Environment Plan

Yolla Infill Drilling

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	02/06/2022	Submitted to NOPSEMA for acceptance	DB/AF	PW	
1	17/06/2022	Submitted to NOPSEMA for acceptance	DB/AF	PW	

Review due	Review frequency
Annually from date of acceptance	Five-yearly

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

Table of contents

Table of figures

List of tables

List of appendices

Acronyms

Terms/acronyms	Definition/Expansion
3DTZSS	3D Transitions Zone Seismic Survey
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ACN	Australian Company Number
ADIOS	Automated Data Inquiry for Oil Spills
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHO	Australian Hydrographic Office
AICS	Australian Inventory of Chemical Substances
ALARP	As Low As Reasonably Possible
AMP or AMPs	Australian Marine Park/s
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
APPEA	Australian Petroleum and Production and Exploration
ARI	Average Recurrence Interval
AS	Australian Standard
ASAP	As Soon As Possible
AVG	Abalone Viral Ganglioneuritis
BIA or BIAs	Biologically Important Area/s
BoM or BOM	Bureau of Meteorology
BOP	Blow-out Preventer
BRS	Bureau of Resource Sciences
BWMC	Ballast Water Management Certificate
BWMP	Ballast Water Management Plan
CAMBA	China-Australian Migratory Bird Agreement
CBS	Central Bass Strait
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CEO	Chief Executive Officer
CFSR	Climate Forecast System Reanalysis
CHARM	Chemical Hazard Assessment and Risk Management
CM	Control Measure
CMT	Crisis Management Team
CO_2	Carbon Dioxide
COVID-19	Coronavirus Disease of 2019
CPUE	Catch Per Unit Effort
CSIRO	Commonwealth Scientific and Industrial Research Organization
DJPR	(Victoria) Department of Jobs, Precincts and Regions
DSM	Drill Site Manager

Terms/acronyms	Definition/Expansion
EAC	East Australian Current
EARPL	Esso Australia Resources Pty Ltd
EMBA or EMBAS	Environment/s that May Be Affected
EMT	Emergency Management Team
EP	Environment Plan
EPBC or EPBC Act	(Commonwealth) *Environmental Protection and Biodiversity Conservation Act*
EPO or EPOs	Environmental Performance Objective/s
EPS or EPSs	Environmental Performance Standard/s
ERP	Emergency response plan
ERT	Emergency Response Team
ESD	Ecological Sustainable Development
FFG Act	(Victoria) *Flora and Fauna Guarantee Act*
GAB	Great Australian Bight
GIS	Geographic Information System
HAZID	Hazard Identification
HF	High Frequency
HMCS	Hamonised Mandatory Control Scheme
HQ	Hazard Quotient
HSE	Health Safety and Environment
HSEMS	Health Safety and Environment Management System
HYCOM	Hybrid Coordinate Ocean Model
IAPP	International Air Pollution Prevention
ID	Identification
IFC	International Finance Corporation
IMCRA	Interim Marine and Coastal Regionalisation of Australia
IMO	International Maritime Organisation
IMP or IMPs	Invasive Marine Pest/s
IMS	Invasive Marine Species
IOGP	International Association of Oil and Gas Producers
IPCC	International Panel on Climate Change
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australian Migratory Bird Agreement
JRCC	Joint Rescue Coordination Centre
KEF or KEFs	Key Ecological Feature/s
LF	Low Frequency
LOWC	Loss Of Well Control
MARPOL	International Convention for the Prevention of Pollution from Ships.

Terms/acronyms	Definition/Expansion
MDO	Marine Diesel Oil
MMO or MMOs	Marine Mammal Observer/s
MNES	Matters of National Environmental Significance
MNP	Marine National Park
MO	Marine Order
MOC	Management Of Change
MODU	Mobile Offshore Drilling Unit
MPEC	Marine Environment Protection Committee
NA or N/A	Not Available
NADF	Non-Aqueous Drilling Fluid
NCEP	National Centre for Environmental Prediction
NEPM	National Environmental Protection Measure
NGER Act	(Commonwealth) *National Greenhouse and Energy Reporting Act*
NIA or NIAs	Nature Improvement Area/s
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NNTT	National Native Title Tribunal
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NOx	Nitrogen Oxides
NSW	New South Wales
NZ	New Zealand
OCNS	Offshore Chemical Notification Scheme
OGUK	Oil and Gas UK
OHSAS	Occupational Health and Safety
OIM	Offshore Instillation Manager
OM	Operations Manager
OPEP	Oil Pollution Emergency Plan
OPGGS Act	(Commonwealth) *Offshore Petroleum and Greenhouse Gas Storage Act*
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
PK	Peak Pressure Levels
PLONOR or PLONORs	Post Little Or No Risk/s to the environment
PMST	Protected Matters Search Tool
POB	Persons On Board
POLREP	Marine Pollution Report
PSZ	Petroleum Safety Zone
PTS	Permanent Threshold Shift

Terms/acronyms	Definition/Expansion
RMR	Riserless Mud Recovery
ROC	Rate Of Change
ROKAMBA	Republic of Korea-Australian Migratory Bird Agreement
ROV or ROVs	Remote Operational Vehicle/s
SBDF	Synthetic-based Drilling Fluid
SCE	Solids Control Equipment
SCUBA	Self-Contained Underwater Breathing Apparatus
SEEMP	Ship Energy Efficiency Management Plan
SEL_{24h}	Sound Exposure Level over 24 hours
SEMR	Southeast Marine Region
SIMAP	Spill Impact Mapping Analysis Program
SMPEP	Shipboard Marine Pollution Emergency Plan
SMS	Short Message Service
SOP or SOPs	Standard Operating Procedure/s
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Levels
SPRAT	Species Profile And Threat Database
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TARC	Total Allowable Recreational Catch
TECs	Threatened Ecological Communities
TPH	Total Petroleum Hydrocarbons
TTS	Temporary Threshold Shift
UK	United Kingdom
VFA	Victorian Fisheries Association
VHF	Very High Frequency
WBDF	Water-based Drilling Fluid
WECS	Well Engineering Construction Management Systems

1 Overview of the Activity

Beach Energy (Operations) Limited (Beach) proposes to drill a single new infill well in Commonwealth waters 147 km south of Kilcunda (Victoria) in Bass Strait. The proposed well location is at a water depth of approximately 80 m.

The Operational Area for the Yolla Infill Drilling program is defined as a 2 km radius around the MODU whilst on location. The 2 km radius encompasses the existing 500 m Petroleum Safety Zone.

Drilling and support operations are conducted on a 24-hour basis for the duration of the program. Activities included in the scope of this Environment Plan (EP) are detailed in Section 4. Activities excluded from the scope of this EP include:

- activities associated with the establishment and operation of a shore base to support the activity which are regulated by the relevant State government
- vessels transiting to or from the Operational Area. The vessels are deemed to be operating under the Commonwealth *Navigation Act 2012* and not performing a petroleum activity whilst outside the Operational Area
- flowing of hydrocarbons from the Yolla 7 Well to the Yolla-A platform (i.e. start-up and operations)
- mobilisation of the MODU into Australian Commonwealth waters and Victorian State waters, and associated biosecurity and ballast water management prior to the arrival of the MODU to the well location. The MODU is subject to biosecurity control on entering Australian territory (12 nm offshore) in accordance with the *Biosecurity Act 2015*. Ballast water must be managed in accordance with the Australian Ballast Water Management Requirements Rev 8. Both biosecurity and ballast water management are administered by the Commonwealth Department of Agriculture, Water and Environment (DAWE). The planned mobilisation of the MODU into Victorian waters prior to the commencement of drilling activities in Commonwealth waters is administered by Victorian State regulators and the Victorian Port. Biosecurity and ballast water management of the MODU prior to the movement of the MODU to the well location is managed directly by and remains the responsibility of the Drilling Contractor.

1.1 Environment Plan Summary

This Yolla Infill Drilling 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)(a) 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 4.1
A description of the receiving environment	Section 5
A description of the activity	Section 4
Details of the environmental impacts and risks	Section 7
The control measures for the activity	Section 7
The arrangements for ongoing monitoring of the titleholder's environmental performance	Section 7
Response arrangements in the oil pollution emergency plan	Section 7.16
Consultation already undertaken and plans for ongoing consultation	Section 9
Details of the titleholders nominated liaison person for the activity	Section 2.2

2 Introduction

This document has been prepared to meet the requirements of an EP under the OPGGS(E)R. It addresses the activities associated with the Yolla Infill Drilling Program located in Commonwealth waters in the Bass Strait off the coast of Victoria.

This activity is located in Production Licence T/L1. Figure 2-1 details the proposed location of the infill well and the Yolla-A platform.

2.1 Background

Beach Energy (Operations) Ltd (Beach) is the Operator of the BassGas Development. The BassGas Development consists of gas and liquids produced from the Yolla gas field that are transported via a subsea pipeline to the Victorian mainland via a coastal crossing near Kilcunda. Commercial gas production started in June 2006.

The purpose of the Yolla Infill Drilling Program is to exploit additional gas reserves within T/L1 to maintain production capacity at the Yolla-A platform.

2.2 Titleholder and liaison person details

Beach is the operator of production licence T/L1. Table 2-1 details the titleholders 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 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.

In accordance with the Regulation 15(3) of the OPGGS(E)R Beach shall notify the Regulator (National Offshore Petroleum Safety and Environmental Management Authority [NOPSEMA]) of a change to the 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 during the proposed activity.

Table 2-1 Details of titleholder and liaison person

Petroleum Title	**Details**	
T/L1	Titleholders	Beach Energy (Operations) Limited – Operator Beach Energy (Bass Gas) Limited Beach Energy Limited Prize Petroleum International Pte. 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	Beach Energy (Operations) Limited (ACN: 007 845 338)
Titleholder Liaison Person		
Ming Hwa Lee Lead Drilling Engineer	Business address	Level 4, 80 Flinders Street, Adelaide, South Australia 5000
	Telephone number	(08) 8115 5232
	Fax number	(08) 8338 2336
	Email address	info@beachenergy.com.au

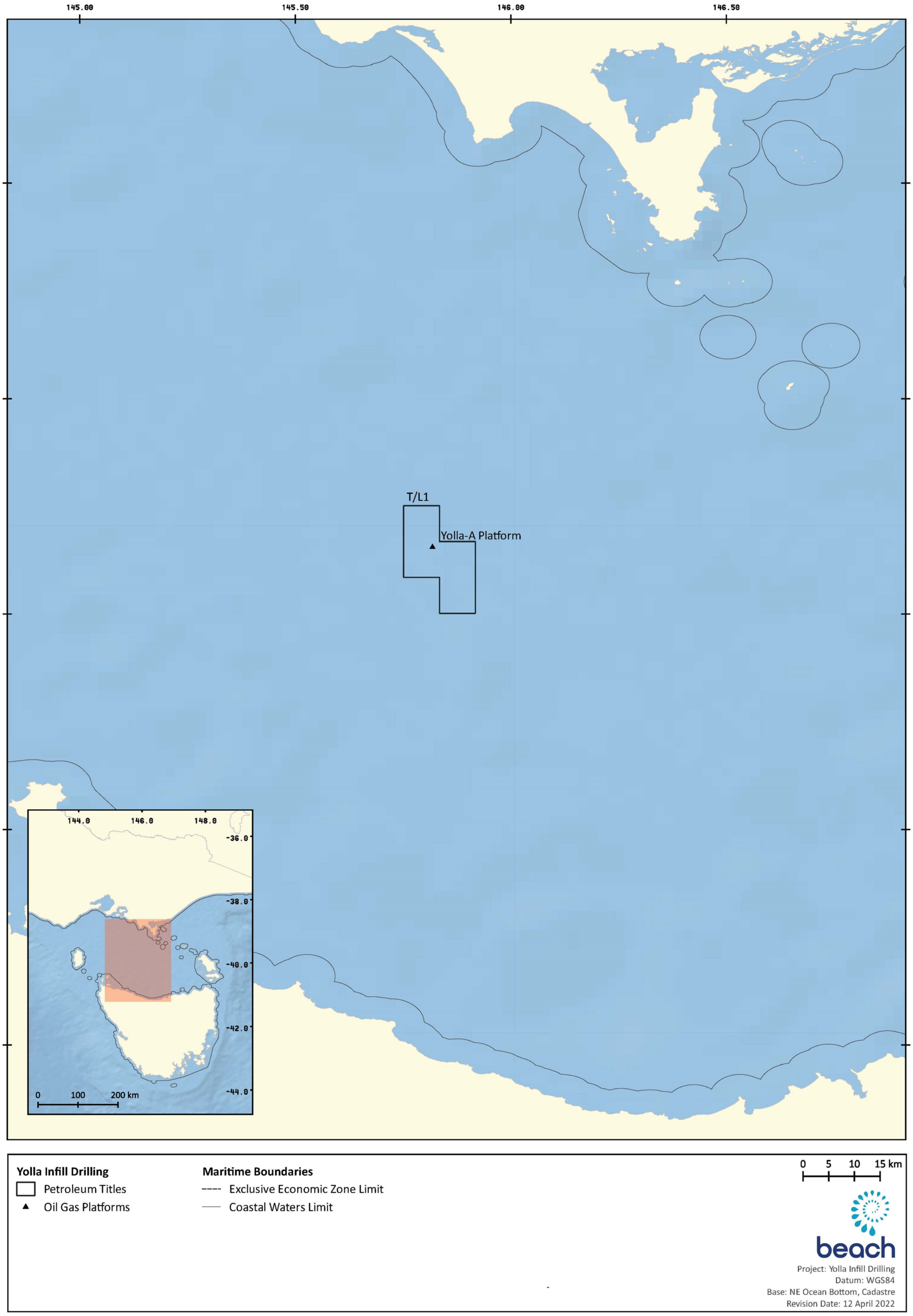


Figure 2-1 Location Map

3 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 within Commonwealth waters. Commonwealth legislation (including relevant international conventions) and other requirements relevant to the petroleum activity are summarised in Table 3-3.

Although activities under this EP are located entirely in Commonwealth waters, Victorian and Tasmanian legislation relevant to offshore petroleum activities is described in Table 3-4 and Table 3-5 on the basis that a worst-case credible oil spill has the potential to intersect Victorian or Tasmanian waters.

3.1 Environment Protection and Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the key legislation regulating projects that may have an impact on matters of national environmental significance (MNES). The Commonwealth Department of Agriculture, Water and the Environment (DAWE) (formerly the Department of the Environment and Energy (DoEE)) is the Regulator of the EPBC Act.

In February 2014, NOPSEMA became the sole designated assessor of petroleum and GHG activities in Commonwealth waters in accordance with the Minister for the Environment's endorsement of NOPSEMA's environmental authorisation process under Part 10, section 146 of the EPBC Act. Under the streamlined arrangements, impacts on the Commonwealth marine area by petroleum and GHG activities are assessed solely through NOPSEMA.

No Offshore Project Proposal exists for this asset, as the development's Environmental Impact Statement (EIS) and resulting EPBC Decision 2001/321 gave the previous titleholder approval, with conditions, to construct and operate the production wells in the Yolla gas field, the Yolla offshore production facility, the onshore and offshore pipelines, an onshore gas treatment and compression plant and an onshore pipeline. As the development includes drilling of production wells, approved under Part 9 of the EPBC Act, no further approvals are required.

In 2015, the approval conditions under EPBC 2001/321 were subject to a variation given the transfer of powers under the EPBC Act to NOPSEMA under the OPGGS Act. Specifically, conditions that are relevant to this EP are included in Table 3-1.

Table 3-1 EPBC 2001/321 conditions

Condition		Relevant section of this EP
1	The person taking the action must submit for the Minister's approval, prior to commencing offshore drilling, an Offshore Environmental Management Plan which addresses the following matters: • monitoring acoustic noise during construction and operation; and • details of hydrotest water additives and drilling muds to demonstrate low toxicity. The approved plan must be implemented.	See Condition 5
2	The person taking the action must submit for the Minister's approval, prior to the Yolla offshore production facility commencing operations, an Oil Spill Contingency Plan. The approved plan must be implemented.	See Condition 5
5	A plan required by condition 1 or 2 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; and b) either: i) is in force under the OPGGS Environment Regulations; or ii) has ended in accordance with regulation 25A of the OPGGS Environment Regulations.	This Environment Plan is taken to fulfil the commitments under EPBC 2001/321 in line with Condition 5.

3.2 EPBC Act Requirements

In addition to the primary approval, this EP further considers the impacts to MNES protected under Part 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Relevant requirements associated with the Primary Approval, EBPC Act, related policies, guidelines, plans of management, recovery plans, threat abatement plans and other relevant advice issued by the Department of the Environment and Energy (DoEE), now DAWE, are detailed in the applicable sections within Section 5 as part of the description of the existing environment. The recovery plans, threat abatement plans and species conservation advices applicable to species, are detailed in Table 3-2.

Table 3-2 Recovery plans, threat abatement plans and species conservation advices relevant to the activity

Relevant Plan/Advice	**Description**	**Relevant conservation objectives / actions**
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.
Birds		
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.
Lord Howe Island biodiversity management plan (DECC 2007)	The Management plan is a co-ordinated conservation strategy for all biodiversity within the Lord Howe Island Group listed as threatened.	Prevent Habitat degradation / erosion. **Marine debris** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
Threatened Tasmanian Eagles Recovery Plan: 2006 – 2010 (DPIaW 2006)	This recovery plan is a co-ordinated conservation strategy for two species, the wedge-tailed eagle and the white-bellied Sea-eagle.	**Marine debris** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
National Recovery Plan for *Anthochaera phrygia* (Regent Honeyeater) (DoE 2016)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the regent honeyeater.	None Identified.
Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (TSSC 2019b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australasian bittern.	None Identified.
Approved Conservation Advice for *Caldris cantus* (Red Knot) (TSSC 2016a)	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 *Calidris ferruginea* (Curlew Sandpiper) (TSSC 2015e)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the curlew sandpiper.	Prevent habitat degradation / loss (oil pollution).

Relevant Plan/Advice	Description	Relevant conservation objectives / actions
Approved Conservation Advice for *Calidris tenuirostris* (Great Knot) (TSSC 2016b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the great knot.	Prevent habitat degradation / loss (oil pollution and exploration).
Approved Conservation Advice for *Ceyx azureus diemenensis* (Tasmanian Azure Kingfisher) (TSSC 2010)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Tasmanian azure kingfisher.	None Identified.
Approved Conservation Advice for *Charadrius leschenaultia* (Greater Sand Plover) (TSSC 2016c)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the greater sand plover.	Prevent habitat degradation / loss (oil pollution and exploration).
Approved Conservation Advice for *Charadrius mongolus* (Lesser Sand Plover) (TSSC 2016d)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the lesser sand plover.	Prevent habitat degradation / loss (oil pollution and exploration).
National Recovery Plan for *Dasyornis brachypterus* (Eastern Bristlebird) (OEH 2012)	The recovery plan is a co-ordinated conservation strategy for the eastern bristlebird.	None Identified.
Approved Conservation Advice for *Falco hypoleucos* (Grey Falcon) (TSSC 2020b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the grey falcon.	None Identified.
Approved conservation Advice for *Grantiella picta* (Painted Honeyeater) (TSSC 2015f)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the painted honeyeater.	None Identified.
Approved Conservation Advice for *Halobaena caerulea* (Blue Petrel) (TSSC 2015g)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the blue petrel.	None Identified.
Approved Conservation Advice *for Hirundapus caudacutus* (White-throated Needletail) (TSSC 2019a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the white-throated needletail.	None Identified.
National Recovery Plan for *Lathamus discolor* (Swift Parrot) (Saunders and Tzaros 2011)	The recovery plan is a co-ordinated conservation strategy for the swift parrot.	None Identified.
Approved Conservation Advice for *Limosa lapponica baueri* (Bar-tailed Godwit (western Alaskan)) (TSSC 2016f)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the bar-tailed godwit (western Alaskan).	Prevent habitat degradation / loss.
National Recovery Plan for *Neophema chrysogaste* (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.
Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (TSSC 2015i)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the eastern curlew.	Prevent habitat degradation / loss (oil pollution).
Approved Conservation Advice for *Pachyptila tutur subantarctica* (Fairy Prion (southern)) (TSSC 2015h)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy prion (southern).	None Identified.

Relevant Plan/Advice	Description	Relevant conservation objectives / actions
National Recovery Plan for *Pardalotus quadraginatus* (Forty-Spotted Pardalote) (DPIaW 2006)	The recovery plan is a co-ordinated conservation strategy for the forty-spotted pardalote.	None Identified.
Approved Conservation Advice for *Platycercus caledonicus brownie* (Green Rosella (King Island)) (TSSC 2015j)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the green rosella (King Island).	None Identified.
National Recovery Plan for *Pterodroma leucoptera* (Gould's Petrel) (DEC 2006)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Gould's petrel.	None Identified.
Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged Petrel) (TSSC 2015k)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the soft-plumaged petrel.	None Identified.
Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (DSEWPaC 2013b)	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 *Sternula nereis* (Australian Fairy Tern) (Commonwealth of Australia 2019)	Draft recovery plan for actions so species no longer qualifies for listing as threatened under any of the EPBC Act listing criteria.	Prevent Habitat degradation and loss of breeding habitat via Pollution.
Approved Conservation Advice for *Strepera fuliginosa colei* (Black Currawong (King Island)) (TSSC 2015m)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the black currawong (King Island).	None Identified.
Approved Conservation Advice for *Thalassarche cauta* (Shy Albatross) (TSSC 2020a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the shy albatross.	**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 *Thalassarche chrysostoma* (Grey-headed Albatross) (DEWHA 2009)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the grey-headed albatross.	**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 *Thinornis rubricollis* (Hooded Plover (eastern)) (DoE 2014a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the hooded plover (eastern).	**Marine Pollution** Prepare oil spill response plans to ensure effective rehabilitation of oiled birds. **Marine debris** Reduce in-shore marine debris, including educating fishers and the public to properly dispose of fishing lines.
Approved Conservation Advice for *Tyto novaehollandiae castanops* (Tasmanian Masked Owl) (DEWHA 2010)	Conservation advice provides management actions that can be	None Identified.

Relevant Plan/Advice	Description	Relevant conservation objectives / actions
	undertaken to ensure the conservation of the Tasmanian masked owl.	
Crustaceans		
Recovery Plan for *Astacopsis gouldi* (Giant Freshwater Crayfish) (DoE 2017)	The recovery plan is a co-ordinated conservation strategy for the giant freshwater crayfish.	None Identified.
Approved Conservation Advice for *Engaeus martigener* (Furneaux Burrowing Crayfish) (TSSC 2016e)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the furneaux burrowing crayfish.	None Identified
Fish		
Approved Conservation Advice for *Epinephelus daemelii* (Black Cod) (DSEWPaC 2012b)	Identify and mitigate key threats to the black cod and undertake priority research actions.	None Identified.
National Recovery Plan for *Galaxiella pusilla* (Dwarf Galaxias) (Saddlier, Jackson and Hammer 2010)	Support development in the wild. This is achieved through maintaining the extent of existing habitat and increasing community awareness and support.	None Identified.
National Recovery Plan for *Nannoperca obscura* (Yarra Pygmy Perch) (Saddlier and Hammer 2010)	Details its distribution, habitat, conservation status, threats, and recovery objectives and actions necessary to ensure the long-term survival of the yarra pygmy perch.	None Identified.
National Recovery Plan for *Prototroctes maraena* (Australian Grayling) (Backhouse, Jackson and O'Connor 2008)	Details the species' distribution and biology, conservation status, threats, and recovery objectives and actions necessary to ensure the long-term survival of the Australian grayling.	**Marine Pollution** Manage water quality where Australian Grayling occurs to maintain waters free of significant levels of nutrient, sediment, pesticide and other pollutants, consistent with the ANZECC guidelines for water quality. Impact of introduced fish: Typically, from onshore sources.
Recovery Plan for *Carcharias taurus* (Grey Nurse Shark) (DoE 2014b)	Improve the population status of the grey nurse shark to remove from threatened species list and ensure anthropogenic activities do not hinder the species recovery in the near future.	**Marine Pollution** Evaluate habitat degradation from pollution (coastal development and persistent toxic pollutants).
Recovery Plan for *Carcharodon carcharias* (White Shark) (DSEWPaC 2013a)	Mitigate key threats to the white shark and to assist the recovery of the white shark throughout its range in Australian waters.	**Marine Pollution** Evaluate habitat degradation from pollution (coastal development and persistent toxic pollutants).
Approved Conservation Advice for *Rhincodon typus* (Whale Shark) (TSSC 2015l)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the whale shark.	**Marine Pollution** Evaluate habitat disruption from mineral exploration, production and transportation. **Vessel disturbance** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Raja sp. L* (Maugean Skate) (DEWHA 2008a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the maugean skate.	**Marine Pollution** Manage any changes to hydrology that may result in changes to the water table levels, increased run-off, sedimentation or pollution.
Cetaceans		

Relevant Plan/Advice	Description	Relevant conservation objectives / actions
Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC 2015c)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the sei whale.	**Marine Pollution** Evaluate habitat degradation from pollution (increasing port expansion and coastal development and persistent toxic pollutants). **Noise interference** Evaluate risk of anthropogenic noise and acoustic disturbance 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 *Balaenoptera musculus* (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 anthropogenic noise and acoustic disturbance 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 2015d)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the fin whale.	**Marine Pollution** Evaluate habitat degradation from pollution (increasing port expansion and coastal development and persistent toxic pollutants). **Noise interference** Evaluate risk of anthropogenic noise and acoustic disturbance 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 *Eubalaena australis* (Southern Right Whale) (DSEWPaC 2012a)	Conservation management plan provides threat abatement activities that can be undertaken to ensure the conservation of the southern right whale.	**Marine Pollution** Evaluate habitat degradation from pollution (increasing port expansion and coastal development and persistent toxic pollutants). **Noise interference** Evaluate risk of anthropogenic noise and acoustic disturbance 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.
Reptiles		
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

Relevant Plan/Advice	Description	Relevant conservation objectives / actions
		• noise interference • vessel disturbance.
Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA 2008b)	See above for the Recovery plan for marine turtles in Australia, 2017-2027.	

3.3 Commonwealth Legislation

A summary of Commonwealth legislation and related international conventions are provided in Table 3-2.

Legislation relevant to this EP within the state jurisdiction of Victoria, Tasmania and New South Wales, is provided in Table 3-4, Table 3-5 and Table 3-6 respectively.

Table 3-3 Relevant Commonwealth environmental legislation

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 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 Victorian OPEP (CDN/ID 18986979).	International Convention on Oil Pollution Preparedness, Response and Cooperation 1990. Protocol on Preparedness, Response and Cooperation 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 19 and 221 of the United Nations Convention on the Law of the Sea 1982.	Australian Maritime Safety Authority (AMSA)
Australian Ballast Water Management Requirements (DAWE 2020c)	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 7.11 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 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 nm from the coastline. Biosecurity risks associated with the activity are detailed in Section 7.11. For the activity the Act regulates vessels entering Australian territory regarding ballast water and hull fouling.	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
National Greenhouse and Energy Reporting Act 2007 (NGER) (and Regulations 2008)	Establishes the legislative framework for the NGER Scheme, which is a national framework for reporting GHG emissions, GHG projects and energy consumption and production by corporations in Australia. **Application to activity**: Beach is a registered reporter under this Act (ABN 200 076 179 69). The development as a whole triggers this legislation because of the volume of emissions from the various assets. Section 7.3 details how these requirements are applied	UNFCCC 1994.	Clean Energy Regulator
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 7.5 details the requirements applicable to vessel activities.	-	DAWE
Native Title Act 1993	Allows for recognition of native title through a claims and mediation process and also sets up regimes for obtaining interests in lands or waters where native title may exist. **Application to activity**: Identification of the presence of Native title claims and assessment of any impacts and risks to these sites. Section 5.9.3 details the Native Title claims relevant to this activity.	-	Department of Families, Housing, Community Services and Indigenous Affairs
Navigation Act 2012	This Act regulates ship-related activities in Commonwealth waters 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 the environmental and social management 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 relevant vessels (according to class) adhere with the relevant MO with regard to navigation and preventing collisions in Commonwealth waters. Section 7 details the requirements applicable to vessel activities.	Certain sections of MARPOL International Convention for the Safety of Life at Sea 1974 COLREG 1972	AMSA
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 3 nm limit.	-	NOPSEMA

Legislation	Scope	Related International Conventions	Administering Authority
	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 as low as reasonably practicable (ALARP) • so that environmental impacts and risks of the activity are of an acceptable level. Demonstration that the activity is to 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 7. Section 572 of the OPGGSA requires all structures, equipment and other property in the title areas to be maintained in good condition and repair. In addition, a titleholder must remove from the title area all structures, equipment and other property that are neither used nor to be used in connection with operations The scope of this EP includes the permanent plug and abandonment of wells Section 4.5.4 in the unexpected event that the drilling program is unsuccessful. A successful program results in the well entering into production and maintenance under the BassGas operations EP.		
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (and Regulations 1994)	Regulates 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: • MO 91: Marine Pollution Prevention – Oil • MO 93: Marine Pollution Prevention – Noxious Liquid Substances • MO 95: Marine Pollution Prevention – Garbage • MO 96: Marine Pollution Prevention – Sewage • MO 97: Marine Pollution Prevention – Air Pollution • MO 98: Marine Pollution Prevention – Anti-fouling Systems.	Various parts of MARPOL.	AMSA

Legislation	Scope	Related International Conventions	Administering Authority
	Section 7 details the requirements applicable to vessel and MODU 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 7 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 is specified. **Application to activity**: In the event of removal, damage or interference to shipwrecks, sunken aircraft or relics declared to be historic under the legislation, activity is proposed with declared protection zones, or there is the discovery of shipwrecks or relics. Section 5.9.1 identifies no known shipwrecks of sunken aircraft in the Operational Area.	Agreement between the Netherlands and Australia concerning old Dutch Shipwrecks 1972.	DAWE

Table 3-4 Victorian environment legislation relevant to potential impacts and risk in State waters and lands

Legislation	Scope	Application to Activity	Administering Authority
Environment Protection Act 1970 (and 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 (Department of Jobs, Precincts and Regions [DJPR]) with EPA enforcement consistent with the *Environment Protection Act 1970* and the *Pollution of Waters by Oil & Noxious Substances Act 1986*	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
	• 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.		
Emergency Management Act 2013 (and 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 is triggered in the event of a spill impacting or potentially impacting State waters. See OPEP (CDN/ID 18986979).	Department of Justice and Regulation (Inspector General for Emergency Management)
Flora and Fauna Guarantee Act 1988 (and 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 (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) in state waters.	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)
Marine Safety Act 2010 (and 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	Applies to vessel masters, owners, crew operating vessels in Victorian State waters.	Maritime Safety Victoria

Legislation	Scope	Application to Activity	Administering Authority
	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.		
National Parks Act 1975	This Act 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) (and 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

Table 3-5 Tasmanian environment legislation relevant to potential impacts and risk in State waters and lands

Legislation	Scope	Application to Activity	Administering Authority
Environmental Management and Pollution Control Act 1994 (EMPCA) (and 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 (CDN/ID 18986979).	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 state waters.	DPIPWE

Table 3-6 NSW environment legislation relevant to potential impacts and risk in state waters and lands

Legislation	Scope	Application to Activity	Administering Authority
Marine Pollution Act 2012 (and Regulations 2014)	This Act is designed to protect State waters from pollution by oil and other substances and to provide the Minister with powers of intervention with regard to detaining or directing commercial and trading vessels.	Gives effect to MARPOL in NSW state waters.	AMSA, in conjunction with the Minister
Protection of the Environment Operations Act 1997 (and Protection of the Environment Operations (General) Regulations 2009)	This Act applies to all navigable waters, with authorised officers have powers to non-pilotage vessels to give clean-up directions and direct a person to take preventative action.	Defines EPA's jurisdiction in the event of an oil spill in NSW state waters.	EPA in conjunction with relevant Local Government Authorities (LGA)
Ports and Maritime Administration Act 1995	This Act provides for the relevant port authority (in this case, Port Authority of NSW (Eden)) to exercise port safety functions, which involves providing or arranging for the provision of emergency environment protection services for responding to pollution incidents and carrying out investigations into marine incidents.	The Port Authority is the lead agency for emergency response to marine pollution events and assists coordinated response to any serious marine incident in NSW state waters.	Port Authority of New South Wales

3.4 Commonwealth guidance material

This EP has been prepared considering the following regulatory guidance:

- APPEA - Australian Offshore Titleholders Source Control Guideline (APPEA 2021)
- AMSA - Technical guidelines for preparing contingency plans for marine and coastal facilities (AMSA 2015b)
- AMSA - National Plan for Maritime Environmental Emergencies (the NatPlan)
- Commonwealth of Australia - National Light Pollution Guidelines for Wildlife (Commonwealth of Australia 2020a)
- Commonwealth of Australia - National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2018)
- Commonwealth of Australia Guidance on key terms within the Blue Whale Conservation Management Plan (DAWE 2021a)
- Commonwealth of Australia - Matters of National Environmental Significance: Significant Guidelines 1.1 (Commonwealth of Australia 2013)
- NOPSEMA - Bulletin #1: Oil Spill Modelling – Rev 0 (A652993) (2019)
- NOPSEMA - EP Decision making guidelines (NOPSEMA 2018)
- IFC - Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development (IFC 2015)
- NOPSEMA - Guideline When to submit a proposed revision of an EP (N04750-GL1705, Rev 1, January 2017).

3.5 Industry codes of practice and guideline material

This EP has been prepared considering the following petroleum industry codes of practice and guidance material:

- IFC environmental, health, and safety guidelines for offshore oil and gas development (IFC 2015). These guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP) and contain the performance levels and measures that are generally considered to be reasonably achievable, depending on the impacts and risks associated with the activity.
- Australian Maritime Safety Authority (AMSA) technical guidelines for preparing contingency plans for marine and coastal facilities (AMSA 2015b)
- Australian Standard AS ISO 31000:2018 Risk Management and Handbook 203:2012 Managing Environment related Risk
- ISO 14001 (Environmental Management)
- ISO 31000 (Risk Management)
- ISO 45001 (Occupational Health and Safety Management Systems).

4 Activity Description

This chapter provides a description of the Yolla infill drilling activities in accordance with Regulation 13(1) of the OPGGS(E) and Regulation 15(1) of the OPGGS Regulations.

4.1 Activity location

This EP provides for an infill well (potential re-spud / sidetrack) in Commonwealth waters, at a water depth of approximately 80 m. Indicative coordinates for the proposed well is presented in Table 4-1.

Although the well is planned to be drilled from an existing rig slot on the Yolla-A platform, the well is an extended reach well that is planned to primarily intersect the Yolla West Target. In the event the Yolla West target is not commercially viable, the well would be plugged back to a predetermined depth and then sidetracked to drill to the Yolla North target. The Yolla West and Yolla North Targets are depicted graphically in Figure 4-1.

Table 4-1 Well coordinates (GDA94)

Well name	Latitude	Longitude
Yolla 7 / Yolla 7 DW1	39°50'40.6496"S	145°49'6.0434"E

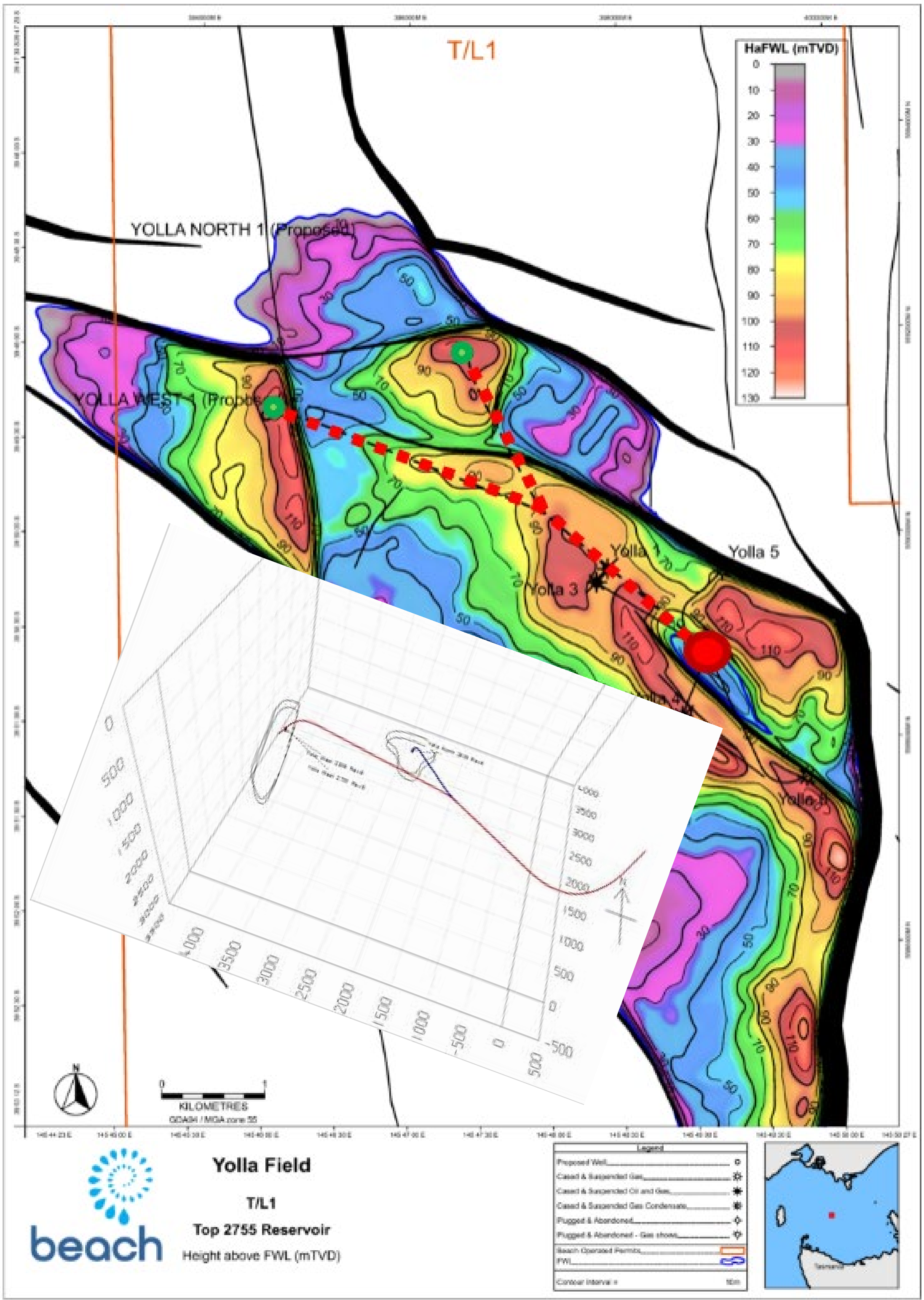


Figure 4-1 Yolla West and Contingent Yolla North Targets

4.2 Operational Area

The Operational Area has been defined as the area within which routine drilling operations occur at the well site. For this drilling activity, the Operational Area is a 2 km radius around the MODU whilst the MODU is on location (Figure 4-2). This radius encompasses the 500 m rig safety exclusion zone and existing petroleum safety zone (PSZ) around the Yolla-A platform.

4.3 Activity timing

The activity is scheduled to commence Q4 2022. Activities are expected to take approximately 130 days, depending on the final work program and potential operational delays. Consequently, the activities are planned to be completed by Q4 2023 subject to operational delays.

Drilling and support operations will be conducted on a 24-hour basis for the duration of the program.

4.4 Field characteristics

Previous seismic investigation in the region has identified multiple stacked reservoirs. The proposed infill well will target one (or multiple) isolated gas pockets. The infill drilling activity is located at the Yolla-A platform, which accommodates four producing wells: Yolla-3, Yolla-4, Yolla-5 and Yolla-6. These wells access the Yolla gas field. The proposed infill well is targeting the same formation, and subsurface structure as the existing Yolla wells. Based upon the knowledge of the existing formation, the reservoir fluids are expected to be of a similar nature to that of the Yolla gas field.

The reservoir fluid produced to surface (raw gas) by the existing Yolla wells consists of hydrocarbon gas and liquids, condensed water vapour and formation water. The Yolla gas field reservoir contains 65-70 % methane (C_1), 17-20 % carbon dioxide (CO_2), 5-8 % ethane (C_2) and smaller quantities of heavier hydrocarbons. Reservoir fluid composition for each well is detailed in Table 4-2.

Yolla condensate is low in viscosity and has a high proportion (98.5 %) of non-persistent components. Table 4-3 presents the physical characteristics of the Yolla condensate, verifying its highly volatile nature (i.e., it is quick to weather).

Well fluid contaminants include hydrogen sulphide (H_2S), mercury (Hg), radon (Rn) and CO_2. Maximum H_2S levels in the well fluids are approximately 40 parts per million (ppm) and the range for mercury is 100-1,000 microgram per standard cubic metre ($\mu g/sm^3$). Radon levels detected in onshore equipment have been below the threshold limits of 50 millisievert per hour (µSV/h) (Radiation Regulation 2007).

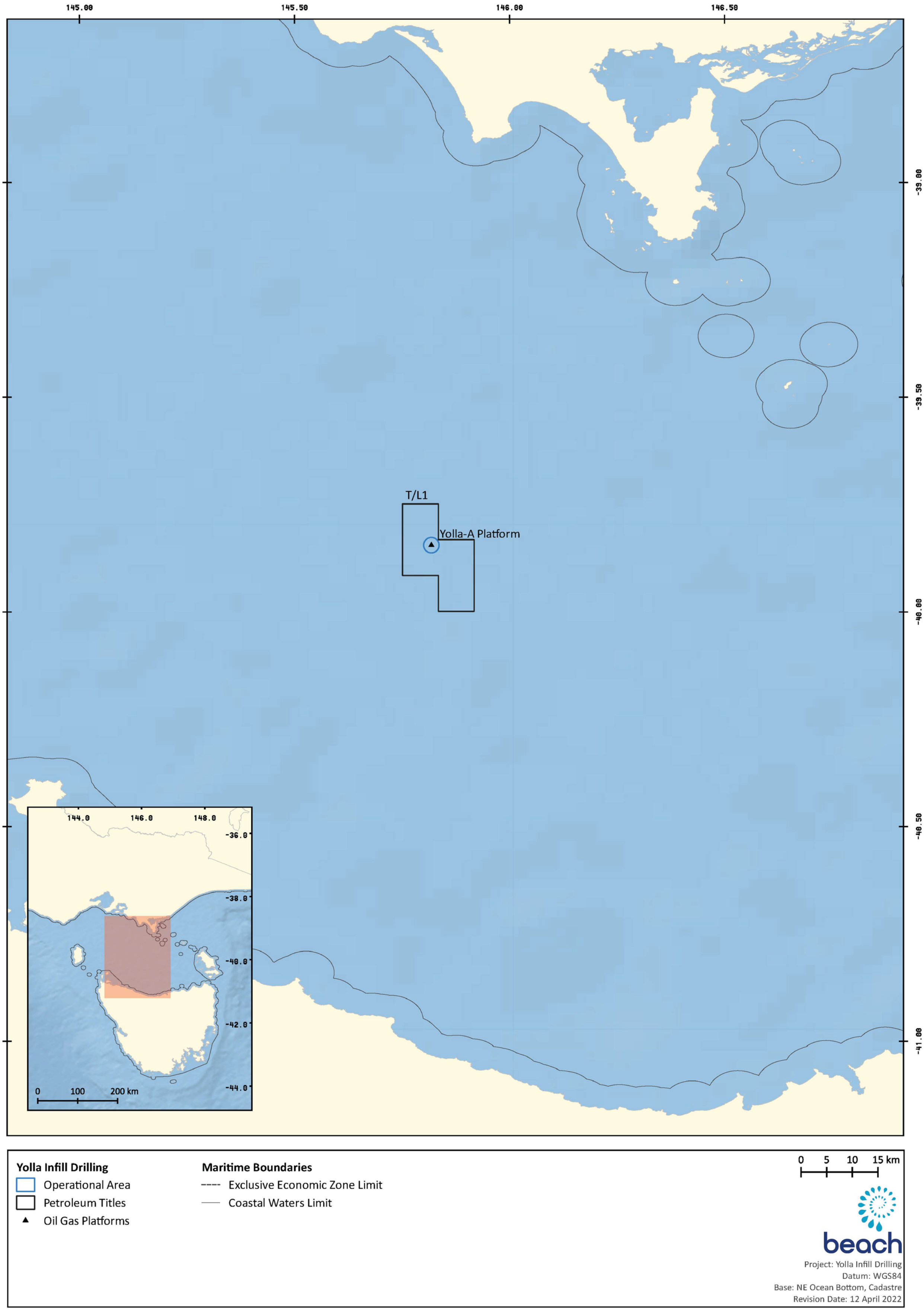


Figure 4-2 Operational Area for the Yolla infill drilling activities

Table 4-2 Yolla reservoir fluids composition

Well	**Yolla-3**	**Yolla-4**	**Yolla-5**	**Yolla-6**
Sample Date	08/09/2004	02/08/2007	21/07/2015	18/6/2015
Composition (mol %)				
CO_2 (carbon dioxide)	18.86	20.33	20.47	20.34
N_2 (nitrogen)	0.16	0.22	0.19	0.24
C_1 (methane)	67.16	67.27	66.45	66.72
C_2 (ethane)	6.49	6.38	6.79	6.59
C_3 (propane)	2.76	2.59	2.97	2.75
iC_4	0.48	0.42	0.46	0.48
nC_4	0.77	0.67	0.72	0.76
iC_5	0.26	0.20	0.21	0.25
nC_5	0.27	0.20	0.22	0.26
C_6	0.43	0.29	0.24	0.32
C_7	0.70	0.39	0.37	0.44
C_8	0.65	0.25	0.26	0.26
C_9	0.36	0.22	0.24	0.23
C_{10}	0.19	0.12	0.13	0.14
C_{11}	0.10	0.07	0.07	0.07
C_{12}+	0.36	0.38	0.22	0.15
Total	**100**	**100**	**100**	**100**

Table 4-3 Physical characteristics of Yolla condensate

	Volatiles	**Semi-volatiles**	**Low Volatiles**	**Residual Oil (%)**	**Density (kg/m^3 @ 15 °C)**	**Dynamic Viscosity (cP @ 25 °C)**
Boiling Point (°C)	<180	180-265	265-380	380	770.6	0.14
Yolla Condensate (%)	80.0	12.0	6.55	1.45		
Persistence	Non-persistent			Persistent		

4.5 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. The activities included in this EP are:

- MODU positioning
- drilling activities
- completion activities
- plug and abandonment

- topsides (platform) piping fabrication
- operations support activities (vessels and helicopters).

4.5.1 MODU Positioning

The MODU is towed to the Operational Area and moved into position using three support vessels. This method is also utilised for demobilisation of the MODU from location once the activity is complete. Once within vicinity of the Yolla-A platform, up to two anchors may be run from the MODU to ensure that MODU positioning is sufficiently controlled. If required, the Anchors are run and set in position by one of the three support vessels.

Figure 4-3 Previous Jack-up rig work on the Yolla-A platform

Other wells within the proximity (Yolla-3, -4, -5 and -6) may be shut in prior to the arrival of the MODU as required by the Simultaneous Operations Management Plan, which ensures that any risks for multiple well failures to occur whilst activities covered under this EP are undertaken are managed to ALARP.

The legs are jacked up during MODU positioning to avoid contact with the seabed. Once at the desired location adjacent to the platform and with the MODU stationary, the legs are lowered to be fully in contact with the seabed (soft pinning). The bases of the legs are each fitted with a 'spud can' (each 18 m in diameter). The MODU self-elevates itself above the sea surface to conduct pre-load operations and jacks up to operational elevation. Finally, the cantilever is skidded out over the well slot of the Yolla-A platform (Figure 4-3).

The spud cans will be positioned within the existing depressions caused from previous drilling programs. This ensures that the environmental impacts and risks associated with the activity are minimised.

To remove the spud-cans from the existing depressions, Beach may need to engage the leg jetting system on the MODU which is a commonly utilised sequence of operations. These activities are implemented for most Jack-up drilling operations and comprise the connection of several hoses, and alignment of a number of valves. Once connections are made, sea water is pumped down the legs at pressure loosening the sediment around the spud cans, allowing the legs to be jacked up. Leg jetting activities are estimated to take a couple of days.

4.5.2 Well construction and completion methodology

An indicative overview of the drilling design and process is described in this section. This process is subject to change, depending on individual well design requirements and the final location of the well. Well schematics are provided in the Well Operations Management Plan (WOMP) submitted to NOPSEMA for assessment prior to drilling. Prior to drilling commencing, a standard shallow gas study will be completed to verify Beach's existing understanding that the risk of encountering shallow gas is low.

Drilling of the new well is performed from an existing slot available on the Yolla-A platform. The drilling of the new well may take approximately 90-130 days, depending on the finalised well design, operational delays and geological success in terms of finding a commercially viable gas reservoir.

Drilling of a new well is undertaken by installing a new 508 mm conductor. The conductor is driven rather than drilled and grouted due to the requirement of the platform foundation designers to not disturb the seabed for the first 50 m below the mud line, protecting the integrity of the non-piled mat base of the platform. This activity is conducted on the rig floor with a hydraulic hammer and chaser system connected to the rig top drive, driving the conductor for approximately 140 m to the required depth of ~260 m below seabed. The scope of this operation is similar to what was conducted in offset wells Yolla 3, 4, 5 and 6, based on offset wells records the estimated drive duration is around 4-8 hours. Offset well conductors were able to be run without restriction in the first 60 m or with only intermittent slight weight of the hammer therefore reducing the effective drive duration / hammering time.

The top-hole section (surface hole) is drilled to approximately 1000 - 1700 mMDRT with returns to the MODU via a low pressure riser where the cuttings (rock chips) are separated from the drilling fluids using solids control equipment. The solids control equipment comprises of shale shakers that remove coarse cuttings from the drilling fluids. After processing by the shale shakers, the recovered fluids, that have been separated from the cuttings, may be directed to centrifuges, which are used to remove the finer solids. The cuttings are discharged from the MODU to the sea surface and the reconditioned fluids are recirculated into the fluid system. Where synthetic-based drilling fluids (SBDF) are used, the fluids may be further processed using an additional stage of cuttings/fluid separation during which the cuttings are processed through a cuttings dryer system.

Once the surface casing is cemented in place, a high-pressure riser and blow-out preventer (BOP) is then installed prior to drilling the deeper intermediate and production hole sections. For the drilling of the intermediate and production hole sections, returns are also taken back to the MODU where solids control equipment is used to separate drill cuttings from the drilling fluid prior to discharging the cuttings to the sea surface.

The indicative well design for the activity is included as Table 4-4.

For the purpose of this EP, side-tracks that are undertaken have been considered within the scope of this plan, and evaluated accordingly.

4.5.2.1 Blow-out preventer installation and function testing

A BOP is installed onto the wellhead after installing the surface casing. A BOP consists of a series of hydraulically operated valves and sealing mechanisms (annular preventers and ram preventers) that are normally open to allow the drill fluid to circulate up the marine riser to the MODU during drilling. The BOP is used to close in the well in the event of an influx or kick, in which the hydrostatic pressure the wellbore fluid is exceeded by the formation pressure. The MODU's high-pressure circulating system would be used in this event, after closing of the BOP, to remove the influx from the well and regain hydrostatic overbalance. The annular and ram preventers are used to shut in around various tubulars in the well, while the blind shear rams are designed to shear the pipe and seal the well.

The BOP hydraulic system is a dry/surface BOP and comprises a closed loop system. As such there will be no hydraulic fluid discharged overboard during normal BOP annular and ram functioning.

Once the BOP is installed, regular function and pressure tests are undertaken. Function tests are generally undertaken every 7 days, and pressure tests on a 21-day basis, in accordance with industry standards and the Drilling Contractor's maintenance system. Function testing is undertaken by activating the hydraulic control system aboard the MODU to confirm functionality of the BOP systems, whilst a pressure test is undertaken to verify seals on the BOP stack.

4.5.2.2 Drill fluids and cuttings handling and disposal

Drilling fluids used during the program will be water-based (WBDF), synthetic-based drilling fluid (SBDF) and brines. Drilling fluid performs several functions including cooling and lubrication of the drill bit; transportation of drill cuttings to the surface; and maintaining hydrostatic pressure in excess of formation pressure, thus preventing the influx of hydrocarbons from the formation into the wellbore, this is the primary well control barrier.

Drilling fluid, bulk dry products, base oil, brine, and drill water are transferred to the MODU from supply vessels and stored in tanks and pits. Dry and liquid additives are mixed into the fluid system from sacks or containers.

Lost circulation materials (inert solids, cellulosic or other benign particulates and polymers) may be available to pump should downhole losses occur while drilling.

Contingency discharges associated with bulk drilling chemicals may occur over the course of the activity, however these are not planned. In the situation that a significant weather event occurs, the MODU may need to discharge all barite stores to the ocean to maintain stability.

A summary of the planned drilling fluids and cuttings discharges are described in Table 4-4. In addition to these, some discharges may raise from flushing the diverter system. These volumes are minimal in comparison to the volumes provided in Table 4-4.

Table 4-4 Summary of well design and drilling methodology

Hole size	Conductor / casing / liner size	Approx. MDRT (m) / TVD (m) *	Fluid type	Approx. cuttings volume (m^3)	Approx. residual oil on cuttings volume (m^3)	Fluid discharge location	Cuttings discharge location
Yolla 7							
Driven Conductor	20"	~260 m MDRT	N/A	N/A	--	N/A	N/A
17-1/2"	13-3/8"	1,660 m MDRT / 1,450 m TVD	WBDF	238	--	No whole fluid discharge	Surface
12-1/4"	9-5/8"	5,992 m MDRT / 2,732 m TVD	SBDF	324	86	No whole fluid discharge	Surface – with residual SBDF
8-1/2"	4 1/2"	6,427 m MDRT / 3,153 m TVD	SBDF	18	5	No whole fluid discharge	Surface – with residual SBDF

*MDRT – measure depth rotary table. TVD – total vertical depth.

Yolla 7 DW1 (from 1300m MDRT)							
Hole size	**Conductor / casing / liner size**	**Approx. MDRT (m) / TVD (m) ***	**Fluid type**	**Approx. cuttings volume (m^3)**	**Approx. residual oil on cuttings volume (m^3)**	**Fluid discharge location**	**Cuttings discharge location**
12-1/4"	9-5/8"	5,050 m MDRT / 2,570 m TVD	SBDF	285	76	No whole fluid discharge	Surface – with residual SBDF
8-1/2"	4 1/2"	5,500 m MDRT / 2,950 m TVD	SBDF	16	4	No whole fluid discharge	Surface – with residual SBDF

*MDRT – measure depth rotary table. TVD – total vertical depth.

4.5.2.3 Cementing operations

Bulk dry cement is transported to the MODU via supply vessels and transferred to dry bulk storage tanks. During the transfer process, the holding tanks are vented to atmosphere, resulting in small amounts of dry cement being discharged from venting pipes located under the MODU.

Prior to the commencement of cementing operations, the cementing unit is tested resulting in a discharge of between 2.4 m^3 (15 bbl) to 8 m^3 (50 bbl) of cement slurry to sea.

After a string of casing or liner has been installed into the well, a cementing spacer is pumped to flush drilling fluids and filter cake from the well to allow a good cement bond to be formed with the formation. All cementing operations are conducted with all returns to the MODU via a high pressure or low-pressure riser. Depending on volumes of cement and spacer pumped, the spacer either remains downhole or returned to the MODU and is discharged to sea.

Cement slurry is pumped down the inside of the landing string and then casing (or liner). A displacement fluid is then pumped into the casing with a wiper plug to displace the cement out of the bottom of the casing and up into the annular space between the pipe and the borehole wall. For all casing and liner cementations the cement predominantly remains downhole, with minor excess cement returned to the MODU and discharged into the sea. When the wiper plug is pumped and reaches the bottom of the casing string it stops and allows the casing to be pressure tested.

Several contingency cement discharges may occur over the course of the activity, however these activities are not planned discharges. In the event that mixed batches of cement spoil within the cementing unit, or there is a problem during the cementing operation, cement slurry is either flushed from the cement unit or circulated out of the well and discharged to sea. A discharged batch of cement slurry may be up to 22 m^3 (140 bbl), but this is not expected. In the situation that a significant weather event occurs, the MODU may need to discharge cement stores to the ocean to maintain stability.

Upon completion of each cementing activity, the cementing head and blending tanks are cleaned which results in a release of cement contaminated water to the ocean. While this volume may vary, it is typically in the order of <1 m^3 (<6 bbl) per cement job.

4.5.2.4 Sidetrack drilling

Either in the event drilling difficulties are experienced and the programmed well operations cannot progress; or the primary wellbore is not considered viable for future production, the existing borehole may be plugged and abandoned using cement plugs before sidetrack drilling the well around the existing borehole.

These activities would require additional time on location and an increase in the excavated rock volume (i.e., cuttings), drilling fluids and cement consumed compared to the planned activity.

Sidetrack operations may involve milling a window into the existing casing string, which would generate metal swarf. To ensure this is lifted from the well efficiently, a viscous drilling or milling fluid is used. This may include a simple water-based mud system that has sufficient viscosity to lift the swarf, or alternatively the same synthetic based drilling fluid (SBDF) used for drilling. High viscosity sweeps are pumped periodically to enhance hole cleaning. A swarf recovery system including ditch magnets is installed on surface to provide a hands-free method of separating the swarf from formation and milling fluid.

- during any milling operations, the mud weight will be sufficient to overbalance any well bore or formation pressures. This also helps prevent wellbore instability during milling operations
- on both wells, a cement stinger is used to set and verify all permanent abandonment cement barriers to the reservoir. Upon barrier verification, the surface BOP is unlatched and stored.

4.5.2.5 Formation evaluation

During drilling, the formation is evaluated to determine the presence and quantity of hydrocarbon within the target reservoir. This information is gathered real-time from Logging Whilst Drilling (LWD) techniques and mud logging.

Sonic logs are considered part of the primary formation evaluation objective for the well. The sonic tool is a completely self-contained down-hole tool. There are no airguns or any other noise sources on surface, and as such no noise is expected to be transmitted to the surface. The tool is run as part of a standard LWD (or wireline) suite, and the data is transmitted to surface in the same way as the data from all the other LWD tools using mud pulse technology.

Additional down-hole logging sources may include the deployment of resistivity tools and sensors or low-level radioactive sources (such as density-neutron Am-Be & Gamma-Ray Cesium-137). These sources may be required to acquire additional information that cannot be gathered during primary evaluation. These low-level radioactive sources are stored in lockers aboard the MODU and deployed directly down hole with no exposure to the marine environment. Formation pressure and downhole sampling formation evaluation tools (LWD or wireline) may also be run to fully evaluate the reservoir.

Vertical Seismic Profiling (VSP) or check-shot surveys are not proposed to be undertaken as part of this activity.

4.5.3 Completion Activities

4.5.3.1 Well completion

Following drilling to total depth and completing formation evaluation operations, a production liner is installed and cemented. The entire well will then be displaced to clean kill weight brine during a wellbore clean-up (WBCU) operation. The objective of the WBCU operation is to ensure the well is full of clean kill weight brine and to remove sediment and debris from the wellbore which could cause formation damage and foul downhole completion equipment. Fouling material includes drill cuttings, residual SBDF, metal shavings from the drill string or casing and rubber from the BOP. The majority of displaced SBDF is then returned to holding tanks on the MODU for use in future programs or for onshore disposal.

Throughout the WBCU operation, when necessary the brine will be filtered utilising cartridge filter units to achieve the necessary cleanliness criteria. The desired criteria for completion brine for perforating and completion operations is total suspended solids (TSS) < 0.05 % and turbidity < 50 NTU. The well volume which is displaced and circulated to clean filtered brine is approximately 1,500 bbl. Operations may require consumption of up to two times this volume to achieve cleanliness criteria. Any contaminated brine planned to be discharged overboard. This may result in a discharge volume of up to 3000 bbl.

Uncontaminated brine will be kept onboard the MODU in the brine (or mud) tanks for further use as follows:

- contingency to replace any losses which may occur post perforating
- used to replace any brine which may be contaminated during wellhead and BOP clean-up operation
- used as the base fluid for suspension packer fluid.

The brine composition is expected to be Sodium Chloride (NaCl) or a NaCl / Sodium Bromide (NaBr) blend, with a density to maintain a suitable overbalance as per Beach Well Engineering and Construction Management System (WECS) standards.

Once the well is determined to be clean it is considered suitable to perforate. The perforating guns are planned to be deployed on the drill pipe and detonated via pressure application once placed at the designated depth. Once detonated the well will be monitored for losses to ensure they are within necessary limits prior to recovery of the perforating guns to surface. Once the guns are recovered the BOP and wellhead are then jetted with clean filtered brine utilising a specific WBCU BHA to ensure all areas and cavities are clean. Brine may be contaminated during this process requiring it to be either stored for onshore disposal or discharged overboard. This volume would be expected to be approximately 100 bbl.

Once the well is determined to be clean, an option may be to deploy perforating guns set on a gun hanger. In this instance the guns would not be detonated until after the well is completed and well barriers tested and verified. Immediately post completion integrity verification, the flow back/well test operations would be conducted.

The upper completion will consist of a tubing retrievable safety valve and production packer deployed on 5-1/2" production tubing with premium gas tight connections. A permanent downhole gauge may also be included in the completion string should the requirement be confirmed.

Prior to setting the packer, the production annulus will be displaced to a packer fluid. Once the packer is set the packer fluid will be isolated within the production annulus with the intention for it to remain in place throughout the well's production life. The purpose of the packer fluid is to restrict or eliminate the degradation of the tubing and casing within the production annulus void. Whilst the packer fluid is circulated into the well the tubing may be displaced to an underbalance fluid (such as base oil). Throughout this operation completion brine is returned to the MODU brine tanks and may be stored or diluted and discharged (approx. 1350 bbl).

The completion packer fluid may contain amine-type corrosion inhibitors, oxygen scavengers, biocide, and soda ash or caustic soda for pH (alkalinity) control. There is likely to be excess packer fluid left at the end of completion and flow back operations. Depending on the volume it may be stored for future use or diluted and discharged.

The production packer will be set, and the completion tested to confirm well integrity, prior to undertaking well testing and clean-up operations.

Cartridge filters utilised during the WBCU operation, and any subsequent circulating operation are returned to shore for suitable disposal.

4.5.3.2 Installation of Christmas tree

Following completions operations and prior to the installation of the tree, plugs are installed within the downhole completion, providing barriers ensuring that the formation is isolated and well integrity is maintained when the BOP is removed.

Once the BOP is removed, a Christmas tree (XMT) is fitted to the well, which comprises of hydraulically controlled fail-safe upper master and wing valves that close on loss of hydraulic pressure. There will be a fail-safe TRSSV located down hole for each well that are held open under hydraulic pressure and close when the hydraulic pressure drops, generally due to a surface signal controlled by the Emergency Shutdown System (ESS). The pumps operate automatically by pressure control.

Once the tree is in place, then the retrievable plugs in the completion can be removed prior to well flowback and testing.

4.5.3.3 Well flowback and testing

The base case for the well flowback and testing, including flaring activities, is via the MODU.

Well flowback and testing involves the controlled flow of wellbore and reservoir fluids to surface to clean up the well and further understand the reservoir characteristics. These activities are undertaken via a surface well test package aboard the MODU.

Fluids recovered during well testing will be directed to the well test package where the fluids are measured, separated, treated for overboard discharge (non-hydrocarbons) and flared (hydrocarbons). Fluids that cannot be flared (typically produced water with condensate content) are cycled through a filtration system prior to discharge overboard. Produced fluids not meeting the necessary cleanliness criteria will be stored in tanks and transported to shore for appropriate disposal.

There is no planned cold venting of hydrocarbons to atmosphere during flow-back and testing operations. During these activities, incidental unburnt hydrocarbon gas is emitted via the surge tank and when lines are purged following conclusion of the well clean-up and testing operations.

Flow back and testing program is likely to occur over several days with a cased and cemented liner. The overall duration of flaring during the program is expected to take approximately 48 hours.

Beach are currently working to minimise this time period by undertaking detailed engineering studies to optimise the drilling and completion fluid system as well as performing modelling to ascertain the ideal conditions which will maximise clean-up efficiency and minimise the time required to achieve cleanliness criteria.

Residual well bore fluids are directed via the surface well test package and flared with commingled reservoir fluids. There is expected to be limited 'drop-out' from the flare nozzle to surface waters given the high percentage of volatile gas and limited residual fluid expected during well flow-back.

The flare will be initiated via a pilot light which will be located at the outlet of the burner heads. The pilot light source will be LPG located on the MODU in 45 kg bottles, each containing 88.2 L of LPG.

If the well does not flow or is assessed as a high risk of not flowing, even with the use of a cushion fluid underbalance, a contingency operation is planned to rig up coiled tubing or coil hose and lift the wells with nitrogen. This would result in nitrogen emissions being processed through the surface well test facility and vented to atmosphere.

Table 4-5 Predicted well completion and testing emissions and discharges

Emission parameter	Amount	Discharge location
Volume of gas (MMscf)	90	Atmosphere via flare
Volume of water (bbl)	450	Sea following filtration
Volume of condensate (bbl)	3,600	Atmosphere via flare
Volume underbalance cushion (bbl)	450	Re-use or to atmosphere via flare
Volume of brine, well flow back (bbl)	150	Atmosphere via flare, re-use or sea following filtration
Volume of methanol (L)	360	Atmosphere via flare
Volume of MEG (L)	720	Atmosphere via flare
Volume of nitrogen (L)	36,400	Atmosphere via flare / vent lines
LPG Pilot Light (L)	265	Atmosphere via flare
Duration of flaring (approx. hours)	48	N/A

4.5.3.4 Well suspension

Following well flowback operations the well is secured, and integrity confirmed with suspension barriers as per the NOPSEMA-accepted WOMP. The MODU will then rig down and move out from location with assistance of support vessels to tow the MODU from the Operational Area.

The well will be suspended and handed over to Production for subsequent tie-in activities on the platform to connect the well for long term production (Section 4.5.5).

4.5.4 Plug and abandonment

Depending on the outcome of the formation evaluation, should the well and the contingent sidetrack not be considered viable for future production, the well shall be permanently plugged and abandoned. Plug and abandonment procedures are designed to permanently isolate the well and mitigate the risk of a potential release of wellbore fluids to the marine environment.

Plug and abandonment operations involve setting a series of permanent cement and mechanical plugs within the wellbore, including plugs above and between any hydrocarbon bearing intervals identified for isolation, at appropriate barrier depths in the well and at the surface. These plugs are tested to confirm their integrity.

As with other cementing operations detailed, most of the cement remains down-hole, but minor volumes may be discharged to the environment, including:

- when the cement system is flushed to prevent curing inside the cement unit and pipework after each cement job is completed (up to 8 m^3 (50 bbls) cement based on 3 km drill string recirculation and cleaning of pumping lines and cement tanks)
- during setting of down-hole cement plugs near the surface, hard cement may return to surface where it will be treated through the shale shakers and discharged at the sea surface (up to ~5 m^3)
- during cementing of top-hole section of each abandoned well, cement will overflow at the seabed surface (up to ~15 m^3).

When abandoning wells, kill fluid and various additives may be required for specific well abandonments to control wellbore pressure. The carrying medium of a kill fluid is either fresh water (drill water), seawater or a brine. A combination may be used during any well abandonment program. Brines are used to achieve the required density parameters of the kill fluid. Setting cement plugs in vertical or deviated wells may require weighed high viscosity fluid pills to prevent the cement plug from slumping down hole.

Once complete, in alignment with Section 572(3) of the OPGGS Act, the surface conductor will ultimately be cut below seabed level using a mechanical or abrasive cutting tool (or similar).

All plug and abandonment operations will be conducted in accordance with a NOPSEMA-accepted WOMP. The MODU will then rig down and move out from location with assistance of support vessels to tow the MODU from the Operational Area.

4.5.5 Topsides (platform) piping fabrication

Once drilling activities are complete, and if the target is considered commercially viable, additional piping and equipment must be installed to connect the completed production well to the existing Yolla processing equipment. The well is connected to the platform via the spare ~508 mm conductor installed from the seafloor to the dry tree in the well bay (equipped with master valve and wing valve). Process piping (flowline) is then fabricated to connect the well to a choke valve to allow flow control into the existing production manifold. Additional connections and piping runs are made to tie-in existing utility services (including diesel, methanol, hydraulic fluid) to the new well and these connections require limited modifications to existing production systems. Additionally, pipe supports will be installed to support new piping and additional well instrumentation will be tied-in to the existing Yolla control system. In total, it is expected that installation of the new topsides piping, and instrumentation will take three months with most components fabricated off-site and shipped to the platform to enable efficient installation. Standard installation methods will be used for all topsides modifications consistent with existing Yolla facility maintenance practices such as scaffolding, rigging, cutting, grinding welding, flange torquing, coating repair, tube bending, cutting, cable pulling and termination. Flushing, hydro-testing, and leak testing of piping systems will utilize existing platform fluids such as inhibited water, nitrogen, and diesel. Volumes of test fluids will be minor and will be processed through the existing production equipment.

4.5.6 MODU details and layout

A ‘jack up’ drilling MODU will be used to drill the infill well. The MODU will be positioned alongside the Yolla-A platform; the MODU will cantilever the drill floor over the platform to allow positioning the MODU’s drill centre over the proposed well location.

Whilst the specific MODU is yet to be confirmed, the Noble Tom Prosser is likely to be used. The specifications of this MODU have been used to inform relevant aspects of the environmental impact and risk assessment (Section 7) of this EP, as either this MODU or a MODU with similar capabilities, design and capacities will be used. Minor variations in jack up size are not considered to result in any material changes in environmental impact.

Generally, a MODU of this capacity operates with up to 150 persons on board (POB). Indicative storage capacities as summarised in Table 4-6. Routine operational discharges from the MODU within the Operational Area at full POB are detailed in Table 4-7.

Table 4-6 Indicative MODU storage capacities

Tank	Capacity
Fuel	5,185 bbl
Drill water	11,255 bbl
Liquid mud	7,847 bbl
Brine storage	2,213 bbl
Base oil storage	2,213 bbl

Tank	Capacity
Bulk storage	18,000 cu ft
Sack storage	5,000 sacks
Ballast water	86,736 bbl
Sewage	158.5 bbl
Bilge and drain tanks	Bilge 75.8 bbl Drain - 121.69 bbl
Cement	9000 bbl

4.5.6.1 Power generation system

The MODU engine room is equipped with multiple diesel engines coupled to generators. Additionally, the MODU is fitted with emergency diesel engine and generator auxiliary system, including batteries, transformers, and switchboards.

4.5.6.2 Fuel

As described in Table 4-6, the MODU has a fuel capacity of 5,185 bbl.

4.5.6.3 Saltwater distribution and cooling system

The primary purpose of the saltwater distribution and cooling system is to provide saltwater for the reverse osmosis (RO) units, the fire water system, the main engine cooling system heat exchanger, the draw works brake cooling unit heat exchanger and various flushing and deck wash connection points throughout the facility.

4.5.6.4 Freshwater generation, distribution and cooling system

The freshwater generation system provides freshwater to the potable water, drill water, engine jacket water. The RO freshwater generators use seawater to generate freshwater, and this sea water is supplied with the saltwater from a RO submersible pump. Brine is discharged from the RO system to the sea.

4.5.6.5 Drainage, effluent and waste systems

The drainage, effluent systems and associated environmental pollution control systems on the facility include:

- non-contaminated bilge sumps, deck drains, headers and oily water tanks and separators
- contaminated drains, oily water tanks and solids separators
- helideck drainage and containment system
- sewage and greywater drainage and sewage treatment plant
- domestic waste segregation and disposal
- galley waste disposal including macerator
- equipment oil drainage, bunding and waste oil tanks
- cutting processing equipment (see solids control equipment).

4.5.6.6 Solids control equipment

Solids control equipment (SCE) will be used when drilling to separate the solids in the drilling fluids that are crushed by the drill bits and carried out of the well surface. SCE aboard the facility includes:

- shale shakers
- centrifuging systems
- cuttings dryer (for SBDF).

4.5.7 Support activities

4.5.7.1 Vessels

Vessel operations include:

- MODU mobilisation/demobilisation and positioning
- Deployment and retrieval of anchors
- standby at close proximity to the MODU during critical operations
- standby support to monitor and maintain the 500 m rig safety exclusion zone from errant vessels
- transfer of goods and equipment to and from the MODU
- deployment of survey equipment including remote operated vehicles
- transportation of passengers, if required
- assistance for safety rescue operations.

At least one support vessel will remain on standby to the MODU within the distance defined in the Safety Case (nominally three nautical miles). The MODU is supported by three support vessels, with the other two vessels typically outside the Operational Area. Vessels only enter the 500 m rig safety exclusion zone or Yolla-A PSZ under instruction from the MODU when transferring cargo to the MODU or supporting specific operations. Support vessels generally have approximately 12 to 15 persons on board (POB) at any given time. Routine operational discharges from a single vessel within the Operational Area at full POB are detailed in Table 4-7.

Support vessels maintain station-keeping via dynamic positioning (DP) during the drilling activity therefore no anchoring is required. Support vessels will not anchor in the Operational Areas during the activity. While the specific vessels to be used for this activity are not yet confirmed and are dependent on availability, the fuel used will be Marine Diesel Oil (MDO) / Marine Gas Oil (MGO) with the maximum fuel tank capacity is conservatively assumed to be 300 m^3.

Table 4-7 Support activity discharges within Operational Area

Discharge Type	Quantity MODU (approx.)	Quantity per vessel (approx.)
Putrescible waste	280 kg/day (1-2 kg pp/day)	30 kg/day (1-2 kg pp/day)
Sewage & grey water	63 m^3/day (0.45 m^3 pp/day)	7 m^3/day (0.45 m^3 pp/day)
Cooling water	4,800 m^3/d combined (MODU + single vessel)	
Atmospheric emissions (e-CO_2)	42 ktCO_2e/month combined (MODU + single vessel)	
RO brine	168 m^3 /day combined (MODU + single vessel)	

4.5.7.2 Helicopter

Helicopters are the primary form of transport for personnel to and from the MODU but may also be used during emergency situations, including operational and scientific monitoring in the event of a hydrocarbon spill. Helicopters may service the MODU in the order of 7 times per week] for the duration of the program, dependent on the progress of the well activities and logistical constraints, and generally operating in daylight hours.

Beach Energy's current service provider is Offshore Services Australasia Pty Ltd. There are no helicopter refuelling facilities on the platform; helicopters carry enough fuel to travel to the platform and return. The approximate flight time (one way) between the helicopter base at Tooradin and the Yolla-A platform is 45 minutes.

Helicopter operations within the Operational Area are limited to landing and take-off directly to and from the MODU helideck.

4.5.7.3 ROV activities

Underwater remotely operated vehicles (ROVs) may be deployed and controlled from either the MODU or support vessel to undertake:

- pre and post-activity site surveys
- equipment deployment, monitoring and retrieval
- tool deployment and operation.

ROVs are generally equipped with a video camera, lighting and have the ability to monitor the subsea infrastructure and the 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 to move components and is designed not to release hydraulic fluid.

The ROVs are stored on the deck of the vessels and/or MODU and are unlikely to be temporarily parked on the seabed during the program.

4.5.8 End of Activity

In the event that the drilling program is unsuccessful, and the well is decommissioned, activities are deemed complete when the well is successfully plugged and abandoned and the MODU demobilises from location.

