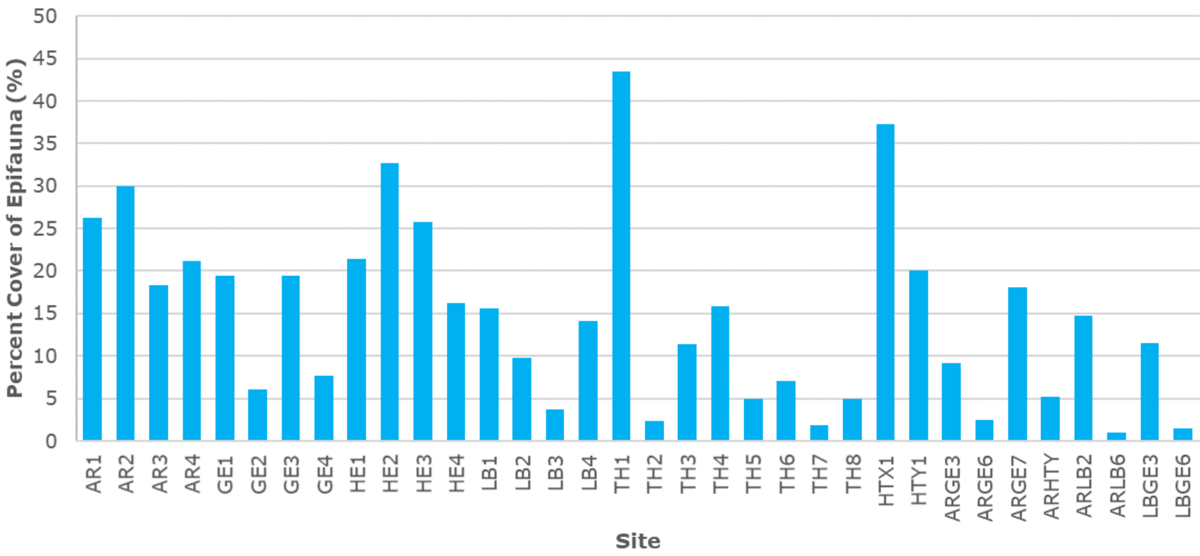

Figure 13 Percent cover of epifauna at drop camera sites in Otway Basin.

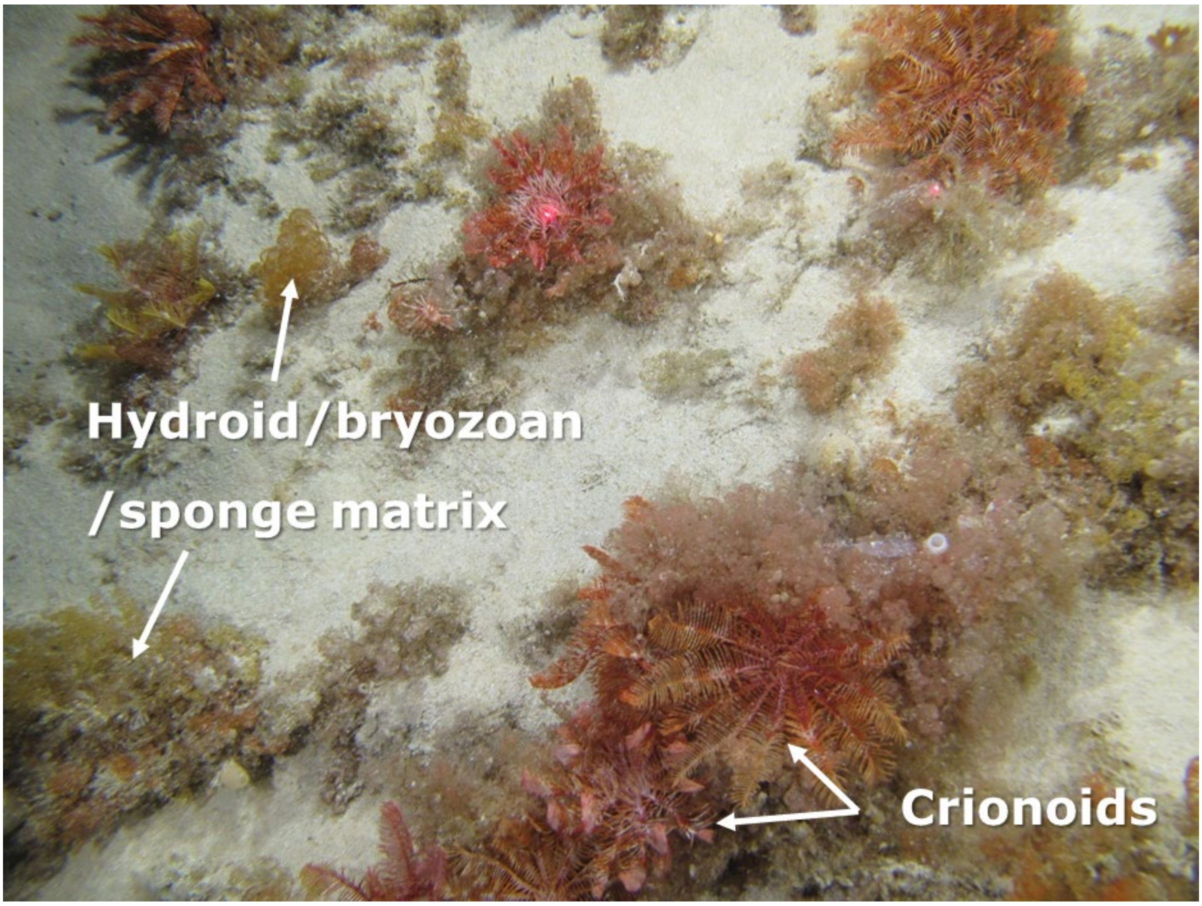

Figure 14 Example of the typical seabed epifauna with high percent cover at Thylacine 1 (TH1).

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

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

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

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

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

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

5. DISCUSSION

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

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

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

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

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

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

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

6. REFERENCES

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

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APPENDIX 1
ENVIRONMENTAL SAMPLE LOGS

SAMPLE MANAGEMENT ROUTINES

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

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

Comments:

SAMPLING LOG

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

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

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

SAMPLING LOG

Project Code: 318000803						**Project Name: Otway Offshore Development**					
Vessel: VOS Shine					**Sampling Team: Irene Middleton**			**Sky/Wind: 20 knots**		**Date: 22/11/2019**	
Location: Artisan					**Sampling Gear: Van Veen Double benthic grab sampler**			**Sea State: 2 m swell**		**Shift: 04:00-20:00**	
Site No.	**Local Time**	**Sample No.**	**Replicate No.**	**Image ID**	**Sample Acceptable?**	**Munsell Colour**	**ORP (mV)**	**Texture / Surface or Vertical Structure**	**Odour (describe)**	**Visual Contamination**	**Organic Fragments /Bioturbation /other Fauna**
AR_GS-1	8:36	1	1	1-5	NO, not enough material	7.5YR 8/4	-	Sand and epibenthos/sponges	None	None	Sponges, bryozoans, ascidians
AR_GS-1	9:12	1	2	-	NO, grab not triggered	-	-	-	-	-	-
AR_GS-1	9:40	1	3	6-10	YES, small sample used for composite sample	10YR 8/4	Not able to be measured for small sample	Sand, some sponge	None	None	Sponge, coral fragments and tubeworms
AR_GS-1	10:05	1	4	11-13	YES, small sample (3 cm deep) used for composite sample	10YR 8/4	176.4 at 2 cm	Sand	None	None	No sponges, just shell
AR_GS-1	10:39	1	5	14-15	NO	-	-	Only some epifauna retained for examination	None	None	Sponges and bryozoans
AR_GS-1	10:56	1	6	16-19	YES, small sample used for composite sediment sample, no infauna sampled	10YR 8/4	176.3 at 1 cm	Sand	None	None	Bryozoans and corals
AR4_GS-3_1	12:25	3	1	-	NO, grab not triggered	-	-	-	-	-	-
AR4_GS-3_2	12:45	3	2	20-21	NO, small sample (3 cm deep) for sediment only. Infauna grab not triggered	10YR 8/4	217.3 at 2 cm	Shelly sand	None	None	-

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

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

SAMPLING LOG

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

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

Comments:

SAMPLING LOG

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

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

Comments:

SAMPLING LOG _REDOX MEASUREMENTS

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

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

ORP Reading Depth (mm)

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

Comments:

APPENDIX 2
WATER QUALITY LABORATORY REPORT

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.

WORLD RECOGNISED ACCREDITATION

Attention: **Dan McClary**

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

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

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

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

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

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

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

eurofins | Environment Testing

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

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

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	**Order No.:**		**Received:**	Dec 4, 2019 10:56 AM
Address:	Suite 3, Level 2, 200 Adelaide Terrace	**Report #:**	690395	**Due:**	Dec 11, 2019
	East Perth	**Phone:**	08 9225 5199	**Priority:**	5 Day
	WA 6004	**Fax:**		**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														
Test Counts	8	8	8	8	8	8	8	8	8	5	8	8	8	8

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

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Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
TRH C10-C14	mg/L	< 0.05			0.05	Pass	
TRH C15-C28	mg/L	< 0.1			0.1	Pass	
TRH C29-C36	mg/L	< 0.1			0.1	Pass	
Method Blank							
BTEX							
Benzene	mg/L	< 0.001			0.001	Pass	
Toluene	mg/L	< 0.001			0.001	Pass	
Ethylbenzene	mg/L	< 0.001			0.001	Pass	
m&p-Xylenes	mg/L	< 0.002			0.002	Pass	
o-Xylene	mg/L	< 0.001			0.001	Pass	
Xylenes - Total	mg/L	< 0.003			0.003	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/L	< 0.01			0.01	Pass	
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
TRH >C10-C16	mg/L	< 0.05			0.05	Pass	
TRH >C16-C34	mg/L	< 0.1			0.1	Pass	
TRH >C34-C40	mg/L	< 0.1			0.1	Pass	
Method Blank							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/L	< 0.001			0.001	Pass	
Acenaphthylene	mg/L	< 0.001			0.001	Pass	
Anthracene	mg/L	< 0.001			0.001	Pass	
Benz(a)anthracene	mg/L	< 0.001			0.001	Pass	
Benzo(a)pyrene	mg/L	< 0.001			0.001	Pass	
Benzo(b&j)fluoranthene	mg/L	< 0.001			0.001	Pass	
Benzo(g.h.i)perylene	mg/L	< 0.001			0.001	Pass	
Benzo(k)fluoranthene	mg/L	< 0.001			0.001	Pass	
Chrysene	mg/L	< 0.001			0.001	Pass	
Dibenz(a.h)anthracene	mg/L	< 0.001			0.001	Pass	
Fluoranthene	mg/L	< 0.001			0.001	Pass	
Fluorene	mg/L	< 0.001			0.001	Pass	
Indeno(1.2.3-cd)pyrene	mg/L	< 0.001			0.001	Pass	
Naphthalene	mg/L	< 0.001			0.001	Pass	
Phenanthrene	mg/L	< 0.001			0.001	Pass	
Pyrene	mg/L	< 0.001			0.001	Pass	
Method Blank							
Ammonia (as N)	mg/L	< 0.01			0.01	Pass	
Nitrate & Nitrite (as N)	mg/L	< 0.05			0.05	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Phosphate total (as P)	mg/L	< 0.01			0.01	Pass	
Phosphorus reactive (as P)	mg/L	< 0.01			0.01	Pass	
Total Kjeldahl Nitrogen (as N)	mg/L	< 0.2			0.2	Pass	
Total Suspended Solids Dried at 103–105°C	mg/L	< 1			1	Pass	
Method Blank							
Heavy Metals							
Arsenic	mg/L	< 0.001			0.001	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	

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

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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	
Benz(a)anthracene	M19-No38324	CP	%	72			70-130	Pass	
Benzo(a)pyrene	M19-No38324	CP	%	82			70-130	Pass	
Benzo(b&j)fluoranthene	M19-No38324	CP	%	79			70-130	Pass	
Benzo(g.h.i)perylene	M19-No38324	CP	%	89			70-130	Pass	
Benzo(k)fluoranthene	M19-No38324	CP	%	113			70-130	Pass	
Chrysene	M19-No38324	CP	%	106			70-130	Pass	
Dibenz(a.h)anthracene	M19-No38324	CP	%	83			70-130	Pass	
Fluoranthene	M19-No38324	CP	%	89			70-130	Pass	
Fluorene	M19-No38324	CP	%	101			70-130	Pass	
Indeno(1.2.3-cd)pyrene	M19-No38324	CP	%	82			70-130	Pass	
Naphthalene	M19-No38324	CP	%	81			70-130	Pass	
Phenanthrene	M19-No38324	CP	%	93			70-130	Pass	
Pyrene	M19-No38324	CP	%	94			70-130	Pass	
Spike - % Recovery									
				Result 1					
Phosphate total (as P)	M19-No38324	CP	%	92			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	M19-No38329	CP	%	95			70-130	Pass	
Cadmium	M19-No38329	CP	%	94			70-130	Pass	
Chromium	M19-No38329	CP	%	87			70-130	Pass	
Cobalt	M19-No38329	CP	%	88			70-130	Pass	
Copper	M19-No38329	CP	%	84			70-130	Pass	
Lead	M19-No38329	CP	%	90			70-130	Pass	
Mercury	M19-No38329	CP	%	80			70-130	Pass	
Nickel	M19-No38329	CP	%	85			70-130	Pass	
Zinc	M19-No38329	CP	%	88			70-130	Pass	

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Environment Testing

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	B19-De02116	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
TRH C10-C14	M19-De05913	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH C15-C28	M19-De05913	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C29-C36	M19-De05913	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
BTEX				Result 1	Result 2	RPD			
Benzene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Toluene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Ethylbenzene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
m&p-Xylenes	B19-De02116	NCP	mg/L	< 0.002	< 0.002	<1	30%	Pass	
o-Xylene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Xylenes - Total	B19-De02116	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
Naphthalene	B19-De02116	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
TRH C6-C10	B19-De02116	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
TRH >C10-C16	M19-De05913	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH >C16-C34	M19-De05913	NCP	mg/L	< 0.1		<1	30%	Pass	
TRH >C34-C40	M19-De05913	NCP	mg/L	< 0.1		<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Ammonia (as N)	B19-De03253	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Chlorophyll a	M19-De06051	NCP	ug/L	28	34	21	30%	Pass	
Nitrate & Nitrite (as N)	B19-De03253	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Nitrate (as N)	B19-De03253	NCP	mg/L	0.04	0.05	34	30%	Fail	Q15
Nitrite (as N)	B19-De03253	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Phosphate total (as P)	M19-De05566	NCP	mg/L	0.91	0.88	4.0	30%	Pass	
Total Kjeldahl Nitrogen (as N)	M19-De03633	NCP	mg/L	79	77	2.8	30%	Pass	
Total Suspended Solids Dried at 103–105°C	M19-De06128	NCP	mg/L	230	230	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M19-No38322	CP	mg/L	0.001	0.001	2.0	30%	Pass	
Cadmium	M19-No38322	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Lead	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Mercury	M19-No38322	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Nickel	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Zinc	M19-No38322	CP	mg/L	0.011	0.012	9.0	30%	Pass	
Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Acenaphthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Acenaphthylene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benz(a)anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(a)pyrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(b&j)fluoranthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(g.h.i)perylene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(k)fluoranthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chrysene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibenz(a.h)anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	

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	

Environment Testing

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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Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

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

Attention: **Dan McClary**

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

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

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

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chlorophyll a	Melbourne	Nov 27, 2019	2 Days

- Method:

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NATA # 1261 Site # 18217

Brisbane
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NATA # 1261 Site # 20794

Perth
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NATA # 1261
Site # 23736

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace 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 | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
External Laboratory																					
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																
1	THYLACINE_GS1_3_MET1	Nov 22, 2019		Soil	M19-No38233	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
2	THYLACINE_GS1_3_MET2	Nov 22, 2019		Soil	M19-No38234	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
3	THYLACINE_GS1_3_PSD1	Nov 22, 2019		Soil	M19-No38235	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
4	THYLACINE_GS1_MET2	Nov 22, 2019		Soil	M19-No38236	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
5	THYLACINE_GS-1_MET1	Nov 22, 2019		Soil	M19-No38237	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
6	THYLACINE_	Nov 22, 2019		Soil	M19-No38238	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

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NATA # 1261
Site # 23736

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**	
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690387
		Phone:	08 9225 5199
		Fax:	
Project Name:	OTWAY OFFSHORE EBS		
Project ID:	318000803		

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

Eurofins Analytical Services Manager : Swati Shahaney

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

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

Eurofins Analytical Services Manager : Swati Shahaney

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

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
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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 | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS3_MET1																				
21	ARTISON-GS3_PAR 4	Nov 22, 2019		Soil	M19-No38253	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
22	ARTISON-GS3_PAR 2	Nov 22, 2019		Soil	M19-No38254	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
23	ARTISON-GS3_MET 2	Nov 22, 2019		Soil	M19-No38255	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
24	ARTISON-GS3_PAR 3	Nov 22, 2019		Soil	M19-No38256	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
25	ARTISON-1	Nov 22, 2019		Filter paper	M19-No38257					X											
26	ARTISON-5	Nov 22, 2019		Filter paper	M19-No38258					X											
27	ARTISON-2	Nov 22, 2019		Filter paper	M19-No38259					X											
28	THYLACINE GS1_3	Nov 22, 2019		Filter paper	M19-No38260					X											

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Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
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		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 | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
29	THYLACINE GS1_1	Nov 22, 2019		Filter paper	M19-No38261					X											
30	THYLACINE GS1_2	Nov 22, 2019		Filter paper	M19-No38262					X											
Test Counts						24	24	24	24	6	24	24	24	24	24	24	24	24	24	24	24

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

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

Glenn Jackson

General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

APPENDIX 3
SEDIMENT QUALITY LABORATORY REPORT

eurofins

Environment Testing

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

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

Attention: **Dan McClary**

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

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

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

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

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

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

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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 | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
External Laboratory																					
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																
1	THYLACINE_ GS1_3_MET1	Nov 22, 2019		Soil	M19-No38233	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
2	THYLACINE_ GS1_3_MET2	Nov 22, 2019		Soil	M19-No38234	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
3	THYLACINE_ GS1_3_PSD1	Nov 22, 2019		Soil	M19-No38235	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
4	THYLACINE_ GS1_MET2	Nov 22, 2019		Soil	M19-No38236	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
5	THYLACINE_ GS-1_MET1	Nov 22, 2019		Soil	M19-No38237	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
6	THYLACINE_	Nov 22, 2019		Soil	M19-No38238	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

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		Fax:	
Project Name:	OTWAY OFFSHORE EBS	**Received:**	Dec 4, 2019 1:54 PM
Project ID:	318000803	**Due:**	Dec 5, 2019
		Priority:	7 Day
		Contact Name:	ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS-1_PSD1																				
7	THYLACINE_ GS1-2_PSD1	Nov 22, 2019		Soil	M19-No38239	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
8	THYLACINE_ GS1-2_MET1	Nov 22, 2019		Soil	M19-No38240	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
9	THYLACINE_ GS1-2_MET2	Nov 22, 2019		Soil	M19-No38241	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
10	THYLACINE_ GS2_PSD1	Nov 22, 2019		Soil	M19-No38242	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
11	THYLACINE_ GS2_MET1	Nov 22, 2019		Soil	M19-No38243	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
12	THYLACINE_ GS2_MET2	Nov 22, 2019		Soil	M19-No38244	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
13	ARTISON-	Nov 22, 2019		Soil	M19-No38245	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

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Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

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

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Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

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

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

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Quality Control Results

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

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38238	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38238	CP	mg/kg	5.7	5.8	1.0	30%	Pass	
Copper	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38238	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38238	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38239	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38239	CP	mg/kg	5.2	5.5	6.0	30%	Pass	
Copper	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38239	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38239	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38248	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38248	CP	mg/kg	6.9	6.8	1.0	30%	Pass	
Copper	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38248	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38248	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38248	CP	mg/kg	< 5	6.3	54	30%	Fail	Q15
Duplicate									
				Result 1	Result 2	RPD			
Total Organic Carbon	M19-No38249	CP	%	< 0.1	< 0.1	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q15	The RPD reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

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

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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.

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WA 6004

Attention: **Serena Orr**

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

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

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

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

Client Sample ID			THYLACINE_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
Dibutylchlorendate (surr.)	1	%	139	112	105	64
Tetrachloro-m-xylene (surr.)	1	%	80	90	86	75
% Moisture	1	%	37	35	33	35

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Environment Testing

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

Environment Testing

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

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Feb 05, 2020	
- Method: LTM-ORG-2010 TRH C6-C40			
BTEX	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Polycyclic Aromatic Hydrocarbons	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2130 PAH and Phenols in Soil and Water			
Polychlorinated Biphenyls	Melbourne	Feb 05, 2020	28 Days
- Method: LTM-ORG-2220 OCP & PCB in Soil and Water (USEPA 8082)			
% Moisture	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-GEN-7080 Moisture			

Australia

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

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

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

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

New Zealand

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

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

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

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

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

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

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail						Polycyclic Aromatic Hydrocarbons	Polychlorinated Biphenyls	BTEX	Moisture Set	Total Recoverable Hydrocarbons
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X
Sydney Laboratory - NATA Site # 18217										
Brisbane Laboratory - NATA Site # 20794										
Perth Laboratory - NATA Site # 23736										
External Laboratory										
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**					
1	THYLACINE_GS1_3_MET1	Nov 22, 2019		Soil	M20-Fe05003	X	X	X	X	X
2	THYLACINE_GS1_3_MET2	Nov 22, 2019		Soil	M20-Fe05004	X	X	X	X	X
3	THYLACINE_GS1_MET2	Nov 22, 2019		Soil	M20-Fe05005	X	X	X	X	X
4	THYLACINE_GS-1_MET1	Nov 22, 2019		Soil	M20-Fe05006	X	X	X	X	X
5	THYLACINE_GS1-2_MET1	Nov 22, 2019		Soil	M20-Fe05007	X	X	X	X	X
6	THYLACINE_GS1-2_MET2	Nov 22, 2019		Soil	M20-Fe05008	X	X	X	X	X

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

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail						Polycyclic Aromatic Hydrocarbons	Polychlorinated Biphenyls	BTEX	Moisture Set	Total Recoverable Hydrocarbons
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X
Sydney Laboratory - NATA Site # 18217										
Brisbane Laboratory - NATA Site # 20794										
Perth Laboratory - NATA Site # 23736										
7	THYLACINE_GS2_MET1	Nov 22, 2019		Soil	M20-Fe05009	X	X	X	X	X
8	THYLACINE_GS2_MET2	Nov 22, 2019		Soil	M20-Fe05010	X	X	X	X	X
9	ARTISON-GSA_MET1	Nov 22, 2019		Soil	M20-Fe05011	X	X	X	X	X
10	ARTISON-GSA_MET2	Nov 22, 2019		Soil	M20-Fe05012	X	X	X	X	X
11	ARTISON-GS3_MET1	Nov 22, 2019		Soil	M20-Fe05013	X	X	X	X	X
12	ARTISON-GS3_MET 2	Nov 22, 2019		Soil	M20-Fe05014	X	X	X	X	X
Test Counts						12	12	12	12	12

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Eurofins Environment Testing

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	Lab Sample ID	QA Source	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.