In the event the drilling program is successful, activities are deemed complete when the well is successfully tied-in to the existing Yolla-A platform, the MODU demobilises from location and the well is ready to produce to the platform.

5 Description of the Environment

5.1 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 5-1 and Figure 5-1 detail the EMBA associated with the activity that has been used to describe the environmental context relevant to the Activity and to support the impact and risk assessments.

The environment within the Operational Area (a 2 km radius around the MODU location) is described where this information exists.

Table 5-1 Description of Operational Area and EMBA

EBMA Zones	Description
Operational Area	For this drilling activity, the Operational Area is a 2 km radius around the MODU whilst on location. This radius encompasses both the outer extent of mooring equipment on the seabed and the 500 m rig safety exclusion zone around the MODU.
EMBA	The boundary of the EMBA was defined using the modelling results for a Loss of Well Control (LOWC) event and a vessel collision event. Spill modelling was completed for both these scenarios (Appendix A and Appendix B). These modelling reports consider the creditable spill scenarios identified in Section 7 at the Yolla-A platform, in accordance with thresholds required by (NOPSEMA 2019). Specifically, as the entrained exposure comprised the largest area, the EMBA was based upon a 10 ppb entrained instantaneous hydrocarbon concentration.

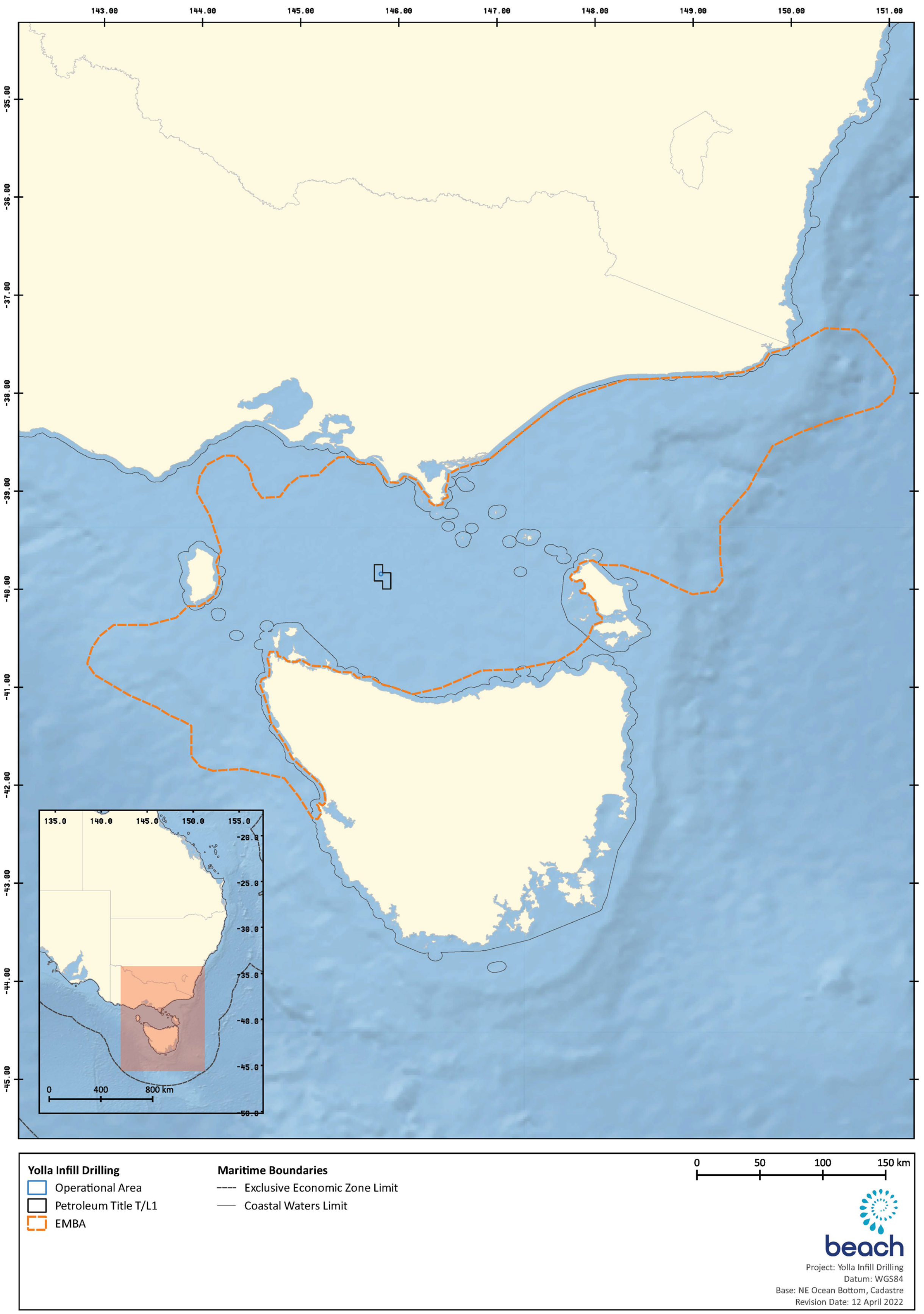


Figure 5-1 Operational Area and EMBA

5.2 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

    ii. Commonwealth land within the meaning of that Act.

With regards to 13(3)(c), information on the ecological character of declared Ramsar wetlands is provided in Section 5.5.5.

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) or habitat critical to survival – as they are spatially defined areas where aggregations of individuals of a regionally significant species are known to display biologically important behaviours such as breeding, foraging, resting or migration.

With regards to 13(3)(f) more detail has been provided in Section 5.5.10 for Key Ecological Features (KEFs) as they are considered as conservation values of the Commonwealth marine area; and in Section 5.5.1. for Australian Marine Parks (AMPs) as they are enacted under the EPBC Act.

Where appropriate, descriptions of the Bass Strait environment (beyond the EMBA) are provided for context. The 'environment' is defined by Regulation 4 of the OPGGS(E)R as:

- ecosystems and their constituent parts, including people and communities
- natural and physical resources
- the qualities and characteristics of locations, places and areas
- the heritage value of places
- the social, economic and cultural features of these matters.

5.3 Regional environmental setting

The proposed infill well and EMBA are located in 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 (Commonwealth of Australia 2015c). 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 SEMR has a high diversity of species and 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).

The Operational Area is within the Bass Strait Provincial Interim Marine and Coastal Regionalisation for Australia (IMCRA) Bioregion which separates Tasmania from the southern Australian mainland by approximately 230 km at its narrowest point and contains a number of islands, with the largest being King Island and Flinders Island (see Figure 5-2). At the mesoscale level, the Central Bass Strait (CBS) bioregion, is approximately 60,000 km^2 in size with water depths between 50 m at the margins and 80 m at the centre and is on the continental shelf (DEH 2006). The substrate in the central area of the CBS is predominantly mud (DEH 2006).

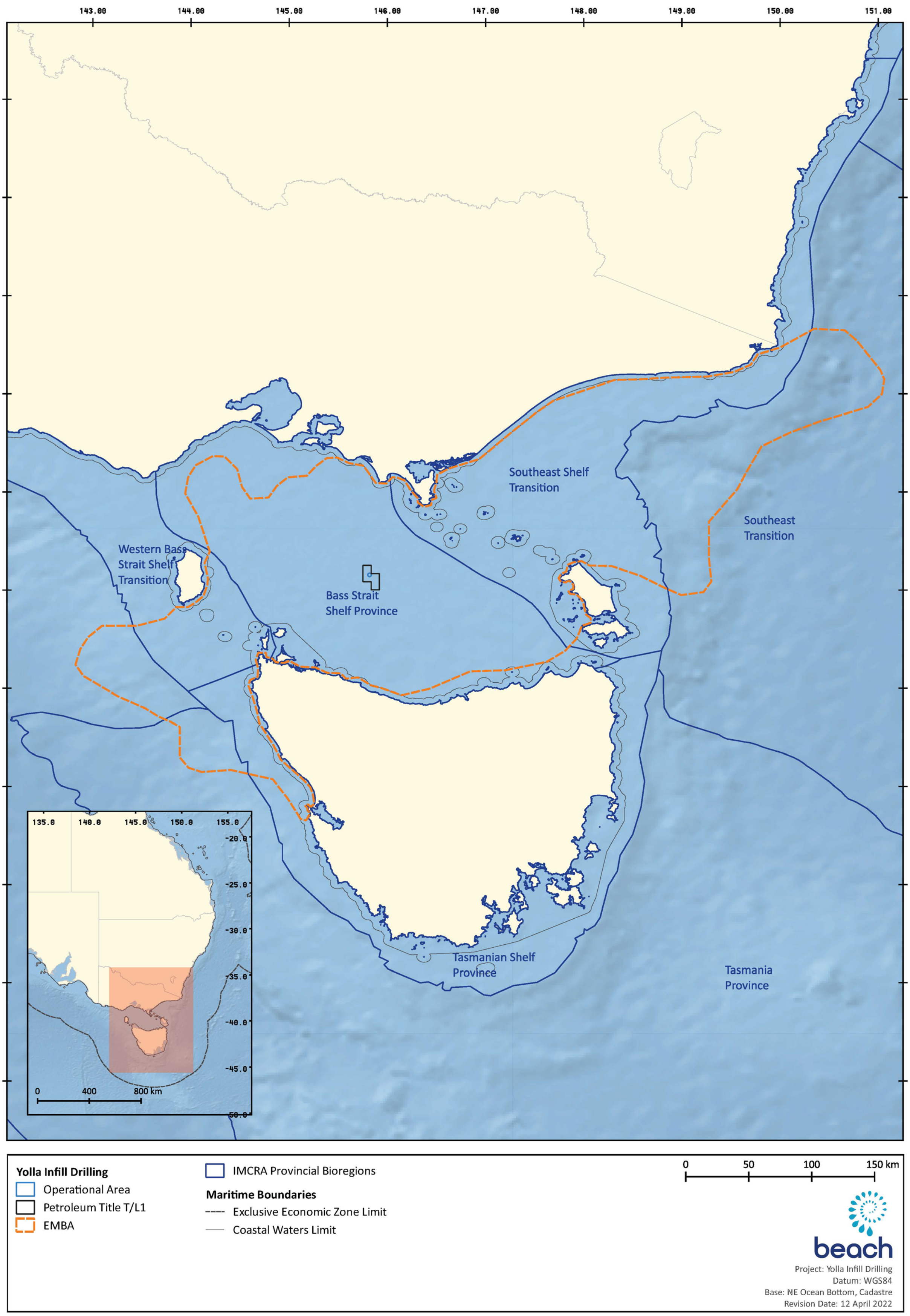


Figure 5-2 IMCRA provincial bioregions

5.4 Summary of environmental receptors within the EMBA

The following tables list the presence of ecological (Table 5-2) and socio-economic and cultural (Table 5-3) receptors that may occur within the Operational Area and EMBA.

Values and sensitivities associated with each of the receptors have been included in the tables. These values and sensitivities have been identified based on:

- presence of listed Threatened or Migratory species or Threatened Ecological Communities (TEC) identified in the EPBC Protected Matter search (Appendix C and Appendix D)
- presence of BIAs and habitats critical to the survival of the species
- presence of important behaviours (e.g. foraging, roosting or breeding) by fauna, including those identified in the EPBC Protected Matter search (Appendix C and Appendix D)
- important linkage to other receptors (e.g. nursery habitat, food source, commercial species)
- important benefit to human activities (e.g. recreation and tourism, aesthetics, economic benefit).

Table 5-2 Presence of ecological receptors within the Operational Area and the EMBA

Receptor Type	Receptor Category	Values and Sensitivities	Presence	
			Operational Area	EMBA
Shoreline	Shoreline habitat	• foraging habitat (e.g. birds) • nesting or breeding habitat (e.g. birds, pinnipeds) • haul-out sites (e.g. pinnipeds)	x	x Note
Mangroves	Intertidal/subtidal habitat, mangrove communities	• nursery habitat (e.g. crustaceans, fish) • breeding habitat (e.g. fish)	x	✓
Saltmarsh	Upper intertidal zone, saltmarsh habitat, habitat for fish and benthic communities	• nursery habitat (e.g. crustaceans, fish) • breeding habitat (e.g. fish)	x	✓
Soft Sediment	Predominantly unvegetated soft sediment substrates	• key habitat (e.g. benthic invertebrates)	✓	✓
Seagrass	Seagrass meadows	• nursery habitat (e.g. crustaceans, fish) • food source (e.g. fish, turtles)	x	✓
Algae	Macroalgae	• nursery habitat (e.g. crustaceans, fish) • food source (e.g. fish, turtles)	x	✓
Coral	Soft corals, hard corals	• nursery habitat (e.g. crustaceans, fish) • breeding habitat (e.g. fish)	x	✓
Plankton	Phytoplankton and zooplankton	• food source (e.g. fish, cetaceans, marine turtles)	✓	✓
Marine Invertebrates	Benthic and pelagic invertebrates	• food source (e.g. fish)	✓	✓
		• commercial species (e.g. rock lobsters)	✓	✓
Fish	Fish (including fish and sharks)	• listed marine species	✓	✓

Receptor Type	Receptor Category	Values and Sensitivities	Presence	
		• listed threatened species • listed migratory species • BIA		
	Pipefish, seahorse, seadragons	• listed marine species	✓	✓
Seabirds	Birds that live near or frequent the ocean	• listed marine species • listed threatened species • listed migratory species • BIA	✓	✓
Marine Reptiles	Marine turtles	• listed marine species • listed threatened species • listed migratory species	✓	✓
Cetaceans and Pinnipeds	Seals, sea lions	• listed marine species	✓	✓
	Whales	• listed marine species • listed threatened species • listed migratory species • BIA	✓	✓
	Dolphins	• listed marine species • listed migratory species	✓	✓

Note: Modelling indicates that no hydrocarbon exposure to shorelines are expected above low thresholds. Consequently, they have not been described in this EP.

Table 5-3 Presence of socio-economic and cultural receptors within the Operational Area and EMBA

Receptor Type	Receptor Category	Values and Sensitivities	Presence	
			Operational Area	EMBA
Commonwealth Marine Areas	Australian Marine Park (AMP)	• aggregations of marine life	x	✓
	Key Ecological Feature (KEF)	• high productivity • aggregations of marine life	x	✓
	Threatened Ecological Communities (TECs)	• wildlife corridors • aggregations of marine life	x	✓
State Parks and Reserves	Marine Protected Areas	• aggregations of marine life	x	✓
	Terrestrial Protected Areas	• aggregations of terrestrial life	x	✓
Wetlands of National Importance	Ramsar Wetlands	• aggregation, foraging and nursery habitat for marine life	x	✓
Commercial Fisheries	Commonwealth Managed	• economic benefit	✓	✓
	Victorian State Managed	• economic benefit	✓	✓
	Tasmanian State Managed	• economic benefit	✓	✓
Recreation and Tourism	Various human activities and interaction	• community • recreation • economic benefit	x	✓
Industry	Shipping	• community • economic benefit	✓	✓
	Petroleum exploration and production	• economic benefit	x	✓
Heritage	Maritime	• shipwrecks	x	✓
	Cultural	• World Heritage Properties • Commonwealth Heritage Places • National Heritage Places	x	✓

5.5 Conservation values and sensitivities

The following section details the conservation values and sensitivities identified as relevant to this EP.

5.5.1 Australian Marine Parks

The South-east Commonwealth Marine Reserves 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 are 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.

There are no Australian Marine Parks (AMPs) identified within the Operational Area.

The PMST report for the EMBA (Appendix D) identified five AMPs as being present within the search area:

- Apollo
- Beagle
- Boags
- East Gippsland
- Franklin.

Although the Apollo AMP is located outside of the EMBA (Figure 5-3), it has been described in this Section given it is located adjacent to the EMBA.

All the AMPs, in whole or part, are classified as 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 South-east Marine Reserves are managed under the South-east Marine Reserves Management Plan (DNP 2013).

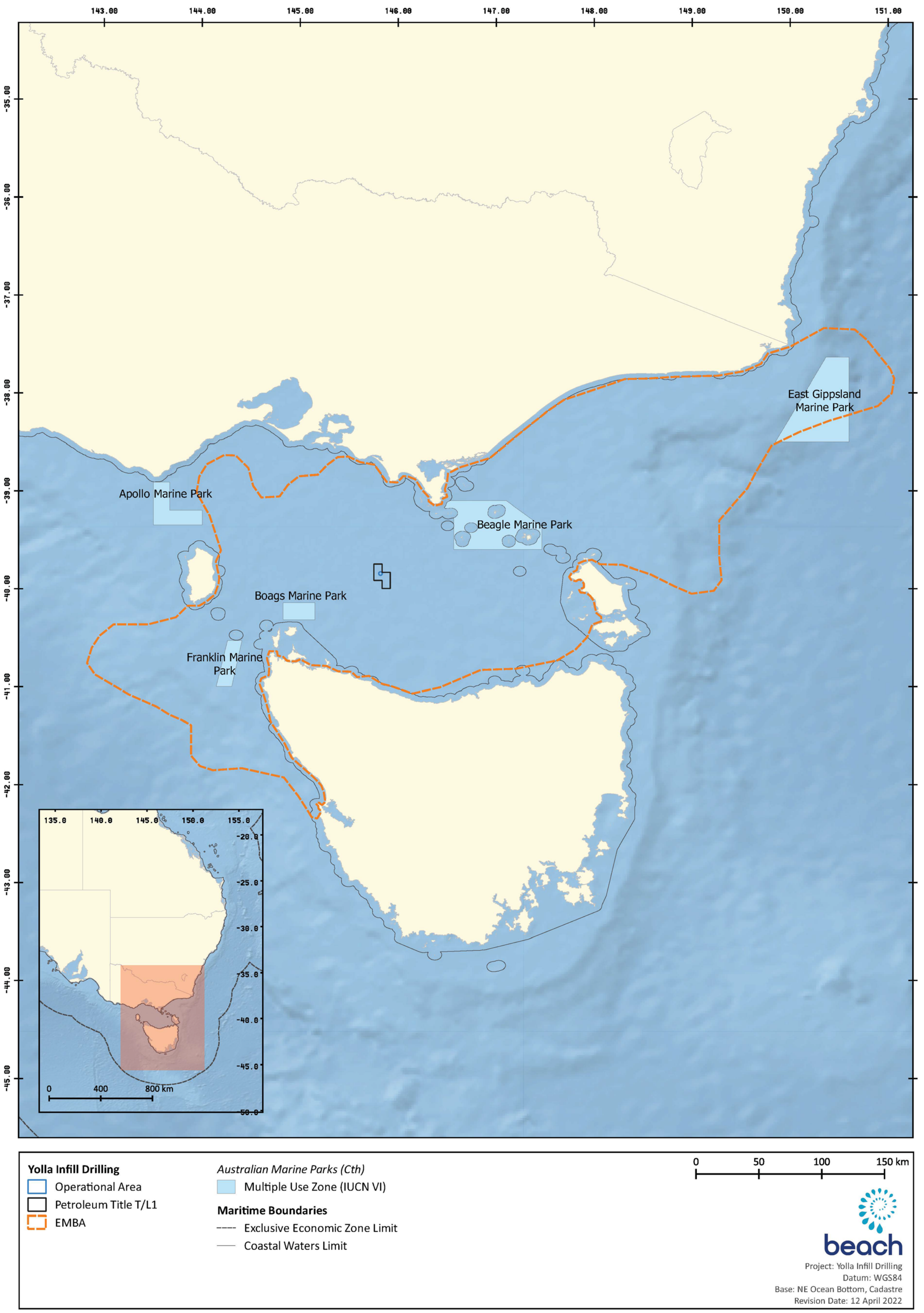


Figure 5-3 AMPs in the EMBA

5.5.1.1 Apollo AMP

The Apollo AMP is located 165 km northwest from the Operational Area, and approximately 10 km west of the EMBA. 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).

5.5.1.2 Beagle AMP

The Beagle AMP is located 67 km northeast from Operational Area. 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).

5.5.1.3 Boags AMP

The Boags AMP is a shallow continental ecosystem about 64 km southwest of the Operational Area ranging from depths of 40 m to 80 m and covering a total area of approximately 537 km^2 (DNP 2013). The marine park encompasses the highly biodiverse benthic fauna of the central Bass Strait and contains a rich array of life. The benthic sediments and muds support crustaceans, polychaete worms, and molluscs while the pelagic zone is known to support White Shark foraging. The marine park is also adjacent to important seabird breeding colonies that reside on the Hunter group of islands (Three Hummock Island, Hunter Island, Steep Island, Bird Island, Stack Island and Penguin Islet) which support seabird foraging.

The major conservation values of the Boags AMP are:

- ecosystems, habitats and communities associated with the Bass Strait Shelf Province and associated with the seafloor features: plateau and tidal sandwave/sandbank
- it provides important foraging habitat for the shy albatross, Australasian gannet, short-tailed shearwater, fairy prion, black-faced cormorant, common diving petrel and little penguin (DNP 2013).

5.5.1.4 East Gippsland AMP

The East Gippsland AMP is located 378 km northeast from the Operational Area. The East Gippsland AMP contains an extensive network of canyons, continental slope and escarpment at water depths from 600 m to more than 4,000 m. The mix of both warm and temperate waters in the reserve create habitat for free-floating aquatic plants or phytoplankton. The East Australian Current combined with complex seasonality in oceanographic patterns creates large eddies of warm water with cooler, nutrient rich waters around the outside of the eddies (DNP 2013). The mixing of these patterns creates conditions for highly productive phytoplankton growth, which support a rich abundance of marine life. Oceanic birds including albatrosses, petrels and shearwaters are known to forage in these waters. Humpback whales pass by the reserve during their migrations north and south (DNP 2013).

The major conservation values of the East Gippsland AMP are:

- ecosystems, habitats and communities associated with the Southeast Transition feature: Abyssal plain / deep ocean floor, canyon, escarpment, knoll / abyssal hill and slope
- it is important for biodiversity and productivity from the Bass Cascade and the upwelling east of Eden
- it provides important foraging habitat for wandering albatross, black-browed albatross, yellow-nosed albatross, shy albatross, great-winged petrel, wedge-tailed shearwater and cape petrel
- it is an important area for the migration of humpback whales (DNP 2013).

5.5.1.5 Franklin AMP

The Franklin AMP is located 142 km southwest from Yolla-A platform and 25 km off the north-west coast of Tasmania in waters ranging from 40 m to 150 m deep over a total area of 671 km^2. The reserve represents an area of shallow continental shelf ecosystems and incorporates the major bioregions of western Bass Strait and the Tasmanian shelf (DNP 2013). The ocean reserve provides feeding grounds for seabirds including species of albatross, petrel, shearwater and cormorant that have breeding colonies on the nearby Hunter group of islands. Great white sharks are also known to forage in the reserve (DNP 2013).

The major conservation values of the Franklin AMP are:

- ecosystems, habitats and communities associated with the Tasmanian Shelf Province and the Western Bass Strait Shelf Transition and associated with the seafloor features: shelf, deep / hole / valley, escarpment and plateau
- it provides important foraging habitat for the shy albatross, short-tailed shearwater, Australasian gannet, fairy prion, little penguin, common diving petrel, black-faced cormorant and silver gull (DNP 2013).

5.5.2 World Heritage Properties

The PMST Reports (Appendix C and Appendix D) did not identify any marine or coastal World Heritage Areas within the Operational Area or the EMBA.

5.5.3 National Heritage Places

No National Heritage listed places are identified within the Operational Area.

The National Heritage List is Australia's list of natural, historic and Indigenous places of outstanding significance to the nation. These places are protected under Chapter 5, Part 15 of the EPBC Act.

One National Heritage Place was identified in the EMBA PMST Report (Appendix D):

Western Tasmania Aboriginal Cultural Landscape (Figure 5-4).

This cultural landscape stretches along much of the west coast of Tasmania (in an approximately 3 km wide strip of land that includes the shoreline, from near Marrawah in the north to Duck Creek, north of Granville Harbour, in the south). The Western Tasmania Aboriginal Cultural Landscape contains shell middens, hut depressions, stone artefact scatters, stone arrangements, rock engravings and shelters and human burials.

5.5.4 Commonwealth Heritage Places

No Commonwealth Heritage Places are identified within the Operational Area.

The EMBA PMST Report (Appendix D) Identified five Commonwealth Heritage Places, all of which are located on land and therefore are outside the EMBA (Figure 5-5). As these sites are not located within the EMBA, they have not been described but identified as they are located adjacent to the EMBA:

- Cape Sorell Lighthouse (Listed place)
- Gabo Island Lighthouse (Listed place)
- Goose Island Lighthouse (Listed place)
- Table Cape Lighthouse (Listed place)
- Wilsons Promontory Lighthouse (Listed place).

5.5.5 Wetlands of International Importance

No Wetlands of International Importance are located within the Operational Area.

The EMBA PMST Report (Appendix D) identified three marine or coastal Wetlands of International Importance (Ramsar-listed wetlands) (Figure 5-6). These wetlands are located onshore, and as modelling has predicted no shoreline loading of hydrocarbons in the event of a spill (Section 7.15), these wetlands are considered outside of the EMBA. However, as they are located adjacent to EMBA and to address Regulation 13(3) of the OPGGS(E)R, the ecological character and values of the identified Ramsar listed wetlands are described in the following sections.

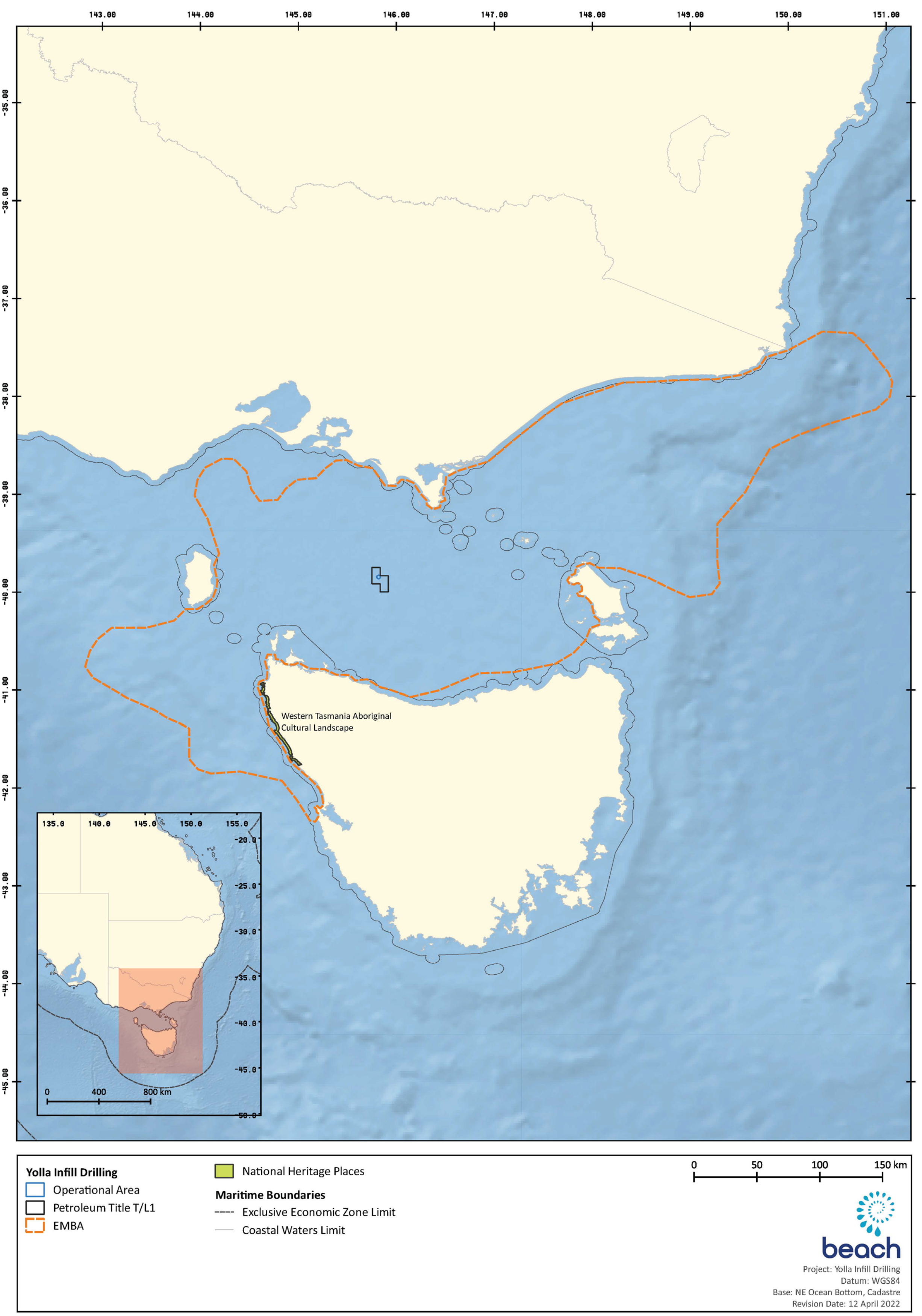


Figure 5-4 National Heritage Places present within the EMBA

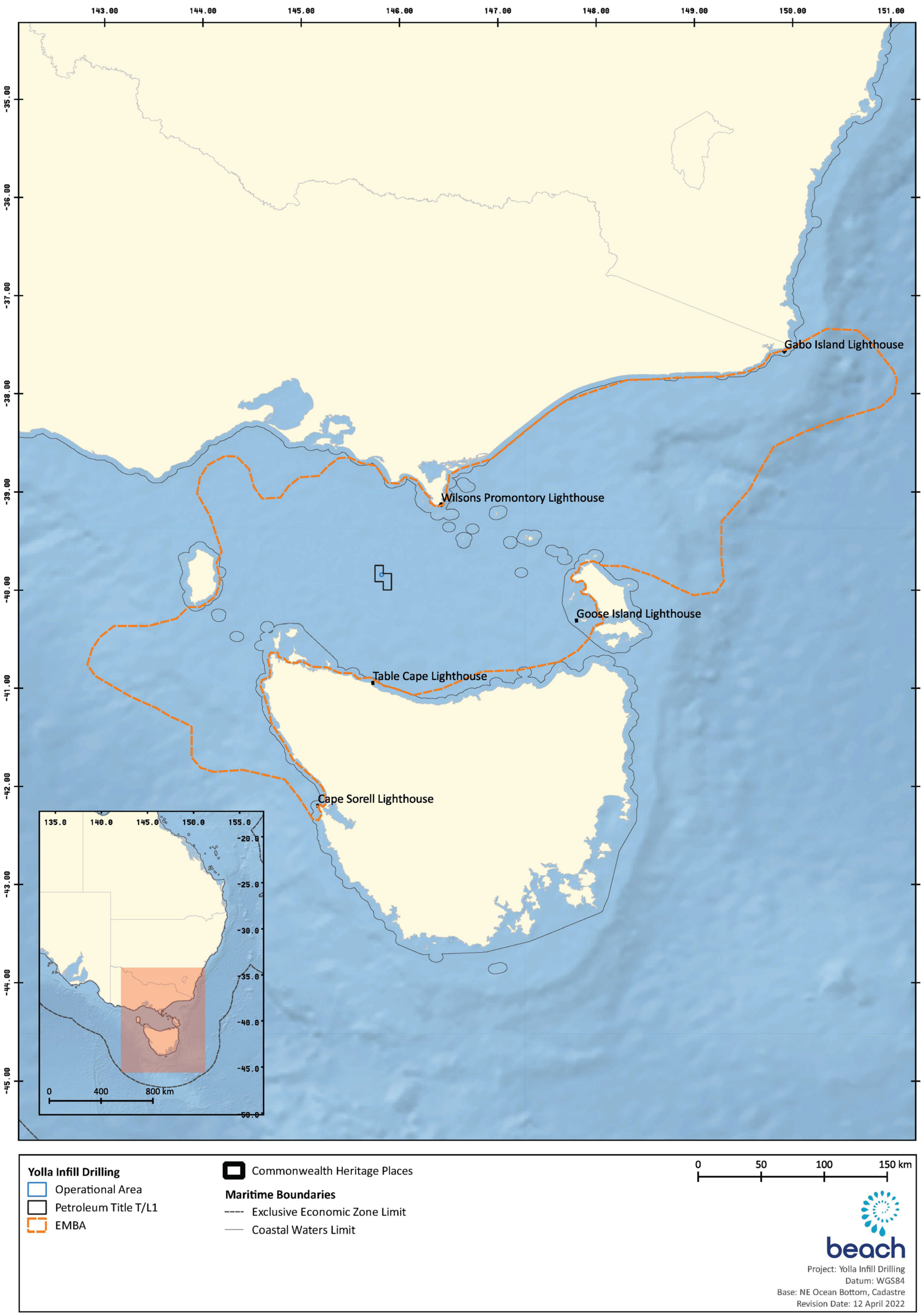


Figure 5-5 Commonwealth Heritage Places identified within the EMBA

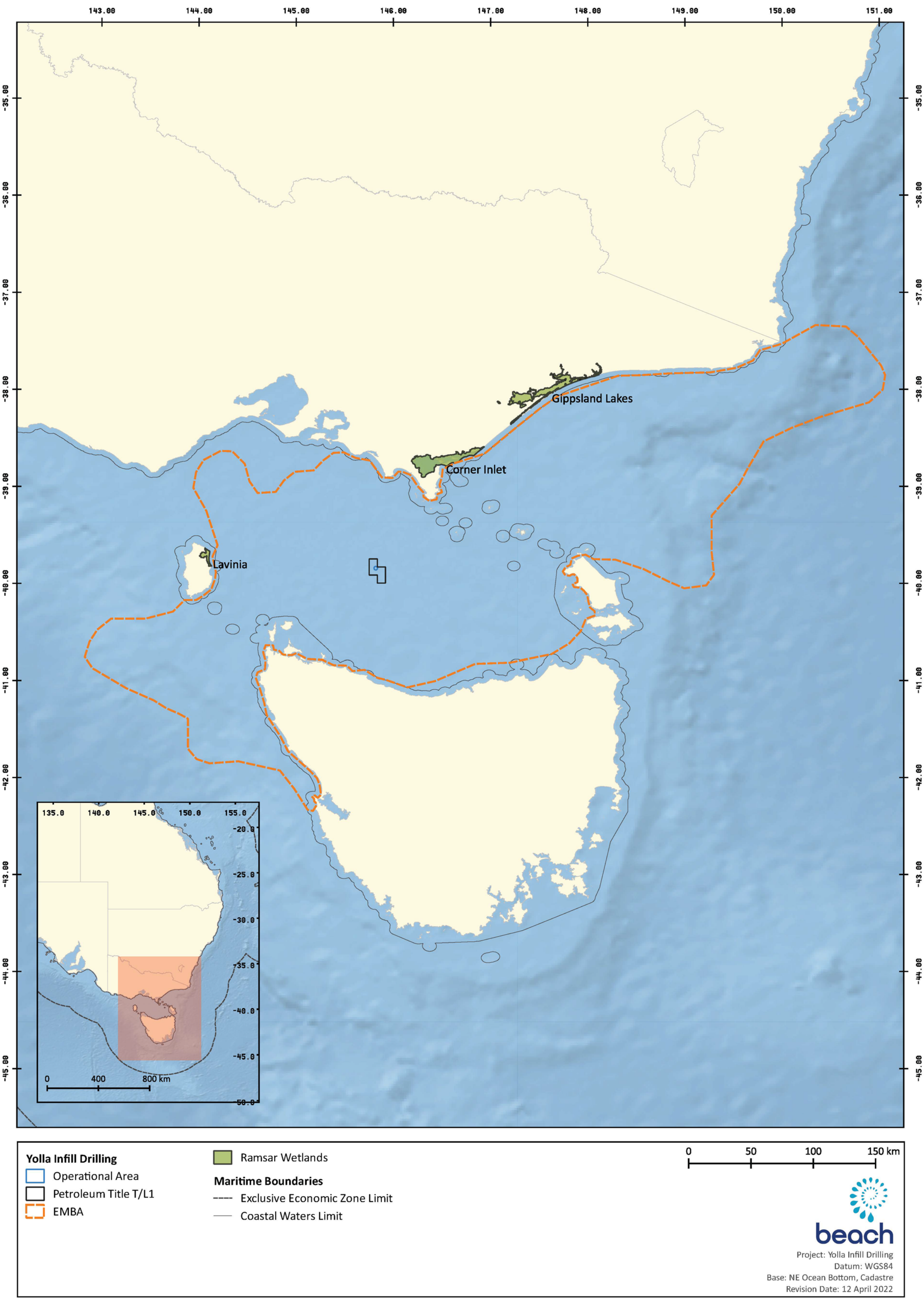


Figure 5-6 Ramsar wetlands

5.5.5.1 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 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.

5.5.5.2 Gippsland Lakes

The Gippsland Lakes Ramsar site is a system of lakes and wetlands extending eastward from Sale to Lake Tyers, in some areas extending to the high-water mark of the ocean, and covers an area of 58,824 ha (EGCMA 2015). The site is about 70 km long and 10 km wide (at its widest point) and was designated in 1982. These lakes and wetlands occur landwards of the coastal dunes adjacent to the EMBA. The EMBA does not intersect where the Lakes meet the sea at Lakes Entrance. Nevertheless, the site of international importance is described here.

Most of the Ramsar site (64 %) is reserved under the *Crown Land (Reserves) Act 1978* (Vic) as Nature Conservation Reserve, Natural Features Reserve and Public Purpose Reserve. Approximately one-third of the Gippsland Lakes Ramsar site is located within the Lakes National Park (2,390 ha) and Gippsland Lakes Coastal Park (17,584 ha), which are proclaimed under the *National Parks Act 1975* (Vic).

The Gippsland Lakes are separated from the sea by sand dunes and fringed on the seaward side by the Ninety Mile Beach. The Gippsland Lakes form the largest navigable inland waterway in Australia. These features create a distinctive regional landscape of wetlands and flat coastal plains that is of considerable environmental significance in terms of its landforms, vegetation and fauna (EGCMA 2015). The lakes are linked to the sea by an artificial entrance at its eastern end, being Lakes Entrance.

The Gippsland Lakes Ramsar site contains three main habitat types; permanent saline/brackish pools, coastal brackish / saline lagoons and permanent freshwater marshes (EGCMA 2015). Threatened, endangered, vulnerable or rare native fish communities, and mammal, amphibian and plant species exist within these habitats.

The permanence of the main lakes and the relatively regular flooding of the adjacent wetlands mean that this wetland system is an important drought refuge for many waterfowl. The lakes and their associated swamps and morasses regularly support an estimated 40,000 to 50,000 ducks, swans, coots and other waterfowl. Lake Reeve (at the western end of the lake system) is a site of international zoological significance, attracting up to 12,000 migratory waders and is one of the five most important areas for waders in Victoria. The total concentration of waders at the south-western end of Lake Reeve fluctuates in response to local conditions of salinity, water depth and probably human disturbance (EGCMA 2015). The lake has supported the largest concentration (5,000) of red knot (*Calidris canutus*) recorded in Victoria, as well as up to 3,000 sharp-tailed sandpiper (*Calidris acuminata*) and up to 1,800 curlew sandpiper (*Calidris ferruginea*). 24 bird species listed under JAMBA and 26 species listed under CAMBA have been recorded at the lakes.

Most of the wetlands of the Gippsland Lakes are bordered by emergent reed beds dominated by common reed (*Phragmites australis*) or saltmarsh communities, with characteristic saltmarsh species including beaded glasswort (*Sarcocornia quinqueflor*a) and sea rush (*Juncus kraussii*) (EGCMA 2015).

There is a high concentration of archaeological sites in the Gippsland Lakes area including artefact scatters, shell middens, scarred trees, occupation sites, burials and axe-grinding grooves.

Parts of the Lakes system are heavily used for commercial and recreational fisheries and for other water-based recreation, while the immediate hinterland has been developed for agricultural uses and limited residential and tourism purposes.

5.5.5.3 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. It is subject to the Lavinia Nature Reserve Management Plan (2000) (in draft).

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, Kind 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 (PWS 2000). 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.

5.5.6 Nationally important wetlands

No nationally important wetlands are located within the Operational Area.

Nationally important wetlands are considered important for a variety of reasons, including their importance for maintaining ecological and hydrological roles in wetland systems, providing important habitat for animals at a vulnerable stage in their life cycle, supporting 1 % or more of the national population of nay native plant or animal taxa or for its outstanding historical or cultural significance (DAWE 2022f).

The EMBA PMST Report (Appendix D) identified 18 Nationally Important Wetlands. These wetlands are located onshore, and as modelling has predicted no shoreline loading of hydrocarbons in the event of a spill (Section 7.15), these wetlands are considered outside of the EMBA.

5.5.7 Victorian Protected Areas

No Victorian protected areas are located within the Operational Area.

As discussed in Section 7.15, no shoreline loading of hydrocarbons was predicted in the event of a spill. As such, Victorian Terrestrial Protected Areas are not considered further. Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodata sets from the DAWE, and the 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).

Beach identified that three Marine National Parks, and two parks or reserves protected under the *National Parks Act 1975* (Vic) are located within the EMBA (Figure 5-7). No marine sanctuaries are identified within the EMBA.

The protected areas within the EMBA are:

- Cape Howe
- Point Hicks
- Wilsons Promontory Marine National Park
- Wilsons Promontory Marine Park
- Wilsons Promontory Marine Reserve.

These areas are detailed in the following subsections.

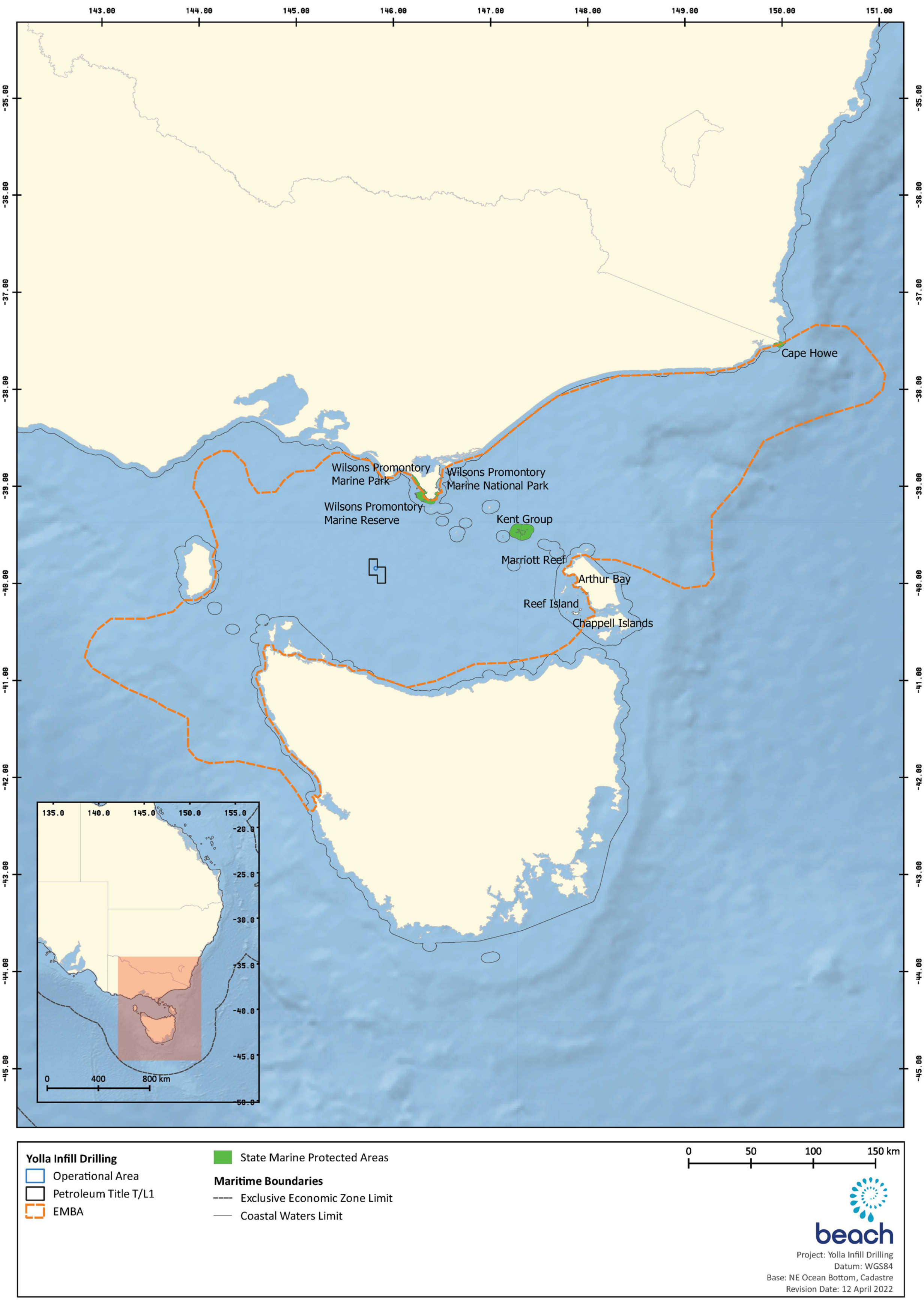


Figure 5-7 State Marine Protected Areas

5.5.7.1 Cape Howe

The Cape Howe MNP covers 4,060 ha and extends along 4.8 km of coastline and offshore from the high-water mark to the 3 nm state waters limit to water depths of 105 m (Parks Victoria 2006d). The waters of the park contain both high-profile granite and low-profile sandstone reefs.

The park's key natural values are listed as:

- diversity of habitats including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches
- co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters
- marine mammals such as whales, dolphins, Australian fur-seals and New Zealand fur-seals
- transient reptiles such as green turtles from northern waters
- Threatened fauna including whales and birds
- foraging area for a significant breeding colony of Little Penguins from neighbouring Gabo Island
- outstanding active coastal landforms within and adjoining the park, such as granite and sandstone reefs
- outstanding landscapes, seascapes and spectacular underwater scenery
- Victoria's most easterly Marine National Park abutting one of only three wilderness zones on the Victorian coast
- excellent opportunities for scientific investigation and learning
- outstanding opportunities to build knowledge of marine protected areas and their management, and to further understand marine ecological function and changes over time.

Subtidal soft sediment communities are the most widespread communities in the park, with the diversity of invertebrates expected to be high. Common fish are herring cale (*Odax cyanomelas*), six-spine leatherjacket (*Meuschenia freycineti*), mado (*Atypichthys strigatus*), banded morwong (*Cheilodactylus spectabilis*) and damselfishes (*Parma microlepis and Chromis hypsilepis).* Its deep (30 to 50 m) sandstone reefs are heavily covered with a diverse array of sponges, ascidians and gorgonians. Transient mammals such as southern right whales, humpback whales, killer whales, Australian fur-seals, New Zealand fur-seals, bottlenose dolphins and common dolphins are transient visitors to the park.

5.5.7.2 Point Hicks

The Point Hicks MNP covers 3,810 ha and extends along 9.6 km of coastline and offshore from the high-water mark to the 3 nm state waters limits to water depths of 88 m. The reefs directly below Point Hicks, Whaleback Rock and Satisfaction Reef are the best-known geological features of the park. Point Hicks itself is a granite headland with a wide rocky and bouldery shore formed up to 10,000 years ago.

The park's key natural values are listed as:

- a diversity of habitats, including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches
- a very high diversity of fauna, including intertidal and subtidal invertebrates
- co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters

- a range of rocky habitats
- mammal mammals such as dolphins, whales and fur-seals
- transient reptiles from northern waters, including turtles and sea snakes
- threatened fauna, including whales and several bird species
- outstanding landscapes, seascapes and underwater scenery
- outstanding active coastal landforms, such as granite reefs and mobile sand dunes
- excellent opportunities for scientific investigation and learning
- outstanding opportunities to build knowledge of marine protected areas and their management and to further understand marine ecological function and changes over time.

A prominent biological component of the subtidal reef areas is kelp and other seaweeds. Large species of brown algae, such as Common/Golden kelp (*Ecklonia radiata*) and crayweed (*Phyllospora comosa)*, are present along the open coast in dense stands. Giant species of seaweeds such as string kelp and bull kelp also occur (Parks Victoria 2006c). The front reefs and Whaleback Reef, which have high relief gutters of up to 15 m have high sessile invertebrate diversity and abundance on the vertical walls.

An important characteristic of Point Hicks MNP is its canopy-forming algae (a mixture of crayweed and common kelp) and small understorey algae. The reef beneath the canopy varies from encrusting and erect sponges to small fleshy red algae. The invertebrate community includes moderate abundances of blacklip abalone (*Haliotis rubra*) and the red bait crab (*Plagusia chabrus*).

5.5.7.3 Wilsons Promontory Marine National Park, Marine Park and Marine Reserve

Wilsons Promontory MNP is a distinct bioregion of Victoria’s coastline due to the different types of rock present and its position at the boundary between two major ocean currents. Its offshore islands support several colonies of Australian fur-seals (*Arctocephalus pusillus*) and provide breeding sites for many seabirds, including cape barren geese (*Cereopsis novaehollandiae*), little penguins, gulls, mutton birds and ospreys (Parks Victoria, 2006b).

Wilsons Promontory MNP is the first in Australia to receive a Global Ocean Refuge Award, joining a group of ten marine protected areas that comprise the Global Ocean Refuge System. The award signifies that the park meets the highest science-based standards for biodiversity protection and best practices for management and enforcement. Located at the southernmost tip of mainland Australia, it’s one of the country’s best examples of marine biodiversity protection (Parks Victoria, 2006b).

Wilsons Promontory Marine Park, together with the Marine Reserve and MNP, make significant contributions to Victoria’s marine protected areas. The marine park includes biological communities with distinct biogeographic patterns, including shallow subtidal reeds, deep subtidal reefs, intertidal rocky shores, sandy beaches, seagrass, subtidal soft substrates and expansive areas of open water (Parks Victoria, 2006b).

The marine park provides important habitat for several threatened shorebird species and islands within the park act as important breeding sites for Australian fur seals (Parks Victoria, 2006b).

5.5.8 Tasmanian Protected Areas

No Tasmanian protected areas are located within the Operational Area.

As discussed in Section 7.15, no shoreline loading of hydrocarbons was predicted in the event of a spill. As such, Tasmanian Terrestrial Protected Areas are not considered further. Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodata sets from the DAWE, and the 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 5-7, five marine Tasmanian Protected Area are identified within the EMBA, being:

- Arthur Bay
- Chappel Islands
- Kent Group
- Marriott Reef
- Reef Island.

These areas are detailed in the following subsections.

5.5.8.1 Arthur Bay

Arthur Bay Conservation Area covers 7.5 km^2 and includes the coastline and marine areas south of Blue Rocks and north of Whitemark on the west coast of Flinders Island. There is no management plan in place.

5.5.8.2 Chappel Islands

Mount Chappell Island Indigenous Protected Area is found in Bass Strait and forms parts of the Furneaux Group of islands. The island has long been regarded by Aboriginal people as an important part of the seasonal food-gathering cycle, and the Tasmanian Government handed it back to the Aboriginal community in 1995. The small island is now managed as an Indigenous Protected Area by the Tasmanian Aboriginal Centre. There is no management plan in place.

5.5.8.3 Kent Group

Kent Group Marine Reserve comprises five granitic islands and extends from the high-water mark to three nautical miles offshore. The marine reserve is divided into two zones; the western half is a ‘no-take’ zone where all marine life is protected and the eastern half is a ‘restricted-take’ zone where some fishing is permitted.

The Kent Group is the southern strong-hold for several species including the violet roughy (*Optivus agastos*), mosaic leatherjacket (*Eubalichthys mosaicus*), Wilsons weedfish (*Heteroclinus wilsoni*), maori wrasse (*Cheilinus undulates*) and one-spot puller (*Chromis hypsilepis*). It is also the most southerly location to see the eastern shovelnose ray and the snakeskin wrasse. Giant cuttlefish (one of the largest cuttlefish species in the world, reaching up to 80 cm in length) are commonly seen at the Kent Group.

Seagrass beds are found at depths of greater than 20 m in Murray Pass due to the very clear waters in the area. In deeper waters, sponge gardens are very common, covering 40 % of habitat in water depths greater than 40 m. Unusual stony corals (*Plesiastrea versipora*) are found in deeper waters and in areas shaded by cliffs where light levels are too low for algae to grow.

Kent Group National Park is an important Australian fur-seal breeding site and is the largest of only five sites in Tasmanian waters. It is secure from high seas when pups are young and vulnerable. The islands are also important sanctuaries for the common diving petrels (*Pelecanoides urinatrix*) and fairy prions (*Pachyptila turtur*) and are home to significant colonies of short-tailed shearwaters (*Ardenna tenuirostris*), little penguins (*Eudyptula minor*), sooty oystercatchers (*Haematopus fuliginosus*), cormorants and terns.

5.5.8.4 Marriott Reef

The Marriott Reef Conservation Area covers an area of 0.16 km^2 of the marine environment and begins 500 m off the west coast of Flinders Island. The Area is designated IUCN Category V and there is no management plan in place.

5.5.8.5 Reef Island

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.

5.5.9 NSW Protected Areas

No New South Wales protected areas are located within the Operational Area or the EMBA (Figure 5-7).

5.5.10 Key Ecological Features

No Key Ecological Features are located within the Operational Area.

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 PMST Report (Appendix D) identified three KEFs as being present within the EMBA:

- Big Horseshoe Canyon
- Upwelling East of Eden
- West Tasmania Canyons.

These KEFs are described in the following sections.

5.5.10.1 Big Horseshoe Canyon

The Big Horseshoe Canyon is known as an area of high productivity with aggregations of marine life. The canyon, which is the easternmost arm of the Bass Canyon Systems is located south of the eastern coast of Victoria. The steep, rocky slopes provide hard substrate habitat for attached large megafauna. Sponges and other habitat forming species provide structural refuges for benthic fishes, including the commercially important pink ling (*Genypterus blacodes*). It is the only known temperate location of the stalked crinoid (*Metacrinus cyaneu)*, which occurs at 200-300 m depth (DAWE 2015).

5.5.10.2 Upwelling East of Eden

The Upwelling east of Eden is valued for having high productivity and aggregations of marine life. In this region, dynamic eddies of the east Australian current cause episodic productivity events when they interact with the continental shelf and headlands. The episodic mixing and nutrient enrichment events drive phytoplankton blooms that are the basis of productive food chains including zooplankton, copepods, krill and small pelagic fish. The upwelling supports regionally high primary productivity that supports fisheries and biodiversity, including top order predators, marine mammals and seabirds. This area is one of two feeding areas for blue whales (*Balaenoptera musculus*) and humpback whales (*Megaptera* *novaeangliae*), known to arrive when significant krill aggregations form. The area is also important for seals, other cetaceans, sharks and seabirds.

5.5.10.3 West Tasmania 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 and Harris 2008). A significant feature of this reserve is a series of four submarine canyons that incise the continental slope, extending from the shelf edge to the abyssal plain (DNP 2013). 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, (Williams 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).

5.6 Physical environment

5.6.1 Metocean conditions

5.6.1.1 Climate

Bass Strait is located on the northern-most zone of an area known as the 'Roaring Forties' with its climate determined chiefly by the presence of sub-tropical high-pressure ridges and migratory low-pressure systems (extra-tropical cyclones). Migrating low pressure systems typically bring a westerly wind regime to Bass Strait and are likely to affect the area every three to five days on average during the winter months.

The annual rainfall measurements recorded at King Island Airport (the closest point for a Bureau of Meteorology [BoM] weather station, located approximately 165 km west of the Yolla-A platform) for the period 1974-2021 average 858.2 mm, with the highest rainfall totals falling in June, July and August (with an average minimum of 32 mm in February and an average maximum of 117.2 mm in July) (BoM 2022) Average air temperatures recorded at the same BOM station for 1995-2021 range from a minimum of 7.6 °C to a maximum of 21.2 °C (BoM 2022).

5.6.1.2 Winds

RPS (2022) acquired high-resolution wind data from 2010–2019 (inclusive) across their modelling domain from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR). Table 5-4 lists the monthly average and maximum winds derived from the CFSR station located nearest to the Yolla-A platform. Figure 5-8 illustrates the monthly wind rose distributions from 2010–2019 (inclusive), with Figure 5-9 illustrating the modelled total wind distributions from 2010–2019 (inclusive), which clearly indicates that winds from the southwest dominate this region.

Table 5-4 Predicted average and maximum wind speeds for the representative wind station near Yolla-A platform (RPS 2022)

Month	Average Wind Speed (knots)	Maximum Wind Speed (knots)	General Direction (from)
January	15.6	39.1	Southwest - Northeast
February	15.9	42.3	Southwest - Northeast
March	15.9	43.1	Southwest - Northeast
April	15.5	44.4	Southwest - Northeast
May	17.9	48.7	West
June	17.3	45.4	West
July	19.6	50.2	West
August	18.7	44.2	West
September	18.0	45.4	West
October	18.0	45.8	West
November	16.3	40.7	Southwest - Northeast
December	16.0	42.2	Southwest - Northeast
Minimum	15.5	39.1	
Maximum	19.6	50.2	

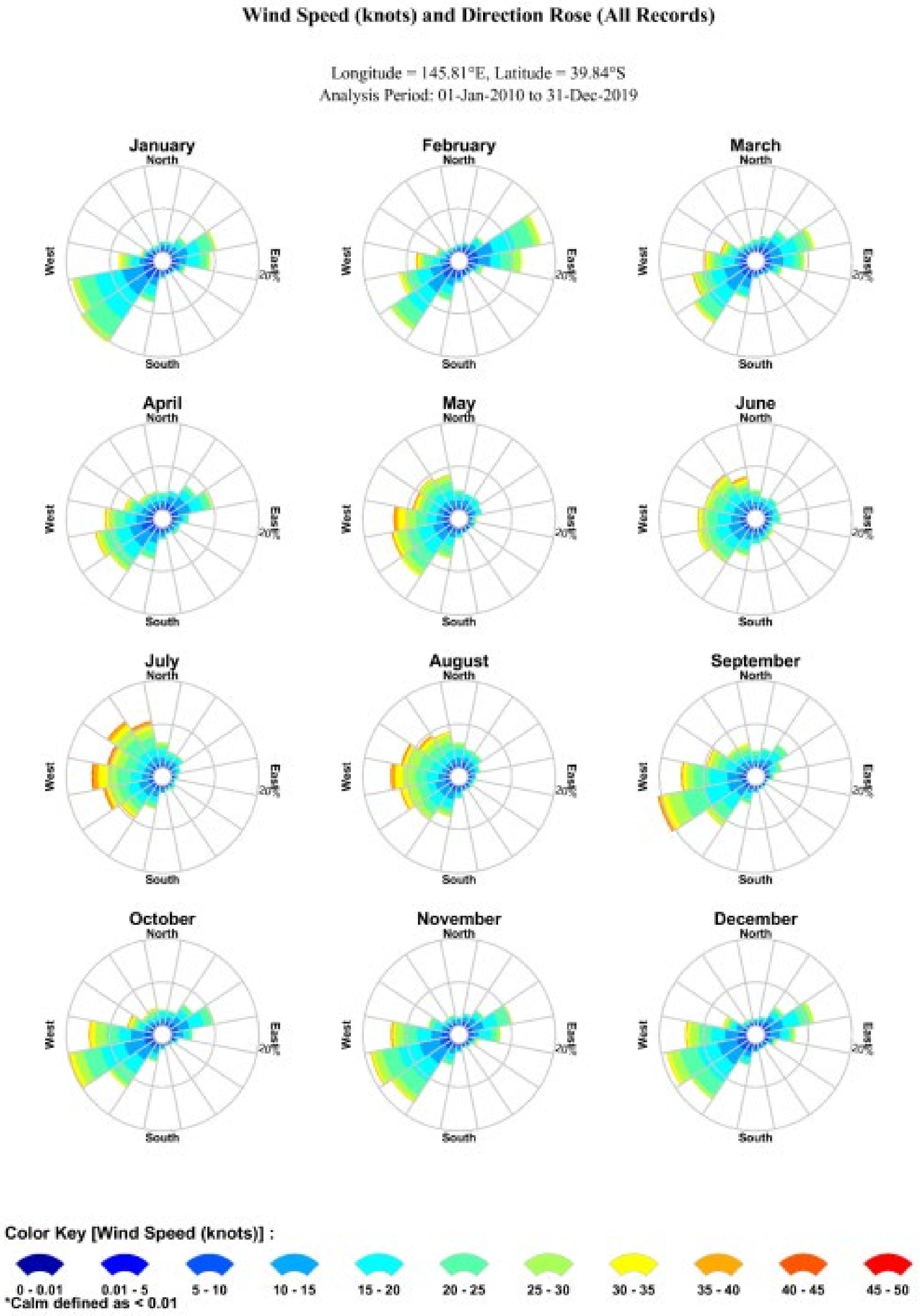


Figure 5-8 Modelled monthly wind rose distributions from 2010–2019 (inclusive), for the representative wind station nearby Yolla-A platform (RPS 2022)

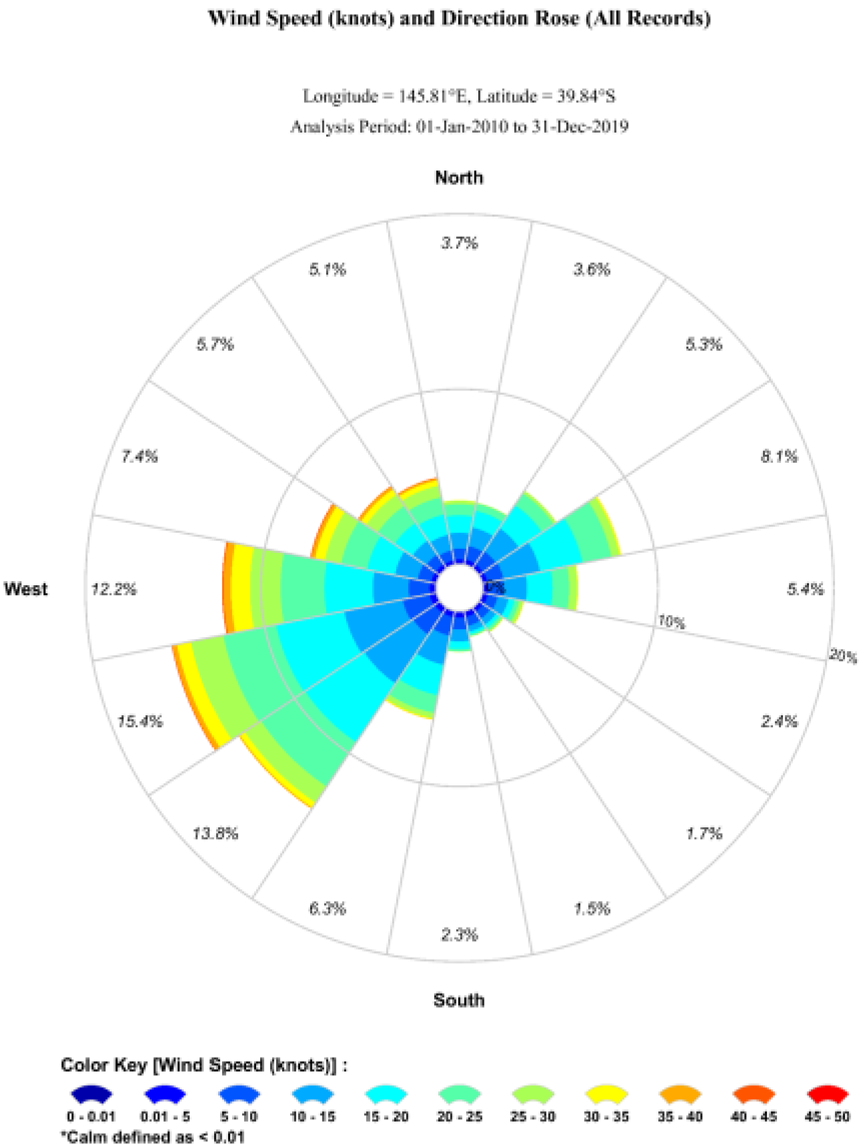


Figure 5-9 Modelled total wind rose distributions from 2010–2019 (inclusive), for the representative wind station nearby the Yolla-A platform (RPS 2022)

5.6.1.3 Tides

The tides of central Bass Strait are semi-diurnal with the dominant large-scale water movements due to the astronomical tide (I. S. Jones 1980). The tidal waves enter Bass Strait from the east and west almost simultaneously and as a result in the centre of the strait there is an area with small tidal currents where the two waves meet. The magnitude of the tidal currents then increases as the distance from the central strait increases with relatively strong tidal currents at either end. The times and magnitudes of the tide within Bass Strait are relatively uniform and predictable. However, the effects of meteorological phenomena may be significant, causing variations in level and also changing the phasing or timing of the tide (Sandery and Kampf 2005).

5.6.1.4 Ocean currents

Bass Strait is a relatively shallow area on the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. The strait has a reputation for strong tidal currents, which are primarily driven by tides, winds and density-driven flows. In winter and spring, waters within the strait are well mixed with no obvious stratification while during summer the central regions of the strait become stratified (Baines and Fandry 1983, Middleton and Black 1994).

The region is oceanographically complex, with sub-tropical influences from the north and sub-polar influences from the south (Commonwealth of Australia 2015c). There is a slow easterly flow of waters in Bass Strait and a large anti-clockwise circulation (Commonwealth of Australia 2015c). Three key water currents influence Bass Strait:

1. the Leeuwin Current transports warm, sub-tropical water southward along the Western Australian (WA) coast and then eastward into the Great Australian Bight (GAB), where it mixes with the cool waters from the Zeehan Current running along Tasmania's west coast (Commonwealth of Australia 2015c). The Leeuwin and Zeehan currents are stronger in winter than in summer, with the latter flowing into Bass Strait during winter

2. the East Australian Current (EAC) is up to 500 m deep and 100 km wide, flows southwards adjacent to the coast of NSW and eastern Victoria, and carries with it warm equatorial waters (Commonwealth of Australia 2015c). The EAC is strongest in summer when it can flow at a speed of up to 5 knots, but flows more slowly (2-3 knots) in winter where it remains at higher latitudes

3. the Bass Strait Cascade occurs during winter along the shelf break, which brings nutrient-rich waters to the surface as a result of the eastward flushing of the shallow waters of the strait over the continental shelf mixing with cooler, deeper nutrient-rich water (Commonwealth of Australia 2015c).

Table 5-5 provides the average and maximum net current speeds from combined HYCOM and tidal currents near the Yolla-A platform.

Figure 5-10 illustrates the major ocean currents in south-eastern Australian waters during summer and winter.
Figure 5-11 illustrates the monthly surface current rose distributions from the combination of HYCOM ocean current data and HYDROMAP tidal data near the Yolla-A platform for 2010-2019 (inclusive) and Figure 5-12 shows the total surface current rose distributions for the same time period. This data indicates that surface currents flow predominantly eastwards.

Semi-diurnal astronomical tides provide the major water level variations in the region with four current reversals each day and a relatively small tidal range of about 1.3 m. The tidal range at the Yolla-A platform location is estimated to be about 2.3 m at spring tides and 1.7 m at neap tides and the combined sea and tidal currents vary in intensity with the time of year, typically reaching speeds of up to 1.0 m/s. The lowest and highest astronomical tides at the platform are -1.47 m and +1.33 m, respectively. Tidal currents at the platform move in an ellipse and tend to flood and ebb to the southeast and northwest respectively.

Table 5-5 Predicted monthly average and maximum surface current speeds nearby the Yolla-A platform (RPS 2022)

Month	Average Current Speed (m/s)	Maximum Current Speed (m/s)	General Direction (towards)
January	0.18	0.66	Variable
February	0.17	0.70	Variable
March	0.17	0.75	Variable
April	0.16	0.73	Variable
May	0.19	0.87	East
June	0.19	0.70	East and Northwest
July	0.22	0.96	East
August	0.20	0.95	East
September	0.19	0.81	East
October	0.18	0.64	Variable
November	0.17	0.63	Variable
December	0.17	0.61	Variable
Minimum	0.16	0.61	
Maximum	0.22	0.96	

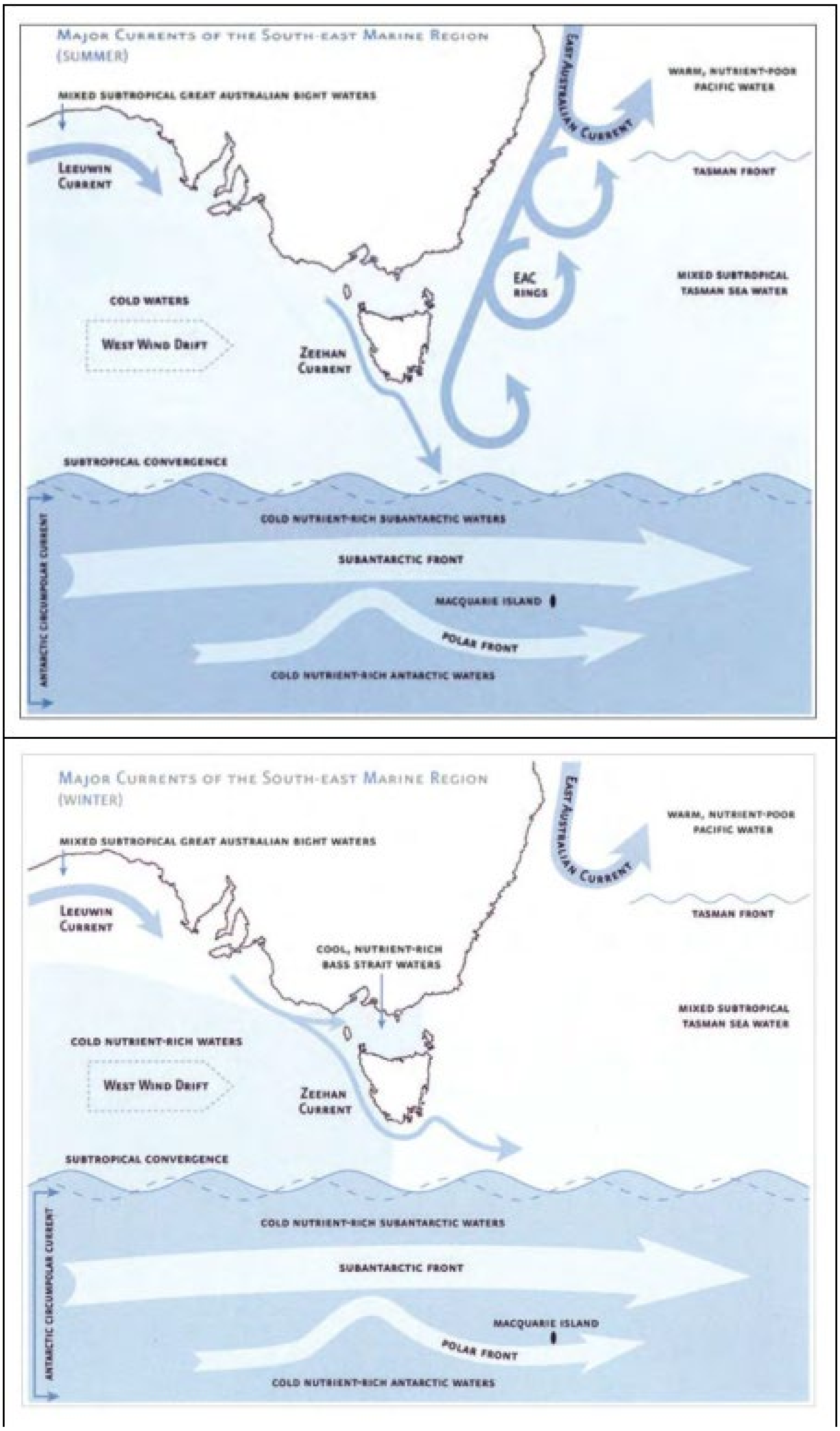


Figure 5-10 Major ocean currents in south-eastern Australian waters during summer (top) and winter (bottom) (Commonwealth of Australia 2015c)

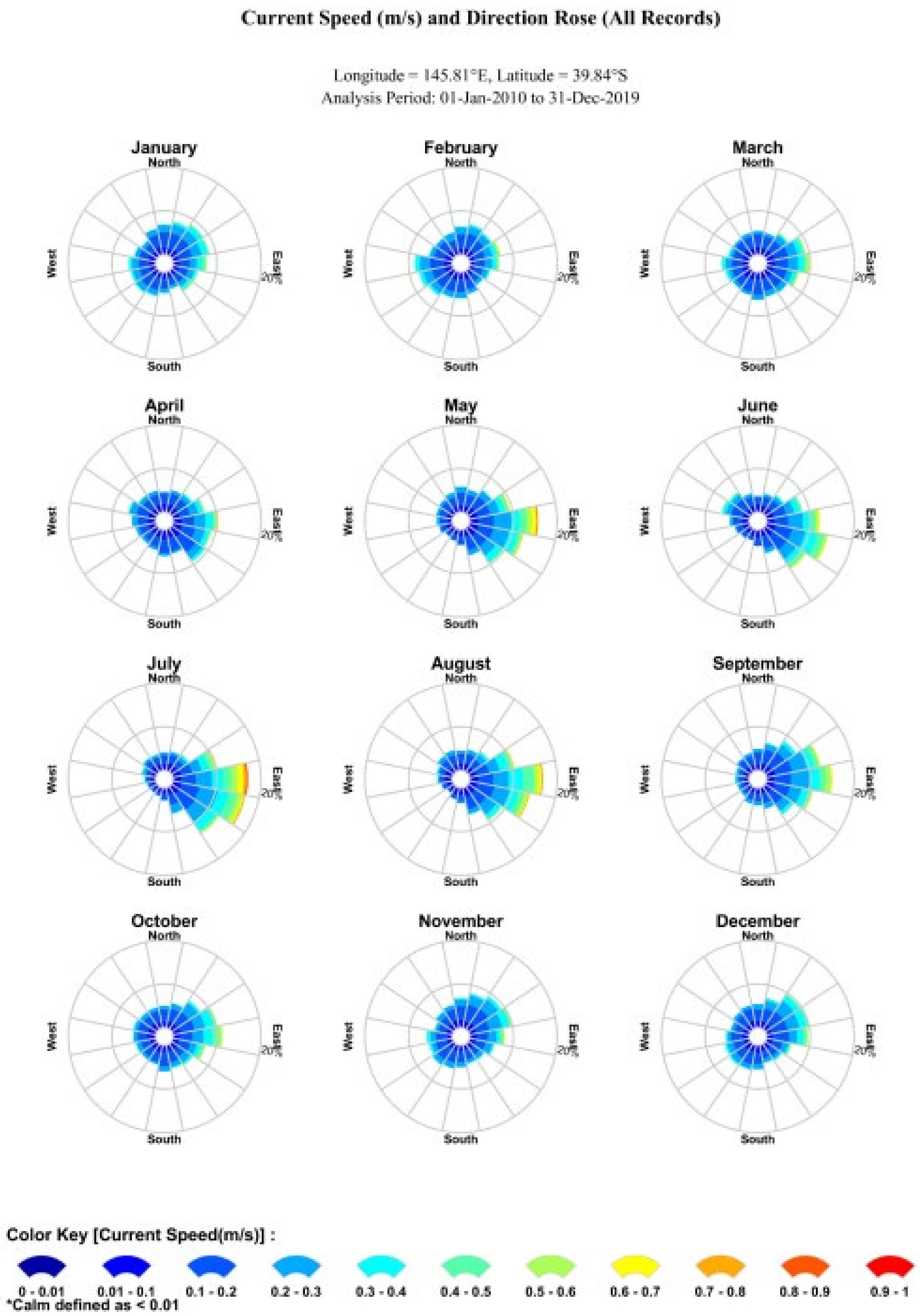


Figure 5-11 Monthly surface current rose plots nearby the Yolla-A platform (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive) (RPS 2022)

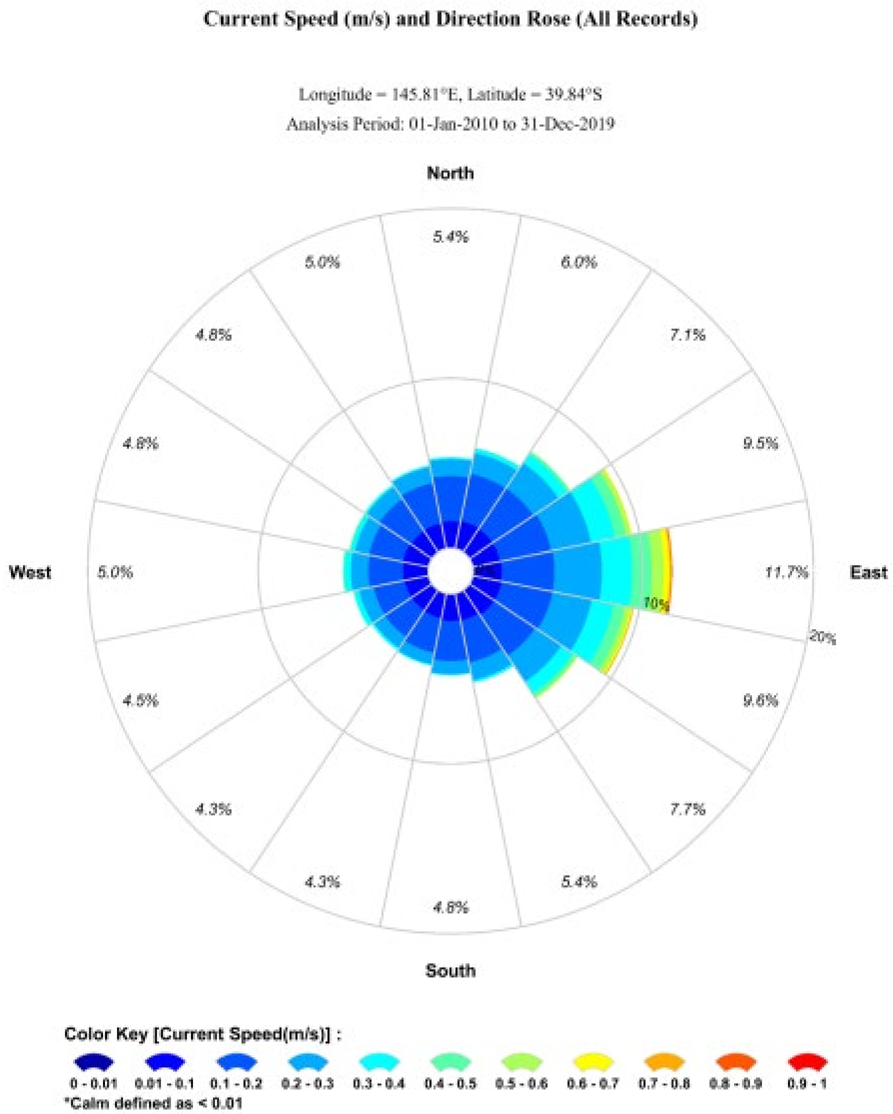


Figure 5-12 Total surface current rose plot nearby the Yolla-A platform (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive) (RPS 2022)

5.6.1.5 Waves

In Bass Strait, the interaction between sea and swell and the resultant wave motion is complicated by the islands and Australian mainland coastline embayments, peninsulas and headlands. This restricts the access of swell from the Southern Ocean into Bass Strait. Some swell is blocked completely and some refracted by the seabed and modified as it passes into shallower waters of Bass Strait. There are also waves generated by wind within Bass Strait and the conditions at any location will be the result of these two wave-energy bands (Falconer and Linforth 1972).