APPENDIX 4
DROP CAMERA SITES (GDA94 UTM 54 S)

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

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

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

APPENDIX 5
SEABED PHOTOGRAPH ASSESSMENT DATA

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

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

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

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

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

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

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

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

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

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

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

APPENDIX 6
EXAMPLE SEABED PHOTOGRAPHS


Artisan – AR4


Artisan – AR4


Geographe – GE2


Geographe – GE4


Hercules – HE1


Hercules – HE3


La Bella – LB2

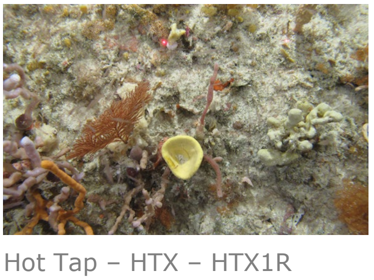

La Bella – LB4 Extra DC

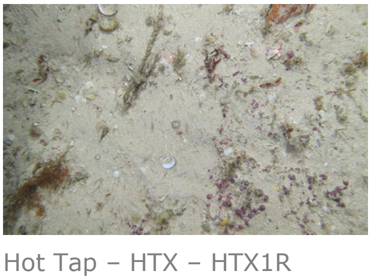

Thylacine – TH2


Thylacine – TH4


Thylacine – TH6


Thylacine – TH8


Hot Tap – HTX – HTX1R


Hot Tap – HTX – HTX1R


Hot Tap – HTY – HTY1R


Hot Tap – HTY – HTY1R


Routes – ARGE – ARGE3R


Routes – ARGE – ARGE6R


Routes – ARGE – ARGE7R


Routes – ARHTX – ARHTX1R

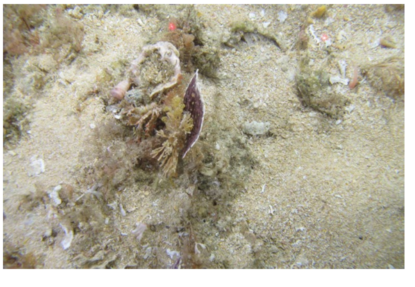

Routes – ARHTX – ARHTX1R


Routes – ARHTY – ARHTY1R


Routes – ARHTY – ARHTY1R


Routes – ARLB – ARLB2R


Routes – ARLB – ARLB6R


Routes – LBGE – LBGE3R


Routes – LBGE – LBGE6R

Appendix F Acoustic Modelling Report

Unit 1, 14 Hook Street
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TECHNICAL ADDENDUM

DATE: 23 July 2021

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

TO: Phil Wemyss (Beach Energy)

SUBJECT: Beach Otway Project: Additional and Revised Modelling Study

1. Summary

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

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

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

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

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

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

Scenario number	Well Area	Description	R_{max} (km)	$R_{95\%}$ (km)
A1	Thylacine North-1	MODU Drilling	1.24	1.12
A2		OSV under DP	7.1	6.5
A3		OSV Standby Transit	0.38	0.35
A4	Thylacine A	Platform Operations	0.20	0.19
A5	Thylacine North-1	MODU Drilling + OSV resupply	7.89	6.56
A7		MODU Drilling + OSV Standby Transit	1.32	1.19
1	Thylacine A	Platform Operations + OSV resupply	7.28	6.56
5		Platform Operations + OSV Standby	0.45	0.43
7	Thylacine North-1	Pipelay Vessel stationary (June), operating at 20% MCR	2.71	2.57
8		Pipelay Vessel stationary (November), operating at 20% MCR	2.70	2.55
11	Artisan-1	Pipelay Vessel stationary (June), operating at 20% MCR	2.27	2.09
12		Pipelay Vessel stationary (November), operating at 20% MCR	2.26	2.02
15	Thylacine North-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	2.98	2.76
16		Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	2.97	2.73
17	Artisan-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	2.98	2.75
18		Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	2.97	2.72
19	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + OSV resupply	7.90	6.65
21		MODU Drilling + Platform + Skid installation	4.85	4.29

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

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

2. Introduction

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

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

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

2.1. Validation Monitoring Study Summary

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

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

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

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

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

Source Levels

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

- The support vessels are quieter than estimated when they are under slow transit speeds, such as 7 knots.
- The support vessels are louder than estimated when they are travelling at faster transit speeds, with 9 knots used to represent these speeds and the associated MSL.
- The support vessels are louder than estimated when holding station or moving under dynamic positioning.
- The drilling operations of the *Ocean Onyx* are both louder at some frequencies and quieter at others than those for the proxy rig the *Polar Pioneer* (Austin et al. 2018), although the results presented for the *Polar*

Pioneer did not examine the changes in level with increased drilling depth (over time) as completed within this study.

Comparison of Results

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

Geological Environment Representation

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

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

Propagation Loss

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

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

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

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

2.2. Scenario Details

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

1. Otway Offshore Project Development Drilling Campaign, Thylacine North-1 Operations:
    a. Mobile Offshore Drilling Unit (MODU) conducting normal drilling operations
    b. MODU with Offshore Supply Vessel (OSV) in attendance, standing by and conducting resupply operations under Dynamic Positioning (DP)
2. Otway Offshore Project Operations scenarios:
    1. Operations of the Thylacine platform (at Thylacine-A)
    2. OSV vessel resupply at Thylacine platform for periods of 2, 4, 6 and 8 hrs.
    3. OSV vessel on standby at Thylacine platform for periods of 8 and 24 hrs
4. Otway Offshore Project Construction scenarios: A single nominated pipelay/construction vessel, the Skandi Singapore, was considered for these scenarios. Each scenario was considered with a sound speed profiles for the 'worst case over the year' and for the period pygmy blue whales are present in the region, between November and January:
    a. Pipelay vessel (PLV) both stationary and laying pipe at Thylacine North-1 and Artisan-1 operating at 20% of its Maximum Continuous Rating (MCR).
    b. Pipelay vessel operating a Remotely Operated Vehicle (ROV) and cutting tool at Geographe-4. The vessel at Geographe-4 was also modelled operating at 20% of its Maximum Continuous Rating (MCR).
    c. Quantitively assess the combined sound levels of drilling activities and the construction vessel(s) at the emerging SRW aggregation area at Port Campbell. This scenario considered the drilling activities at Thylacine North-1 presented in Koessler et al. (2020) and the nominated construction vessel (Skandi Singapore) operating at Geographe-4.
5. Simultaneous assessment for drilling, operations and construction operations were considered for key scenarios:
    a. Drilling at Thylacine while doing Thylacine platform resupply
    b. Drilling at Thylacine while doing installation of Thylacine skid near Thylacine platform.

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

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

Scenario number	Well Name	Description	SSP Month	Modelled sites
17	Artisan-1 + Geographe-4	Pipelay Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	June	7,8,9
18	Artisan-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Pipelay Vessel -1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	November	7,8,9
19	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + 4h OSV resupply	June	1,4,5
20		MODU Drilling + Platform + 8h OSV resupply	June	1,4,5
21		MODU Drilling + Platform + Skid installation	June	1,4,6
22	Thylacine North-1 + Geographe-4	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	June	1,2,3,8,9

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

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

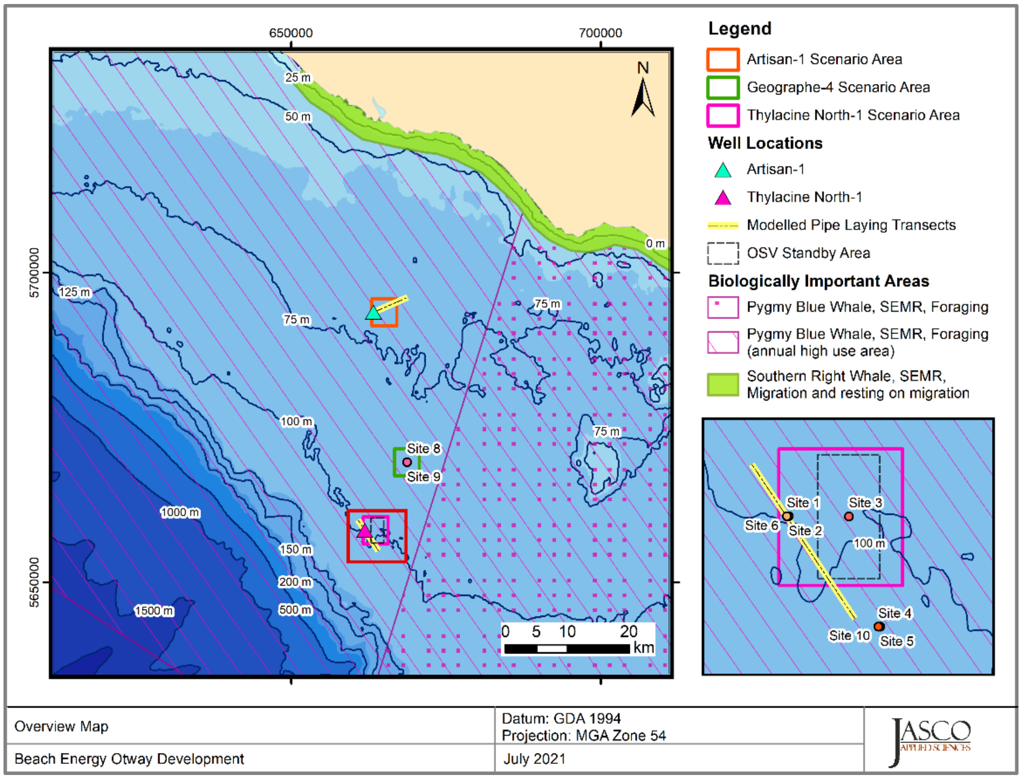

Figure 1. Overview of the modelled area (focus on Thylacine North-1 Scenario Area) and local features within the South East Marine Region (SEMR).

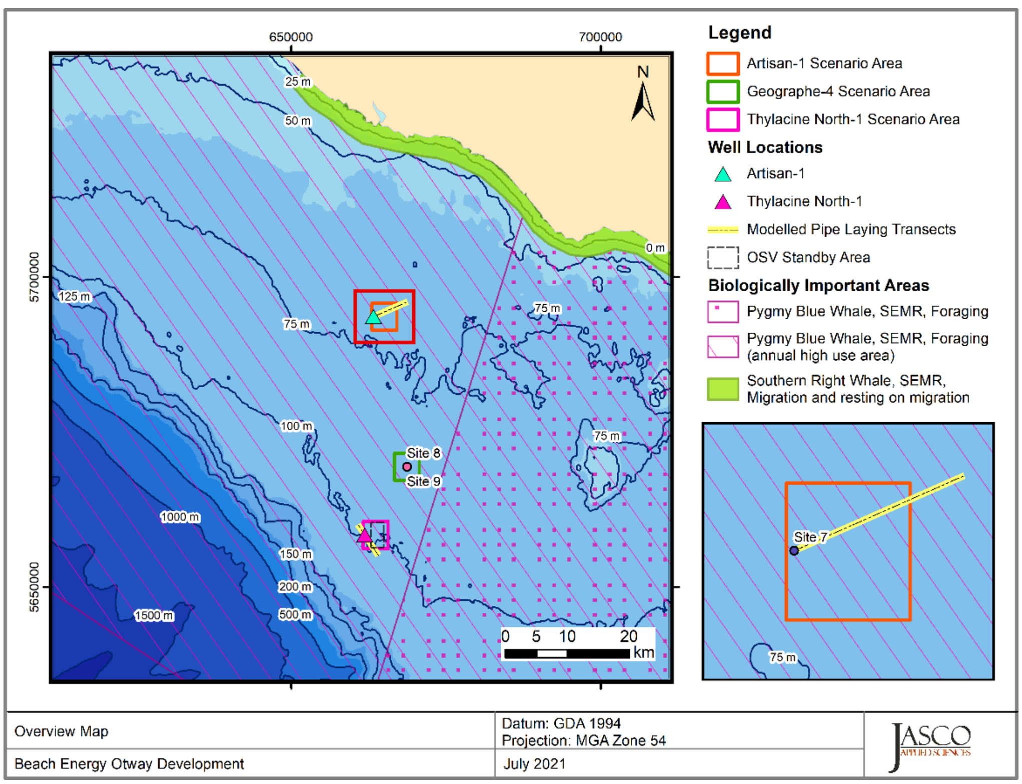

Figure 2. Overview of the modelled area (focus on Artisan-1 Scenario Area) and local features within the South East Marine Region (SEMR).

3. Methods and Parameters

A details description of the employed modelling method and input parameters can be found in refer to Koessler et al. (2020), Matthews et al. (2020), Matthews et al. (2021), Connell et al. (2021) and McPherson et al. (2021). A brief a summary of key elements used in this addendum are provided as follows.

The measured monopole source levels (MSLs) and spectra for the MODU and OSV were used here from McPherson et al. (2021):

- For the MODU drilling, mean levels from Section 5.5.1 in McPherson et al. (2021) were used.
- For scenarios where the OSV was under dynamic positioning (DP) the average spectrum from Section 5.5.2 in McPherson et al. (2021) was used.
- For scenarios where the OSV was transiting or standing by the average slow transit (7 knots) spectrum in McPherson et al. (2021) was used.

For the construction phase scenarios, estimates of the energy source levels (ESLs) for the pipelay/construction vessel were based on the specifications of the *Skandi Singapore* and a ESL derived from recordings of the TechnipFMC flexible lay and construction vessel *Deep Orient*. The specifications of proxy vessel and details on scaling can be found in Matthews et al. (2020), Matthews et al. (2021) and Connell et al. (2021).

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

A study involving the Endeavour Jack-up Rig, operating in Cook Inlet, was conducted by Illingworth and Rodkin (2014) during drilling activities. The results from the sound source verification indicated that sound generated from drilling or generators were below ambient sound levels. The generators used on the Endeavour are mounted on pedestals specifically to reduce sound transfer through the infrastructure, and they are enclosed in an insulated engine room, which may have reduced further underwater sound transmission to levels below those generated by the Spartan 151. The sound source verification revealed that the submersed deep-well pumps that charge the fire-suppression system and cool the generators (in a closed water system) were the most likely dominant contributor the sound field. The measurements are reported as near-source levels recorded close to the bow leg pump system (at 10 m range) (Figure 3-5 in Illingworth and Rodkin Inc. (2014). These were backpropagated using spherical spreading to determine an energy source level (ESL) spectrum. Considering the similarities between a Jack-up Rig and a static WHP the decidecade band spectrum is shown in Figure 3 was used in modelling noise emissions from the Thylacine-A platform.

Furthermore, as discussed by (McPherson et al. 2021) and discussed above in Section 2.1, significant rates of propagation loss were found when analysing the data from the measurement study. As part of the model-measurement validation an adjustment factor was applied broadband received level predictions to account for the loss associated with a cemented limestone seabed (calcarenite) (Section 6.2 in McPherson et al. (2021)). A similar adjustment, which only differed by accounting for sources in different water depths, was applied to broadband level predictions in this addendum as a very similar type of seabed environment is expected at the Thylacine scenario area

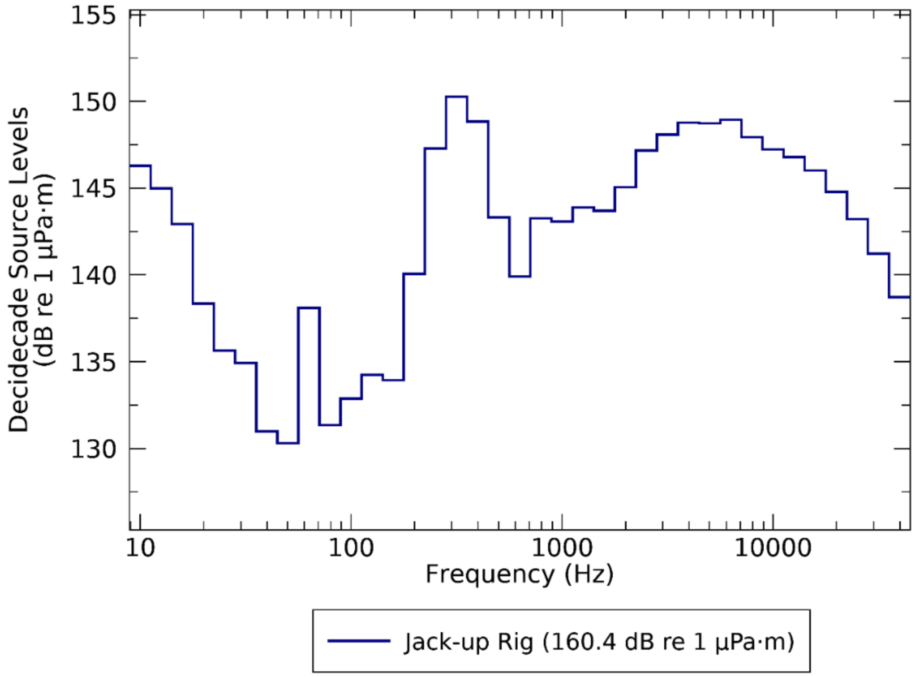

Figure 3. Energy source level (ESL) spectra (in decidecade frequency-band) for the Jack-up Rig considered as a proxy source for the Thylacine WHP.

4. Results

For the considered scenarios (described in Section 2.2), the maximum-over-depth sound fields for the modelled scenarios are presented below in two formats: as tables of distances to sound levels and, where the distances are long enough, as contour maps showing the directivity and distance to various sound levels. Distances to isopleths/thresholds were reported from either the centroid of several sources or from the most dominant single source. When an isopleth completely envelopes multiple sources the centroid was used. When several closed isopleths exist the most dominant source was used.

Tables 5–7 present the maximum and 95% distances (defined in Appendix B.1) to SPL isopleths. Since the SPL metric does not depend on the duration of the operation, these estimates are valid for both, stationary and non-stationary scenarios. Tables 9–14 present the distances to frequency-weighted SEL_{24h} threshold, as well as the total ensonified area for all scenarios.

The maximum-over-depth sound fields for nine scenarios (described in Section were extracted at the emerging SRW aggregation area at Port Campbell, and can be compared to the 120 dB re 1 µPa threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

4.1. Tabulated Results

Table 5. *Scenarios A1–A7:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenarioA dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, DP: Dynamic Positioning.

SPL (L_p; dB re 1 µPa)	MODU Drilling (Scenario A1)		OSV under DP (Scenario A2)		OSV Standby Transit (Scenario A3)		Platform (Scenario A4)		MODU Drilling and OSV Resupply (Scenario A5)		MODU Drilling and OSV Standby (Scenario A7)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	0.05	0.05	–	–
170[A]	–	–	–	–	–	–	–	–	0.05	0.05	–	–
160	–	–	0.08	0.08	–	–	–	–	0.11	0.10	–	–
158[B]	–	–	0.13	0.12	–	–	–	–	0.15	0.15	–	–
150	–	–	0.32	0.31	–	–	–	–	0.36	0.31	–	–
140	0.09	0.09	0.87	0.81	–	–	–	–	0.88	0.82	0.09	0.09
130	0.38	0.35	2.3	2.15	0.17	0.16	–	–	2.51	2.18	0.38	0.35
120[C]	1.24	1.12	7.10	6.50	0.38	0.35	0.20	0.19	7.89	6.56	1.32	1.19
110	3.90	3.53	21.1	17.6	1.03	0.97	0.57	0.54	21.1	17.8	4.96	4.45

[A] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[B] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 6. *Scenarios 1–11:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). OSV: Offshore Supply Vessel, PLV: Pipelay Vessel.

SPL (L_p; dB re 1 µPa)	Platform and OSV resupply (Scenario 1)		Platform and OSV standby (Scenario 5)		PLV stationary, Thylacine				PLV stationary, Artisan			
					June (Scenario 7)		November (Scenario 8)		June (Scenario 11)		November (Scenario 12)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–	–	–	–	–
160	0.08	0.08	–	–	–	–	–	–	–	–	–	–
158[B]	0.14	0.09	–	–	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
150	0.28	0.27	–	–	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
140	0.85	0.80	–	–	0.33	0.32	0.33	0.32	0.29	0.29	0.29	0.29
130	2.48	2.18	0.17	0.16	0.95	0.85	0.94	0.84	0.87	0.80	0.87	0.80
120[C]	7.31	6.56	0.45	0.43	2.71	2.57	2.70	2.55	2.27	2.09	2.26	2.02
110	21.2	17.6	1.02	0.98	8.29	6.72	8.29	6.55	4.95	4.67	4.91	4.65

[A] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[B] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 7. *Scenarios 15–21:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

SPL (L_p; dB re 1 µPa)	PLV stationary, at Thylacine and ROV Operations at Geographe-4				PLV stationary, at Artisan and ROV Operations at Geographe-4				MODU Drilling, Platform and OSV resupply		MODU Drilling, Platform and Skid Installation	
	June (Scenario 15)		November (Scenario 16)		June (Scenario 17)		November (Scenario 18)		(Scenario 19)		(Scenario 21)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–	–	–	–	–
160	–	–	–	–	–	–	–	–	0.08	0.08	–	–
158[B]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.14	0.09	0.04	0.04
150	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.28	0.27	0.09	0.09
140	0.32	0.31	0.32	0.31	0.32	0.31	0.32	0.31	0.85	0.80	0.31	0.30
130	0.91	0.86	0.91	0.84	0.91	0.86	0.91	0.84	2.48	2.18	0.85	0.83
120[C]	2.98	2.76	2.97	2.73	2.98	2.75	2.97	2.72	7.90	6.65	4.85	4.29
110	11.3	8.64	11.3	8.70	7.14	6.14	7.11	6.01	21.2	17.7	9.42	7.80

A 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
B 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
C Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 8. Received SPL at the Port Campbell SRW receiver for relevant scenarios.

Scenario	Description	Location(s)	SPL (Lp; dB re 1 µPa) at Port Campbell SRW Receiver
22	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	Thylacine North-1 + Geographe-4	93.8

Table 9. *Scenarios A1-A7:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	MODU Drilling (Scenario A1)		OSV under DP (Scenario A2)		OSV Standby Transit (Scenario A3)		Platform (Scenario A4)		MODU Drilling and 4h OSV resupply (Scenario A5)		MODU Drilling and 8h OSV resupply (Scenario A6)		MODU Drilling and OSV Standby Transit (Scenario A7)	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS															
LF cetaceans	199	0.03	0.004	0.09	0.03	–	–	0.02	0.001	0.12	0.03	0.18	0.08	0.06	0.004
MF cetaceans	198	0.02	0.001	0.02	0.001	–	–	0.02	0.001	0.05	0.002	0.05	0.002	0.04	0.001
HF cetaceans	173	0.23	0.16	0.06	0.01	–	–	0.03	0.004	0.26	0.16	0.26	0.17	0.26	0.16
Phocid seals	201	0.02	0.001	0.03	0.003	–	–	0.02	0.001	0.05	0.004	0.07	0.01	0.04	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	0.03	0.001	0.05	0.001	–	–
Turtles	220	–	–	0.02	0.001	–	–	–	–	0.05	0.002	0.05	0.002	–	–
TTS															
LF cetaceans	179	0.39	0.33	0.95	2.33	–	–	0.04	0.004	1.06	2.49	1.31	4.39	0.39	0.33
MF cetaceans	178	0.13	0.06	0.06	0.01	–	–	0.03	0.003	0.16	0.06	0.16	0.07	0.13	0.06
HF cetaceans	153	1.12	3.22	0.47	0.69	–	–	0.30	0.28	1.16	3.71	1.16	3.99	1.12	3.22
Phocid seals	181	0.12	0.04	0.28	0.24	–	–	0.03	0.00	0.32	0.27	0.46	0.55	0.12	0.04
Otariid seals	199	0.02	0.001	0.04	0.01	–	–	0.02	0.001	0.07	0.01	0.09	0.01	0.02	0.001
Turtles	200	0.02	0.002	0.07	0.02	–	–	0.02	0.001	0.10	0.02	0.16	0.06	0.02	0.002

Table 10. *Scenarios 1–6:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), OSV: Offshore Supply Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	Platform and OSV resupply 2 h (Scenario 1)		Platform and OSV resupply 4 h (Scenario 2)		Platform and OSV resupply 6 h (Scenario 3)		Platform and OSV resupply 8 h (Scenario 4)		Platform and OSV 8h standby (Scenario 5)		Platform and OSV 24h standby (Scenario 6)	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS													
LF cetaceans	199	0.10	0.02	0.12	0.03	0.14	0.04	0.18	0.07	0.02	0.001	0.02	0.001
MF cetaceans	198	0.05	0.001	0.05	0.001	0.05	0.002	0.05	0.002	0.02	0.001	0.02	0.001
HF cetaceans	173	0.08	0.01	0.09	0.02	0.10	0.02	0.11	0.02	0.03	0.004	0.03	0.004
Phocid seals	201	0.05	0.002	0.06	0.004	0.06	0.01	0.08	0.01	0.02	0.001	0.02	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	0.04	0.001	0.04	0.001	–	–	–	–
TTS													
LF cetaceans	179	0.75	1.31	0.95	2.30	1.11	3.15	1.25	4.01	0.04	0.004	0.04	0.004
MF cetaceans	178	0.06	0.01	0.08	0.01	0.09	0.02	0.10	0.02	0.03	0.003	0.03	0.003
HF cetaceans	153	0.45	0.60	0.52	0.79	0.60	1.05	0.63	1.17	0.30	0.28	0.30	0.28
Phocid seals	181	0.23	0.12	0.30	0.24	0.37	0.36	0.43	0.46	0.03	0.00	0.03	0.00
Otariid seals	199	0.06	0.004	0.07	0.01	0.08	0.01	0.08	0.01	0.02	0.001	0.02	0.001
Turtles	200	0.08	0.01	0.10	0.02	0.11	0.02	0.17	0.04	0.02	0.001	0.02	0.001

Table 11. *Scenarios 7–10:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary, at Thylacine				PLV laying pipe, at Thylacine			
		June (Scenario 7)		November (Scenario 8)		June (Scenario 9)		November (Scenario 10)	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.02	0.21	0.02	0.21
MF cetaceans	198	0.02	0.001	0.02	0.001	0.01	0.02	0.01	0.02
HF cetaceans	173	0.09	0.03	0.09	0.03	0.03	0.37	0.03	0.36
Phocid seals	201	0.02	0.001	0.02	0.001	0.01	0.14	0.01	0.14
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	0.02	0.001	0.02	0.001	–	–	–	–
TTS									
LF cetaceans	179	0.60	1.04	0.59	1.04	1.18	13.62	1.17	13.53
MF cetaceans	178	0.07	0.02	0.07	0.02	0.02	0.22	0.02	0.22
HF cetaceans	153	0.84	2.02	0.70	1.36	1.19	15.04	1.46	16.02
Phocid seals	181	0.19	0.12	0.19	0.12	0.13	1.54	0.13	1.54
Otariid seals	199	0.02	0.001	0.02	0.001	0.01	0.15	0.01	0.15
Turtles	200	0.08	0.02	0.08	0.02	0.02	0.27	0.02	0.27

Table 12. *Scenarios 11–14:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary, at Artisan				PLV laying pipe, at Artisan			
		June (Scenario 11)		November (Scenario 12)		June (Scenario 13)		November (Scenario 14)	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.02	0.25	0.02	0.25
MF cetaceans	198	0.01	0.001	0.01	0.001	–	–	–	–
HF cetaceans	173	0.09	0.03	0.09	0.03	0.03	0.37	0.03	0.37
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.13	0.02	0.13
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	0.01	0.001	0.01	0.001	–	–	–	–
TTS									
LF cetaceans	179	0.67	1.14	0.67	1.12	0.90	10.76	0.90	10.69
MF cetaceans	178	0.07	0.02	0.07	0.02	0.03	0.30	0.03	0.30
HF cetaceans	153	0.77	1.60	0.62	1.18	0.95	11.92	0.91	10.68
Phocid seals	181	0.19	0.11	0.19	0.11	0.12	1.36	0.12	1.36
Otariid seals	199	0.02	0.001	0.02	0.001	0.02	0.22	0.02	0.22
Turtles	200	0.07	0.02	0.07	0.02	0.03	0.29	0.03	0.29

Table 13. *Scenarios 15–18:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†	PLV stationary, at Thylacine and ROV Operations at Geographe-4				PLV stationary, at Artisan and ROV Operations at Geographe-4			
		June (Scenario 15)		November (Scenario 16)		June (Scenario 17)		November (Scenario 18)	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.06	0.01	0.06	0.01
MF cetaceans	198	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
HF cetaceans	173	0.12	0.04	0.11	0.04	0.12	0.04	0.11	0.04
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
Otariid seals	219	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001
Turtles	220	0.02	0.001	0.02	0.001	0.01	0.001	0.01	0.001
TTS									
LF cetaceans	179	0.66	1.35	0.66	1.34	0.67	1.35	0.67	1.33
MF cetaceans	178	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03
HF cetaceans	153	0.87	2.37	0.83	1.93	0.87	2.37	0.83	1.93
Phocid seals	181	0.19	0.12	0.19	0.12	0.19	0.11	0.19	0.11
Otariid seals	199	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
Turtles	200	0.08	0.02	0.08	0.02	0.08	0.02	0.08	0.02

Table 14. *Scenarios 19–21:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel.

Hearing group	**SEL_{24h} threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**MODU Drilling, Platform and 4 h OSV resupply (Scenario 19)**		**MODU Drilling, Platform and 8 h OSV resupply (Scenario 20)**		**MODU Drilling, Platform and Skid Installation (Scenario 21)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS							
LF cetaceans	199	0.09	0.03	0.15	0.07	0.06	0.01
MF cetaceans	198	0.04	0.001	0.04	0.001	0.04	0.001
HF cetaceans	173	0.26	0.16	0.26	0.16	0.26	0.16
Phocid seals	201	0.04	0.004	0.05	0.008	0.04	0.001
Otariid seals	219	–	–	–	–	–	–
Turtles	220	–	–	0.03	0.001	0.03	0.001
TTS							
LF cetaceans	179	0.95	2.31	1.23	4.03	0.65	1.10
MF cetaceans	178	0.16	0.06	0.16	0.06	0.16	0.06
HF cetaceans	153	1.15	3.25	1.15	3.26	1.15	3.26
Phocid seals	181	0.28	0.24	0.41	0.46	0.18	0.09
Otariid seals	199	0.04	0.005	0.06	0.011	0.04	0.001
Turtles	200	0.08	0.02	0.15	0.04	0.08	0.02

4.2. Sound Field Maps

4.2.1. SPL Maps

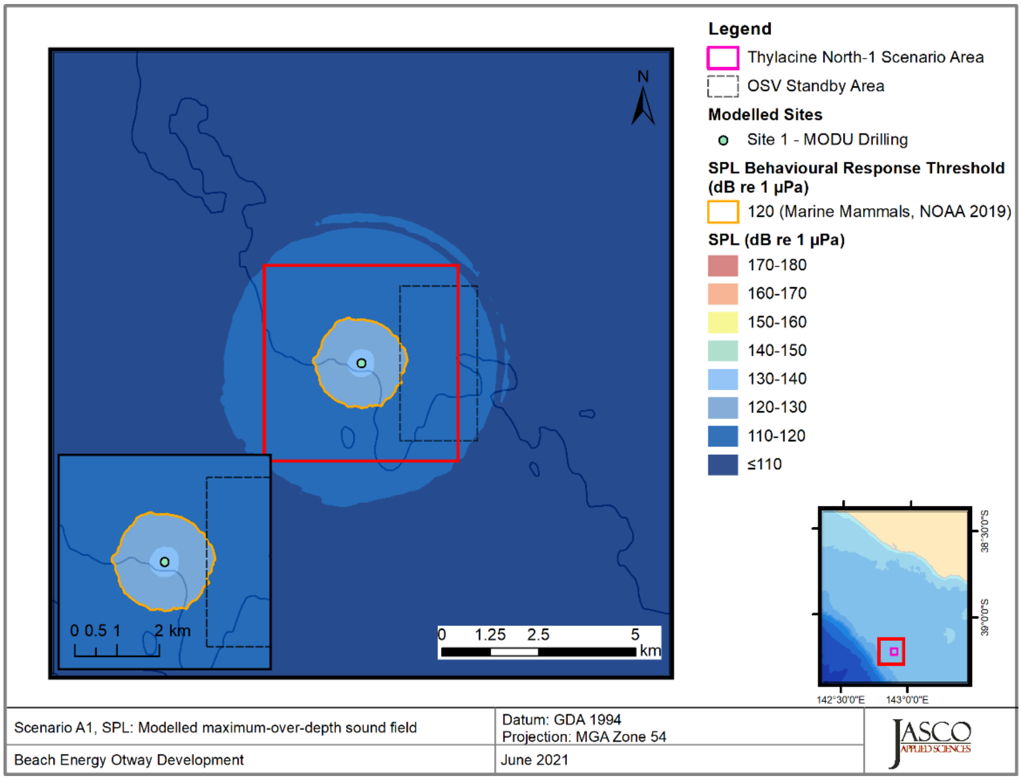

Figure 4. *Thylacine North-1, MODU Drilling (Scenario A1) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

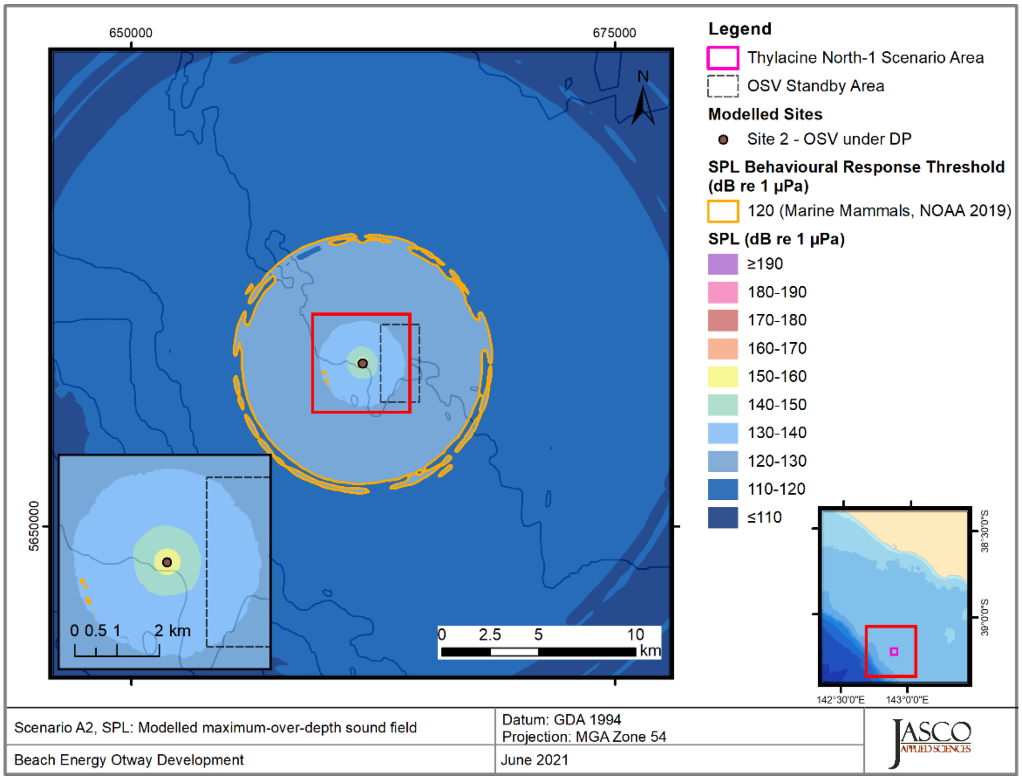

Figure 5. *Thylacine North-1, OSV on DP (Scenario A2) :* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

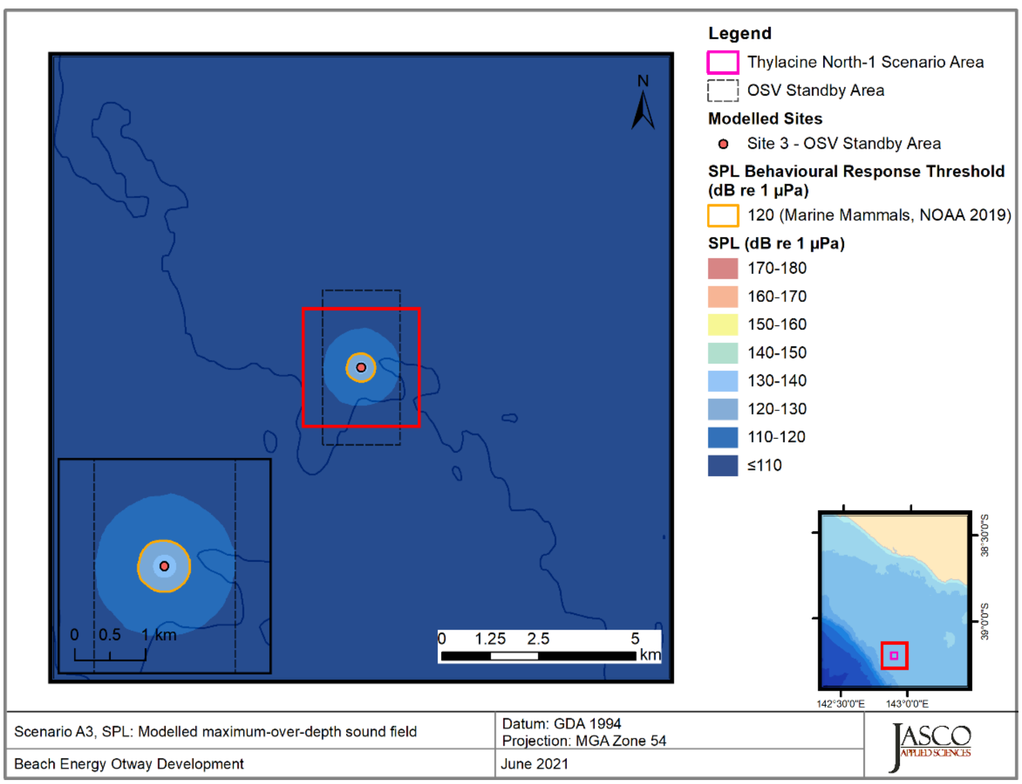

Figure 6. *Thylacine North-1, OSV Standby (Scenario A3) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

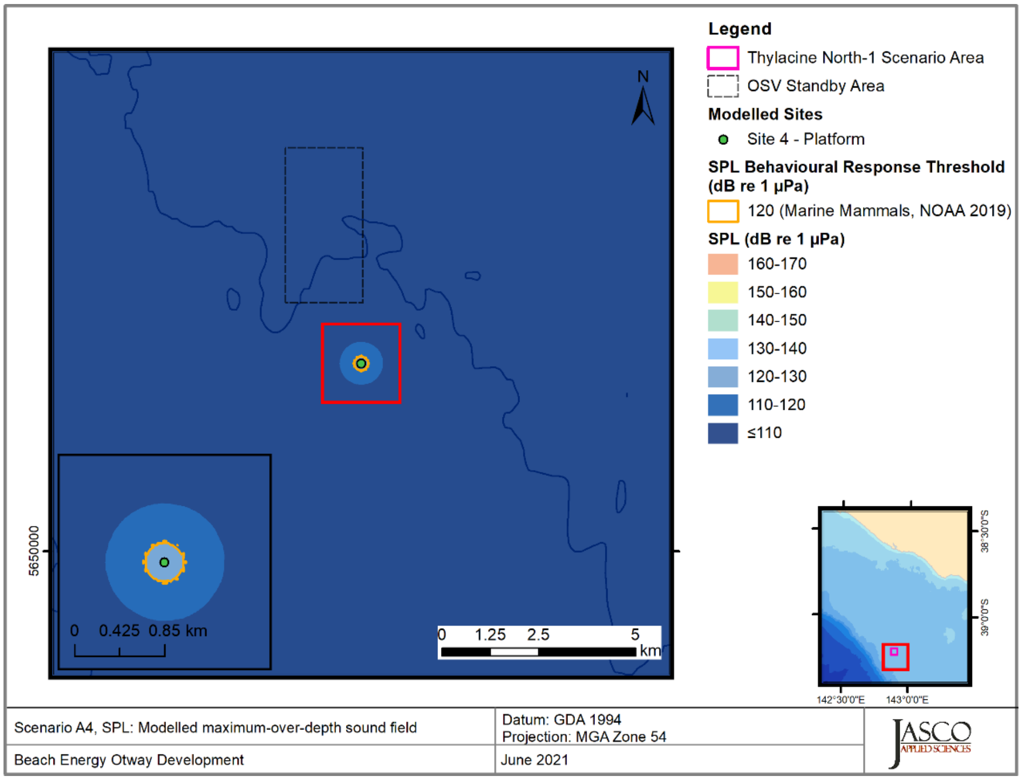

Figure 7. *Thylacine A, Platform Operations (Scenario A4) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

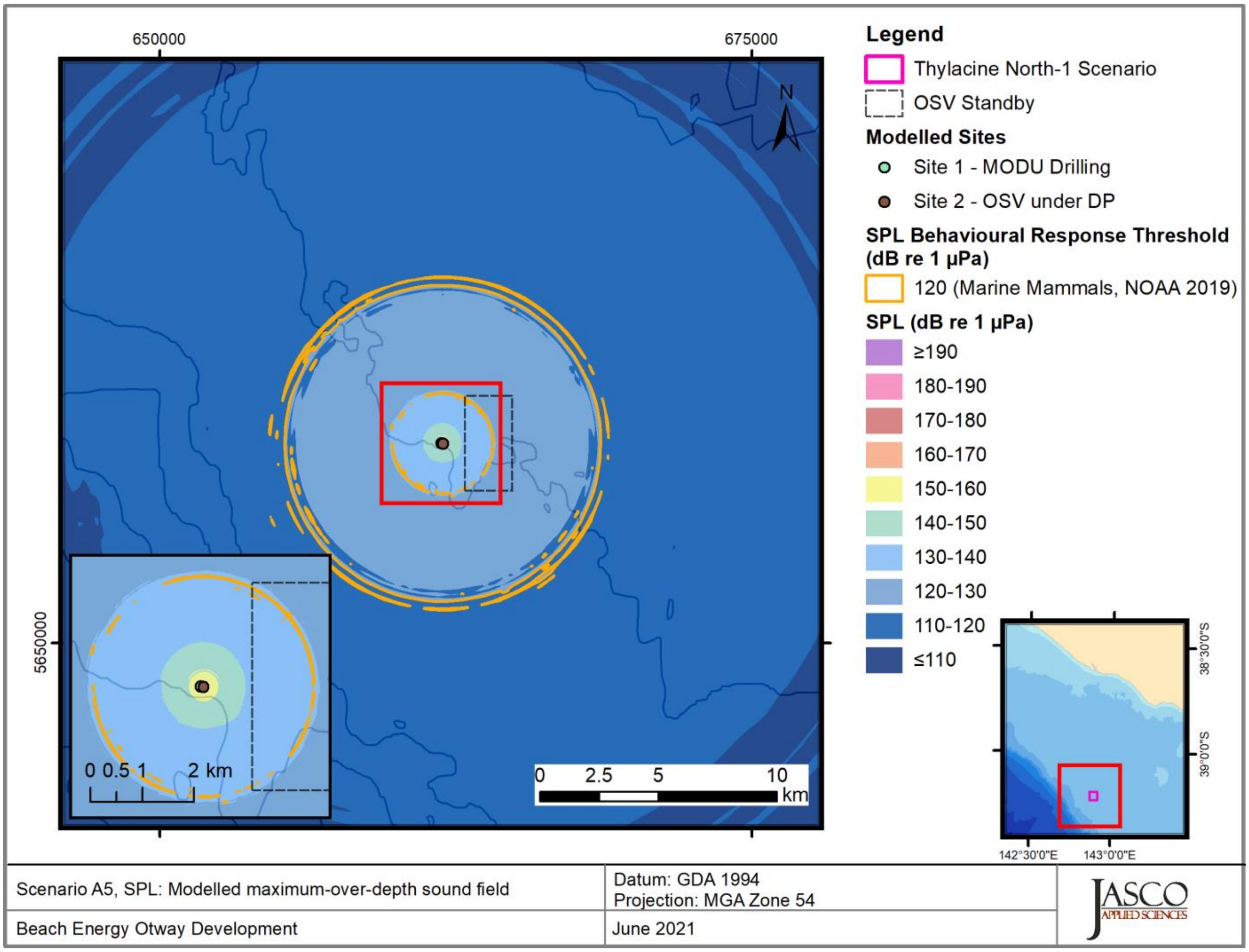

Figure 8. *Thylacine North-1, MODU Drilling and OSV Resupply (Scenario A5) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

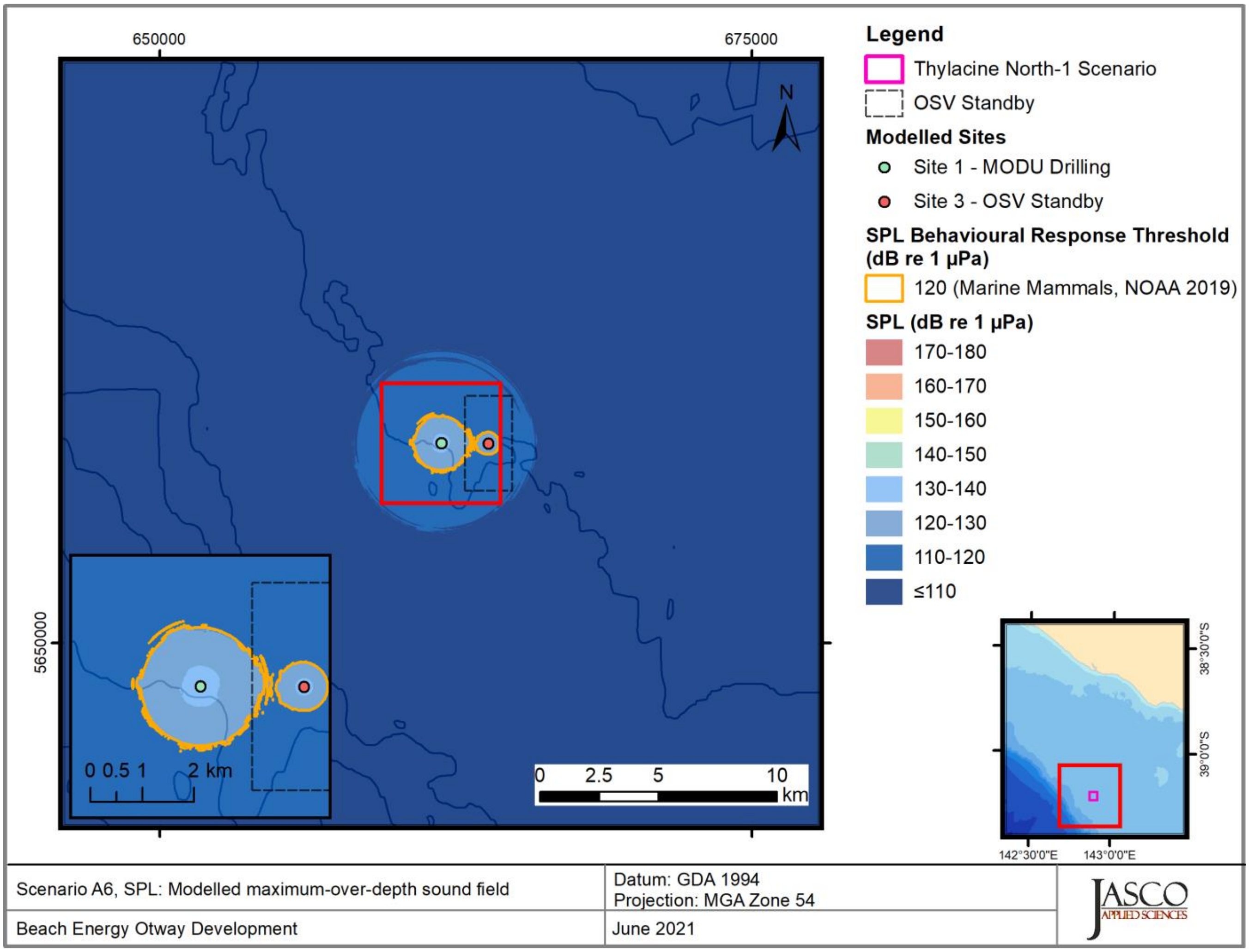

Figure 9. *Thylacine North-1, MODU Drilling and OSV Standby (Scenario A7) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