The local wave climate is derived principally from locally-generated wind waves mostly from the west and southwest. Wave heights range from 1.5 m to 2 m with periods of 8 s to 13 s, although heights of 5 m to 7 m can occur during storm events.

The 100-year Average Recurrence Interval (ARI) for waves near the Yolla-A platform has a maximum significant wave height of 8.3 m and a period of 12 s from the west to west-northwest. Maximum significant wave heights for 1-year and 10-year ARIs are 6.7 m and 7.4 m respectively. Smaller 100-year ARI maximum significant wave heights (4.4 m to 7.4 m) and periods (7.6 s to 10.2 s) have been estimated for non-critical directions. The maximum is likely to be about twice the significant wave height.

5.6.1.6 Sea temperature

The shallowness of Bass Strait means that its waters more rapidly warm in summer and cool in winter than waters of nearby regions (Commonwealth of Australia 2015c). The sea surface temperatures in the area reflect the influence of warmer waters brought into Bass Strait by the EAC (IMCRA 1998, Barton, Pope and Howe 2012).

Waters of eastern Bass Strait are generally well-mixed, but surface warming sometimes causes weak stratification in calm summer conditions. During these times, mixing and interaction between varying water masses leads to variations in horizontal water temperature and a thermocline (temperature profile) develops. The thermocline acts as a low-friction layer separating the wind-driven motions of the upper well-mixed layer of Bass Strait from the bottom well-mixed layer.

RPS (2020a, 2020b) reports that sea surface temperature in the region (based on the World Ocean Atlas) varies from an average minimum of 12.7 °C in winter to a maximum of 18.1 °C in late summer. In the shallower waters of the EMBA such as the Bunurong Marine National Park (MNP) and Bunurong Marine Park, Parks Victoria (2006a) notes that surface water temperatures range from 13°C in the warmer months to 17.5 C in the cooler months.

5.6.2 Ambient Sound Levels

Ambient noise within the EMBA and Operational Area offshore Bass Strait region is expected to be dominated by naturally occurring physical (e.g. wind, waves, rain) and biological (e.g. echo-location and communication noises generated by cetaceans and fish) sources. Anthropogenic noise sources are also likely to be experienced in the area and include low-frequency noise from vessels.

5.6.3 Water quality

The nutrient concentrations in Central Bass Strait are low compared to that of what is seen at its extremities (Gibbs, Tomczak and Longmore 1986, Gibbs 1992). It is hypothesised that this could be due to the biological demands of the Bass Strait waters consuming much of the nutrients before moving into Central Bass Strait (Gibbs 1992). In the nearshore areas of the EMBA, water quality may be negatively affected through the discharge of polluted waters from rivers, which drain catchments dominated by stock grazing and small coastal settlements (Parks Victoria 2006a).

5.6.4 Sediment quality

5.6.4.1 Bass Strait

The bathymetry of Bass Strait shown in Figure 5-13 illustrates that the seafloor is gently sloping with water depths increasing gradually from the shore to reach a maximum of about 80 m at the Yolla-A platform.

Mainland Tasmania and the Bass Strait islands belong to the same continental landmass as mainland Australia. The continental shelf is narrow along the east coast of Tasmania but broadens in the northwest, underlying Bass Strait and the Otway and Gippsland basins. The central part of Bass Strait contains a depression that exchanges water with the ocean to the north of King Island. The Basinal Plain is the main seafloor feature of Bass Strait; a ridge along the western edge of this plain extends from King Island to northwest Tasmania.

Sedimentation in Bass Strait is generally low due to the low supply from rivers and the relatively low productivity of carbonate.

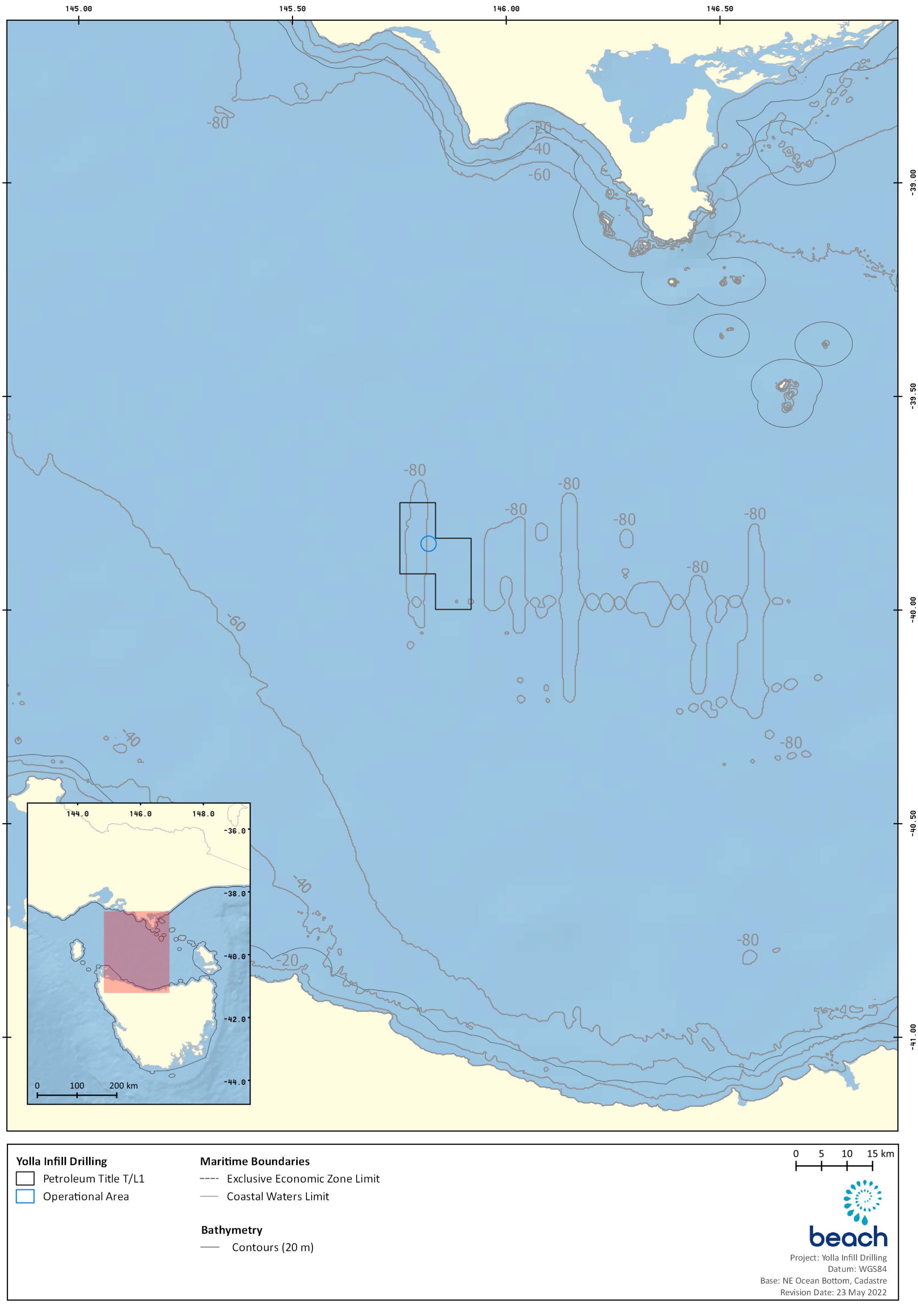


Figure 5-13 Bathymetry of Bass Strait and the EMBA

5.6.4.2 Yolla Location

Origin Energy, as the previous operator of the BassGas development, undertook several geotechnical surveys in and around the Yolla-A platform. These surveys indicate that there are no obstructions or wrecks in the area (Thales Geosolutions 2001). The seabed is flat and featureless, with surveys prior to construction indicating the seabed has very soft to soft alternating layers of silty carbonate clay and silty sands containing fragile white shell fragments (Thales Geosolutions 2001).

Three depressions are located on the east side of Yolla-A platform, formed from the spud cans of the jack-up drill rigs that drilled the Yolla wells. These depressions are shown in Figure 5-14 and the approximate dimensions are 5 m below mean seabed level and approximately 36 m in diameter. Their shape and depth is preserved in a clay seabed base and the total spud can volume has not substantially changed over the course of three surveys conducted between 2007 and 2015 (Fugro 2007, Neptune 2015)

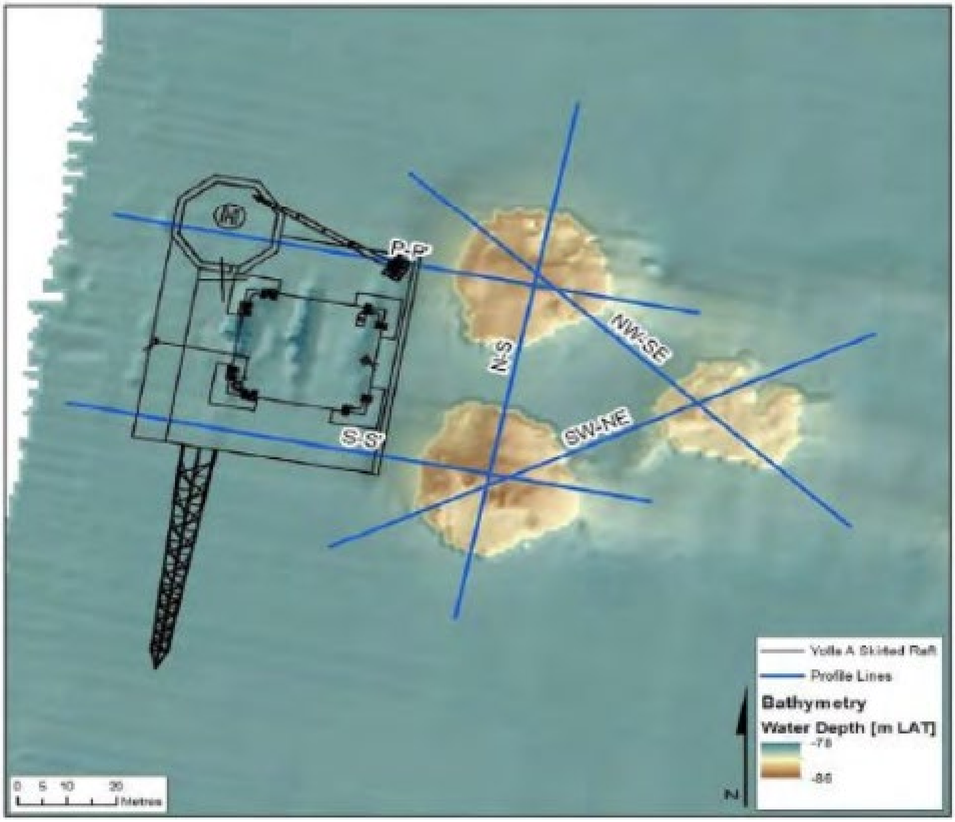


Figure 5-14 Existing drill rig spud can depressions on the east side of the Yolla-A platform

5.6.5 Air quality

The offshore region is remote and therefore air quality is expected to be high. However, anthropogenic sources such as commercial vessel traffic, or natural sources such as a bushfire could contribute to local variations in air quality. With commercial vessels adhering to the PSZ and with coastal regions over 90 km away, impacts on local air quality is assumed to be both seldom and minimal.

5.7 Ecological Environment

To characterise the ecological environment where the drilling activity is to be conducted, a literature search, online resources and databases and previous in-situ studies in the area have been reviewed to identify and assess flora and fauna species known to be present or potentially present in the EMBAs. 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 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 Bass Strait
- seabed surveys in and around the Yolla-A Platform (Benthic, 2001; Fugro, 2002; Benthic, 2009; Benthic, 2013) (Thales Geosolutions 2001, Fugro 2007, Neptune 2015)
- relevant listings under the Victorian FFG Act 1988 (DELWP 2017)
- relevant environmental guidelines and publicly available scientific literature on individual species.

5.7.1 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.

Marine invertebrates in Bass Strait include porifera (e.g. sponges), cnidarians (e.g. jellyfish, corals, anemones, seapens), bryozoans, arthropods (e.g., sea spiders), crustaceans (e.g. rock lobster, brine and fairy shrimps), molluscs (e.g. scallops, sea slugs), echinoderms (e.g. sea cucumbers), and annelids (e.g. polychaete worms). Studies by the Museum of Victoria (Wilson and Poore 1987, Poore, et al. 1985) found that invertebrate diversity was high in southern Australian waters, and the distribution of species was irregular with little evidence of any distinct biogeographic regions. The results of invertebrate sampling undertaken in shallower inshore sediments indicate a high diversity and patchy distribution. In these areas crustaceans, polychaetes, and molluscs are dominant (Parry, Campbell and Hobday 1990). Surveys of the seabed near the Yolla-A platform prior to previous drilling and construction showed sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and predatory snails (whelk) (Thales Geosolutions 2001).

Generally, the epibiota of the region is sparse and characterised by scallops and other large bivalve molluscs, crabs, seasquirts, seapens, sponges and bryozoans. A variety of mobile crabs, prawns and brittle stars are also relatively common. Many of the mobile epibiota appear to occur in aggregations from time to time (scallops, prawns and crabs) while some of the fixed epibiota occur in patches (sponges and bryozoans). For example, trawling conducted for the Museum of Victoria biological sampling programs recorded large hauls of sponges along some trawl transects. The main hauls of sponges were located in an arc around southern Bass Strait (Butler, et al. 2002).

Within the EMBA, key benthic habitats and assemblages include:

- soft sediment
- seagrass
- algae
- coral reef.

Soft sediment communities are common throughout the EMBA. Known assemblages of seagrass, algae and coral reef habitat within the EMBA are displayed on Figure 5-15.

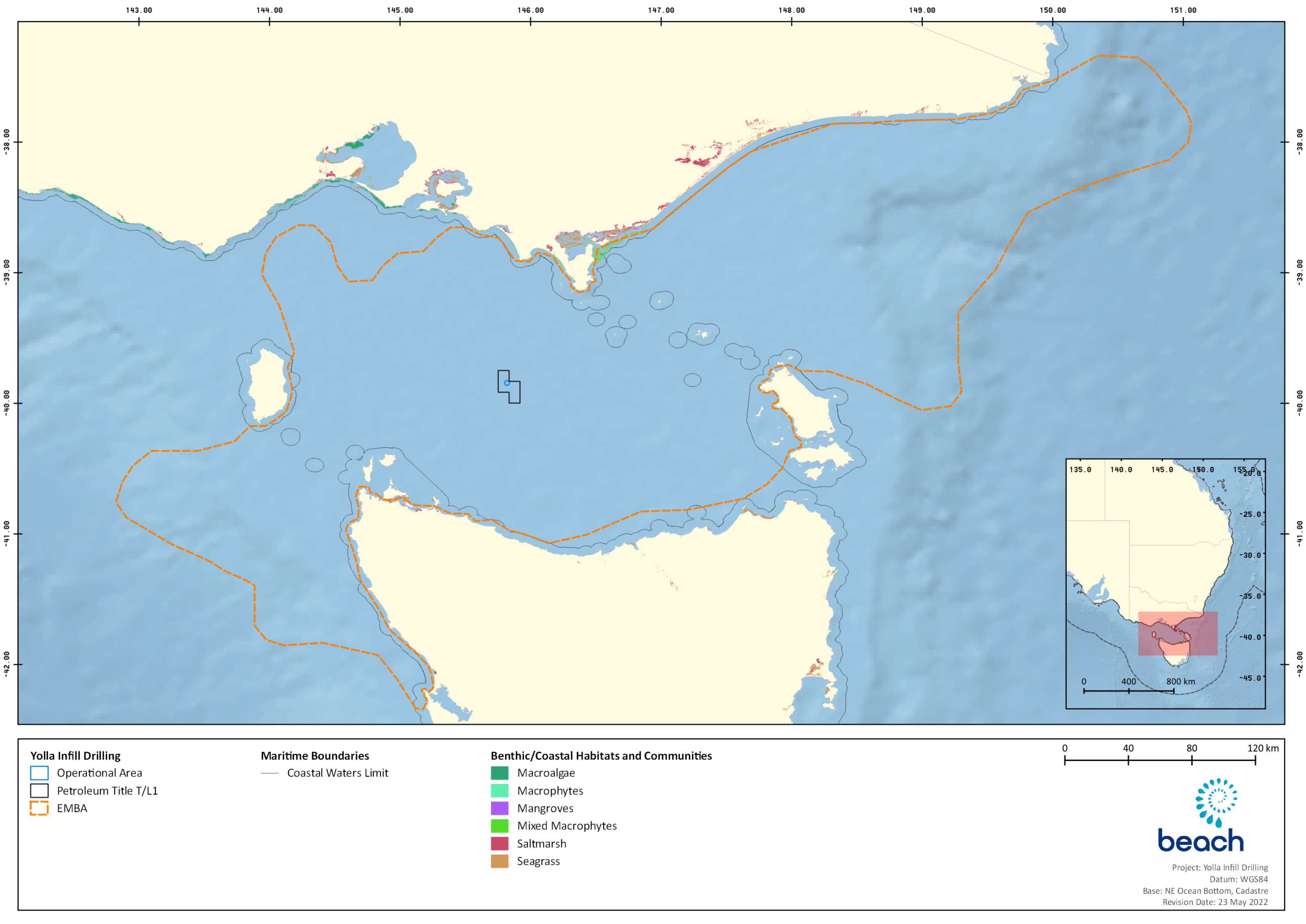


Figure 5-15 Sensitive benthic and shoreline habitats and assemblages within the EMBA

5.7.1.1 Soft Sediment

Based upon surveys undertaken within the Operational Area, the seabed is flat and featureless, with surveys prior to construction indicating the seabed has very soft to soft alternating layers of silty carbonate clay and silty sands containing fragile white shell fragments (Thales Geosolutions 2001).

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.

According to NRE Tas (2021), very little is known of Tasmania's offshore marine ecosystems as there have only been limited surveys of benthic biota. However, it is known that unvegetated soft sediments (sand, mud and unconsolidated substrates) are the dominant feature of subtidal marine environment in Tasmania, comprising around 75 % of the seabed in nearshore areas (Parsons 2011). The apparently barren appearance of these areas is deceptive and hides a diversity of life, as well as important nursery habitats and rare species limited to Tasmanian waters. There are few places to hide, so many species living on sand and mud have developed special mechanisms for protection, such as camouflage or being adept at quickly burrowing into the sediment, such as the spotted flounder (*Ammoteris lituratus*) and girdled goby (*Nesogobius maccullochi*) (Parsons 2011). These sediments generally have a lower productivity than seagrass and macroalgal beds (such as those found in abundance off the west coast of Flinders Island) due to the absence of large photosynthesising plants, however they are often rich in small invertebrates that live on microscopic algae, bacteria and food particles in the passing water. These in turn provide food for larger surface dwelling and burrowing invertebrates, which in Tasmanian waters are dominated by crustaceans, polychaete worms, gastropods and bivalve molluscs (Parsons 2011).

5.7.1.2 Seagrass

Seagrass habitat is not present within the Operational Area. However, seagrass is known to be present along the Victorian and Tasmanian coastline within the EMBA (Figure 5-15).

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) (Kirkman 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, Sorokin, et al. 2003). Known seagrass meadows within the EMBA include Corner Inlet. 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, Kirkman 1997).

5.7.1.3 Algae

Algae habitat is not present within the Operational Area. However, key algal communities are known to be present along the Victorian and Tasmanian coastline within the EMBA (Figure 5-15).

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, Gibson and Barnes 1999). Benthic microalgae can also provide a food source to grazers such as gastropod and amphipods (Ansell, Gibson and Barnes 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 EMBA macroalgae is present along the coast of Victoria (Figure 5-15).

5.7.1.4 Coral

Although coral polyps may be present, no Coral Reef habitat is present within the Operational Area.

Scleractinia corals are generally divided into two broad groups: The hermatypic (reef-building, and most common) corals that often contain the symbiotic microalgae, zooxanthellaethae, which enhance growth and allow the coral to deposit large amounts of calcium carbonate; and the ahermatypic (non-reef building, and least common) corals, which can still have zooxanthellae but often do not and are unable to deposit large amounts of calcium carbonate to create a hard reef framework. Corals that do not contain zooxanthellae are called azooxanthellate and can be found at most depths, even beyond the shallow photic zone (deeper than 50 m) which most zooxanthellae containing corals live (Tzioumis and Keable 2007).

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. 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).

5.7.2 Mangroves

Mangroves are not present within the Operational Area.

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).

Within the EMBA Mangroves are present along the coast of Victoria (Figure 5-15).

5.7.3 Saltmarsh

Saltmarsh is not present within the Operational Area.

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 Tasmanian and Victorian coast. Along the Victorian coast, it 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 5-15) (Boon, et al. 2011).

5.7.4 Plankton

Plankton is a key component in oceanic food chains and comprises two elements; phytoplankton and zooplankton, as described herein.

Phytoplankton (photosynthetic microalgae) comprise 13 divisions of mainly microscopic algae, including diatoms, dinoflagellates, gold-brown flagellates, green flagellates and cyanobacteria and prochlorophytes (McLeay, Sorokin, et al. 2003).

Phytoplankton drift with the currents, although some species have the ability to migrate short distances through the water column using ciliary hairs. Phytoplankton biomass is greatest at the extremities of Bass Strait (particularly in the northeast) where water is shallow and nutrient levels are high.

Zooplankton is the faunal component of plankton, comprising small crustaceans (such as krill), fish eggs and fish larvae. Zooplankton includes species that drift with the currents and also those that are motile. More than 170 species of zooplankton have been recorded in eastern and central Bass Strait, with copepods making up approximately half of the species encountered (Watson and Chaloupka 1982). The high diversity may be due to considerable intermingling of distinctive water bodies and may be higher in eastern than in western Bass Strait. Although a high diversity of zooplankton has been recorded, Kimmerer and McKinnon (1984) found that seven dominant species make up 80 % of individuals.

As part of a marine seismic survey undertaken in early 2018, the CarbonNet Project commissioned plankton sampling across nine sites in shallow waters off Golden Beach, Gippsland (227 km to the northeast of Yolla-A platform). The results of this work (CarbonNet 2018) found that:

- the composition of zooplankton was a typical healthy example of those expected for temperate coastal waters
- copepods are the dominant group, with varying proportions of appendicularians, cladocerans and doliolids. Numerous other groups occurred in small numbers, including siphonophores, fish larvae, fish eggs, polychaetes, ghost shrimps and cnidarians (jellies).

Although this work was undertaken to the northeast of the BassGas development, it is likely that a similar plankton assemblage would occur in the EMBA given the well-mixed nature of Bass Strait waters.

5.7.5 Invertebrates

Historic environmental surveys around the Yolla-A suggest there is minimal invertebrate activity within the OA (Thales Geosolutions 2001).

However, throughout the EMBA there will be a range of different invertebrate habitats and activity. 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 (DNP 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).

5.7.6 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 EMBA PMST Report (Appendix D) identified the following TECs:

- Alpine Sphagnum Bogs and Associated Fens
- 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
- Littoral Rainforest and Coastal Vine Thickets of Eastern Australia
- Lowland Grassy Woodland in the South East Corner Bioregion
- Lowland Native Grasslands of Tasmania
- Natural Damp Grassland of the Victorian Coastal Plains
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria
- Subtropical and Temperate Coastal Saltmarsh
- Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (*Eucalyptus ovata / E. brookeriana*)
- Tasmanian white gum (*Eucalyptus viminalis*) wet forest.

Of the TECs listed above, many are terrestrial listings. 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, Littoral Rainforest and Coastal Vine Thickets of Eastern Australia, and Subtropical and Temperate Coastal Saltmarsh are marine/coastal features.

As discussed in Section 7.15, no shoreline loading of hydrocarbons was predicted in the event of a spill. As such, no TEC is expected to be exposed to impacts associated with these activities.

5.7.7 Threatened and Migratory species

PMST reports were generated for the Operational Area and EMBAs to identify the listed Threatened and Migratory species that may be present in these EMBAs (Appendix C and Appendix D). The EMBA encompasses the smaller Operational Area.

A total of 136 listed threatened species and 78 migratory species are identified as potentially occurring within the broader EMBA. There are also 123 listed marine species and 32 cetacean species identified as potentially occurring within the EMBA.

5.7.7.1 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
- marine.

A full list of the recovery plans for MNES within the EMBA can be found in Section 3.2 with details of listed fauna and their likely presence in the Operational Area and 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 and EMBA are considered to have conservation significance warranting further discussion, given these provide sufficient information to enable an environmental risk assessment to be completed. Likely occurrence was determined by the PMST report or through designation of important habitat (e.g. Biologically Important Areas [BIAs]).

5.7.7.2 BIAs and Critical Habitat to the survival of the species

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. The EMBA overlaps with one listed critical habitat, the Listed Critical Habitat for the Shy Albatross (*Thalassarche cauta*) – Albatross Island, The Mewstone, Pedra Branca. This critical habitat comprises the entire breeding range of the shy albatross. If these island habitats were lost, it is unlikely that the species which use them would persist. Albatrosses are extremely site-faithful and the populations currently breeding on these islands are unlikely to breed elsewhere (DAWE 2002).

BIAs within the Operational Area and EMBA are summarised in Table 5-6 with further details in the relevant species sections.

Table 5-6 BIAs identified within the Operational Area and EMBA

Receptor	Type of BIA	Operational Area	EMBA
Birds			
Antipodean albatross	Foraging	>110 km	Overlap
Australasian gannet	Foraging	>88 km	Overlap
Lack-browed albatross	Foraging	Overlap	Overlap
Black-faced cormorant	Foraging	>95 km	Overlap
	Breeding	>180 km	Overlap
Bullers albatross	Foraging	Overlap	Overlap
Campbell albatross	Foraging	Overlap	Overlap
Common diving-petrel	Foraging	Overlap	Overlap
Indian yellow-nosed albatross	Breeding	Overlap	Overlap
Little penguin	Foraging	>70 km	Overlap

Receptor	Type of BIA	Operational Area	EMBA
	Breeding	>79 km	Overlap
Short-tailed shearwater	Foraging	Overlap	Overlap
	Breeding	>79 km	Overlap
Shy albatross	Foraging Likely	Overlap	Overlap
	Breeding	>112 km	Overlap
Soft-plumaged petrel	Foraging	>193 km	Overlap
Wondering albatross	Foraging	Overlap	Overlap
Wedge-tailed shearwater	Foraging	>137 km	Overlap
White-faced storm-petrel	Foraging	Overlap	Overlap
	Breeding	>500 km	Overlap
White-fronted tern	Foraging	>182 km	Overlap
Fish			
White shark	Known Distribution	Overlap	Overlap
	Distribution (low density)	Overlap	Overlap
	Breeding (nursery area)	>96 km	Overlap
	Foraging	>55 km	Overlap
	Distribution	Overlap	Overlap
Cetaceans			
Humpback whale	Foraging	>440 km	Overlap
Pygmy blue whale	Foraging	Overlap	Overlap
	Distribution	Overlap	Overlap
	Known Foraging Area	>74 km	Overlap
Southern right whale	Migration and Resting on Migration (breeding may occur)	>82 km	Overlap
	Connecting Habitat	>104 km	Overlap
	Known Core Range	Overlap	Overlap
Spotted bottlenose dolphin	Breeding (calving)	>445 km	Overlap

5.7.7.3 Fish

Fish species present in the Operational Area or 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 EMBA PMST report (Appendix D) identified 48 listed fish species that potentially occur in the EMBA.Table 5-7 details the listed fish species identified in the Operational Area and EMBA PMST report. A brief description of listed Threatened or Migratory fish species has been provided. Where species were identified as having a preference for freshwater habitats, and no potential for impacts exists, these species were not described further.

Table 5-7 Listed fish species identified in the PMST report

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[1]	Operational Area	EMBA
		Listed Threatened	Listed Migratory	Listed Marine			
Fish							
Black rockcod, Black cod, Saddled rockcod	*Epinephelus daemelii*	Vulnerable			SHM		✓
Eastern dwarf galaxias, Dwarf Galaxias	*Galaxiella pusilla*	Vulnerable			SHK		✓
Orange Roughy, Deep-sea perch, Red roughy	*Hoplostethus atlanticus*	Conservation Dependent			SHL		✓
Yarra pygmy perch	*Nannoperca obscura*	Vulnerable			SHM		✓
Australian grayling	*Prototroctes maraena*	Vulnerable			SHK		✓
Eastern gemfish	*Rexea solandri*	Conservation Dependent			SHL		✓
Blue warehou	*Seriolella brama*	Conservation Dependent			SHK	✓	✓
Southern bluefin tuna	*Thunnus maccoyii*	Conservation Dependent			SHL	✓	✓
Sharks and Rays							
Grey nurse shark	*Carcharias taurus*	Critically Endangered			SHM		✓
Oceanic whitetip shark	*Carcharhinus longimanus*		Migratory		SHM		✓
White shark, Great white shark	*Carcharodon carcharias*	Vulnerable	Migratory		BK	✓	✓
Harrisson's dogfish, Endeavour dogfish, Dumb gulper shark, Harrison's deepsea dogfish	*Centrophorus harrissoni*	Conservation Dependent			SHL		✓

[1] 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 EMBA's or Operational Area.

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[1]	Operational Area	EMBA
Southern dogfish, Endeavour dogfish, Little gulper shark	*Centrophorus zeehaani*	Conservation Dependent			SHL		✓
School shark, eastern school shark, Snapper shark, Tope, Soupfin shark	*Galeorhinus galeus*	Conservation Dependent			SHL	✓	✓
Shortfin mako, Mako shark	*Isurus oxyrinchus*		Migratory		SHL	✓	✓
Porbeagle, Mackerel shark	*Lamna nasus*		Migratory		SHL	✓	✓
Whale shark	*Rhincodon typus*	Vulnerable	Migratory		SHM		✓
Maugean skate, Port Davey skate	*Zearaja maugeana*	Endangered			SHK		✓
Pipefish, seahorse, seadragons							
Upside-down pipefish, Eastern upsidedown pipefish, Eastern Upside-down pipefish	*Heraldia nocturna*			Listed	SHM	✓	✓
Big-belly seahorse, Eastern potbelly seahorse, New Zealand potbelly seahorse	*Hippocampus abdominalis*			Listed	SHM	✓	✓
Short-head seahorse, Short-snouted seahorse	*Hippocampus breviceps*			Listed	SHM		✓
Bullneck seahorse	*Hippocampus minotaur*			Listed	SHM	✓	✓
Crested pipefish, Briggs' crested pipefish, Briggs' pipefish	*Histiogamphelus briggsii*			Listed	SHM		✓
Rhino pipefish, MacLeay's crested pipefish, Ring-back pipefish	*Histiogamphelus cristatus*			Listed	SHM		✓
Knifesnout pipefish, Knife-snouted pipefish	*Hypselognathus rostratus*			Listed	SHM		✓
Deepbody pipefish, Deep-bodied pipefish	*Kaupus costatus*			Listed	SHM		✓
Trawl pipefish, Bass Strait pipefish	*Kimblaeus bassensis*			Listed	SHM	✓	✓
Brushtail pipefish	*Leptoichthys fistularius*			Listed	SHM		✓
Australian smooth pipefish, Smooth pipefish	*Lissocampus caudalis*			Listed	SHM		✓
Javelin pipefish	*Lissocampus runa*			Listed	SHM		✓
Sawtooth pipefish	*Maroubra perserrata*			Listed	SHM	✓	✓

Common Name	Species Name	EPBC Act Status		Type of presence (within the EMBA)[1]	Operational Area	EMBA
Mollison's pipefish	*Mitotichthys mollisoni*		Listed	SHM		✓
Halfbanded pipefish	*Mitotichthys semistriatus*		Listed	SHM		✓
Tucker's pipefish	*Mitotichthys tuckeri*		Listed	SHM		✓
Red pipefish	*Notiocampus ruber*		Listed	SHM	✓	✓
Leafy seadragon	*Phycodurus eques*		Listed	SHM	✓	✓
Common seadragon, Weedy seadragon	*Phyllopteryx taeniolatus*		Listed	SHM	✓	✓
Pugnose pipefish, Pug-nosed pipefish	*Pugnaso curtirostris*		Listed	SHM		✓
Robust pipehorse, Robust spiny pipehorse	*Solegnathus robustus*		Listed	SHM	✓	✓
Spiny pipehorse, Australian spiny pipehorse	*Solegnathus spinosissimus*		Listed	SHM	✓	✓
Spotted pipefish, Gulf pipefish, Peacock pipefish	*Stigmatopora argus*		Listed	SHM		✓
Widebody pipefish, Wide-bodied pipefish, Black pipefish	*Stigmatopora nigra*		Listed	SHM		✓
Ringback pipefish, ring-backed pipefish	*Stipecampus cristatus*		Listed	SHM		✓
Double-end pipehorse, Double-ended pipehorse, Alligator pipefish	*Syngnathoides biaculeatus*		Listed	SHM		✓
Hairy pipefish	*Urocampus carinirostris*		Listed	SHM		✓
Mother-of-pearl pipefish	*Vanacampus margaritifer*		Listed	SHM		✓
Port Phillip pipefish	*Vanacampus phillipi*		Listed	SHM	✓	✓
Longsnout pipefish, Australian longsnout pipefish, Long-snouted pipefish	*Vanacampus poecilolaemus*		Listed	SHM		✓

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.

BK: Breeding known to occur within area.

Black rockcod, Black cod, Saddled rockcod

The black rockcod (*Epinephelus daemelii*) is a large cod species distributed in warm temperate to temperate marine waters of south-eastern Australia, from southern Queensland to Mallacoota in Victoria (428 km northeast of Yolla-A and within the EMBA), and rarely west of this point (DSEWPaC 2012b). The species inhabits caves, gutters and crevices generally to depths of 50 m, with juveniles found inshore. Individuals are highly territorial and have small home ranges (DSEWPaC 2012b). The black rockcod is a protogynous hermaphrodite, meaning it changes sex from female to male during its life cycle. The species has declined in number due to angling and spearfishing (DSEWPaC 2012b). Given their known distribution, the black rockcod may occur in suitable habitat within the EMBA but is not likely to occur in the Operational Area.

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 New South Wales, Victoria and Tasmania migrating between streams and the ocean (Backhouse, Jackson and O'Connor 2008, DELWP 2015). The species spends most of its life in freshwater (DELWP, 2015) and migrates to lower reaches of rivers to spawn in autumn (Museums Victoria 2019), though timing is dependent on many variables including latitude and varying temperature regimes (Backhouse, Jackson and O'Connor 2008), with increased stream flows also thought to initiate migration (Backhouse, Jackson and O'Connor 2008).

The Australian Grayling Action Statement (DELWP 2015) lists Victorian rivers that flow into Bass Strait that are known habitat for this species. The Cann, Thurra, Wingan and Tarwin river mouths are intersected by the EMBA. The Australian grayling is known to occur on King Island however its mapped habitat occurs on the western coast of the island which is not intersected by the EMBA. The National Recovery Plan for the Australian Grayling (Backhouse, Jackson and O'Connor 2008) lists the Pieman, Arthur and Detention rivers in Tasmania as important rivers for the species. The Australian Grayling Action Statement (DELWP 2015) list the threatening processes to this species as barriers to movement, river regulation, poor water quality, siltation, introduced fish, climate change, diseases and fishing. It is unlikely that the Australian grayling is present in the Operational Area or spill EMBA due to its preference for freshwater stream and river habitats.

Grey nurse shark

The grey nurse shark (*Carcharius Taurus*) (eastern population) is a large robust species that has become critically endangered due to commercial fishing, spearfishing and protective beach meshing (TSSC 2001). It was historically widespread in sub-tropical and warm temperate seas and previously recorded from all Australian states except Tasmania, and have all but disappeared from Victorian waters (TSSC 2001). Only one record of the species occurs from Gippsland, at Mallacoota Inlet in the early 1970s.

The species currently has a broad inshore distribution throughout sub-tropical to cool temperate waters on the continental shelf, with separate east coast and west coast populations (DoE 2014b). The east coast population extends from central Queensland to southern NSW, occasionally as far south as the NSW/Victoria border (DoE 2014b), which coincides with the BIA for their distribution and breeding (October to November).

Oceanic whitetip shark

The oceanic whitetip shark (*Carcharhinus longimanus*) is a widely distributed tropical and subtropical pelagic species. They are found in water from Cape Leeuwin (Western Australia) through parts of the Northern Territory, down the east coast of Queensland and New South Wales to Sydney (Last and Stevens 2009). They are generally found offshore in the open ocean, on the outer continental shelf, or around oceanic islands in deep water areas. Although they can make deep dives and have been recorded up to 1,082 m deep, they typically live in the upper part of the water column, from the surface to at least 200 m (NOAA 2021a). No known habitat occurs within Victorian or Tasmanian waters (DAWE 2022o). The oceanic whitetip shark has the potential to be present within the Operational Area and EMBA.

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 (DAWE 2022j). Studies of white sharks indicate that they are largely transient. However, individuals are known to return to feeding grounds on a seasonal basis (Klimey and Anderson 1996). In the Australasian region, white sharks differ genetically from other populations and data suggest there are two populations in southern Australia east and west by Bass Strait (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 EMBA and Operational Area (Figure 5-16). 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 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, and they are known to forage in waters off pinniped colonies throughout the SEMR. It is likely that white sharks are present in the EMBA.

Shortfin Mako

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 between 2008 and 2011 investigated habitat and migration patterns. It revealed GAB and south east of Kangaroo Island near the norther extent of the Bonney coast upwelling region, to be areas of highest fidelity and 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 EMBA in low numbers.

Porbeagle Mackerel 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 EMBA in low numbers.

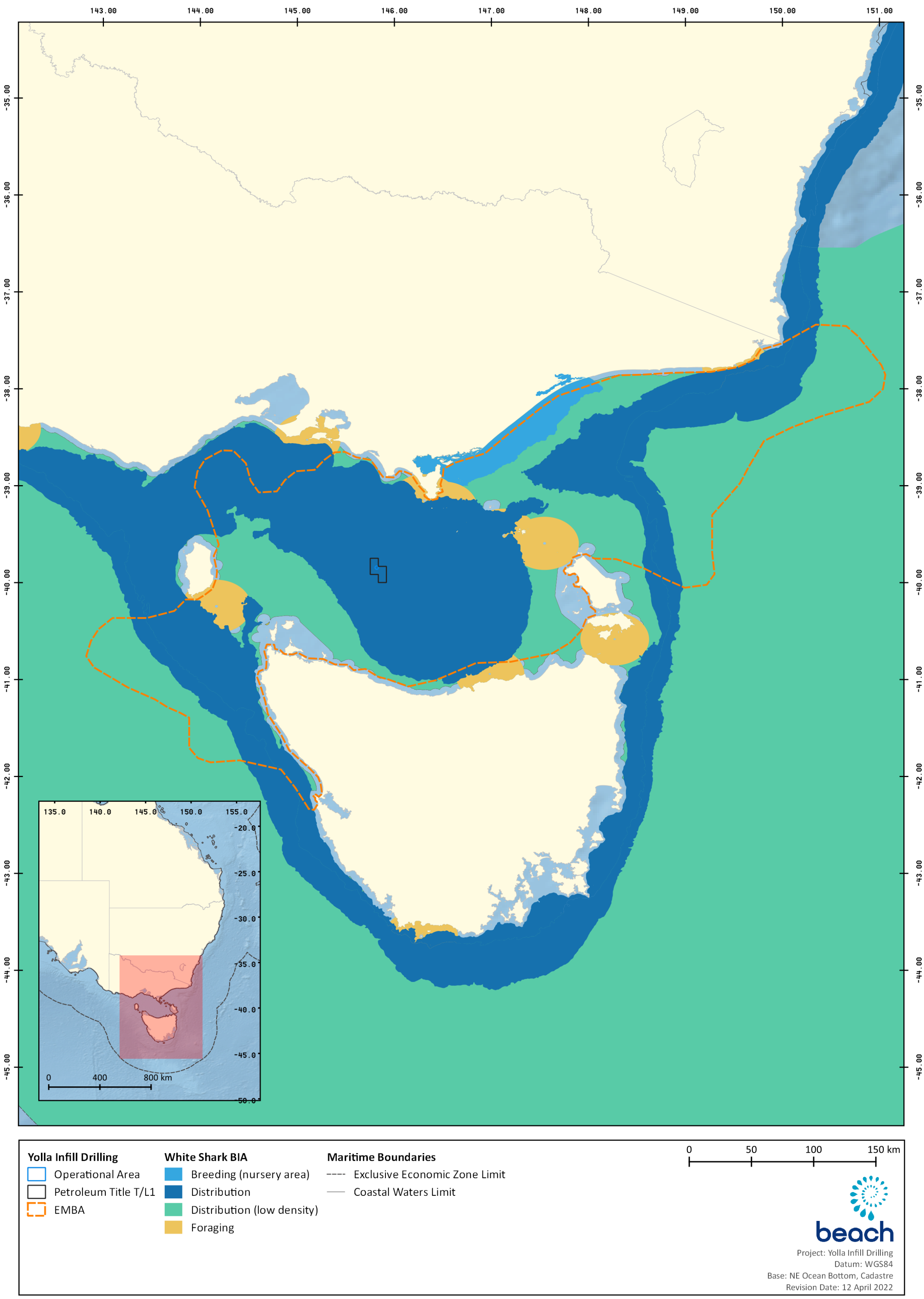


Figure 5-16 BIAs for the White Shark within the spill EMBA

Whale shark

The whale shark (*Rhincodon typus*) is the world's largest fish and one of only three filter feeding shark species (TSSC 2015b). They have a broad distribution in warm and tropical waters of the world and in Australia are known only to occur on the west coast of Western Australia with a feeding aggregation occurring off the Ningaloo Reef between March and July each year (TSSC 2015b). The species is not known to migrate through Bass Strait, and it is highly unlikely to migrate through the Operational Area or the EMBA.

5.7.7.4 Birds

A diverse array of seabirds and terrestrial birds, some of which are protected by international agreements (Bonn Convention, JAMBA, CAMBA and ROKAMBA), utilise the Bass Strait region to potentially forage within or fly over the EMBA's as they travel between the Bass Strait Islands, mainland Victoria and Tasmania (DAWE 2020b). Infrequently and often associated with storm events, birds that do not normally cross the ocean are sometimes observed over the Bass Strait, 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 EMBA (this includes species or species habitat), are shown in Table 5-8. Given the number of species present, a brief description of listed Threatened or Migratory birds is provided grouped by major genus.

Table 5-8 Listed bird species identified in the PMST report

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[2]	Operational Area	EMBA
		Listed Threatened	Listed Migratory	Listed Marine			
Albatrosses							
Antipodean albatross	*Diomedea antipodensis*	Vulnerable	Migratory	Listed	FL	✓	✓
Gibson's albatross	*Diomedea antipodensis gibsoni*	Vulnerable		Listed	FL	✓	✓
Southern royal albatross	*Diomedea epomophora*	Vulnerable	Migratory	Listed	FL	✓	✓
Wandering albatross	*Diomedea exulans*	Vulnerable	Migratory	Listed	FL	✓	✓
Northern royal albatross	*Diomedea sanfordi*	Endangered	Migratory	Listed	FL	✓	✓
Sooty albatross	*Phoebetria fusca*	Vulnerable	Migratory	Listed	SHL	✓	✓
Buller's albatross, pacific albatross	*Thalassarche bulleri*	Vulnerable	Migratory	Listed	FL	✓	✓
Northern Buller's albatross, pacific albatross	*Thalassarche bulleri platei*	Vulnerable		Listed	FL	✓	✓
Indian yellow-nosed albatross	*Thalassarche carteri*	Vulnerable	Migratory	Listed	SHL	✓	✓
Shy albatross	*Thalassarche cauta*	Endangered	Migratory	Listed	BK		✓
Grey-headed albatross	*Thalassarche chrysostoma*	Endangered	Migratory	Listed	SHM	✓	✓
Chatham albatross	*Thalassarche eremita*	Endangered	Migratory	Listed	FL		✓
Campbell albatross, Campbell black-browed albatross	*Thalassarche impavida*	Vulnerable	Migratory	Listed	FL	✓	✓
Black-browed albatross	*Thalassarche melanophris*	Vulnerable	Migratory	Listed	FL	✓	✓
Salvin's albatross	*Thalassarche salvini*	Vulnerable	Migratory	Listed	FL	✓	✓
White-capped albatross	*Thalassarche steadi*	Vulnerable	Migratory	Listed	FL	✓	✓
Shearwaters							

[2] 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 EMBA's or Operational Area.

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[2]	Operational Area	EMBA
Flesh-footed shearwater, fleshy-footed shearwater	*Ardenna carneipes*		Migratory	Listed	FL	✓	✓
Sooty shearwater	*Ardenna grisea*		Migratory	Listed	SHL	✓	✓
Short-tailed shearwater	*Ardenna tenuirostris*		Migratory	Listed	BK		✓
Petrels							
White-bellied storm-petrel	*Fregetta grallaria*	Vulnerable			SHL	✓	✓
Blue petrel	*Halobaena caerulea*	Vulnerable		Listed	SHM	✓	✓
Southern giant-petrel, southern giant petrel	*Macronectes giganteus*	Endangered	Migratory	Listed	FL	✓	✓
Northern giant petrel	*Macronectes halli*	Vulnerable	Migratory	Listed	SHM	✓	✓
Gould's petrel, Australian Gould's petrel	*Pterodroma leucoptera*	Endangered			SHM	✓	✓
White-faced Storm-petrel	*Pelagodroma marina*			Listed	BK		✓
Common diving-petrel	*Pelecanoides urinatrix*			Listed	BK		✓
Soft-plumaged petrel	*Pterodroma mollis*	Vulnerable		Listed	SHM	✓	✓
Other							
King Island brown thornbill, Brown thornbill	*Acanthiza pusilla magnirostris listed as Acanthiza pusilla archibaldi*	Endangered			SHK		✓
King Island scrubtit, Scrubtit	*Acanthornis magna greeniana*	Critically Endangered			SHK		✓
Common sandpiper	*Actitis hypoleucos*		Migratory	Listed	SHK	✓	✓
Regent honeyeater	*Anthochaera phrygia*	Critically Endangered			FL		✓
Fork-tailed swift	*Apus pacificus*		Migratory	Listed	SHL		✓
Tasmanian wedge-tailed eagle, Wedge-tailed eagle	*Aquila audax fleayi*	Endangered			BK		✓
Ruddy turnstone	*Arenaria interpres*		Migratory	Listed	RK		✓

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[2]	Operational Area	EMBA
Australasian bittern	*Botaurus poiciloptilus*	Endangered			SHK		✓
Cattle egret	*Bubulcus ibis as Ardea ibis*			Listed	SHM		✓
Sharp-tailed sandpiper	*Calidris acuminata*		Migratory	Listed	RK	✓	✓
Sanderling	*Calidris alba*		Migratory	Listed	RK		✓
Red knot, Knot	*Calidris canutus*	Endangered	Migratory	Listed	SHK	✓	✓
Curlew sandpiper	*Calidris ferruginea*	Critically Endangered	Migratory	Listed	SHK	✓	✓
Pectoral sandpiper	*Calidris melanotos*		Migratory	Listed	SHM	✓	✓
Red-necked stint	*Calidris ruficollis*		Migratory	Listed	RK		✓
Great knot	*Calidris tenuirostris*	Critically Endangered	Migratory	Listed	RK		✓
Tasmanian azure kingfisher	*Ceyx azureus diemenensis*	Endangered			SHK		✓
Black-eared cuckoo	*Chalcites osculans as Chrysococcyx osculans*			Listed	SHL		✓
Double-banded plover	*Charadrius bicinctus*		Migratory	Listed	RK		✓
Greater sand plover, Large sand plover	*Charadrius leschenaultii*	Vulnerable	Migratory	Listed	SHL		✓
Lesser sand plover, Mongolian plover	*Charadrius mongolus*	Endangered	Migratory	Listed	RK		✓
Red-capped plover	*Charadrius ruficapillus*			Listed	RK		✓
Silver gull	*Chroicocephalus novaehollandiae as Larus novaehollandiae*			Listed	BK		✓
Eastern bristlebird	*Dasyornis brachypterus*	Endangered			SHK		✓
Little penguin	*Eudyptula minor*			Listed	BK		✓
Grey falcon	*Falco hypoleucos*	Vulnerable			SHL		✓
Latham's snipe, Japanese snipe	*Gallinago hardwickii*		Migratory	Listed	SHK		✓
Swinhoe's snipe	*Gallinago megala*		Migratory	Listed	RK		✓

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[2]	Operational Area	EMBA
Pin-tailed snipe	*Gallinago stenura*		Migratory	Listed	SHK		✓
Painted honeyeater	*Grantiella picta*	Vulnerable			SHK		✓
White-bellied sea-eagle	*Haliaeetus leucogaster*			Listed	BK		✓
Pied stilt, Black-winged stilt	*Himantopus himantopus*			Listed	RK		✓
White-throated needletail	*Hirundapus caudacutus*	Vulnerable	Migratory	Listed	SHK		✓
Caspian tern	*Hydroprogne caspia*		Migratory	Listed	BK		✓
Kelp gull	*Larus dominicanus*			Listed	BK		✓
Pacific gull	*Larus pacificus*			Listed	BK		✓
Swift parrot	*Lathamus discolor*	Critically Endangered		Listed	BK		✓
Bar-tailed godwit	*Limosa lapponica*		Migratory	Listed	SHK		✓
Nunivak bar-tailed godwit, Western Alaskan bar-tailed godwit	*Limosa lapponica baueri*	Vulnerable			SHK		✓
Black-tailed godwit	*Limosa limosa*		Migratory		RK		✓
Rainbow bee-eater	*Merops ornatus*			Listed	SHM		✓
Black-faced monarch	*Monarcha melanopsis*		Migratory	Listed	SHK		✓
Yellow wagtail	*Motacilla flava*		Migratory	Listed	SHK		✓
Satin flycatcher	*Myiagra cyanoleuca*		Migratory	Listed	BK		✓
Orange-bellied parrot	*Neophema chrysogaster*	Critically Endangered		Listed	ML	✓	✓
Blue-winged parrot	*Neophema chrysostoma*			Listed	SHK		✓
Eastern curlew, Far eastern curlew	*Numenius madagascariensis*	Critically Endangered	Migratory	Listed	SHK	✓	✓
Little curlew, Little whimbrel	*Numenius minutus*		Migratory	Listed	RK		✓
Whimbrel	*Numenius phaeopus*		Migratory	Listed	RK		✓
Sooty tern	*Onychoprion fuscatus as Sterna fuscata*			Listed	BK		✓

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[2]	Operational Area	EMBA
Fairy prion (southern)	*Pachyptila turtur subantarctica*	Vulnerable		Listed	SHK	✓	✓
Osprey	*Pandion haliaetus*		Migratory	Listed	SHK		✓
Forty-spotted pardalote	*Pardalotus quadragintus*	Endangered			FL		✓
Black-faced cormorant	*Phalacrocorax fuscescens*			Listed	BK		✓
Ruff (Reeve)	*Philomachus pugnax*		Migratory	Listed	RK		✓
Green rosella (King Island)	*Platycercus caledonicus brownii*	Vulnerable			SHK		✓
Pacific golden plover	*Pluvialis fulva*		Migratory	Listed	RK		✓
Grey plover	*Pluvialis squatarola*		Migratory		RK		✓
Red-necked avocet	*Recurvirostra novaehollandiae*			Listed	RK		✓
Rufous fantail	*Rhipidura rufifrons*		Migratory	Listed	SHK		✓
Australian painted snipe	*Rostratula australis*	Endangered		Listed	SHK		✓
Great skua	*Stercorarius skua as Catharacta skua*			Listed	SHM	✓	✓
White-fronted tern	*Sterna striata*			Listed	BK		✓
Little tern	*Sternula albifrons*		Migratory	Listed	BK		✓
Australian fairy tern	*Sternula nereis nereis*	Vulnerable		Listed	SHK	✓	✓
Black currawong (King Island)	*Strepera fuliginosa colei*	Vulnerable			BK		✓
Spectacled monarch	*Symposiachrus trivirgatus as Monarcha trivirgatus*		Migratory	Listed	SHK		✓
Greater crested tern	*Thalasseus bergii*		Migratory	Listed	BK		✓
Hooded dotterel, Hooded plover	*Thinornis cucullatus as Thinornis rubricollis*			Listed	SHK		✓
Eastern hooded plover, Eastern hooded plover	*Thinornis cucullatus cucullatus*	Vulnerable		Listed	SHK		✓
Grey-tailed tattler	*Tringa brevipes*		Migratory	Listed	RK		✓
Wood sandpiper	*Tringa glareola*		Migratory	Listed	RK		✓

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[2]	Operational Area	EMBA
Common greenshank, Greenshank	*Tringa nebularia*		Migratory	Listed	SHK		✓
Marsh sandpiper, Little greenshank	*Tringa stagnatilis*		Migratory	Listed	RK		✓
Masked owl (Tasmanian)	*Tyto novaehollandiae castanops*	Vulnerable			BK		✓
Terek sandpiper	*Xenus cinereus*		Migratory	Listed	RK		✓

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.

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 EMBAs. Albatross Island, supporting a breeding population of approximately 5,000 shy albatross (*Thallassarche 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 and EMBA (Figure 5-17). These BIAs cover either most or all the SEMR (Commonwealth of Australia 2015c). 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 (Commonwealth of Australia 2015d). 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 EMBA. The common-diving petrel also has a breeding BIA that overlaps the spill EMBA. The white-faced storm petrel foraging BIA also 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 (K. Thiele 1977, Pizzey and 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 (Marchant and Higgins 1990, DSEWPaC 2011a). Therefore, it is likely that these along with the Tasmanian shy albatross will be present and forage within the EMBA.

The white-capped albatross (*Thalassarche cauta steadi*) has a distribution spanning most of the southern hemisphere, though most individuals tend to remain around Australia and NZ throughout the year with the majority of nesting sites occur within or around New Zealand, though some small nesting sites occur around Africa (DAWE 2022m, OEH 2022). Breeding tends to occur with this species in October with eggs being laid in late November, hatching in February with the fledglings becoming self-sufficient and leaving the breeding sites around June, though it is characteristic for some adults to stay around the breeding grounds year-round (Birdlife 2022). As is common with many albatross species, the white-capped albatross tends to forage around the coastlines which causes an overlap with commercial fisheries (Birdlife 2022). There are no known nesting sites nearby or studies that investigate their presence in the Bass Strait.

The grey-headed albatross (*Thalassarche chrysostoma*) (listed as endangered under the EPBC Act) has a circum-global distribution in the southern hemisphere with nesting habitats precarious to the species survival existing on several islands that surround Antarctica, New Zealand, Australia and Africa (DEWHA 2009). Breeding typically occurs as early as September which leads to egg laying in October and November with the chicks hatching in December that require provisioning typically until the end of May when the fledglings able to survive on their own (ACAP 2009). After the breeding seasons the albatrosses tend to disperse across the southern hemisphere for long periods of time, sometimes years, foraging anywhere they can (ACAP 2009). This foraging behaviour influencing their distribution causes them to overlap with commercial fisheries on a regular basis requiring special consideration in fisheries management plans even though grey-headed albatrosses seldom visit fisheries vessels (ACAP 2009, DEWHA 2009). The nearest known nesting site is over 1000 km to the south east of the EMBA on Macquarie Island.

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 Internation 2019).

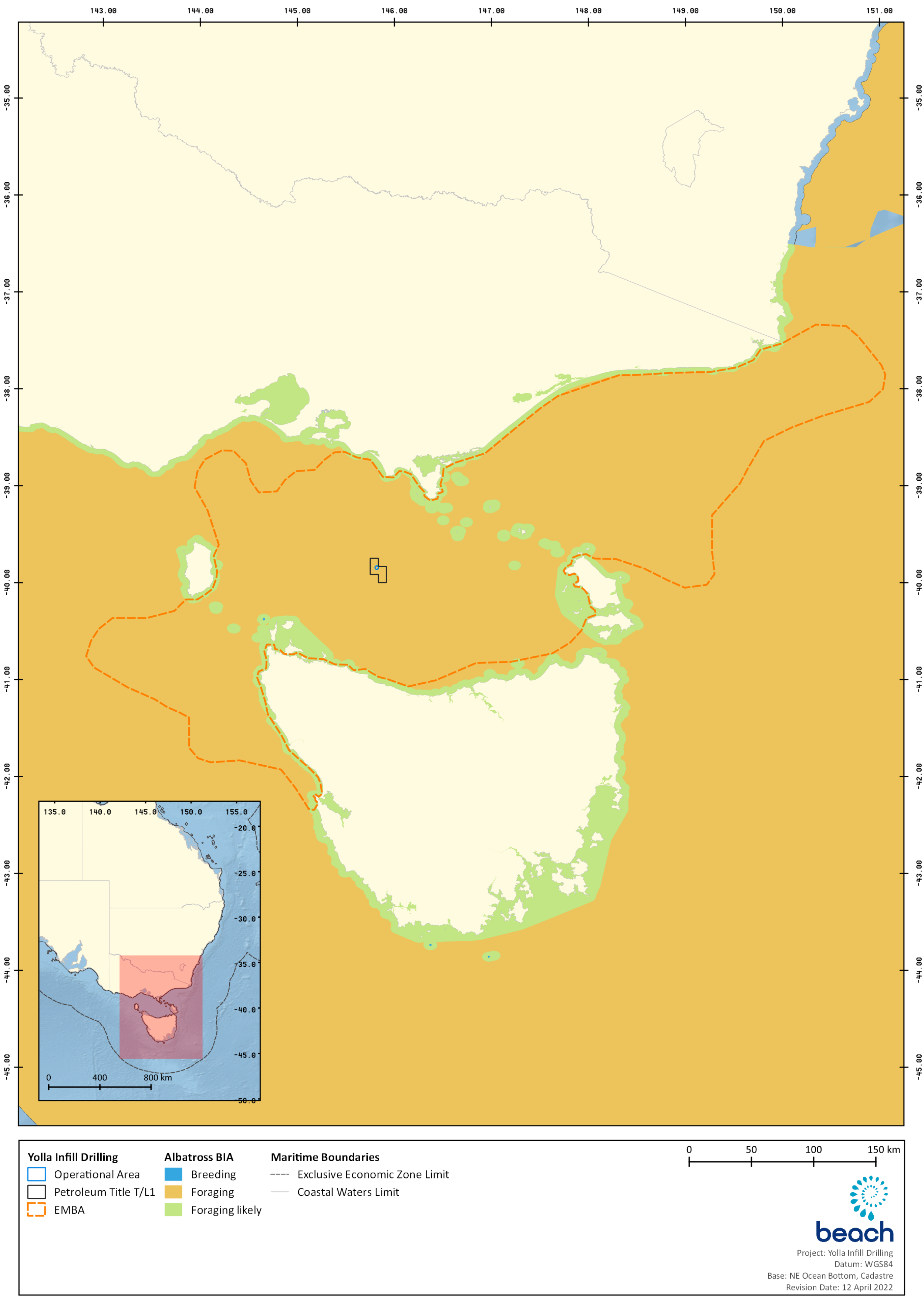


Figure 5-17 Albatross BIA within the EMBA

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') (DAWE 2022n). This species is likely to be an uncommon visitor to the Operational Area and EMBA.

The short-tailed shearwater has foraging and breeding BIAs within the EMBA and the foraging BIA is within the light EMBA. The short-tailed shearwater is migratory, and breeding is restricted to southern Australia being most abundant in Victoria and Tasmania (Skira, Brothers and Pemberton 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 and 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 and breeding BIA within the Operational Area and EMBA. A review of the DAWE SPRAT profile, 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 DAWE SPRAT profile does not show any locations for the wedge-tailed shearwater in Victoria and Beaver (DAWE 2022d) 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.

The sooty shearwater (*Ardenna grisea*) has a global distribution in which most individuals forage and breed in the southern hemisphere, typically on and around sub-antarctic islands, during the summer and migrate to the northern hemisphere during the winter (DAWE 2022i). Within Australia the majority of the breeding and foraging sites are on islands off the coast of NSW and Tasmania, though some small populations occur off the coast of Queensland (DAWE 2022i). The breeding season of the sooty shearwater tends to occur at the start of September with most adults and fledglings leaving around early May to start their migration to the northern hemisphere (DAWE 2022i).

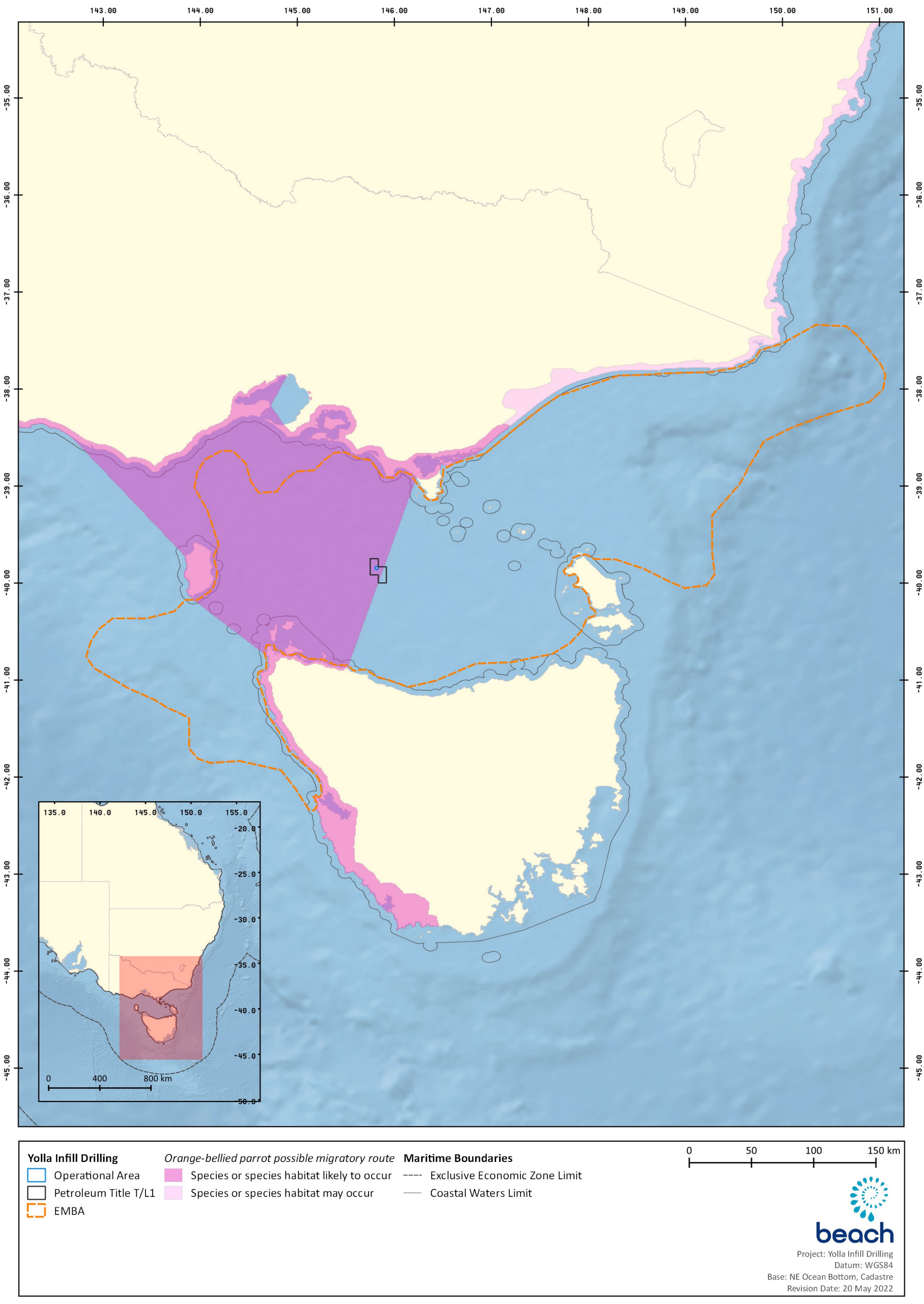
Caspian tern is the largest turn in Australia, they inhabit both coastal and inland regions and breeding occurs widespread throughout Australia. In Victoria breeding sites are mostly along coastal regions with three significant regular breeding colonies, Corner Inlet, Mud Island and Mallacoota (Minton and 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 and Davies 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 and Davies 1996).

The sooty tern has a much larger foraging range, encompassing open shelf waters, shelf edge and deep water (DSEWPaC 2011b). 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 and Davies 1996). Foraging diet consists of pelagic fish, cephalopods, crustaceans and insects.

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, intersecting with both the Operational Area and the EMBA (Figure 5-18). 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 and Davies 1996). The orange-bellied parrot is protected under the National Recovery Plan for the orange-bellied parrot (DELWP 2016). 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 (DAWE 2022b). There are also non-breeding orange-bellied parrots on mainland Australia, between Goolwa in Australia and Corner Inlet in Victoria.

The orange-bellied parrot breeds in Tasmania during summer, migrates north across Bass Strait in autumn and over-winters on the mainland. 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 (Higgens 1999). King Island is known as a key location in the migration route between breeding and non-breeding sites and is located 140 km from the Yolla-A platform and outside the EMBA (DELWP 2016). The Operational Area has the potential to overlap with the orange-bellied parrots migratory route (Figure 5-18) from the Australia - Species of National Environmental Significance Distributions (public grids) dataset from DAWE.



(Source: Australia - Species of National Environmental Significance Distributions (public grids) dataset from DAWE).

Figure 5-18 Orange-bellied parrot migratory route

Other shorebirds

A number of species listed in Table 5-8 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, 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. These species are unlikely to be present in the 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 and Higgins 1993, Higgins and 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 and 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 and 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 and 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 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 and 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 and Davies 1996). These species are critically endangered and may occur within the EMBA.

5.7.7.5 Marine reptiles

The PMST reports for the Operational Area and EMBA identified 4 marine turtle species likely to occur within the EMBAs. Table 5-9 details marine turtle species identified in the PMST reports. A brief description of listed Threatened or Migratory marine reptile species has been provided.

Table 5-9 Listed marine reptile species identified in the PMST

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[3]	Operational Area	EMBA
		Listed Threatened	Listed Migratory	Listed Marine			
Loggerhead turtle	*Caretta caretta*	Endangered	Migratory	Listed	FK	✓	✓
Green turtle	*Chelonia mydas*	Vulnerable	Migratory	Listed	FK	✓	✓
Leatherback turtle, Leathery turtle, luth	*Dermochelys coriacea*	Endangered	Migratory	Listed	FK	✓	✓
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable	Migratory	Listed	FK		✓
		Likely Presence FK: Foraging, feeding or related behaviour likely to occur within area					

[3] 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 EMBA's or Operational Area.

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, Wicksten and Amos 1993). The main Australian breeding areas for loggerhead turtles are generally confined to southern Queensland and Western Australia (Cogger, Cameron, 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 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 (DAWE 2008), therefore it is expected they would only be occasional visitors in the 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 EMBA.

Hawksbill turtle

Hawksbill turtles (*Eretmochelys imbricata*) typically occur in tidal and sub-tidal coral and rocky reef habitats throughout tropical waters, extending into warm temperate areas as far south as northern New South Wales. In Australia the main feeding area extends along the east coast, including the Great Barrier Reef. Other feeding areas include Torres Strait and the archipelagos of the Northern Territory and Western Australia, possibly as far south as Shark Bay or beyond. Hawksbill turtles also feed at Christmas Island and the Cocos (Keeling) Islands.

5.7.7.6 Cetaceans

The PMST reports identified several cetaceans that potentially occur in the Operational Area and EMBA (Appendix C and Appendix D). Table 5-10 details cetaceans identified in the PMST reports. A brief description of listed Threatened or Migratory marine cetacean species has been provided.

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).

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 5-11 and Table 5-12). 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.

Species of cetacean sighted in the period 31 October to 19 December 2010 during the Speculant 3D Transitions Zone Seismic Survey (3DTZSS) undertaken by Origin Energy, recorded species of common dolphin (Delphinus spp.), bottlenose dolphin (Tursiops spp.), unidentified small cetaceans and fur-seals.

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.

Table 5-10 Listed Cetacean species identified in the PMST report

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[4]	Operational Area	EMBA
		Listed Threatened	Listed Migratory	Listed Marine			
Whales							
Minke whale	*Balaenoptera acutorostrata*			Listed	SHM	✓	✓
Antarctic minke whale, Dark-shoulder minke whale	*Balaenoptera bonaerensis*		Migratory	Listed	SHL		✓
Sei whale	*Balaenoptera borealis*	Vulnerable	Migratory	Listed	FL	✓	✓
Bryde's whale	*Balaenoptera edeni*		Migratory	Listed	SHM		✓
Blue whale	*Balaenoptera musculus*	Endangered	Migratory	Listed	FK	✓	✓
Fin whale	*Balaenoptera physalus*	Vulnerable	Migratory	Listed	FL	✓	✓
Arnoux's beaked whale	*Berardius arnuxii*			Listed	SHL		✓
Pygmy right whale	*Caperea marginata*		Migratory	Listed	FM	✓	✓
Southern right whale	*Eubalaena australis*	Endangered	Migratory	Listed	SHK	✓	✓
Short-finned pilot whale	*Globicephala macrorhynchus*			Listed	SHM		✓
Long-finned pilot whale	*Globicephala melas*			Listed	SHM		✓
Southern bottlenose whale	*Hyperoodon planifrons*			Listed	SHM		✓
Pygmy sperm whale	*Kogia breviceps*			Listed	SHM		✓
Dwarf sperm whale	*Kogia sima as Kogia simus*			Listed	SHM		✓
Humpback whale	*Megaptera novaeangliae*		Migratory	Listed	FK	✓	✓
Andrew's beaked whale	*Mesoplodon bowdoini*			Listed	SHM		✓

[4] 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 EMBA's or Operational Area.

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[4]	Operational Area	EMBA
Blainville's beaked whale, Dense-beaked whale	*Mesoplodon densirostris*			Listed	SHM		✓
Gray's beaked whale, Scamperdown whale	*Mesoplodon grayi*			Listed	SHM		✓
Hector's beaked whale	*Mesoplodon hectori*			Listed	SHM		✓
Strap-toothed beaked whale, Strap, toothed whale, Layard's beaked whale	*Mesoplodon layardii*			Listed	SHM		✓
True's beaked whale	*Mesoplodon mirus*			Listed	SHM		✓
Killer whale, Orca	*Orcinus orca*		Migratory	Listed	SHL	✓	✓
Sperm whale	*Physeter macrocephalus*		Migratory	Listed	SHM		✓
False killer whale	*Pseudorca crassidens*			Listed	SHL	✓	✓
Shepherd's beaked whale, Tasman beaked whale	*Tasmacetus shepherdi*			Listed	SHM		✓
Cuvier's beaked whale, Goose-beaked whale	*Ziphius cavirostris*			Listed	SHM		✓
Dolphins							
Common dolphin, Short-beaked common dolphin	*Delphinus delphis*			Listed	SHM	✓	✓
Risso's dolphin, Grampus	*Grampus griseus*			Listed	SHM	✓	✓
Dusky dolphin	*Lagenorhynchus obscurus*		Migratory	Listed	SHL	✓	✓
Southern right whale dolphin	*Lissodelphis peronii*			Listed	SHM		✓
Indian Ocean bottlenose dolphin, Spotted bottlenose dolphin	*Tursiops aduncus*			Listed	SHL		✓
Bottlenose dolphin	*Tursiops truncatus s. str.*			Listed	SHM		✓

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.

Table 5-11 Cetacean species recorded during arial 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
Balaenoptera borealis	Sei and like sei whale	ROR	12	14	1.3 ± 0.5
Balaenoptera acutorostrata	Dwarf minke whale	ROR	1	1	1
Balaenoptera 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 5-12 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).

Minke whales

The minke whale (*Balaenoptera acutorostrata*) is a widely distributed baleen whale that has been recorded in all Australian waters except the Northern Territory (DAWE 2022e). 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 (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, Kemper and Warneke 1996). The minke whale has been observed within the region, however, there are no BIAs in the EMBA and Operational Area. Therefore, it is unlikely to be present in significant numbers within the EMBA and Operational Area.

Sei whale

Sei whales (*Balaenoptera borealis*) 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 (Bannister, Kemper and Warneke 1996, Chatto and Warneke 2000, Thiele, Chester and Gill 2000).

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, Pirzl, 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 EMBA.

Bryde's whale

Bryde's whales are currently considered monotypic (belonging to one species). Currently, there are two subspecies of Bryde's whales. Eden's whale (*Balaenoptera edeni*) is a smaller form found in the Indian and western Pacific oceans, primarily in coastal waters. The Bryde's whale (*Balaenoptera edeni brydei*) is a larger form, found primarily in pelagic waters (NOAA 2021b).

Bryde's Whales occur in temperate to tropical waters, both oceanic and inshore, bounded by latitudes 40° N and 40° S, or the 20 °C isotherm (Bannister, Kemper and Warneke 1996). Bryde's Whales have been recorded from all Australian states except the Northern Territory (Bannister, Kemper and Warneke 1996).

Bryde's Whale may migrate seasonally, heading towards warmer tropical waters during the winter. Limited data suggest that this migration may be to allow breeding and calving in lower latitudes (Kato 2002). Insufficient information exists as to how Australian Bryde's Whales use their habitat, as no specific feeding or breeding grounds have been discovered off Australia (DAWE 2022h).

Review of the Bryde's Whale SPRAT Profile (DAWE 2022h) indicated that no habitat was likely to occur within the EMBA. As such, it is likely to be an uncommon visitor to the EMBA.

Blue whales

The blue whale (*Balaenoptera musculus*) is listed as an endangered species under the Australian Government 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*). The pygmy blue whale has a foraging BIA within the Operational Area and EMBA (Table 5-6). 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).

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 (P. C. Gill, M. G. Morrice, et al. 2011, Gavrilov 2012, McCauley, Gavrilov, et al. 2018).

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, Matsuoka and Miyashita 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, Matsuoka and Miyashita 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, Gavrilov, et al. 2018). The updated abundance estimate uses acoustic chorus squared pressure levels to estimate growth rate off Portland (McCauley, Gavrilov, 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.

Underwater acoustic monitoring programs have detected Antarctic and pygmy blue whale calls in the region. Acoustic detection of Antarctic blue whales indicates that they occur along the entire southern coastline of Australia (McCauley, Gavrilov, et al. 2018). 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, Gavrilov, 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, Gavrilov, 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. 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 (P. C. Gill, M. G. Morrice, et al. 2011, McCauley, Gavrilov, et al. 2018).

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 5-20). 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 5-20) 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.

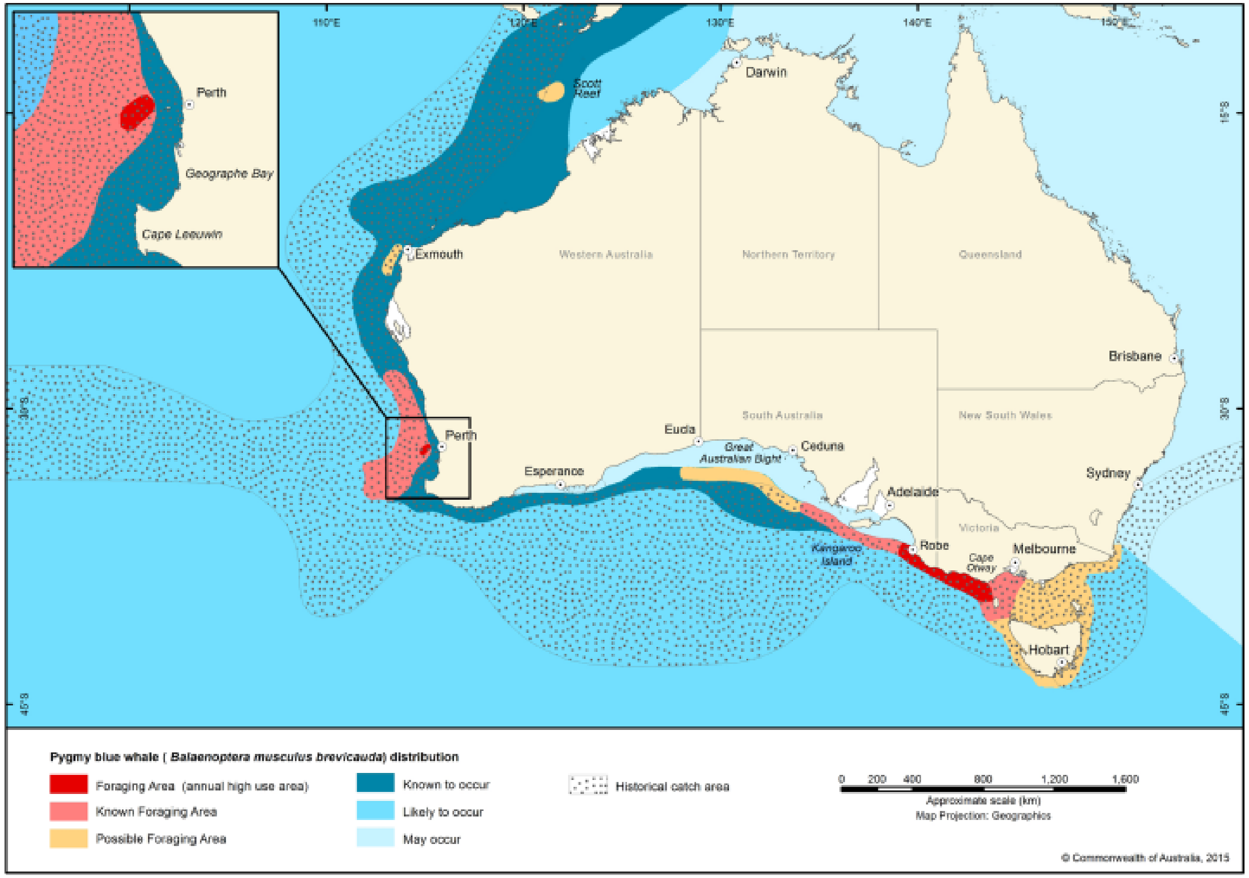
The seasonal distribution and abundance of blue whales are variable across years and influenced by climate variables. The time and location of the appearance of blue whales in the east generally coincides with the upwelling of cold water in summer and autumn along the coast (the Bonney coast upwelling) 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 5-19), 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 2015b). McCauley et al. (2018) suggests that acoustic detection of pygmy blue whales indicate they predominantly occur west of Bass Strait. 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, Gavrilov, 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.

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, Gavrilov, 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.

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, Gavrilov, et al. 2018).

BIAs for pygmy blue whales have been identified around Australia with the foraging BIA intersecting the Operational Area and EMBA (Figure 5-21). The presence of blue whales within the Operational Area is possible, particularly during December to May. 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 Area (Annual high use area)	Blue whales are regularly observed feeding on a seasonal basis
Known Foraging Area	Known foraging occurs in these areas but is highly variable both between and within seasons
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

Known to occur	Blue whales are known to occur based on direct observations, satellite tagged whales or based on acoustic detections
Likely to occur	Blue whales are likely to occur based on occasional observations in the area and nearby areas
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 5-19 Pygmy blue whale foraging areas around Australia (Commonwealth of Australia 2015b)

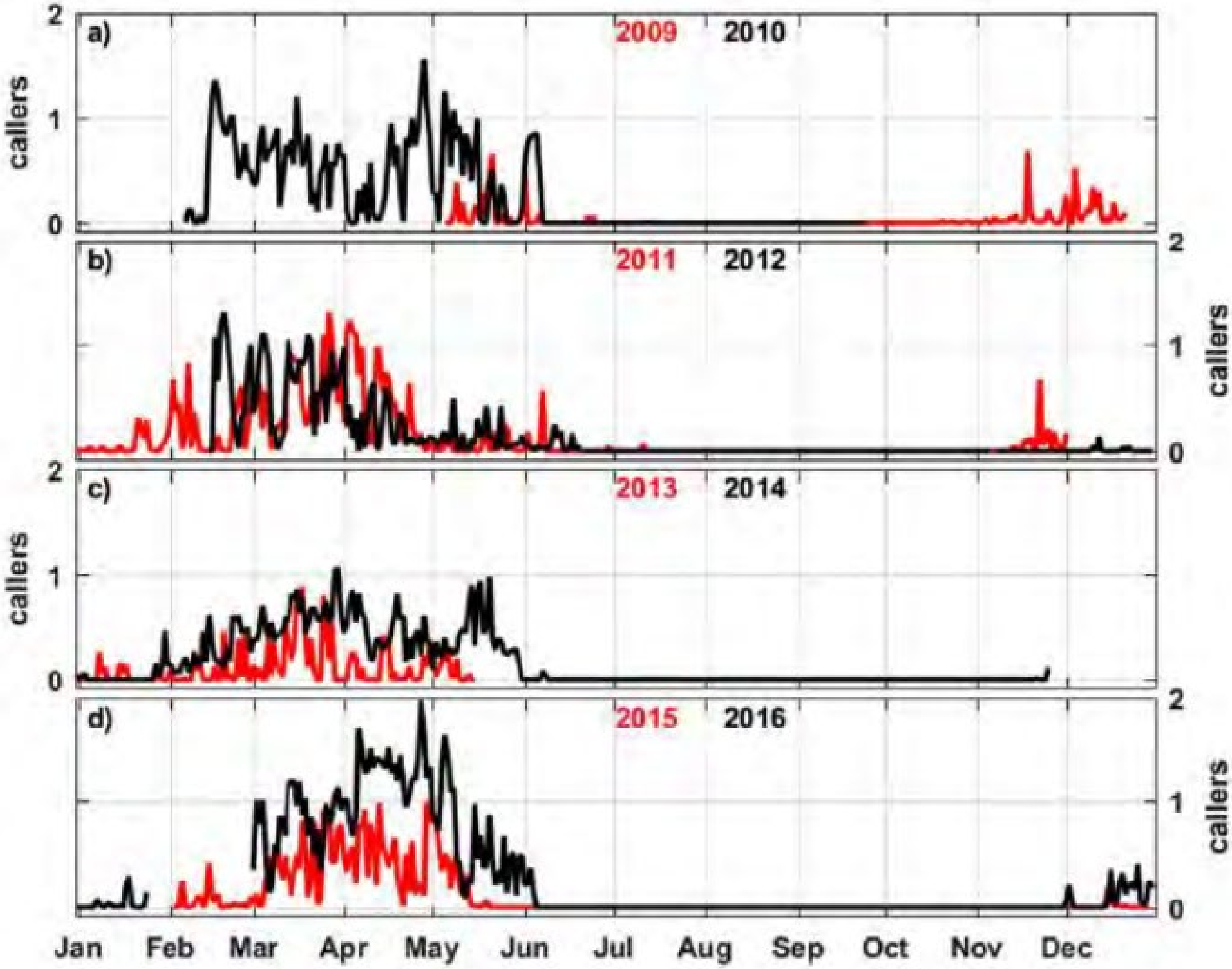


Figure 5-20 Mean number of individual pygmy blue whales calling (McCauley, Gavrilov, et al. 2018)

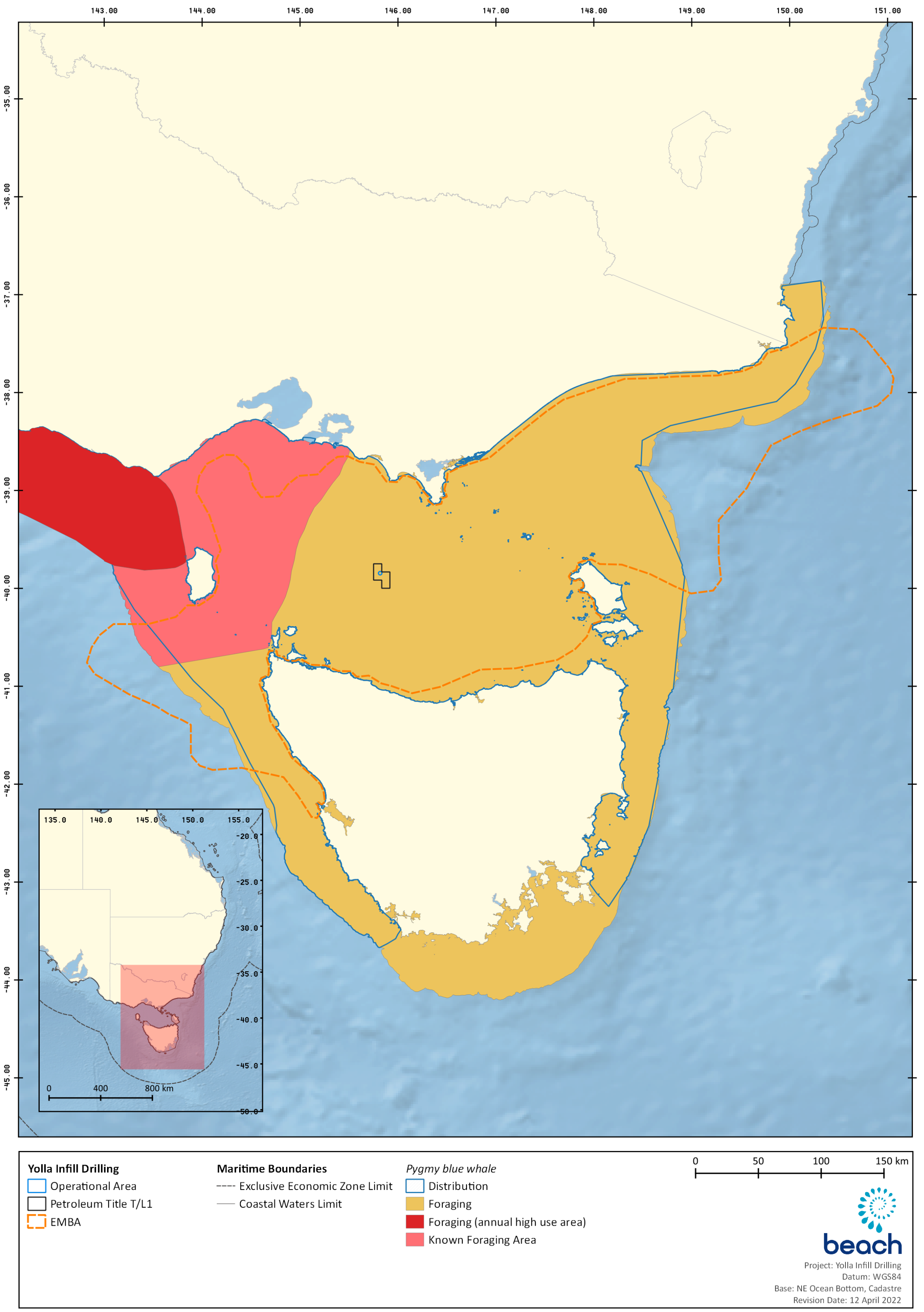


Figure 5-21 BIA for the pygmy blue whale within the spill EMBA

Fin whale

Fin whales (*Balaenoptera physalus*) 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, Kemper and Warneke 1996). The fin whale has been infrequently recorded between November and February during aerial surveys in the region (Gill, Pirzl, 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 (P. C. 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, Pirzl, 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, Pirzl, 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 EMBAs, they are likely to be uncommon visitors to the EMBAs.

Southern right whale

The EMBA overlaps the southern right whale (*Eubalaena australis*) aggregation, connecting habitat and migration BIAs and current core coastal range (Figure 5-22).

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 2018). 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 subpopulation 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. 2020). 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 (Stamation, et al. 2020). A rate of around 7 % p.a. is considered the maximum biological rate of increase for southern right whale (IWC 2018). Connectivity between the two populations is unknown however, some limited movement between the two areas has been recorded (Burnell 2001, C. M. 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, Kemper and Warneke 1996). They are distributed across thirteen primary aggregation areas along the southern coast of Australia (Figure 5-23) (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).

There is variation in annual abundance on the coast of Australia due to the 3-year calving cycles (C. M. 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).

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). A defined near-shore coastal migration corridor is unlikely given the absence of any predictable directional movement of southern right whales such as that observed for humpback whales. 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).

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). 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).

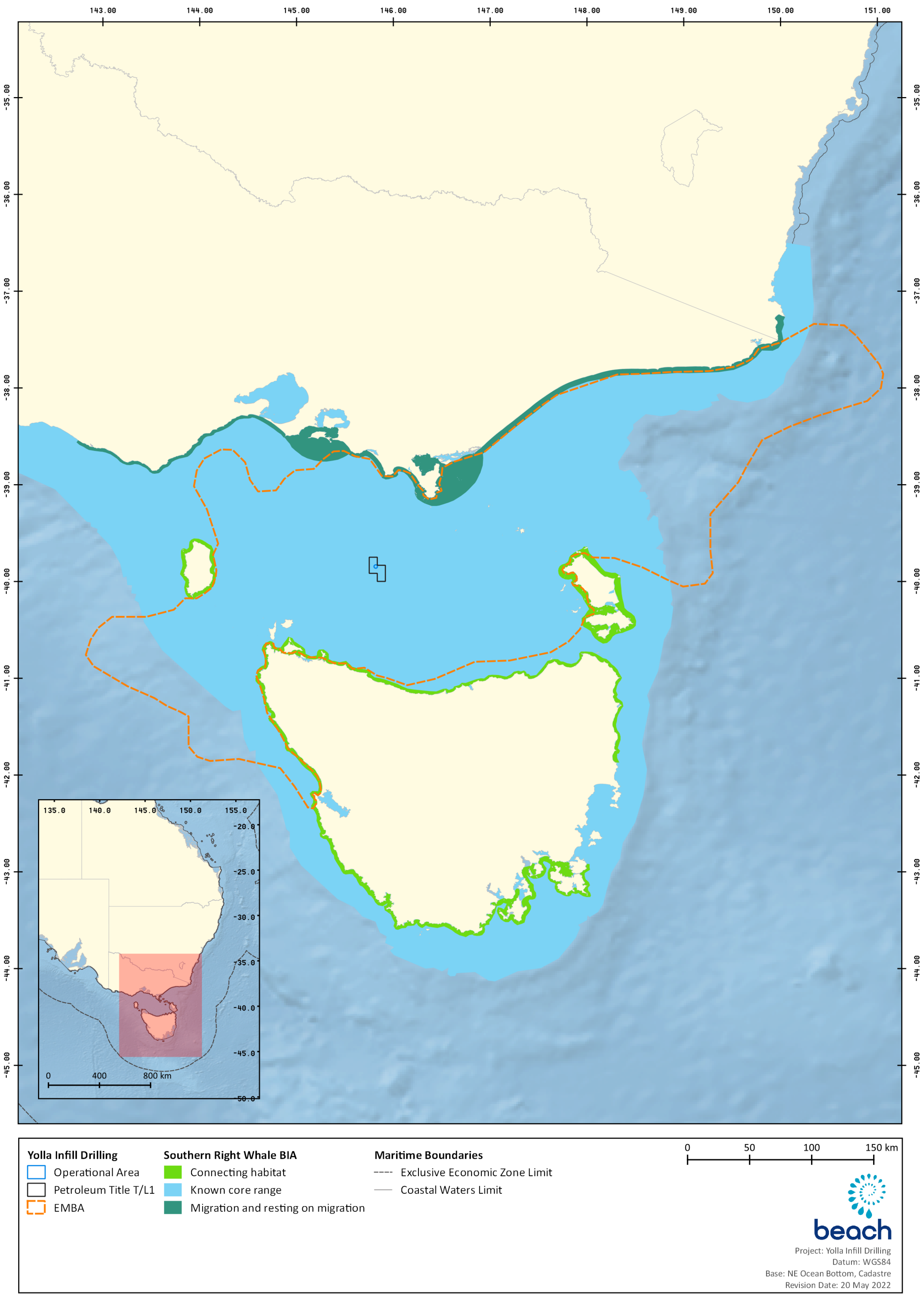


Figure 5-22 BIA for the Southern right whale within the spill

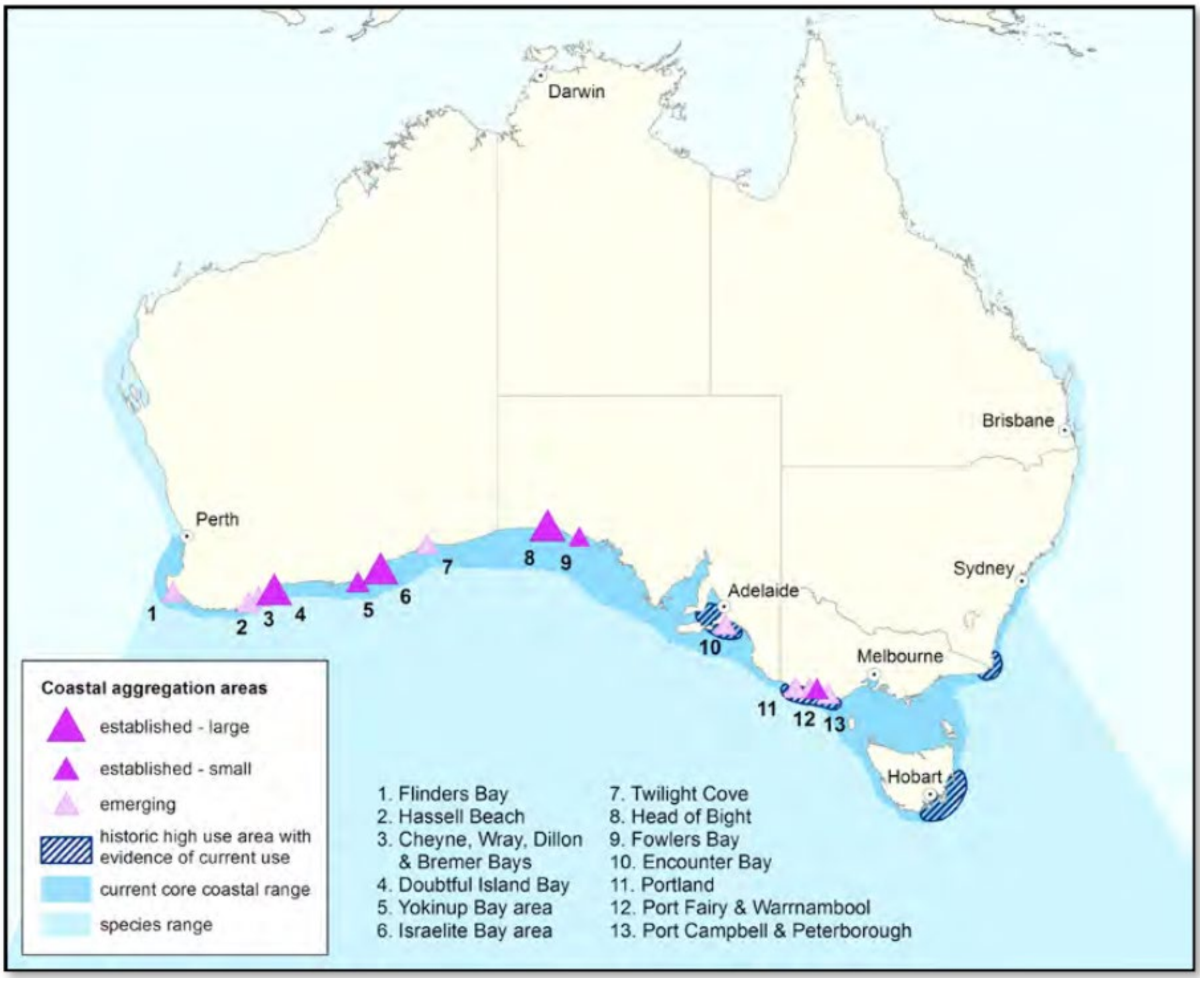


Figure 5-23 Aggregation areas for southern right whales (DSEWPaC, 2012a)

Dusky dolphin

The dusky dolphin (*Lagenorhynchus obscurus*) 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 (DAWE 2022k). Only 13 reports of the dusky dolphin have been made in Australia since 1828, and key locations are yet to be identified (Bannister, Kemper and Warneke 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 (DAWE 2022k).

Humpback Whale

The humpback whale (*Megaptera novaeangliae*) is a moderately large (15-18 m long) baleen whale that has a worldwide distribution and a geographic segregation. In the 19th and 20th centuries, humpback whales were hunted extensively throughout the world's oceans and as a result it is estimated that 95% of the population was eliminated. Commercial whaling of humpback whales ceased in 1963 in Australia, at which time it is estimated that humpback whales were reduced to between 3.5 and 5% of pre-whaling abundance (TSSC 2015a).

In early 2022, the Humpback whale was removed from the threatened species list given a review of its conservation status considered that it no longer meets any criteria for listing as threatened under the EPBC Act.

Feeding, resting or calving is not known to occur in Bass Strait (TSSC 2015a) though migration through Bass Strait occurs (Figure 5-24). The nearest area that humpback whales are known to congregate and potentially forage is at the southernmost part of NSW near the eastern border of Victoria, approximately 600 km northeast of Yolla-A (Figure 5-24) at Twofold Bay, Eden off the New South Wales south coast.

Humpback whales migrate from their summer feeding grounds in Antarctic waters northward up the Australian east coast to their breeding and calving grounds in sub-tropical and tropical inshore waters (TSSC 2015a). The northern migration off the southeast coast starts in April and May with the southern migration occurring from November to December. This migration tends to occur close to the coast along the continental shelf boundary in waters about 200 m deep (TSSC 2015a) (Figure 5-25).

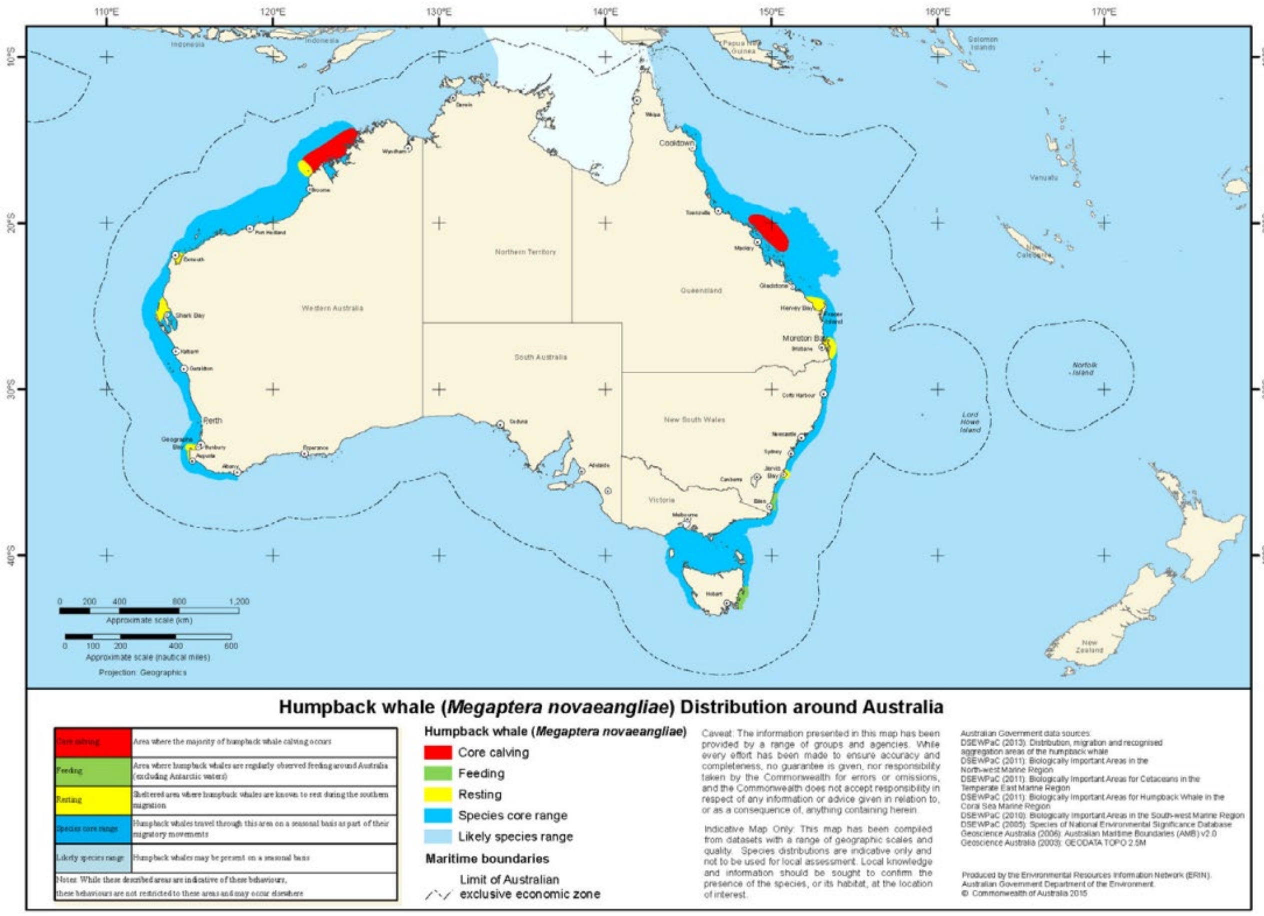


Figure 5-24 Humpback whale distribution around Australia (TSSC 2015a)

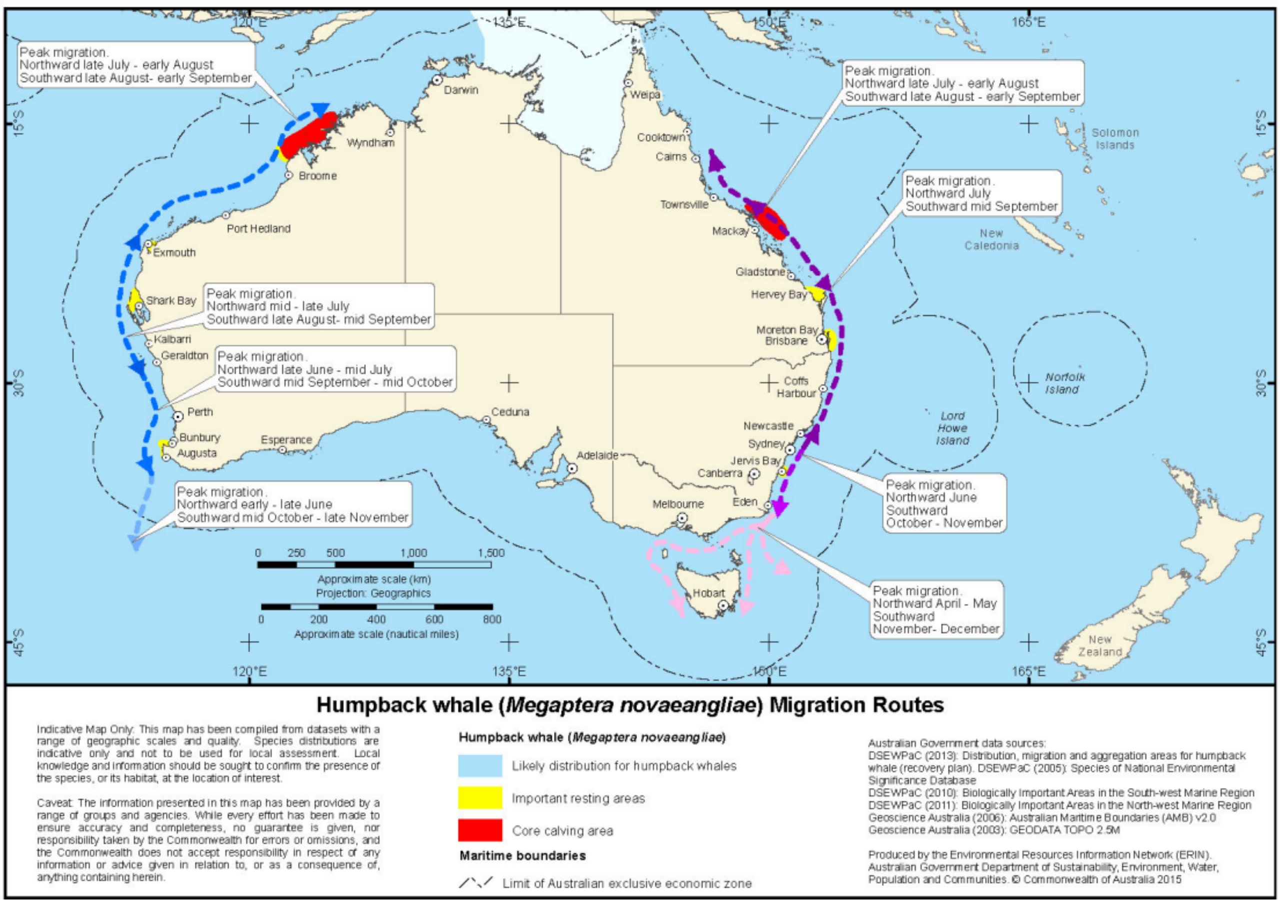


Figure 5-25 Humpback whale migration routes around Australia (TSSC 2015a)

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, Kemper and Warneke 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, Kemper and Warneke 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 (DAWE 2022l).

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, Kemper and Warneke 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, Kemper and Warneke 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 EMBA. Therefore, it is likely that they would be uncommon visitors in the EMBA.

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 (DAWE 2022j). 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) (DAWE 2022j). 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 (DAWE 2022j).

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 (DAWE 2022j).

Sperm whales are prolonged and deep divers often diving for over 60 minutes (Bannister, Kemper and Warneke 1996) however studies have observed sperm whales do rest at, or just below, surface for extended periods (>1 hour) (Gannier, Drouot and Gould 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 EMBAs.

5.7.7.7 Pinnipeds

The PMST reports identified 2 pinnipeds that potentially occur in the Operational Area and EMBA (Appendix C and Appendix D), as detailed in Table 5-13. Although neither species identified are listed Threatened or Migratory, a brief description has been provided for both these species.

Table 5-13 Listed Pinniped species identified in the PMST search

Common Name	Species Name	EPBC Act Status			Type of presence (within the EMBA)[5]	Operational Area	EMBA
		Listed Threatened	Listed Migratory	Listed Marine			
Long-nosed fur-seal, New Zealand fur-seal	*Arctocephalus forsteri*			Listed	SHM	✓	✓
Australian fur-seal, Australo-African fur-seal	*Arctocephalus pusillus*			Listed	BK	✓	✓
		Likely Presence SHM: Species or species habitat may occur within area BK: Breeding known to occur within area					

[5] 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 EMBA's or Operational Area.

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, Kanowna Island (near Wilsons Promontory) and The Skerries in eastern Victoria.

Figure 5-26 illustrates the known breeding colonies of New Zealand fur-seal (Kirkwood, Warneke and Arnould, Recolonization of Bass Strait, Australia, by the New Zealand fur seal, Arctocephalus forsteri 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 vicinity of the EMBA include Seal Rocks (off King Island), Judgement Rocks (Kent Group Islands), Cat Island and Cone Point (Cape Barren Island) (Figure 5-26).

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 and Gales 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 5-27). 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 and 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, Warneke and Arnould 2009, Hume, et al. 2004).

Beach have observed Australian fur-seals transiting past the Yolla-A platform thus are known to be present within the operational area.

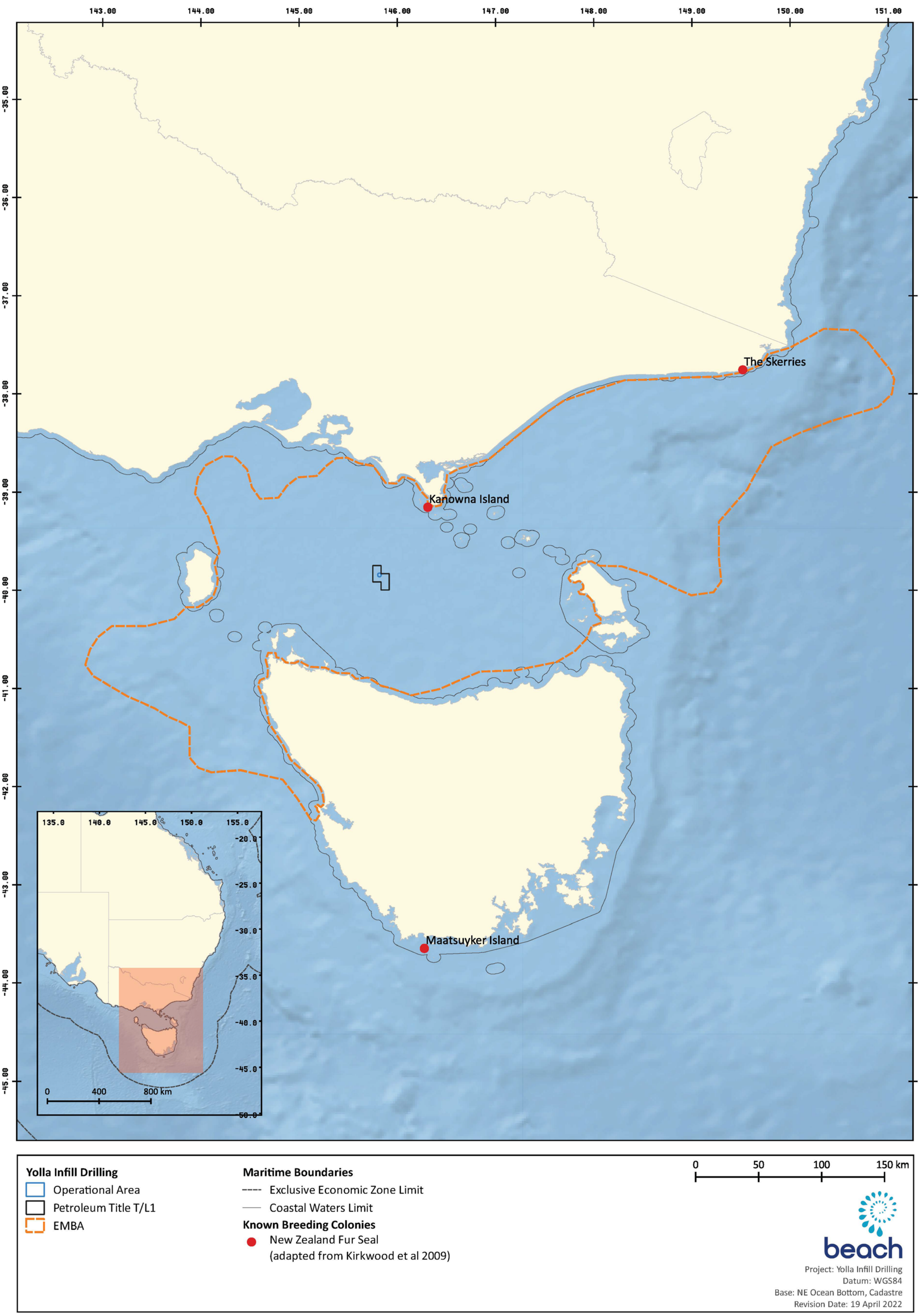


Figure 5-26 Locations of New Zealand fur-seal breeding colonies (Kirkwood, Warneke and Arnould 2009)

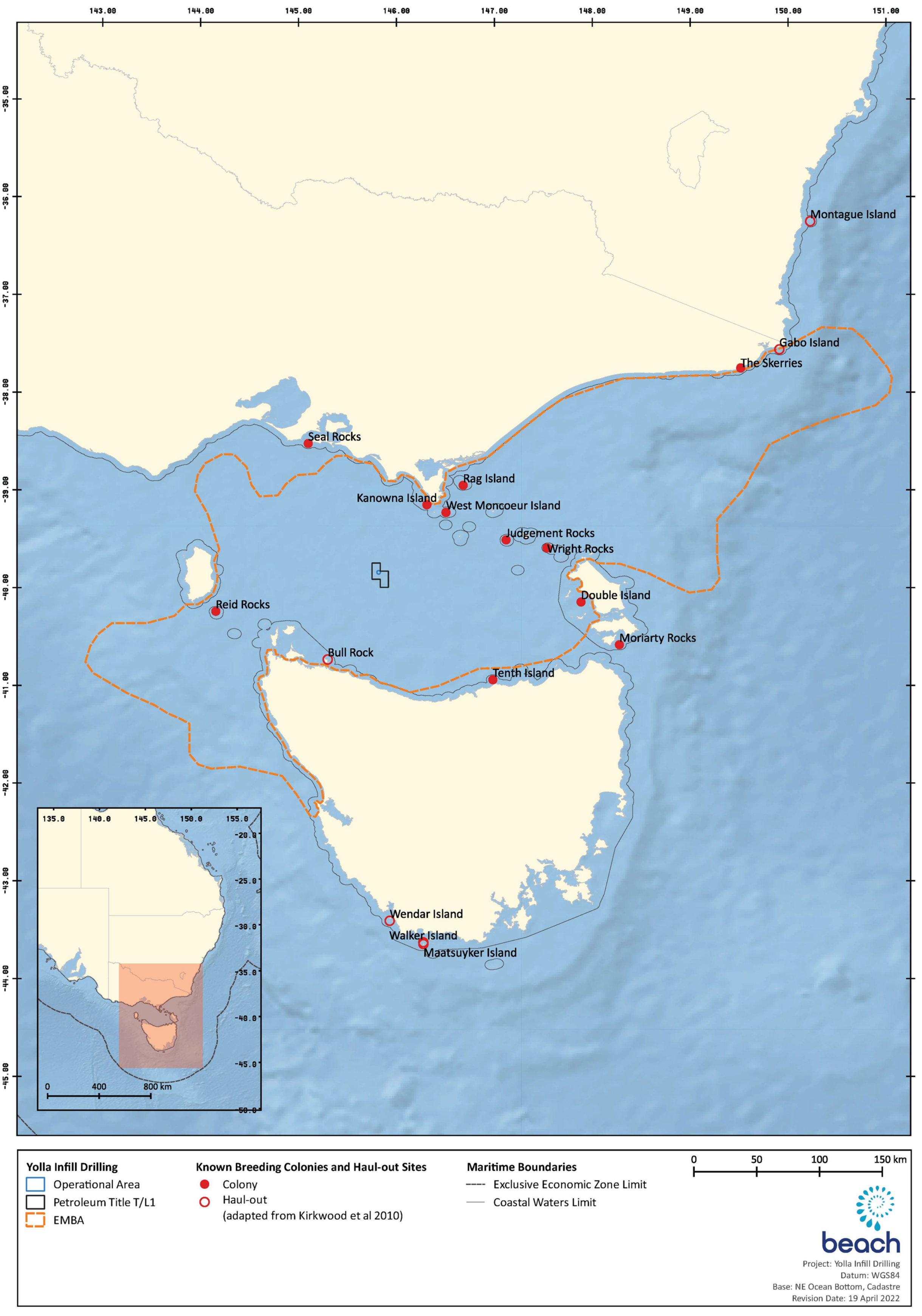


Figure 5-27 Locations of Australian fur-seal breeding colonies and haul out sites (Kirkwood, Pemberton, et al. 2010)

5.7.7.8 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 and 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.

Marine pests known to occur in Bass Strait, according to Parks Victoria (2015), Bax et al. (2003)and Hirst and Bott (2016) include:

- Pacific oyster (*Crassostrea gigas*) – small number of this oyster species are reported to occur in Western Port Bay and at Tidal River in the Wilsons Promontory National Park
- northern Pacific seastar (*Asterias amurensis*) – prefer soft sediment habitat, but also use artificial structures and rocky reefs, living in water depths usually less than 25 m (but up to 200 m water depths). It is thought to have been introduced in 1995 through ballast water from Japan
- New Zealand screw shell (*Maoricolpus roseus*) – lies on or partially buried in sand, mud or gravel in waters up to 130 m deep. It can densely blanket the sea floor with live and dead shells and compete with native scallops and other shellfish for food. This species is known to be present in the Port Phillip and the Western Port region
- European shore crab (*Carcinus maenas*) – prefers intertidal areas, bays, estuaries, mudflats and subtidal seagrass beds, but occurs in waters up to 60 m deep. It is widespread across Victorian intertidal reef and common in Western Port
- dead man’s fingers (*Codium fragile ssp. fragile*) – Widespread in Port Phillip and known to inhabit San Remo and Newhaven in Western Port. It grows rapidly to shade out native vegetation and can regenerate from a broken fragment enabling easy transfer from one area to another. Attaches to subtidal rocky reed and other hard surfaces
- Asian date mussel (*Musculista senhousia*) – prefers soft sediments in waters up to 20 m deep, forming mats and altering food availability for marine fauna
- cord grass (*Spartina anglica* and *Spartina x townsendii sp*) – found at the mouth of Bass River and in drain outlets near Tooradin in Western Port. Widespread in South Gippsland including Anderson’s Inlet and Corner Inlet. Invades native saltmarsh, mangroves and mudflats, altering the mud habitat and excluding other species.

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

5.8 Socio-economic environment

This section describes the socio-economic environment within the Operational Area and EMBA.

5.8.1 Coastal Settlements

Australian’s have a strong affinity to the coast, with over 80 % of the population living within 50 km of the coast. The EMBA borders the Bass Coast Shire, located in south-eastern Victoria, about 130 kilometres south-east of the Melbourne

CBD and is a popular holiday destination. The Victorian coastal settlements along the coast of the EMBA and are subject to potential impact are described below based on Australian Bureau of Statistics (ABS) 2016 census data:

- Kilcunda has a population of 396 people and a median age of 51. Of those in the labour force, 51.7 % worked full-time and 37.8 % worked part-time. Professionals, managers and technicians and trade workers made up 52.4 % of the population's occupations
- Wonthaggi has a population of 4,965 people and a median age of 52, occupying 2,400 dwellings. The greatest proportion of the population are employed as technicians, trade workers and labourers
- Cape Paterson has a population of 891 people and a median age of 52. There are 1,077 private dwellings and the median weekly household income is $897. Professionals and technicians and trades workers were the two most common occupations at 22.4 % and 17.6 %, respectively
- Cape Woolamai (Phillip Island) has a population of 1,549 and a median age of 38. It has 1,629 private dwellings, of which only 35.1 % are permanently occupied, reflecting its popularity as a holiday home destination
- Inverloch, with a population of 5,437, had 47.6 % of its 4,290 dwellings permanently unoccupied. The area is a popular tourist destination, particularly for swimming, kitesurfing and windsurfing in the calm waters of Anderson Inlet. Fishing and surfing are also popular.

There are no NSW or Tasmanian coastal settlements along shorelines modelled to be potentially exposed to shoreline loading of hydrocarbons in the event of a spill.

5.8.2 Petroleum exploration and production

The EMBA intersects the Gippsland oil and gas production province, which contains numerous offshore platforms, subsea wells and pipelines. Petroleum production from the offshore Gippsland Basin is centred on the Esso Australia Resources Pty Ltd (EARPL) operations for the Gippsland Basin Joint Venture. EARPL produces oil and gas from 23 platforms and subsea developments, hundreds of wells and some 880 km of associated pipelines, tied back to the Longford Gas Plant and Long Island Point. Production first commenced in 1969 from the Barracouta field. The latest fields to come into production were the Kipper-Tuna-Turrum oil and gas fields in 2013.

The EMBA overlaps the Tasmanian Gas Pipeline, which connects the Victorian and Tasmanian gas networks. The subsea section of this pipeline is 301 km long and has a capacity of 47 PJ/annum (TPG 2022).

The EMBA intersects the investigation area of the Star of the South Wind Farm (130 km northeast of Yolla-A platform), which is the first proposed offshore wind farm in Australia. The project involves installation of offshore wind turbines and offshore substations, submarine cables from the wind farm to the Gippsland coast and a transmission network of cables and substations connecting to the La Trobe Valley. The project is currently in its feasibility phase with preliminary site investigations such as metocean, geophysical, geotechnical and environmental studies underway.

There is no non-Beach oil and gas infrastructure within the Operational Area.

5.8.3 Shipping

The SEMR (which includes Bass Strait) is one of the busiest shipping regions in Australia (Commonwealth of Australia 2015c). Shipping consists of international and coastal cargo trade, passenger services and cargo and vehicular ferry services such as the Spirit of Tasmania ferry across the Bass Strait (Commonwealth of Australia 2015c). 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.

AMSA collects vessel traffic data from a variety of sources, including satellite shipborne automated identification system data, across Australia's Search and Rescue region. This data has been used to develop Figure 5-28, which shows recent vessel traffic within the vicinity of the permit area, noting the heavy traffic line to the west of the Yolla-A platform is primarily ferry and cargo traffic.

Ports Australia (2020) provide statistics for port operations throughout Australia's main commercial ports. Based on the recent 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).

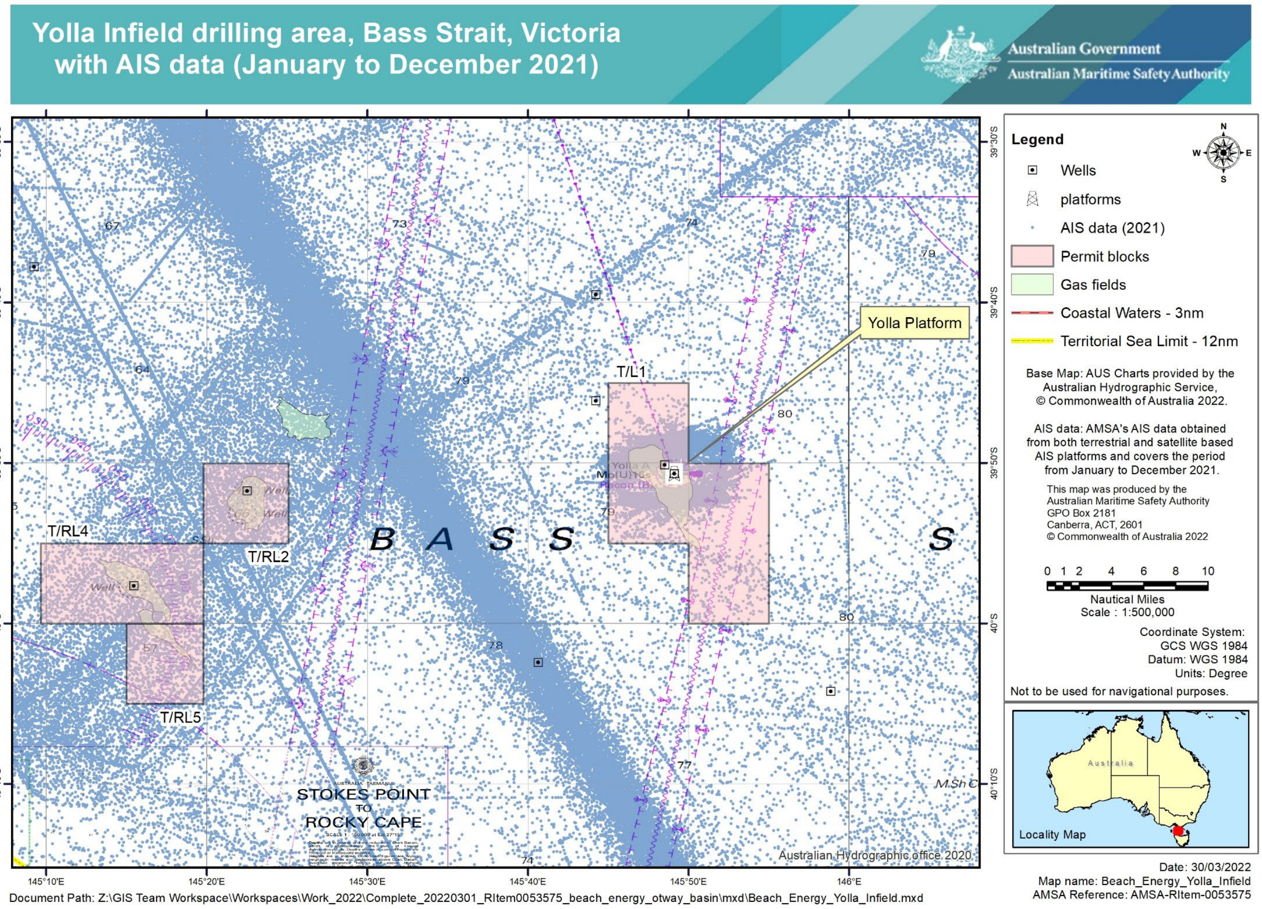


Figure 5-28 Vessel traffic within the vicinity of the T/L1 permit area with AIS data (January to December 2021)

5.8.4 Tourism

Marine-based tourism and recreation in Bass Strait is primarily associated with recreational fishing, boating and ecotourism.

Seaside towns are the primary destinations that attract tourists and holidaymakers to the south coast of Victoria and northwest coast of Tasmania. These coastal communities are popular tourist towns for their boating and fishing activities, along with bushwalking, bird watching and other nature-focused activities. Towns including Inverloch, Venus Bay, Cape Paterson and Cape Woolamai in Victoria are especially popular in summer as well. The George Bass Coastal Walk is one such nature-focused activity that stretches from the outskirts of San Remo to Kilcunda and features a cliff-top trail that follows the route of explorer George Bass and offers spectacular views of the coastline. It is estimated that the tourism industry in Bass Coast has generated approximately $245 million and supports approximately 1,426 jobs in the region (Remplan 2019).

At Stanley on the northwest coast of Tasmania, The Nut provides a range of tourism and recreational opportunities including scenic viewing, walking, picnicking and nature study, which were enjoyed by an estimated 108,500 interstate and overseas visitors in 1999 (PWS 2003).

5.8.5 Recreation

Recreational fishing along the Bass, Gippsland typically targets snapper, King George whiting, flathead, bream, sharks, tuna, calamari, and Australian salmon. Along the Tasmanian north coast, a range of recreational species are targeted including salmon, bream, tuna and rock lobster using gear including rods, nets and pots.

As Bass Strait is relatively shallow, the water currents through the Bass Strait can create unpredictable seas, reducing the numbers of small recreational boats from venturing long distances from shore. Larger game fishing boats are likely to fish further out to sea and use boat ramps and marinas along the Victorian coast of the EMBA (e.g., Inverloch, San Remo, Cape Paterson and New Haven).

Recreational diving and snorkelling are popular activities with a diverse range of sites in around the Victorian and Tasmanian coast. Open water dives to shipwrecks off the coast of Wilsons Promontory, such as the wreck of the *SS Cambridge* and the *SS Gulf of Carpentaria* are also common spots for recreational divers.

5.8.6 Commonwealth managed fisheries

Commonwealth fisheries are managed by the Australian Fisheries Management Authority (AFMA) under the *Fisheries Management Act 1991* (Cth). AFMA jurisdiction covers the area of ocean from 3 nm from the coast out to the 200 nm limit (the Australian Fishing Zone [AFZ]). Commonwealth commercial fisheries with jurisdictions to fish within the EMBA are the:

- bass strait central zone scallop fishery
- southern squid jig fishery
- small pelagic fishery
- southern and eastern scalefish and shark fishery, incorporating:
    - Danish-seine sub-sector
    - gillnet and shark hook sector
    - Commonwealth trawl sector
    - scalefish hook sector
- southern bluefin tuna fishery
- eastern tuna and billfish fishery
- eastern skipjack fishery.

Information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery is included in Table 5-14.

Table 5-14 Commonwealth managed fisheries within the Operational Area and EMBA

Fishery	Target species	Description	Fishing effort within Operational Area	Fishing effort within EMBA
Bass Strait Central Zone Scallop Fishery	Commercial scallop (*Pecten fumatus*)	Central Bass Strait area that lies within 20 nm of the Victorian and Tasmanian coasts. Fishery does not operate in state waters. Fishing effort is	Yes. There has been fishing effort in the EMBA based on ABARES data	Yes. There is a very tiny overlap between the

Fishery	Target species	Description	Fishing effort within Operational Area	Fishing effort within EMBA
		concentrated east of King Island, off Apollo Bay and north of Flinders Island. Towed scallop dredges that target dense aggregations ('beds') of scallops.	2014-2018. However, scallop fishers have advised Beach that the muddy sediments around Yolla-A platform are not suitable for scallop settlement.	western extent of the EMBA and the King Island scallop fishing grounds.
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. Fishing effort is generally concentrated along the 200 m bathymetric contour with highest fishing intensity south of Portland and Warrnambool.	Yes. There has been fishing effort in the Operational Area based on ABARES data 2014-2018. However, no areas of intensity overlap with the Operational Area.	Yes. There has been fishing effort in the EMBA based on ABARES data 2017-2020.
Small Pelagic Fishery	Australian sardine (*Sardinops sagax*) Jack mackerel (*Trachurus declivis*) Blue mackerel (*Scomber australasicus*) Redbait (*Emmelichthys nitidus*)	Fishing efforts occur within Commonwealth waters extending from southern Queensland around southern Western Australia. The fishery includes purse-seine and midwater trawl fishing vessels.	No. No fishing effort identified within the Operational Area based on ABARES data 2014-2018.	No. The EMBA intersects 3.5 % of the fishery, but in an area that is not fished.
Southern Bluefin Tuna Fishery	Southern bluefin tuna (*Thunnus maccoyii*)	The Southern Bluefin Tuna Fishery 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. The fishery operates year-round. Fishery effort is generally concentrated in the Great Australian Bight and off the southern NSW coast.	No. No fishing effort identified within the Operational Area based on ABARES data 2014-2018.	No. The EMBA intersects 1.3 % of the fishery, but in an area that is not fished.
Eastern Tuna and Billfish Fishery	Albacore tuna (*Thunnus alulunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*), broadbill swordfish (*Xiphias gladius*), striped marlin (Tetrapturus audux)	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.	No. No fishing effort identified within the Operational Area between based on ABARES data 2014-2018.	No. The EMBA intersects 3.3 % of the fishery, but in an area that is not fished.
Eastern Skipjack Fishery.	Skipjack tuna (*Katsuwonus pelamis*)	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 fishing effort identified within the Operational Area based on ABARES data 2014-2018.	No. No fishing effort identified within the EMBA between 2017-2020
SESSF – Trawl Sector Danish-	Tiger flathead (*Neoplatycephalus richardsoni*) and eastern	Danish seine fishing target fish species on the ocean floor.	Yes. There has been fishing effort in the area based	Yes. There has been fishing effort in

Fishery	Target species	Description	Fishing effort within Operational Area	Fishing effort within EMBA
seine sub-sector (SCDS)	school whiting (*Sillago flindersi*)	Fishing is generally concentrated off of the eastern coast of Victoria	on ABARES data 2014-2018. No areas of intensity overlap with the Operational Area.	the area based on ABARES data 2014-2018.
SESSF - Shark Gillnet and Shark Hook Sector (SSKN)	Gummy shark (*Mustelus antarcticus*) is the key target species, with bycatch of elephant fish (*Callorhinchus milii*), sawshark (*Pristiophorus cirratus, P. nudipinnis*), and school shark (*Galeorhinus galeus*).	Waters from the NSW/Victorian border westward to the SA/WA border, including the waters around Tasmania, from the low water mark to the extent of the AFZ. Most fishing occurs in waters adjacent to the coastline in Bass Strait	Yes. There has been fishing effort in the Operational Area based on ABARES data 2014-2018.	Yes. Based on 2017-18 fishing intensity data, the EMBA overlaps areas of low and medium intensity fishing. The EMBA intersects 8 % of the fishery
SESSF – Commonwealth Trawl Sector (SCTR)	Key species targeted are eastern school whiting (*Sillago flindersi*), flathead (*Platycephalus richardsoni*) and gummy shark (*Mustelus antarcticus*).	Covers the area of the AFZ extending southward from Barrenjoey Point (north of Sydney) around the New South Wales, Victorian and Tasmanian coastlines to Cape Jervis in South Australia.	No. No fishing effort identified within the Operational Area based on ABARES data 2014-2018.	No. Based on 2017-18, 2016-17 and 2015-16 fishing intensity data that shows no intensity recorded in the EMBA. The EMBA intersects 10 % of the fishery.
SESSF – Scalefish Hook Sector	Key species targeted are gummy shark (*Mustelus antarcticus*), elephantfish (*Callorhinchus milii*) and draughtboard shark (*Cephaloscyllium laticeps*).	Includes all waters off South Australia, Victoria and Tasmania from 3 nm to the extent of the AFZ.	No. Based on the distance offshore, the fishing area does not overlap the operational are.	No. Based on 2017-18, 2016-17 and 2015-16 fishing intensity data that shows no SHS intensity recorded in the EMBA. The EMBA intersects 4.7 % of the fishery

Data / information sources: Australian Fisheries Management Authority (www.afma.gov.au), (ABARES 2021)

5.8.7 Victorian managed fisheries

Victorian-managed commercial fisheries with access licences that authorise harvest in the waters of the EMBA include the following:

- scallop
- abalone
- rock lobster
- wrasse
- ocean access (general)
- pipis (the entire Victorian coastline)
- ocean Purse Seine

- inshore trawl
- giant crab.

A description of these fisheries is detailed in Table 5-15, and indicates that all of the above-listed fisheries, except the scallop and inshore trawl, are actively fishing in the EMBA.

Table 5-15 Victorian managed fisheries in the Operational Area and EMBAs

Fishery	Target species	Description	Fishing methods and licences	Fishing effort within Operational Area	Fishing effort within EMBA
Bass Strait Scallop Fishery	Commercial scallop (*Pecten fumatus*).	Extends 20 nm from the high tide water mark of the entire Victorian coastline (excluding bays and inlets where commercial scallop fishing is prohibited). Management of the Bass Strait Scallop fishery was split between the Commonwealth, Victoria and Tasmania in 1986 under an Offshore Constitutional Settlement, whereby Commonwealth central, Victorian and Tasmanian zones were created. The EMBA intersects 54 % of the fishery.	Towed scallop dredges (typically 4.5 m wide) that target dense aggregations ('beds') of scallop. A tooth-bar on the bottom of the mouth of the dredge lifts scallops from the seabed and into the dredge basket. There are a maximum of 90 licences available with 89 currently assigned. Only a few vessels fishing these licenses operate in any one year (generally between 12 and 20).	No. Fishing effort is east of Wilsons Promontory.	No. Fishing effort is east of Wilsons Promontory. The Tasmanian sector is currently closed
Abalone Fishery	Blacklip abalone (*Haliotis rubra*) is the primary target, with greenlip abalone (*H. laevigata*) taken as a bycatch.	Victorian Central Abalone Zone is located between Lakes Entrance and the mouth of the Hopkins River. Most abalone live on rocky reefs from the shore out to depths of 30 m. The EMBA intersects: • 44 % of the entire Victorian fishery. • 53.7 % of the central zone	Abalone diving activity occurs close to shoreline (generally no greater than 30 m depth) using hookah gear (breathing air supplied via hose connected to an air compressor on the vessel). Commercial divers do not use SCUBA gear. Divers use an iron bar to prise abalone from rocks. The fishery consists of 71 fishery access licences, of which 34 operate in the central zone.	No. Based the distance offshore and the catch distribution along the Victorian coast.	Yes. Based on catch distribution along the Victorian coast.
Rock Lobster Fishery	Southern rock lobster (*Jasus edwardsii*). Very small bycatch of species including southern rock cod (*Lotella* and *Pseudophycis spp*), hermit crab (family *Paguroidea*), leatherjacket (*Monacanthidae spp*) and octopus (*Octopus spp*).	The eastern zone stretches from Apollo Bay in southwest Victoria to the Victorian/NSW border. Rock lobster abundance decreases moving from western Victoria to eastern Victoria. Larval release occurs across the southern continental shelf, which is a high-current area, facilitating dispersal. The EMBA intersects:	Fished from coastal rocky reefs in waters up to 150 m depth, with most of the catch coming from inshore waters less than 100 m deep. Baited pots are generally set and retrieved each day, marked with a surface buoy. As of June 2019, there were 33 fishery access licences in the eastern zone.	No The Operational Area is outside of the fishery zones.	Yes. Based on catch data in the San Remo Region and prevalence of rocky reef in the Victorian coastal area.

Fishery	Target species	Description	Fishing methods and licences	Fishing effort within Operational Area	Fishing effort within EMBA
		• 44.3 % of the entire Victorian fishery • 88.8 % of the San Remo region.			
Wrasse Fishery	Blue-throat wrasse (*Notolabrus tetricus*), saddled wrasse (*N. fucicola*), orange-spotted wrasse (*N. parilus*)	Entire Victorian coastline out to 20 nm (excluding marine reserves, bays and inlets). The EMBA intersects 54.2 % of the fishery	Handline fishing (excluding longline), rock lobster pots (if in possession of a rock lobster access fishing licence).	No. Based on the distance offshore, the fishery is not expected to be active within the Operational Area.	Yes. In recent years, catches have been highest off the central coast (Port Phillip Heads, Western Port and Wilson's Promontory) and the west coast.
Pipi fishery (Eastern Zone)	Pipi (*Donax deltoids*)	Covers the entire Victorian coastline, with pipis found in the surf zone of high-energy sandy beaches. The EMBA intersects 21.5 % of the fishery (being the Victorian shoreline).	This fishery opened in 2017- 2018. Other than three bait fisheries that operate outside the EMBA (e.g., Snowy River and Mallacoota), only Ocean Access Fishery licence holders are permitted to harvest pipis.	No. Based on the distance offshore, the fishery is not expected to be active within the Operational Area.	Yes. Wherever there are high-energy sandy beaches. Venus Bay is a popular harvesting area.
Giant crab (Western Zone)	Giant crab (*Pseudocarcinus gigas*)	The boundaries of the fishery mimic those of the Rock Lobster Fishery, however the fishery is based in the Western Zone.	Fishers target giant crabs using baited rock lobster pots. As of June 2019, there were 11 fishery access licenses.	No. fishing is concentrated west of Apollo Bay, distant from the Operational Area,	Yes. However, fishing is concentrated west of Apollo Bay; the western most extent of the EMBA intersects this area.
Ocean Purse Seine Fishery	Australian sardine (*Sardinops sagax*), Australian salmon *(Arripis trutta*) and sandy sprat (*Hyperlophus vittatus*) are the main species. Southern anchovy (*Engraulis australis*) caught in some years.	Entire Victorian coastline, excluding marine reserves, bays and inlets.	Purse seine is generally a highly selective method that targets one species at a time, thereby minimising bycatch. The purse seine method does not touch the seabed. A lampara net may also be used. Only one licence is active in Victorian waters (based out of Lakes Entrance), with fishing focused close to shore and during the day. This licence is held by Mitchelson Fisheries Pty Ltd, a family business that catches primarily sardines, salmon, mackeral, sandy sprat, anchovy and white bait using the Maasbanker purse seine vessel.	No. Based on the distance offshore, the fishery is not expected to be active within the Operational Area.	Yes. An assumption, based on limited data availability.

Fishery	Target species	Description	Fishing methods and licences	Fishing effort within Operational Area	Fishing effort within EMBA
Ocean Access (or Ocean General) Fishery	Gummy shark (*Mustelus antarcticus*), school shark (*Galeorhinus galeus*), Australian salmon (*Arripis trutta*), snapper (*Pagrus auratus*). Small bycatch of flathead (*Platycephalidae spp*).	Entire Victorian coastline, excluding marine reserves, bays and inlets	Utilises mainly longlines (200 hook limit), but also haul seine nets (maximum length of 460 m) and mesh nets (maximum length of 2,500 m per licence). As of June 2019, there were 157 fishery access licences. Fishing usually conducted as day trips from small vessels (<10 m).	Yes. An assumption, based on limited data availability.	Yes. An assumption, based on limited data availability.
Inshore Trawl Fishery	Key species are eastern king prawn (*Penaeus plebejus*), school prawn (*Metapenaeus macleayi*) and shovelnose lobster/Balmain bug (*Ibacus peronii*). Minor bycatch of sand flathead (*Platcephalus bassensis*), school whiting (*Sillago bassensis*) and gummy shark (*Mustelus antarcticus*).	Entire Victorian coastline, excluding marine reserves, bays and inlets. Most operators are based at Lakes Entrance.	Otter-board trawls with no more than a maximum head-line length of 33 m, or single mesh nets are used. As of June 2019, there were 54 fishery access licences, with only about 15 active to various degrees.	No. Based out of Lakes Entrance with catch locations being distant from the Operational Area.	No. Based out of Lakes Entrance with catch locations being distant from the EMBA.

5.8.8 Tasmanian managed fisheries

Tasmanian-managed commercial fisheries with access licences that authorise harvest in the waters of the EMBA include the following (DPIPWE, 2020):

- abalone
- commercial dive
- giant crabs
- rock lobster
- scalefish
- scallop
- seaweed
- shellfish
- octopus.

Table 5-16 summarises the key information for each of these fisheries and indicates that all the above-listed fisheries, except the seaweed, scallop and shellfish fisheries, are actively fishing in the EMBA.

Table 5-16 Tasmanian managed fisheries in the Operational Area and EMBAs

Fishery	Target species	Description	Fishing method	Fishing effort within Operational Area	Fishing effort within EMBA
Abalone Fishery	Blacklip abalone (*Haliotis rubra*) is the primary target, with greenlip abalone (*H. laevigata*) taken as a bycatch	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 1561 t for 2017, comprising 1421 t of blacklip and 140 t of greenlip abalone. Production value was approximately $70 million.	Abalone diving activity occurs close to shoreline (generally no greater than 30 m depth) using hookah gear (breathing air supplied via hose connected to an air compressor on the vessel). Commercial divers do not use SCUBA gear. Divers use an iron bar to prise abalone from rocks.	No. Based on the water depth at the platform, the fishery is not expected to be active within the Operational Area.	Yes Fishing blocks occur in the EMBA.
Commercial Dive Fishery	Short spined sea urchin (*Heliocidaris erythrogramma*), long spined sea urchin (*Centrostephanus rodgersii*), periwinkles (genus *Turbo*) and Japanese kelp (*Undaria pinnatifida*).	Dive capture fishery that targets several different species; the main species collected being sea urchins and periwinkles. In 2010-2011 (the most recent period for which information was available) approximately 100 t of sea urchins and 15 t of periwinkles were harvested, and the fishery had a total commercial value of around $250,000. 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 coasts of Tasmania around ports. The 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).	There are currently 52 commercial dive licences.	No. Based on the distance offshore, the fishery is not expected to be active within the Operational Area.	Yes. EMBA intersects the northern and western zones of the fishery.

Fishery	Target species	Description	Fishing method	Fishing effort within Operational Area	Fishing effort within EMBA
Giant Crab Fishery	Tasmanian giant crab (*Pseudocarcinus gigas*).	The giant crab fishery is a comparatively small fishery with the annual harvest set at 46.6 tonnes but with a high landed value of around $2 million. 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 2017/18 and 2019/2020 to address the issue	Giant crabs are harvested on the continental shelf, with the most abundant catches at water depths of 110-180 m. They are harvested via baited pots.	Yes. Due to unavailability of information, the presence of this fishery was unable to be ruled out. However, based on the water depth at the platform, and that the majority of the catch occurs off the southern coast of Tasmania the fishery is not expected to be active within the Operational Area.	Yes. Majority of catch occurs off the southern coast of Tasmania
Rock Lobster Fishery	Southern rock lobster (*Jasus edwardsii*)	Southern rock lobster are the other major wild-caught Tasmanian fishery. For 2019-20 the Total Allowable Catch has remained at 1220.7 t which includes the Total Allowable Recreational Catch (TARC) of 170 tonnes and the Total Allowable Commercial Catch (TACC) of 1050.7 tonnes or 100 kg per unit for the 2019-20 season. 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.	Fished from coastal rocky reefs in waters up to 150 m depth, with most of the catch coming from inshore waters less than 100 m deep. Baited pots are generally set and retrieved each day, marked with a surface buoy.	Yes. The Operational Area is within the Western Rock Lobster Fishing Region.	Yes. The EMBA intersects with the North-east Catch Area.
Scalefish Fishery	Multi-species fishery including banded morwong (*Cheilodactylus spectabilis*), Tiger flathead (*Neoplatycephalus richardsoni*) and southern school whiting (*Sillago flindersi*).	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. The highest landings of finfish include wrasse (81 t), southern calamari (76 t), flathead (36 t), southern	The fishery targets multiple species and therefore uses multiple gear-types including drop-line, Danish seine, fish trap, hand-line and spear. There were 259 vessels operating in 2017/18 across the fishery.	No. The Operational Area does not overlap with the fishery area.	Yes. Fishing blocks occur in the EMBA.

Fishery	Target species	Description	Fishing method	Fishing effort within Operational Area	Fishing effort within EMBA
		garfish (34 t), banded morwong (30 t) and Australian salmon (23 t).			
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 since 2016.	Towed scallop dredges (typically 4.5 m wide) that target dense aggregations ('beds') of scallop. A tooth-bar on the bottom of the mouth of the dredge lifts scallops from the seabed and into the dredge basket.	No. Fishery currently closed for stock assessment.	No. Fishery currently closed for stock assessment.
Seaweed Fishery	Bull kelp (*Nereocystis luetkeana*) and Wakame (*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	Seaweeds are harvested as they wash ashore.	No. The primary sites of the fishery occur off the east coast of Tasmania and west coast of King Island.	No. The primary sites of the fishery occur off the east coast of Tasmania and west coast of King Island.

Fishery	Target species	Description	Fishing method	Fishing effort within Operational Area	Fishing effort within EMBA
		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.			
Shellfish Fishery	Pacific oyster (*Crassostrea gigas*), Native oyster (*Ostrea angasi*), Venerupis clam (*Venerupis largillierti*) and Katelysia cockle (*Katelysia scalarina*).	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 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 shellfish targeted by the fishery can be collected by hand in shallow water using a basket rake. In deeper water a dredge is used.	No. The designated zones occur off the east coast of Tasmania.	No. The designated zones occur off the east coast of Tasmania.
Octopus Fishery	Pale octopus (*Octopus pallidus*).	For pale octopus, the 2018/19 catch of 129 t was well above the long-term average for the fishery, with an annual average catch of 85.4 t observed over the last decade. Effort decreased slightly from last year's total, with 347,000 potlifts recorded in 2018/19. Almost all of this effort and resulting catch occurred in the western portion of the fishery surrounding King Island.	Octopus are caught via traps and pots. There are only two active vessel licences.	No. The Operational Area does not overlap with the 2019/2020 catch and effort data (IMAS 2021).	Yes. The EMBA intersects catch area of the fishery.

Source: DPIPWE (DPIPWE 2020a, DPIPWE 2020b, DPIPWE 2020c, DPIPWE 2020d, DPIPWE 2020e, DPIPWE 2020f, DPIPWE 2020g, DPIPWE 2020h), (Department of Natural Resources & Environment 2022), (Bradshaw, Moore and Gartmann 2018)

5.9 Cultural environment

5.9.1 Maritime Archaeological heritage

Shipwrecks over 75 years old are protected within Commonwealth waters under the *Historic Shipwrecks Act 1976* (Cth), in Victorian waters under the *Victorian Heritage Act 1995* (Vic), and in Tasmanian waters under the *Historic Cultural Heritage Act 1995* (Tas).

There are 255 shipwrecks mapped within the EMBA using a search of the Australian National Shipwreck Database (DAWE 2022g). There are no shipwrecks within the Operational Area. The nearest shipwreck to Yolla-A platform is the Albert (shipwreck ID 5794), located approximately 48 km southwest of the platform.