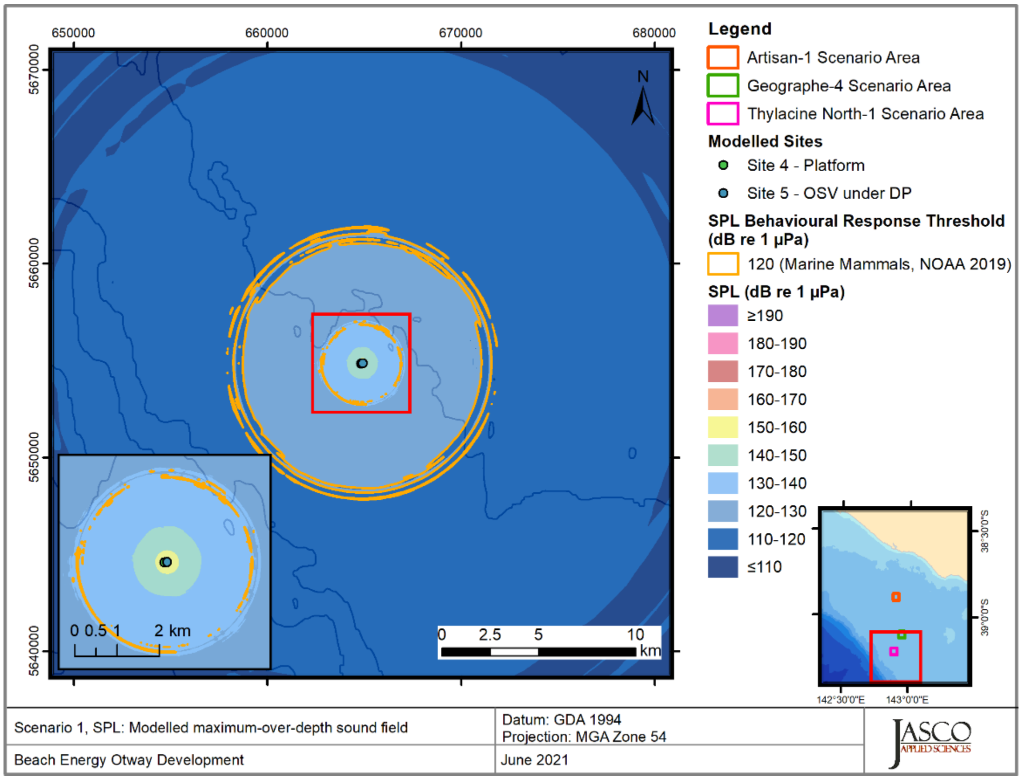

Figure 10. *Thylacine A Platform, Platform Resupply (Scenario1) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

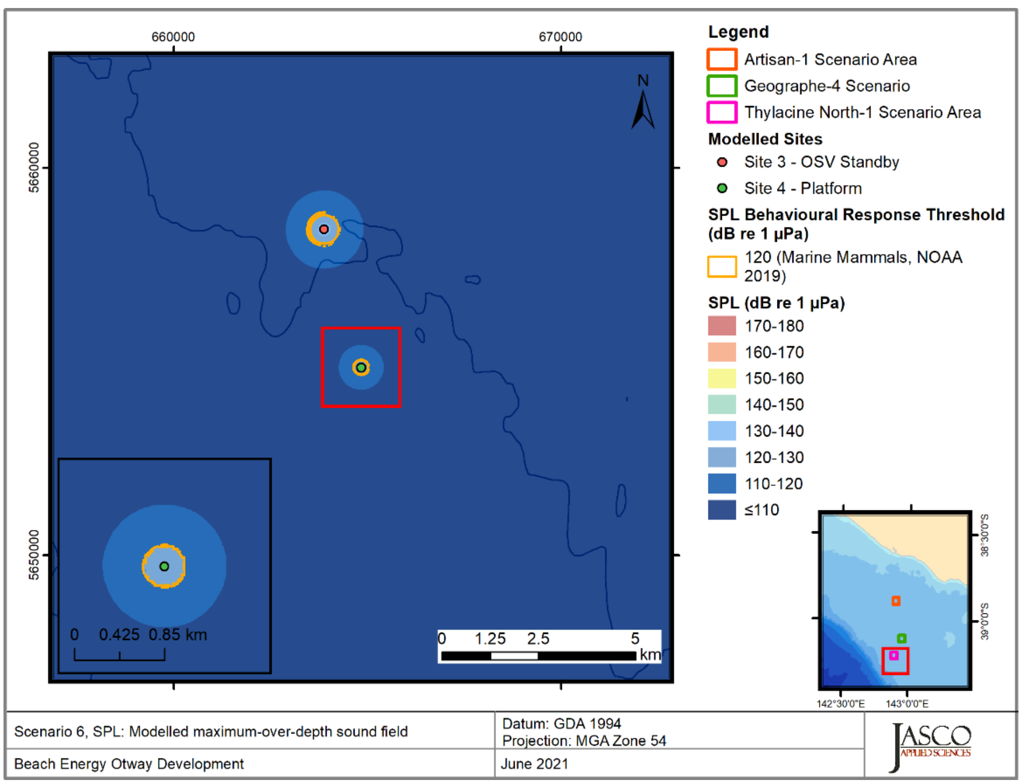

Figure 11. *Thylacine A Platform, OSV standby (Scenario 6) SPL :* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

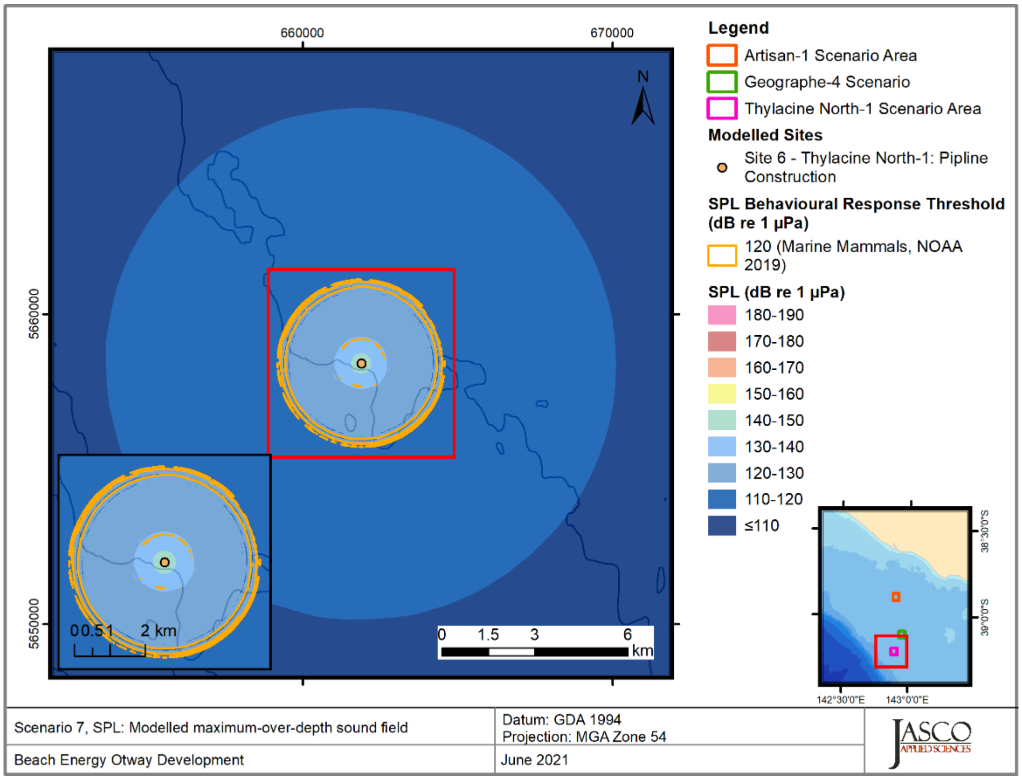

Figure 12. *Thylacine North-1, PLV stationary -June (Scenario 7) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

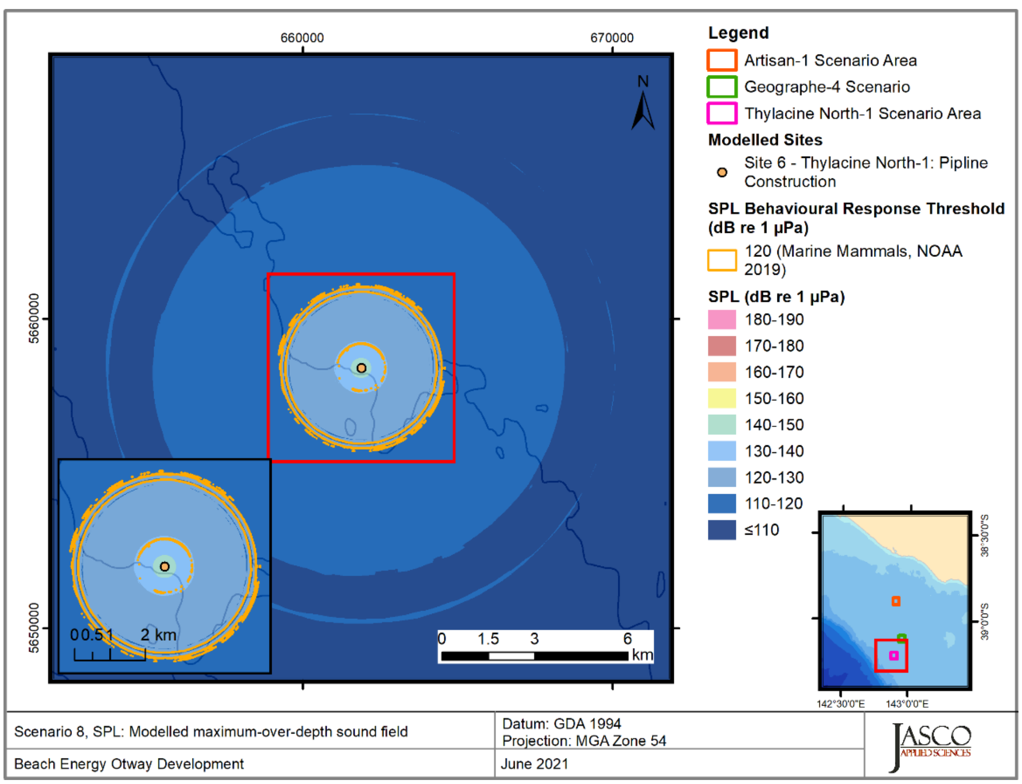

Figure 13. *Thylacine North-1, PLV stationary -November (Scenario 8) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

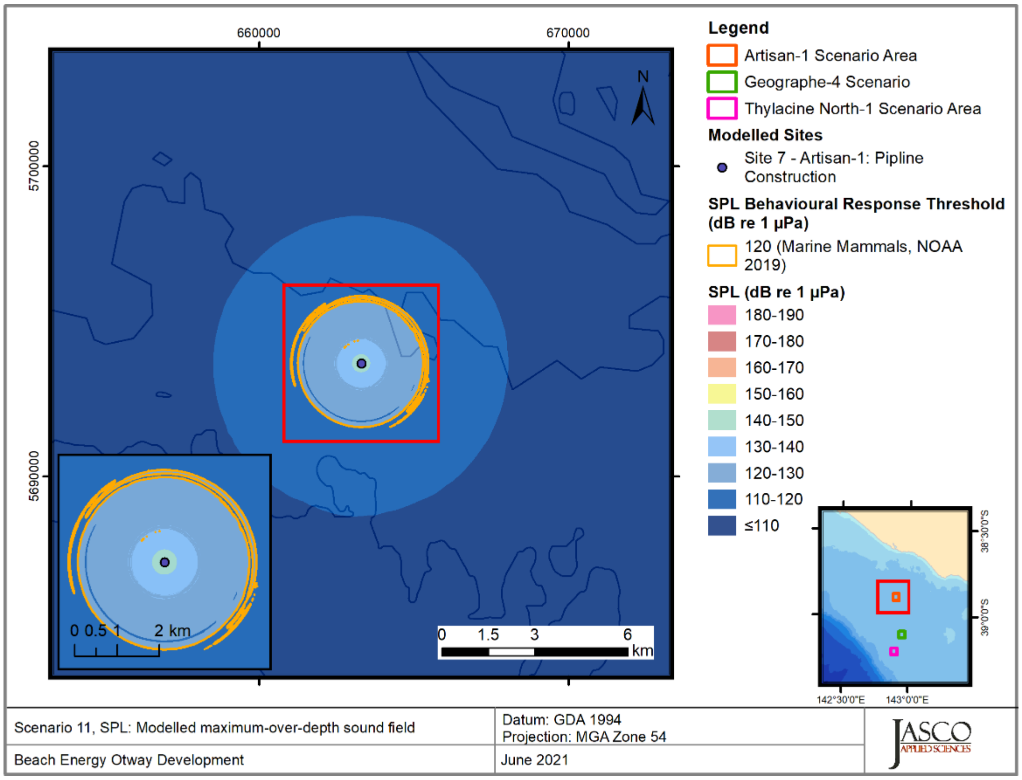

Figure 14. *Artisan-1, PLV stationary -June (Scenario 11) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

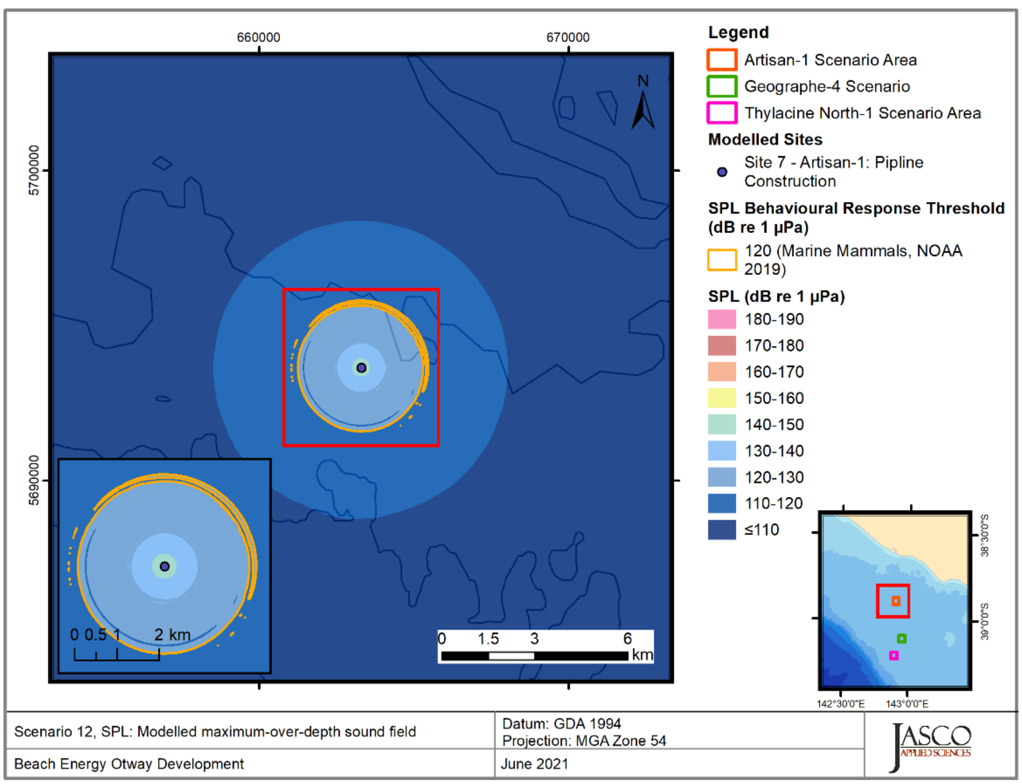

Figure 15. *Artisan-1, PLV stationary -November (Scenario 12) SPL:* S Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

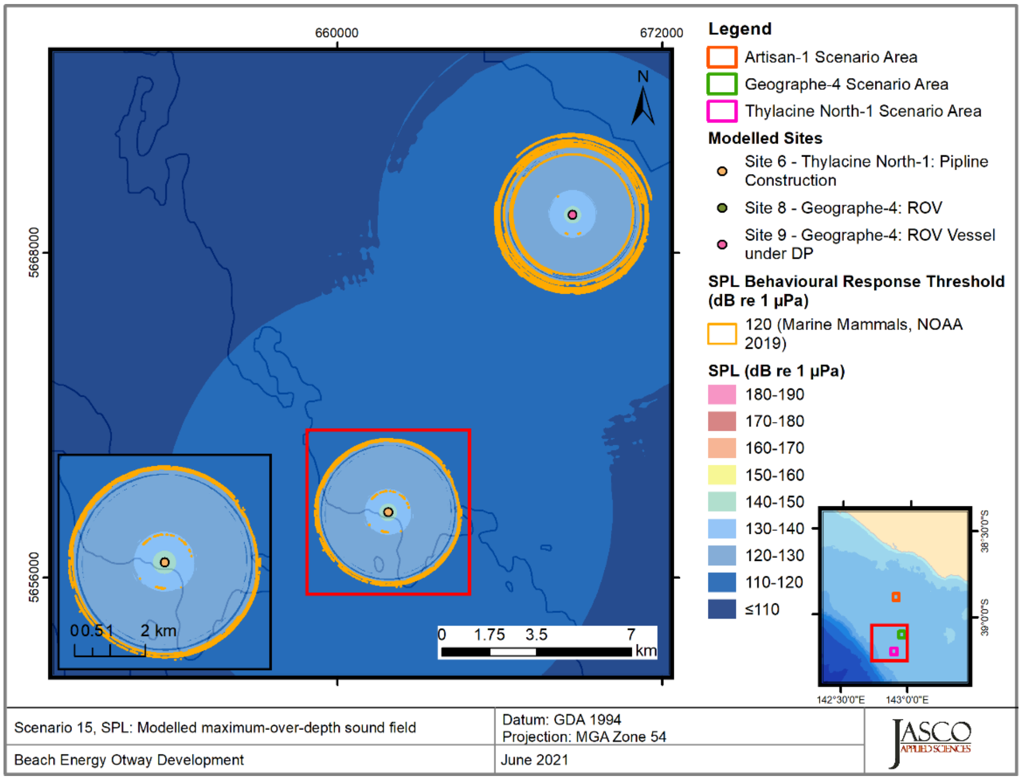

Figure 16. *Thylacine North-1, PLV stationary and ROV operations at Geographe-4 - June (Scenario 15) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

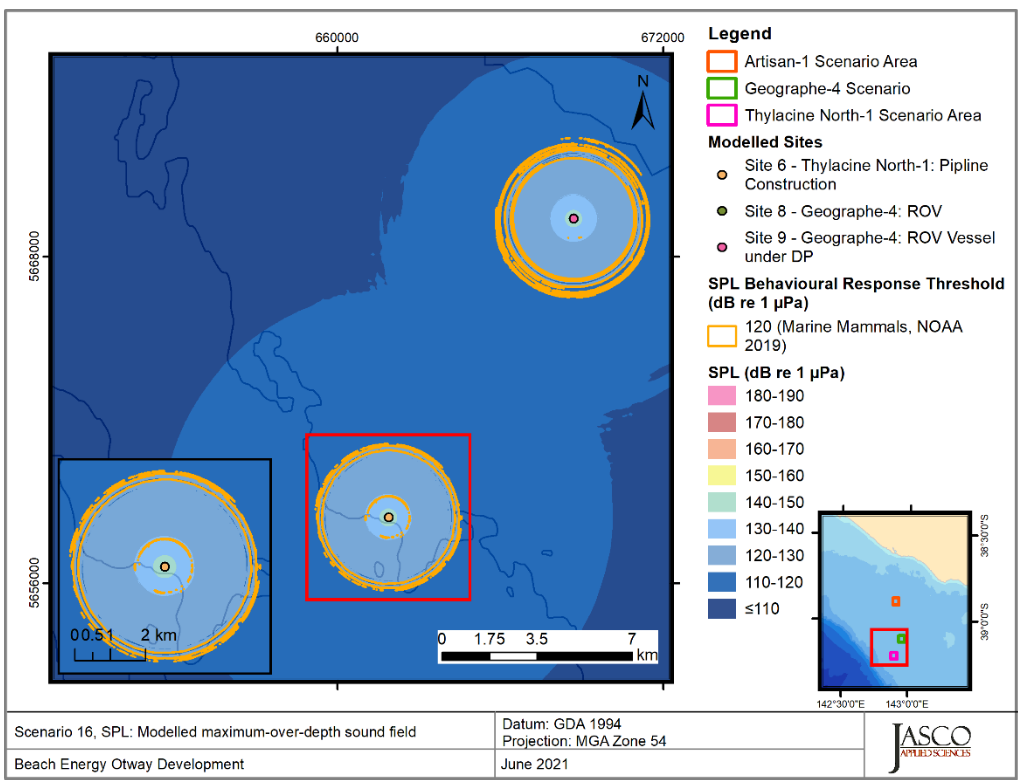

Figure 17. *Thylacine North-1, PLV stationary and ROV operations at Geographe-4 – November (Scenario 16) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

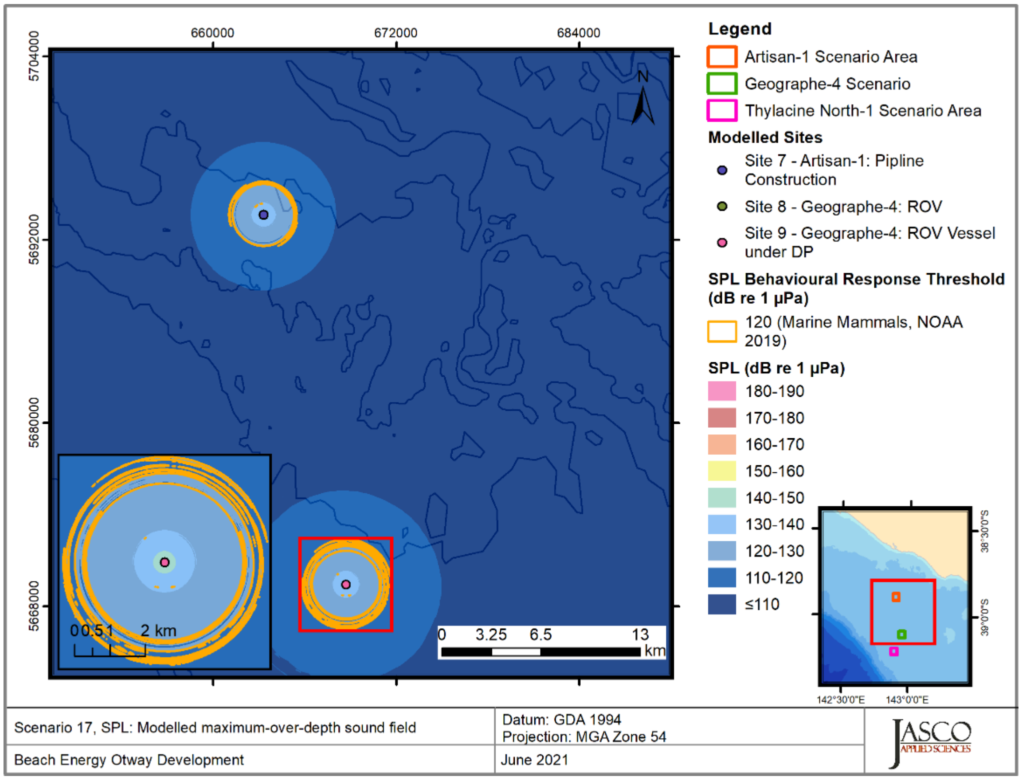

Figure 18. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 – June (Scenario 17) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

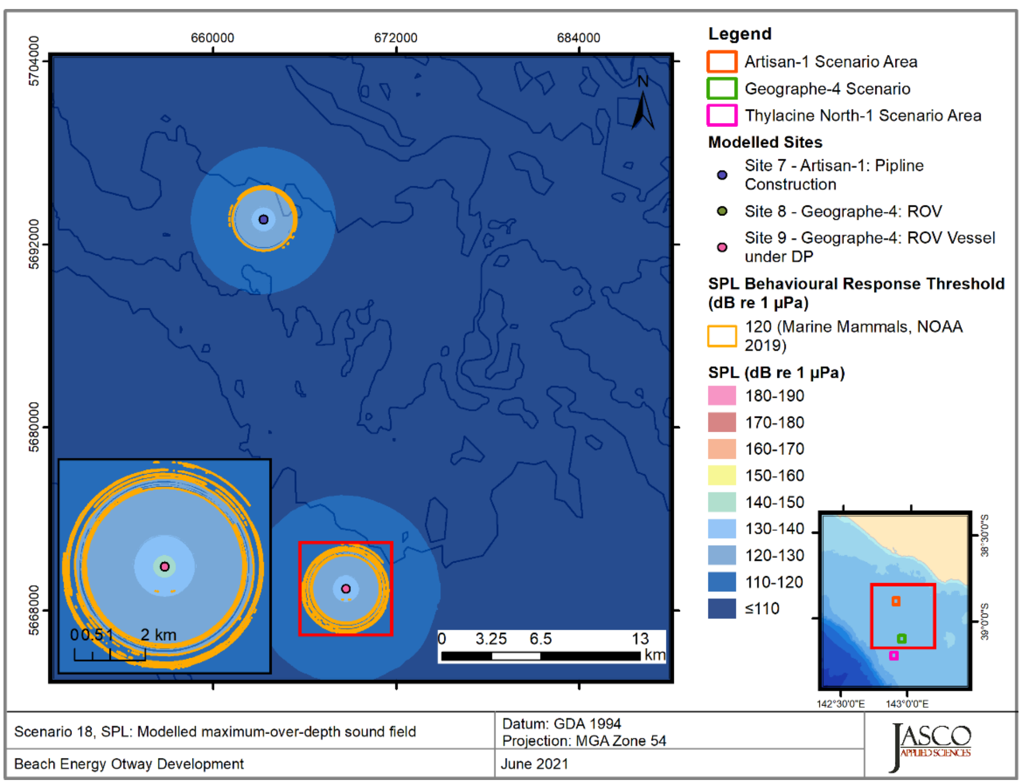

Figure 19. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 – November (Scenario 18) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