Of the 650 shipwrecks in Victoria, nine have been placed within protected zones (a no-entry zone of 500 m radius [78.5 ha] around a particularly significant and/or fragile shipwreck) (DAWE 2022g). The closest shipwreck protection zone to Yolla-A platform is the *SS Glenelg*, located 187 km northeast of the platform. The *SS Glenelg* is intersected by the EMBA.

5.9.2 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).

The Aboriginal Heritage Register, lists over 13,000 sites; however, there is no searchable database to identify any sites in the EMBAs. It is assumed that sites may be scattered along the coast of King Island within the EMBA.

5.9.3 Native title

A search of the National Native Title Tribunal (NNTT) database identified no claims within the Operational Area. The EMBA intersects with two native title claims associated with the coast of Victoria, and one native title claim associated with the coast of New South Wales. There are no registered claims in Tasmania.

Victoria

In 2010, the Federal Court recognised that the Gunaikurnai holds native title over much of Gippsland. On the same day the state entered into an agreement with the Gunaikurnai under the *Traditional Owner Settlement Act 2010*. The agreement area extends from west Gippsland near Warragul and Inverloch east to the Snowy River and north to the Great Dividing Range. It also includes 200 metres of sea country offshore. The determination of native title under the *Native Title Act 1993* covers the same area (GLaWAC 2019). The agreement and the native title determination only affect undeveloped Crown land within the Gippsland region.

The Gunaikurnai and Victorian Government Joint Management Plan was approved by the Minister for Energy, Environment and Climate Change in July 2018. The plan guides the partnership between the Gunaikurnai people and the Victorian Government in the joint management of the ten parks and reserves for which the Gunaikurnai have gained Aboriginal Title as a result of their 2010 Recognition and Settlement Agreement with the Victorian Government.

An additional native title claim is intersected by the EMBA that includes Cape Otway and the waters 100 m seaward from the mean low-water mark of the coastline. In 2012, the Eastern Maar traditional owner group lodged a native title determination application in the Federal Court of Australia which was registered on 20 March 2013. The Eastern Maar Aboriginal Corporation manages these native titles rights for Eastern Maar Peoples. The Eastern Maar traditional owner group and the State of Victoria have agreed to negotiate a Recognition and Settlement Agreement under the *Traditional Owner Settlement Act 2010*.

New South Wales

In 2017, the South Coast People lodged a native title claim in the Federal Court of Australia that was registered on 31 January 2018. The South Coast people's claim covers 16,808 km^2, extending south from Sydney to Eden, along the south coast of NSW and west towards Braidwood and also extends 3 nm seaward.

6 Environmental Impact and Risk Assessment Methodology

6.1 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 6-1 outlines this risk assessment process.

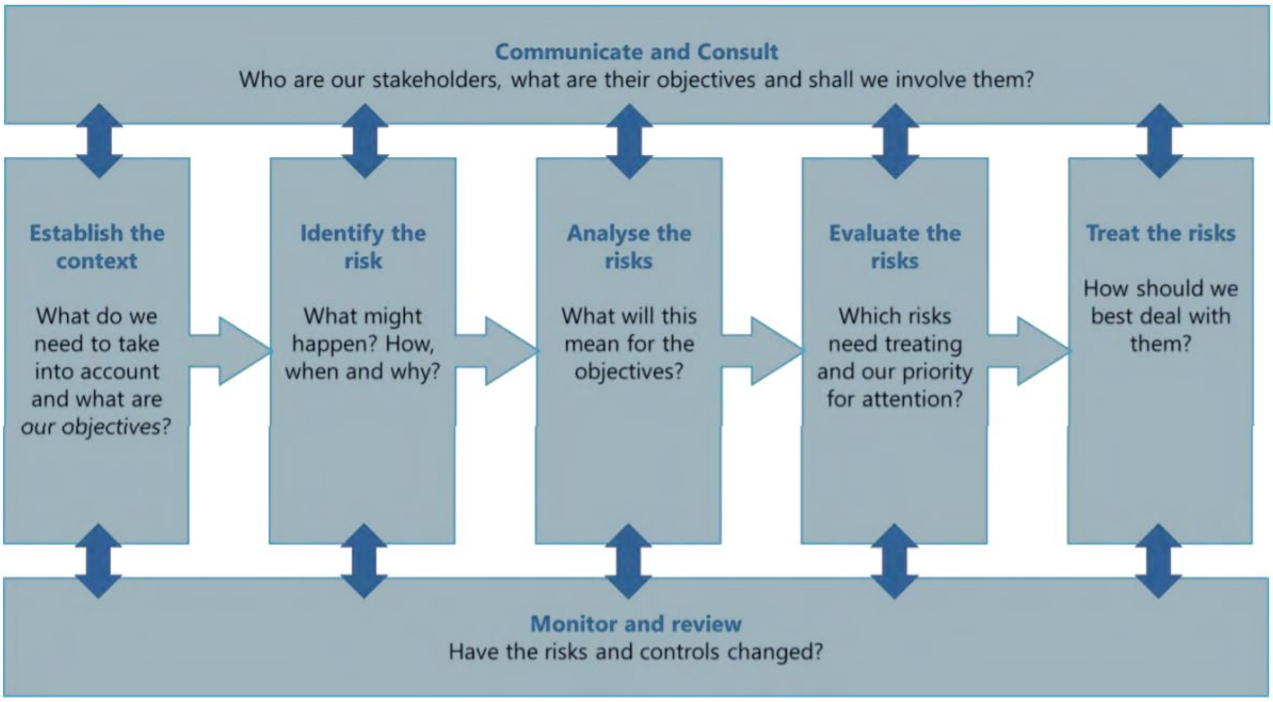


Figure 6-1 Risk assessment process

6.1.1 Definitions

Definitions of the terms used in the risk assessment process are detailed in Table 6-1.

Table 6-1 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 petroleum title c. 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.

Term	Definition
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.
Hazard	An environmental hazard is a potential source of harm that has the potential to impact environmental receptors
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).

6.2 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 9.

6.3 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 3, '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 4)
- identifying the environment that may be affected, either directly or indirectly, by the activity (based upon the 'Existing Environment' as described in Section 5)
- understanding the concerns of stakeholders and incorporating those concerns into the design of the activity where appropriate (outlined in Section 9, 'Stakeholder Consultation').

6.4 Identify the potential impacts and risk

Potential impacts (planned aspect) and risks (unplanned aspect) associated with 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. Where a planned aspect is identified, likelihood and residual risk will not be considered. Table 7-1 details the aspects identified for the activity.

6.5 Analyse the potential impacts and risk

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.

6.5.1 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: MNES: Significant Guidelines 1.1 (Commonwealth of Australia 2013) 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)
- potential to interfere with other marine user rights: OPGGS Act 2006 (Cth) Section 280.

6.6 Evaluate and treat the potential impacts and risks

The following steps are undertaken using the environmental risk assessment matrix (Table 6-2) 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 6.7) and an acceptable level (Section 6.8)
- establish environmental performance standards for each of the identified control measures.

Table 6-2 Environmental risk assessment matrix (BSTD 8.1 Beach Risk Management Standard)

		Likelihood of occurrence					
		1 (Remote)	**(2) Highly Unlikely**	**(3) Unlikely**	**(4) Possible**	**(5) Likely**	**(6) Almost Certain**
Consequence Rating	**Description (Environment)**	< 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 probably 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)	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	High	High	Severe	Severe	Extreme	Extreme
5 (Critical)	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	Medium	Medium	High	Severe	Severe	Extreme
4 (Major)	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	Medium	Medium	Medium	High	Severe	Severe
3 (Serious)	Minor offsite or onsite release ort spill; serious short-term effect to ecosystem functions; serious impact on valued species or habitats; moderate effects on biological or physical environment	Low	Medium	Medium	Medium	High	Severe
2 (Moderate)	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.	Low	Low	Medium	Medium	Medium	High
1 (Minor)	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.	Low	Low	Low	Medium	Medium	Medium

6.7 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
- 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 2018) 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 2018) has been applied, whereby the level of ALARP assessment is dependent upon the:

- residual impact and risk level (high versus low)
- 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 2018) has been applied to this EP

6.7.1 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 6.7.2.1) 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 6-2), 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 6.7.2.

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 environmental interactions and the risks of unplanned events is outlined in Table 6-3.

Table 6-3 ALARP determination for consequence (planned environmental interactions) and risk (unplanned events)

Consequence ranking	Minor	Moderate	Serious	Major	Critical	Catastrophic
Planned environmental interactions	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		

6.7.2 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.

In alignment with NOPSEMA's ALARP Guidance Note (NOPSEMA 2015), Beach have adapted the approach developed by Oil and Gas UK (OGUK) (2014) for use in an environmental context to determine the assessment technique required to demonstrate that potential impacts and risks are ALARP (Figure 6-2). Specifically, the framework considers impact severity and several guiding factors:

- activity type
- risk and uncertainty
- stakeholder influence.

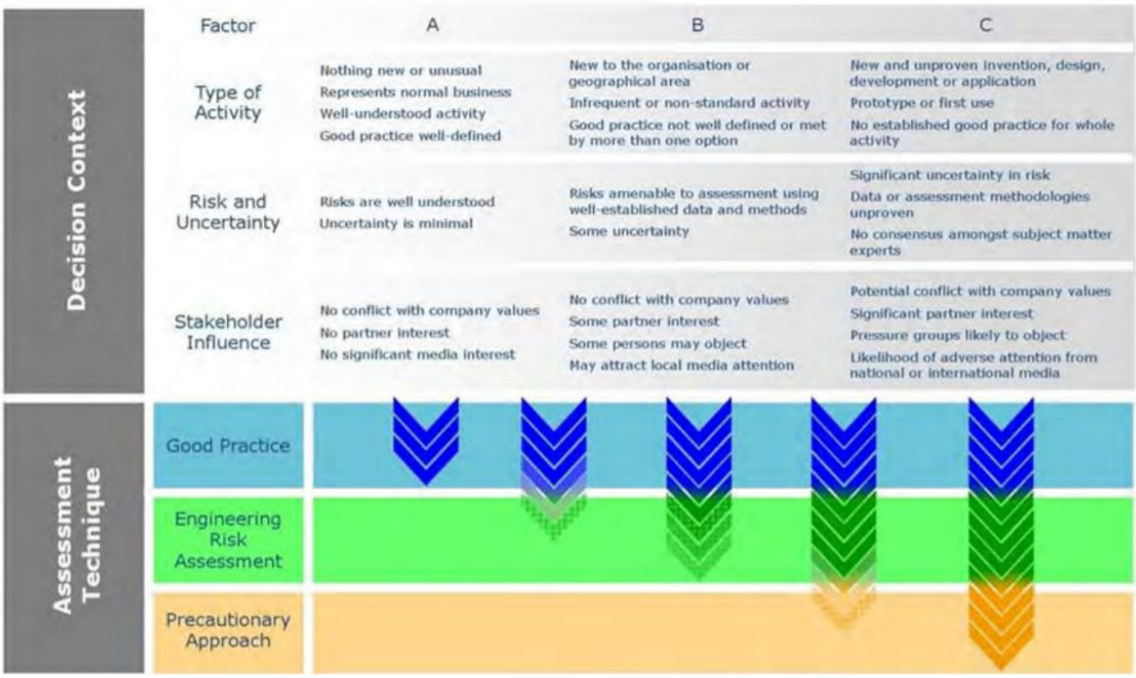


Figure 6-2 OGUK (2014) decision support framework

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
- precautionary approach.

6.7.2.1 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
- 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.

6.7.2.2 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.

6.7.2.3 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.

6.8 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 6.8.1 which is based on Beach's interpretation of the NOPSEMA EP content requirements (NOPSEMA 2018).

6.8.1 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
- other requirements.

These criteria are described in the following sections and are consistent with NOPSEMA EP content requirements (NOPSEMA 2018).

6.8.1.1 Principles of Ecologically Sustainable Development

Section 3A of the EPBC Act defines ecologically sustainable development (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.

6.8.1.2 Internal Context

The Health Safety and Environment Management System (HSEMS) includes Standards and Procedures relevant to the way Beach operates.

At the core of the HSEMS are 20 performance standards which detail specific performance requirements for the implementation of the HSE Environmental Policy and management of potential HSE impacts and risks

Where relevant, Standards and Procedures in the management system 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 the company HSE Environment Policy. Where specific internal procedures, guidelines, expectations are in place for management of the impact or risk in question, acceptability is demonstrated.

6.8.1.3 External Context

External context considers stakeholder expectations, obtained from stakeholder consultation.

Beach has undertaken stakeholder consultation, which is described in detail in Section 9. 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.

6.8.1.4 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 3)
- policies and guidelines (described in Section 3.5)
- international agreements (described in Section 3)
- EPBC Management Plans (described in Section 3.1
- Australian Marine Park designations (described in Section 5.2).

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.

6.9 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).

7 Environmental Impact and Risk Assessment

7.1 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 environmental performance outcomes (EPO's), control measures (systems, procedures, personnel or equipment) that will be used to reduce potential impacts and risks to ALARP and acceptable levels, and the associated environmental performance standards (EPSs) and measurement criteria.

Table 7-1 Activity - Aspect Relationship

	Aspect													
	Planned									Unplanned				
Activities	Light Emissions	Atmospheric Emissions	Underwater noise emissions	Physical presence (marine fauna)	Physical presence (marine users)	Benthic disturbance	Waste waters and putrescible waste	Drilling cuttings and fluids	Cement and swarf	Introduction of IMP	Waste	Minor spills	Vessel collision (marine diesel oil)	LOWC
MODU positioning			x	x	x	x				x	x		x	
Well construction and completion methodology			x			x	x	x	x					x
Completion activities	x	X												x
Plug and abandonment								x	x					
Topsides (platform) piping fabrication														
MODU details and layout	x	X		x	x		x							
Support activities	x	X	x	x	x		x			x	x	x	x	

7.2 Light emissions

7.2.1 Establish the context

The activity will be undertaken 24 hours a day and as such, lighting is required at night for navigation and to ensure safe operations when working on the MODU and vessels. As detailed in Section 4.3, the MODU may be on location for a duration of up to 130 days. In addition to onboard lighting, light emissions will also be generated for short durations during well testing; as discussed in Section 4.5.3. The duration of these activities is expected to be in the order of 36 hours.

7.2.2 Known and potential environmental impacts

Light emissions from MODU and vessel operations and flaring will result in a change in ambient light.

A change to ambient light levels has the potential to impact on sensitive fauna behaviours by disrupting these behaviours through attraction of light-sensitive species to artificial light sources.

7.2.3 Consequence evaluation

Light sensitive species have been identified by reviewing the National Light Pollution Guidelines for Wildlife (the light pollution guidelines) (Commonwealth of Australia 2020a). The light pollution 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. As such this assessment will focus on marine turtles, seabirds and migratory shorebirds.

For the light impact assessment, the process outlined in the light pollution guidelines is used. The aim of the light pollution guideline is for artificial light to be managed so wildlife is:

4. not disrupted within, nor displaced from, important habitat

5. able to undertake critical behaviours such as foraging, reproduction and dispersal.

The light pollution guidelines recommend undertaking a light impact assessment where important habitat for listed species sensitive to light are located within 20 km of the light source. 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 MODU was used to identify any areas where turtles, shorebirds and seabirds may be foraging, breeding, roosting or migrating. Although the MODU will generate greater light emissions than the support vessels, as the Yolla-A platform is an operating facility with existing lighting in place, the presence of additional lighting from the MODU is expected to change ambient levels minimally.

Several listed turtle species may occur within 20 km of the MODU, 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 expected, and they are not discussed further.

Table 7-2 details the biologically important areas associated with birds that are present within 20 km of the MODU (as per Section 5.7.7).

Table 7-2 Light sensitive receptors within 20 km of the MODU

Species	PMST Report Type of Presence	% BIA exposed within 20 km of MODU
Black-browed albatross (foraging BIA)	FL	0.08 %
Bullers albatross (foraging BIA)	FL	0.18 %
Campbell albatross (foraging BIA)	FL	0.08 %

Species	PMST Report Type of Presence	% BIA exposed within 20 km of MODU
Indian Yellow-nosed albatross (foraging BIA)	SHL	0.12 %
Wandering albatross (foraging BIA)	FL	0.11 %
White-faced Storm-petrel (foraging BIA)	BK	0.97 %
	FL: Foraging, feeding or related behaviour likely to occur within area. SHL: Species or species habitat likely to occur within area. BK: Breeding known to occur within area.	

Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Wiese, et al. 2001) and that lighting can attract birds from large catchment areas (Shell 2010). These studies indicate that migratory birds are attracted to lights from offshore platforms when travelling within a radius of 5 km from the light source, but their migratory paths are unaffected outside this zone (Kamrowski, et al. 2014).

Further to this, 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 to albatross foraging BIAs are not predicted based on these species forage most actively during daylight.

Petrel species exhibit a broad range of diets and foraging behaviours, hence their at-sea distributions are diverse. While petrels may forage at night (Commonwealth of Australia 2020a), the white-faced storm-petrel foraging BIA overlaps with only 0.97% of the area within 20 km of the Operational Area, as described in Table 7-2.

As discussed in Section 5.7.7.4, the identified likely migration route for the orange-bellied parrot overlaps with the Operational Area. No BIA or habitat critical to the survival of the species where identified. The orange-bellied parrot recovery plan identifies illuminated structures and illuminated boats as a potential barrier to migration and movement (DELWP 2016). The orange-bellied parrot is a ground feeding parrot which breeds in south-west Tasmania between November and March and then overwinters on the coast of south-east mainland Australia between April and October (DELWP 2016). The migration route overlaps with <1.92% of the area within 20 km of the Operational Area, a small percentage or the total area.

There are no islands or coasts where shorebirds and seabirds present within 20 km of the MODU. As the Operational Area is located over 80 km from coastal habitats, only a small number of threatened of migratory listed seabird species would be expected to be present within the area. It is not expected that light emissions from this activity would result in any impact to seabirds.

Based on the distance to coastal habitats and the low-level impacts on the biological environment, Beach has ranked the consequence associated with this risk as Minor (1).

7.2.4 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 and there is limited uncertainty associated with the level of impact associated with these emissions. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. The Yolla-A platform is manned with lights and has been operational for over 15 yeas and no incidents have been recorded of bird fatalities on the platform over this period of time. There were no objections from stakeholders regarding light emissions from this activity. As the impact consequence is rated as Minor (1) applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.

Adopted Control Measures	Source of good practice control measures
National Light Pollution Guidelines	The 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: A Seabird Lighting Management Plan will be developed and implemented as per the National Light Pollution Guidelines (Commonwealth of Australia 2020a). The Seabird Lighting Management Plan will detail: • activity lighting • seabird population and behaviour within the light EMBA • risk assessment • 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 MODU and support vessels ◦ outdoor/deck lights when not necessary for human safety or navigation will be turned off ◦ changes to MODU and vessel lighting that has a cost/benefit. • biological and light monitoring and auditing • rescue program for if birds land on the MODU or support vessels including 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. The Seabird Lighting Management Plan will be developed and reviewed by an appropriately qualified person.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	NA
Acceptability assessment	
To meet the principles of ESD	Light emissions were assessed as having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with light emissions. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.
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 are managed in accordance with: • the National Light Pollution Guidelines for Wildlife (Commonwealth of Australia 2020a). The activity was not deemed to be inconsistent with the following plans, conservation advice or recovery plans, none of which identify light emissions as a key threat to species with BIA's located within 20 km of the MODU: • National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a) • Approved Conservation Advice for *Caldris cantus* (Red Knot) (TSSC 2016a) • Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (TSSC 2015e) • Approved Conservation Advice for *Halobaena caerulea* (Blue Petrel) (TSSC 2015g) • National Recovery Plan for *Neophema chrysogaste* (Orange-bellied Parrot) (DELWP 2016) • Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (TSSC 2015i)

	• Approved Conservation Advice for *Pachyptila tutur subantarctica* (Fairy Prion (southern)) (TSSC 2015h) • National Recovery Plan for *Pterodroma leucoptera* (Gould's Petrel) (DEC 2006) • Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged Petrel) (TSSC 2015k) • Draft National Recovery Plan for *Sternula nereis* (Australian Fairy Tern) (Commonwealth of Australia 2019) • Approved Conservation Advice for *Thalassarche chrysostoma* (Grey-headed Albatross) (DEWHA 2009). Further to this, the EP has evaluated the risks of lighting on vessels and offshore structures in accordance with the National Recovery Plan for *Neophema chrysogaste* (Orange-bellied Parrot) (DELWP 2016) and deemed the risk to be low.
Monitoring and review	Light emissions will be monitored in accordance with the Seabird Lighting Management Plan. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.
Acceptability outcome	**Acceptable**

Environmental performance outcome	Environmental performance standard	Measurement criteria
Biologically important behaviours within a BIA or outside a BIA can continue while the activity is being undertaken.	**National Light Pollution Guidelines** A Seabird Lighting Management Plan will be developed and implemented as per the National Light Pollution Guidelines for Wildlife (Commonwealth of Australia 2020a). Specifically, the Management plan will minimise light emissions by ensuring Beach will: • Utilise screens, blinds or window tinting on windows to contain light inside the MODU and support vessels • Turn off outdoor/deck lights when not necessary for human safety or navigation • Complete a light audit over the course of the program.	Seabird Lighting Management Plan developed and implemented evidenced by lighting audit, and environmental inspections.

7.3 Atmospheric emissions

7.3.1 Establish the context

Atmospheric emissions are generated from combustion engines used on the MODU and vessels, during flaring activities and from fugitive emissions from surge tanks. The activity will be undertaken 24 hours a day and is expected to be approximately 130 days in duration.

Emissions from well testing are expected occur for a period of 48 hours. Beach Energy has estimated the atmospheric emissions (e-CO_2) generated from the operation a MODU and a single vessel during this Activity are in the order of 42 ktCO_2e/month (Table 4-7). Flaring activities are expected to generate ~10 ktCO_2e based upon Table 4-5. Based upon a 130 day program, Beach estimate the total emissions from this activity to be in the order of 192 ktCO_2e.

7.3.2 Known and potential environmental impacts

Atmospheric emissions will result in a:

- localised and temporary reduction in air quality
- an increase in GHG emissions.

7.3.3 Consequence evaluation

7.3.3.1 Localised and temporary reduction in air quality

Vessels, MODU and onboard machinery are typically powered by combustion engines using Marine Diesel Oil (MDO) resulting in exhaust fumes being released as part of routine operations. Upon release, atmospheric emissions rapidly disperse as they rise through the atmosphere, limiting the extent of any potential impact to the immediate vicinity other the release location.

Modelling for nitrogen dioxide (NO_2) emissions from MODU power generation was completed for another offshore project (BP 2013). Although not a like for like comparison, the modelling provides an indication of the extent to which ambient air quality can be changed from an offshore drilling activity. NO_2 is the focus of the modelling because it is considered the main (non-greenhouse) atmospheric pollutant of concern, with larger predicted emission volumes compared to other pollutants, and has potential to impact on human health (as a proxy for environmental receptors). Results of this modelling indicate that on an hourly average, there is the potential for an increase in ambient NO_2 concentrations of 0.0005 ppm within 10 km of the emission source and an increase of 0.00005 ppm in ambient NO_2 concentrations >40 km away. The National Environmental Protection (Ambient Air Quality) Measure (NEPM) recommends that hourly exposure to NO_2 is <0.08 ppm with annual average exposure <0.015 ppm. This indicates that the extent to which ambient air quality is impacted is limited to a localised airshed adjacent to the MODU.

Upon release, atmospheric emissions resulting from MODU operations will rapidly disperse as they rise through the atmosphere, limiting the extent of any potential impact to the immediate vicinity other the release location. Consequently, any localised and temporary reduction in air quality is limited to the duration of the activity within close proximity of the MODU.

The Operational Area is located away from coastal settlements and given the limited extent of reduced air quality within the local airshed, no environmental or socioeconomic receptors have been identified as having the potential to be impacted by these changes. Consequently, Beach has ranked the consequence associated with this risk as Minor (1).

7.3.3.2 Increase in GHG emissions

Direct greenhouse gas emissions from activities within this EP are estimated to be ~0.19 Mt CO2-e , which represents ~0.0004 % of the national Australian emissions (when compared to 2021 inventory) (DISER 2022).

The IPCC defines the term “carbon budget” as “refer[ing] to the maximum amount of cumulative net global anthropogenic CO_2 emissions that would result in limiting global warming to a given level with a given probability, taking into account the effect of other anthropogenic climate forcers. This is referred to as the total carbon budget when expressed starting from the pre-industrial period, and as the remaining carbon budget when expressed from a recent specified date. Historical cumulative CO_2 emissions determine to a large degree warming to date, while future emissions cause future additional warming. The remaining carbon budget indicates how much CO_2 could still be emitted while keeping warming below a specific temperature level.” (IPCC 2021).

The remaining carbon budget for a 50 % likelihood to limit global warming to 1.5 °C, 1.7 °C, and 2 °C is respectively, 500 Gt CO_2, 850 Gt CO_2, and 1,350 Gt CO_2 (IPCC 2021).

If the total direct greenhouse emissions from activities associated with this EP are ~0.19 Mt CO_2-e, then the activities under this EP may contribute ~1.5–4.0 x 10^{-7} percent to the reduction in the total remaining global carbon budget, which is a *de minimis* decrease.

Due to the overall de minimis contribution to the reduction of the global carbon budget from the activities under this EP, the impact of contribution to the global carbon budget has been evaluated as Minor (1).

Applying Section 527E of the EPBC Act' to GHG emissions, the Yolla Infill Drilling activity does not involve the recovery of hydrocarbons for production. Accordingly, there are no Scope 3 GHG emissions associated with natural gas consumption/combustion which would be considered impacts of the activity. This is consistent with previous NOPSEMA accepted drilling activities (NOPSEMA 2022).

7.3.4 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 associated with the emissions from this activity. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding atmospheric emissions from this activity. As the impact consequence is rated as Minor (1) applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good practice control measures**
MO 97: Marine Pollution Prevention – Air Pollution	Vessels and MODU 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.
Preventative Maintenance System	Combustion equipment shall be maintained in accordance with manufacturer's specification as detailed within the preventative maintenance system.
Burner head selection	Use of environmentally friendly burner head which maximises combustion of hydrocarbon and eliminates drop out through use of shuttle valves. Condensate is pumped to the burner manually via holding vessel to maintain control of volumes and velocities of fluid flow.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	NA
Acceptability assessment	
To meet the principles of ESD	Atmospheric emissions were assessed as having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with atmospheric emissions. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.
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 atmospheric emissions.
Other requirements	Atmospheric emissions are managed in accordance with: • Marine Order 97 • MARPOL 73/78. No environmental management plans, conservation advice or recovery plans were identified as relevant to this aspect.
Monitoring and review	Diesel use and flaring volumes shall be recorded and reported as detailed within Section 8.12.1.1 of this EP.

	Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.	
Acceptability outcome	**Acceptable**	
Environmental performance outcome	**Environmental performance standard**	**Measurement criteria**
No significant reduction in air quality caused by atmospheric emissions produced during the activity. .	**MO 97: Marine Pollution Prevention – Air Pollution** Very low sulphur fuel oil (VLSFO) (e.g., maximum 0.50 % S VLSFO-DM, maximum 0.50 % S VLSFORM) shall be used in support vessels from 1st January 2020. Vessels with diesel engines> 130 kW must be certified to emission standards (e.g., International Air Pollution Prevention [IAPP]). Vessels 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
	Preventative Maintenance System Power generation and propulsion systems on the vessels and MODU will be operated in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation. Equipment used to treat planned discharges shall be maintained in accordance with manufacturer's specification as detailed within the preventative maintenance system.	PMS records
	Flare Tip Selection The selected flare tip shall include shuttle valves to maximise combustion of hydrocarbon and minimise the chance of 'drop out' of non-combusted hydrocarbons.	Flare tip design

7.4 Underwater sound emissions

7.4.1 Establish the context

During normal operations the vessels will generate continuous sound emissions from propeller cavitation, thrusters, hydrodynamic flow around the hull, and operation of machinery and equipment.

Underwater sound emissions from MODUs primarily originate from on-board equipment vibrations, although some emissions are transmitted directly into the water through vibration of the drill string, installation of the conductor and from interaction between the drill bit and the seafloor (Austin, Hannay and Broker 2018). With the exception of conductor installation, all sound sources are continuous. Conductor installation will result in noise emissions for approximately 4-8 hours (Section 4.5.1).

Underwater sound can be propagated by helicopters during take-off and landing from the MODU. Given the nature of helicopter operations (i.e., crew transfers) covered under this EP, exposure from this source for an extended period (e.g., 12 or 24 hours) is not credible, and as such this assessment focused on underwater sound generated from vessel and MODU activities.

7.4.2 Underwater sound characterisation

7.4.2.1 Continuous sound emissions

JASCO Applied Sciences (JASCO) were contracted to undertake a modelling study of underwater sound levels associated with the drilling activity. The modelling considers specific components of the activity within the Operational Area. The modelling report (JASCO 2022) is available in Appendix E.

The study considered the following relevant activities:

- operational noise from an offshore platform
- drilling noise from a stationary jack-up drill rig
- vessel noise from a Platform Support Vessel (PSV) conducting resupply operations under directional positioning (DP).

Four scenarios were modelled, as detailed in Table 7-3.

Table 7-3 Description of modelling scenarios

Scenario	Description
1	Yolla Platform Operations
2	Yolla Platform Operations + Noble Tom Prosser Jack-Up Drilling
3	Yolla Platform Operations + Tom Prosser Jack-Up Drilling + OSV under DP conducting Resupply Ops (4 h)
4	Yolla Platform Operations + OSV under DP conducting Resupply Ops (4 h)

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

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

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. 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 if it remained in that location for 24 hours. More realistically, cetaceans (as well as fish and turtles) would not be expected to stay in the same location for 24 hours, however given the proclivity for pinnipeds to reside around the Yolla-A platform for extended periods, they are the most at risk from prolonged exposure.

The Endeavor jack-up rig was used as a proxy source for the Yolla-A platform, due to the similarities between a jack-up rig and a small well head platform like Yolla. At this stage, the exact vessel specifications as well as the precise operational scenarios are not known. As such, estimates of the source levels for the PSV operations were based on a generic PSV. Specifically, the source level and spectrum used to represent any of these vessels was based upon potential nominal specifications presented below.

The main propulsion system will have two aft propellers, with the following specifications likely:

- 3.2 m propeller diameter,
- 165 rpm nominal propeller speed, and
- 2200 kW maximum continuous power input.

Additional thruster modules active during DP operations include two bow tunnel thrusters and a single bow azimuth thruster. The two bow tunnel thrusters could have the following specifications:

- 2.0 m propeller diameter,
- 318 rpm nominal propeller speed, and
- 1000 kW maximum continuous power input.

The bow azimuth thruster could have the following specifications:

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

Source levels were then calculated by Jasco in accordance with Appendix E (JASCO 2022).

Thresholds

Southall et al. (2019) has assigned species of marine mammals (cetaceans and pinnipeds)to one of six functional hearing groups based on behavioural psychophysics, evoked potential audiometry and auditory morphology. Sirenians are not expected within the operational are or EMBAs and therefore these are not discussed further. Cetacean species have been grouped as low frequency , high frequency, and very high frequency.

Different species groups perceive and respond to sound differently, and so a variety of thresholds for the different types of impacts and species groups are considered. Beach have selected the following noise effect thresholds, based on current best available science, for use in the impact assessment:

- frequency-weighted SEL_{24h} for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals for impulsive and continuous noise (Southall, Finneran, et al. 2019, NMFS 2018)
- un-weighted SPL for behavioural threshold for marine mammals for continuous noise (NOAA 2019)
- frequency-weighted SEL_{24h} for the onset of PTS and TTS in marine turtles for continuous noise (Finneran, et al. 2017)
- sound exposure guidelines for fish, eggs and larvae (Popper, et al. 2014).

The selected noise effect thresholds are shown in Table 7-4. The frequency weight SEL_{24h} is a cumulative metric that assumes a receptor is consistently exposed to the relevant noise effect criteria for a 24-hour period.

It is noted that PTS is considered injurious in marine mammals, but there are no published data on the sound levels that cause PTS in these animals. Onset levels of PTS are typically extrapolated from TTS onset levels and assumed growth functions (Southall, Bowles, et al. 2007). Recent Commonwealth guidance has defined “injury to blue whales” as both PTS and TTS hearing impairment, as well as any other form of physical harm arising from anthropogenic sources of underwater noise (DAWE 2021a).

Table 7-4 Noise effect thresholds for continuous sound for different types of impacts and species groups

Receptor	Mortal or potential mortal injury	Recoverable injury	Permanent threshold shift	Temporary threshold shift	Masking	Behavioural
Low frequency cetaceans	N/A	N/A	SEL_{24h}: 199 dB re 1 µPa2s	SEL_{24h}: 179 dB re 1 µPa2s	N/A	SPL: 120 dB re 1 µPa
High frequency cetaceans	N/A	N/A	SEL_{24h}: 198 dB re 1 µPa2s	SEL_{24h}: 178 dB re 1 µPa2s	N/A	SPL: 120 dB re 1 µPa
Very high frequency cetaceans	N/A	N/A	SEL_{24h}: 173 dB re 1 µPa2s	SEL_{24h}: 153 dB re 1 µPa2s	N/A	SPL: 120 dB re 1 µPa
Marine turtles	N/A	N/A	SEL_{24h}: 220 dB re 1 µPa2s	SEL_{24h}: 200 dB re 1 µPa2s	N/A	N/A
Fish (no swim bladder) (relevant to sharks)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	N/A	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish (swim bladder not involved in hearing)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	N/A	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish (swim bladder involved in hearing)	(N) Low (I) Low (F) Low	SEL48h: 170 dB	N/A	SEL_{12h}: 158 dB	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae (relevant to plankton)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	N/A	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Phocid pinnipeds	N/A	N/A	SEL_{24h}: 201 dB re 1 µPa2s	181	N/A	SPL: 120 dB re 1 µPa
Other marine carnivores	N/A	N/A	SEL_{24h}: 219 dB re 1 µPa2s	199	N/A	SPL: 120 dB re 1 µPa

Relative risk (high, moderate, low) is given for fauna at three distances from the source (near [N], intermediate [I] and far [F]).

Modelling results

Table 7-5 presents the maximum and 95 % distances to SPL isopleths. Table 7-6 presents the maximum distances to frequency-weighted SEL_{24h} thresholds, as well as total area exposed to sound.

Table 7-5 Maximum (R_{max}) and 95 % ($R_{95\%}$) horizontal distances (in km) to sound pressure level

SPL (L_p; dB re 1 µPa)	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
180	–	–	–	–	0.01	0.01	0.01	0.01
170[6]	–	–	–	–	0.03	0.03	0.03	0.03
160	–	–	0.02	0.02	0.11	0.11	0.11	0.11
158[7]	–	–	0.08	0.08	0.11	0.11	0.11	0.11
150	0.02	0.02	0.10	0.10	0.12	0.11	0.12	0.11
140	0.02	0.02	0.10	0.06	0.50	0.47	0.49	0.46
130	0.03	0.03	0.39	0.37	2.23	1.95	2.00	1.87
120[8]	0.16	0.16	2.14	2.06	6.20	5.85	5.94	5.55
110	0.81	0.77	8.08	7.67	17.8	16.9	15.5	14.6

Note: A dash indicates the threshold is not reached within the limits of the modelled resolution (20 m). A slash indicates that $R_{95\%}$ is not reported when the R_{max} is greater than the maximum modelling extent.

Table 7-6 SEL thresholds and predicted distances and areas

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa^2·s)	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
		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									
Low-Frequency cetaceans	199	–	–	0.08	/	0.11	/	0.11	/
High-frequency cetaceans	198	–	–	0.08	/	0.11	/	0.11	/
Very High-frequency cetaceans	173	0.02	/	0.10	/	0.12	0.01	0.12	/
Otariid seals	219	–	–	–	–	–	/	–	/
Marine turtles	220	–	–	–	–	0.01	/	0.01	/
TTS									
Low-Frequency cetaceans	179	0.03	/	0.17	0.08	0.49	0.58	0.35	0.34
High-frequency cetaceans	178	0.02	/	0.10	/	0.12	/	0.12	/
Very High-frequency cetaceans	153	0.28	0.22	0.44	0.47	0.55	0.81	0.47	0.57
Otariid seals	199	–	–	0.08	/	0.11	/	0.11	/
Marine turtles	200	–	–	0.08	/	0.11	/	0.11	/

[6] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper, et al. 2014)
[7] 12 hour threshold for TTS for fish with a swim bladder involved in hearing (Popper, et al. 2014)
[8] Threshold for marine mammal behavioural response to non-impulsive noise (NOAA 2019)

Note: A dash indicates the threshold is not reached within the limits of the modelled resolution (20 m). A slash indicates that $R_{95\%}$ is not reported when the R_{max} is greater than the maximum modelling extent.

7.4.2.2 Impulsive sound emissions

As detailed in Section 4.5.1, impulsive sound emissions will arise for during conductor installation for approximately 4-8 hours. Given the nature and scale of these emissions and given the absence of quantitative modelling data for this emission source, Beach Energy reviewed studies of similar activities to understand the extent to which underwater sound levels would change.

Beach Energy reviewed outcomes of sound emission monitoring conducted during installation of several conductors at the Harmony Platform (MacGillivray 2018). Although this platform was located in deeper waters (365 m), it is considered sufficient to provide an indication of SPLs associated with this activity given activities are limited to 4-8 hours' worth of impulsive sound. During this program, underwater sound levels were measured at distances of 10–1475 m during driving conductors into the seabed. Levels were monitored through the deployment of Autonomous Multichannel Acoustic Recorders (AMAR) on oceanographic moorings around the Harmony platform and a heavy mooring buoy southeast of the platform (Table 7-7).

Table 7-7 Summary of Autonomous Multichannel Acoustic Recorders deployed at the Harmony Platform

AMAR	Hydrophones	Sampling rate (kHz)	Conductors recorded	Distance from source (m)	Hydrophone depth (m)	Water depth (m)
H	1	32/365	2-6	1475	430	436
S	1	48	2-3	380-395	20	380

Sound levels measured at different depths showed evidence of a shadow zone near the sea-surface. A summary of Mean per-pulse sound levels measured 380 m from the source and 1475 m from the source are provided in Table 7-8.

Table 7-8 Mean per-pulse sound levels measured on AMARs H and S during conductor driving activities

AMAR	Conductor Number	2	3	4	5	6
H	PK (dB re 1 uPa)	170.0	167.7	168.3	169.8	169.3
	SPL (dB re 1 uPa)	150.1	148.1	148.6	150.3	149.5
	SSEL (dB re 1 uPa^{2}s)	142.3	141.6	141.6	143.6	142.6
S	PK (dB re 1 uPa)	168.9	168.5	Not recorded		
	SPL (dB re 1 uPa)	151.9	151.7			
	SSEL (dB re 1 uPa^{2}s)	145.6	145.8			

Thresholds

Different species groups perceive and respond to sound differently, and so a variety of thresholds for the different types of impacts and species groups are considered. For impulsive sound levels, Beach have selected the noise effect thresholds detailed in Table 7-9, based on current best available science, for use in the impact assessment.

Table 7-9 Noise effect thresholds for impulsive sound for different types of impacts (Marine Mammals)

Receptor	Permanent threshold shift (NMFS 2018)		Temporary threshold shift (NMFS 2018)		Behavioural (NOAA 2019) SPL (Lp; dB re 1 µPa)
	Weighted SEL24h (LE,24h; dB re 1 µPa2 ·s)	PK (Lpk; dB re 1 µPa)	Weighted SEL24h (LE,24h; dB re 1 µPa2 ·s)	PK (Lpk; dB re 1 µPa)	
Low frequency cetaceans	183	219	168	213	160
High frequency cetaceans	185	230	170	224	
Very high frequency cetaceans	155	202	140	196	
Phocid pinnipeds in wate	185	218	170	212	
Otariid pinnipeds in water	203	232	188	226	

Table 7-10 Noise effect thresholds for impulsive sound for different types of impacts (Fish) (Popper, et al. 2014)

Receptor	Mortality and Potential mortal injury	Impairment			Behavioural (NOAA 2019) SPL (Lp; dB re 1 µPa)
		Recoverable injury	TTS	Masking	
Fish (no swim bladder) (relevant to sharks)	>219 dB SEL24h or >213 dB PK	>216 dB SEL24h or >213 dB PK	>>186 dB SEL24h	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish (swim bladder not involved in hearing)	210 dB SEL24h or >207 dB PK	203 dB SEL24h or >207 dB PK	>>186 dB SEL24h	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish (swim bladder involved in hearing)	207 dB SEL24h or >207 dB PK	203 dB SEL24h or >207 dB PK	186 dB SEL24h	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae (relevant to plankton)	>210 dB SEL24h or >207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

7.4.3 Known and potential environmental impacts

Underwater noise emissions may result in a localised and temporary change in ambient underwater sound.

A change in ambient underwater sound may result in:

- behavioural disturbance
- auditory impairment, permanent threshold shift (PTS) and temporary threshold shift (TTS).

7.4.4 Consequence evaluation

7.4.4.1 Localised and temporary change in ambient underwater sound

Anthropogenic underwater sound emitted during vessel activities will result in a change in ambient sound levels. The rate of sound attenuation from the source is dependent on local sound propagation characteristics, including seawater temperature and salinity profiles, water depth, bathymetry and the geo-acoustic properties of the seabed.

A study involving the Endeavour Jack-up Rig, operating in Cook Inlet, was conducted by Illingworth and Rodkin (2014, referenced in JASCO 2022) during drilling activities. The results from the sound source verification indicated that sound generated from drilling or generators were below ambient sound levels.

Studies of underwater sound generated from propellers of offshore vessels when holding position indicate highest measured SPL up to 137 dB re 1 µPa and 120 dB re 1 mPa at 405 m and ~3-4 km from the sound source (R. McCauley 1998). When underway at ~12 knots vessel sound of 120 dB re 1 µPa was recorded at 0.5–1 km (R. McCauley 1998).

Given the details above, the consequence of petroleum activities under this EP causing a change in ambient underwater sound has been assessed as Minor (1).

7.4.4.2 Behavioural disturbance (continuous sound emissions)

Based upon the receptors located within the operational area, the following were considered at risk of behavioural impacts to underwater sound:

- Fish
- Marine Mammals.

An assessment of these receptors is provided below.

Fish

Continuous sound sources have been identified as a moderate risk of causing behavioural changes, a high risk of causing masking changes, within the near and intermediate vicinity of a sound source for all fish groups (Table 7-4).

As identified in Section 5.7.7, several marine species listed as threatened and/or migratory under the EPBC Act have the potential to occur within the Operational Area. Although the Operational Area overlaps with a distribution BIA for the White Shark, fish (including the White Shark) are expected to transit through the area, with no important behaviours (e.g., foraging, migrating, etc.) expected to occur.

Continuous sound of any level that is detectable by fishes can mask signal detection, and thus may have a pervasive effect on fish behaviour. However, the consequences of this masking and any attendant behavioural changes for the survival of fishes are unknown (Popper, et al. 2014). If fish are within the immediate vicinity of the sound source, behavioural responses are expected to be limited to an initial startle reaction before either returning to normal or resulting in the fish moving away from the area (Wardle, et al. 2001). It is expected that most fish (including sharks and rays) will exhibit avoidance behaviour from a sound source if it reaches levels that may cause behavioural or physiological effects.

As the Yolla-A platform has been operational for 15 years and has an exclusion zone around it to prevent vessel access and, subsequently, commercial fishing activities occurring, any localised indirect impacts to commercial fisheries are not expected. Based upon the risk profile in Table 7-4, and the sensitivities expected, only low level, localised short-term behavioural impacts to transient individuals have the potential to arise from these activities.

As such, Beach has ranked the consequence associated with this risk as Minor (1).

Marine Mammals

Based upon the threshold for marine mammal behavioural response to non-impulsive noise (NOAA 2019), acoustic modelling (Table 7-5) indicates that the maximum distance in any direction from the source to 120 dB re 1 µPa was 0.16-6.2 km (JASCO 2022).

As identified in Section 5.7.7, several marine species listed as threatened and/or migratory under the EPBC Act have the potential to occur within the region. The Operational Area also overlaps a pygmy blue whale distribution and foraging BIA, and the southern right whale known core range.

No additional whale BIAs were identified within a 6.2 km radius of the MODU.

The Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) and Guidance on key terms within the Blue Whale Conservation Management Plan (DAWE 2021a) 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 conservation plan details that shipping and industrial noise, which includes drilling activities, are classed as a minor consequence where individuals are affected but no affect at a population level. The conservation plan details that given the behavioural impacts of noise on pygmy blue whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences. The maximum extent of exposure is predicted to be a distance of 6.2 km from the MODU in which potential behavioural response could occur. Although individuals may move outside of the 6.2 km exposure area, as the foraging BIA is not restricted, and extends over a large area (Figure 5-), this activity would not displace species from outside of the BIA. As such any behavioural impacts would be limited.

The southern right whale current core coastal range overlaps with the operational are. As detailed in Section 5.7.70, there is the potential for southern right whales to be transiting through the area during May-June and September-November as they move to and from coastal aggregation areas. The southern right whale generally occupy shallow sheltered bays within 2 km of shore and within water depths of less than 20 m. Calves reside in shallow coastal waters, and as detailed in Section 5.7.7.6, the peak nursing / calving period is between June and October outside the planned schedule of this activity. As such, exposure to changes in ambient levels of underwater sound would not be expected.

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. The conservation plan details that given the behavioural impacts of noise on southern right whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences. The maximum extent of exposure is predicted to be 6.2 km from the MODU in which potential behavioural response could occur. Although individuals may move outside of the 6.2 km exposure area, as core coastal range is not restricted, and extends over a large area, this activity would not displace species to outside of this area. As such any behavioural impacts would be limited.

Consequently, only low level, localised short-term behavioural impacts to transient individuals have the potential to arise from these activities.

As such, Beach has ranked the consequence associated with this risk as Moderate (2)

7.4.4.3 Behavioural disturbance (impulsive sound emissions)

Based upon the receptors located within the operational area, the following were considered at risk of behavioural impacts to underwater sound:

- Fish
- Marine Mammals.

An assessment of these receptors is provided below.

Fish

Impulsive sound sources have been identified as a high risk of causing behavioural disturbance to fish with no swim bladder, fish with swim bladder not involved in hearing, and fish with swim bladder involved in hearing, within the near (tens of metres) vicinity of a sound Table 7-10.

Given the infrequent and short duration (e.g., 4-8 hours) associated with conductor installation, the limited spatial area of exposure to impulsive sounds above behavioural thresholds, the consequence of this risk event has been evaluated as Minor (1) due to the minor and localised disturbances that may occur to individuals.

Marine Mammals

Based upon the threshold for marine mammal behavioural response to non-impulsive noise (NOAA 2019), monitoring completed for a similar activity (Table 7-8Table 7-5) indicates that sound levels fall below 160 dB re 1 µPa within 380-395 m from the source (MacGillivray 2018).

This predicted ensonsifed area is within the caution and no approach zone distances to cetaceans required by vessels under the EPBC Regulations 2000, which further reduces the risk of any behavioural changes occurring.

Given the infrequent and short duration of impulsive activities associated with this EP (4-8 hours) the consequence of this risk has been evaluated as Minor (1) due to the minor and localised disturbances that may occur to individuals.

7.4.4.4 Auditory impairment, PTS and TTS (continuous)

Based upon the receptors located within the operational area, the following were considered at risk of auditory impairment, PTS and TTS to underwater sound:

- Fish
- Marine Mammals
- Marine Turtles.

An assessment of these receptors is provided below.

Fish

Continuous sound sources have been identified as low risk of causing injury or mortality to fish with no swim bladders, or those with bladders not involved in hearing (Table 7-4). Results from acoustic modelling indicates that the maximum radial distance in any direction from the source to a SEL_{48} threshold of 170dB re 1 µPa^2·s (for fish with a swim bladder involved in hearing) was 0.03 km and SEL_{24} threshold of 158 dB re 1 µPa^2·s (for fish with a swim bladder involved in hearing) was 0.11 dB re 1 µPa^2·s (Table 7-6).

As identified in Section 5.7.7.3, several fish species listed as threatened and/or migratory under the EPBC Act have the potential to occur within the Operational Area. However, the presence of these species is expected to be of a transitory nature only, with no important behaviours (e.g., foraging, migrating, etc.) expected to occur within the Operational Area. The Operational Area overlaps with a distribution BIA for the White Shark, however the Recovery Plan for the White Shark *(Carcharodon carcharias)* (DSEWPaC 2013a) does not identify noise impacts as a threat.

Given common behavioural responses in fish such as startle reaction and avoidance, any exposure to SPL or SEL levels are not expected to occur as individuals would be expected to avoid the area prior to exceeding noise exposure criteria. Given the nature of the activity and as behavioural responses are likely to prevent exceedance of criteria, any auditory impairment or injury is expected to be localised and only to individuals, and not affecting ecosystem functions.

As such, Beach has ranked the consequence associated with this risk as Minor (1).

Marine Mammals

Results from acoustic modelling indicates that the maximum radial distance in any direction from the source to a SEL_{24} threshold of 179 dB re 1 µPa²·s (for low frequency cetaceans) was 0.49 km, SEL_{24} threshold of 178 dB re 1 µPa²·s (high frequency cetaceans) was 0.12 km and SEL_{24} threshold of 199 dB re 1 µPa²·s (for Otariid seals) was 0.11 km (Table 7-6).

Low frequency (baleen whales [e.g., blue, fin, humpback, whales]) cetaceans have been identified as having the potential to be present within the Operational Area (Section 5.7.7) and the Operational Area overlaps with a pygmy blue whale distribution and foraging BIA, and the southern right whale known core range.

High frequency (e.g., dolphins, toothed whales) cetaceans and Otariid seals have been identified as having the potential to be present within the Operational Area (Section 5.7.7), however no sensitive or critical habitat for these species are present within Operational Area indicating that, if present, they are unlikely to display sedentary behaviours. As such this assessment will focus on low frequency cetaceans to provide a conservative risk assessment.

The activity is located within an open-water environment (i.e., not a confined migratory pathway) and receptors are required to be located within close proximity (<0.49 km) to the sound source for a period of time before impacts such as TTS or PTS occur. As cetacean species are expected to display transient (not sedentary) behaviours within the Operational Area, prolonged exposure would not be expected. As such, any auditory impairment or injury is expected to be localised and only to individuals, and would not be expected to result in population level impacts.

As such, Beach has ranked the consequence associated with this risk as Moderate (2).

Marine Turtles

As identified in Section 5.7.7, several turtle species listed as threatened and/or migratory under the EPBC Act have the potential to occur within the Operational Area. However, the presence of these species is expected to be of a transitory nature only, with no important behaviours (e.g., foraging, internesting, etc.) expected to occur within the Operational Area. No BIAs or critical habitat for the listed species overlaps with the Operational Area.

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. No important habitats for marine turtles are known to be present or exposed to sound emissions from this activity.

Popper et al. (2014) details that there is no direct evidence of mortality or potential mortal injury to sea turtles from ship noise. 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 the MODU, 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 (tens 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 (2 km). Finneran et al. (2017) presented revised thresholds for turtle PTS and TTS for continuous sound. Under these thresholds, PTS were not predicted to occur within the modelling resolution (Table 7-6). The TTS threshold would be met within 0.11 km of the sound source (Table 7-6).

Given the nature of the activity and as behavioural responses are likely to prevent exceedance of criteria, any auditory impairment or injury is expected to be localised and only to individuals, and not affecting ecosystem functions.

As such, Beach has ranked the consequence associated with this risk as Minor (1).

7.4.4.5 Auditory impairment, PTS and TTS (impulsive)

Based upon the receptors located within the operational area, the following were considered at risk of auditory impairment, PTS and TTS to underwater sound:

- Fish
- Marine Mammals

An assessment of these receptors is provided below.

Fish

The SEL24h effect criteria for TTS or PTS for all fish hearing groups cannot be exceeded due the duration of the activity (4-8 hours).

Further to this, monitoring completed for similar activities indicates that PK sound emissions do not rise above impulsive noise effect threshold for this species group (MacGillivray 2018). As such, auditory impairments, or auditory injuries to fish from impulsive sound is not evaluated further.

Marine Mammals

The SEL24h effect criteria for TTS or PTS for all marine mammal groups (i.e., low-frequency cetaceans, mid-frequency cetaceans, high-frequency cetaceans, or otariid seals) cannot be exceeded due the duration of the activity (4-8 hours).

Further to this, monitoring completed for similar activities indicates that PK sound emissions do not rise above impulsive noise effect threshold for this species group (MacGillivray 2018). As such, auditory impairments, or auditory injuries to marine mammals from impulsive sound is not evaluated further.

7.4.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Underwater noise emissions	
ALARP decision context and justification	**ALARP Decision Context: Type B** Impacts from underwater noise emissions are well understood and there is limited uncertainty associated with the level of impact associated with these emissions. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. The Yolla-A Platform is manned and been operational for over 15 years without any incidents reported of impacts to marine fauna from underwater sound emissions. In addition to this, the Operational Area is located adjacent to a high use shipping route with no publicly reported incidents of impacts to marine fauna from underwater sound emissions. No objections or claims were raised by stakeholders in relation to underwater noise emissions. Although the impact consequence is rated as Moderate (2) and applying good industry practice control measures (as defined in Section 6.7.2.1) is considered sufficient to manage the impact to ALARP, the activities are located within an area that overlaps a pygmy blue whale known foraging BIA, and the southern right whale known core range. Under the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) Conservation Management Plan for the Southern Right Whale (DSEWPaC 2012a), underwater sound is identified as a threat to the species. Consequently, an ALARP Decision context Type B has been selected for this aspect.
Adopted Control Measures	**Source of good practice control measures**
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. All vessels 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. This will be implemented for all whales at all times with the exception of a foraging whale, a pygmy blue whale and a southern right whale for which the safe operating distance will be increased to 1.2 km.

		Helicopters will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. Helicopters will not fly lower than 1650 ft when within 500 m horizontal distance of a cetacean except when landing or taking off and will not approach a cetacean from head on.	
Additional controls assessed			
Control	**Control Type**	**Cost/Benefit Analysis**	**Control Implemented?**
Conduct drilling activities outside of peak SRW and Pygmy blue whale presence	Substitute	Based upon the known temporal occurrence of the Southern Right Whale and the Pygmy blue whales (Table 5-12) it is not feasible to conduct drilling activities outside of both of the peak periods for these species given SRW are present over the winter months and Pygmy blue whales are present over the summer months. Given the physical environment within the operational area, the proposed drilling window coincides with the required weather window for drilling activities (as detailed in Section 4.3) which is planned to commence in Q4 and continue to Q2 based upon a 130 day program. As such the SRW peak period can be avoided but Pygmy blue whale cannot, and it is not feasible to plan the activity outside of the Pygmy blue what peak period given the weather window that will enable the activities to be taken out with the lowest HSE risk profile possible.	No
Whale Management Standard Operating Procedure	Administration	The development and implementation of a whale management standard operating procedure provides an adaptive approach for minimising anthropogenic noise threats to all whales to ensure impacts and risks are reduced to ALARP. The plan specifically covers including: • pre-mobilisation and pre-resupply survey vessels, and • safe operating distances The plan also details clear Safe Points to be followed before commencing an activity (such as mobilisation and demobilisation of the MODU). Safe points ensure, the activity can be undertaken in a safe manner to achieve its desired outcomes, whilst minimising potential environmental impacts.	Yes
Marine mammal observers (MMO)	Administration	Through utilising MMOs on each vessel, observations can accurately identify whales up to 3 km. As support vessels move around the MODU, the MMO will be able to observe towards and away from the MODU thus increasing observation distances. MMO's will enable suitable implementation of the Drilling Whale management procedure. In addition: • each vessel crew who acts as Office of the Watch will receive training from the MMO in whale observation and distance estimation • an additional MODU crew member will receive training from the MMO in whale observation and distance estimation to allow continuous daytime observations to be undertaken • as part of the activity induction all vessel and MODU crew will receive information on the EP noise controls and the importance of reporting whale sightings to the vessel MMO immediately. This will have a cost to Beach but ensures potential impacts to whales that may be undertaking biologically important behaviours are managed to an acceptable level. As such the costs are grossly disproportionate to the level of risk reduction achieved.	Yes
Other forms of monitoring	Administration	In addition to MMOs, on board the vessel, other options are available to monitoring for the presence of marine mammals in proximity of the MODU. These include: • Satellite observation has been considered however the technology is considered unreliable for the purpose of whale	No

	behaviour identification thus no environmental benefit achievable regardless of the cost. • Drone Surveys have been considered as a method of increasing the observation distance of MMOs. However, as MMOs will be present on all vessels and the MODU the extended distance from using drones provides negligible observation benefit. The additional cost, safety liabilities, and operational limitations are disproportionate to the level of risk reduction achieved. • Passive acoustic monitoring 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. As this technique has limited utility in detecting lower frequency calls of baleen whales (such as blue whales) especially when in the presence of constant background low frequency noise such as that generated by the MODU and vessel(s) towing the PAM system, the level of risk reduction is considered grossly disproportionate to the cost of implementing such techniques.
Consequence rating	Moderate (2)
Likelihood of occurrence	NA
Residual risk	NA
Acceptability assessment	
To meet the principles of ESD	Noise emissions were assessed as having a Moderate (2) 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	Underwater sound emissions are to be managed in consideration with: • EPBC Regulations 2000 – Part 8 Division 8.1 – Interacting with cetaceans. With the controls in place, the activity was not deemed to be inconsistent with the following management plans, conservation advice or recovery plans: • Conservation Management Plan for the Blue Whale 2015–2025 (Commonwealth of Australia 2015b) • Conservation Advice Megaptera novaeangliae Humpback Whale (TSSC 2015a) • Conservation Advice Balaenoptera borealis Sei Whale (TSSC 2015c) • Conservation Advice Balaenoptera physalus Fin Whale (TSSC 2015d) • Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017b) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA 2008b).
Monitoring and review	As detailed within Section 8.12.1.1 of this EP, MMOs will be present for the duration of this activity. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.
Acceptability outcome	**Acceptable**

Environmental performance outcome	Environmental performance standard	Measurement criteria
No death or injury to fauna, including listed threatened or migratory species, from the activity. Noise emissions in BIAs will be managed such that any whale, including blue	**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:	Project induction DAWE cetacean sighting sheets

whales, continues to utilise the area without injury, and is not displaced from a foraging area.	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, with the exception of a foraging whale, a blue whale and a southern right whale, specifically iv. do not approach a whale v. maintain a distance of 300 m from a whale vi. if a whale 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 vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with a foraging whale, a blue whale and a southern right whale, specifically: vii. do not approach a whale viii. maintain a distance of 1.2 km from a whale ix. if a whale approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal. Helicopters will not fly lower than 1650 ft when within 500 m horizontal distance of a cetacean except when landing or taking off and will not approach a cetacean from head on.	
	Drilling Whale Management Standard Operating Procedure Pre-start actions, start criteria, and noise control actions as detailed in the Whale management Standard Operating Procedure (Appendix F) will be used adaptively manage underwater sound emissions in the field.	Daily report MMO reports
	MMO There will be two MMO's on each support vessel. As part of the activity induction all vessel and MODU crew will receive information on the EP noise controls and the importance of reporting whale sightings to the vessel MMO immediately.	MMO CV MMO reports Training records Induction package Induction records

7.5 Physical presence (marine fauna)

7.5.1 Establish the context

The physical presence and use vessels can lead to collision with marine fauna. The potential for unplanned interactions with marine fauna is limited to within the Operational Area. The duration of exposure to physical presence is limited to the duration of drilling activities, which is expected to be approximately 130 days.

7.5.2 Known and potential environmental impacts

Physical interaction with marine fauna may result in injury or death.

7.5.3 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
- 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.

Species at risk for vessel strike with BIAs present in the Operational Area (and therefore with an increased risk of exposure) include:

- blue whale (foraging and distribution)
- southern right whale (known core range)
- white shark (distribution).

Three marine turtle species may occur within the Operational Area (as per Section 5.7.7.5) 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) identifies vessel disturbance as a key threat; however, it also notes that this is particularly an issue in shallow coastal foraging habitats. Given vessel activity is limited to within the Operational Area and is not located in shallow water, vessel disturbance to turtles is not evaluated further.

Both the 'Conservation Management Plan for the Southern Right Whale' (DSEWPaC 2012a) and the 'Conservation Management Plan for the Blue Whale' (Commonwealth of Australia 2015b) indicates that either vessel disturbance or interaction (such as collisions) as a key threat to the recovery of the species. However, as the MODU will be next-to the Yolla-A platform, the potential for interaction with fauna is limited to MODU supply activities from support vessels.

Cetaceans are naturally inquisitive marine mammals that are often attracted to offshore vessels. The reaction of whales to the approach of a vessel is quite variable. Some species remain motionless when near a vessel, while others are curious and often approach vessels that have stopped or are slow moving, although they generally do not approach, and sometimes avoid, faster-moving vessels (W. J. Richardson, et al. 1995). 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. There have been recorded instances of cetacean deaths in Australian waters (e.g., a Bryde's whale in Bass Strait in 1992) (WDCS 2006), although the data indicates deaths are more likely to be associated with container ships and fast ferries. However, 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 a fauna strike occurred and resulted in death, it is not expected that a single individual would have a detrimental effect on the overall population, suggesting this event would result in a limited environmental impact.

Consequently, Beach have ranked the consequence as Minor (1).

7.5.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Physical presence (marine fauna)	
ALARP decision context and justification	**ALARP Decision Context: Type A** The risk to marine fauna from physical presence is well understood and there is nothing new or unusual associated with these activities. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding physical presence and marine fauna from this activity As the risk is rated as Low applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good practice control measures**
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.
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 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: (Commonwealth of Australia 2017a, Weinrich 2004). 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	Minor (1)
Likelihood of occurrence	Highly Unlikely (2)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with the potential for fauna strike. A vessel collision with marine fauna was assessed as having a Moderate (2) consequence which is not considered as having the potential to result in serious or irreversible environmental damage (or impacts to wider populations). Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.
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 vessel collision with marine fauna.
Other requirements	Interactions with marine fauna are managed in accordance with: • EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans The activity was not deemed to be inconsistent with the following plans, conservation advice or recovery plans: • Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC 2015c) • Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC 2015d) • Conservation Management Plan for the Blue Whale 2015–2025 (Commonwealth of Australia 2015b)

	• Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017b) • Recovery Plan for the White Shark (DSEWPaC 2013a) • Conservation Management Plan for the Southern Right Whale' (DSEWPaC 2012a) • Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). Further to this, the EP has evaluated the risks of fauna strike in accordance with: • Approved Conservation Advice for Balaenoptera borealis (Sei Whale) (TSSC 2015c) • Approved Conservation Advice for Balaenoptera physalus (Fin Whale) (TSSC 2015d) • Conservation Management Plan for Eubalaena australis (Southern Right Whale) (DSEWPaC 2012a) and deemed the risk to be low.
Monitoring and review	Assurance requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.
Acceptability outcome	**Acceptable**

Environmental performance outcome	Environmental performance standard	Measurement criteria
No death or injury to fauna, including listed threatened or migratory species, from the activity	**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, with the exception of a foraging whale, a blue whale and a southern right whale, 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. Vessel operators shall adhere to the vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with a foraging whale, a blue whale and a southern right whale, specifically: iv. do not approach a whale v. maintain a distance of 1.2 km from a whale vi. if a whale approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal. Helicopters will not fly lower than 1650 ft when within 500 m horizontal distance of a cetacean except when landing or taking off and will not approach a cetacean from head on.	Project induction DAWE cetacean sighting sheets
	Vessel speed restrictions Vessel speeds within the Operational Area will be restricted to 10 knots.	Project induction Vessel log

7.6 Physical presence (marine users)

7.6.1 Establish the context

The physical presence of the MODU and support vessels can result in physical interaction or the displacement of other marine users.

7.6.2 Known and potential environmental impacts

The physical presence of the MODU and support vessels can result in the interaction or displacement of other marine users such as:

- disruption to recreation and tourism
- commercial shipping
- commercial fishing.

7.6.3 Consequence evaluation

The duration of potential disruption to commercial activities is limited to the length of the drilling activity, which, based on the scope and estimated time frames described in Section 4.3, is expected to be approximately 130 days.

The physical presence of the MODU and support vessels could result in disruption to marine users. However, as a PSZ is established around the Yolla-A platform preventing access to the area in which the MODU is positioned, any disruption to other marine users will be limited to the presence of support vessels. As discussed in Section 5.8.4, marine tourism and recreation in the Bass Strait is primarily located along the coast. As the Operational Area is located over 80 km from the coast and considering the Operational Area accounts for a small proportion of the Bass Strait region, limited tourism and recreation vessels are expected to be impacted.

Bass Strait is one of the busiest shipping routes in Australia. The Operational Area is close to two minor shipping lanes, as detailed in Section 5.8.3. In addition to this, several commercial fisheries have management areas and recent fishing effort recorded adjacent to the Yolla-A platform (Section 5.8.5, Section 5.8.7 and Section 5.8.8,). MODU and vessel activities associated with the BassGas development have been ongoing with production at the facility commencing in 2006. To date, there has been no interactions or incidents with other vessels. This activity will not result in any new deviation requirements or displacement impacts as a PSZ is currently in place for the Yolla-A platform. Consequently, the activity is not expected to impact on the functions, interests, or activities of other marine users (as confirmed by stakeholder consultation records).

In summary, the physical presence of the MODU and support vessels is not expected to cause significant impacts to other marine users, and the risks are considered limited with potential consequences. Therefore, Beach has ranked the potential consequence to other marine users from physical presence as Minor (1).

7.6.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Physical presence (marine users)	
ALARP decision context and justification	**ALARP Decision context: Type A** Impacts from physical presence are well understood and there is nothing new or unusual associated with this activity. These activities and their mitigation are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding physical presence from this activity. As the risk is rated as Low, applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP

Adopted Control Measures	Source of good practice control measures
Ongoing 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.
	Engagement with AMSA requested that the jack-up MODU rig notify AMSA's Joint Rescue Coordination Centre (JRCC) for promulgation of radio-navigation warnings 24-48 hours before operations commence. AMSA's JRCC will require the jack-up MODU rig details including: • name • callsign • Maritime Mobile Service Identity (MMSI)) • satellite communications details (including INMARSAT-C and satellite telephone) • area of operation • requested clearance from other vessels and • operations start and end dates
	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. Engagement with AMSA requested the Australian Hydrographic Office be contacted through datacentre@hydro.gov.au no less than four working weeks before operations commence for the promulgation of related notices to mariners.
Permanent Petroleum Safety Zone (PSZ)	PSZs, administrated by NOPSEMA under the OPGGS Act, are specified areas surrounding petroleum wells, structures or equipment which vessels or classes of vessel are prohibited from entering or being present in. Applicants of a PSZ must demonstrate effective consultation with parties which may be directly impacted.
Fair Ocean Access Procedure	Beach's Fair Ocean Access Procedure (CDN/ID 18987651) was developed and provided to fishers who have identified that they may be potentially impacted. The protocol was developed based on feedback from consultation with the fishers who have identified they could be potentially impacted.
Consequence rating	Minor (1)
Likelihood of occurrence	Remote (1)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with disturbance to other marine users. Impacts to other marine users as a result of physical presence was assessed as having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.
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	Engagement with AMSA noted there is predominately support and cargo craft directly surrounding the gas field, and that there is fishing vessels and passenger/ferry routes present west of the Yolla platform. However, with the exception of the request to implement standard navigational controls and notifications, no objections to the activities were raised. These controls have been included in this EP. There have been no stakeholder objections or claims regarding physical presence.
Other requirements	Physical displacement is managed in accordance with: • Commonwealth *Navigation Act 2012.* No environmental management plans, conservation advice or recovery plans were identified as relevant to this aspect.

Monitoring and review	Monitoring of potential impacts to marine users is detailed within Section 8.12.1.1 of this EP. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.	
Acceptability outcome	**Acceptable**	
Environmental performance outcome	**Environmental performance standard**	**Measurement criteria**
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.	**Ongoing consultation** Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 9 (Stakeholder Consultation). This includes: • AMSA's Joint Rescue Coordination Centre (JRCC) will be notified 24-48 hours before operations commence • The AHO will be contacted through datacentre@hydro.gov.au no later than four weeks before operations commence.	Notification records Communication records
	Permanent PSZ The currently established permanent PSZ shall be maintained at the Yolla-A platform that includes the MODU location	PSZ Gazetted Notice
	Fair Ocean Operating Procedure Beach's Fair Ocean Operating Procedure (CDN/ID 18987651) shall be implemented with Fishers who have identified they fish in the area of the well locations.	Notification records Communication records

7.7 Benthic disturbance

7.7.1 Establish the context

Benthic disturbance can occur where there is interaction with the seabed. Specifically, for the activities detailed in this EP (Section 4), benthic interaction will occur from the MODU spud-cans, planned release of drill cuttings and cement and any contingent wet parking or storing equipment on the seabed.

In addition to this, leg jetting during the demobilisation of the MODU will result in a direct seabed disturbance. However, any jetting will occur within the existing depressions to loosen the substrate around the spud cans.

7.7.2 Known and potential 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.

7.7.3 Consequence evaluation

The extent of benthic disturbance is estimated to be approximately 0.785 km^2 within the Operational Area, as detailed in Table 7-11. For this assessment an area of 0.8 km^2 is used to provide a conservative estimate of the area of impact. It should be noted that anchors may impact an area outside of the 500 m however it is expected if they are required, they will be set within the operational area.

Table 7-11 Activities that will result in benthic disturbance

Activity	Description	Area of impact (km^2)
MODU positioning / spud-cans	For this infill drilling activity, the spud cans will be situated in existing depressions from the previous program to minimise disturbance.	NA
MODU positioning anchors	Although a contingency, Beach may require the MODU to set temporary anchors in place prior to moving alongside the Yolla-A platform to control the mobilisation when adjacent to the platform.	0.0013 (NERA 2018)
MODU demobilisation	The leg jetting system comprises pumping seawater at pressure down the legs of the MODU to loosen the sediment around the spud cans. These activities can take a couple of days.	NA
Drill cuttings and cement discharges	Drill cuttings and cement discharges may be present up to 500 m from the well site (see Section 7.9 and 7.10).	0.785
RoV operations	The ROV may be temporarily parked on the seabed. This would cover an area of 2 m^2. This would be within the area drill cuttings and cement discharges may potentially impact the seabed (500 m from the well site).	NA
	Total	0.785

Surveys of the seabed around the Yolla-A platform have verified the three depressions located on the east side of the platform that were formed from the spud cans of the jack-up drill rig that drilled the Yolla-5 and -6 wells (see Section 5.6.4.2) are still present. The 36 m diameter depressions are preserved in a clay seabed base. Surveys indicate that the total depression volume has not substantially changed over the course of surveys conducted between 2007 and 2019 (Section 5.6.4.2).

As described in Section 5.6.4.2, the seabed at Yolla-A platform has very soft to soft alternating layers of silty carbonate clay and silty sands. The soft sediment benthic habitat is moderately abundant in the region. No KEFs or TECs were identified within the 0.8 km^2 area of impact. Geotechnical surveys conducted in the area did not identify hard substrate or features.

If soft sediment communities are impacted, any damage would be limited to incidental temporary disturbance given the small extent of impact, limited use in the area, and similarity of surrounding habitat. When the potential disturbance footprint of the impact area (0.8 km^2) is considered against the widespread distribution of soft sediment infauna communities, the potential disturbance is highly localised. As Beach Energy plan will position the spud cans in the existing depressions, no longer term impacts to the benthic profile are expected.

Given the potential impacts are limited to low level, localised benthic disturbance, Beach have ranked the consequence as Minor (1).

7.7.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Benthic disturbance	
ALARP decision context and justification	Impacts from benthic disturbance are well understood and there is nothing new or unusual associated with these activities. The activities resulting in benthic disturbance are well practised, and there are no conflicts with company values, no partner interests, and no significant media interests. There were no objections from stakeholders regarding benthic disturbance from this activity. As the impact consequence is rated as Minor (1) applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP
Adopted Control Measures	**Source of good practice control measures**

Spud-can location	Spud cans will be situated in existing depressions from the previous program to minimise disturbance. Specifically, the MODU selection process considered compatibility with existing spud can depressions to reduce benthic disturbance.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	NA
Acceptability assessment	
To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with benthic disturbance. Benthic disturbance was assessed as having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.
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 legislation, environmental management plans, conservation advice or recovery plans were identified as relevant to this aspect.
Monitoring and review	Impacts associated with benthic disturbance are over a small area and not expected to result in impacts to protected or commercially important receptors. Therefore, the monitoring is not proposed. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.
Acceptability outcome	**Acceptable**

Environmental performance outcome	Environmental performance standard	Measurement criteria
Seabed and associated biota disturbance will be less than 0.8 km^2 and within the Operational Area.	**Spud-can location** MODU compatibility reviewed and MODU selected to ensure that spud cans will be situated in existing depressions from the previous program.	Drilling report MODU selection process

7.8 Planned marine discharges – waste waters and putrescible waste

7.8.1 Establish the context

The vessels and MODU have planned marine discharges within the Operational Area. These discharges include cooling water, brine, bilge water, deck drainage, putrescible waste, sewage and grey water. A summary of the discharges associated with the activity are provided in Table 7-12.

Table 7-12 Discharges of waste waters and putrescible waste from MODU and a single support vessel within the Operational Area

Discharge type	Predicted volume	Predicted concentration	Duration
Putrescible waste	310 kg/day	N/A	Intermittent discharge for 64 to 100 days during drilling and 30 days per well abandonment
Sewage and grey water	70 m^3/day	N/A	
Cooling water	4,800 m^3/day	N/A	Constant for 64 to 100 days during drilling and 30 days per well abandonment

Discharge type	Predicted volume	Predicted concentration	Duration
Bilge water	Limited to holding capacity of bilge – either MODU or vessel	Treated to 15 ppm	Infrequent for 64 to 100 days during drilling and 30 days per well abandonment
RO Brine	168 m^3/day	Typically, 20 % to 50 % higher in salinity than the intake seawater	Intermittent discharge for 64 to 100 days during drilling and 30 days per well abandonment
		Low concentrations of scale inhibitors and biocides	

7.8.2 Known and potential 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.

7.8.3 Consequence evaluation

7.8.3.1 Localised and temporary reduction to water quality

Open marine waters are typically influenced by regional wind and large-scale ocean current patterns resulting in the rapid mixing of surface and near-surface waters—where vessel discharges would occur (NERA 2017). Vessel and MODU discharges would occur in these surface and near-surface waters. A review of literature regarding offshore discharges indicate that these standard operational discharges will not accumulate due to the highly dispersive environment (NERA 2017).

Sewage discharge monitoring for another offshore project (Woodside Energy Ltd 2014), determined that a 10 m^3 sewage discharge reduced to ~1 % of its original concentration within 50 m of the discharge location. In addition, monitoring at distances 50 m, 100 m, and 200 m downstream, and at five different water depths, confirmed that discharges were rapidly diluted and no elevations in water quality monitoring parameters (e.g., total nitrogen, total phosphorous, and selected metals) were recorded above background levels at any station.

Monitoring of desalination brine of continuous wastewater discharges (including cooling water) undertaken by Woodside for its Torosa South-1 drilling program in the Scott Reef complex found that discharge water temperature decreases quickly as it mixes with the receiving waters, with the discharge water temperature being <1 °C above ambient within 100 m (horizontally) of the discharge point, and 10 m vertically (Woodside Energy Ltd 2014).

A vessel's bilge system is designed to safely collect, contain and dispose of oily water so that discharge of hydrocarbons to the marine environment is minimised or avoided. Bilge water is processed via an oil-water separator before being discharged to sea. Discharge is intermittent and occurs at or near surface waters. As such, oily bilge discharges are expected to readily dilute and disperse under the action of waves and currents in surface waters. In addition, once exposed to air, any volatile components of the oil will readily evaporate.

As a change to water quality is expected to readily disperse in the offshore marine environment and is limited to within a close proximity of the discharge location and returns to ambient levels rapidly following completion of the discharge, no lasting effects are expected. As such, Beach have ranked the consequence as Minor (1).

7.8.3.2 Changes to predator-prey dynamics

The overboard discharge of sewage and macerated food waste creates a localised and temporary food source for scavenging marine fauna or seabirds, whose numbers may temporarily increase as a result, thus increasing the food source for predatory species.

However, the rapid consumption of this food waste by scavenging fauna, and physical and microbial breakdown, ensures that the impacts of food waste discharges are insignificant and temporary and that all receptors that may potentially be in the water column are not impacted.

The values and sensitivities within the Operational Area with the potential to be affected by changes in predator–prey dynamics include:

- black-browed albatross (foraging)
- Bullers albatross (foraging)
- Campbell albatross (foraging)
- Indian Yellow-nosed albatross (foraging)
- wandering albatross (foraging)
- white-faced storm-petrel (foraging).

Although birds may to be attracted to these discharges, any attraction and consequent change to predator–prey dynamics is expected to be limited to close to the release and thus is expected to result in localised impacts to species. Effects on environmental receptors along the food chain—fish, reptiles, birds, and cetaceans—are not expected beyond the immediate vicinity of the discharge in open waters (NERA 2017). As such, Beach have ranked the consequence as Minor (1).

7.8.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Planned marine discharges – waste waters and putrescible waste	
ALARP decision context and justification	**ALARP Decision Context: Type A** Impacts from planned marine discharges are well understood and there is there is limited uncertainty associated with the level of impact associated with these emissions. These discharges are well managed through existing regulations, and there are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding planned marine discharges from this activity. As the impact consequence is rated as Minor (1) applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good practice control measures**
Hazardous Material Risk Assessment Process	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.
Commonwealth *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, putrescible waste, garbage, air pollution etc.
Preventative Maintenance System	Equipment to treat marine discharges such as bilge water, slops from deck drainage, sewage and food waste are maintained as per manufacturer's instructions to ensure efficient operation.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	NA
Acceptability assessment	

To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with these planned marine discharges. Planned marine discharges of waste waters and putrescible wastes were assessed as having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.	
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 are managed in accordance with: • Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* • Marine Order 91 • Marine Order 95 • Marine Order 96 • MARPOL 73/78 Annex I, IV and V. The activity was not deemed to be inconsistent with the following plans, conservation advice or recovery plans: • The Threat Abatement Plan for the impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean (Commonwealth of Australia 2018) • National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a) • Approved Conservation Advice for *Caldris cantus* (Red Knot) (TSSC 2016a) • Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (TSSC 2015e) • Approved Conservation Advice for *Halobaena caerulea* (Blue Petrel) (TSSC 2015g) • National Recovery Plan for *Neophema chrysogaste* (Orange-bellied Parrot) (DELWP 2016) • Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (TSSC 2015i) • Approved Conservation Advice for *Pachyptila tutur subantarctica* (Fairy Prion (southern)) (TSSC 2015h) • National Recovery Plan for *Pterodroma leucoptera* (Gould's Petrel) (DEC 2006) • Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged Petrel) (TSSC 2015k) • Draft National Recovery Plan for *Sternula nereis* (Australian Fairy Tern) (Commonwealth of Australia 2019) • Approved Conservation Advice for *Thalassarche chrysostoma* (Grey-headed Albatross) (DEWHA 2009).	
Monitoring and review	Impacts associated with planned marine discharges are limited to a small area within proximity of the MODU and not predicted to impact protected or commercially important receptors. Therefore, monitoring is not proposed. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.	
Acceptability outcome	**Acceptable**	
Environmental performance outcome	**Environmental performance standard**	**Measurement criteria**
No impact to water quality or sediment quality at a distance >500 m from each well from planned marine discharges	**Hazardous Material Risk Assessment Process** Chemicals that will be or have the potential to be discharged to the marine environment will meet the chemical acceptance criteria as per Beach's Chemical Management Plan(S4000AD719917), including: i. components of water-based drilling fluid (WBDF) ii. components of synthetic-based drill fluid (SBDF)	Completed and approved chemical assessment Register of approved chemicals

	iii. stock barite iv. cementing products hydraulic control fluids.	
	Commonwealth Protection of the Sea (Prevention of Pollution from Ships) Act 1983 Oil contaminated water from machinery space bilges 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 records
	Preventative Maintenance System Systems on the vessels and MODU will be operated in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation. Equipment used to treat planned discharges shall be maintained in accordance with manufacturer's specification as detailed within the preventative maintenance system.	PMS records

7.9 Planned marine discharges – brines, completion fluids, drilling cuttings and fluids

7.9.1 Establish the context

Drilling activities will result in a range of planned discharges which will be discharged to the marine environment at the surface and seabed, as described in Table 7-13.

Table 7-13 Discharges of brine, completion fluids, and drilling cuttings and fluids within the Operational Area

Discharge type	Predicted volume	Predicted concentration	Duration
Filtered completion fluids	~250 m^3	Total suspended solids (TSS) < 0.05 % and turbidity < 50 NTU.	Intermittent during completion activities
		Low concentrations of scale inhibitors and biocide	
Filtered packer fluids	~19 m^3	Total suspended solids (TSS) < 0.05 % and turbidity < 50 NTU.	Infrequent discharge during completion activities
		Low concentrations of scale inhibitors and biocide	
Filtered formation water	~450 m^3	Filtered formation water (30 ppm)	Infrequent discharge during completion activities
Filtered formation water interface	~56 m^3	Filtered formation water 30 ppm	
		Low concentrations of scale inhibitors and biocide	
Drilling cuttings and fluids	~238 m^3	Cuttings seabed discharge	Intermittent for 64 to 100 days (only whilst drilling is occurring) and for 30 days during abandonment activities
	~643 m^3	Cuttings surface discharge	
	~169 m^3 seabed discharge	Seawater and non-toxic gel sweeps	
	~171 m^3 surface discharge	SBDF	

Discharge type	Predicted volume	Predicted concentration	Duration
Corrosion inhibitor	~159 L (1 bbl) of corrosion inhibitor	Low concentrations of scale inhibitors and biocides	Short duration, single discharge during abandonment
Well suspension fluids	~ 45 m^3 (280 bbl)	1.3 sg inhibited suspension fluid	

7.9.2 Known and potential environmental impacts

A planned discharge of drill cuttings and fluids will cause:

- a change in water quality
- smothering.

As a result of a change in water and sedimentation may result in toxicity effects to marine fauna.

7.9.3 Consequence evaluation

7.9.3.1 Change in water quality

Hinwood et al. (1994) indicates that larger particles of cuttings and adhered muds (90-95 %) fall to the seabed within proximity of the release point. When cuttings are discharged to the ocean, the larger particles, representing about 90 % of the mass of the mud solids, form a plume that settles quickly to the bottom (or until the plume entrains enough seawater to reach neutral buoyancy). About 10 % of the mass of the mud solids form another plume in the upper water column that drifts with prevailing currents away from the platform and is diluted rapidly in the receiving waters (Neff 2005, Neff 2010).

Neff (2005) states that in well-mixed oceans waters (as is the case within the Operational Area), the drilling cuttings and fluid plume is diluted by more than 100-fold within 10 m of the discharge. Because of the rapid dilution of the drilling mud and cuttings plume in the water column, "harm to communities of water column plants and animals is unlikely and has never been demonstrated" (Neff 2005).

Drilling activities will require the use of both WBDF and SBDF. Due to the inert / PLONOR nature of its components, WBDF have been shown to have little or no toxicity to marine organisms (Jones, F.V., C. Hood, and G. Moiseychenko. 1996). Barite (a major insoluble component of water-based mud discharges) has been widely shown to accumulate in sediments following drilling (reviewed by (Hartley 1996)). Barium sulphate is of low bioavailability and toxicity to benthic organisms. Other metals present mainly as salts, in drilling wastes may originate from formation cuttings, or from impurities in barite and other mud components, however, do not contribute to mud toxicity due to their low bioavailability (Schaanning M.T. 2002).

Treated seawater and sweeps are also inert / PLONOR or low toxicity.

The American Chemistry Council (2006) found that because SBDF adhered to cuttings tends to clump together in particles that rapidly settle to the ocean floor, this suggests that SBDF-coated cuttings tend to be less likely to increase water column turbidity.

Neff (2010) explains that the lack of toxicity and low bioaccumulation potential of the drilling fluids means that the effects of the discharges are highly localised and are not expected to spread through the food web.

The release of formation water will temporarily change water quality due to concentrations of formation hydrocarbons. Given OSPAR (2014) indicates that the predicted no effect concentration (PNEC) for marine organisms exposed to dispersed oil is 70.5 ppb, any potential impact is predicted to be sub-lethal. Additionally, the PNEC value is based upon no observed effect concentrations (NOEC) after exposure to certain concentrations for an extended period that was greater than 7 days (OSPAR 2014). The discharge of treated brine and formation water during well completion activities are both intermittent and short in duration.

The discharge of treated completion brine is likely to increase salinity levels within surface waters in close proximity to the discharge point. Modelling by Shell (2009) indicates that upon discharge, hydrocarbon and other chemical concentrations are rapidly diluted and expected to be below PNEC within a relatively short period of time.

The change in water quality from these discharges is limited to a localised area and returns to ambient following the completion of the discharge, resulting in no lasting effects. Any potential impact from this discharge is expected to be short term and limited to a small number of individuals.

As such, Beach have ranked the consequence as Minor (1).

7.9.3.2 Smothering

Environmental receptors with the potential to be exposed to a change in habitat through smothering of flora and fauna and alteration of seabed sediment distribution include:

- benthic habitat (soft sediment)
- marine invertebrates.

Hinwood et al. (1994) explain that the main environmental disturbance from discharging drilling cuttings and fluids is associated with the smothering and burial of sessile benthic and epibenthic fauna. Neff et. al. (2010) suggests that SBDF-coated cuttings, tend to clump and settle rapidly as large particles over a small area near the discharge point and tend not to disperse rapidly (Neff 2010) indicating that when drilling with SBDF, extent of dispersion is expected to decrease, but thickness of cuttings piles can be expected to increase.

Many studies have shown that the effects on seabed fauna and flora from the discharge of drilling cuttings with water based muds are subtle, although the presence of drilling fluids in the seabed close to the drilling location (<500 m) can usually be detected chemically (as discussed above in Section 7.9.3.1) (Bakke, Klungsøyr and Sanni 2013, OSPAR 2009, Currie and Isaacs 2004, Hyland, et al. 1994, Neff, Bothner, et al. 1986, Cranmer 1988, Daan and Mulder 1996)

Jones et al. (2012, 2006) compared pre- and post-drilling ROV surveys and documented physical smothering effects from WBDF cuttings within 100 m of the well. Outside the area of smothering, fine sediment was visible on the seafloor up to at least 250 m from the well. After three years, there was significant removal of cuttings particularly in the areas with relatively low initial deposition (Jones, Gates and Lausen 2012). The area impacted by complete cuttings cover had reduced from 90 m to 40 m from the drilling location, and faunal density within 100 m of the well had increased considerably and was no longer significantly different from conditions further away.

Neff (2010) found that recolonisation of synthetic-based, mud-cuttings piles in cold-water marine environments began within one to two years of ceasing discharges, once the hydrocarbon component of the cutting piles biodegraded. Additional studies indicate that benthic infauna and epifauna recover relatively quickly, with ecological recovery reported to begin shortly after drilling completion and be well advanced within a year (IOGP 2016, Manoukian, et al. 2010), with substantial recovery in deepwater benthic communities within three to ten years (Jones, Gates and Lausen, Recovery of deep-water megafaunal assemblages from hydrocarbon drilling disturbance in the Faroe–Shetland Channel 2012).

As described in Section 5.6.4.2, the seabed at Yolla-A platform has very soft to soft alternating layers of silty carbonate clay and silty sands. The soft sediment benthic habitat is moderately abundant in the region. No KEFs or TECs were identified within the 0.8 km^2 area of impact. Geotechnical surveys conducted in the area did not identify hard substrate or features and visual surveys indicate that no cuttings piles are present from previous drilling programs.

In general, research and seabed surveys from the Yolla-A Platform suggests that any smothering impacts within the Operational Area will be limited to 500 m from the well site, and full recovery is expected. No hard substrates are present within the Operational Area, and consequently direct ecological impacts are expected to be low. As the area is expected to recover with surveys indicating no drill cutting piles are present from the previous drilling program the potential impacts from smothering and alteration of seabed substrate are not considered to be significant and thus have been ranked as Minor (1) as this type of event may result in limited environmental impacts.

7.9.3.3 Toxicity effects to marine fauna

Receptors potentially impacted by a change in water quality through increased turbidity, chemical toxicity and oxygen depletion include:

- pelagic marine fauna
- benthic invertebrates and plankton.

Pelagic marine fauna

As discussed in Section 5.7.7, several marine species listed as threatened and/or migratory under the EPBC Act have the potential to occur within the Operational Area.

Marine fauna found in the water column, such as fish, marine mammals and marine reptiles, are expected to actively avoid discharge plumes and associated turbidity and toxicity within the water column. Neff et al. (2000) states that drill cuttings are of little risk to water column biota as they will be rapidly diluted near the source.

Within the Operational Area, the particular values and sensitivities related to marine fauna with the potential to be exposed to this discharge include:

- Blue Whale (foraging and distribution BIA)
- Southern Right Whale (known core range)
- White Shark (distribution BIA).

Whilst the Operational Area is within a distribution BIA, interactions with white sharks are very unlikely due to their transitory / migratory nature and distance of the Operational Area from the preferred habitats (Bruce, Stevens and Malcolm 2006). The white shark recovery plan does not list changes to water or sediment quality as a key threat to the species (DSEWPaC 2013a).

The blue whale and southern right whale conservation management plans do not list water or sediment quality as a key threat to the species. These species are likely to be transient within the Operational Area thus toxicity impacts are not predicted due to the rapid dilution and transient nature of the species (Commonwealth of Australia 2015b, DSEWPaC 2012a)

Based on the transitory nature of receptors and the expected rapid dilution of the discharges, any potential impact from this discharge is expected to be short term and limited to a small number of individuals.

As such, Beach have ranked the consequence as Minor (1).

Benthic invertebrates and plankton

Jenkins and McKinnon (2006) reported that levels of suspended sediments greater than 500 mg/L are likely to produce a measurable impact upon larvae of most fish species, and that levels of 100 mg/L will affect the larvae of some species if exposed for periods greater than 96 hours. Jenkins and McKinnon (2006) also indicated that levels of 100 mg/L may affect the larvae of several marine invertebrate species, and that fish eggs and larvae are more vulnerable to suspended sediments than older life stages. Though, any impact to fish larvae is also expected to be limited due to high natural mortality rates (McGurk 1986), intermittent exposure, and the dispersive characteristics of the open water in the Operational Area.

Based upon dilutions identified by Hinwood et al. (1994)and Neff (2005), turbidity in the water column is expected to be reduced to below 10 mg/L (9 ppm) within 100 m of release. Therefore, as previous dilution estimates (Hinwood, et al. 1994, Neff 2005) suggest suspended sediment concentrations caused by the discharge of drill cuttings will be well below the levels required to cause an effect on fish or invertebrate larvae (i.e. predicted levels are well below a 96-hr exposure at 100 mg/L, or instantaneous 500 mg/L exposure), minimal impact to larvae is expected from the discharge of drill cuttings.

Plankton have a patchy distribution linked to localised and seasonal productivity that produces sporadic bursts in populations. Plankton distribution 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. A change in water quality as a result of drill cuttings and fluids is unlikely to lead to injury or mortality of plankton at a measurable level and will not result in a change in the viability of the population or ecosystem. Therefore, no impacts from drill cuttings or fluids discharges are predicted.

Any potential impact from this discharge is expected to be short term and limited, with no impact expected to valued species or habitats. As such, Beach have ranked the consequence as Minor (1).

7.9.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Planned marine discharges – brines, completion fluids, drilling cuttings and fluids

ALARP decision context and justification	**ALARP Decision Context: Type B** The planned release of drill cuttings and adhered fluids, brines completion fluids and other fluids offshore is a well understood and practiced activity both nationally and internationally. The potential impacts are well regulated via various treaties and legislation, which specify industry best practice control measures. These are well understood and implemented by the industry. No stakeholder objections or were claims raised with regards to this activity. For this aspect, the Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development (IFC 2015) recommend that feasible alternatives for disposing of drilling cuttings should be evaluated to ensure that impacts are reduced to ALARP. In accordance with this, ALARP Decision Context B has been applied.
Adopted Control Measures	**Source of good practice control measures**
Hazardous Materials Risk Assessment Process	The Beach Energy Hazardous Materials Risk Assessment Process assesses chemicals that have the potential to be discharged to the environment to ensure selection criteria are met. This control addresses Environmental, Health, and Safety Guidelines Offshore Oil and Gas Development (IFC 2015) – Drilling Fluids and Drilled Cuttings Guidance Number 59 that requires operators carefully select drilling fluid additives, considering their concentration, toxicity, bioavailability, and bioaccumulation potential.
Drill Fluid and Cuttings Management Plan	Environmental, Health, and Safety Guidelines Offshore Oil and Gas Development (IFC 2015) – Drilling Fluids and Drilled Cuttings Guidance Number 53 requires that consideration of discharges of drilling fluids including chemical content. Environmental, Health, and Safety Guidelines Offshore Oil and Gas Development (IFC 2015) – Drilling Fluids and Drilled Cuttings Guidance Number 59 requires that environmental hazards related to residual chemical additives on discharged cuttings are reduced through the drilling fluid selection. In addition to this, the management plan details how fluids on cuttings will be reduced using solids control equipment. Specifically, solids control equipment is used to reduce residual on cuttings to 8% per hole section.

Additional controls assessed

Control	Control Type	Cost/Benefit Analysis	Control Implemented?
Reinject fluids and cuttings to subsurface formation	Elimination	Cuttings reinjection is a possible method for disposing of cuttings without discharge to the marine environment; however, significant time and costs are associated with site selection and reinjection requires a suitable, existing offshore well, with appropriate treatment facilities and a viable subsurface reservoir in proximity of	No

		the development wells. Given this is not the case, this is not a feasible option.	
Contain and transfer cuttings to shore for treatment	Elimination	This option require access to dedicated facilities onshore available to treat cuttings, which do not currently exist. This control measure may result in increased offshore environmental impacts via generation of additional vessel movements and associated atmospheric emissions. In addition, this control may increase in environmental impact onshore (out of scope of this EP) due to emissions generated through transport, treatment and disposal. This control measure is considered to provide a small environmental benefit, that would be grossly disproportionate in time, cost and effort given the extent of impact from the discharge of drilling cuttings demonstrated to be localised and short-term.	No
Eliminate SBDF and use WBDF Only	Substitution	WBDF are less toxic than SBDF. As such Beach Energy consider the use of only WBDF for this well. The Yolla 7 well is an Extended Reach (ERD) well. The well profile has a long tangent section in the 12-1/4" hole section. This coupled with potential tight hole can create wellbore stability issues. The use of SBDF is recommended under these situations to mitigate drilling risks. Further to this, SBDF has been proven to result in lower friction factors range which reduce the risks of drilling and running casing in an ERD well profile by reducing the drilling torque and drag to a range within the tubular and surface equipment limitations. SBDF also assists with managing Equivalent Circulating Density by providing reduced equivalent circulating densities when compared to a WBDF. The SBDF will be reclaimed and reused during the drilling of the well using rig-based solids control equipment and cuttings handling systems (cuttings dryer etc) to minimise any residual oil on cuttings. Eliminating the use of SBDFM would only result in a marginal environmental benefit but could impact the potential for drilling the well safely by causing wellbore stability issues thus benefits are considered grossly disproportionate to the level of risk reduction achieved.	No
Reconditioning and storage of synthetic-based drilling fluid for reuse	Substitution	Remaining synthetic-based drill fluid shall be contained on board the MODU. When unable to be reconditioned offshore, whole synthetic-based drill fluid shall be transported to shore for reconditioning.	Yes
Flowback fluids to be returned to shore via existing infrastructure	Substitution	Given the nature of this program and presence of existing infrastructure associated with the Yolla-A Platform, there is an option for well flowback fluids to be returned to shore for disposal. This will mitigate the potential to discharge ~450 m^3 of formation water offshore. Although this does reduce the volume of discharges offshore, it shifts the environmental liability and risk onshore. Given the nature of the receiving environment, and the scale of existing discharges and potential environmental impacts, this was deemed to result in a marginal environmental benefit as other discharges (such as drilling fluids and cuttings, brines, completion fluids etc) will be discharged offshore	No
Riserless Mud Recovery (RMR) system	Equipment	RMR may be applied to recirculate drill fluids and cuttings from the top-hole section of the well, thus eliminating discharge to seabed (when applied in conjunction with containment and transfer to shore). RMR may also be implemented where shallow hazards are anticipated. Given low to no toxicity water- based fluids (e.g. water and gel sweeps) shall be used for riserless drilling sections and shallow hazards are not anticipated, there is limited technical benefit in using this system.	No

		Given the small extent and temporary nature of impacts from the discharge of gel sweeps, WBDF and drill cuttings from the top-hole sections of the well, and the deep-water environment at the well locations not in the vicinity of formally managed benthic communities, the application of RMR is considered grossly disproportionate to the negligible environmental benefit potentially gained.	
Caisson discharge closer to seabed	Equipment	Based on the small extent and short-term impacts resulting from an increase in turbidity and smothering of benthic habitats, modifying the discharge depth of drill cuttings is not expected to result in a significant change to the severity of the impact.	No
Slim hole / coil tubing drilling	System	This drilling technique results in a reduction of the volume of cuttings produced. However, as this well is an extended reach well with a long tangent section in the 12-1/4" hole section, slim the hole size has already been selected to be the smallest possible while ensuring management of dynamic downhole pressures to minimise drilling fluid losses to the formation while drilling, minimising risk of a LOWC event. As such this method is not considered practicable for this activity.	No
Solids Control Equipment (SCE) - Thermal desorption	Equipment	Additional equipment such as cuttings driers, thermal desorption and thermomechanical cleaning can be used to reduce the volumes of oil on cuttings. Equipment such as de-sanders, de-silters and centrifuges are used to reduce the solids content during treatment of used drilling fluids, while thermal desorption and thermal mechanical cleaning units are designed to clean oily residues from oily cuttings prior to their discharge. The addition of one or more of these control measures would result in a reduction in the overall level of environmental impact associated with the discharge of cuttings. Thermal desorption technology is not fitted to the MODU, due to this equipment not being available for rental and the significantly high purchase price, the elevated running costs (energy consumption) and the significant rig modifications required to install, thermal desorption technology is not considered a practical option. Given the above, Beach considers the adoption of thermal desorption technology to be grossly disproportionate to the limited environmental benefit gained via a further reduction (likely in the order of 4 to 5 %) in overall residual fluid on cuttings in a deep water, open-ocean environment where cuttings are likely to disperse rapidly.	No

Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	NA
Acceptability assessment	
To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with these planned marine discharges. The planned marine discharge was assessed as having a Moderate (2) which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.
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	No objections or claims have been raised during stakeholder consultation regarding the planned discharges of drilling cuttings and fluids.
Other requirements	No legislation, environmental management plans, conservation advice or recovery plans were identified as relevant to this aspect. However, the Environmental, Health, and Safety Guidelines

	Offshore Oil and Gas Development (IFC 2015) – Drilling Fluids and Drilled Cuttings Guidance was used to support identification of controls, and options to minimise environmental impacts.		
Monitoring and review	Impacts associated with planned marine discharges are expected to occur within close proximity of the MODU and not predicted to impact protected or commercially important receptors. Therefore, monitoring is not proposed. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.		
Acceptability outcome	**Acceptable**		
Environmental performance outcome		**Environmental performance standard**	**Measurement criteria**
No impact to water quality or sediment quality at a distance > 500 m from each well from planned marine discharges.		**Hazardous Materials Risk Assessment Process** Chemicals that will be or have the potential to be discharged to the marine environment will meet the chemical acceptance criteria as per Chemical Management Plan (S4000AD719917). Chemicals used as a component of a planned drilling discharge will meet the drilling chemical acceptance criteria as per Chemical Management Plan (S4000AD719917), including: i. components of water-based drilling fluid (WBDF) ii. components of synthetic-based drill fluid (SBDF) iii. stock barite iv. cementing products v. hydraulic control fluids.	Completed and approved chemical assessment Register of approved chemicals
Seabed and associated biota disturbance will be less than 0.8 km^2 and within the Operational Area.		**Drill Fluid and Cuttings Management Plan** No whole SBDF shall be discharged overboard. Remaining synthetic-based drill fluid shall be contained on board the MODU to be reconditioned for future activities When unable to be reconditioned offshore, whole synthetic-based drill fluid shall be transported to shore for reconditioning. Residual on cuttings will not exceed 8 % per hole section. Discharge tank wash shall not exceed 2 % base fluid content.	Daily drill reports

7.10 Planned marine discharges – cement and swarf

7.10.1 Establish the context

Cement will be discharged at both the surface and the seabed during the petroleum activity. The discharge is a combination of cement slurry and mix or wash water and is in the order of ~31 m^3 per well over the course of the activity (Section 4.5.2.3).

Swarf will be generated from the activity where the casing is cut to enable a side-track or well abandonment to occur. Where a side-track occurs any steel swarf will be discharged to the environment from the surface along with other cuttings and drilling fluids. Specifically, if required milling may require result in discharges of flocculant, drilling fluids and metal swarf.

Where well abandonment occurs, steel swarf will remain in-situ at the seabed directly adjacent to the wellhead.

7.10.2 Known and potential environmental impacts

Planned discharge of cement and swarf has the potential to result in:

- increased turbidity of the water column from surface discharges
- smothering of benthic habitat and fauna by seabed discharges.

Toxicity impacts are not predicted as cement is considered to Pose Little or No Risk to the Environment (PLONOR) (Cefas 2018).

7.10.3 Consequence evaluation

7.10.3.1 Increased turbidity of the water column from surface discharges

Modelling of a release of 18 m^3 of cement wash water by de Campos et al. (2017) indicated an ultimate average deposition of 0.05 mg/m^2 of material on the seabed; with particulate matter deposited within the three-day simulation period. Given the low concentration of the deposition of the material, it is therefore expected that the in-water suspended solids (i.e. turbidity) created by the discharge is not likely to be high for an extended period.

Modelling of larger cement discharges (approximately 78 m^3 over a one-hour period) was completed for another offshore drilling project (BP 2013). Results of this modelling showed that within two hours suspended solid concentrations ranged between 5-50 mg/L within the extent of the plume (approximately 150 m horizontal and 10 m vertical); and by four hours post-discharge, that concentrations were <5 mg/L. Given the maximum individual cementing discharge (being a spoiled cement batch) is in the order of 22 m^3, which is much less than the volume modelled, it is expected that the concentration of suspended sediments would be lower.

As such, the extent of increased turbidity is conservatively estimated to be 150 m from the MODU for a duration of four hours after each discharge. Modelling shows that the extent of the plume was only 10 m vertically and consequently impacts to sediments and benthic biota including invertebrates is not predicted. Within the 150 m extent of potential impact potential receptors to change in water quality would be plankton, and marine fauna.

Though plankton may be sensitive to some aspects of marine discharges 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, Matear and Lenton 2017) impacts from short term exposure to suspended solids of low toxicity that will rapidly dilute is unlikely to have lethal effects to plankton that are ecologically significant.

Jenkins and McKinnon (2006) reported that levels of suspended sediments greater than 500 mg/L are likely to produce a measurable impact upon larvae of most fish species, and that levels of 100 mg/L will affect the larvae of some species if exposed for periods greater than 96 hours. Jenkins and McKinnon (2006) also indicated that levels of 100 mg/L may affect the larvae of several marine invertebrate species and that fish eggs and larvae are more vulnerable to suspended sediments than older life stages. Neither the modelling by de Campos et al. (2017) or BP (2013) suggest that suspended solids concentrations from cement discharges will be at or near levels required to cause an effect on fish or invertebrate larvae, i.e. predicted levels were well below a 96 hour exposure at 100 mg/L, or instantaneous 500 mg/L exposure.

The Operational Area overlaps with one BIA for fish species; the White Shark known distribution Operational Area. The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC 2013a) does not identify MODU discharges or equivalent as a threat. As these species would be transient impacts are not predicted due to the low toxicity of the suspended solids and rapid dilution.

Other marine species such as turtles, mammals and other fish species would be transient through the Operational Area impacts, acute impacts are not expected due to the low toxicity of the suspended solids and rapid dilution.

The extent of the area effected by cement discharges is limited, and any receptor exposure would be short term, with discharges expected to rapidly disperse in the marine environment.

As such, Beach have ranked the consequence as Minor (1).

7.10.3.2 Smothering of benthic habitat and fauna by seabed discharges.

It is estimated that approximately 15 m^3 of cement will be discharged to seabed. BP (2013) modelled a 200 t cement discharge with the extent of potential impact from this discharge expected to be limited to 10 m of the seabed discharge point. 1 m^3 of cement is approximately 2.4 t and consequently, as 15 m^3 of cement would be 36 t, the modelling is considered suitable for providing an indication as to the extent of the potential seabed impact.

As described in Section 5.6.4.2, the seabed at Yolla-A platform has very soft to soft alternating layers of silty carbonate clay and silty sands. The soft sediment benthic habitat is moderately abundant in the region. No KEFs, TECs or habitat critical to the survival of the species were identified within the Operational Area. Geotechnical surveys conducted in the area did not identify hard substrate or features.

The extent of the area of impact resulting from the planned discharge of cement is limited, and no sensitive or protected benthic habitat or species have been identified in the area of impact.

As such, Beach have ranked the consequence as Minor (1).

7.10.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Planned marine discharges – cement and swarf	
ALARP decision context and justification	**ALARP Decision Context: Type A** Impacts from these discharges are well understood and there is nothing new or unusual associated with these discharges. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding planned discharges from this activity. As the impact consequence is rated as Minor (1) applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP
Adopted Control Measures	**Source of good practice control measures**
Hazardous Material Risk Assessment Process	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.
Cementing procedure	Cementing procedures shall be developed to minimise the amount of cement discharged to the marine environment.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	NA
Acceptability assessment	
To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with these planned marine discharges. Cement and swarf discharges were assessed as having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.

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	No legislation, environmental management plans, conservation advice or recovery plans were identified as relevant to this aspect.
Monitoring and review	Impacts associated with planned marine discharges are over a small area and not predicted to impact protected or commercially important receptors. Therefore, monitoring is not proposed. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.
Acceptability outcome	**Acceptable**

Environmental performance outcome	Environmental performance standard	Measurement criteria
No impact to water quality or sediment quality at a distance > 500 m from each well from planned marine discharges.	**Hazardous Material Risk Assessment Process** Chemicals that will be or have the potential to be discharged to the marine environment will meet the chemical acceptance criteria as per the Chemical Management Plan (S4000AD719917) Chemicals used as a component of a planned drilling discharge will meet the drilling chemical acceptance criteria as per the Chemical Management Plan (S4000AD719917), including: i. components of water-based drilling fluid (WBDF) ii. components of synthetic-based drill fluid (SBDF) iii. stock barite iv. cementing products v. hydraulic control fluids.	Completed and approved chemical assessment Register of approved chemicals
Seabed and associated biota disturbance will be less than 0.8 km2 and within the Operational Area.	**Cementing procedure** Holding capacity will be available for fluid storage which is not suitable to be sent to the burner or discharged to sea. This volume will be returned to shore for processing and disposal.	Backloading records

7.11 Introduction of Invasive Marine Pest

7.11.1 Establish the context

The mobilisation and use of vessels and the MODU within the Operational Area have the potential to result in the introduction of an invasive marine pest (IMP) through:

- planned discharged of ballast water or
- the presence of biofouling.

7.11.2 Known and potential environmental impacts

An introduction of an IMP may result in:

- displacement of, or compete with, native species.

7.11.3 Consequence evaluation

IMPs 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 >250 introduced marine pests, and that approximately one in six introduced marine species becomes a pest (DAWE [n.d]).

No conservation values or sensitivities (including KEFs) with the potential to be impacted by the introduction of an IMP were identified as present within the Operational Area.

IMPs primarily occur in shallow waters with high levels of slow-moving or stationary shipping traffic (such as ports). The probability of successful IMP settlement and recruitment decreases in well-mixed, deep ocean waters away from coastal habitats. IMP colonisation also requires a suitable habitat in which to establish itself, such as rocky and hard substrates or subsea infrastructure. The Australian Government Bureau of Resource Sciences (BRS) established that the relative risk of an IMP becoming established around Australia decreases with distance from the coast. Modelling conducted by BRS (BRS 2007) estimates: 33 % chance of colonisation at 3 nm, 8 % chance at 12 nm, and 2 % chance at 24 nm.

The Operational Area does not present a benthic habitat that is typically favourable to IMP survival. The Operational Area is located over 80 km (>43 nm) from the closest coastline, in waters of depths of ~80 km. As discussed in Section 5.7.1, the benthic substrate within the Operational Area is classified as calcareous gravel, sand and silt, (CSIRO 2015). As such, the typical requirements of hard substrate and light for IMP survival do not occur within the Operational Area.

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 was 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, Lambert and Meyer 2002).

If an IMP was introduced, and if it did colonise an area, there is the potential to significantly impact local ecosystems.

As such, Beach have ranked the consequence as Serious (3)

7.11.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Introduction of IMP	
ALARP decision context and justification	**ALARP Decision Context: Type A** The risk of IMP introduction is well understood and there is nothing new or unusual associated with these activities. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding the risk of introducing an IMP from this activity As the consequence is rated as Serious (3), applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good practice control measures**
MO 98: Marine pollution – anti-fouling systems	Marine Order 98 (Marine pollution — anti-fouling systems) 2013 provide for controls on anti-fouling systems and for the survey, inspection and certification of ships for those systems. Subject to class, vessels operating in Australian waters are required to hold a valid an anti-fouling system certificate
Australian Ballast Water Management Requirements	The Australian Ballast Water Management Requirements (DAWE 2020c) describe the requirements for ballast water management specifically: • vessel ballasting operations must be undertaken as per an approved Ballast Water Management Plan (BWMP) • international vessels entering Australian waters require an International Ballast Water Management Certificate (BWMC)

	• vessels that carry ballast water must maintain a complete and accurate Ballast Water Record System (record book).
National Biofouling Management Guidance for the Petroleum Production and Exploration Industry	The National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2018) recommends and provides information on undertaking a vessel specific risk assessment to identify the level of risk a vessel poses, and the level of controls required to reduce IMS introduction risks. It also recommends that routine cleaning, maintenance, drying and storage of ROVs and in-water equipment to maintain a low risk of any biofouling mediated translocation of marine pests.
Australian Biofouling Management Requirements (Proposed) consistent with International Maritime Organization (IMO) 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species	The proposed Australian Biofouling Management Requirements, require a biofouling management plan and record book consistent with IMO Biofouling Guidelines.
Beach Domestic IMS Biofouling Risk Assessment Process	All MODUs, vessels and submersible equipment 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.
Consequence rating	Serious (3)
Likelihood of occurrence	Remote (1)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Based upon the risk assessment completed for this project, the activities were assessed as having the potential to result in a Serious (3) consequence. Although there is the potential for a sever consequence, the likelihood of any impact occurring was deemed Remote (1). This is based upon the location of the activity and the industry control measures that are in place for its management. The risk of any impact occurring is low. The habitat within the Operational Area is known from baseline studies, thus the understanding of benthic habitat at these locations is well understood. As such, there is limited scientific uncertainty associated with this aspect. Consequently, the activity is considered to be consisted with the principles of ESD.
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 drilling activity.
Other requirements	The risks associated with the introduction of an IMP are to be managed in consideration with: • Commonwealth *Biosecurity Act 2015* • Commonwealth *Protection of the Sea (Harmful Anti-fouling Systems) Act 2006* (enacted by Marine Order 98 [Marine pollution – anti-fouling systems]) • Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species (Biofouling Guidelines) MPEC.207(62)) 2011 (IMO 2012) • Offshore Installations - Biosecurity Guide (DAWE 2020a) • National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2018) • Australian Ballast Water Management Requirements (DAWE 2020c) 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). No environmental management plans, conservation advice or recovery plans were identified as relevant to this aspect.

Monitoring and review	In accordance with the Beach Domestic IMS Biofouling Risk Assessment Process, an inspection of the vessel or MODU may be undertaken subject to the outcomes of the risks assessment. Where the risk of IMS introduction is higher than low, and additional mitigations are unable to be implemented to achieve the low-risk criteria, and treatment and verification of internal seawater systems is not possible / unsuccessful, then an inspection will be completed by a suitably qualified marine scientist with experience in IMS inspections. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.	
Acceptability outcome	**Acceptable**	
Environmental performance outcome	**Environmental performance standard**	**Measurement criteria**
No introduction of a known or potential invasive marine species.	**MO 98: Marine pollution – anti-fouling systems** Support vessels shall have a current anti-fouling certificate.	Vessel anti-fouling certificate
	Australian Ballast Water Management Requirements Support vessels shall have a valid Ballast Water Management Plan and ballast water management certificate. Prior to mobilisation to the first drilling location for the program, Beach shall validate that the MODU complies with the Australian Ballast water Requirements (Rev 7), specifically, ensuring the MODU has: • a valid Ballast Water Management Plan • a ballast water management certificate • a ballast water record system with a minimum of 2 years records retained on board. Beach shall validate MODU ballast water has been exchanged outside 12 nm from the nearest land and in water depths greater than 50 m prior to undertaking drilling activities.	Ballast water records Vessel Ballast Water Management Plan Vessel Ballast Water Management certificate
	National Biofouling Management Guidance for the Petroleum Production and Exploration Industry Support vessels shall have a low-risk rating based on (or equivalent to) the WA Department of Fisheries Biofouling Risk Assessment Tool (in lieu of a Commonwealth or VIC specific tool).	Documented biofouling risk assessment indicating 'low-risk' rating
	Australian Biofouling Management Requirements (Proposed) consistent with International Maritime Organization (IMO) 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species Prior to arrival at the drilling location, Beach shall validate that the MODU has a biofouling management plan and record book consistent with IMO Biofouling Guidelines.	Biofouling Management Plan Biofouling Record Book
	Beach Domestic IMS Biofouling Risk Assessment Process Prior to the initial mobilisation into the Operational Area of any MODU, vessel or submersible equipment, Beach shall undertake a domestic IMS biofouling risk assessment as per Section 8.11.1.2 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/project area • identify the potential IMS risk profile of MODUs, vessels and submersible equipment prior to deployment within the operational/project area • identification in potentially deficiency of IMS controls prior to entering the Operational Area	Domestic IMS biofouling risk assessment records

	• identification of additional controls to manage IMS risk • prevent the translocation and potential establishment of IMS into non-affected environments (either to or from the operational/project area).

7.12 Unplanned marine discharge - waste

7.12.1 Establish the context

Waste is generated onboard the MODU and support vessels due to the use of general consumables and other materials required to support the activity. If waste is stored and managed incorrectly, it can be accidently lost overboard the vessels or MODU.

7.12.2 Known and potential environmental impacts

Waste accidently released to the marine environment may lead to injury or death to individual marine fauna through ingestion or entanglement.

7.12.3 Consequence evaluation

Waste accidently released to the marine environment may occur within the Operational Area. If hazardous or non-hazardous waste is lost overboard, the extent of exposure to the environment is limited.

Marine fauna most at risk from marine pollution include marine reptiles and seabirds, through ingestion or entanglement (Commonwealth of Australia 2017b, DSEWPaC 2011a). Ingestion or entanglement has the potential to limit feeding or foraging behaviours and thus can result in marine fauna injury or death.

The Operational Area overlaps foraging BIAs for several albatross species, petrel species and the Short-tailed Shearwater (Section 5.7.7.2). Marine debris is identified as a threat in the Draft National Recovery Plan for Albatrosses and Petrels (DAWE 2021b)

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. Specifically, the plan details ship-sourced, solid non-biodegradable floating materials lost or disposed of at sea.

Given the restricted exposures and the limited quantity of waste with the potential to cause marine pollution that is expected to be generated from petroleum activities, it is expected that in the unlikely event that waste is lost overboard, any impacts would be limited to individuals. As such, Beach have ranked the consequence as Minor (1).

7.12.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Unplanned marine discharge – waste	
ALARP decision context and justification	**ALARP Decision Context: Type A** The risk of marine debris impacts to marine fauna are relatively well understood and there is limited uncertainty associated with the level of impact. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding the risk of an unplanned discharge of waste from this activity. As the risk is rated as Low, applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.

Adopted Control Measures	Source of good practice control measures
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.
Rubbish bins fitted with lids	It is good industry practice to ensure that any waste with the potential to be windblown is fitted with lids to prevent unplanned releases to the environment. This is in line with Beach's Waste Management Plan that will inform waste management objectives (including implementation of the waste hierarchy) during the activity.
Likelihood of occurrence	Remote (1)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with loss of waste overboard. The unplanned discharge of waste was assessed as having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.
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 marine fauna injury or death from unplanned discharge of waste.
Other requirements	Waste on board the vessels and MODU will be managed in consideration with: • Marine Order 95 • MARPOL 73/78 The activity was not deemed to be inconsistent with the following plans, conservation advice or recovery plans: • Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017b) • National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (DSEWPaC 2011a) • Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia 2015d) • Approved Conservation Advice for *Caldris cantus* (Red Knot) (TSSC 2016a) • Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (TSSC 2015e) • Approved Conservation Advice for *Halobaena caerulea* (Blue Petrel) (TSSC 2015g) • National Recovery Plan for *Neophema chrysogaste* (Orange-bellied Parrot) (DELWP 2016) • Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (TSSC 2015i) • Approved Conservation Advice for *Pachyptila tutur subantarctica* (Fairy Prion (southern)) (TSSC 2015h) • National Recovery Plan for *Pterodroma leucoptera* (Gould's Petrel) (DEC 2006) • Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged Petrel) (TSSC 2015k) • Draft National Recovery Plan for *Sternula nereis* (Australian Fairy Tern) (Commonwealth of Australia 2019) • Approved Conservation Advice for *Thalassarche chrysostoma* (Grey-headed Albatross) (DEWHA 2009).
Monitoring and review	Waste lost overboard will be managed and recorded in accordance with Section 8.12.1.1. Impacts associated with waste discharges are over a small area and not predicted to impact protected or commercially important receptors. Therefore, monitoring is not proposed. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.

Acceptability outcome	Acceptable	
Environmental performance outcome	**Environmental performance standard**	**Measurement criteria**
No unplanned discharge of waste to the marine environment.	**MO 95: Marine Pollution Prevention – Garbage** Marine vessels >400 T (or certified to carry >15 persons) will have a Garbage Record Book on board, in accordance with MARPOL 73/78 Annex V.	**Garbage record book**
	Rubbish bins fitted with lids Waste with potential to be windblown shall be stored in covered containers.	HSE inspection records Garbage record book Incident report

7.13 Loss of containment - minor spills

7.13.1 Establish the context

The operation of the MODU and support vessels includes handling, use and transfer of hydrocarbons and chemicals with the following were identified as potentially leading to a loss of containment event:

- use, handling and transfer of hydrocarbons and chemicals on board
- hydraulic line failure from equipment
- transfer of hazardous materials between the MODU and vessel (refuelling).

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.

AMSA (2015b) suggests the maximum credible spill volume from a refuelling incident with continuous supervision is approximately the transfer rate over 15 minutes. Assuming failure of dry-break couplings and an assumed ~200 m^3/h transfer rate (based on previous operations), this equates to an instantaneous spill of ~50 m^3. Given the volume associated with this type of incident, it has been conservatively applied to conduct the risk consequence evaluation for this event.

7.13.2 Known and potential environmental impacts

Unplanned release of hazardous material to the environment may result in:

- indirect impacts to fauna arising from chemical toxicity.

7.13.3 Consequence evaluation

To evaluate the potential extent of this scale of hydrocarbon spill, an Automated Data Inquiry for Oil Spills (ADIOS) model was generated for an instantaneous 50 m^3 spill of MDO, with results showing that:

- within 6-hours of the spill approximately 8 % of the product evaporates, 92 % disperses with 0 % remaining on the sea surface
- the surface life for an instantaneous diesel spill of 50 m^3 from a refuelling incident is estimated at 3 hours.
- given the release location at the platform and the distance offshore, no shorelines would be impacted.

Based on the nature of these unplanned releases, which are non-continuous the extent and duration of any exposure to concentrations that could cause an impact is expected to be limited.

Based upon the values and sensitivities that are located within proximity of the MODU, no species have been identified that may practice sedentary behaviours with listed species identified as being transient. Consequently, any exposure to these species would be extremely limited.

Given the nature of unplanned releases and the transient nature of identified values and sensitivities, fauna would need to pass directly through the plume almost immediately upon release to be impacted.

Any potential impact from such an event is expected to be short term and limited to a small number of individuals, and no lasting effect to biological and physical environment in an area that is not formally managed is expected.

As such, Beach have ranked the consequence as Minor (1).

7.13.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Loss of containment - Minor spills	
ALARP decision context and justification	**ALARP Decision Context: Type A** The risks associated with a minor spill are relatively well understood and there is limited uncertainty. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding the risk of minor spills from this activity. As the risk is rated as Low, applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good practice control measures**
Bunkering procedure	Drilling Contractor management system includes managed bunkering operations.
Drain management	Drilling Contractor management system includes the lock-out of overboard discharge drains with potential to release hazardous substances, inclusive of hydrocarbons. Specifically, the MODU will have maintain an environmentally critical valve register that lists all valves and whether they are locked-out and only to be opened under a permit to work.
Spill containment	Drilling Contractor management system includes provision to maintain spill containment and clean-up equipment aboard the MODU and clean spills aboard the MODU to prevent release to the marine environment.

SMPEP or SOPEP (appropriate to class)	In accordance with MARPOL Annex I and AMSA's MO 91 [Marine Pollution Prevention – oil], a SMPEP or 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
	• 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 release of hydrocarbon
	  ◦ 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.

Consequence rating	Minor (1)
Likelihood of occurrence	Unlikely (3)
Residual risk	Low

Acceptability assessment	
To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with a minor loss of containment event. The loss of containment of minor spills was assessed as having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.
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 minor spills.
Other requirements	Minor spills are to be managed in consideration with: • Marine Order 91, Marine pollution prevention – oil • MARPOL 73/78. No environmental management plans, conservation advice or recovery plans were identified as relevant to this aspect.
Monitoring and review	Impacts associated with minor spills are over a small area and not predicted to impact protected or commercially important receptors. Beach will regular monitor the environmentally critical valves over the course of the program to ensure they remain locked, and spills overboard are prevented. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.
Acceptability outcome	**Acceptable**

Environmental performance outcome	Environmental performance standard	Measurement criteria
No spills of chemicals or hydrocarbons to the marine environment	**Bunkering procedure** Chemical and hydrocarbon bunkering shall be undertaken in accordance with Drilling Contractor bunkering procedures.	JHA records Bunkering records
	Drain management All overboard discharge points from mud pits, and areas containing potentially hazardous substances locked closed and only open under permit.	Permits issued HSE Inspection
	Spill containment Materials and equipment that have the potential to spill onto the deck or marine environment shall be stored within a contained area.	MODU/vessel inspection
	SMPEP or SOPEP (appropriate to class) Support vessels 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 MODU/vessel test schedule. spill response kits shall be available and routinely checked to ensure adequate stock is maintained.	Vessel SMPEP MODU/vessel inspection MODU/vessel exercise schedule

7.14 Loss of containment – vessel collision (marine diesel)

7.14.1 Establish the context

Marine diesel oil is used in offshore vessels. During drilling activities, an accidental release of fuel may occur. A collision between a Beach contracted vessel and third-party vessel or the platform has the potential to result in a spill of fuel. A vessel collision typically occurs as a result of:

- mechanical failure/loss of DP
- navigational error
- foundering due to weather.

A vessel collision event within the Operational Area is considered a credible (but unlikely) loss of containment event. An assessment of the potential impact from this event is based upon a loss of inventory from the largest fuel tank on a support vessel resulting from a vessel collision incident. Based on the types of support vessels typically used for offshore drilling activities, the size of the largest fuel tanks and fuel type to be utilised, Beach identified the credible worst-case scenario as a surface release of 300 m^3 of MDO. The Yolla-A platform location has been applied as collision with the platform is considered the most credible scenario. For further information regarding LOWC events from this scenario, refer to Section 7.15.

The calculation of the release volume and timing aligns with the methodology recommended in the AMSA Technical guidelines for preparing contingency plans for marine and coastal facilities (AMSA 2015b).

7.14.2 Spill modelling

Beach commissioned PRS Australia West Pty Ltd (RPS) to conduct quantitative spill modelling (RPS 2022) for the credible, yet hypothetical, worst-case hydrocarbon release scenario associated with a vessel collision. The modelling report for this scenario is included as Appendix B.

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

The modelling study was carried out in several stages. Firstly, a current dataset (2000-2019) 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 (CFSR) 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 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, providing a wide range of predictions regarding the movement and weathering of the oil for any season over the course of a year.

Table 7-14 Vessel collision spill scenario model settings

Parameter	Details
Release Location	Yolla-A platform
Coordinates	-39.843883, 145.81805 (WGS84)
Water Depth	80 m

Parameter	Details
Oil type	MDO
Simulation release type	Surface
Simulation release volume	300 m^3
Simulation release duration	6 hours
Total simulation duration	20 days
Number of randomly selected spill simulation start times	100
Seasons modelled	Annual

7.14.2.1 Characteristics of diesel oils

Diesel oils are generally considered to be low viscosity, non-persistent oils, which are readily degraded by naturally occurring microbes. They are considered to have a higher aquatic toxicity in comparison to many other crude oils due to the types of hydrocarbons 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 7-15), 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 7-16 shows the boiling point ranges for the diesel used in the spill modelling.

Table 7-15 Physical characteristics of MDO

Parameter	Characteristics
Density (kg/m^3)	829 at 25 °C
API	37.6
Dynamic viscosity (cP)	4.0 at 25 °C
Pour point (°C)	-14
Oil category	Group II
Oil persistence classification	Light-persistent oil

Table 7-16 Boiling point ranges of MDO

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

7.14.2.2 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. Specifically, hydrocarbon concentrations will affect environmental receptors different based upon their sensitivity to exposure. Hydrocarbon exposure thresholds used in the modelling to support the environmental risk assessment are presented in Table 7-17. These thresholds align with NOPSEMA (2019).

Table 7-17 Hydrocarbon exposure thresholds

	Threshold	Description
Surface exposure		
Low exposure	1 g/m^2	Approximates range of socioeconomic effects and establishes planning area for scientific monitoring
Moderate exposure	10 g/m^2	Approximates lower limit for harmful exposures to birds and marine mammals
High exposure	50 g/m^2	Approximates surface oil slick and informs response planning
Shoreline exposure		
Low exposure	10 g/m^2	Predicts potential for some socio-economic impact
Moderate exposure	100 g/m^2	Loading predicts area likely to require clean-up effort
High exposure	1000 g/m^2	Loading predicts area likely to require intensive clean-up effort
Dissolved hydrocarbons		
Low exposure	10 ppb	Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers
Moderate exposure	50 ppb	Approximates potential toxic effects, particularly sublethal effects to sensitive species
High exposure	400 ppb	Approximates toxic effects including lethal effects to sensitive species
Entrained hydrocarbons		
Low exposure	10 ppb	Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers
High exposure	100 ppb	As appropriate given oil characteristics for informing risk evaluation

*In-water (entrained & dissolved) hydrocarbon thresholds are based upon an instantaneous (1 hour) hydrocarbon exposure.

7.14.2.3 Modelling results

A summary of the modelling results for the vessel collision scenario is presented in Table 7-18. No shoreline oil accumulation above the low shoreline contact threshold was predicted for the scenario. Modelling results for sea surface contact are presented in Figure 7-1, dissolved hydrocarbons in Figure 7-2 and entrained hydrocarbons in Figure 7-3.

Figure 7-4 and Figure 7-5 show the predicted weathering of the MDO under the constant 5 knot (~2.5 m/s) wind case and the variable-wind case respectively.

Under the constant wind case (Figure 7-4) shows that ~40 % of the oil is predicted to evaporate within 24 hours. Under calm conditions, the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation shall cease when the residual compounds remain, and they will be subject to more gradual decay through biological and photochemical processes.

Under the variable-wind case (Figure 7-5), where the winds are of greater strength on average, entrainment of MDO into the water column is predicted to increase. Approximately 24 hours after the spill, ~60 % of the oil mass is forecast to have entrained and a further ~38 % is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface.

Table 7-18 Summary of modelling results for the vessel collision scenario

Distance and direction	Zones of predicted exposure		
Sea surface exposure	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (>50 g/m^2)
Maximum distance travelled from release site	59.8 km	13.8 km	1.9 km
Direction	East	South	South
Shoreline exposure	Low (10 g/m^2)	Moderate (100 g/m^2)	High (>1,000 ppb)
Maximum length of shoreline coating	No contact	No contact	No contact
Dissolved hydrocarbon exposure	Low (10-50 ppb)	Moderate (50-400 ppb)	High (>400 ppb)
Maximum distance travelled from release site	80 km	15.2 km	-
Direction	East-southeast	North	-
Entrained hydrocarbon exposure	Low (10-100 ppb)	Moderate (N/A)	High (>100 ppb)
Maximum distance travelled from release site	492.4 km	-	120.4 km
Direction	East-northeast	-	East-southeast

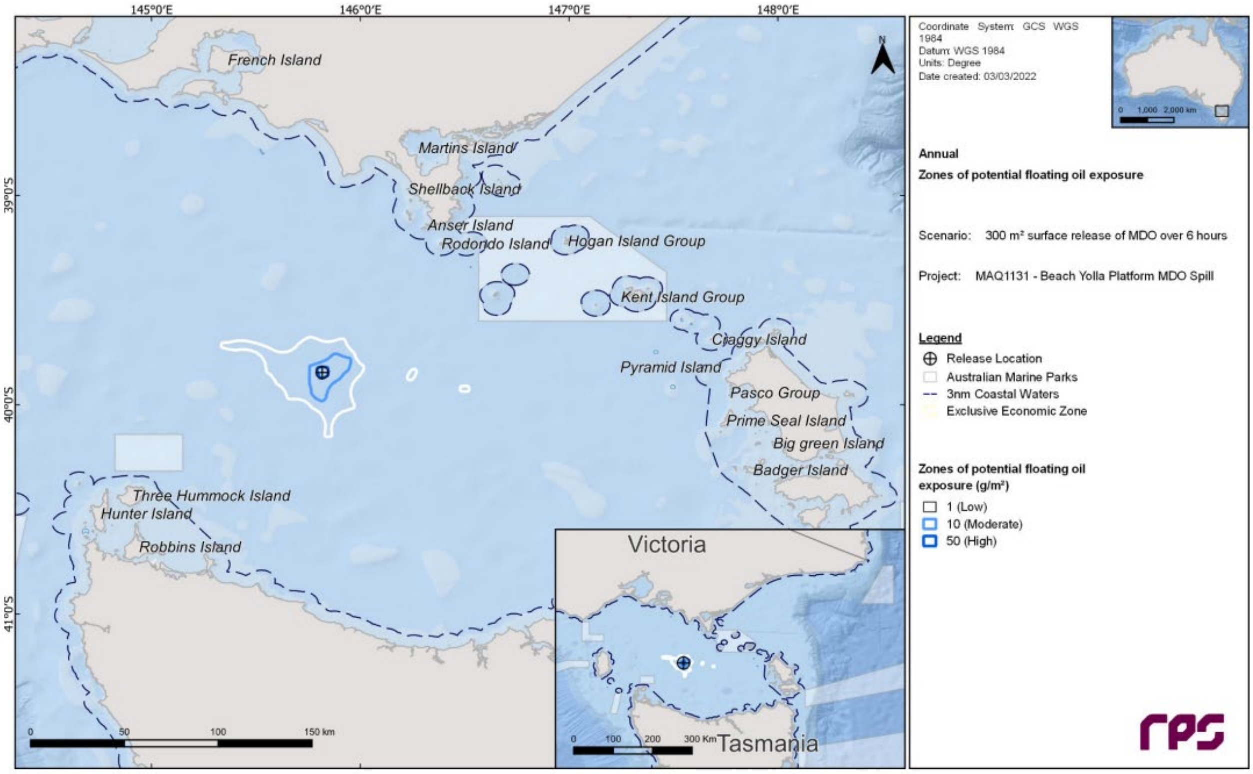


Figure 7-1 Zones of potential exposure on the sea surface in the event of a 300 m^3 of MDO containment loss over 6 hours tracked for 20 days

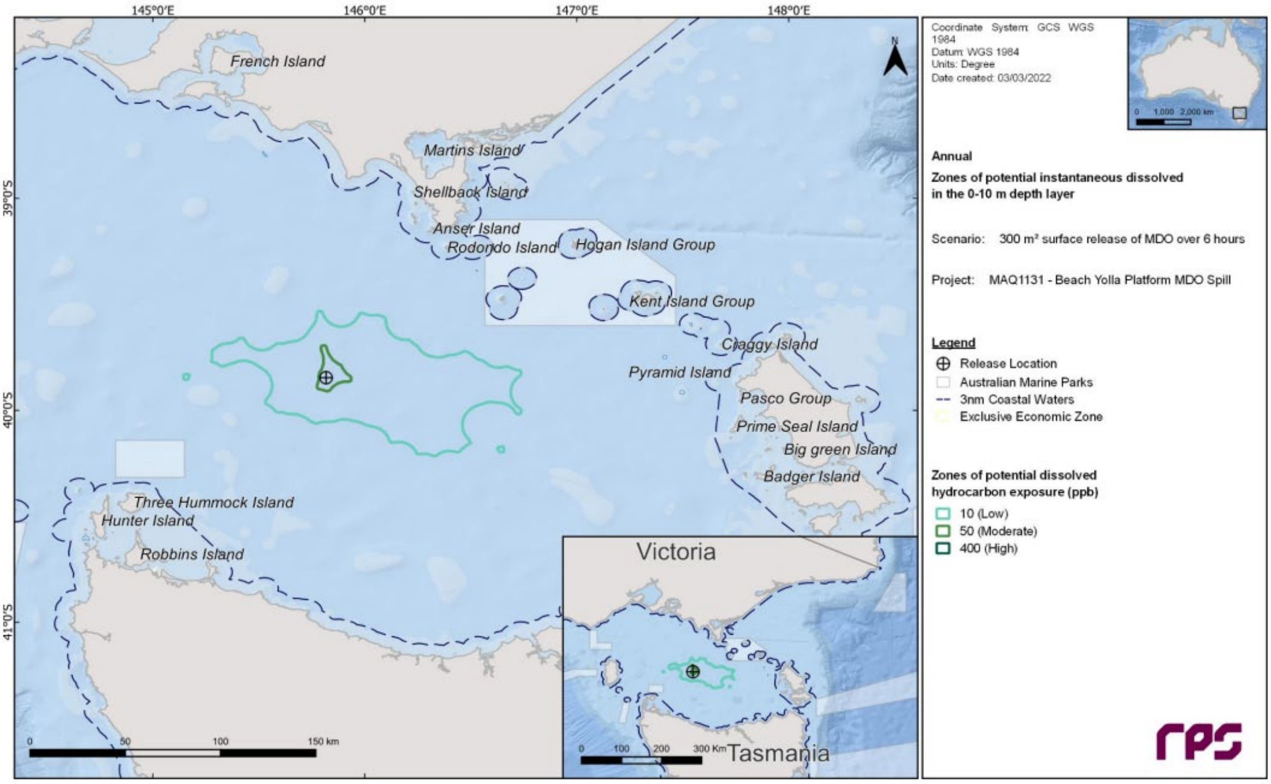


Figure 7-2 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 300 m³ of MDO containment loss over 6 hours tracked for 20 days

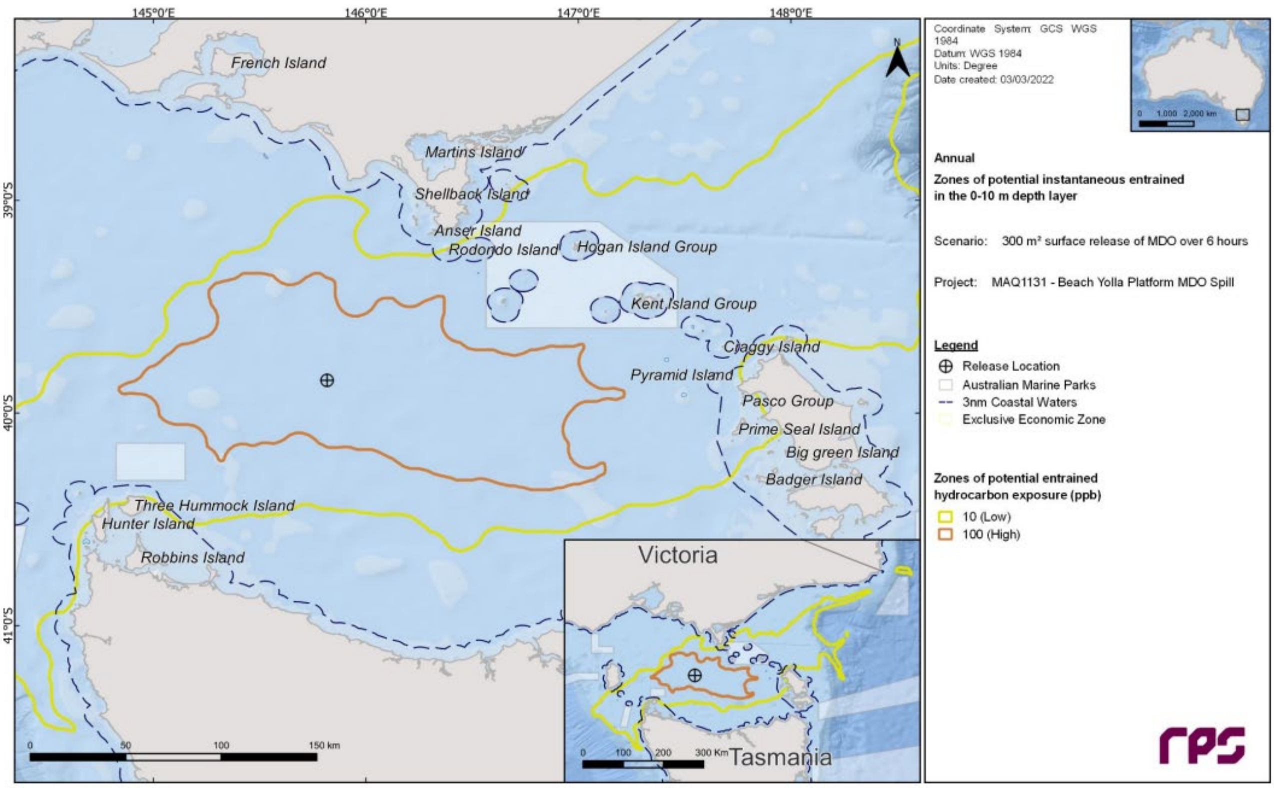


Figure 7-3 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 300 m³ of MDO containment loss over 6 hours tracked for 20 days

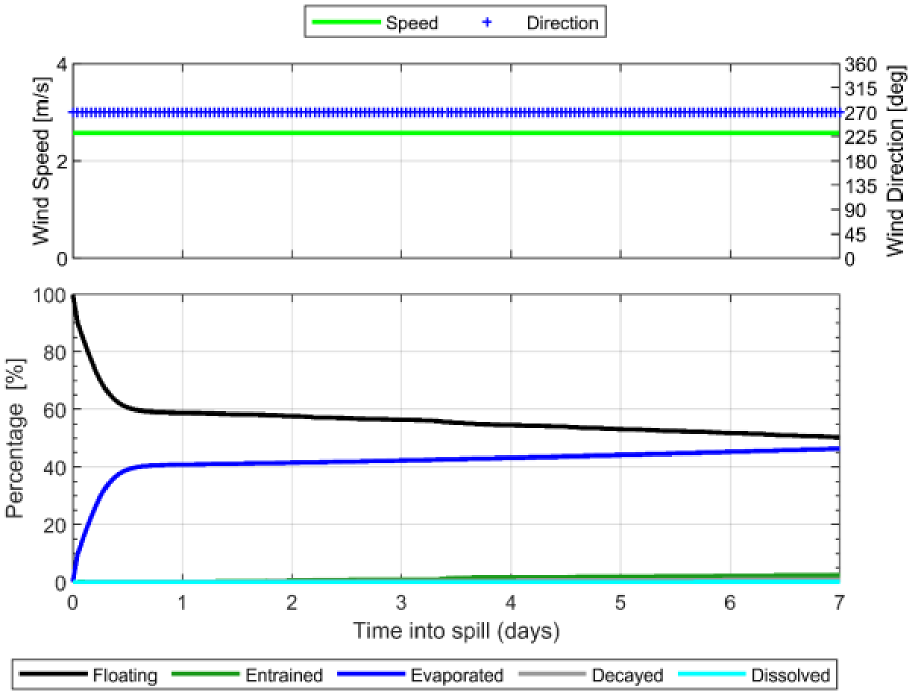


Figure 7-4 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15 °C water temperature and 20 °C air temperature

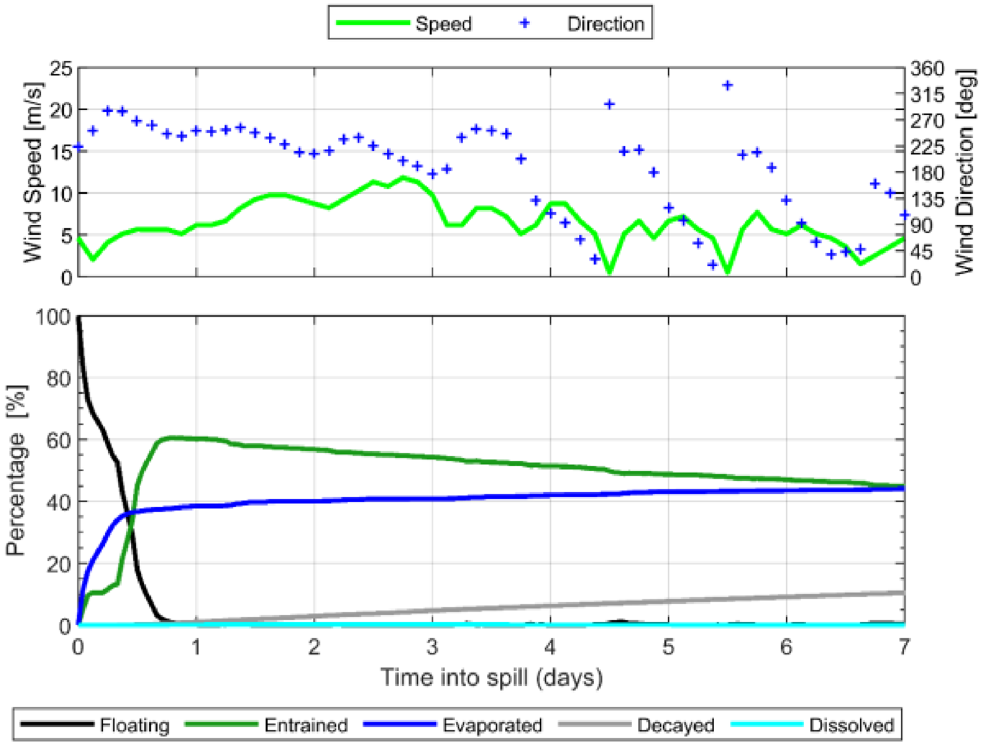


Figure 7-5 Proportional mass balance plot representing the weathering of MDO spilled onto the water over 1 hour and subject to variable wind speeds (1-12 knots) at 15 °C water temperature and 20 °C air temperature

7.14.3 Known and potential environmental impacts

The potential environmental impacts associated with hydrocarbon exposures from a vessel collision event include:

- marine pollution resulting in sublethal or lethal effects to marine fauna
- indirect impacts to commercial fisheries
- reduction in amenity resulting in impacts to tourism and recreation.

7.14.4 Consequence evaluation

7.14.4.1 Marine pollution resulting in sublethal or lethal effects to marine fauna

No shoreline oil accumulation above the low shoreline contact threshold was predicted for this event; therefore, shoreline exposure to marine fauna is not discussed further.

Marine Mammals

Marine mammals may be exposed to hydrocarbons from an oil spill at the water surface or within the water column. Marine mammals can be exposed to oil externally (e.g., swimming through surface slick) or internally (e.g., swallowing the oil, consuming oil-affected prey, or inhaling of volatile oil related compounds) (AMSA 2015b, IPIECA 1995).

Direct contact with hydrocarbons may result in skin and eye irritation, burns to mucous membranes of eyes and mouth, and increased susceptibility to infection (Garcia and St Aubin 1988). However, direct contact with surface oil is considered to have little deleterious effect on whales, possibly due to the skin's effectiveness as a barrier. Furthermore, effect of oil on cetacean skin is probably minor and temporary (Garcia and St Aubin 1988). French-McCay (French-McCay 2009) identifies that a ≥10 g/m^2 oil thickness threshold has the potential to impart a lethal dose to the species; however, also estimates a probability of 0.1 % mortality to cetaceans if they encounter these thresholds based on the proportion of the time spent at surface.

The physical impacts from ingested hydrocarbons with subsequent lethal or sublethal impacts are applicable; however, the susceptibility of cetaceans varies with feeding habits. Baleen whales are not particularly susceptible to ingestion of oil in the water column as they feed by skimming the surface (i.e., they are more susceptible to surface slicks). Toothed whales and dolphins may be susceptible to ingestion of dissolved and entrained oil as they gulp feed at depth. As highly mobile species, in general it is very unlikely that these animals will be constantly exposed to concentrations of hydrocarbons in the water column for continuous durations (e.g., >48–96 hours) that would lead to chronic effects.

Studies have shown little impact on Bottlenose Dolphins after hydraulic and mineral oil immersion and ingestion, although there was evidence of temporary skin damage in dolphins and a sperm whale from contact with various oil products including crude oil (Garcia and St Aubin 1988, F. Engelhardt 2009).

Marine mammals are vulnerable if they inhale volatiles when they surface within a hydrocarbon slick. For the short period that they persist, vapours from the spill are a significant risk to mammal health, with the potential to damage mucous membranes of the airways and the eyes, which will reduce the health and potential survivability of an animal. Inhaled volatile hydrocarbons are transferred rapidly to the bloodstream and may also accumulate in tissues (Garcia and St Aubin 1988).

Modelling was used to identify BIAs for marine mammals that may be exposed to hydrocarbon concentrations greater than impact thresholds. These were limited to:

- blue whale (distribution and foraging)
- southern right whale (migration).

As these species are considered most sensitive to surface exposures, deterministic analysis for the largest sea surface swept area was utilised to understand the potential extent and duration of exposure. The deterministic model indicates that surface hydrocarbons concentrations ≥10 g/m^2 are present for <2 days following the spill event, with a maximum area of coverage of ~7 km^2. Using the southern right whale migration BIA as an example, modelling indicates that the extent of surface exposures was predicted to be limited to <0.004 % of the entire BIA.

Based on the assessment of the predicted magnitude and duration of surface oil, it is expected that only a small proportion of any marine mammal population would be exposed above the defined impact exposure thresholds. Consequently, the potential impacts to cetaceans are considered to be Serious (3) as they could be expected to result in short-term impacts to formally managed species/habitats of recognised conservation value.

Reptiles

Marine reptiles may be exposed to hydrocarbons from an oil spill at the water surface or on the shoreline. Marine reptiles can be exposed to oil externally (e.g., swimming through surface slick) or internally (e.g., swallowing the oil, consuming oil-affected prey, or inhaling of volatile oil related compounds) (National Oceanic and Atmospheric Administration 2010).

Marine turtles are vulnerable to the effects of oil at all life stages: eggs, hatchlings, juveniles, and adults. Several aspects of turtle biology and behaviour place them at risk, including a lack of avoidance behaviour, indiscriminate feeding in convergence zones, and large pre-dive inhalations (AMSA 2015a). Oil effects on turtles can include impacts to the skin, blood, digestive, and immune systems, and increased mortality due to oiling.

As identified in Section 5.7.7, several turtle species listed as threatened and/or migratory under the EPBC Act have the potential to occur within the region. No BIAs for marine turtles were identified as having the potential to be exposed to hydrocarbon concentrations greater than the impact threshold.

The deterministic model indicates that surface hydrocarbons concentrations ≥10 g/m^2 are present for <2 days following the spill event, with a maximum area of coverage of ~7 km^2.

Based on an assessment of the predicted magnitude and duration of surface oil, it is expected that only a small proportion of any marine reptile population would be exposed above the defined impact thresholds. Consequently, the potential impacts to marine reptiles are considered to be Serious (3) as they could be expected to result in short-term impacts to formally managed species.

Fish

Fish, including sharks and rays, may be exposed to hydrocarbons from an oil spill within the water column. Most fish do not break the sea surface, and therefore the risk from surface oil is not relevant; however, some shark species (including white sharks) feed in surface waters, so there is also the potential for surface hydrocarbons to be ingested.

Potential effects include damage to the liver and lining of the stomach and intestine, and toxic effects on embryos (Lee, et al. 2011). Fish are most vulnerable to oil during embryonic, larval and juvenile life stages. However, very few studies have demonstrated increased mortality of fish as a result of oil spills (IPIECA 1995, Fodrie, et al. 2014, Hjermann, et al. 2007).

Demersal fish are not expected to be impacted given the presence of entrained oil is predicted in the surface layers (<20 m water depth) only.

Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons are typically insufficient to cause harm (ITOPF 2014). Pelagic species are also generally highly mobile and as such are not likely to suffer extended exposure (e.g., >48–96 hours) at concentrations that would lead to chronic effects due to their patterns of movement. Near the sea surface, fish can detect and avoid contact with surface slicks meaning fish mortalities rarely occur in the event of a hydrocarbon spill in open waters (Volkman, et al. 2004). Fish that have been exposed to dissolved hydrocarbons can eliminate the toxicants once placed in clean water;

hence, individuals exposed to a spill are likely to recover (King, et al. 1996). Marine fauna with gill-based respiratory systems, including whale sharks, are expected to have higher sensitivity to exposures of entrained oil.

BIA for fishes including sharks and rays that may be exposed to hydrocarbon concentrations greater than impact thresholds include:

- white shark (distribution).

As the white shark is an epipelagic fish, the impact threshold for dissolved hydrocarbon was assessed. The deterministic model indicates that there will be no dissolved hydrocarbons above the impact threshold (≥50 ppb). Entrained hydrocarbons pose the largest exposure to pelagic species. A deterministic model for the total area of entrained hydrocarbon exposure (km^2) indicates there is the potential for a maximum entrained hydrocarbon exposure area of 55 km^2 above 100 ppb. Comparing this to the White shark distribution BIA, this exposure equates to approximately 0.03 % of the BIA. This indicates there is limited exposure to the BIA which in turn is not expected to result in exposure to a significant impact to this species.