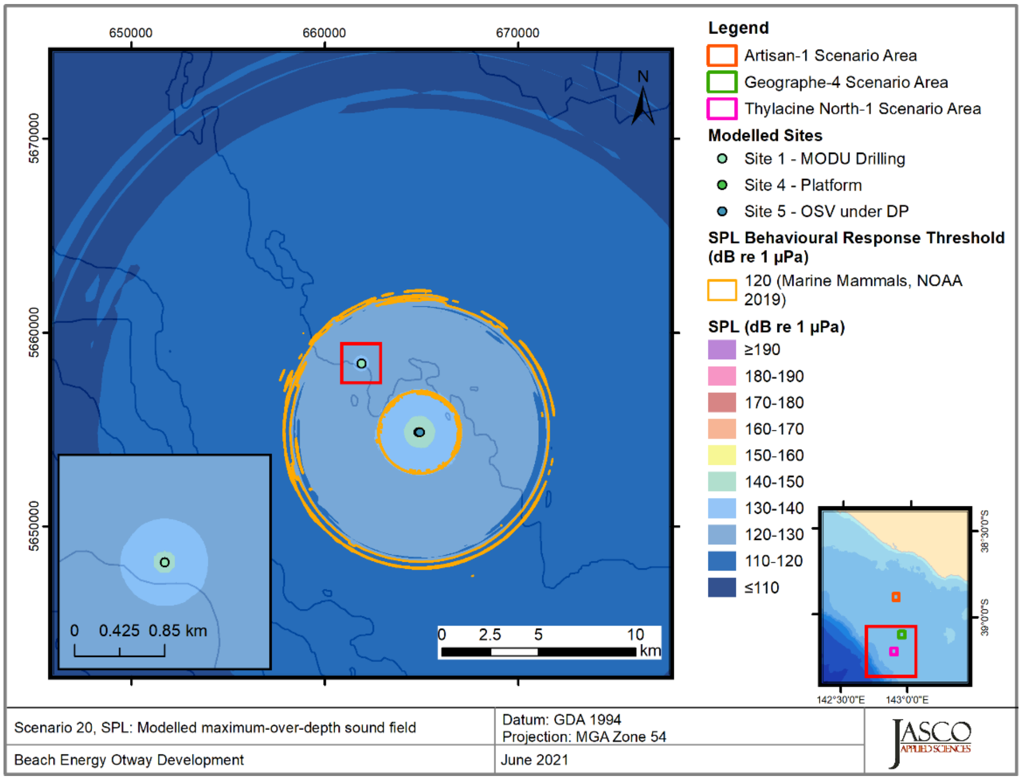

Figure 20. *Thylacine A Platform, Platform Resupply and MODU Drilling (Scenario 20) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

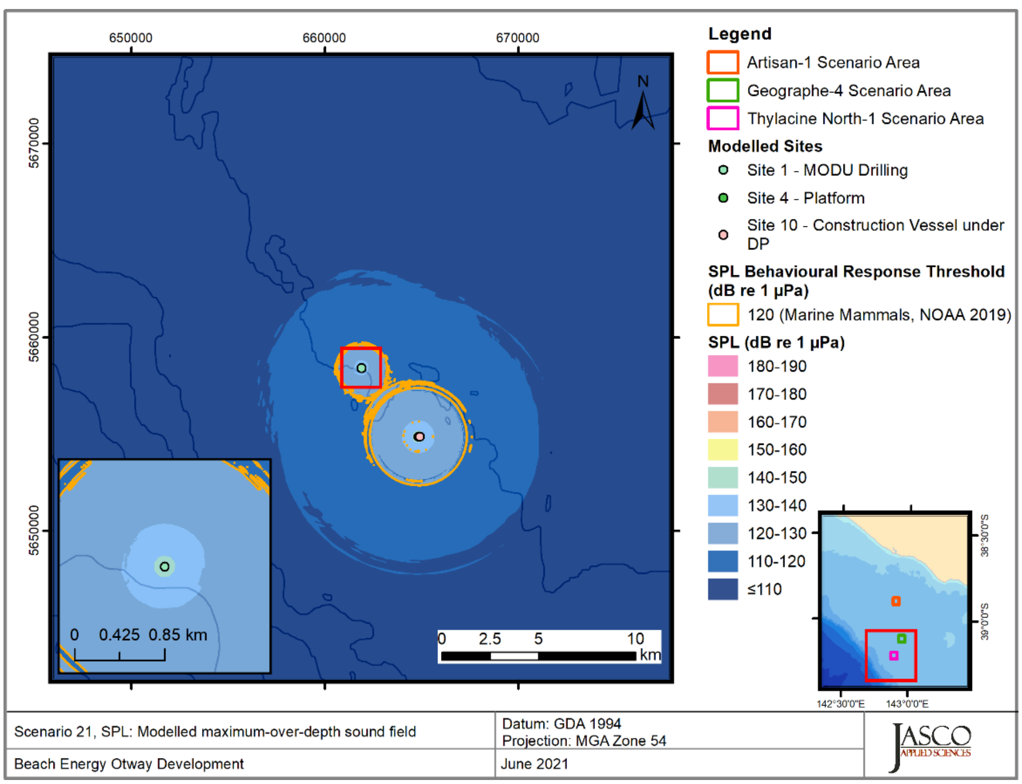

Figure 21. *Thylacine A Platform, Platform Resupply and skid installation (Scenario 20) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

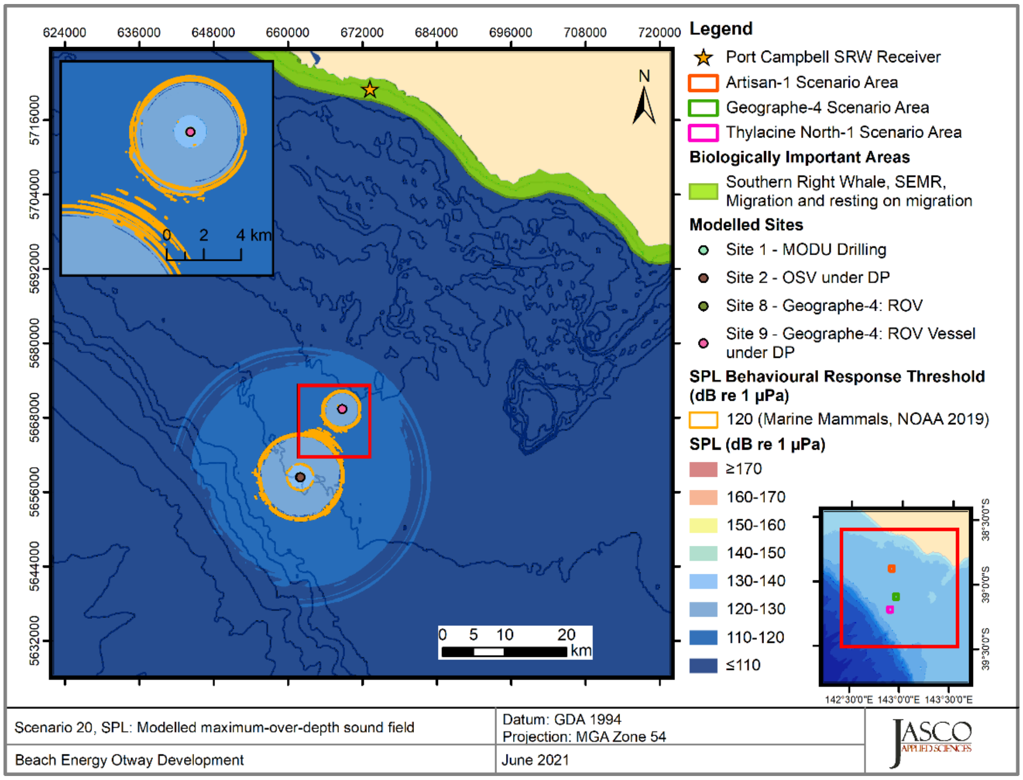

Figure 22. *Concurrent drilling operations at Thylacine North-1 and construction operations at Geographe-4 (Scenario 22) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

4.2.2. Accumulated SEL_{24h} Maps

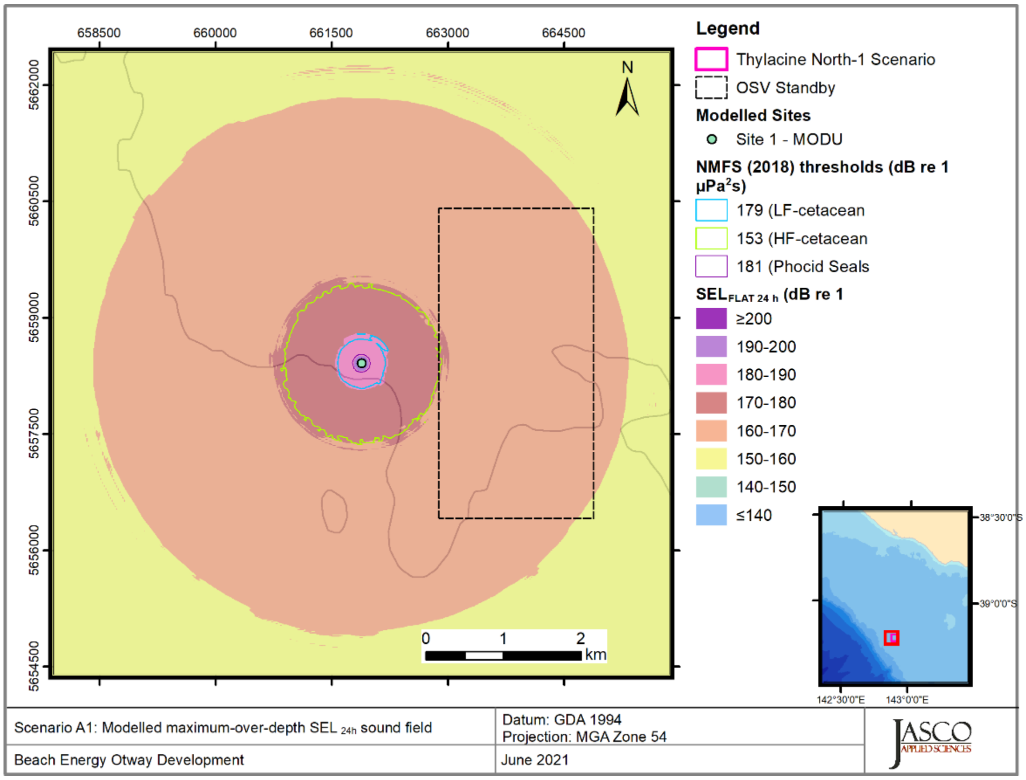

Figure 23. *Thylacine North-1, MODU Drilling (Scenario A1) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

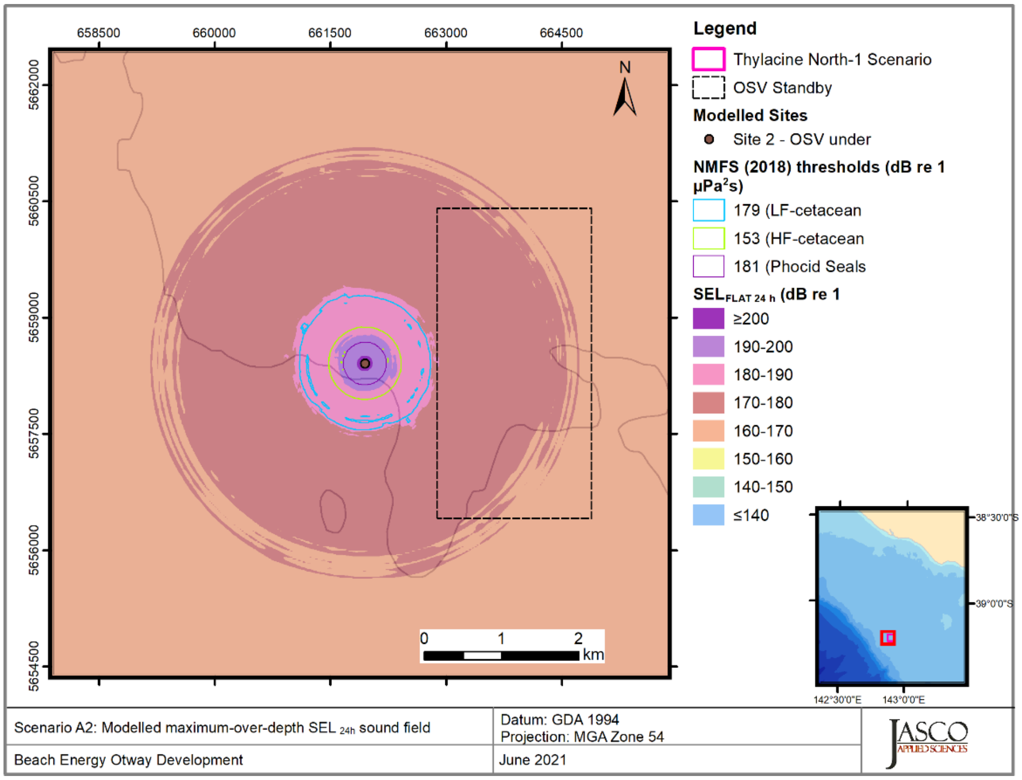

Figure 24. *Thylacine North-1, OSV on DP (4h) (Scenario A2) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

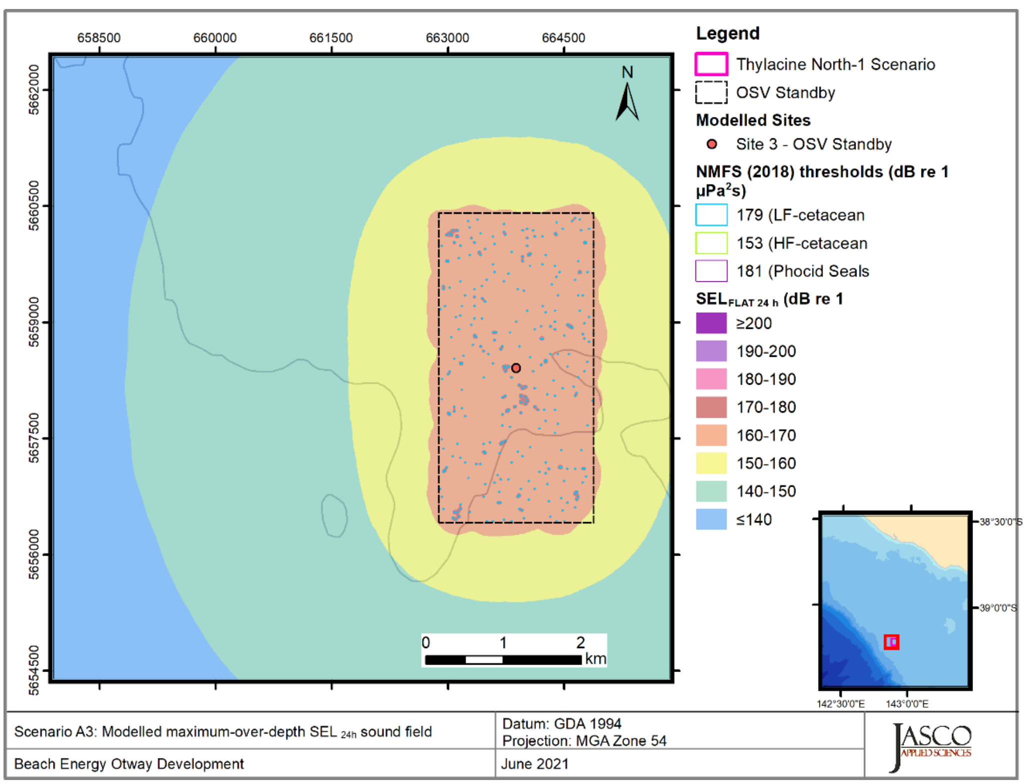

Figure 25. *Thylacine North-1, OSV Standby (Scenario A3) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

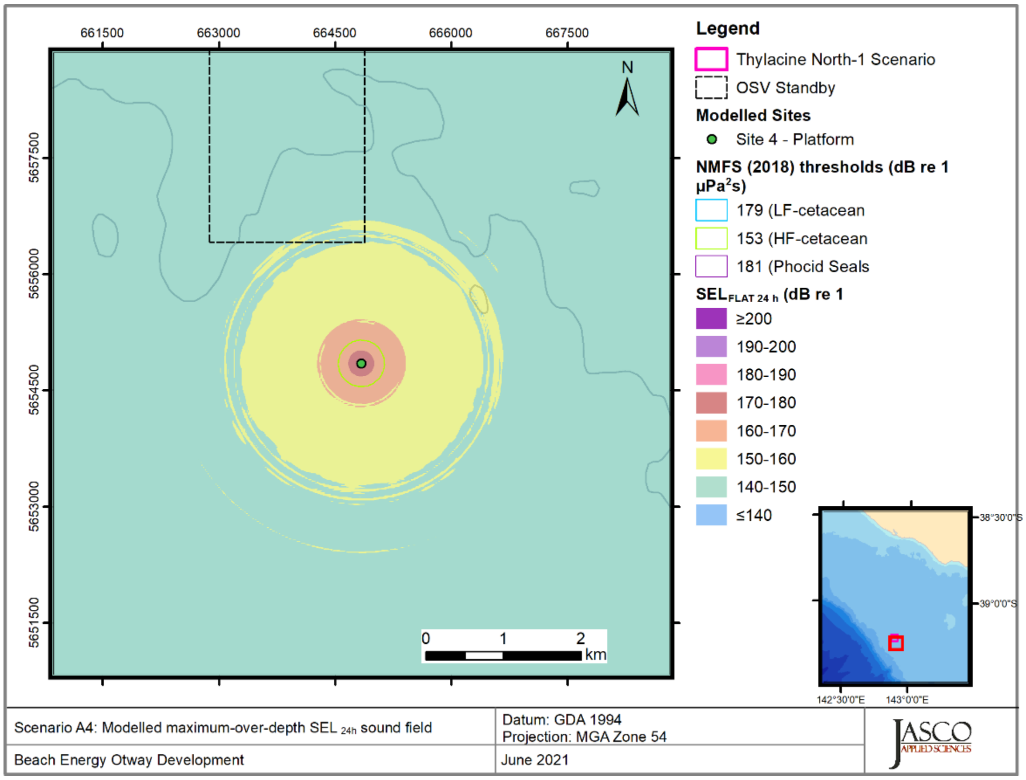

Figure 26. *Thylacine A, Platform Operations (Scenario A4) SEL*$_{24h}$: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

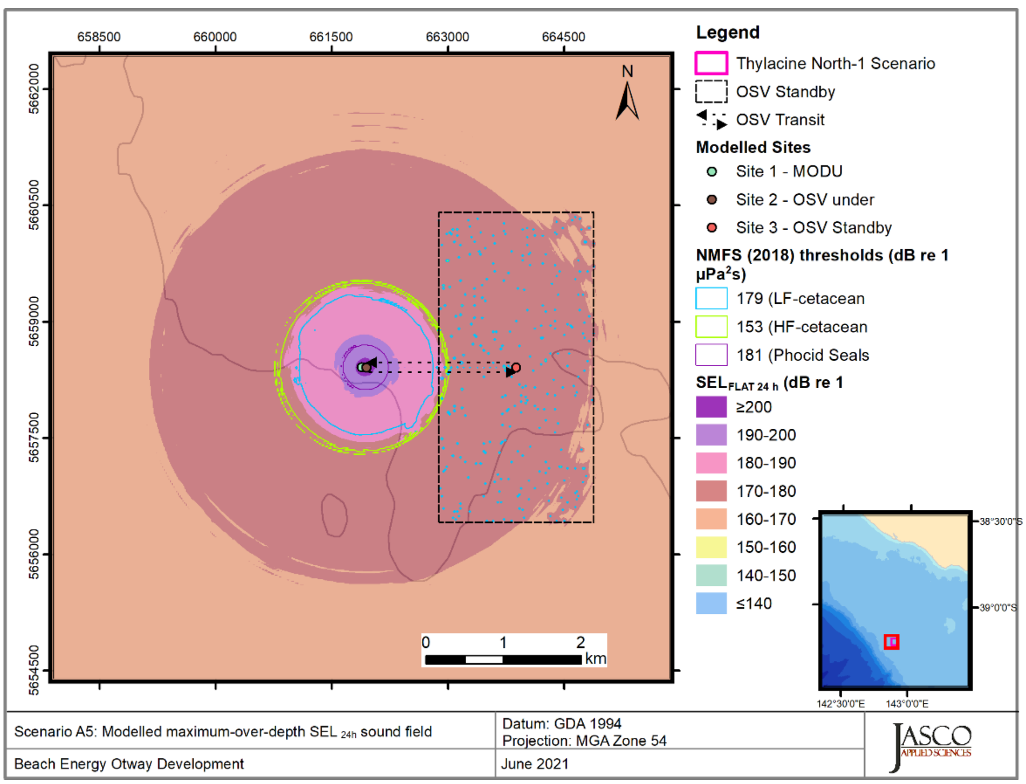

Figure 27. *Thylacine North-1, MODU 4h Resupply Operations (Scenario A5) SEL*$_{24h}$: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

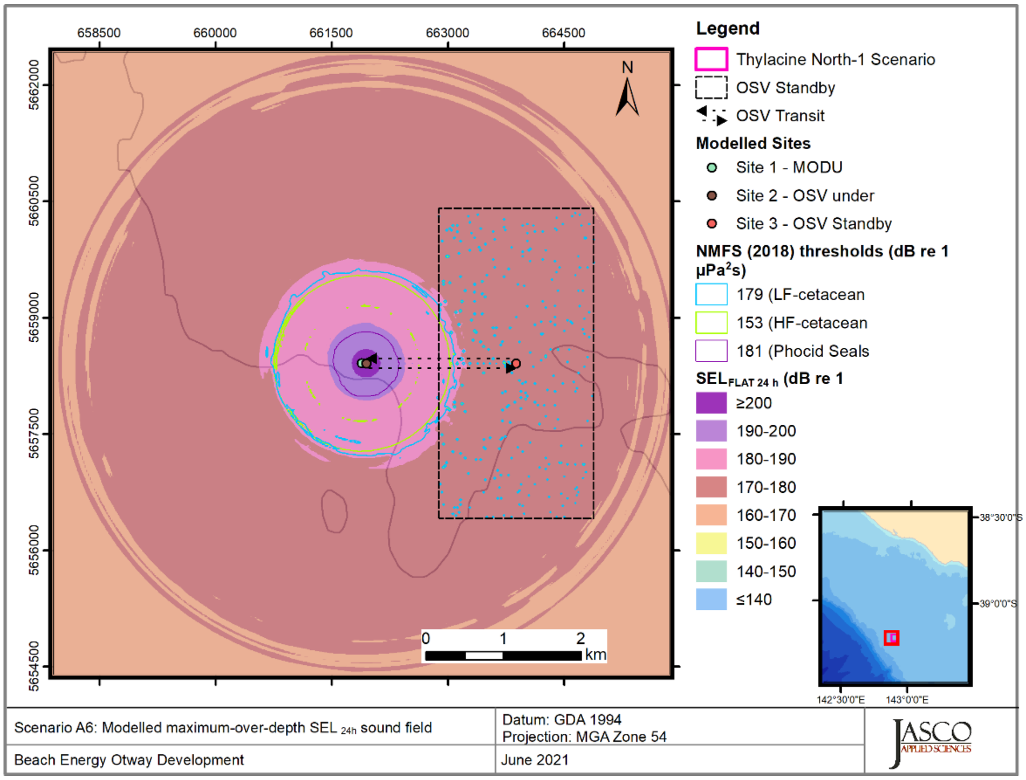

Figure 28. *Thylacine North-1, MODU 8h Resupply Operations (Scenario A6) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.*SEL24h:*