Based on an assessment of the predicted magnitude of dissolved and entrained oil, it is expected that only a small proportion of any fish population would be exposed above the defined impact thresholds. Consequently, the potential impacts to fish are considered to be Serious (3) as they could be expected to result in short-term impacts to formally managed species/habitats of recognised conservation value.

Seabirds and shorebirds

Birds may be exposed to hydrocarbons from an oil spill at the water surface (e.g., foraging, resting) or on the shoreline (e.g., roosting, nesting).

Birds that rest at the water's surface (e.g., shearwaters) or surface-plunging birds (e.g., terns, boobies) are particularly vulnerable to surface hydrocarbons (AMSA 2015a, Clark 1984). Damage to external tissues, including skin and eyes, can occur, along with internal tissue irritation in lungs and stomachs (Peakall, Wells and Mackay 1987). Acute and chronic toxic effects may result where the product is ingested as the bird attempts to preen its feathers (Peakall, Wells and Mackay 1987).

BIAs for seabirds and shorebirds that may be exposed to hydrocarbon concentrations greater than impact thresholds include:

- black-browed albatross (foraging)
- Bullers albatross (foraging)
- Campbell albatross (foraging)
- common diving-petrel (foraging)
- Indian yellow-nosed albatross (foraging)
- short-tailed shearwater (foraging)
- shy albatross (foraging)
- wandering albatross (foraging)
- white-faced storm-petrel.

These species are most sensitive to surface and shoreline hydrocarbon exposures. However, as no shoreline oil accumulation above the low shoreline contact threshold was predicted for the scenario; impacts from shoreline exposures were not discussed further with this assessment focused on impacts arising from surface hydrocarbon concentrations.

The deterministic model indicates that surface hydrocarbons concentrations ≥10 g/m^2 are present for <2 days following the spill event, with a maximum area of coverage of ~7 km^2. Using the black-browed albatross foraging BIA as an example, modelling indicates that the extent of surface exposures was predicted to be limited to <0.08 % of the entire BIA.

Based on an assessment of the predicted magnitude and duration of surface oil, it is expected that only a small proportion of any seabird or shorebird population would be exposed above the defined impact thresholds. This exposure would be limited to a couple of days, and consequently, the potential impacts to seabirds are considered to be Serious (3) as they could be expected to result in short-term impacts to formally managed species/habitats of recognised conservation value.

7.14.4.2 Indirect impacts to commercial fisheries

As identified in Section 5.8.5, 5.8.7 and 5.8.8, several commercial fisheries have management areas and recent fishing effort recorded within the EMBA.

Stochastic modelling showed that dissolved oil above impact thresholds (≥50 ppb) was predicted to extend up to 15.2 km (north) of the release location. Entrained oil above low (10-100 ppb) and high (≥100 ppb) impact thresholds up to 492.4 km (east-northeast) and 120.4 km (east southeast) from the release location respectively.

Although exposures above impact thresholds have the potential to affect the recruitment of targeted commercial and recreational fish species, any acute impacts are expected to be limited, given this event is singular, non-continuous, and will result in a limited volume of hydrocarbon being released over a short time. Any short-term impacts to fish larvae and plankton are expected to recover rapidly as oceanic currents both disperse any hydrocarbon and replenish biomass.

On this basis recruitment of targeted species is not expected to be impacted significantly given the extent of exposure to concentrations above impact thresholds are limited due to rapid dilution and dispersion upon release. Further the replenishment of

Spill events also have the potential to impact commercial fisheries through indirect impacts associated with tainting. Tainting is a change in the characteristic smell or flavour and renders the catch unfit for human consumption or sale due to public perception. Tainting may not be a permanent condition but will persist if the organisms are continuously exposed; but when exposure is terminated, depuration will quickly occur (McIntyre, et al. 1982). Regardless of the small potential for tainting from this type of event, customer perception that tainting has occurred may cause a larger impact then the direct impact itself. However, as this event is singular, non-continuous, and will result in a limited volume of hydrocarbon being released over a short time period, and the low persistence of the hydrocarbon in the environment, customer perceptions are not expected to be altered for a prolonged period.

Modelling predicts that exposure is expected to rapidly dilute and disperse over time, and it is expected than any impacts for this type of event would likely be limited to short term effects.

As such, Beach has assessed the consequence to commercial fisheries as minor adverse public concern and ranked it as Moderate (2).

7.14.4.3 Reduction in amenity resulting in impacts to tourism and recreation

Surface exposure can impact the visual amenity of offshore areas and limit tourism and recreation activities. As discussed in Section 5.8.4, marine tourism and recreation in the Bass Strait is primarily located along the coast. No shoreline oil accumulation above the low shoreline contact threshold was predicted for the scenario.

As the EMBA is located over 80 km from the coast and considering the EMBA accounts for a small proportion of the Bass Strait region, limited tourism and recreation vessels are expected to be impacted in the event of a spill.

As such, Beach have ranked the consequence tourism and recreation as Minor (1).

7.14.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Loss of marine diesel from vessel collision	
ALARP decision context and justification	**ALARP Decision Context: Type A** Vessels have been used for activities within the Bass Strait offshore natural gas development for many years with no major incident. Vessel activities are well regulated with associated control measures, well understood, and are implemented across the offshore industry. There are no conflicts with company values, no partner interests and no significant media interests. There were no objections from stakeholders regarding the risk of a loss of MDO from a vessel collision from this activity. As the risk is rated Medium, applying good industry practice control measures (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good practice control measures**
Ongoing 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.
	Engagement with AMSA requested that the jack-up MODU rig notify AMSA's Joint Rescue Coordination Centre (JRCC) for promulgation of radio-navigation warnings 24-48 hours before operations commence. AMSA's JRCC will require the jack-up MODU rig details including: • name • callsign • Maritime Mobile Service Identity (MMSI)) • satellite communications details (including INMARSAT-C and satellite telephone) • area of operation • requested clearance from other vessels and operations start and end dates
	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. Engagement with AMSA requested the Australian Hydrographic Office be contacted through datacentre@hydro.gov.au no less than four working weeks before operations commence for the promulgation of related notices to mariners.

SMPEP or SOPEP (appropriate to class)	In accordance with MARPOL Annex I and AMSA's MO 91 [Marine Pollution Prevention – oil], a SMPEP or 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
	• 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 release of hydrocarbon
	  ◦ 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.

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.	
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.	
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.	
Navigation and communication aids.	The MODU and support vessels shall be fitted with an automatic identification system (AIS) transceiver and ensure their navigation status is set correctly in the vessels and MODU AIS unit.	
Rig safety exclusion zone around the MODU during the drilling activity.	A 500 m rig safety exclusion zone shall be established around the MODU during the drilling activity.	
Permanent Petroleum Safety Zone (PSZ)	PSZs, administrated by NOPSEMA under the OPGGS Act, are specified areas surrounding petroleum wells, structures or equipment which vessels or classes of vessel are prohibited from entering or being present in. Applicants of a PSZ must demonstrate effective consultation with parties which may be directly impacted.	
Consequence rating	Serious (3)	
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	Based upon the risk assessment completed for this project, the activities were assessed as having the potential to result in a Serious (3) consequence. This potential impact has not been determined to effect biological diversity and ecological integrity and with the control measures in place, the likelihood of any potential impact occurring is deemed Highly Unlikely (2). Further, quantitative modelling has been undertaken to remove some of the scientific uncertainty associated with this aspect. As such, the activity is considered to be consisted with the principles of ESD.	
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	No objections or claims have been raised during stakeholder consultation regarding the potential for diesel spills.	
Other requirements	A loss of containment is to be managed in consideration with: • Commonwealth *Navigation Act 2012* • MO 21: Safety and emergency arrangements • MO 30: Prevention of collisions • MO 31: SOLAS and non-SOLAS certification • MO 91: Marine Pollution Prevention – oil The management of a loss of containment scenario is not inconsistent with the following management plans, conservation advice or recovery plans: • Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017b) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA 2008b) • Recovery Plan for the White Shark (DSEWPaC 2013a) • Conservation Management Plan for the Southern Right Whale (DSEWPaC 2012a) • Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) • Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC 2015c) • Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC 2015d) • National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (DSEWPaC 2011a).	
Monitoring and review	Impacts as a result of a hydrocarbon spill will be monitored in accordance with the OSMP [CDN/ID S4100AH717908]. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy.	

	The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.	
Acceptability outcome	**Acceptable**	
Environmental performance outcome	**Environmental performance standard**	**Measurement criteria**
No spills of chemicals or hydrocarbons to the marine environment	**Ongoing consultation** Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 9 (Stakeholder Consultation). This includes: • AMSA's Joint Rescue Coordination Centre (JRCC) will be notified 24-48 hours before operations commence • the AHO will be contacted through datacentre@hydro.gov.au no later than four weeks before operations commence.	Notification records Communication records
	SMPEP or SOPEP (appropriate to class) Support vessels 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 MODU/vessel test schedule. • spill response kits shall be available and routinely checked to ensure adequate stock is maintained.	MODU/vessel SMPEP MODU/vessel inspection MODU/vessel exercise schedule
	MO 21: Safety and emergency arrangements Support vessels shall meet the safety measures and emergency procedures of the AMSA MO 21	Vessel inspection
	MO 30: Prevention of collisions **Support vessels shall meet the navigation equipment, watchkeeping, radar and lighting requirements of AMSA MO 30.**	Vessel inspection
	MO 31: SOLAS and non-SOLAS certification Support vessels will meet survey, maintenance and certification of regulated Australian vessels as per AMSA MO 31.	Vessel inspection
	Navigation and communication aids The MODU and support vessels shall be fitted with an automatic identification system (AIS) transceiver enabling the MODU/vessel to receive the data broadcasted by surrounding vessels, such as Maritime Mobile Service Identity (MMSI) number, IMO number, VHF call sign, speed, heading and course over ground. Navigation status will be set correctly in the MODU and vessels AIS unit. AIS shall be monitored 24 hours per day	MODU/vessel inspection
	Rig safety exclusion zone around the MODU during the drilling activity. A 500 m rig safety exclusion zone shall be established around the MODU during the drilling activity. Access into the 500 m rig safety exclusion zone, including approach directions and speed, shall be managed via the MODU. At least one support vessel shall be stationed near the MODU at all times to warn errant vessels. Navigation Charts will indicate the location of both the Yolla-A platform and the 500 m PSZ.	AMSA NTM Control room records Navigational Charts

	Permanent PSZ The existing 500 m PSZ shall be maintained at the Yolla-a platform and will inherently include the MODUs location during drilling activities.	PSZ Gazetted Notice

7.15 LOWC (gas condensate)

7.15.1 Establish the context

During the drilling activity there is the potential for a Loss of Well Control (LOWC) event as a result of:

- a loss of well integrity resulting from the failure of multiple well control barriers
- a prolonged and uncontrolled influx of formation fluid into the well bore (a well kick).

An evaluation of all spill scenarios associated with this petroleum activity, and a LOWC event is considered worst case credible (but unlikely) event. Beach Energy considered the potential for multiple wells flowing during the mobilisation and positioning of the MODU at the Yolla-A platform. However, as the production wells will be shut-in and isolated prior to positioning the MODU onsite, the potential for multiple flowing wells was not deemed credible.

7.15.2 Spill modelling

Beach contracted RPS to conduct quantitative spill modelling (Appendix A) to inform the credible, yet hypothetical, worst-case loss of well control (LOWC) scenario. The LOWC scenario represents a blowout release from the Yolla-A platform location. This modelling and scenario is consistent with the NOPSEMA accepted BassGas Offshore Operations EP (CDN/ID 3972814). Beach completed a review of the modelling inputs to verify the appropriateness of applying the model to activities covered under this EP. It was considered appropriate as:

- the targeted reservoir composition for Yolla 7 / Yolla 7 DW1 was deemed to be the same as the existing Yolla production wells (Section 4.4)
- the duration of the LOWC event was deemed to be sufficient with Beach confirming a relief well can be drilled within 86 days.

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

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 CFSR 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 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. Table 7-19 summarises the model settings.

Table 7-19 LOWC spill scenario model settings

Parameter	Details
Release Location	Yolla-A platform
Coordinates	-39.843883, 145.81805 (WGS84)
Water Depth	80 m
Oil type	Yolla condensate
Simulation release type	Subsea
Simulation release volume	204,250 bbl (32,472 m^3)
Simulation release duration	86 days
Total simulation duration	100 days
Number of randomly selected spill simulation start times	100
Seasons modelled	Annual

7.15.2.1 Characteristics of Yolla condensate

The LOWC scenario has been assessed using Yolla condensate properties. It has a low density, a low pour point and a low dynamic viscosity, indicating that it will spread quickly when spilled at sea and thin out to low thicknesses, increasing the rate of evaporation. The physical characteristics of Yolla condensate are listed in Table 7-20.

On release to the marine environment, condensate would be evaporated, decayed and 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).

Table 7-20 Physical characteristics of Yolla condensate

Parameter	Characteristics
Density (kg/m^3)	770.6 at 15 °C
API	52.15
Dynamic viscosity (cP)	0.14 at 25 °C
Pour point (°C)	-3
Oil category	Group I
Oil persistence classification	Non-persistent oil

7.15.2.2 Thresholds

Hydrocarbon thresholds are described in Table 7-17 in Section 7.14.2.2 and has not been duplicated here.

7.15.2.3 Modelling results

A summary of the modelling results for the LOWC scenario is presented in Table 7-21. No shoreline oil accumulation above the low shoreline contact threshold was predicted for the scenario.

Modelling results for sea surface contact are presented in Figure 7-6, entrained hydrocarbons in Figure 7-7 and dissolved hydrocarbons in Figure 7-8.

Modelling considered three wind conditions (5, 10 and 15 knots, (RPS 2020b)). The fates and weathering graph (Figure 7-9) illustrates rapid evaporation under all three wind speeds.

Table 7-21 Summary of modelling results for the LOWC scenario

Distance and direction	**Zones of predicted exposure**		
Sea surface exposure	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (>50 g/m^2)
Maximum distance travelled from release site	17.3 km	No contact	No contact
Direction	South-southeast	NA	NA
Shoreline exposure	Low (10 g/m^2)	Moderate (100 g/m^2)	High (>1,000 ppb)
Maximum length of shoreline coating	No contact	No contact	No contact
Dissolved hydrocarbon exposure	Low (10-50 ppb)	Moderate (50-400 ppb)	High (>400 ppb)
Maximum distance travelled from release site	223 km	65 km	No contact
Direction	East-northeast	East-northeast	NA
Entrained hydrocarbon exposure	Low (10-100 ppb)	Moderate (N/A)	High (>100 ppb)
Maximum distance travelled from release site	495 km	-	43 km
Direction	East-northeast	-	West

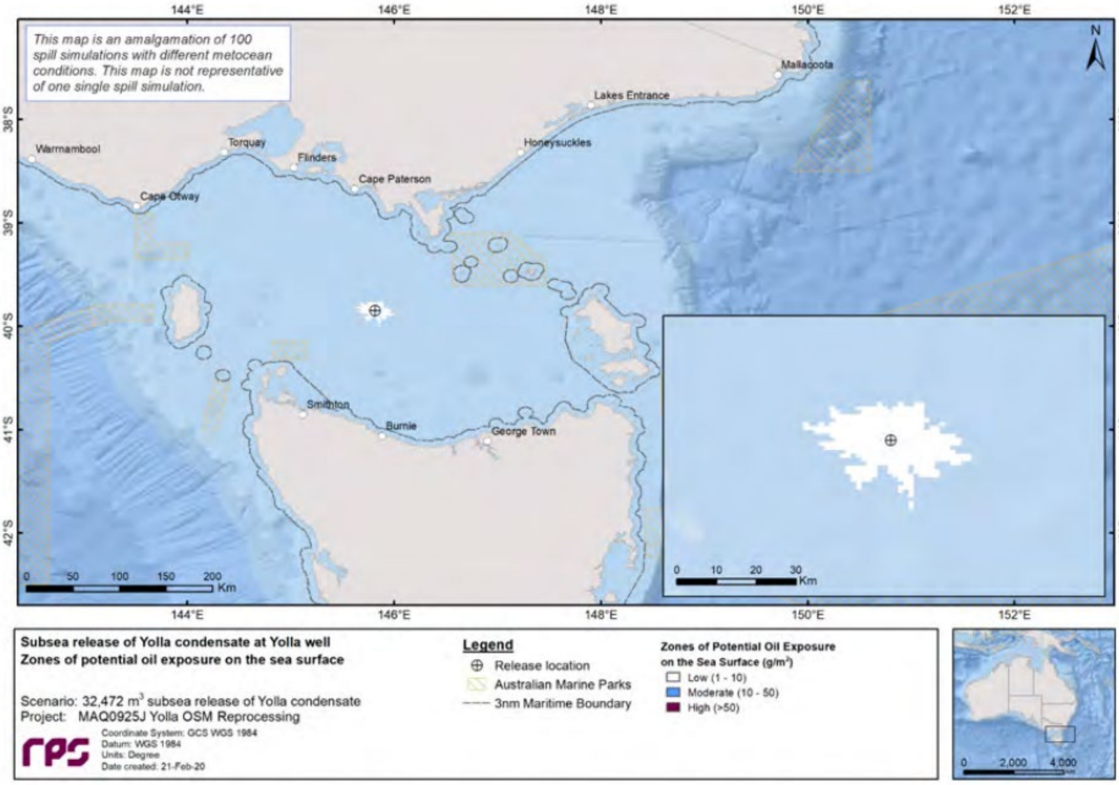


Figure 7-6 Zones of potential exposure on the sea surface in the event of a 204,225 bbl subsea release of Yolla condensate over 86 days

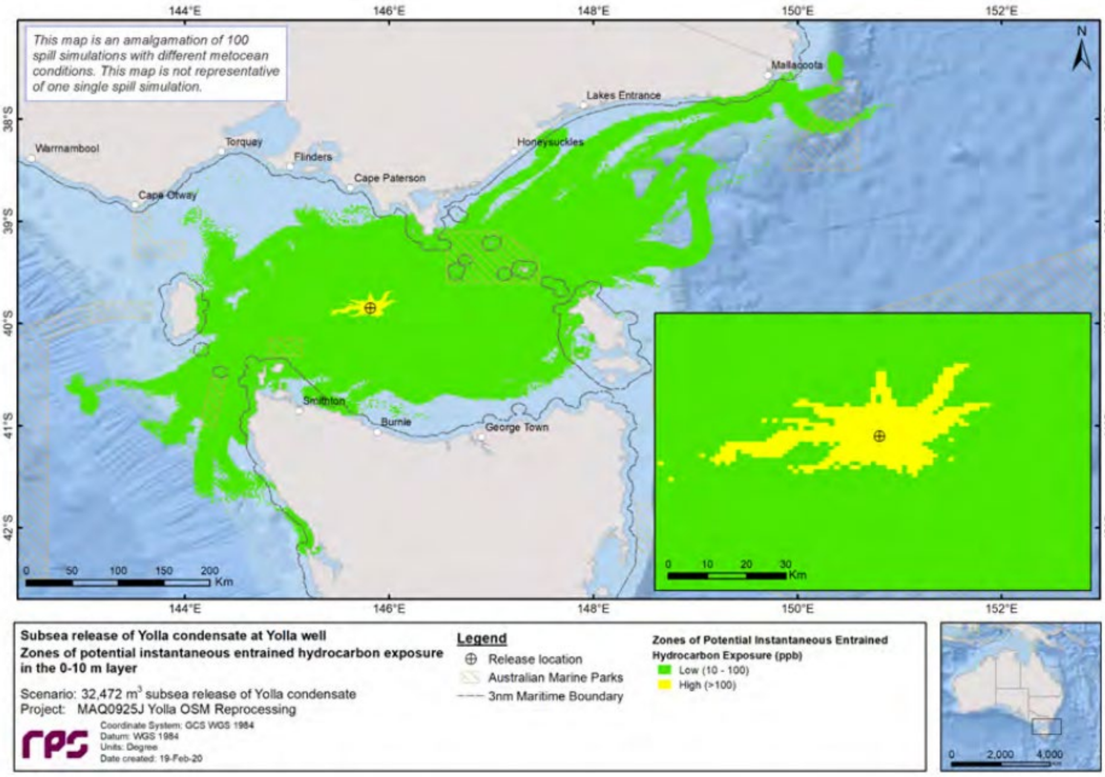


Figure 7-7 Zones of potential entrained aromatic hydrocarbons exposure at 0-10 m below the sea surface in the event of a 204,225 bbl subsea release of Yolla condensate over 86 days

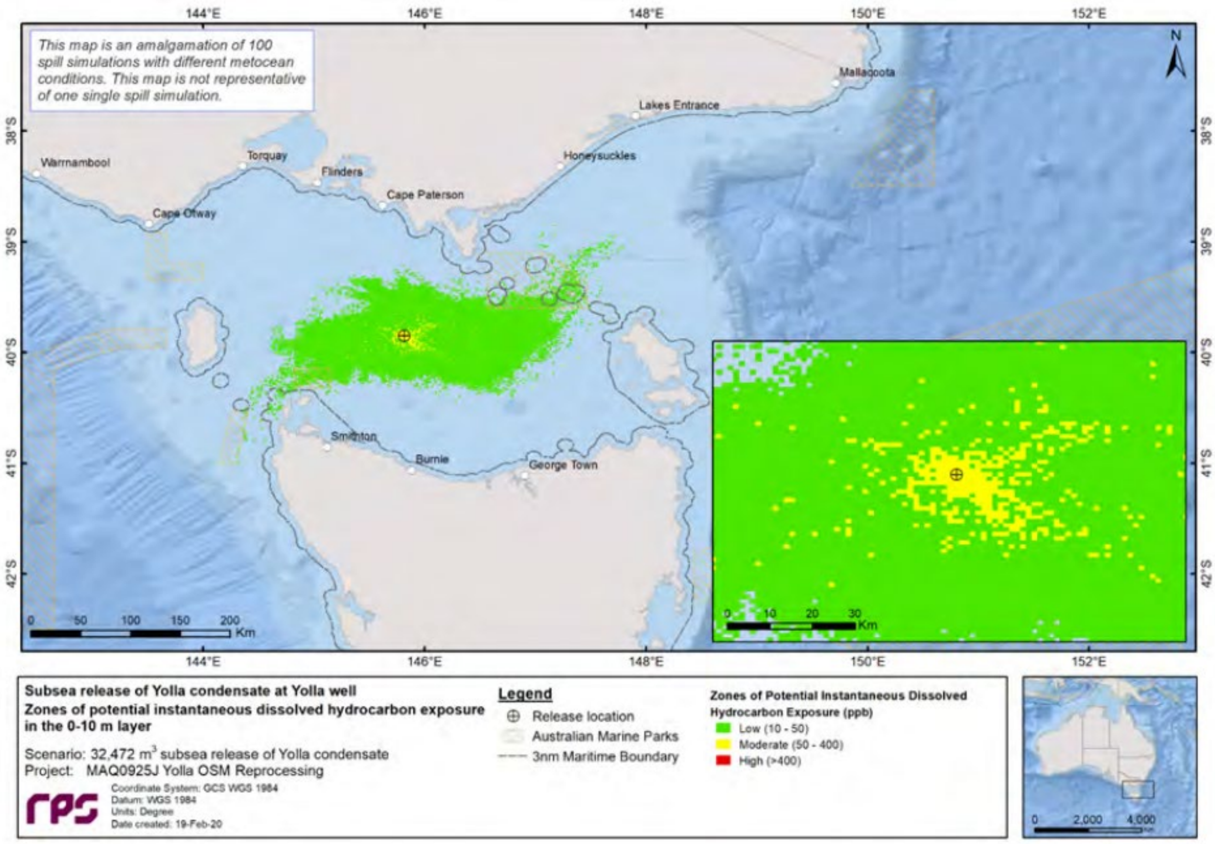


Figure 7-8 Zones of potential dissolved aromatic hydrocarbons exposure at 0-10 m below the sea surface in the event of a 204,225 bbl subsea release of Yolla condensate over 86 days

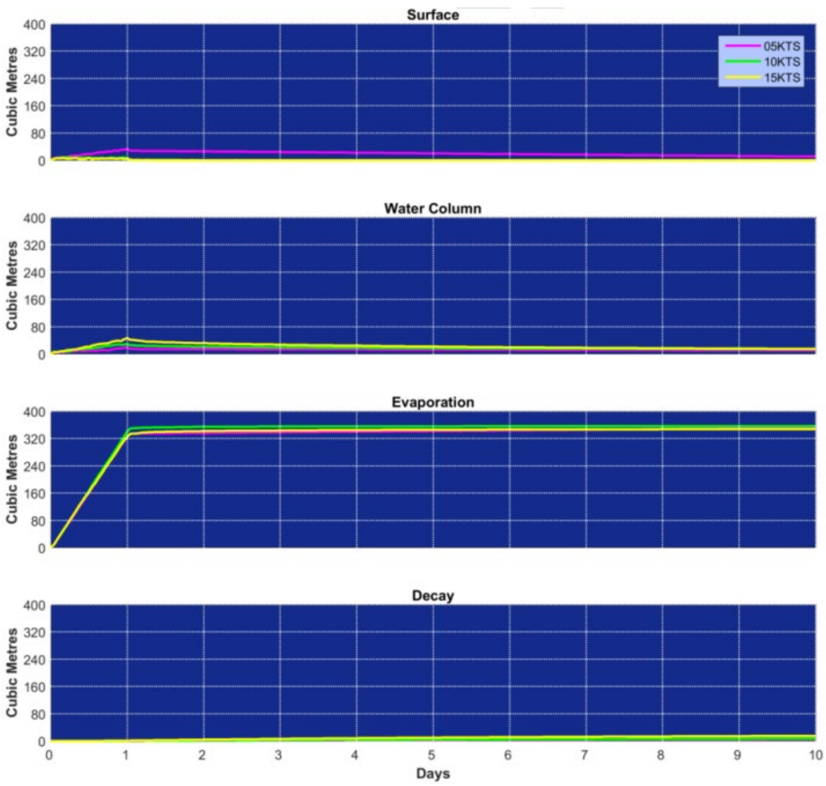


Figure 7-9 Predicted weathering of Yolla condensate under three static wind conditions

7.15.3 Known and potential environmental impacts

The potential environmental impacts associated with hydrocarbon exposures from a LOWC event include:

- marine pollution resulting in sublethal or lethal effects to marine fauna
- marine pollution resulting sublethal or lethal effects to subtidal or intertidal habitats
- indirect impacts to commercial fisheries
- reduction in amenity resulting in impacts to tourism and recreation.

7.15.4 Consequence evaluation

7.15.4.1 Marine pollution resulting in sublethal or lethal effects to marine fauna and invertebrates

No surface exposure above impact thresholds was predicted by the model. Therefore, potential impacts associated with surface exposures to marine fauna is not discussed further.

No shoreline oil accumulation above the impact threshold was predicted by the model. Therefore, potential impacts associated with shoreline exposures to marine fauna is not discussed further.

Plankton

Plankton is found in nearshore and open waters beneath the surface in the water column. These organisms migrate vertically through the water column to feed in surface waters at night (NRDA 2012). As they move close to the sea surface it is possible that they may be exposed to both surface hydrocarbons but to a greater extent, hydrocarbons dissolved or entrained in the water column.

Phytoplankton is typically not sensitive to the impacts of oil, though they do accumulate it rapidly due to their small size and high surface area to volume ratio (Hook, et al. 2016). If phytoplankton is exposed to hydrocarbons at the sea surface, this may directly affect their ability to photosynthesize and would have implications for the next trophic level in the food chain (e.g., small fish) (Hook, et al. 2016). In addition, the presence of surface hydrocarbons may result in a reduction of light penetrating the water column, which could affect the rate of photosynthesis for phytoplankton in instances where there is prolonged presence of surface hydrocarbons over an extensive area such that the phytoplankton was restricted from exposure to light. Oil can affect the rate of photosynthesis and inhibit growth in phytoplankton, depending on the concentration range. For example, photosynthesis is stimulated by low concentrations of oil in the water column (10-30 ppb), but become progressively inhibited above 50 ppb. Conversely, photosynthesis can be stimulated below 100 ppb for exposure to weathered oil (Volkman, et al. 2004).

Plankton found in open water of the EMBA is expected to be widely represented within waters of the wider Bass Strait region. Plankton in the upper water column will be directly (e.g., through smothering and ingestion) and indirectly (e.g., toxicity from decrease in water quality and bioaccumulation) affected by dissolved and dispersed hydrocarbons.

Once background water quality conditions are re-established following the natural weathering and dispersion of the hydrocarbons, plankton populations are expected to recover due to recruitment of plankton from surrounding waters.

On the basis that short term impacts to plankton could occur which would not effect long-term ecosystem function, Beach has ranked the consequence as Moderate (2).

Marine mammals

Marine mammals may be exposed to hydrocarbons within the water column. Marine mammals can be exposed to oil externally (e.g., swimming through surface slick) or internally (e.g., swallowing the oil, consuming oil-affected prey, or inhaling of volatile oil related compounds) (National Oceanic and Atmospheric Administration 2010). Given no surface exposures are expected above impact thresholds this assessment focuses on in water exposures.

Stochastic modelling was used to identify BIAs for marine mammals that may be exposed to hydrocarbon concentrations greater than impact thresholds. These were:

- Blue whale (distribution and foraging)
- Southern right whale (migration known core range).

The physical impacts from ingested hydrocarbons with subsequent lethal or sublethal impacts are applicable; however, the susceptibility of marine mammals varies with feeding habits. For pinnipeds, ingested hydrocarbons can irritate or destroy epithelial cells that line the stomach and intestine, thereby affecting motility, digestion and absorption. However, pinnipeds have been found to have the enzyme systems necessary to convert absorbed hydrocarbons into polar metabolites, which can be excreted in urine (F. R. Engelhardt 1982, Addison and Brodie 1984, Addison, Brodie and Edwards, et al. 1986).

Baleen whales, however, are not particularly susceptible to ingestion of oil in the water column as they feed by skimming the surface (i.e., they are more susceptible to surface slicks). Toothed whales and dolphins may be susceptible to ingestion of dissolved and entrained oil as they gulp feed at depth. As highly mobile species, they are not expected to be constantly exposed to concentrations of entrained hydrocarbons for prolonged durations (e.g., >48–96 hours) that have the potential to result in sublethal effects. Studies have shown little impact on Bottlenose Dolphins after hydraulic and mineral oil ingestion (Garcia and St Aubin 1988, F. Engelhardt 2009).

As a LOWC event could result in short-term effects to formally managed species, Beach has ranked the consequence as Serious (3).

Marine reptiles

Marine reptiles may be exposed to hydrocarbons from an oil spill at the water surface or on the shoreline. Marine reptiles can be exposed to oil externally (e.g., swimming through surface slick) or internally (e.g., swallowing the oil, consuming oil-affected prey, or inhaling of volatile oil related compounds) (National Oceanic and Atmospheric Administration 2010).

Marine turtles are vulnerable to the effects of oil at all life stages: eggs, hatchlings, juveniles, and adults. Several aspects of turtle biology and behaviour place them at risk, including a lack of avoidance behaviour, indiscriminate feeding in convergence zones, and large pre-dive inhalations (AMSA 2015a). Oil effects on turtles can include impacts to the skin, blood, digestive, and immune systems, and increased mortality due to oiling.

No shoreline contact was predicted under the annual conditions modelled for the LOWC event (RPS 2020b). As identified in Section 5.7.7, several turtle species listed as threatened and/or migratory under the EPBC Act have the potential to occur within the EMBA. However, the presence of these species is expected to be of a transitory nature only, with no important behaviours (e.g., foraging, internesting, etc.) expected to occur within the Operational Area. No BIAs or critical habitat for the listed species overlaps with the EMBA.

It is expected that a LOWC event would result in serious short-term effects to formally managed species.

As such, Beach has ranked the consequence as Serious (3).

Fish

Fish, including sharks and rays, may be exposed to hydrocarbons from an oil spill within the water column. Most fish do not break the sea surface, and therefore the risk from surface oil is not relevant; however, some shark species (including white sharks) feed in surface waters, so there is also the potential for surface hydrocarbons to be ingested.

Potential effects include damage to the liver and lining of the stomach and intestine, and toxic effects on embryos (Lee, et al. 2011). Fish are most vulnerable to oil during embryonic, larval and juvenile life stages. However, very few studies have demonstrated increased mortality of fish as a result of oil spills (IPIECA 1995, Fodrie, et al. 2014, Hjermann, et al. 2007).

Given the presence of dissolved or entrained hydrocarbons at or above the low exposure threshold were not predicted to occur below a depth of 10 m, demersal fish are not expected to be impacted.

Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons are typically insufficient to cause harm (ITOPF 2014). Pelagic species are also generally highly mobile and as such are not likely to suffer extended exposure (e.g., >48–96 hours) at concentrations that would lead to chronic effects due to their patterns of movement. Near the sea surface, fish can detect and avoid contact with surface slicks meaning fish mortalities rarely occur in the event of a hydrocarbon spill in open waters (Volkman, et al. 2004). Fish that have been exposed to dissolved hydrocarbons can eliminate the toxicants once placed in clean water; hence, individuals exposed to a spill are likely to recover (King, et al. 1996). Marine fauna with gill-based respiratory systems, including white sharks, are expected to have higher sensitivity to exposures of entrained oil.

As identified in Section 5.7.7, several fish species listed as threatened and/or migratory under the EPBC Act have the potential to occur within the EMBA. BIAs for fishes including sharks and rays that may be exposed to hydrocarbon concentrations greater than impact thresholds include:

- White Shark (foraging, breeding and distribution).

As highly mobile species, they are not expected to be constantly exposed to concentrations of entrained hydrocarbons for prolonged durations (e.g., >48–96 hours) that have the potential to result in sublethal effects. It is possible that a LOWC event could result in serious short-term effects to formally managed species.

As such, Beach has ranked the consequence as Serious (3).

Seabirds and shorebirds

Birds may be exposed to hydrocarbons from an oil spill at the water surface (e.g., foraging, resting) or on the shoreline (e.g., roosting, nesting).

Birds that rest at the water's surface (e.g., shearwaters) or surface-plunging birds (e.g., terns, boobies) are particularly vulnerable to surface hydrocarbons (AMSA 2015a, Clark 1984). Damage to external tissues, including skin and eyes, can occur, along with internal tissue irritation in lungs and stomachs (Peakall, Wells and Mackay 1987). Acute and chronic toxic effects may result where the product is ingested as the bird attempts to preen its feathers (Peakall, Wells and Mackay 1987).

Low levels of potential exposure (1-10 g/m^2) were centred around the release site with low exposure surface oil predicted to extend a maximum distance of 17.3 km (south-southeast) from the release location. No moderate (10-50 g/m^2) or high (≥50 g/m^2) zones of potential oil exposure was predicted. Stochastic modelling was used to identify BIAs for birds that may be exposed to hydrocarbon concentrations greater than impact thresholds. These were:

- black-browed albatross (foraging)
- Bullers albatross (foraging)
- Campbell albatross (foraging)
- Indian Yellow-nosed albatross (foraging)
- wandering albatross (foraging)

- white-faced storm-petrel (foraging).

As discussed in Section 5.7.7.2, the EMBA overlaps with a critical habitat for the shy albatross (*Thalassarche cauta*). This critical habitat comprises of a series of islands recognised as the only suitable breeding habitat under Australian jurisdiction. As no shoreline contact was predicted in a LOWC scenario (RPS 2020b), the habitat is not expected to be impacted.

Based on the limited expected surface extent, it is expected that only a small proportion of any seabird population would be exposed above the defined impact thresholds. However, given the potential to expose rafting and foraging birds, it is possible that a LOWC event could result in serious short-term effects to formally managed species.

As such, Beach has ranked the consequence as Serious (3).

7.15.4.2 Marine pollution resulting in sublethal or lethal effects to subtidal and intertidal habitats

Seagrass, Algae and Coral

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.

LOWC modelling indicates that no entrained or dissolved exposure above impact thresholds is expected below 10 m water depth (RPS 2020b). Modelling also indicates that exposures within 10 m of the surface, in water exposures were limited to within 65 km of the release location. Given the distance offshore, no hydrocarbon exposures to seagrass, algae or coral communities above impact thresholds are expected, they have not been considered further.

Mangroves, Saltmarsh and Coastal wetlands

As detailed within Section 5.7.2 and Section 5.7.3, mangroves and saltmarsh communities are known to be present along the Victorian coastline. LOWC modelling indicates that no hydrocarbon exposure to shorelines or intertidal habitats are expected above impact thresholds. As such impacts to these coastal habitats are not expected, they have not been considered further.

7.15.4.3 Indirect impacts to commercial fisheries

A LOWC event may impact commercial fisheries through tainting, toxic effects on stock and by disrupting business activities.

As identified in Section 5.8.5, 5.8.7 and 5.8.8, several commercial fisheries have management areas and recent fishing effort recorded within the EMBA. Direct impacts commercially targeted fish species are expected to occur from in-water exposures.

A major oil spill may result in the temporary closure of part of fishery management areas. It is unlikely that a complete fishery would be closed due to their large spatial extents, but the partial closure may still displace fishing effort. Oil spills may also foul fishing equipment (e.g., traps and trawl nets) and requiring cleaning or replacement; however due to the volatility of condensate, this is not expected to occur.

Spill events also have the potential to impact commercial fisheries through indirect impacts associated with tainting. Tainting is a change in the characteristic smell or flavour and renders the catch unfit for human consumption or sale due to public perception. Tainting may not be a permanent condition but will persist if the organisms are continuously exposed; but when exposure is terminated, depuration will quickly occur (McIntyre, et al. 1982). Regardless of the potential for tainting, customer perception that tainting has occurred may cause a larger impact then the direct impact itself. As a LOWC event has the potential to impact a large offshore area for a prolonged period of time, customer perception may be altered for an extended period of time.

As such, Beach has assessed the consequence to commercial fisheries as heightened adverse public concern, and is ranked as Serious (3)

7.15.4.4 Reduction in amenity resulting in impacts to tourism and recreation

No shoreline contact was predicted under the annual conditions modelled for the LOWC event (RPS 2020b). Surface exposure is expected to be centred around the release site with low exposure surface oil predicted to extend a maximum distance of 17.3 km (south-southeast) from the release location.

As discussed in Section 5.8.4, most tourism and recreation occur onshore or within coastal waters. Due to the small spatial extent surface exposure, the distance from the well offshore and its occurrence beyond State waters, direct impacts to the recreation and tourism industry associated with a reduction in aesthetics are not expected.

Due to the spatial extent of in-water exposure, indirect impacts may occur. As recreational fishing, boating and ecotourism activities occur within the Bass Strait, changes to ecological receptors (such as the potential acute and chronic effects to marine fauna described in Section 7.14) may indirectly impact tourism and recreation.

Given the potential for short-term and localised disturbance to marine tourism and recreation activities, Beach has ranked the consequence as Moderate (2).

7.15.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: LOWC	
ALARP decision context and justification	**ALARP Decision Context: Type B** Drilling activities have been undertaken previously for the Bass Gas offshore natural gas development with no LOWC incident recorded to date. Drilling activities are highly regulated with associated control measures, well understood, and are implemented across the offshore industry. There were no objections from stakeholders regarding the risk of a LOWC event from this activity. However, a LOWC incident would likely attract public and media interest. Additionally, although modelling has been undertaken to inform the assessment, there is a large degree of uncertainty regarding the risks from a LOWC incident. Consequently, Beach believes that ALARP Decision Context B should be applied.
Adopted Control Measures	**Source of good practice control measures**
Preventative	
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. Engagement with AMSA requested the Australian Hydrographic Office be contacted through datacentre@hydro.gov.au no less than four working weeks before operations commence for the promulgation of related notices to mariners.
Beach Well Engineering and Construction Management System (WECS)	Beach has in place a WECS that ensures Beach well activities are fit for purpose with operational risks managed to a level that is as low as reasonably practicable. It also ensures that changes are made in a controlled manner, that appropriate standards are adhered to, and that a sufficiently resourced and competent organisation is in place. WECS (INT-1000-DRL-STD-17891671) Technical Standard 21: Source Control Contingency Planning conforms to the international standards and delivers requirements under OEMS BSTD 6.4 – Well Construction Management (INT OEMS DRL STDCDN/ID 18985353).
Beach Well Integrity Management System (WIMS) & Well Integrity Risk Ranking	Beach has in place a WIMS, where well integrity status is reviewed, and a risk level assigned (low, medium, or high) depending on the well barrier status. This process provides for an independent assessment of the well integrity status of suspended wells, based upon information available in the well completion reports and daily drilling reports and validates that the risks of hydrocarbon leak while the well remains suspended are being managed to as low as reasonably practicable (as per the respective WOMPs).
NOPSEMA accepted WOMP	Under Part 5 of the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011, NOPSEMA is required to accept a WOMP to enable well

	activities to be undertaken. The WOMP details well barriers and the integrity testing that will be in place for the program. Beach's NOPSEMA-accepted WOMP describes the minimum requirements for well barriers during drilling activities.
NOPSEMA accepted MODU Safety Case	Under the Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009 (OPGGS(S)) set out the requirements for the contents of safety cases. The MODU requires and Australian Safety Case detailing the control in place to prevent a major accident event. The MODU Safety Case: • identifies the hazards and risks • describes how the risks are controlled • describes the safety management system in place to ensure the controls are effectively and consistently applied. Beach will only contract a MODU with a NOPSEMA accepted safety case in place.
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.
Preventative Maintenance System – BOP testing	BOP routinely function and pressure tested in accordance with manufacturer's specifications and in alignment with Drilling Contractors preventative maintenance System.
Response	
NOPSEMA accepted WOMP	Under Part 5 of the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011, NOPSEMA is required to accept a WOMP to enable well activities to be undertaken. The WOMP details the controls in place to restore well integrity in the event of a LOWC incident.
Source Control Contingency Plan (SCCP)	A SCCP shall be developed consistent with International Oil and Gas Producers (IOGP) Report 594 - Subsea Well Source Control Emergency Response Planning Guide for Subsea Wells (January 2019). Specifically detailing: • the structure and function of the Beach Wells Source Control IMT (SC IMT) • a timeline for the effective implementation of source control key events / actions • a well-specific worst-case discharge (WCD analysis) • casing design • structural integrity analysis • gas plume study.
	A relief well plan shall be developed in line with OGUK guidance to ensure that Beach has considered the response requirements in order to: • reduce the time required to initiate relief well drilling operations in the event of a LOWC • allow the relief well to be completed in the shortest time practicable. The relief well plan includes a detailed schedule with estimated times to: • source, mobilise and position a rig • drill and intercept the well • complete the well kill successfully.
NOPSEMA accepted Oil Pollution Emergency Plan (OPEP)	Under the OPGGS(E)R, NOPSEMA require that the petroleum activity have an accepted OPEP in place before the activity commences. In the event of a LOWC, the OPEP will be implemented. The Offshore Victoria OPEP (CDN/ID 18986979) was developed to support all Beach activities within State and Commonwealth waters off Victoria and includes response arrangements for a worst-case LOWC scenario. The OPEP also includes Tactical Response Plans (TRPs) for identified protection priority areas within the region.
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 [CDN/ID S4100AH717908] details: • operational monitoring to inform response planning • 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?
Do not drill the infill well	Elimination	The drilling of the infill wells forms part of the BassGas development.	No
Undertake activity at a different time of year to reduce potential exposure of receptors to hydrocarbons	Substitute	Based upon the probability of exposure to various receptors, and the volatile nature of the gas condensate, there is no discernible benefit to be gained by drilling at a different time of year given the similarity in potential hydrocarbon exposure for both summer and winter seasons	No
Rig safety exclusion zone established around the MODU during the drilling activity.	System	The drilling activity will be short in duration. The temporary exclusion of vessels from a 500 m radius of the MODU would not cause significant impact on socio-economic receptors, such as fisheries and shipping. By restricting the potential interactions between vessels and the MODU, the overall benefit in spill prevention is considered reasonable	Yes
Rig safety exclusion zone - Controlled access to rig safety exclusion zone	System	By the MODU controlling access into the 500 m rig safety zone, including approach directions and speed, the overall benefit in spill prevention is considered reasonable.	Yes
Dedicated guard vessel always on location to guard MODU from errant vessels	Equipment	A dedicated guard vessel would incur a cost to the project of approximately $20-30,000.00/day of operation. Given the presence of a support vessel always on location, there is no identified net benefit in contracting an additional dedicated guard vessel.	No
Rig safety exclusion zone - support vessel always on location to guard MODU from errant vessels	System/equipment	The overall benefit for a support vessel to maintain guard on a 24-hour basis to prevent an errant vessel from impacting the MODU is considered reasonable.	Yes
Alternate MODU on standby	Equipment	Any MODU on location would require an in-force Safety Case to operate in Australian Commonwealth waters. Having a MODU on standby would potentially halve the time to implement source control given the time required to find and mobilise the MODU to the Yolla-A platform, therefore, the overall potential reduction in exposure to shorelines may halve. Halving the potential loading at moderate threshold would produce a marginal overall environment benefit given the nature of weathered condensate. Having another rig on standby would result in significant additional costs (approx. $800,000.00/day) to the project. Beach is a signatory to APPEA mutual aid MOU that provides access to emergency equipment including rig in a course control event Consequently Beach can access other MODU's in the region. In addition to this, Beach maintains a list of rigs available in the area that would be suitable to drill a relief well in the case of an emergency. As such the cost of contracting a MODU to be on standby is considered grossly disproportionate to the level of environmental benefit gained given the other measures that are in place.	No

Consequence rating	Serious (3)
Likelihood of occurrence	Remote (1) Based on 1.5 x 10^{-4} per well drilled based upon exploration (appraisal) drilling normal gas wells drilled to North Sea Standard (IOGP 2019).
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Based upon the risk assessment completed for this project, the activities were assessed as having the potential to result in a Serious (3) consequence. This potential impact has not been determined

	to effect biological diversity and ecological integrity and with the control measures in place, the likelihood of any potential impact occurring is deemed Remote (1). Further, quantitative modelling has been undertaken to remove some of the scientific uncertainty associated with this aspect. As such, the activity is considered to be consisted with the principles of ESD.	
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	No objections or claims have been raised during stakeholder consultation regarding the potential for a LOWC event.	
Other requirements	A LOWC event is to be managed in consideration with: • MO 91: Marine Pollution Prevention – Oil • OPGGS(E)R. The management of a LOWC event was not deemed to be inconsistent with the plans, conservation advice or recovery plans listed in Table 3-2.	
Monitoring and review	Impacts as a result of a hydrocarbon spill will be monitored and reported in accordance with the OSMP [CDN/ID S4100AH717908]. Reviewing requirements are outlined in Section 8.12 of the Implementation Strategy. The environment impacts and risks associated with this aspect are sufficiently monitored and reviewed to inform this risk assessment.	
Acceptability outcome	**Acceptable**	
Environmental performance outcome	**Environmental performance standard**	**Measurement criteria**
No spills of chemicals or hydrocarbons to the marine environment.	**Ongoing consultation** Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 9 (Stakeholder Consultation). This includes: • AMSA's Joint Rescue Coordination Centre (JRCC) will be notified 24-48 hours before operations commence The AHO will be contacted through datacentre@hydro.gov.au no later than four weeks before operations commence	Notification records Communication records
	Beach Well Engineering and WECS The Beach WECS shall be applied to manage operational risks associated with drilling to ALARP; document changes to drilling design and implementation; demonstrate alignment with relevant well design and drilling standards; and track organisational competency for Beach drilling personnel.	WECS records
	Beach WIMS & Well Integrity Risk Ranking In alignment with the Beach WIMS (and consistent with Section 572 of the OPGGSA), wells scheduled for abandonment shall have their integrity status reviewed, and a risk level assigned (low, medium, or high) depending on the well barrier status to determine the potential risks of hydrocarbon leak while the well remains suspended are being managed to as low as reasonably practicable (as per the respective WOMPs).	Well examination review records
	Beach WIMS & Well Integrity Risk Ranking In alignment with the Beach WIMS (and consistent with Section 572 of the OPGGSA), a routine monitoring and inspection program shall be implemented to verify well integrity is maintained until wells are permanently abandoned.	General visual inspection (GVI) records of suspended wells and associated subsea infrastructure
	NOPSEMA accepted WOMP Well integrity shall be maintained in accordance with the NOPSEMA accepted WOMP.	NOPSEMA accepted WOMP in place No LOWC event
	NOPSEMA accepted MODU Safety Case Beach shall validate that a NOPSEMA accepted MODU Safety Case is in place for MODU operations.	NOPSEMA accepted MODU Safety Case in place

	MO 30: Prevention of collisions Support vessels shall meet the navigation equipment, watchkeeping, radar and lighting requirements of AMSA MO 30.	Vessel inspection
	Preventative Maintenance System – BOP testing The BOP shall be routinely function and pressure tested in accordance with manufacturer's specifications and in alignment with Drilling Contractors preventative maintenance system.	BOP maintenance records
Undertake oil spill response in a manner that will not result in additional impacts to marine environment, coastal habitat and oiled wildlife.	**SCCP** Emergency response capability to implement an effective well kill operation shall be maintained in accordance with well-specific SCCP inclusive of relief well plan.	Documented SCCP in place and consistent with IOGP Report 594 prior to drilling.
	SCCP The SCCP shall be consistent with the International Oil and Gas Producers (IOGP) Report 594 - Subsea Well Source Control Emergency Response Planning Guide for Subsea Wells (2019), Specifically detailing: • the structure and function of the Beach Wells Emergency Team (WET) • a timeline for the effective implementation of source control key events/actions • a well-specific WCD analysis • structural integrity analysis • gas plume study.	Documented well-specific relief well plan developed in line with OGUK guidance prior to drilling
	SCCP A relief well plan shall be developed in line with OGUK guidance to ensure that Beach has considered the response requirements in order to: • reduce the time required to initiate relief well drilling operations in the event of a LOWC • allow the relief well to be completed in the shortest time practicable. The relief well plan shall include a detailed schedule with estimated times to: • source, mobilise and position a rig • drill and intersect the well • complete the well kill successfully.	Documented well-specific relief well plan developed in line with OGUK guidance prior to drilling
	NOPSEMA accepted OPEP [CDN/ID 18986979] Emergency spill response capability shall be maintained in accordance with the OPEP (Appendix G).	Outcomes of internal audits and tests demonstrate preparedness
	NOPSEMA accepted OPEP [CDN/ID 18986979] Implement spill response in accordance with relevant EPOs and EPSs in the NOPSEMA accepted OPEP.	EMT log
	NOPSEMA accepted OSMP [CDN/ID S4100AH717908]. Operational and scientific monitoring capability shall be maintained in accordance with the OSMP [Appendix H]: • a month prior to the commencement of drilling a review of the contracted OSMP provider/s capability will be undertaken by Beach to ensure that the OSMP requirements can be met by the contracted OSMP provider/s • during drilling the contracted OSMP provider/s will provide a monthly report to show that capability as detailed in the OSMP is maintained	Outcomes of internal audits and tests demonstrate preparedness

		• the contracted OSMP provider/s capability to meet the requirements detailed in the OSMP will be tested prior to commencing drilling.

7.16 Oil Spill Response

This section presents the risk assessment for oil spill response options as required by the OPGGS(E)R.

7.16.1 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 7-22 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.

Table 7-22 Response option feasibility and effectiveness analysis

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness	Net Environmental Benefit	Implement
Source control	Limit flow of hydrocarbons to environment	Gas condensate and MDO	Feasible & effective	Yes, source control is always considered to provide a net environmental benefit by virtue of reducing the overall spill volume.	Yes
Source Control Capping Stack System	Limit flow of hydrocarbons to environment	Gas condensate	Not feasible	Not considered further given the use of a Capping Stack System is not suitable for this type of well in these water depths.	No
Monitor and evaluate	Visual – aerial & Vessel Satellite Predictive modelling	Gas condensate and MDO	Feasible & effective	Yes, both gas condensate and MDO will largely evaporate and disperse rapidly. However, monitoring and evaluation will help inform response planning and strategy implement, thus providing an indirect environmental benefit.	Yes
Chemical Dispersants	Application of chemical dispersants either surface or subsea	Gas condensate	Feasible but not effective	Not recommended for Group I oils such as condensate due to the very low viscosity and high volatility – generally no environmental benefit gained by the application of dispersant on Group I oils. Subsea dispersant injection (SSDI) may reduce volatile organic compounds (VOCs) at sea surface within the response area, therefore creating a safer work environment for responders. SSDI is also likely to result in additional safety and technical constraints due to shallow water and high gas release rates. Given capping stack system (CSS) are not feasible to deploy, SSDI is not considered further.	No[9]
		MDO	Not feasible & not effective	Although "conditional" for Group II oil, the size of potential spill volume and the natural tendency of spreading into very thin films is	No

[9] If the source control Incident Management Team determine that is a benefit to safe offshore operations, then it may be considered with a separate risk assessment.

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness	Net Environmental Benefit	Implement
				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. Surface expressions are limited to within hours of release and subsequently it is not feasible to mobilise the required equipment and provide a surface response to this type of event.	
Containment and recover	Booms and skimmers to contain surface oil where there is a potential threat to environmental sensitivities	Gas condensate	Not feasible & not effective	High volatility of condensate creates inherent safety risks when attempting to recover mechanically. Logistically, gas condensate will evaporate faster than the collection rate of a thin surface film present. To be useful, contain and recover techniques are dependent on adequate oil thickness (generally over 10 g/m^2).	No
		MDO	Not feasible & not effective	Low viscosity property allows for efficient containment by boom and recovery by oleophilic skimmers (i.e., komara disc skimmer) with ~90 % hydrocarbon to water recovery rate. To be useful, contain and recover techniques are dependent on adequate oil thickness (generally in excess of 10 g/m^2), The normal sea state of the Otway and Bass Basins do not provide significant opportunities to utilise this equipment.	No
Protection and Deflection	Booms and skimmers deployed to protect environmental sensitivities	Gas condensate and MDO	Potentially feasible & partially effective	As subsea release of Yolla condensate spill events associated will not impact shoreline habitats (RPS 2020b), these response options are not considered suitable.	No
Shoreline Clean-up	The active removal and/or treatment of oiled sand and debris	Gas condensate and MDO	Potentially feasible & partially effective	As subsea release of Yolla condensate spill events associated will not impact shoreline habitats (RPS 2020b), these response options are not considered suitable.	No
Oiled Wildlife Response	Capture, cleaning and rehabilitation of oiled wildlife.	Gas condensate and MDA	Potentially feasible & partially effective	At the direction of State Control Agency, impacts to wildlife shall be monitored and oiled wildlife response implemented to affected wildlife as appropriate. Effectiveness of response option depends on affected species and habitat type.	Yes

7.16.2 Capability assessment

As this EP includes identical spill scenarios to that covered in the NOPSEMA accepted BassGas Offshore Operations EP and OPEP, the arrangements and capability assessment is deemed sufficient for the purposes of this EP.

The arrangements in place as detailed in the BassGas Offshore Operations EP (CDN/ID 3972814) are provided in the subsections below.

7.16.2.1 Source Control

Beach has put in place the following capabilities to implement a relief well drilling activity:

- the use of competent and experienced offshore drilling engineers and drilling superintendents to design a relief well and develop a RWP specific to the Yolla field. The Beach Wells Team has competent well engineers that would project manage the relief well planning in conjunction with Wild Well Control and be guided by the WECS workflow and technical standards.
- access to a MODU in accordance with:
  - The APPEA Australian Offshore Titleholders Source Control Guideline.
  - rig broker (with monthly reports provided).
- contracts with well control contractors (Wild Well Control and Cudd Well Control) for the provision of specialist personnel and equipment
- EMT and SC IMT (and associated plans) that is trained and undertakes regular drills and exercises to maintain a state of preparedness
- RWP (T-5100-35-MP-005) that outlines a kill well design, MODU mobilisation times and technical considerations that has been prepared in line with international standards.

7.16.2.2 Monitor and evaluation

Beach (through its membership with AMOSC) and the DJPR (Emergency Management Branch [EMB]) maintain operational monitoring capability as outlined in Table 7-23. The deterministic OSTM results indicate that the largest swept areas of visible oil for each spill scenario are 5 km (pipeline rupture), 13 km (MDO release) and 16.5 km (for LoWC). These are small areas to cover by vessel or aircraft. Given these small areas of exposure, the resources listed in Table 7-23 are deemed to be adequate for monitoring purposes.

Beach acknowledges that are likely to be multiple vessels on the water in and around the source of a spill that are assisting with source control or evacuating personnel to safety and are therefore not able to be dedicated to undertake spill monitoring and evaluation duties. However, in the event of a well blowout, few vessels are likely to be required until a MODU is mobilised to location (given that well capping [with its associated vessel requirements] is not a feasible option for well control). Similarly, few vessels are required to begin repairs on a pipeline rupture, so both condensate spill scenarios are unlikely to deplete the pool of vessels of opportunity (VoO) available from nearby ports.

Table 7-23 Resources available for monitoring and evaluation

Resource required	Beach resources	DJPR (EMB) resources
Aviation	Beach will activate its contract with AMOSC to access helicopter and/or fixed aircraft to assist in spill monitoring. Beach can also request its helicopter contractor (used for routine personnel transfers to and from Yolla-A platform) to assist with aerial observation duties.	Access to Emergency Management Victoria's (EMV's) State Aircraft Unit. Air support can be mobilised within 4 hours of request. Additionally, NatPlan resources can be activated.
Trained observers	Beach can request the assistance of AMOSC's Core Group personnel (>120 oil and gas industry personnel nation-wide) who are available 24/7 to respond to marine oil spills.	EMV's State Response Team (SRT) or AMSA Search and Rescue resources can be called upon but is unlikely to be required given the AMOSC resources available. These resources are available within 4 hours of request.
Oil Spill tracking buoys	Beach currently has access to two oil spill buoys. These buoys allow for immediate deployment (one will be available on the MODU) over the course of the drilling program.	-

Resource required	Beach resources	DJPR (EMB) resources
Vessel-based observations	Beach can access its support vessel to assist in undertaking vessel-based observations. It can also request the vessel contractor to assist in sourcing additional vessels, should they be required. Beach can also use its vessel broker to assist in rapidly sourcing additional VoO. Independently of the support vessel contractor, VoO based in ports nearest to the BassGas infrastructure, such as San Remo and Queenscliff would be engaged directly by Beach as required. VoO from ports slightly further afield, such as Geelong, Barry Beach (in Corner Inlet) and Lakes Entrance would also be considered.	
OSTM	Beach will activate its contract with RPS to access 24/7 emergency OSTM. OSTM results can generally be provided within 4 hours of request.	Available via AMSA.

7.16.2.3 Oiled wildlife response

DELWP is the responsible agency for responding to wildlife affected by a marine pollution incident in the Victorian jurisdiction. DELWP manages the rescue and rehabilitation with assistance from Parks Victoria (a DELWP agency) and Phillip Island Nature Park. DELWP's wildlife response is undertaken in accordance with the Wildlife Response Plan (a sub-plan of the Maritime Emergencies NSR Plan (EMV 2016) by trained DELWP officers. The resources available for OWR are outlined in Table 7-24. In the event DELWP require additional OWR resources, Beach will activate its contract with AMOSC.

DELWP resources include OWR kits stored at Lakes Entrance and Port Welshpool (with additional resources at Long Island Point, Melbourne, Geelong, Warrnambool and Portland). If the NatPlan is activated, additional AMSA and AMOSC resources can be sourced from Geelong and Melbourne.

The Tasmanian DPIPWE (Resource Management and Conservation Division) is responsible for OWR in Tasmanian state waters and Tasmanian shorelines (many of the small islands in the EMBA are within the Tasmanian jurisdiction). Tasmanian OWR is undertaken in accordance with the Tasmanian Oiled Wildlife Response Plan ('WildPlan') (DPIW 2006). In the event that condensate reaches Tasmanian islands, it is unlikely to require an active OWR other than monitoring and evaluation (due to the highly weathered nature of the hydrocarbon and unsafe shorelines [rocky, steep, strong wave action]).

Based on the maximum swept areas of sea surface and as no shoreline loading is predicted in the assessed worst case spill scenarios, Beach assesses that the OWR resources available are sufficient if this response is activated.

Table 7-24 Resources available for OWR

Resource	Availability	Provider
Specialist OWR capability	Wildlife Response Commander.	DELWP
OWR team supervisor	One per team.	DELWP
OWR personnel	Trained group of first response personnel.	DELWP
	Volunteers (working under direction of DELWP).	Beach
	Core group responders (working under direction of DELWP).	AMOSC
OWR kit	Bairnsdale, Port Phillip, Colac, and Warrnambool with one kit each, and one State-wide trailer.	DELWP (~50 units per day)
	Geelong (2 kits).	AMOSC (~100 units per day)

7.16.3 Source control response option

7.16.3.1 Establish the context

Source control activities have the potential to require the operation of MODU and support vessels to reduce the spill volume released. Vessel source control activities are not expected to result in any additional environmental impacts and risks, thus the focus of this section is on relief well drilling. A relief well will possibly the mobilisation of a new MODU to location and require drilling of a relief well.

7.16.3.2 Known and potential environmental impacts

The environmental impacts and risks associated with the mobilisation of a MODU and drilling a well have been considered throughout this entire EP and have not been considered again. The risk profile is not expected to change given the relief well is expected to be located within proximity of the Yolla-A platform. As no additional values and sensitivities are expected to be encountered to that already assessed in this EP, and as the control measures identified throughout this EP will be implemented during any relief well drilling program, the environmental risk profile will remain unchanged.

Consequently, no further assessment has been undertaken.

7.16.4 Monitor and evaluate response option

7.16.4.1 Establish the context

Aircraft and vessel use for monitoring and evaluating activities have the potential to result in physical interaction with marine fauna and result in noise emission.

7.16.4.2 Known and potential environmental impacts

The impacts and risks associated with this response option are:

- routine and non-routine impacts and risks associated with vessel operations
- noise disturbance to marine fauna and shoreline species by aerial flights

These environmental impacts and risks have already been assessed in this EP. Although Beach acknowledge multiple vessels are likely to be utilised to implement environmental monitoring programs over the course of a spill event, as no shoreline impacts are expected, and nearshore effects are expected to be minimal (if any), impacts and risks associated with the use of offshore vessels is expected to remain unchanged. The control measures identified throughout this EP will be implemented during any oil spill response program and as such no further evaluation has been conducted.

7.16.5 Oiled wildlife response (OWR)

7.16.5.1 Establish the context

Untrained resources capturing and handling native fauna may cause discomfort to oiled wildlife.

7.16.5.2 Known and potential environmental impacts

The following potential environmental impacts have the potential to occur through the implementation of OWR:

- hazing of target fauna may deter non-target species from their normal activities (e.g., resting, feeding, breeding)
- distress, injury or death of target fauna from inappropriate handling and treatment

- euthanasia of target individual animals that cannot be treated or have no prospects of rehabilitation.

7.16.5.3 Consequence evaluation

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 also has the potential to result in increased stress levels, resulting in increased fauna mortality. Only appropriately trained oiled wildlife responders will approach and handle fauna to prevent these impacts. This will significantly reduce any handling impacts to fauna from untrained personnel and reduce the potential for distress, injury or death of a species. AMSA as the Control Agency for a vessel spill in Commonwealth waters, or DELWP as the responsible agency for responding to wildlife affected by a marine pollution incident in the Victorian jurisdiction, will managed any OWR and Beach will only undertake OWR under direction from the relevant Department.

Oiled wildlife preparedness and response shall be undertaken in accordance with Section 10.1.5 of the Victorian Offshore OPEP (CDN/ID 18986979).

Oiled wildlife surveillance and wildlife impact studies are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908).

Although fauna interactions from OWR may have impacts to species or habitats of recognised conservation value, the activities and duration of this response are expected to be limited and not affecting local ecosystem functioning. As such, Beach have ranked the consequence as Minor (1).

7.16.5.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Source control response option	
ALARP decision context and justification	**ALARP Decision Context: Type A** The implementation of OWR is well understood with the technique having been applied successfully for several large spill events. There is a good understanding of the response technique, however, there is uncertainty regarding the specific location at which this may be undertaken, the number of animals that may be impacted, and thus the level of response that may be required. 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 OWR. As the consequence is rated as Minor (1) applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good practice control measures**
Victorian Offshore OPEP (CDN/ID 18986979).	Under the OPGG(E)R, NOPSEMA require that the petroleum activity have an accepted OPEP in place before commencing the activity. If oiled wildlife occurs, the OPEP will be implemented. Victorian Offshore OPEP will be followed to support spill response for activities under this EP.
Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908)	Operational monitoring allows adequate information to be provided to aid decision making to ensure response activities are timely, safe, and appropriate. Scientific monitoring identifies if potential longer-term remediation activities may be required.
Consequence rating	Minor (1)
Likelihood of occurrence	Remote (1)

Residual risk	Low	
Acceptability assessment		
To meet the principles of ESD	Based upon the activities proposed, there is limited scientific uncertainty associated with the environmental impacts and risks associated with OWR. OWR activities were assessed having a Minor (1) consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, the activity and associated impacts and risks is proposed to be carried out in a manner consistent with the principles of ESD.	
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 OWR. 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 2006 (Commonwealth) • OPGGS Act 2010 (Victoria) • EPBC Act 1999 and EPBC Regulations 2000 • *Emergency Management Act 2013* (Victoria) • *Wildlife Act 1975* (Victoria). The corresponding EPOs, EPS and control measures for this aspect were developed having regard to the above-mentioned legislation, guidelines and/or plans.	
Monitoring and review	OWR will be monitored and reported in accordance with the OPEP and OSMP.	
Acceptability outcome	**Acceptable**	
Environmental performance outcome	**Environmental performance standard**	**Measurement criteria**
Undertake oil spill response in a manner that will not result in additional impacts to marine environment, coastal habitat and oiled wildlife.	**Victorian Offshore OPEP (CDN/ID 18986979)** Emergency spill response capability shall be maintained in accordance with the OPEP.	Outcomes of internal audits and tests demonstrate preparedness
	Implement spill response in accordance with relevant EPOs and EPSs in the NOPSEMA accepted OPEP.	EMT log
	Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908) Operational and scientific monitoring capability shall be maintained in accordance with the OSMP: • a month prior to the commencement of drilling a review of the contracted OSMP provider/s capability will be undertaken by Beach to ensure that the OSMP requirements can be met by the contracted OSMP provider/s • during drilling the contracted OSMP provider/s will provide a monthly report to show that capability as detailed in the OSMP is maintained • the contracted OSMP provider/s capability to meet the requirements detailed in the OSMP will be tested prior to commencing drilling.	Outcomes of internal audits and tests demonstrate preparedness

8 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 (Appendix I). 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
- arrangements for ongoing consultation.

8.1 Operations Excellence Management System

The activity will be undertaken in accordance with the Beach OEMS. The OEMS documents the Environmental Policy, 11 OEMS Elements, HSE Procedures and the key HSE processes and requirements for activities where Beach is the titleholder. 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 has been developed based on the IOGP Operating Management System Framework and is aligned with the requirements of recognised international and national standards including:

- ISO 14001 (Environmental Management)
- ISO 31000 (Risk Management)
- ISO 45001 (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 (provided in Appendix I) and management of potential HSE impacts and risks (Table 8-1 and Figure 8-1). 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.

The application of OEMS Elements and Standards relevant to the activity are described in the following sections.

Table 8-1 Beach OEMS 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
		Finance 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
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

Figure 8-1 The Beach OEMS

8.2 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 influences the performance of all staff and contractors. Clear levels of authority are necessary to remove organisational ambiguity and to support effective decision making.

There are three standards (see Table 8-1) and 11 outcomes to be delivered under this element. To this effect, Beach's Environment Policy provides a clear commitment to conduct its operations in an environmentally responsible and sustainable manner.

Demonstratable compliance with this EP is a key commitment for Beach. This will be managed through the use of a commitments register to track all EP commitments through to completion.

The Beach CEO has the ultimate responsibility for ensuring that Beach has the appropriate organisation in place to meet the commitments established within this EP. The Beach Project Manager and Principal Environmental Advisor (offshore), have the responsibility and delegated authority to ensure that adequate and appropriate resources are allocated to comply with the OEMS and this EP.

The organisation structure for the activity is illustrated in Figure 8-2 and the roles and responsibilities of key project members are summarised in Table 8-2.

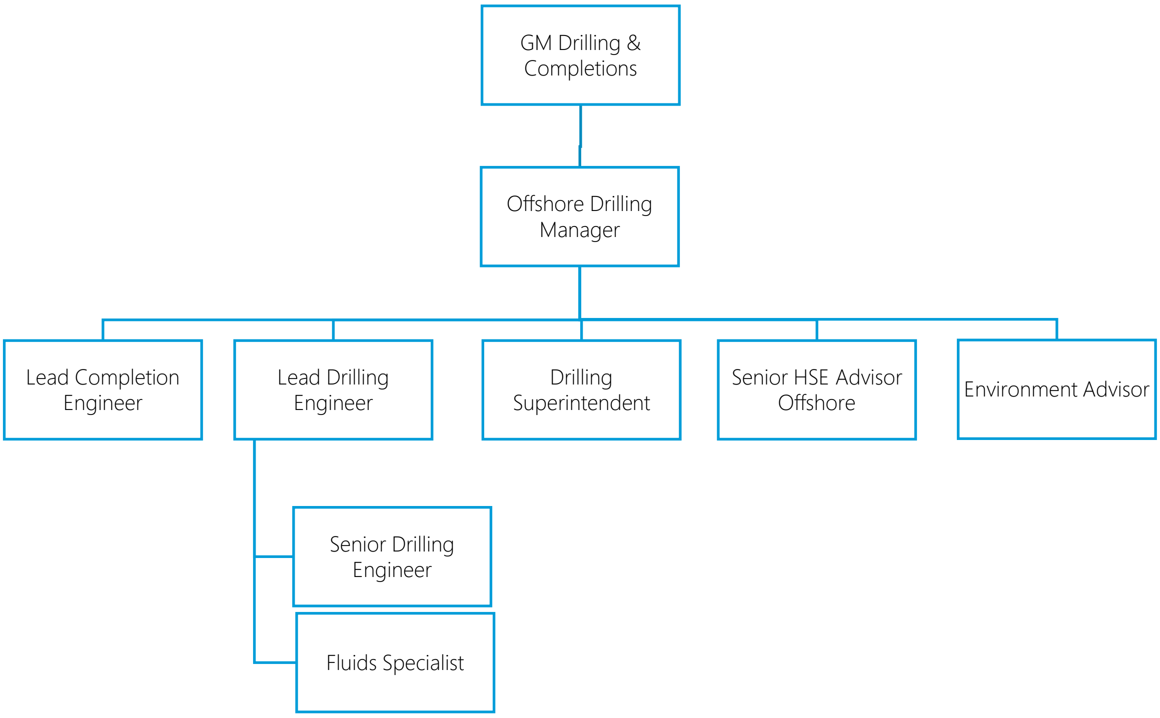


Figure 8-2 Organisation chart

Table 8-2 Activity roles and key environmental responsibilities

Role	Key environmental responsibilities
GM Drilling and Completions	Ensures: • compliance with regulatory and other requirements and this EP • records associated with the activity are maintained as per Section 8.4.2 • personnel who have specific responsibilities pertaining to the implementation of this EP or 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 (MoC) process detailed in Section 8.8.1 • incidents are managed and reported as per Section 8.10.1 • the EP environmental performance report is submitted to NOPSEMA not within three months of activity completion • any 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 in accordance with the MoC process detailed in Section 8.8.1. • oil spill response arrangements for the activity are tested as per Section 8.9 • ensure audits and inspections are undertaken in accordance with Section 8.12.
Offshore Drilling Manager	Ensures: • compliance with regulatory and other requirements and this EP • records associated with the activity are maintained as per Section 8.4.2 • personnel who have specific responsibilities pertaining to the implementation of this EP or OPEP know their responsibilities and are competent to fulfil their designated role

Role	Key environmental 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 8.8.1 • incidents are managed and reported as per Section 8.10 • the EP report is submitted to NOPSEMA not more than three months after the anniversary date of the EP acceptance • any 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 8.8.1 • oil spill response arrangements for the activity are tested as per Section 8.9 ensure audits and inspections are undertaken in accordance with Section 8.12.1.4.
Drilling Superintendent	Ensures: • report any event or incident which may result in a release of contaminant and/or impact upon the environment in relation to the project • report all incidents to the Wells Manager Offshore • notify the designated authority of all reportable incidents within the specified time frames • perform incident investigations. • ensure all workers are complying with HSE requirements • report all incidents to the Drilling Superintendent • implement and comply with this EP • provide support for audits and inspections in accordance with Section 8.12.1.4.
Fluids Specialist	Ensures: • assess any chemicals that will be discharged offshore as per Section 7.9 • establish and monitor procedural controls for the management and monitoring of Offshore chemical use, monitoring and discharge in alignment with relevant commitments within this EP • maintain records of all drill fluid chemicals stored and discharged offshore.
Beach 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 8.10 • the monthly and end-of-activity EP environmental performance report are prepared and submitted • any new or changed environmental impact or risk or a change that may impact the EP is reviewed and documented as per Section 8.12 • that audits and inspections are undertaken as detailed in Section 8.12 and any actions from non-conformances or improvement suggestions tracked • reviews and revisions to the EP are made as per the requirements in Section 8.12. • stakeholder consultation for the activity is undertaken in a timely and thorough manner • objections or claims raised by stakeholders are recorded and reported to the Project Manager and Principal Environmental Advisor (offshore) • a stakeholder consultation log is maintained • stakeholder issues are addressed.
Senior HSE Advisor (field based)	Ensures: • disseminate environmental component of the environment induction to site personnel • conduct audits and inspections detailed in Section 8.12.1.4.
Offshore Installation Manager (OIM)	Ensures: • operate the MODU in accordance with all relevant Drilling Contractor procedures • support Beach in the implementation of this EP, specifically with regards to commitments within this EP relating to the operation of the MODU.

Role	Key environmental responsibilities
Vessel Master	Ensures: • vessel operations are carried out in accordance with regulatory requirements and this EP • vessel personnel are competent to fulfil their designated role • personnel new to the vessel receive a vessel-specific induction • environmental incidents are reported to the Beach Offshore Representative within required timeframes as per Section 8.10 • emissions and discharges identified in Section 8.12 are recorded and provided to the Beach Offshore Representative • the Beach Offshore Representative is informed of any 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 as per Section 8.12 • oil spill response arrangements are in place and tested as per the vessel's SMPEP • general and hazardous wastes are backloaded to port for disposal to a licenced waste facility.
Offshore personnel	All offshore personnel are responsible for: • completing the Beach HSE induction. • reporting fauna sightings and interactions to the Beach Offshore Representative or MMOs. • reporting hazards and/or incidents via company reporting processes. • adhering to vessel's HSEMS and this EP in letter and in spirit. • undertaking tasks safely and without harm to themselves, others, equipment or the environment and in accordance with their training, operating procedures and work instructions. • stopping any task that they believe to be unsafe or will impact on the environment.

This element recognises that a systematic risk-based approach to HSE management is in place as an integral part of leadership and planning, and that HSE goals and targets must be established and measured. A philosophy of continuous improvement is applied to all Beach operations.

Targets for environmental performance of the activity are detailed throughout Section 7 of this EP. The EPO and EPS have been established to ensure that the impacts of planned activities and the risks of unplanned events are managed to ALARP and to an acceptable level.