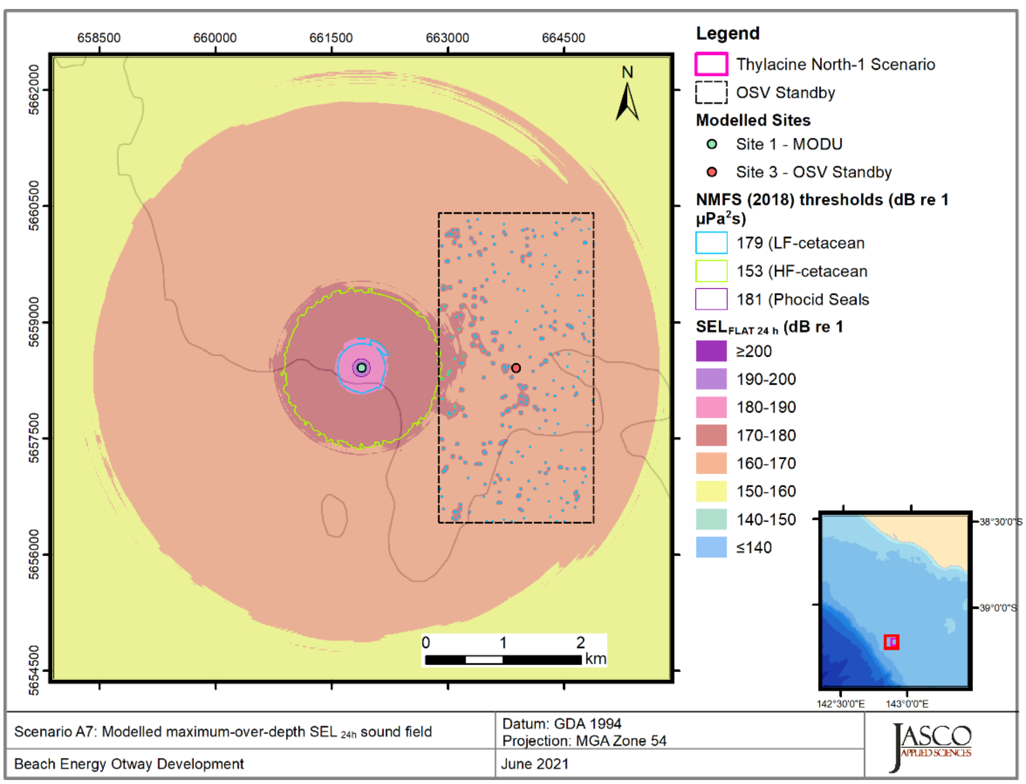

Figure 29. *Thylacine North-1, MODU Drilling and OSV standby (Scenario A7) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

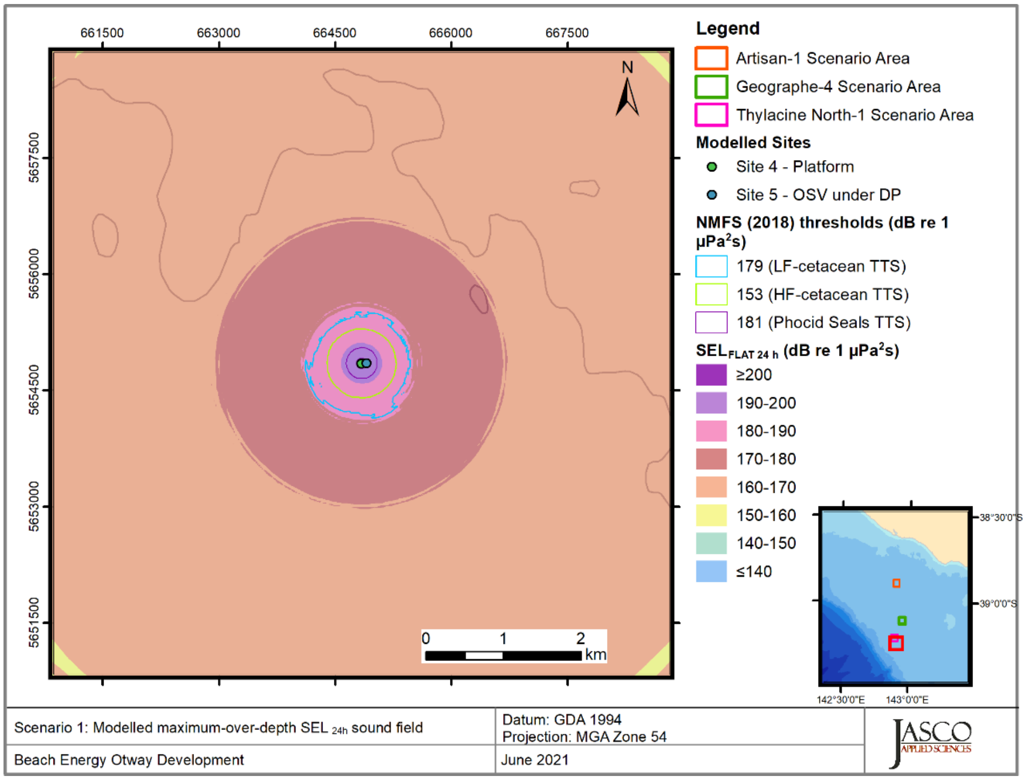

Figure 30. *Thylacine A Platform, 2 h Platform Resupply (Scenario 1)* SEL_{24h}*:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

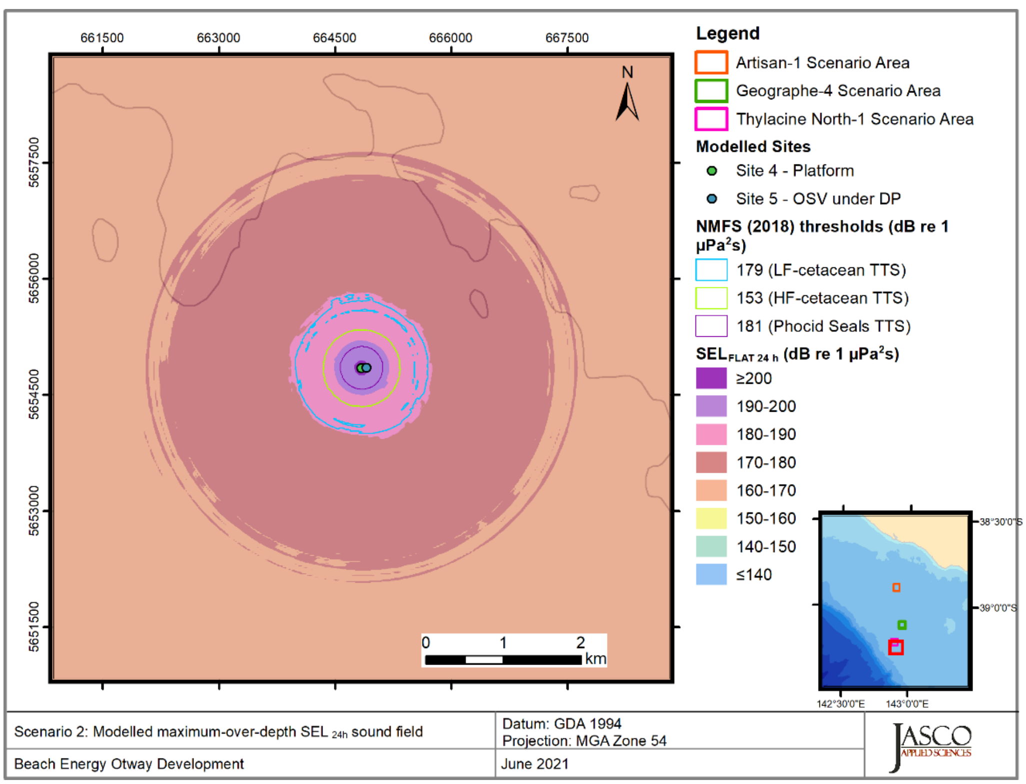

Figure 31. *Thylacine A Platform, 4 h Platform Resupply (Scenario 2)* SEL_{24h}*:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

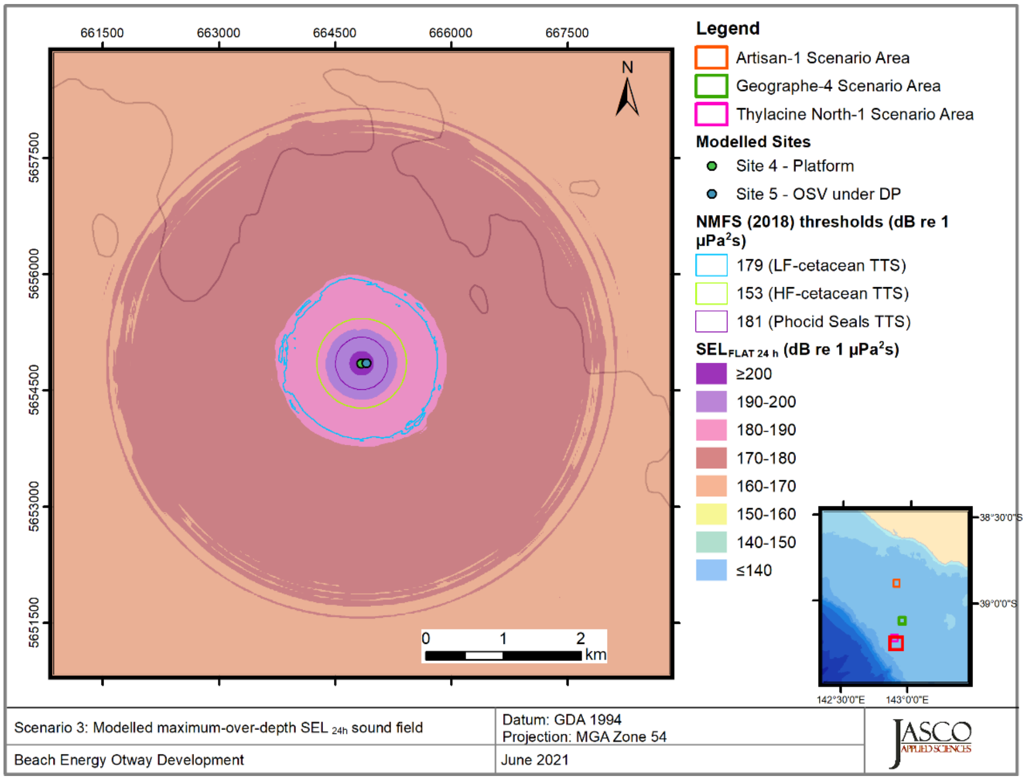

Figure 32. *Thylacine A Platform, 6 h Platform Resupply (Scenario 3) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

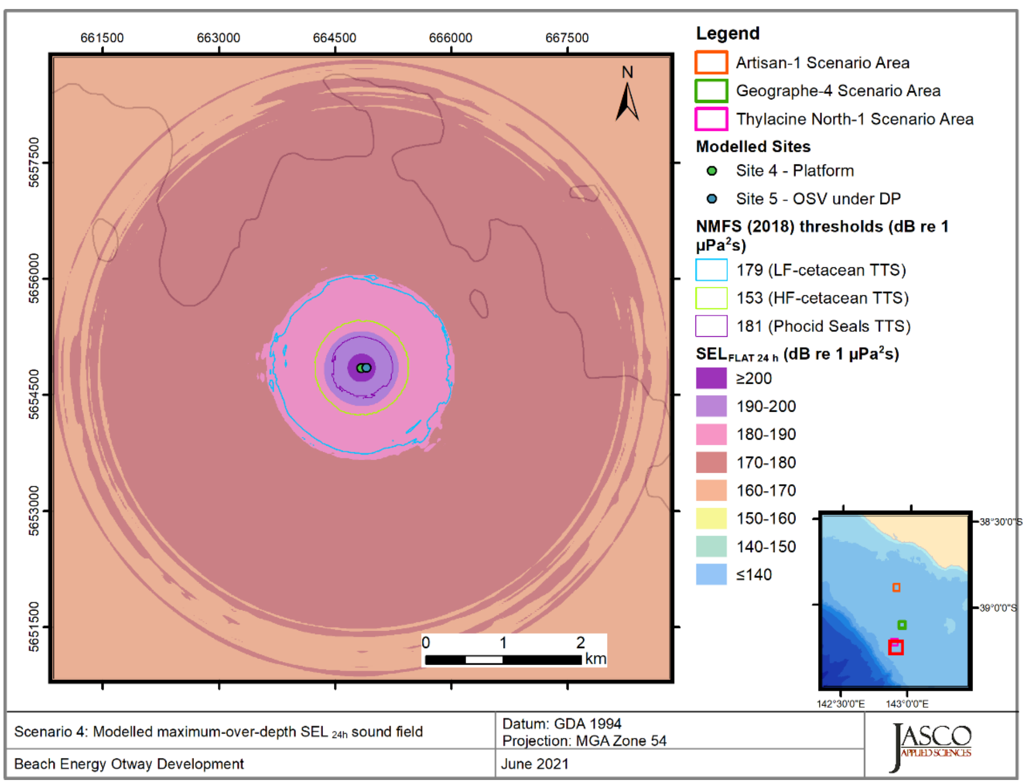

Figure 33. *Thylacine A Platform, 8 h Platform Resupply (Scenario 4) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

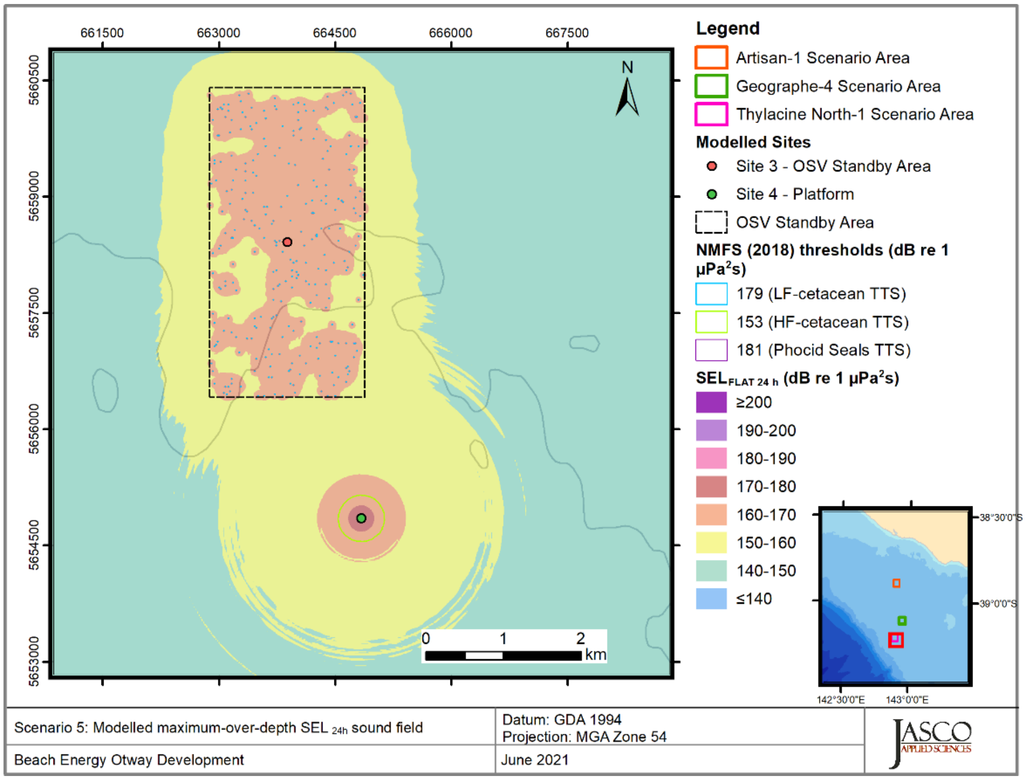

Figure 34. *Thylacine A Platform, 8h OSV standby (Scenario 5) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

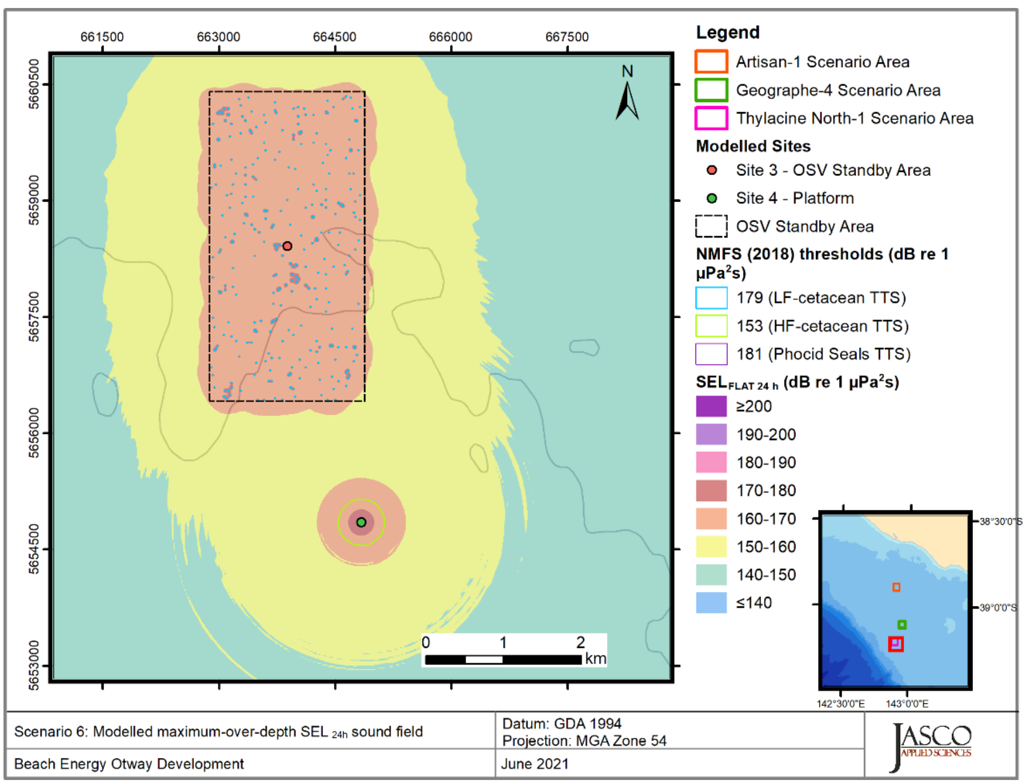

Figure 35. *Thylacine A Platform, 24h OSV standby (Scenario 6) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

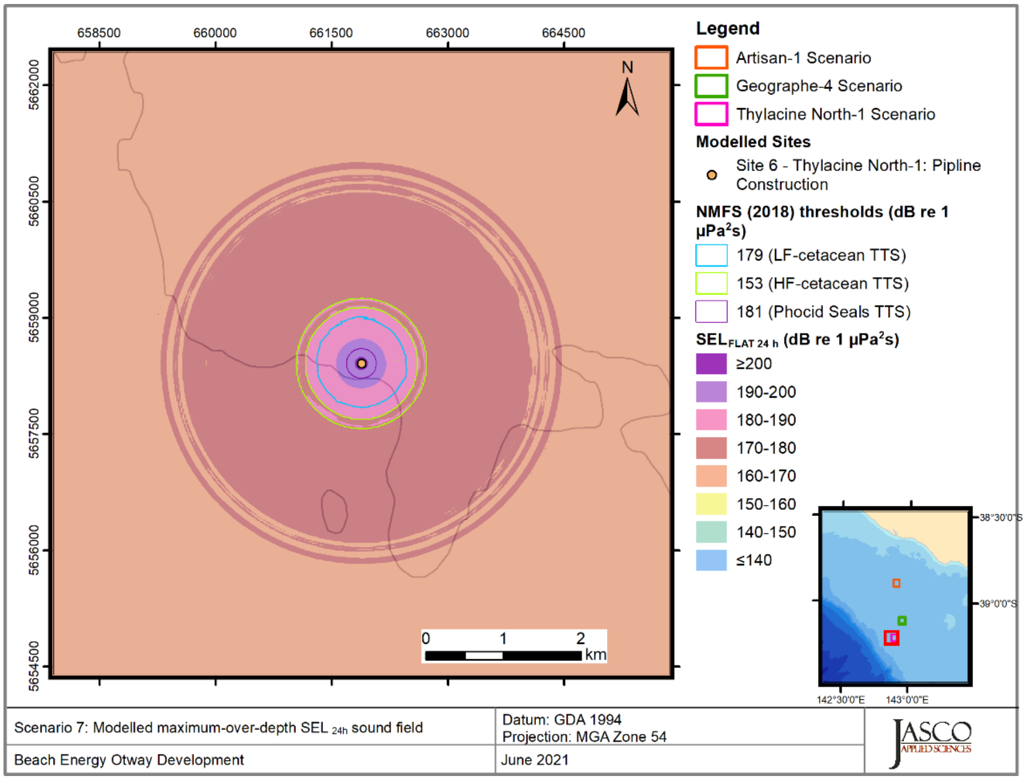

Figure 36. *Thylacine North-1, PLV stationary -June (Scenario 7) SEL24h:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

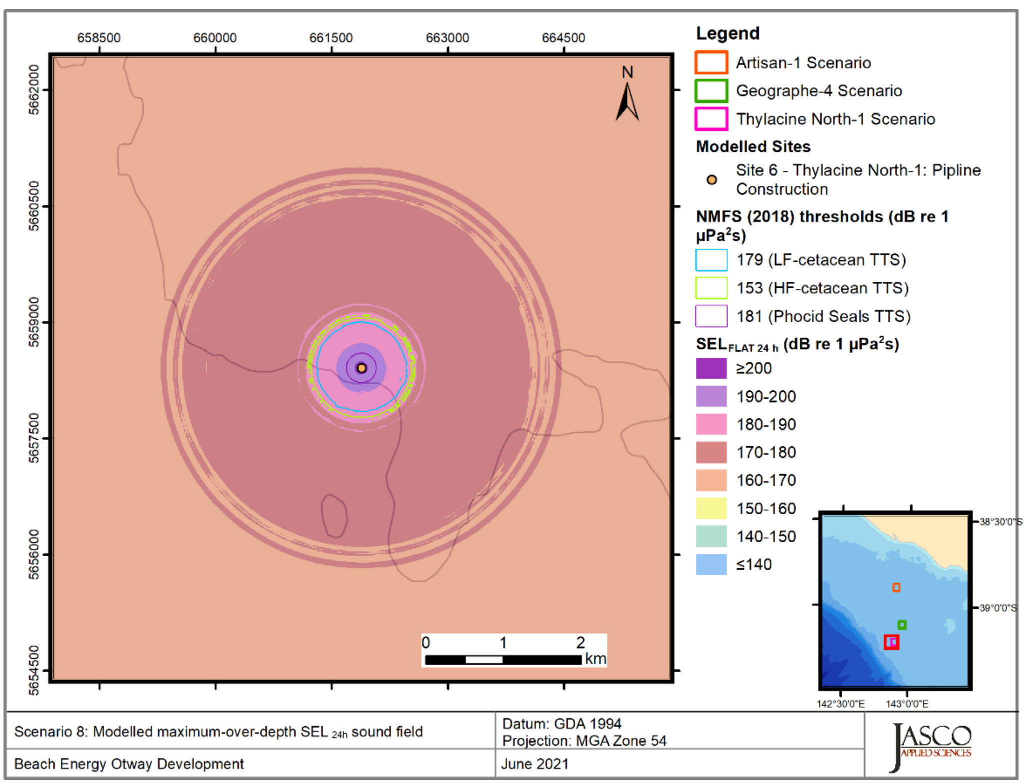

Figure 37. *Thylacine North-1, PLV stationary - November (Scenario 8) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

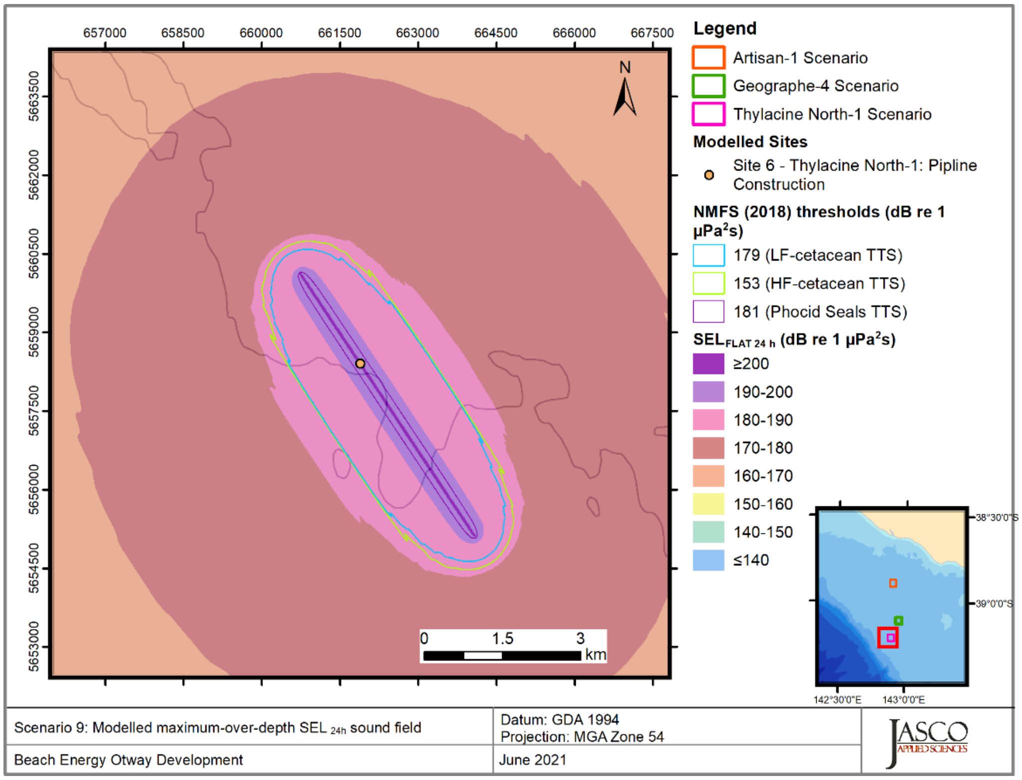

Figure 38. *Thylacine North-1, PLV pipe laying operations - June (Scenario 9) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

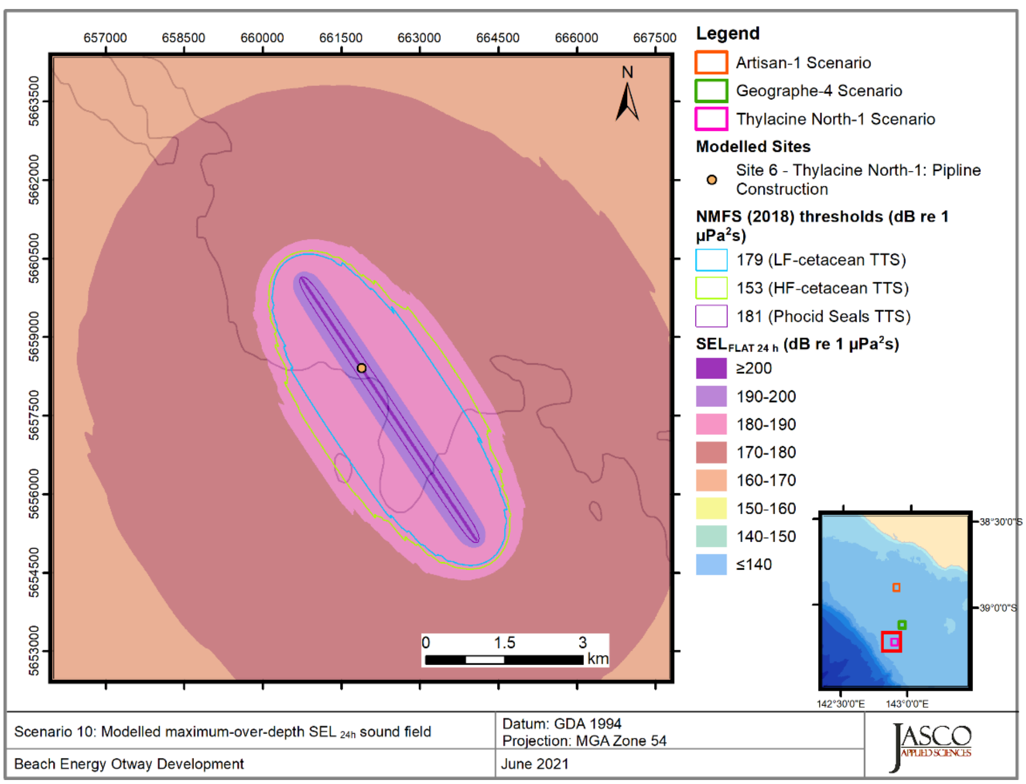

Figure 39. *Thylacine North-1, PLV pipe laying operations - November (Scenario 10) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

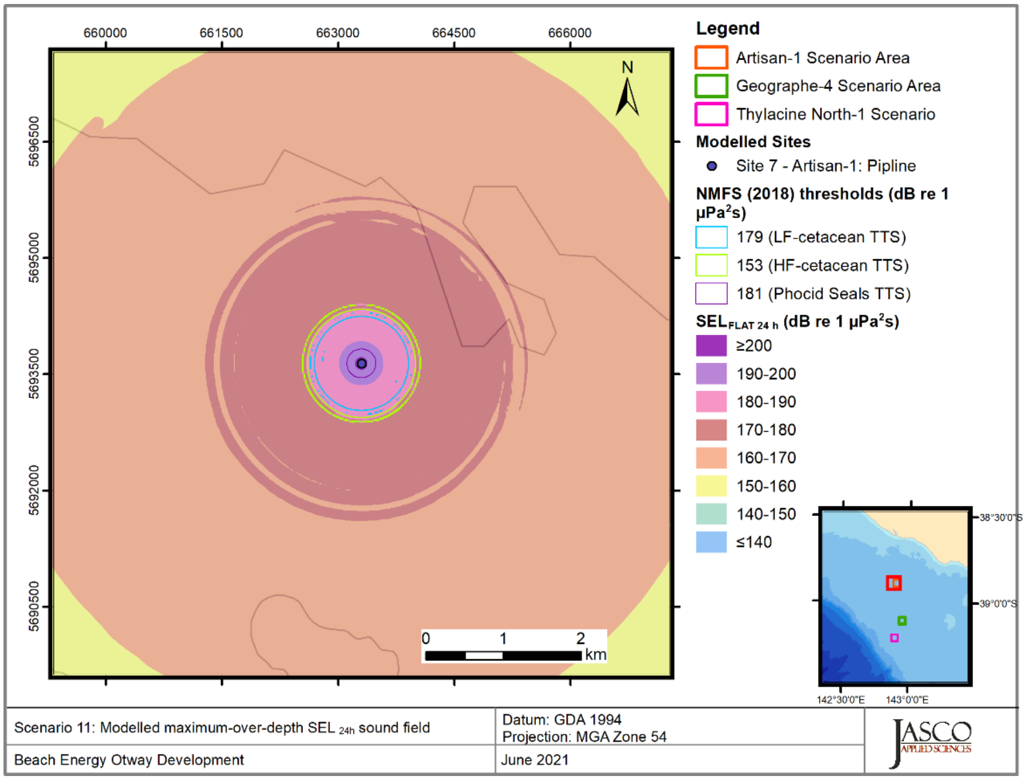

Figure 40. *Artisan-1, PLV stationary - June (Scenario 11) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

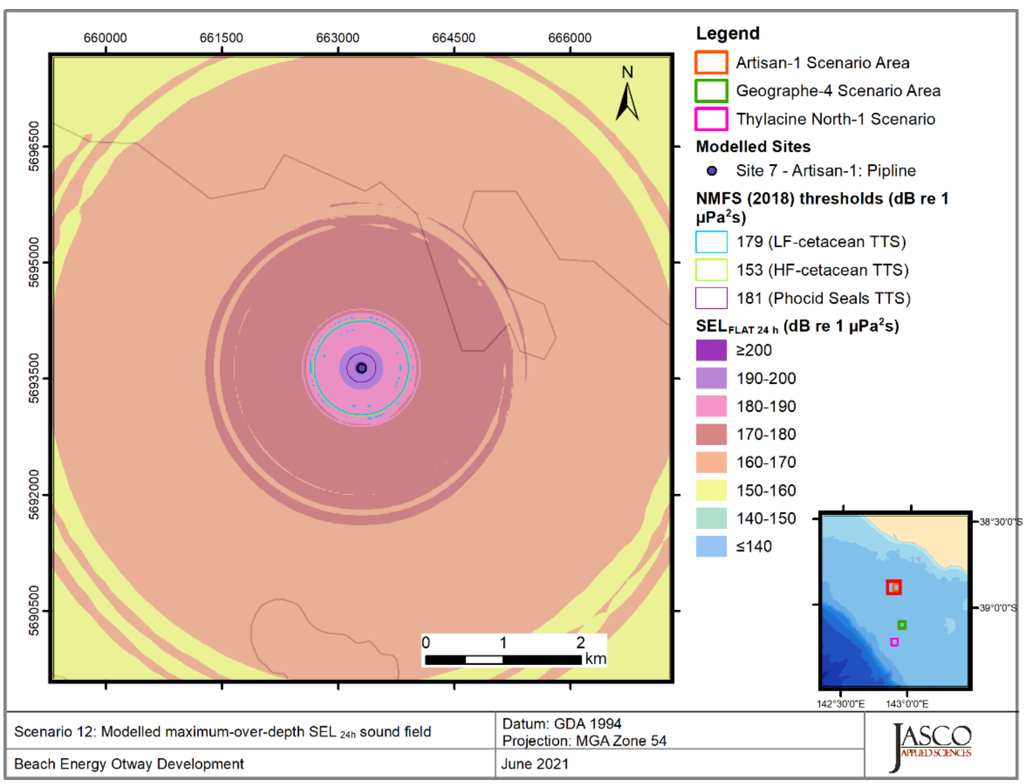

Figure 41. *Artisan-1, PLV stationary - November (Scenario 12) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

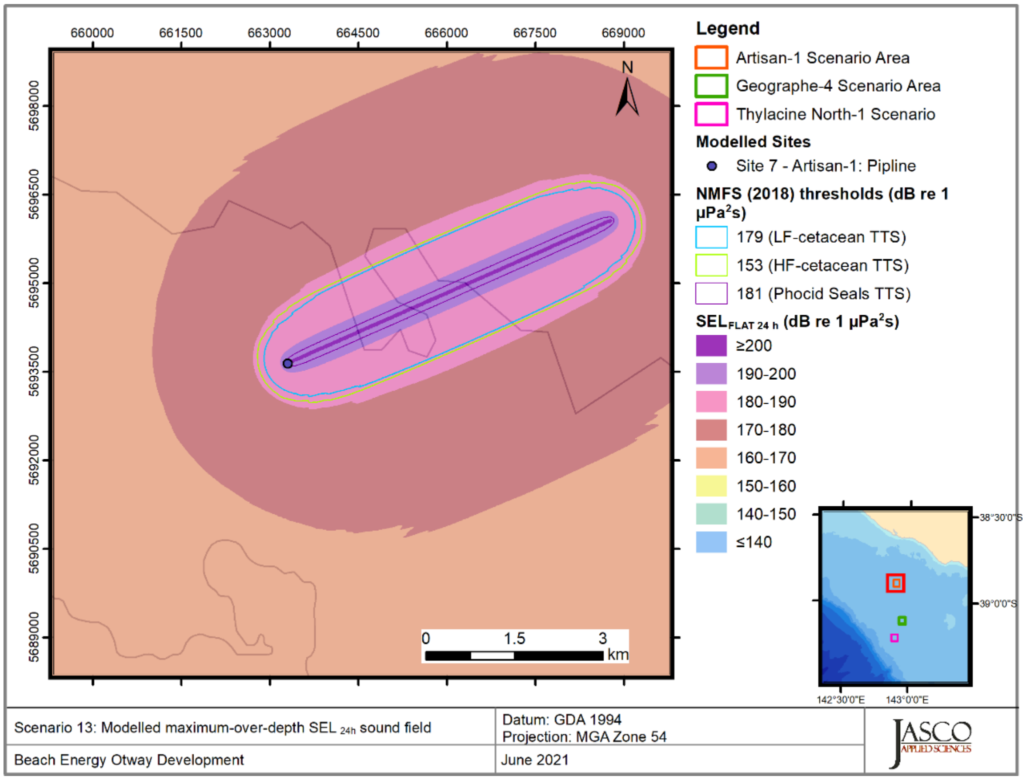

Figure 42. *Artisan-1, PLV pipe laying operations - June (Scenario 13) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

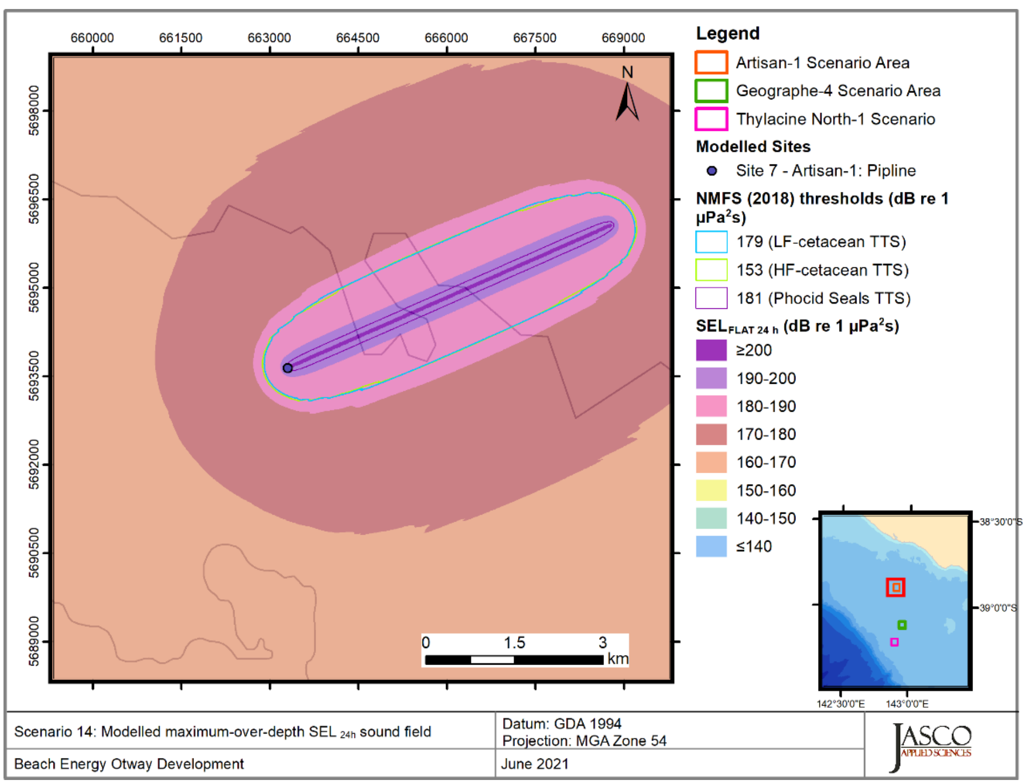

Figure 43. *Artisan-1, PLV pipe laying operations - November (Scenario 14) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

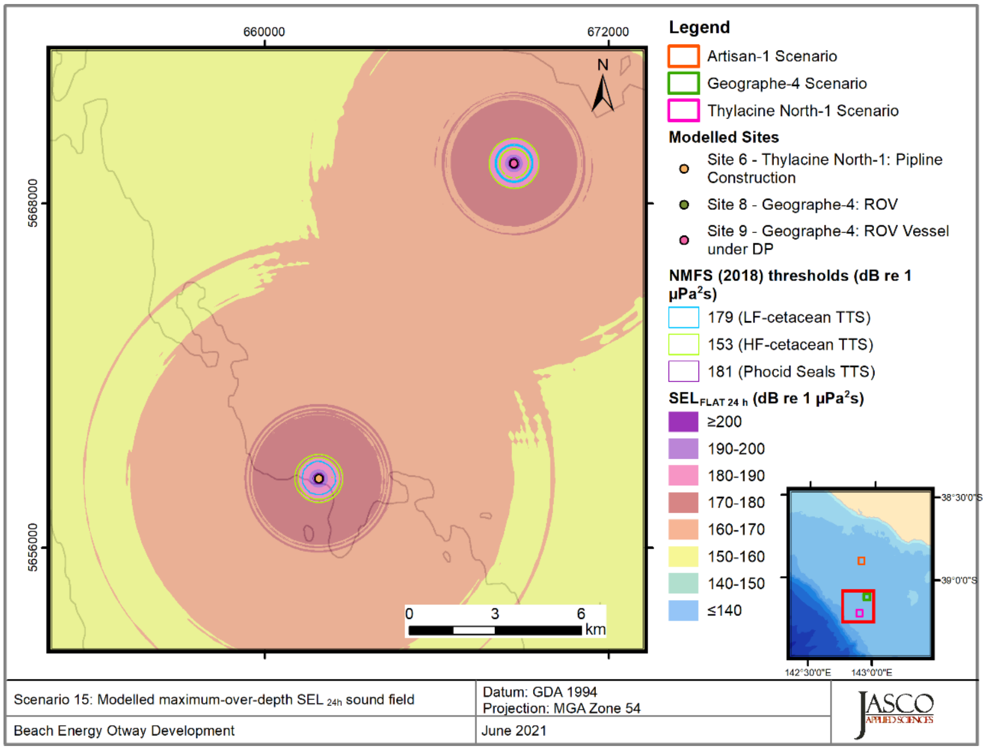

Figure 44. Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 - June (Scenario 15) SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

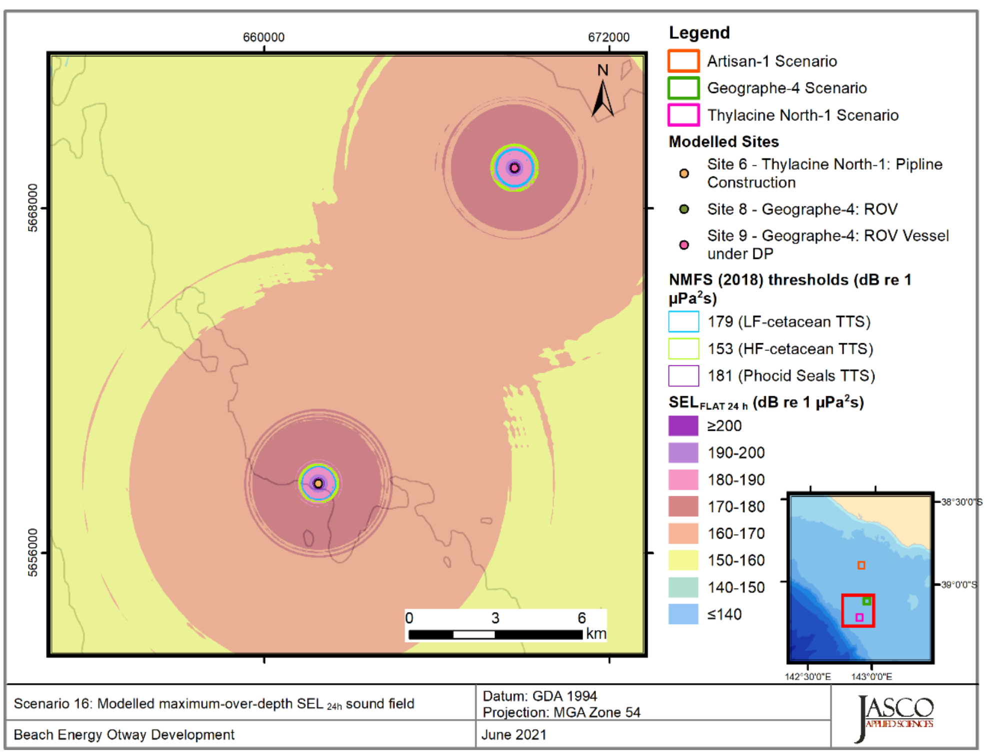

Figure 45. *Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 - November (Scenario 16) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

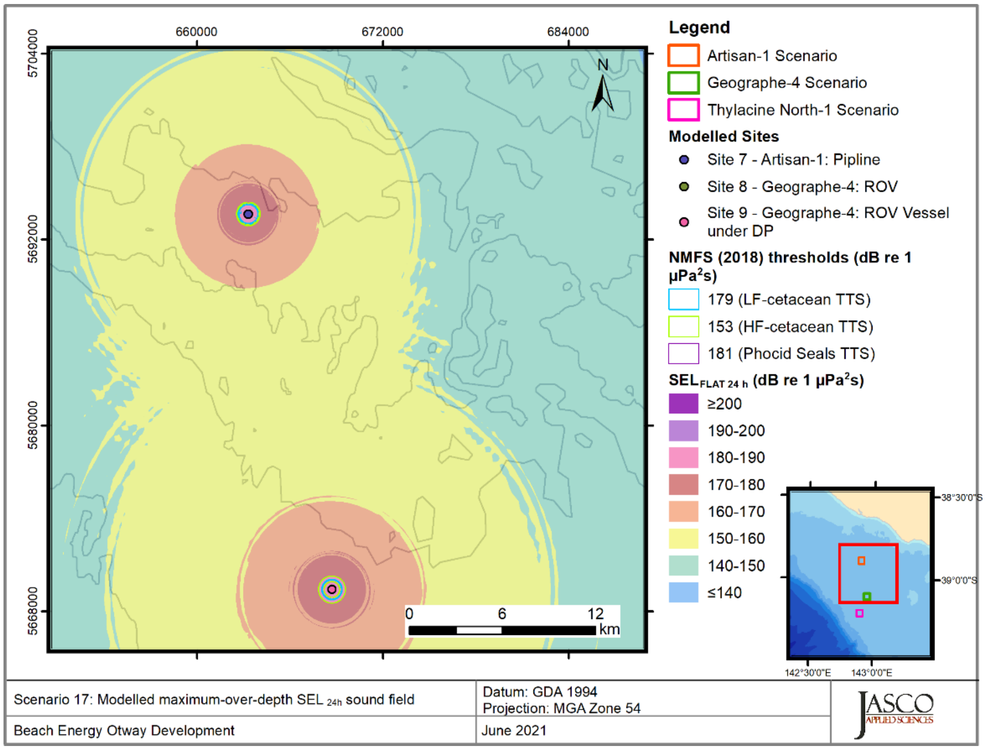

Figure 46. *Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 - June (Scenario 17) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

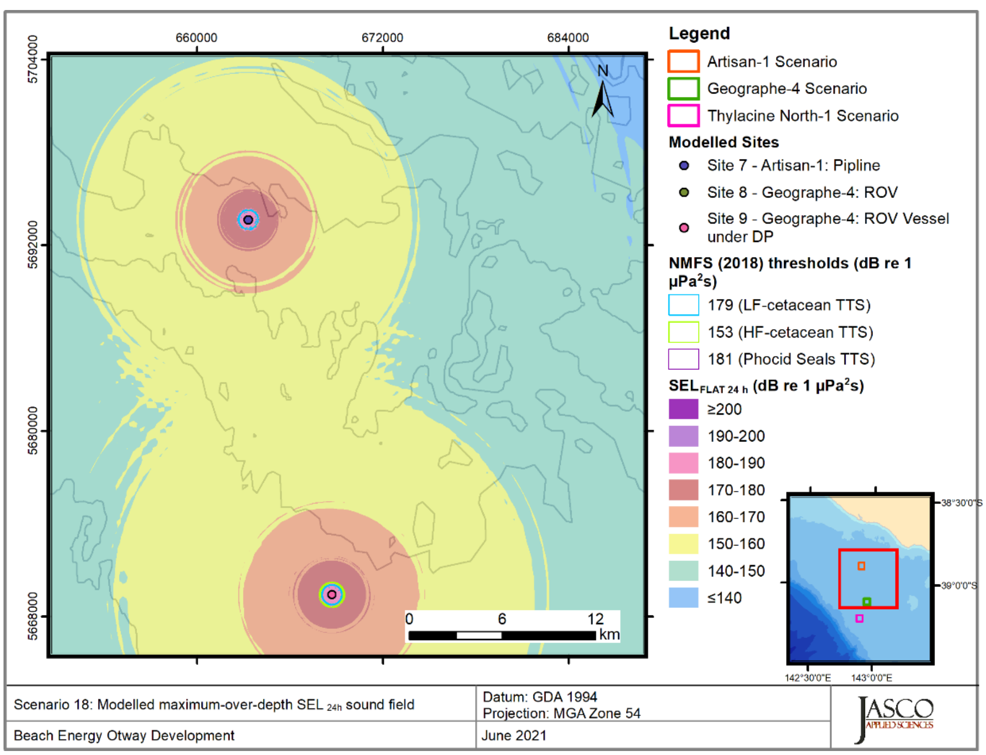

Figure 47. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 - November (Scenario 18) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

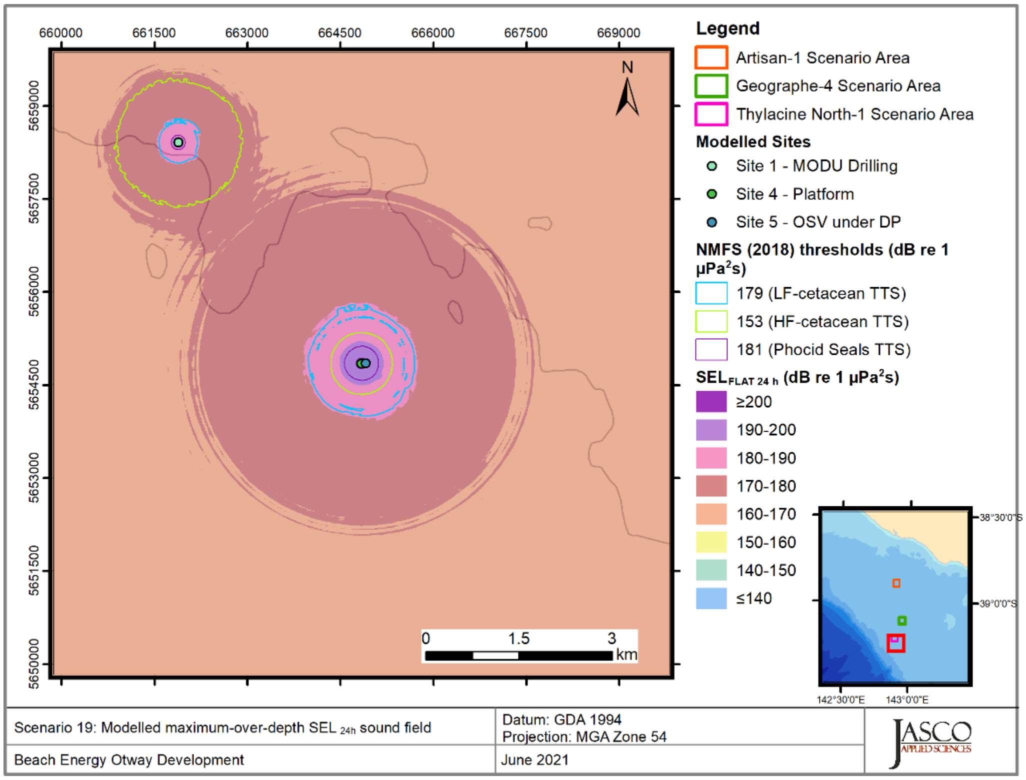

Figure 48. *Thylacine A Platform, 4h Platform Resupply and MODU Drilling (Scenario 19) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

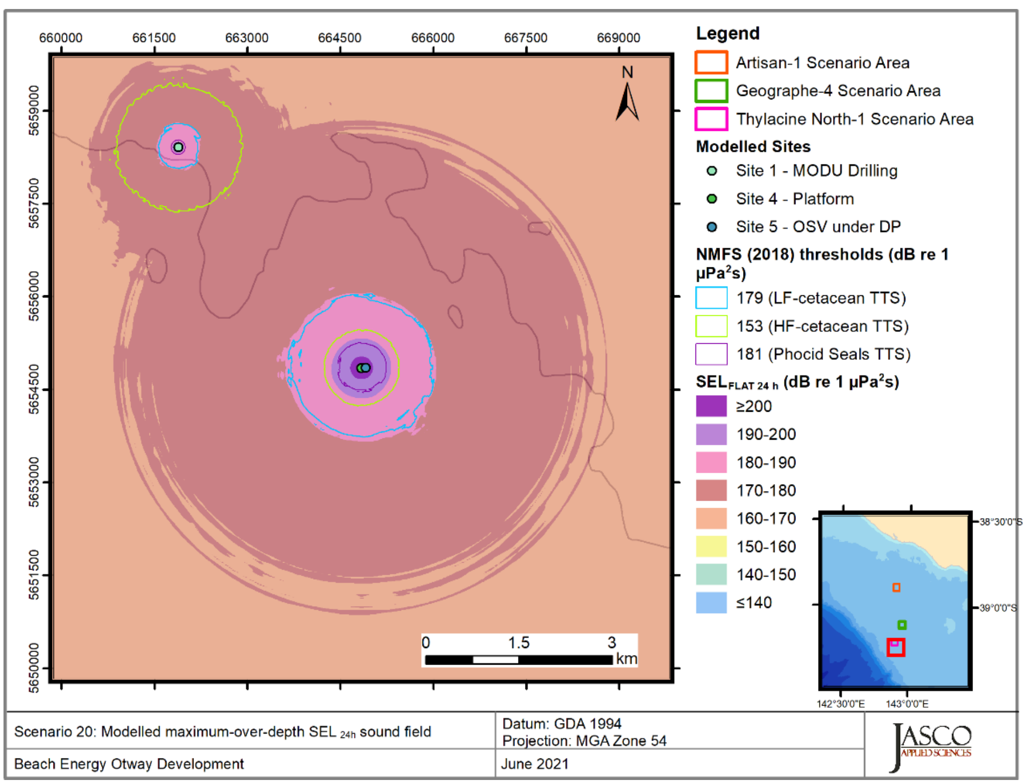

Figure 49. *Thylacine A Platform, 8h Platform Resupply and MODU Drilling (Scenario 20) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

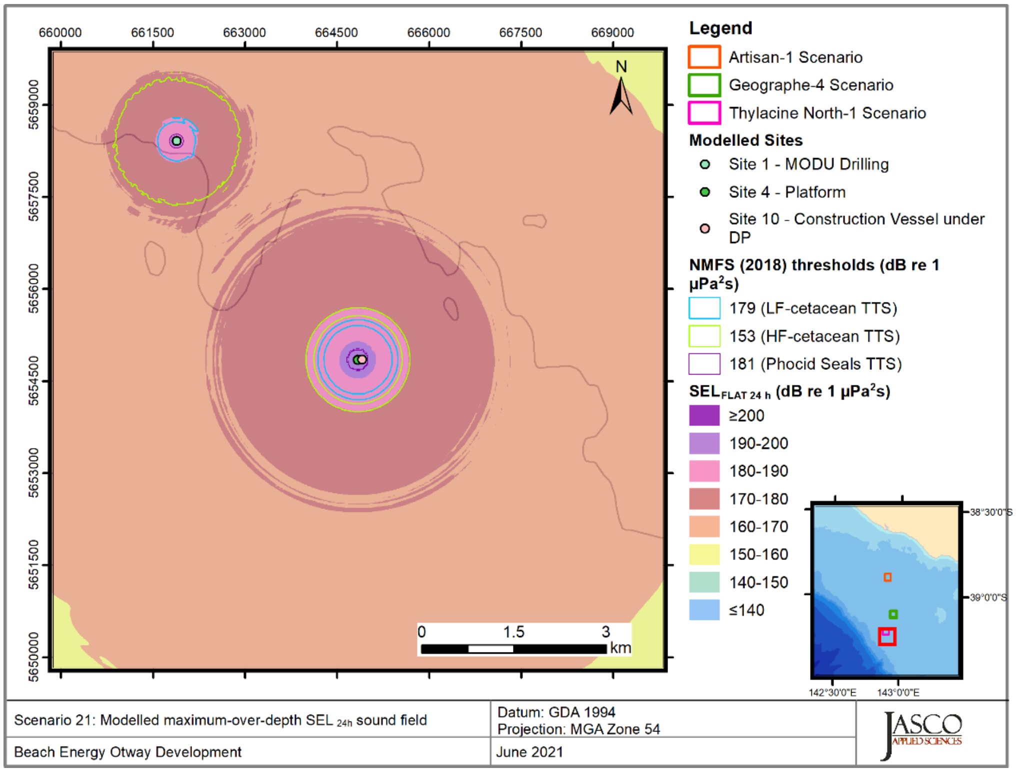

Figure 50. *Thylacine A Platform, Skid installation and MODU Drilling (Scenario 21) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

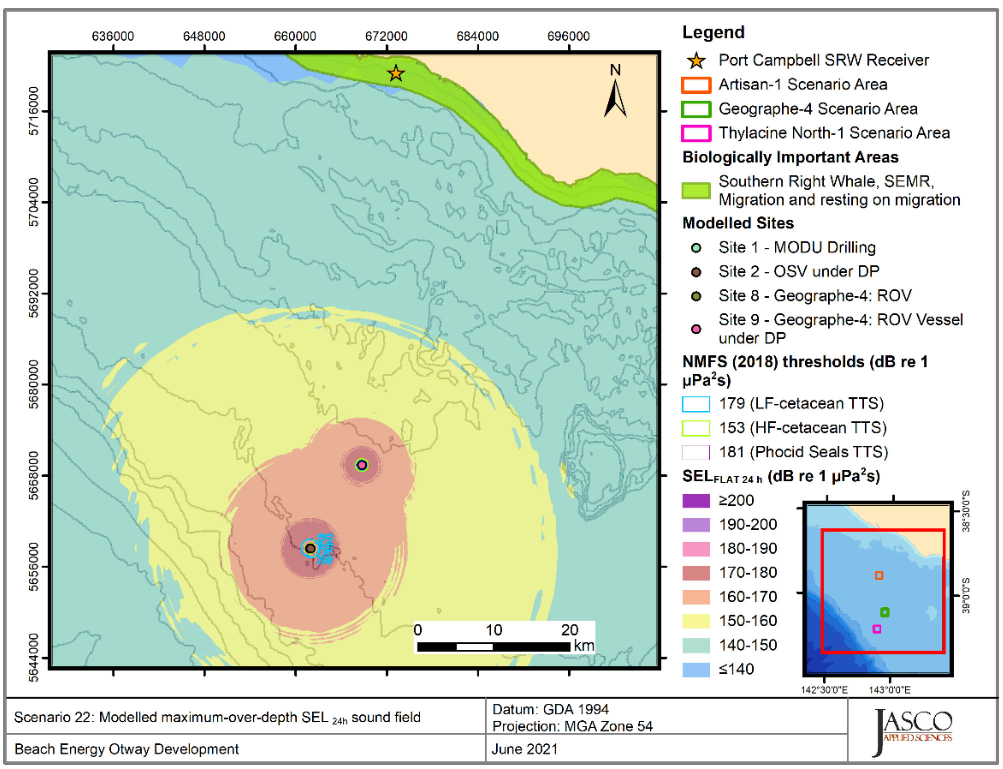

Figure 51 *Concurrent drilling operations at Thylacine North-1 and construction operations at Geographe-4 (Scenario 22) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

5. Discussion

The approach applied here to model the propagation loss was based is suitable for other locations within the continental shelf portion of the Otway Basin because it is supported by measurements of very similar operational activities (McPherson et al. 2021). However, the accuracy of the modelling propagation loss within this environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on the calcarenite seabed within Otway region. In general, for these types of sources (i.e., vessels and other sources with a significant amount of energy above a few hundred Hertz) the thinner the sand layer, the greater the propagation loss. Having accurate source and site-specific information reduces the amount of uncertainty results due to model inputs uncertainty particularly when seemingly small changes in parametrisation can have reasonable significant changes in predicted results.

The distances to the effect thresholds based on modelling conducted here and supported by the results of the measurement study McPherson et al. (2021) are generally smaller when compared to those originally presented in Koessler et al. (2020). The understanding of the environment gained through the measurement study allowed for the geological environment to be represented in a site-specific fashion, and a more appropriate configuration of numerical models to represent the environmental propagation loss particularly with the layered calcarenite seabed. The application of the revised modelling approach to represent other Beach Energy activities on the continental shelf of the Otway Basin would be appropriate.

The effect of different seasonality on predicted distances to the effect thresholds was minor but present. Considering the modelled Otway Offshore Project Construction scenarios, each scenario was modelled with a sound speed profiles for the 'worst case over the year' and for a period pygmy blue whales are present in the region, between November and January. These sound speed profiles were respectively selected as June and November. The effect thresholds applied to pygmy blue was the low-frequency cetacean SEL_{24h} thresholds based on NMFS (2018). The sound speed profile of November generally produced small distances to the low-frequency cetacean PTS and TTS threshold for the same operational activities modelled with a June SSP, see Tables 11–13. The seasonal differences were at most a few hundred metres. The receiver SPL level at the Port Campbell receiver locations presented in Table 8 are therefore expected to be lower in in November.

The SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The corresponding SEL_{24h} radii represent an unlikely worst-case scenario. More realistically, marine mammals (as well as fish and turtles) are unlikely to stay in the same location for 24 hours. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained in that location for 24 hours.

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Appendix A. Acoustic Metrics

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The sound pressure level (SPL; L_p; dB re 1 μPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to a rms pressure level and therefore not instantaneous pressure:

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

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalization, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL.

The sound exposure level (SEL; L_E; $L_{E,p}$; dB re 1 μPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

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

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, SEL can be computed by summing (in linear units) SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right). \tag{A-3}$$

Appendix B. Methods and Parameters

This section describes the specifications of the seismic source that was used at all sites and the environmental parameters used in the propagation models.

B.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure B-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure B-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure B-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

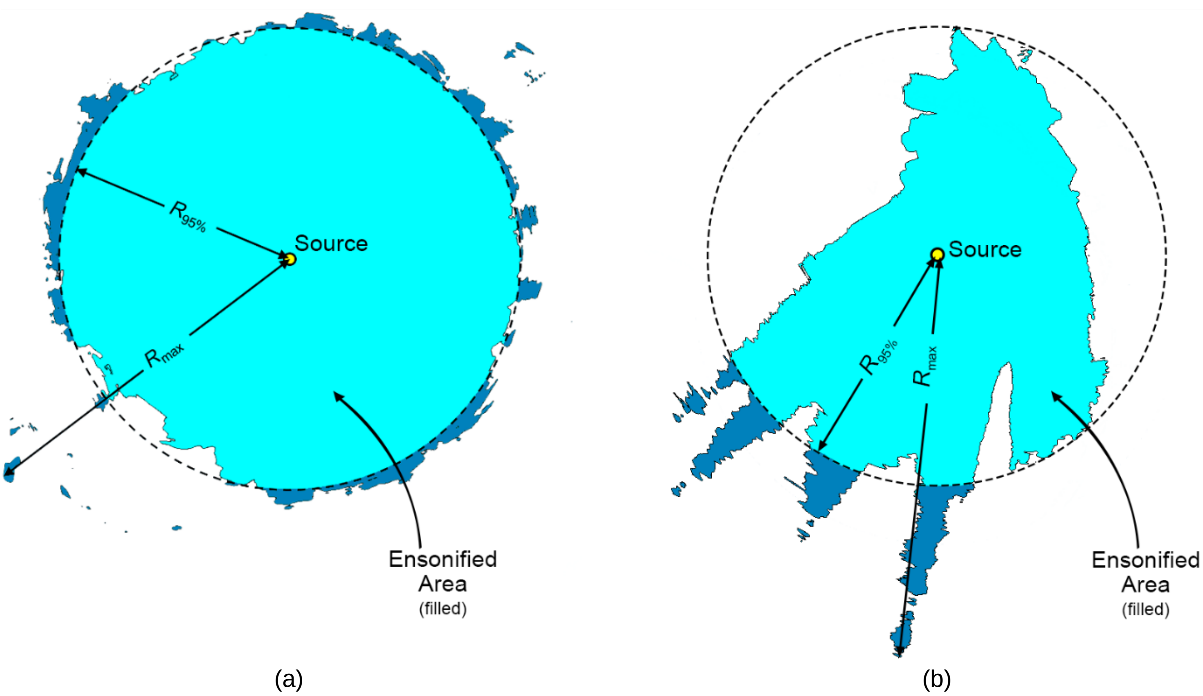

Figure B-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified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

B.2. Environmental Parameters

B.2.1. Bathymetry

Water depths throughout the modelled areas were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009). Bathymetry data were re-gridded onto a Map Grid of Australia (MGA) coordinate projection (Zone 54) with a regular grid spacing of 100 × 100 m.

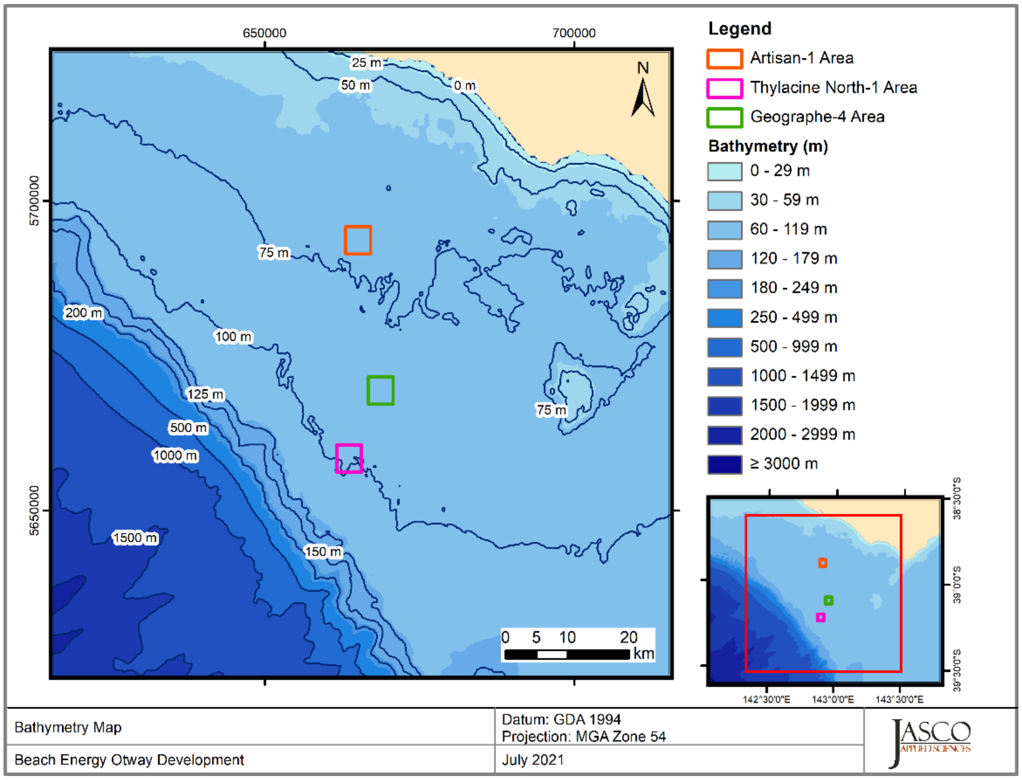

Figure B-2. Bathymetry in the modelled area.

B.2.2. Sound speed profile

The sound speed profile in the area was derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's *Generalized Digital Environmental Model V 3.0* (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

Mean monthly sound speed profiles were derived from the GDEM profiles at distances less than 7 km around the modelled site. The June sound speed profile is expected to be most favourable to longer-range sound propagation across the entire year. As such, June was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. For the pygmy blue whale period between November and January November is expected to be most favourable to longer-range propagation in that period. Figure B-3 shows the resulting profiles, which were used as input to the sound propagation modelling.

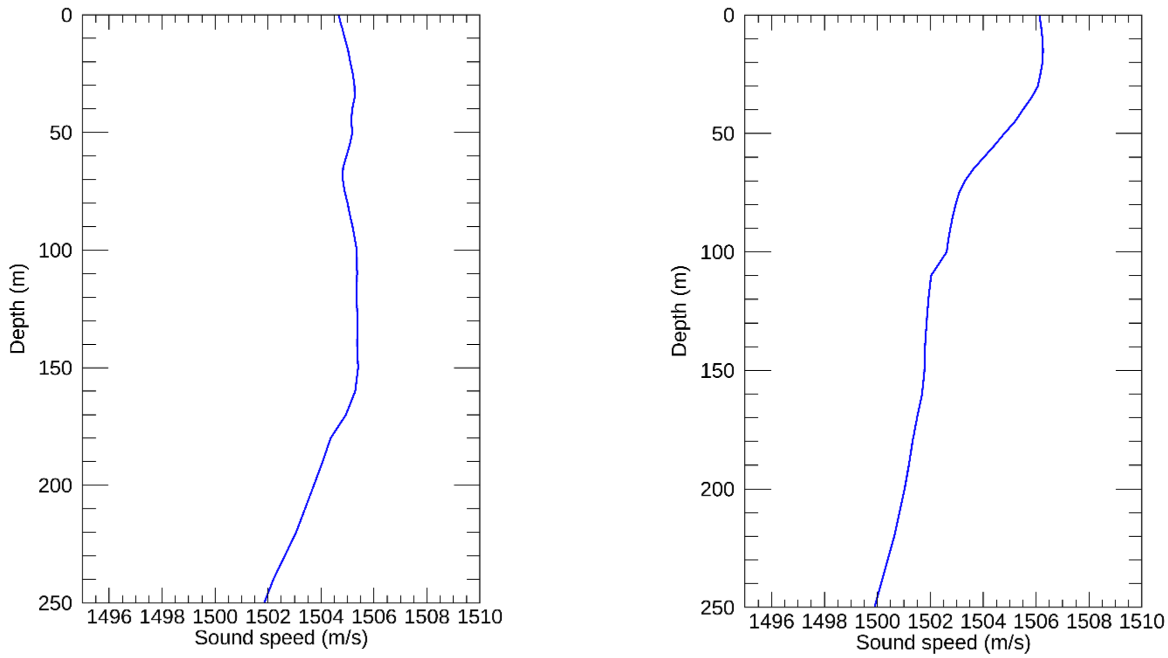

Figure B-3. The modelling sound speed profile corresponding to June (left) and November (right) Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

B.2.3. Geoacoustics

The propagation model used in this study consider a single geoacoustic profile for each development area. These profiles determine how sound is reflected from the seabed, as well as how it is transmitted, reflected and absorbed into the sediment layers. As in previous acoustic studies in the area, the modelling area was divided into two seabed types (Wood and McPherson 2018). Both areas are located on the continental shelf, however the seabed in the Thylacine North-1 and were modelled as being characterised by well-cemented carbonate caprock (calcarenite), overlying semi-cemented carbonate rock (calcarenite). This contrast in seabed environment is consistent with larger scale geological data and interpretations of the Australian continental shelf environment (James and Bone 2010). Table B-1 present the geoacoustic profile used at the modelled sites in each respective development area.

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

Depth below seafloor (m)	Predicted lithology	Density (g/cm³)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–0.5	Well-cemented carbonate caprock	2.7	2600	0.50	1200	0.5
0.5–20	Increasingly cemented calcarenite	2.2	2000	0.30	900	0.27
20-40		2.3	2120	0.34	960	0.32
40-60		2.4	2240	0.38	1020	0.41
60-80		2.5	2360	0.42	1080	0.45
80–100		2.6	2480	0.46	1140	0.5
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Appendix G Stakeholder Consultation Sensitive Information