Additionally, the commitments emerging from this Implementation Strategy are summarised in Section 8.13.

8.3 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 (see Table 8-1) 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.

8.4 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 (see Table 8-1) and seven outcomes to be delivered under this element. The standards relevant to the implementation of this EP are described below.

8.4.1 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.

Section 3 of this EP details the key environmental legislation applicable to the activity. The acceptability discussion for each hazard assessed in Section 7 specifically details the legislation pertaining to each hazard.

8.4.2 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 ('TeamBinder") for a minimum of five years. These records will be made available to regulators in electronic or printed form upon request.

8.4.3 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.

8.5 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 (see Table 8-1) 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.

8.5.1 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 MODU personnel will complete an activity-specific environmental induction. Records of completion of the induction will be recorded and maintained. The induction will cover (but is not limited to):

- description of the environmental sensitivities and conservation values of the activity area
- 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 and vessel interaction procedures.

In addition to the activity-specific induction, each person 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.

The Senior Drilling Supervisor (SDSV) is responsible for delivering the induction, or facilitating it if presented by another member of the project team.

The Drilling Manager, Offshore Australia accountability, implemented by Drilling Superintendent has responsibility for ensuring that systems are in place to facilitate the communication of HSE issues. This is typically via the daily operations meeting and weekly HSE meetings.

8.5.2 Toolbox Talks and HSE Meetings

Environmental matters will be included in daily toolbox talks as, and if, required by the specific task being risk assessed (e.g., waste management).

Environmental issues will also be addressed in daily operations meetings and weekly HSE meetings, where each shift will participate with the Beach Senior Drilling Supervisor (SDSV) in discussing HSE matters that have arisen in the previous week, and issues to consider for the following week.

Records associated with project-specific training, environmental training, inductions and attendance at toolbox meetings will be recorded and maintained.

8.5.3 Communications

The OIM, Vessel Master and Beach Senior Drilling Supervisor (SDSV) are jointly responsible for keeping contractors 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:

- issues associated with implementation of the EP
- any proposed changes to equipment, systems or methods of operation of equipment, where these may have HSE implications
- any proposals for the continuous improvement of environmental protection, including the setting of environmental objectives and training schemes.

Table 8-3 outlines the key meetings that will take place onshore and offshore during the activity.

Table 8-3 Project communications

Meeting	Frequency	Attendees
Onshore		
Beach project team	Daily	All team members

Meeting	Frequency	Attendees
Offshore		
Operations	Daily	Beach onshore project team, department heads, Beach Senior Drilling Supervisor (SDSV)
Pre-tour meeting	Daily – prior to each shift	All personnel
Toolbox / JSA	Before each task	All personnel involved in task
HSE	Weekly	All personnel
MMOs	Daily	MMOs, Beach Senior Drilling Supervisor (SDSV), vessel operator

8.6 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 (see Table 8-1) and four outcomes to be delivered under this element.

Training and competency of contractor personal engaged to work on the activity shall be managed in accordance with the contractor's HSEMS (or equivalent).

8.7 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).

In terms of decommissioning, the minimum requirements for decommissioning activities falls under the Project Management standard (see Table 8-1). Section 4.6.5.5 of this standard outlines the preparation of decommissioning plans. In developing decommissioning plans, the methodology for the activities involved and the resources and equipment identified to undertake the work must be outlined. However as the decommissioning activates covered under this EP are limited to plug and abandonment of a well, no further discussion about decommissioning systems and standards are provided.

8.8 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 (see Table 8-1) and ten outcomes to be delivered under this element. The standard of relevance to this EP is briefly discussed below.

8.8.1 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 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. 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 8.9 identify a change in hazards, controls or risk (compared to those described and assessed in Section 7), and triggers a regulatory requirement to revise this EP, the revision shall be defined, endorsed, completed and communicated in accordance with the MoC Standard.

8.9 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 (see Table 8-1) and seven outcomes to be delivered under this element. The standards of relevance to this EP are briefly discussed below.

8.9.1 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 Section 6 and applied to all the hazards assessed in Section 7 of this EP.

As described in Section 8.12, 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 ensures 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 8.8.1.

8.9.2 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.

8.9.2.1 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 8-3. 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 8-4.

The key emergency response arrangements for the activity are outlined herein.

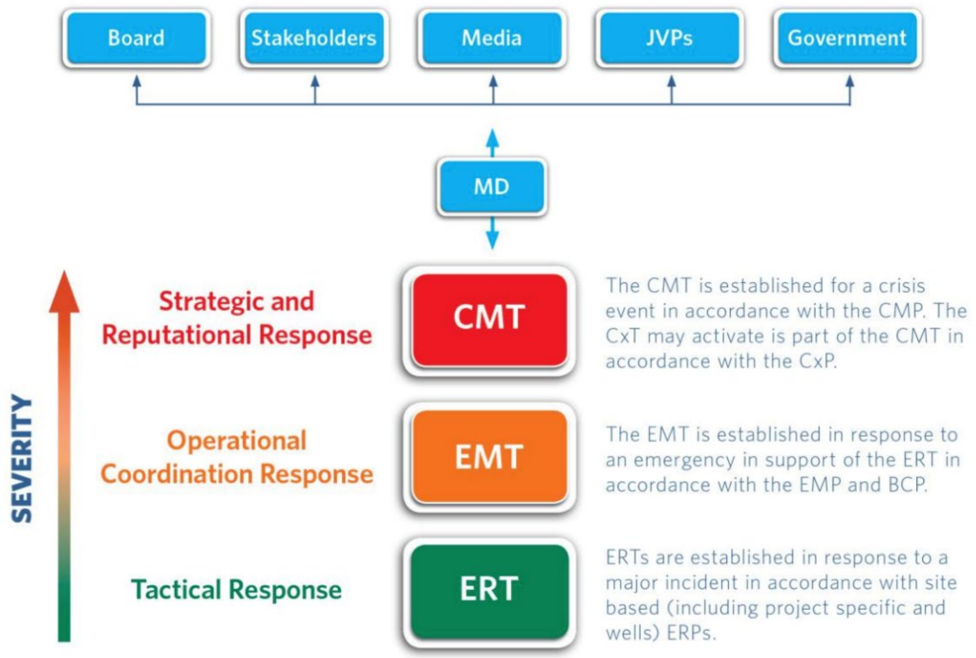


Figure 8-3 Beach Crisis and Emergency Management Framework

Table 8-4 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 CMT if required.
EMT	Adelaide office (or Melbourne office, depending on roster)	Provide operational management support to the ERT to contain and control the incident. Implement the Business Continuity Plan. Liaise with external stakeholders in accordance with the Bridging ERP. Regulatory reporting.
ERT	Vessel/MODU	Respond to the emergency in accordance with the site-specific ERP (e.g., SMPEP).

8.9.2.2 Oil Pollution Emergency Plan

The Victorian OPEP (CDN/ID 18986979) currently provides for spill events associated with the Yolla-A Platform including:

- 300 m^3 release of MDO resulting from a vessel collision
- A prolonged release of gas condensate from the platform resulting from a LOWC event

The spill events provided for in the OPEP are identical to those identified for the activities covered in this EP. The OPEP describes the arrangements in place to facilitate an appropriate and effective response to worst case hydrocarbon spills that have the potential to occur. The response actions outlined in the OPEP are intended to be implemented within Beach's overarching emergency response structure, as described in the EMP.

The ERP and OPEP are reviewed annually and updated if required. Triggers for an update include:

- major changes that affect the emergency response coordination or capabilities
- findings from routine testing
- before installing and commissioning new plant and equipment
- after a major incident
- as directed by a regulator.

In accordance with Regulation 14(8A)(8C) of the OPGGS(E) and Regulation 17(3) of the OPGGS Regulations, the emergency response arrangements in the ERP and OPEP are tested:

- when they are introduced
- when they are significantly amended
- not later than 12 months after the most recent test.

Vessels will operate under the vessel's SMPEP (or equivalent appropriate to class) or spill clean-up procedures to ensure timely response and effective management of any vessel-sourced oil spills to the marine environment. The SMPEP (or equivalent) is routinely tested. The SMPEP (or equivalent) is designed to ensure a rapid and appropriate response to any vessel oil spill and provides guidance on practical information that is required to undertake a rapid and effective response, and reporting procedures in the event of a spill.

Schedule 3 of the Commonwealth OPGGS Act and Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009, along with NOPSEMA's guidance note (N-09000-GN1661) help titleholders to understand when a vessel is classed as a facility or a vessel.

Based upon this information, Beach understands that:

- any vessel performing activities within the scope of this EP is not a facility and consequently AMSA would become the control agency responsibility in a spill event arising from the vessel
- the MODU is a facility, and consequently Beach would become the control agency responsibility in a spill event arising from the MODU.

8.9.2.3 Operational and Scientific Monitoring Plan

The NOPSEMA accepted Offshore Victorian OSMP (CDN/ID S4100AH717908) currently provides the framework to conduct environmental monitoring in response to Level 2 and Level 3 offshore hydrocarbon spill events from petroleum activities undertaken by Beach in the Otway and Bass Basins. Beach developed a location specific Addendum to the OSMP for BassGas Operations (the Yolla-A Platform).

The location, existing environment, credible oil spill modelling, risks and potential impacts, response activities and the decision processes that will apply if a spill occurs are identical to the NOPSEMA accepted BassGas Operations Addendum (CDN/ID 18985299). The OSMP and BassGas Operations Addendum is included as Appendix H.

8.10 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 (see Table 8-1) and five outcomes to be delivered under this element, with the standard discussed below.

8.10.1 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.

The recordable and reportable incident types are described in this section.

Recordable Incident Management

Regulation 4 of the OPGGS(E) regulations defines a 'recordable' incident as:

A breach of an EPO or EPS in the EP that applies to the activity that is not a reportable incident.

Routine monthly recordable incident reports, including 'nil' incident reports, are prepared by the Beach Principal Environment Advisor (offshore) and submitted to NOPSEMA by the 15th of each month. These are reported using the NOPSEMA template Monthly Environmental Incident Reports (N-03000-FM0928). Table 8-5 summarises the recordable incident reporting requirements.

Table 8-5 Recordable incident reporting details

Timing	Reporting requirements	Contact
By the 15th of each month	• All recordable incidents that occurred during the previous calendar month. • The date of the incident. • All material facts and circumstances concerning the incidents that the operator knows or is able to reasonably find out. • The EPO and/or EPS breached.	NOPSEMA – submissions@nopsema.gov.au

Timing	Reporting requirements	Contact
	• Actions taken to avoid or mitigate any adverse environmental impacts of the incident. • Corrective actions taken, or proposed to be taken, to stop, control or remedy the incident. • Actions taken, or proposed to be taken, to prevent a similar incident occurring in the future. • Actions taken, or proposed, to prevent a similar incident occurring in the future.	

Reportable Incident Management

Regulation 4 of the OPGGS(E) defines a 'reportable' incident as:

An incident that has caused, or has the potential to cause, moderate to significant environmental damage.

In the context of the Beach Environmental Risk Matrix, Beach interprets 'moderate to significant' environmental damage to be those hazards identified through the EIA and ERA process (see Section 6) as having an inherent or residual impact consequence of 'Serious (3)' or greater. The aspects identified as having the potential to result in a Serious (3) consequence include:

- introduction of IMP
- loss of containment – vessel collision
- LOWC.

Table 8.6 presents the reportable incident reporting requirements.

Table 8-6 Reportable incident reporting requirements

Timing	Requirements	Contact
Verbal notification		
Within 2 hours of becoming aware of incident	The verbal incident report must include: • all material facts and circumstances concerning the incident that the titleholder knows, or is able, by reasonable search or enquiry, to find out • any actions taken to avoid or mitigate any adverse environmental impacts of the reportable incident • the corrective action that have been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	NOPSEMA – 1300 674 472
	For a Level 1, 2 or 3 hydrocarbon spill, as above.	As above, plus: AMSA – 1800 641 792 (24 hrs) DJPR (Vic) – 0409 858 715 DPIPWE (Tas) – 03 6165 4599 DTI (SA) - 8248 3505
	For a Level 2 or 3 hydrocarbon spill only.	Watersure – 03 5671 9041

Timing	Requirements	Contact
	Oiled wildlife	DELWP (Vic) – 1300 134 444 (24 hrs) DPIPWE (Tas) - 03 6165 4599 DEW (SA) - (08) 8204 1910
	Suspected or confirmed IMS introduction	DELWP – 136 186 (24 hrs) DAWE - 1800 803 772 (general enquiries)
	Injury or death of EPBC Act-listed or FFG Act-listed fauna (e.g., vessel collision)	DELWP – 1300 134 444 (24 hrs) DAWE – 1800 803 772 Whale and dolphin emergency hotline – 1300 136 017 AGL marine response unit – 1300 245 678
Written notification		
Not later than 3 days after the first occurrence of the incident	A written incident report must include: • all material facts and circumstances concerning the incident that the titleholder knows, or is able, by reasonable search or enquiry, to find out • any actions taken to avoid or mitigate any adverse environmental impacts of the reportable incident • the corrective action that have been taken, or is proposed to be taken, to stop, control or remedy the reportable incident • the action that has been taken, or is proposed to be taken, to prevent similar recordable incidents occurring in the future.	NOPSEMA – submissions@nopsema.gov.au
Within 72 hours of the incident	As above, with regard to details of a vessel strike incident with a cetacean	Upload information to DAWE online National Ship Strike Database (https://data.marinemammals.gov.au/ report/shipstrike) DELWP (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.
Within 7 days of the incident	As above, with regard to impacts to MNES, specifically injury to or death of EPBC Act-listed species	EPBC.Permits@environment.gov.au DAWE 1800 803 772
Within 7 days of providing written report to NOPSEMA	As above.	NOPTA – reporting@nopta.gov.au

Incident Investigation

Any non-compliance with the EPS outlined in this EP will be investigated and follow-up action will be assigned as appropriate.

The findings and recommendations of inspections, audits and investigations will be documented and distributed to the relevant offshore contractor and project personnel for review. Tracking the close-out actions arising from investigations is managed via the Beach CMO Incident Management System.

Investigation outcomes will be communicated to the project team via daily operations meetings and to offshore crew during daily toolbox meetings and at weekly HSE meetings.

8.11 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 (see Table 8-1) and three outcomes to be delivered under this element, with the standards discussed below.

8.11.1 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 OEMS standard.

One of the key environmental management issues for this activity are avoiding causing injury to marine mammals and managing IMP risks, discussed below.

8.11.1.1 Whale Management Standard Operating Procedure

Competent MMO will be hired for the activity to be present during the entire activity duration. The MMO will provide an information session to all vessel crew regarding their fauna observation duties and the communication protocols required.

A daily cetacean meeting will be undertaken involving all MMOs. The lead MMO will dial into the daily operations meeting to help plan activities for the following day. 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 7.5 are captured in the Whale Management Standard Operating Procedure (Appendix F). This procedure will be provided to the MMOs to implement the required measures throughout the activity.

8.11.1.2 Beach Domestic IMP Biofouling Risk Assessment Process

Scope

The MODUs, relevant vessels and submersible equipment mobilised from international or domestic waters to undertake the activity within the activity area must complete the Beach Introduced Marine Species Management Plan (S4000AH719916) risk assessment process and complete the associated checklist prior to the initial mobilisation into the activity area. The Beach Introduced Marine Species Management Plan risk assessment process does not include an evaluation of potential risks associated with ballast water exchange given all operators contracted to Beach must comply with the most recent version of the Australian Ballast Water Management Requirements (see Section 7.11).

Purpose

- validate compliance with regulatory requirements (Commonwealth and State) in relation to biosecurity prior to engaging in the activity within the activity area
- identify the potential IMP risk profile prior to deployment within the activity area

- identify potential deficiencies of IMP controls prior to entering the activity area
- identify additional controls to manage IMP risk
- prevent the translocation and potential establishment of IMS into non-affected environments (either to or from the activity area).

Screening Assessment

Prior to the initial mobilisation of the MODU, relevant vessels or submersible equipment to the activity area, a screening assessment must be undertaken considering:

- all relevant IMO and regulatory requirements under the Australian Biosecurity Act 2015 and/or relevant State legislation must be met
- if mobilising from a high or uncertain risk area, the vessel/submersible equipment must have been within that area for fewer than 7 consecutive days or inspected and deemed low risk by an independent IMP 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
- vessels must have a Biofouling Management Plan and record book consistent with the 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/submersible equipment may be deployed into the activity area.

Where relevant criteria have not been met, or there is uncertainty if these criteria have been met, Beach must engage an independent IMP expert to undertake a detailed biosecurity risk assessment, and the vessel/submersible equipment must be deemed low risk prior to mobilisation into the activity area.

Basis of Detailed IMS Biofouling Risk Assessment

The basis by which an independent IMP expert evaluates the risk profile includes:

- age, type and condition of the vessel/MODU/submersible equipment
- previous cleaning and inspection undertaken and the outcomes of previous inspections
- assessment of internal niches with potential to harbour IMP
- vessel/equipment history since previous inspection
- origin of the vessel/submersible equipment including potential for exposure to IMP
- 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 activity area
- 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
- where deemed appropriate, undertake in-water inspections.

8.11.2 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 are to 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 9 of this EP. Wherever possible, concerns expressed by stakeholders have been addressed throughout the EP.

8.12 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 (see Table 8-1) and four outcomes to be delivered under this element, with the standards relevant to the activity discussed below.

8.12.1 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.

The assurance methods that will be used to ensure compliance with the EPS in this EP are described in this section.

8.12.1.1 Emissions and Discharge Records

Beach maintains a quantitative record of emissions and discharges as required under Regulation 14(7) of the OPGGS(E). This includes emissions and discharges to air and water (from both planned and unplanned activities). Results are reported in the end-of-activity EP performance report submitted to NOPSEMA.

A summary of the environmental monitoring to be undertaken for the activity from the vessel is presented in Table 8-7.

Table 8-7 Summary of environmental monitoring

Aspect	Monitoring parameter	Frequency	Record
Planned			
Underwater sound	MMO observations	Continuous during activity	MMO daily reports End-of-activity report
Atmospheric emissions	Fuel consumption Flaring	Tallied at end of activity from daily reports and/or bunker receipts	Emissions register
Planned discharge – waste waters and putrescible waste	Volume discharged during the activity	Each discharge	Waste manifest
Planned discharge – brines, completion fluids, drilling cuttings and fluids	Volume discharged during the activity	Each discharge	Waste manifest
Planned discharge – cement and swarf	Volume discharged during the activity	Each discharge	Waste manifest
Unplanned			
Unplanned marine discharge - waste	Volume discharged during the activity	Tallied at end of activity	Waste manifest
Physical presence (marine users)	Ongoing patrol for, and communications with, third-party vessels by the support vessels. Radar surveillance from source vessel.	Continuous during activity	Bridge communications book
Introduction of IMP	Volume and location of ballast water discharges noted	Each discharge	Ballast water log
Physical presence (marine fauna)	MMO continuous megafauna observations	Continuous during activity	Incident report
Loss of containment – vessel collision	Operational monitoring in line with the OPEP and scientific monitoring in line with the OSMP (depending on spill volume)	As required	Incident reports
LOWC	Operational monitoring in line with the OPEP and scientific monitoring in line with the OSMP (depending on spill volume)	As required	Incident reports

8.12.1.2 Routine Reporting and Notifications

Regulation 11A of the OPGGS(E) specify that consultation with relevant authorities, persons and organisations must take place. This consultation includes an implicit obligation to report on the progress of the activity. Table 8-8 outlines the routine reporting obligations that Beach will undertake with external organisations.

Table 8-8 External routine reporting obligations

Requirement	Timing	Contact details	OPGGS(E) regulation
Pre-activity			

Requirement	Timing	Contact details	OPGGS(E) regulation
Notify AMSA's Joint Rescue Coordination Centre (JRCC) in order to issue daily AusCoast warnings. Beach will provide: • operation start time • jack-up MODU rig details (including name, callsign and Maritime Mobile Service Identity (MMSI) • satellite communications details (including INMARSAT-C and satellite telephone) • area of operation • requested clearance from other vessels.	Within 24 - 48 hours of activity starting.	rccaus@amsa.gov.au 1800 641 792 +61 2 6230 6811	11A
Notify NOPSEMA with the activity commencement date.	At least 10 days prior to activity starting.	submissions@nopsema.gov.au	29
Notify all other stakeholders in the stakeholder register with the activity commencement date.	Two weeks prior to activity starting.	Via email addresses managed by the Community Manager	11A
Notify the AHO of the activity commencement date and duration to enable Notices to Mariners to be issued.	Four weeks prior to activity starting.	datacentre@hydro.gov.au, 02 4223 6500	11A
Activity completion			
Notify AMSA in order to cease daily AusCoast warnings.	Within 24 hours of activity completion.	rccaus@amsa.gov.au	11A
Notify all stakeholders in the stakeholder register.	Within 2 days of activity completion.	Via email addresses managed by the Community Manager	11A
Notify the AHO in order to cease the issuing of Notices to Mariners.	Within 2 days of activity completion.	datacentre@hydro.gov.au, 02 4223 6590	11A
Notify NOPSEMA of the activity end date.	Within 10 days of activity completion.	submissions@nopsema.gov.au	29
Notify NOPSEMA of the end of the operation of the EP.	After acceptance of the end-of-activity EP performance report.	submissions@nopsema.gov.au	25A
Performance reporting			
Submit an end-of-activity EP Performance Report.	Within 3 months of activity completion.	submissions@nopsema.gov.au	26C
Provide marine fauna observation data to the DAWE.	Within 3 months of activity completion.	Upload via the online Cetacean Sightings Application at: https://data.marinemammals.gov.au/nmmdb	N/A – EPBC Act

8.12.1.3 Environment Plan Review

A member of the Beach Environment Team may determine that an internal review of the EP may be necessary based on any one or all of the following factors:

- Changes to hazards and/or controls identified in the review of the EP, which in itself is supported by:
  - Reviewing changes to AMP management arrangements (through subscription to the AMP email update service at https://parksaustralia.gov.au/marine/about/)
  - Environment and industry legislative updates (through subscriptions to NOPSEMA, APPEA and legal firms)
  - Running a new EPBC Act PMST for the EMBA to determine whether there are newly-listed threatened species or ecological communities in the EMBA
  - Remaining up to date with new scientific research that may impact on the EIA/ERA in the EP (for example, through professional networking and APPEA membership)
  - Remaining in regular contact with stakeholders.
- Implementation of corrective actions to address internal or external inspection or audit findings
- An environmental incident and subsequent investigation identifies 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 identified through the MoC process, such as hazards or controls, organisational changes affecting personnel in safety critical roles or OEMS
- Changes to any of the relevant legislation.

The Environment Team provides advice to the Project Manager on the material impact of the items listed previously and whether or not a review of the EP should be undertaken. The scope of a review is determined by the factors that trigger the review and an appropriate team will be assembled by the Principle Environmental Advisor to conduct the review. The team may consist of representatives from the Community, Engineering, HSE, Operations or Supply Chain teams as required by the scope.

All personnel can propose changes to HSE documentation via a register located in the Document Management System. If a review of the EP is initiated, then any proposed changes held in the register will also be considered by the review team.

If a review of the EP relates to a topic that had previously been raised by a stakeholder, an updated response to affected stakeholders will be prepared and provided to affected stakeholders in a process managed by the Community Manager.

Revisions Triggering EP Re-submission

Beach will revise and re-submit the EP for assessment as required by the OPGGS(E) regulations listed in Table 8-9.

Table 8-9 EP revision submission requirements

Regulations	OPGGS(E) regulation
Submission of a revised EP before the commencement of a new activity	17(1)
Submission of a revised EP when any significant modification or new stage of the activity that is not provided for in the EP is proposed	17(5)
Submission of a revised EP before, or as soon as practicable after, the occurrence of any significant new or significant increase in environmental impact or risk not provided for in the EP	17(6)
Submission of a revised EP if a change in titleholder will result in a change in the manner in which the environmental impacts and risks of an activity are managed	17(7)

Revisions and re-submission of the EP generally centre around 'new' activities, impacts or risks and 'increased' or 'significant' impacts and risks. Beach defines these terms in the following manner:

- New impact or risk – one that has not been assessed in Section 7
- Increased impact or risk – one with greater extent, severity, duration or uncertainty than is detailed in Section 7
- Significant change –
  - The change to the activity design deviates from the EP to the degree that it results in new activities that are not intrinsic to the existing Activity Description in Section 4
  - The change affects the ability to achieve ALARP or acceptability for the existing impacts and risks described in Section 7
  - The change affects the ability to achieve the EPO and EPS contained in Section 7.

A change in the activities, knowledge, or requirements applicable to the activity are considered to result in a 'significant new' or 'significant increased' impact or risk if any of the following criteria apply:

- The change results in the identification of a new impact or risk and the assessed level of risk is not 'Low', acceptable and ALARP;
- The change results in an increase to the assessed impact consequence or risk rating for an existing impact or risk described in Section 7; and
- There is both scientific uncertainty and the potential for significant or irreversible environmental damage associated with the change.

While an EP revision is being assessed by NOPSEMA, any activities addressed under the existing accepted EP are authorised to continue. Additional guidance is provided in NOPSEMA Guideline When to submit a proposed revision of an EP (N04750-GL1705, Rev 1, January 2017).

Minor EP Revisions

Minor revisions to this EP that do not require resubmission to NOPSEMA will be made where:

- Minor administrative changes are identified that do not impact on the environment (e.g., document references, contact details, etc.).
- A review of the activity and the environmental risks and impacts of the activity do not trigger a requirement for a revision, as outlined in Table 8-9.

Minor revisions to the EP will not be submitted to the regulators for formal assessment. Minor revisions will be tracked in the document control system.

8.12.1.4 Inspections and Audits

Various inspections and audits will be undertaken for the activity using competent personnel, as outlined in Table 8-10.

Any non-compliances or opportunities for improvement identified at the time of an inspection or audit will be communicated to the relevant Beach and contractor personnel at the time of the inspection or audit. These are tracked in the Beach incident management system, which includes assigning responsibilities to personnel to manage the issue and verify that it is closed out.

A summary of the EP commitments for the activity will be distributed aboard the MODU (including role-specific checklists), and implementation of the EPS will be continuously monitored by the Beach Offshore Representative and verified by the Beach Principal Environmental Advisor (offshore) (or delegate) through review of the completed weekly checklists and attendance at relevant meetings.

Table 8-10 Summary of environmental inspections and audits

Type	When	Frequency	Method	Details
HSE due diligence inspection	Post-award, pre-activity	Once	Desktop or in port/during mobilisation	Focused on ensuring EPS can be met through review of relevant records and databases
EP compliance audit	Post-award, pre-activity	Once	In person on board	A suitably experienced auditor will assess compliance against each EPS through interviews, observations and review of databases and records.
Vessel premobilisation inspection	Before mobilisation	Once (for each vessel)	Desktop or site	Undertaken to confirm the requirements of the EP will be met. This will include ensuring that the EPOs, EPSs and other relevant commitments in the EP can be met in response to COVID-19 measures or restrictions.
MODU premobilisation inspection	Before mobilisation	Once	Desktop or site	Undertaken to confirm the requirements of the EP will be met. This will include ensuring that the EPOs, EPSs and other relevant commitments in the EP can be met in response to COVID-19 measures or restrictions.
Offshore Inspections	During activity	Weekly	In person on board/site	Weekly offshore inspections throughout the activity to ensure ongoing compliance with relevant EP requirements. Inspection will include, but not be limited to: • spill preparedness such as spill kit checks • waste management • review of any new or changed chemicals that maybe discharged offshore • validation all EPOs and EPSs relevant to offshore operations are maintained. • compliance with procedural controls relevant to environmental management of the MODU and drilling activity such as drill fluids and cuttings management.

Non-compliances and/or opportunities for improvement will be communicated to activity personnel in writing and at appropriate meetings (as listed in Table 8-3).

8.12.1.5 Regulatory Inspections

Under Part 5 of the OPGGS Act, NOPSEMA inspectors have the authority to enter Beach premises, including the activity vessel, to undertake monitoring or investigation against this EP. Beach will cooperate fully with the regulator during such investigations.

8.12.1.6 End of Activity Performance Report

In accordance with the OPGGS(E) Regulation 14(2), Beach will submit an end-of-activity EP performance report to NOPSEMA within three months of completion of the activity. Performance will be measured against the EPO and EPS outlined in Section 7. The information in the report will be based on the information collected during routine communications, inspections and audits, as outlined in this chapter.

8.13 Summary of Implementation Strategy Commitments

Table 8-11 summarises the commitments provided throughout this Implementation Strategy by assigning EPOs, EPS and measurement criteria to each commitment.

Table 8-11 Summary of activity implementation strategy commitments

Section	EPO	EPS	Measurement criteria
8.4.2	All records relevant to implementation of the EP are available for five years.	All records relevant to implementation of the EP are stored in Beach's document control system.	EP documents are readily accessible in Beach's document control system.
8.5.1	Activity personnel are trained and competent to fulfil their duties.	The LMS records and tracks core and critical HSE and technical compliance training.	Training records are readily accessible through the LMS.
		Due diligence is undertaken on contractors to ensure they are competent to work on the activity.	Contractor due diligence reports are readily available and verify their suitability to work on the activity.
8.5.1	Activity personnel are familiar with their HSE responsibilities.	All personnel working on the activity vessel are inducted into the activity HSE requirements.	MODU and vessel crews, along with induction familiarisation checklists are readily available, verifying that all personnel working on and visiting the vessels are inducted.
8.5.2 & 8.5.3	Activity personnel are familiar with operations HSE issues.	Regular HSE communications take place between vessel- and office-based personnel.	HSE meeting records are available and verify regularity of communications.
8.6 & 8.7	The MODU and vessel meets maritime standards and has in place the required MARPOL certifications.	Beach will undertake a due diligence inspection of vessels to ensure it meets are required maritime standards and has all required environmental certifications (see also Section 3.5.1).	A due diligence inspection report is available and verifies that all vessel meets required maritime standards.
8.8.1	Changes to approved plans (including this EP), equipment, plant, standards or procedures are assessed through the MoC process.	Changes are documented in accordance with the MoC Directive.	MoC records are available.
8.9.1	The EP is reviewed for currency in light of any changes to the activity, controls, legislation or relevant scientific research.	Beach Environment Team updates the EP as required.	The revision history of this EP is updated to record document changes.

Section	EPO	EPS	Measurement criteria
8.9.2	Emergency response responsibilities are clearly defined.	A Bridging ERP will be prepared to link between Beach's EMP and the vessel contractor's vessel-specific ERP.	Bridging ERP is in place prior to the activity commencing.
8.9.2	MODU, Vessel- and office-based personnel are familiar with their emergency response responsibilities.	All relevant MODU, vessel- and office-based personnel participate in emergency response (e.g., ERP and OPEP) training, drills and exercises.	Training records verify that emergency response exercises were undertaken.
8.10	Incident reports are issued to the regulators as required.	Recordable incidents reports are issued monthly to NOPSEMA as per Table 8-5.	Recordable and reportable incident reports and associated email correspondence is available to verify their issue to NOPSEMA (and other agencies, as required).
		Reportable incidents are reported to NOPSEMA in accordance with the timing requirements provided in Table 8-6.	
8.10	Incidents are investigated.	Incident investigations are undertaken by suitably qualified and experienced personnel in a timely manner.	Incident investigation reports are available and align with incidents recorded in the CMO incident management system.
8.11	Use of MMOs	MMOs will be hired for the activity to be present throughout the activity duration.	MMO daily reports verified and completed by lead MMO.
		The MMO will provide an information session to all vessel crew regarding their fauna observation duties and the communication protocols required.	Vessel crew induction and attendance sheets verify information session was conducted.
8.12.1	Emissions and discharges from the vessels are recorded.	Emissions and discharges from the vessels, in line with Table 8-7, are recorded.	Monitoring records are available and align with the requirements in Table 8.7.
8.12.1	Regulatory agencies and stakeholders are aware of activity start and end.	Pre- and post-activity notifications to regulatory agencies and stakeholders are issued as per Table 8.8.	Notification records verify issue.
8.12.1	This EP is reviewed and updated on an as-required basis.	This EP is reviewed and updated based on the triggers presented in Section 8.12.1 on an as-required basis.	A record of EP reviews and updates is available in Beach's document control system.
			The review and/or update details are recorded in the document control page of this EP.
		If the review identifies that significant changes to the EP are required, the EP (and OPEP, if required) is updated and re-issued to the regulators.	A record of EP revision is included in the document control page of this EP.
			Associated correspondence is available to verify the re-issue of the EP to NOPSEMA.
8.12.1	EP compliance inspections and audits are undertaken for the activity.	EP compliance is assessed pre-activity and during the activity by competent personnel.	Environmental inspection reports, completed checklists and audit report are available and verify compliance with this EP.
8.12.1	An end-of-activity EP performance report is submitted to NOPSEMA.	The end-of-activity EP performance report is issued to NOPSEMA within three months of completion of the activity.	The end-of-activity EP performance report and associated email correspondence is available to verify its issue to NOPSEMA.

9 Stakeholder Consultation

In keeping with Beach's Community and Stakeholder Engagement Policy (Figure 9-1), Beach is committed to open and ongoing engagement with the communities in which it operates and providing information that is clear, timely, relevant and easily understandable. Beach welcomes feedback and is continuously endeavouring to learn from experience in order to manage its environmental and social impacts and risks.

In addition to Beach's Community and Stakeholder Engagement Policy, stakeholder consultation has been undertaken in accordance with the OPGGS(E) regulations and NOPSEMA's stakeholder consultation guidance.

9.1 Stakeholder Consultation Objectives

The objectives of Beach's stakeholder consultation in preparation of the EP are to:

- engage with stakeholders in an open, transparent, timely and responsive manner, building on existing relationships
- minimise community and stakeholder concerns where practicable
- build and maintain trust with stakeholders
- demonstrate that stakeholders have been consulted in accordance with regulations.

The objectives are achieved by:

- identifying and confirming stakeholders ('relevant persons' whose functions, interests or activities may be affected by the Yolla Infill Drilling activity)
- ensuring stakeholders are informed about the activity and its environmental and social impacts and risks
- providing informative, accurate and timely information
- ensuring affected stakeholders are informed about the process for consultation and that their feedback is considered in the EP
- ensuring that issues raised by affected stakeholders are adequately assessed, and where requested or relevant, responses to feedback are communicated back to them.

Policies and Procedures

Community and Stakeholder Engagement Policy

Policy Introduction

This policy outlines Beach's commitment to engage with its stakeholders to ensure that it develops positive relationships with communities within which it operates. This policy applies in all joint venture operations where Beach is the operator. This policy should be read together with other policies including the Aboriginal Engagement Policy and the Environmental Policy.

Scope

This policy applies to all Beach's directors, officers and employees.

Position statement

Beach is committed to open and transparent communication with its stakeholders and recognises that its business success is contingent upon building respectful and mutually beneficial relationships while effectively managing its operations. Beach will take the time to listen, understand, give due consideration and respond to the interests and concerns of its stakeholder groups. Beach's aim is to be seen as the operator of choice for its stakeholders, and that its presence in the community is welcomed as a positive experience.

Stakeholders include, but are not limited to, landholders, Aboriginal communities, communities in which Beach operates, interest groups and government.

Policy commitment

Beach is committed to:

- Acknowledging that local communities are stakeholders in all operations, that there will be access to reliable and timely information about exploration and development activities and transparent, sincere and respectful consultation with them prior to, during and after operations.
- Clearly communicating the goals and parameters for stakeholder engagement.
- Understanding the social, environmental and economic effects of Beach's activities while delivering business outcomes.
- Seeking to understand stakeholder values, interests and concerns with relevant business operations and in a timely manner address these and deliver on any agreed support or commitments.
- Ensuring its employees and contractors are aware of their obligations toward the protection of local community culture and relationships and the environment.
- Contributing to the community by local employment and engagement of local contractors and suppliers where appropriate and possible.
- Participating in community events where appropriate; and
- Communicating frequently and effectively through a number of means including public meetings, stakeholder forums, its website, annual report, road shows and one-on-one meetings.

Figure 9-1 Beach's Community and Stakeholder Engagement Policy

9.2 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 in Regulation 11A as:

2. each Department or agency of the Commonwealth to which the activities to be carried out under the EP, or the revision of the EP, may be relevant
3. each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP, or the revision of the EP, may be relevant
4. the Department of the responsible State Minister, or the responsible Northern Territory Minister
5. a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP, or the revision of the EP
6. any other person or organisation that the titleholder considers relevant.

Further guidance regarding the definition of functions, interests or activities is provided in NOPSEMA's Assessment of Environment Plans: Deciding on Consultation Requirements Guidelines (N-04750-GL1629, Rev 0, April 2016), as follows:

- functions – a person or organisation's power, duty, authority or responsibilities
- activities – a thing or things that a person or group does or has done
- interests – a person or organisation's rights, advantages, duties and liabilities; or a group or organisation having a common concern.

Regulation 14(9) of the OPGGS(E) also defines a requirement for ongoing consultation to be incorporated into the Implementation Strategy defined in the EP (Section 8 of this EP). In addition, Regulation 16(b) of the OPGGS(E) requires that the EP contain a summary and full text of this consultation.

9.3 Identification of Relevant Persons

Beach has identified and consulted with relevant persons whose functions, interests or activities may be affected by the Yolla Infill Drilling activity, as well as those who Beach deems necessary to keep up to date with the activities in Bass Strait. Table 9-1 identifies these relevant persons.

Stakeholder engagement regarding Beach's Bass Basin assets and projects has been ongoing for several years and more recently has included consultation regarding EPs under review or development for:

- BassGas Operations;
- Trefoil Geophysical and Geotechnical Seabed Assessment;
- Prion 3D Marine Seismic Survey;
- Non-production Well Operations;
- Yolla infield wells (current EP).

In addition, Beach has maintained regular engagement with relevant persons in relation to its Otway Basin projects, many of whom overlap with Bass Basin stakeholders. The ongoing engagement process has ensured the regular review of potential additional stakeholders and maintenance of Beach's stakeholder management system to keep records up to date.

Relevant persons are those meeting the definition provided in Section 9.2.

Table 9-1 Relevant persons consulted for the Yolla Infill Drilling EP

Category 1 – Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant	
Australian Hydrographic Office	Australian Fisheries Management Authority
Department of Agriculture, Water and Environment	Australian Marine Safety Authority
Department of Defence	Department of Environment and Energy
Department of Industry, Science, Energy and Resources	
Category 2 – Each Department or agency of a State to which the activities to be carried out under the EP may be relevant	
Victoria	
Department of Jobs, Precincts and Regions - Earth Resources Regulation - Marine Pollution	Heritage Victoria Transport Safety Victoria Office of the Shadow Minister for Environment and Climate Change Victorian Fisheries Authority
Tasmania	
Department of Natural Resources and Environment Tasmania	Department of State Growth
EPA Tasmania	
Category 3 – A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP	
Fisheries - Commonwealth	
ANZT Fishing Company	South East Trawl Fishing Industry Association
Australian Southern Bluefin Tuna Industry Association	Southern Shark Industry Alliance
Bass Strait Scallop Industry Association	Tuna Australia
Commonwealth Fisheries Association	Gazak Holdings
Sustainable Shark Fishing Association	Petuna Sealord Deepwater Fishing
Mures Fishing	Muollo Fishing
Trinsand fisheries	
Fisheries - Victorian	
Seafood Industry Victoria	Victorian Recreational Fishing Peak Body
Victorian Scallop Fishermen's Association	Corporate Alliance Enterprises
Toberfish	Fishwell Consulting
Southern Shark Industry Alliance	

Fisheries – Tasmanian	
Tasmanian Abalone Council	Scallop Fishermen's Association of Tasmania Inc
Tasmanian Rock Lobster Fisherman's Association	King Island Fishing
Tasmanian Seafood Industry Council	Richey Fishing Company
Top Fish Tasmania	Tasmanian association for recreational fishers (TARFish)
Infrastructure asset owners	
Alcatel Submarine Networks	Basslink
Spirit of Tasmania	Marinus Link
Telstra	Watersure, Victorian Desalination Plant
Conservation groups	
Surf Riders Association	Blue Whale Study Inc
Lang Lang Gas Plant Environment Liaison Group	International Fund for Animal Welfare
Native Title and cultural heritage	
Bunurong Land Council Aboriginal Corporation	
Other organisations	
Conoco Phillips	Royal Yacht Club of Tasmania
Australian Petroleum Production and Exploration Association	Mersey Yacht Club
Cooper Energy	SCUBA Divers Federation of Victoria
Esso	Schlumberger Australia Pty Ltd
Atlantis Fisheries Consulting Group	SeaRoad Holdings Pty Ltd
Toll Group	Ocean Racing Club of Victoria
Category 4 – Any other person or organisation that the Titleholder considered relevant	
Not applicable	

Beach recognises that the relevance of stakeholders identified in this EP may change in the event of a non-routine event or emergency. Every effort has been made to identify stakeholders that may be impacted by a non-routine event or emergency, the largest of which is considered a Level 2 MDO spill from the support vessel or a LOWC event.

Beach acknowledges that other stakeholders not identified in this EP may be affected, and that these may only become known to Beach in such an event.

9.4 Engagement Approach

Beach Community Engagement Standard BSTE 10.2 was developed to fulfil the requirements set out in Beach's Community and Stakeholder Engagement Policy and incorporate best practices in line with the International Association for Public Participation (IAP2) spectrum. In order of increasing level of public impact, the elements of the spectrum and their goals are:

- inform – to provide the public with balanced and objective information to assist them in understanding the problems, alternatives and/or solutions
- consult – to obtain public feedback on analysis, alternatives and/or decisions
- involve – to work directly with stakeholders throughout the process to ensure that public concerns and aspirations are consistently understood, considered and addressed
- collaborate – to partner with the public in each aspect of the decisions, including the development of alternatives and the identification of the preferred solution
- empower – to place final decision-making in the hands of the stakeholders.

The manner in which Beach has informed, consulted and involved relevant persons with the Yolla Infill Drilling activity are outlined through this section.

Under the regulatory regime for the approval of EPs, the decision maker is the regulator. This being the case, the final step in the IAP2 spectrum, 'Empower', has not been adopted.

Beach has a Stakeholder Engagement Plan (SEP) developed consistent with BSTD 10.2. The SEP takes a basin wide approach to engagement, in which Beach explains development objectives for the basin as context to each EP being developed for discrete activities. This approach is aimed at minimising confusion about different Beach projects and stakeholder engagement fatigue. The SEP sets out a strategic and systematic approach to engagement with relevant persons, which aims to foster an environment where two-way communication and ongoing, open dialogue is encouraged to build positive relationships. Key principles that guide Beach in its engagement activities are outlined in its Community and Stakeholder Engagement Policy (see Figure 9-1).

Over the last several years Beach has undertaken engagement in relation to its projects in Bass Strait and has a good record of engaging with relevant persons and broader stakeholders, including regulators, local communities, local councils, community groups and fishing industry associations.

9.5 Engagement Methodology

The tools and methods that have been and will continue to be used for engagement with relevant persons are:

- Project Information Sheet – this was issued to most stakeholders on the 21 February 2022 and provided information on activity, location and timing (Appendix J). The information sheet also included questions and answers (Q&As) and contact details to provide the opportunity to provide feedback. Beach Energy then followed up with all stakeholders on the 29 March 2022.
- Project hotline and dedicated project email – A freecall telephone number (1800 797 011) and email address (community@beachenergy.com.au) is provided in the project information sheet and is included in all project information. The phone number and email address are monitored by the Community Manager.
- Company website – the project information flyers have been made available on the Beach website (https://www.beachenergy.com.au/bass-basin/) for ease of access.

Based upon the engagement completed to-date, a total of 4 submissions were received, with the key matters raised being request for:

- standard navigational controls and notifications to be implemented, as per standard response issued by AFMA for all EP notifications from Beach;
- standard comms with commercial fishery operators, requested each time by SETFIA, with whom Beach has good working relationships.

9.6 Summary of Stakeholder Consultation

Of the 84 stakeholders listed in Table 9-1, 12 proactively responded to Beach after they received the project information sheet.

No objections or claims were raised with the activity, with stakeholders requesting that Beach follow standard navigational communications protocols and pre-existing comms processes set-up with commercial fisheries.

A summary of consultation with relevant persons undertaken to date, outlining objections and claims and Beach's assessment of merit for objections and claims is included in Table 9-2.

A complete copy of original communications to and from all relevant persons is provided in Appendix J.

Table 9-2 Summary of consultation undertaken with relevant persons

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Alcatel Submarine Networks	15644	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Alcatel Submarine Networks	14191	Email	29/03/2022	Follow up email following initial engagement	Acknowledged receipt of email (29/03/2022)	N/a
ANZT Fishing Company	14155	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
ANZT Fishing Company	15645	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Atlantis Fisheries Consulting Group	14142	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Atlantis Fisheries Consulting Group	15646	Email	29/03/2022	Follow up email following initial engagement	Acknowledged receipt (30/03/2022) requested that the normal SMS notification be provided to the shark fishery	The requirement is a standard requirement implemented by Beach in this region This is incorporated into activity notifications (Section 8.12.1.2) Response provided 31/03/2022
Australian Fisheries Management Authority	14187	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Australian Fisheries Management Authority	15469	Email	25/03/2022	Follow up email following initial engagement	Response provided (See ID: 15785)	The request has merit and is in line with existing Beach Process
Australian Fisheries Management Authority	15785	Email	29/03/2022	Response to email dated 25/03	Requests Beach engage with Commonwealth Fisheries No objections or claims received	As detailed in Section 4.3 each identified the relevant fisheries and

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
						engaged with them directly
Australian Hydrographic Office	14188	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Australian Hydrographic Office	15647	Email	29/03/2022	Follow up email following initial engagement	Acknowledged receipt (30/03/2022) No objections or claims raised	N/a
Australian Marine Safety Authority	14189	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No objections or claims raised Acknowledgment receipt (See ID: 14559)	N/a
Australian Marine Safety Authority	14559	Email	24/02/2022	Update on Beach Energy activities in Bass Strait	Appreciation of email, the initial advice provided on this project will continue to apply	N/a
Australian Marine Safety Authority	15648	Email	29/03/2022	Follow up email following initial engagement	response provided (See ID: 15808)	N/a
Australian Marine Safety Authority	15808	Email	1/04/2022	email from AMSA	Requested that AMSA's Joint Rescue Coordination Centre (JRCC) be notified via rccaus@amsa.gov.au (Phone: 1800 641 792 or +61 2 6230 6811) 24-48 hours before operations commence Requested the Australian Hydrographic Office be contacted through datacentre@hydro.gov.au no less than four working weeks before operations commence	The requirement is a standard requirement for industry This is incorporated into activity notifications (Section 8.12.1.2)
Australian Petroleum Production and Exploration Association	14204	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Australian Petroleum Production and Exploration Association	15649	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Australian Southern Bluefin Tuna Industry Association	14156	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Australian Southern Bluefin Tuna Industry Association	15650	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Australian Volunteer Coast Guard	14148	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Australian Volunteer Coast Guard	15651	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Bass Strait Scallop Industry Association	14002	Email	9/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Bass Strait Scallop Industry Association	14157	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Bass Strait Scallop Industry Association	15652	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Bass Strait Scallop Industry Association	15720	Email	29/03/2022	Acknowledgement of follow up email	None raised (A Sullivan)	N/a
Bass Strait Scallop Industry Association	15722	Email	29/03/2022	Acknowledgement of follow up email	No issues with drilling the well adjacent Yolla platform (S Richey)	N/a
Basslink	14193	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Basslink	15653	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Ben Maas	14158	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Ben Maas	15654	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Blue Whale Study Inc	14144	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Blue Whale Study Inc	15655	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Bradley Hardy	14194	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Bradley Hardy	15656	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Bunurong Land Council Aboriginal Corporation	14140	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Bunurong Land Council Aboriginal Corporation	15657	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Commonwealth Fisheries Association	14159	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Commonwealth Fisheries Association	15658	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Conoco Phillips	14205	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Conoco Phillips	15659	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Cooper Energy	14206	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	Requested additional contact be added to distribution list (22/02/2022)	N/a
Cooper Energy	15660	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Corporate Alliance Enterprises	14160	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Corporate Alliance Enterprises	15661	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Craig Ross	14195	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Craig Ross	15662	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Department of Agriculture, Water and Environment - Biosecurity	14149	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of Agriculture, Water and Environment - Biosecurity	15663	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Department of Agriculture, Water and the Environment - Fisheries	14150	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of Agriculture, Water and the Environment - Fisheries	15665	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Department of Defence - Australian Hydrographic Office	14151	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of Defence - Australian Hydrographic Office	15666	Email	29/03/2022	Follow up email following initial engagement	Acknowledged receipt (30/03/2022) Requested AHS be notified three weeks prior to the commencement of activities No objections or claims raised	The requirement is a standard requirement for industry This is incorporated into activity notifications (Section 8.12.1.2)
Department of Defence - Infrastructure Division, Defence Support & Reform Group	14152	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of Defence -	15667	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Infrastructure Division, Defence Support & Reform Group						
Department of Environment and Energy	14153	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of Environment and Energy	15668	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Department of Industry, Science, Energy and Resources	14154	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of Industry, Science, Energy and Resources	15669	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Department of Jobs, Precincts and Regions: Earth Resources Regulation	14138	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of Jobs, Precincts and Regions: Earth Resources Regulation	15670	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Department of Jobs, Precincts and Regions: Marine Pollution	14139	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of Jobs, Precincts and Regions: Marine Pollution	15671	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Department of Primary Industries, Parks,	14210	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Water and Environment						
Department of Primary Industries, Parks, Water and Environment	15672	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Department of State Growth - Mineral resources Tasmania	14211	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Department of State Growth - Mineral resources Tasmania	15673	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
EPA Tasmania	14212	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
EPA Tasmania	15674	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Esso	14207	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Esso	15675	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Fishwell Consulting	14161	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Fishwell Consulting	15676	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Gazak Holdings	14162	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Gazak Holdings	15677	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Heritage Victoria	14213	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Heritage Victoria	15678	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Institute for Marine and Antarctic Studies, University of Tasmania	14147	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Institute for Marine and Antarctic Studies, University of Tasmania	15679	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
International Fund for Animal Welfare	14145	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	Acknowledged receipt	N/a
International Fund for Animal Welfare	15680	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
John Cull	14163	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
John Cull	15681	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
King Island Fishing	14164	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
King Island Fishing	15682	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Lang Lang Gas Plant Environment Liaison Group	14141	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Lang Lang Gas Plant Environment Liaison Group	15683	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Marinus Link	14192	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Marinus Link	15684	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Mersey Yacht Club	14196	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Mersey Yacht Club	15685	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Muollo Fishing	14165	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Muollo Fishing	15686	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Mures Fishing	14166	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Mures Fishing	15687	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Ocean Racing Club of Victoria	14143	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Ocean Racing Club of Victoria	15688	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Office of the Shadow Minister for Environment and Climate Change	14214	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Office of the Shadow Minister for Environment and Climate Change	15689	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Petuna Sealord Deepwater Fishing	14167	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Petuna Sealord Deepwater Fishing	15690	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Portland Professional Fishermens Association	14168	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Portland Professional Fishermens Association	14553	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Richey Fishing Company	14169	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Richey Fishing Company	15691	Email	29/03/2022	Follow up email following initial engagement	Acknowledged receipt (29/03/2022) No objections or claims raised	N/a
Royal Yacht Club of Tasmania	14197	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Royal Yacht Club of Tasmania	15692	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Scallop Fishermen's Association of Tasmania Inc	14170	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Scallop Fishermen's Association of Tasmania Inc	15693	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Schlumberger Australia Pty Ltd	14208	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Schlumberger Australia Pty Ltd	15694	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
SCUBA Divers Federation of Victoria	14171	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
SCUBA Divers Federation of Victoria	15695	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Seafood Industry Victoria	14172	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Seafood Industry Victoria	15696	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
SeaRoad Holdings Pty Ltd	14000	Email	9/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
SeaRoad Holdings Pty Ltd	14198	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
SeaRoad Holdings Pty Ltd	15697	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
South East Trawl Fishing Industry Association	14173	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
South East Trawl Fishing Industry Association	15698	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Southern Shark Industry Alliance	13990	Email	8/02/2022	Update on Beach Energy Bass Strait Activities	No response provided	N/a
Southern Shark Industry Alliance	14006	Email	10/02/2022	Project Update and sharing of fishery maps	No objections or claims made Information sharing	N/a
Southern Shark Industry Alliance	14008	Email	10/02/2022	Further discussion re fishery maps	No objections or claims made Information sharing	N/a
Southern Shark Industry Alliance	14174	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Southern Shark Industry Alliance	15699	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Spirit of Tasmania	13996	Email	9/02/2022	Update on Beach Energy Bass Strait Activities	Acknowledgement receipt (See ID: 14199)	N/a
Spirit of Tasmania	14199	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Spirit of Tasmania	14552	Email	2/03/2022	Follow up email following initial engagement	No response provided	N/a
Surf Riders Association	14146	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment. Requested additional contacts be added to the mailing list	No response provided	N/a
Surf Riders Association	15700	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach’s assessment of merit
Sustainable Shark Fishing Association	14175	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Sustainable Shark Fishing Association	15701	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
TARFish	14176	Email	21/02/2022	Update on Beach Energy activities in Bass Strait	No response provided	N/a
TARFish	14177	Email	21/02/2022	Update on Beach Energy activities in Bass Strait	No response provided	N/a
TARFish	15702	Email	29/03/2022	Follow up on Beach Energy Activities in Bass Strait	No response provided	N/a
TARFish	15703	Email	29/03/2022	Follow up on Beach Energy Activities in Bass Strait	No response provided	N/a
Tasmanian Abalone Council	14178	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Tasmanian Abalone Council	15704	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Tasmanian Rock Lobster Fisherman's Association	14179	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Tasmanian Rock Lobster Fisherman's Association	15705	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Tasmanian Seafood Industry Council	14180	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Tasmanian Seafood Industry Council	15706	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Telstra	14200	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Telstra	15002	Email	21/03/2022	Seeking advice on which direction the survey is starting ‘Yolla - Trefoil’ or ‘Trefoil - Yolla’	Meeting organised to discuss	N/a
Telstra	15707	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
TGS	14209	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
TGS	15708	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Toberfish	14181	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Toberfish	15709	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Toll Group	13998	Email	9/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Toll Group	14201	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Toll Group	15710	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Top Fish Tasmania	14004	Email	9/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Top Fish Tasmania	14202	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Top Fish Tasmania	15711	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Transport Safety Victoria - Maritime Safety Victoria	14215	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Transport Safety Victoria - Maritime Safety Victoria	15712	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Trinsand fisheries	14182	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Trinsand fisheries	15713	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Tuna Australia	14183	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a

Relevant person	ID	Date and method (and reference)	Consultation conducted	Consultation conducted	Issues, objections and claims	Beach's assessment of merit
Tuna Australia	15714	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Victorian Fisheries Authority	14216	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Victorian Fisheries Authority	15715	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Victorian Recreational Fishing Peak Body	14184	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Victorian Recreational Fishing Peak Body	15716	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Victorian Scallop Fishermen's Association	14185	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Victorian Scallop Fishermen's Association	15717	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a
Watersure, Victorian Desalination Plant	14203	Email	21/02/2022	Beach Emailed the project information sheet and invited return comment	No response provided	N/a
Watersure, Victorian Desalination Plant	15718	Email	29/03/2022	Follow up email following initial engagement	No response provided	N/a

9.7 Ongoing Consultation

Beach will continue to consult with relevant persons regarding the Yolla Infill Drilling Activity at appropriate times, taking into consideration Beach's desire to minimise 'consultation fatigue' that many relevant persons have expressed (especially in light of the COVID-19 pandemic declared in March 2020 and the issues this has created for commercial fisheries in particular).

Beach has established an arrangement with SETFIA for them to issue SMS messages to their members before, during and after the activity completion.

Once the EP is accepted Beach will provide an update notice to all stakeholders including:

- updated information sheet including map
- information on where stakeholders can view the accepted EP
- timings for the Yolla Infill Drilling activity
- Beach website link to Beach's *Fair Ocean Access* information sheet that summarises Beach's compensation procedures relating to claims of economic loss by a commercial fisher.

Activity notification requirements are provided in Section 8.12.1.2.

9.8 Management of Objections and Claims

If any objections or claims are raised during ongoing consultation or during the activity, these will be verified through publicly available credible information such as scientific research and/or fishing data from relevant Commonwealth or State fishing authorities, as applicable.

Where the objection or claim is substantiated, it will be assessed in line with the risk assessment process detailed in Section 6 and controls applied where appropriate to manage impacts and risks to ALARP and an acceptable level. Relevant persons will be provided with feedback as to whether their objection or claim 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.

10 References

ABARES. 2021. “Fishery status reports 2021.” https://daff.ent.sirsidynix.net.au/client/en_AU/search/asset/1032581/0.

ACAP. 2009. *Grey-headed Albatross Thalassarche chrysostoma.* Agreement on the Conservation of Albatrosses and Petrels. https://www.acap.aq/resources/acap-species/248-grey-headed-albatross/file.

Addison, R F, and P F Brodie. 1984. “Characterization of ethoxyresorufin O-de-ethylase in gray seal Halichoerus grypus.” *Comp. Biochem. Physiol.* 79C: 261-263.

Addison, R F, P F Brodie, A Edwards, and M C Sadler. 1986. “Mixed function oxidase activity in the harbour seal (Phoca vitulina) from Sable Is., N.S.” *Comp. Biochem. Physiol.* 85C (1): 121-124.

AFMA. 2014. *Blue warehou (Seriolella brama) Stock Rebuilding Strategy.* Australian Fisheries Managementy Authority, Australian Government. https://www.afma.gov.au/sites/default/files/uploads/2014/12/Blue-Warehou-Rebuilding-Strategy-2014.pdf.

AFMA. 2022. *Blue Warehou.* Australian Fisheries Management Authority. https://www.afma.gov.au/fisheries-management/species/blue-warehou.

American Chemistry Council. 2006. *A Comparison of the Environmental Performance of Olefin and Paraffin Synthetic Base Fluids (SBF).* American Chemistry Council. https://www.americanchemistry.com/ProductsTechnology/Higher-Olefins/environment.

AMSA. 2015b. *Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities.* Australian Government.

—. 2015a. “The Effects of Maritime Oil Spills on Wildlife including Non-avian Marine Life.” http://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/general-information/oiled-wildlife/marine-life/index.asp.

—. 2021. “Vessel traffic data September 2021.” *Dataset.*

Andrew. 1999. “Under Southern Seas.” University of New South Wales Press, Sydney, Australia, 238.

Andrew, and O’Neill. 2000. “Large-scale patterns in habitat structure on subtidal rocky reefs in New South Wales.” *Marine and Freshwater Research* 51: 255-263.

Ansell, R, R N Gibson, and M Barnes. 1999. “Oceanography and Marine Biology: An Annual Review, Volume 37.” The Dunstaffnage Marine Laboratory, Scotland.

APPEA. 2021. “Australian Offshore Titleholders Source Control Guidelines.” June. Accessed May 14, 2022. https://www.appea.com.au/wp-content/uploads/2021/09/210921-Australian-Offshore-Titleholders-Source-Control-Guideline-Rev-0-APPROVED-Web.pdf.

Arnould, J, and R Kirkwood. 2007. “Habitat selection by female Australian fur seals (Arctocephalus pusillus doriferus).” *Aquatic Conservation: Marine and Freshwater Ecosystems* 17 (1): S53.

Aulich, M G, R D McCauley, B J Saunders, and M J G Parsons. 2019. “Fin whale (Balaenoptera physalus) migration in Australian waters using passive acoustic monitoring.” *Scientific Reports* 9: ARTN 8840.

Austin, M E, D E Hannay, and K C Broker. 2018. “Acoustic characterization of exploration drilling in the Chukch and Beaufort seas.” *J. Acoust. Soc. Am* 144 (1).

Backhouse, G, J Jackson, and J O'Connor. 2008. "National Recovery Plan for Australian Grayling Prototroctes maraena." Department of Sustainability and Environment, Melbourne. https://www.awe.gov.au/sites/default/files/documents/australian-grayling.pdf.

Baines, P G, and C B Fandry. 1983. "Annual cycle of the density field in Bass Strait." *Marine and Freshwater Research* 34: 143-153.

Baker, C S, N Patenaude, J L Bannister, J H Robins, and H Kato. 1999. "Distribution and diversity of mtDNA lineages among southern right whales (Eubalaena australis) from Australia and New Zealand." *Marine Biology* 134 (1): 1-7. doi:10.1007/s002270050519.

Baker, G B, R Gales, S Hamilton, and V Wilkinson. 2002. "Albatrosses and petrels in Australia: a review of their conservation and management." *Emu* 102: 71-97.

Bakke, T, J Klungsøyr, and S Sanni. 2013. "Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry." *Marine Environmental Research* 92: 154-169.

Bannister, J l, C M Kemper, and R M Warneke. 1996. "The Action Plan for Australian Cetaceans. Canberra: Australian Nature Conservation Agency." http://www.environment.gov.au/coasts/publications/cetaceans-action-plan/pubs/whaleplan.pdf.

Barton, J, A Pope, and S Howe. 2012. *Marine Natural Values Study Vol 2: Marine Protected Areas of the Flinders and Twofold Shelf Bioregions.* Parks Victoria, Melbourne: Parks Victoria Technical Series. Number 79.

Bax, N J, F R Mcennulty, and K L Gowlett-Holmes. 2003. *Distribution and biology of the introduced gastropod, Maoricolpus roseus (Quoy and Gamard, 1834) (Caenogastropoda: Turritellidae) In Australia.* Centre for Research on Introduced Marine Pests, Hobart: CSIRO Marine Research. http://www.cmar.csiro.au/e-print/open/CRIMP_Tech_Report_25.pdf.

Beaman, Daniell, and Harris. 2005. "Geology-benthos relationships on a temperate rocky bank, eastern Bass Strait, Australia." *Marine and Freshwater Research* (CSIRO publishing) 56. https://www.deepreef.org/images/stories/publications/peer-reviewedliterature/GeologyBenthosRelations2005.pdf.

BHP Petroleum. 1999. "Minerva Gas Field development: Environmental Impact Statement and Environment Effects Statement."

BirdLife Internation. 2019. *Species factsheet: Pterodroma macroptera.* http://www.birdlife.org.

BirdLife International. 2020. "Important Bird Areas factsheet: Hunter Island Group." http://www.birdlife.org.

Birdlife. 2022. *Species factsheet: Ardenna grisea.* BirdLife International. http://datazone.birdlife.org/species/factsheet/sooty-shearwater-ardenna-grisea/text.

Birdlife. 2022. "Species factsheet: Thalassarche steadi." Birdlifel International. http://datazone.birdlife.org/species/factsheet/white-capped-albatross-thalassarche-steadi/text.

Blower, D C, J M Pandolfi, B D Bruce, M Gomez-Cabrera, and J R Ovenden. 2012. "Population genetics of Australian white sharks reveals fine-scale spatial structure, trans - oceanic dispersal events and low effective population sizes." *Mar Ecol Prog Ser* 455: 229-244.

BMT WBM. 2011. *Ecological Character Description of the Corner Inlet Ramsar Site – Final Report.* Department of Sustainability, Environment, Water, Population and Communities, Canberra: Prepared for the Australian Government.

BoM. 2022. "Climate Statistics for Australian Locations: King Island." Bureau of Meteorology, Perth. http://www.bom.gov.au/climate/averages/tables/cw_098017.shtml.

Bone, C. 1998. '*Preliminary investigation into leatherback turtle, Dermochelys coriacea (L.) distribution abundance and interactions with fisheries in Tasmanian waters. Unpublished Report.* Tasmanian Parks and Wildlife Service.

Boon, P, T Allen, J Brook, G Carr, D Frood, C Harty, J Hoye, et al. 2011. "Mangroves and Coastal Saltmarsh of Victoria, Distribution, Condition, Threats and Management." Institute for Sustainability and Innovation, Victoria University.

BP. 2013. *Shah Deniz 2 Project. Environmental and Socio-Economic Impact Assessment.* BP Development Pty Ltd. https://www.bp.com/en_az/caspian/sustainability/environment/ESIA.html.

Bradshaw, S, B Moore, and K Gartmann. 2018. *Tasmanian Octopus Fishery Assessment 2017/18.* UTAS: Institute for Marine and Antartic Studies.

Branch, T A, K Matsuoka, and T Miyashita. 2004. "Evidence for increases in Antarctic blue whales based on Bayesian modelling." *Marine Mammal Science* 20 (4): 726-754.

Bransbury, J. 1985. "Waders of littoral habitats in south-eastern South Australia." *South Australian Ornithologist* 29: 180-187.

BRS. 2007. *Designated Exchange Areas Project – Providing Informed Decision on the Discharge of Ballast Water in Australia (Phase II) Ed. Knight, E., Barry, S., Summerson, R., Cameron S., Darbyshire R.* Bureau of Rural sciences.

Bruce, B D, D Harasti, K Lee, C Gallen, and R Bradford. 2019. "Broad-scale movements of juvenile white sharks Carcharodon carcharias in eastern Australia from acoustic and satellite telemetry." *Marine Ecology Progress Series* 619: 1-15. doi:3354/meps12969.

Bruce, BD, JD Stevens, and H Malcolm. 2006. "Movements and swimming behaiour of white sharks (Carcharodon carcharias) in Australian waters." *Marine Biology* 150:161-172.

Brusati, E D, and E D Grosholz. 2006. "Native and Introduced Ecosystem Engineers Produce Contrasting Effects on Estuarine Infaunal Communities." *Biological Invasions* 8: 683.

Burnell, S R. 2001. "Aspects of the reproductive biology, movements and site fidelity of right whales off Australia." *Journal of Cetacean Research and Management* Special Issue 2: 89-102.

Butler, A, F Althaus, D Furlani, and Ridgway. 2002. *Assessment of the Conservation Values of the Bass Strait Sponge Beds Area: A component of the Commonwealth Marine Conservation Assessment Program 2002-2004.* Report to Environment Australia, CSIRO Marine Research.

CarbonNet. 2018. "Geotechnical and Geophysical Investigations Environment Plan Summary." Department of Jobs, Precincts and Regions, Melbourne. https://info.nopsema.gov.au/home/underway_offshore.

Carlyon, K, D Pemberton, and T Rudman. 2011. *Islands of the Hogan Group, Bass Strait: Biodiversity and Oil Spill Response Survey.* Department of Primary Industries, Water and Environment Resource Management and Conservation Division, Hobart: Nature Conservation Report Series.

Carlyon, K, M Visoiu, C Hawkins, K Richards, and R Alderman. 2015. *Rodondo Island, Bass Strait: Biodiversity & Oil Spill Response Survey, January 2015.* Department of Primary Industries, Water and Environment Natural and Cultural Heritage Division, Hobart: Nature Conservation Report Series.

Carroll, E, N Patenaude, A Alexander, D Steel, R Harcourt, S Childerhouse, S Smith, J Bannister, R Constantine, and C S Baker. 2011. "Population structure and individual movement of southern right whales around New Zealand and Australia." *Marine Ecology Progress Series* 432: 257-268. doi:10.3354/meps09145.

Cefas. 2018. “PLONOR List issued (23 August 2018).” https://www.cefas.co.uk/cefas-data-hub/offshore-chemical-notification-scheme/ocns-bulletin-board/new-plonor-list-issued-23-august-2018/.

Charlton, C M. 2017. *Population demographics of southern right whales (Eubalaena australis) in Southern Australia.* PhD Thesis, Curtin University, Western Australia, 171.

Charlton, C, R Ward, R D McCauley, R L Brownell Jr, S Guggenheimer, C P Salgado Kent, and J L Bannister. 2019. “Southern right whales (Eubalaena australis) return to a former wintering calving ground: Fowlers Bay, South Australia.” *Marine Mammal Science* 35 (4): 1438-1462. doi:https://doi.org/10.1111/mms.12611.

Chatto, R, and R M Warneke. 2000. “Records of cetacean strandings in the Northern Territory of Australia.” *The Beagle, Records of the Museums and Art Galleries of the Northern Territory* 16: 163-175.

Chevron Australia. 2014. *Gorgon Gas Development Fourth Train Expansion Proposal Public Environmental Review / Draft Environmental Impact Statement.* Perth, Western Australia: Chevron Australia.

City of Geelong. 2022. *Brochure 7 in the series covering information on Wetland Wanderings.* Geelong: City of Geelong. https://www.geelongaustralia.com.au/wetlands/article/item/8cf9165b37f60bd.aspx#:~:text=Lake%20Victoria%20is%20a%20shallow,Reserve%20administered%20by%20Parks%20Victoria.

Clark, R. 1984. “Impacts of oil pollution on seabirds.” *Environmental Pollution Series: Ecology and Biology* 1–22.

Clemann, N, and G R Gillespie. 2012. “National Recovery Plan for the Southern Bell Frog Litoria raniformis.” Department of Sustainability and Environment, Melbourne. https://www.awe.gov.au/sites/default/files/documents/litoria-raniformis_0.pdf.

Cogger, HG. 1992. *Reptiles and amphibians of Australia, Rev. 1992 [i.e. 4th rev.] ed.* Frenchs Forest, N.S.W.

Cogger, HG, EE Cameron, RA Sadlier, and P Eggler. 1993. *The Action Plan for Australian Reptiles.* Canberra, ACT: Australian Nature Conservation Agency.

Commonwealth of Australia. 2020b. “Australian Ballast Water Management Requirements.” Rev 8.

Commonwealth of Australia. 2015b. “Conservation Management Plan for the Blue Whale—A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 Commonwealth of Australia, 2015.”

Commonwealth of Australia. 2019. “Draft National Recovery Plan for the Australian Fairy Tern (Sternula nereis nereis).” https://www.awe.gov.au/sites/default/files/env/consultations/16a0c908-32d4-4210-b07f-1018e34b5a13/files/draft-recovery-plan-australian-fairy-tern.pdf.

—. 2013. “MNES: Significant impact guidelines 1.1.” https://www.awe.gov.au/sites/default/files/documents/nes-guidelines_1.pdf.

Commonwealth of Australia. 2015a. *National Conservation Values Atlas.* Canberra: Commonwealth of Australia. http://www.environment.gov.au/webgisframework/apps/ncva/ncva.jsf.

Commonwealth of Australia. 2020a. “National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020.”

Commonwealth of Australia. 2017a. “National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna 2017.”

Commonwealth of Australia. 2017b. “Recovery Plan for Marine Turtles in Australia.” https://www.awe.gov.au/sites/default/files/documents/recovery-plan-marine-turtles-2017.pdf.

Commonwealth of Australia. 2015c. "South-east Marine Region Profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region."

Commonwealth of Australia. 2018. "Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean."

Commonwealth of Australia. 2015d. *Wildlife Conservation Plan for Migratory Shorebirds.* Department of the Environment, Commonwealth of Australia. doi:https://www.awe.gov.au/sites/default/files/documents/widlife-conservation-plan-migratory-shorebirds.pdf.

Cranmer, G. 1988. *Environmental survey of the benthic sediments around three exploration well sites.* United Kingdom Offshore Operators Association, Aberdeen University Marine Studies Ltd.

CSIRO. 2005. *Corner Inlet Environmental Audit.* Report to the Gippsland Coastal Board. Prepared by Molloy R., Chidgey S., Webster I., Hancock G. and Fox D.

—. 2015. *Marine Benthic Substrate Database - CAMRIS - Marsed. v1. Data Collection.* CSIRO.

CSIRO. 2015. *Plankton 2015: State of Australia's Oceans.* CSIRO Report.

Currie, D R, and L R Isaacs. 2004. "Impact of exploratory offshore drilling on benthic communities in the Minerva gas field." *Australia. Mar. Environ. Res* 59 (3): 217-233.

Daan, R, and M Mulder. 1996. *Long-term effects of OBM cutting discharges at 12 locations on the Dutch Continental Shelf.* The Netherlands, Texel: NIOZ, 1-36.

DAWE. 2020c. "Australian Ballast Water Management Requirements version 8." Department of Agriculture, Water and the Environment. https://www.awe.gov.au/sites/default/files/documents/australian-ballast-water-management-requirements.pdf.

DAWE. 2022g. "Australian National Shipwreck Database." Dataset, Department of Agriculture, Water and the Environment, Canberra. http://environment.gov.au/heritage/historic-shipwrecks/australian-national-shipwreck-database.

DAWE. 2015. *Big Horseshoe Canyon Species Profile and Threats Database.* Department of Agriculture, Water and Environment, Commonwealth of Australia. https://www.environment.gov.au/sprat-public/action/kef/view/88;jsessionid=E3817126861BF9F0C79A0C895BB02A21.

DAWE. 2022. "Conservation Advice for Litoria watsoni (Watson's Tree Frog)." Department of Agriculture, Water and the Environment, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/91509-conservation-advice-18022022.pdf.

DAWE. 2021. "Conservation Advice for Mixophyes balbus (Stuttering Frog, Southern Barred Frog in Victoria)." Department of Agriculture, Water and the Environment, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/1942-conservation-advice-23112021.pdf.

DAWE. 2022f. "Directory of Important Wetlands in Australia." Department of Agriculture, Water and the Environment, Canberra. https://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands.

—. 2021b. "Draft National Recovery Plan for albatrosses and petrels." https://www.awe.gov.au/sites/default/files/env/consultations/0a859b65-5cbd-4e5a-9d93-65f2e0465864/files/draft-national-recovery-plan-albatrosses-petrels-2021.pdf.

DAWE. 2021a. *Guidance on key terms within the Blue Whale Conservation Management Plan*. Department of Agriculture, Water and the Environment, Australian Government. https://www.awe.gov.au/sites/default/files/documents/guidance-key-terms-blue-whale-conservation-management-plan-2021.pdf.

DAWE. 2015. “Listing advice Seriolella brama (Blue Warhou).” Department of Agriculture, Water and the environment. https://www.environment.gov.au/biodiversity/threatened/species/pubs/69374-listing-advice.pdf.

DAWE. 2020a. “Offshore Installations - Biosecurity Guide.” Department of Agriculture, Water and Environment, Canberra. https://www.awe.gov.au/sites/default/files/sitecollectiondocuments/aqis/airvesselmilitary/vessels/pests/offshore-installations-guide.pdf.

DAWE. 2020b. “Species Profile and Threats (SPRAT) Database.” Department of Agriculture, Water and the Environment, Canberra.

DAWE. 2022i. “SPRAT Profile - Ardenna grisea — Sooty Shearwater.” Department of Agriculture, Water and the Environment, Canberra. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82651.

DAWE. 2022j. “SPRAT Profile - Carcharodon carcharias — White Shark, Great White Shark.” Department of Agriculture, Water and Environment. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64470#:~:text=The%20Great%20White%20Shark%20is,upper%20surface%20and%20white%20below.

DAWE. 2022k. “SPRAT Profile - Lagenorhynchus obscurus — Dusky Dolphin.” Department of Agricultre, Water and the Environment, Canberra. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=43.

DAWE. 2022l. “SPRAT Profile - Orcinus orca — Killer Whale, Orca.” Department of Agriculture, Water and the Environment, Canberra. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=46.

DAWE. 2022m. “SPRAT Profile - Thalassarche steadi — White-capped Albatross.” Department of Agriculture, Water and the Environment, Canberra. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64462.

—. 2022n. *SPRAT Profile Ardenna carneipes — Flesh-footed Shearwater, Fleshy-footed Shearwater*. Accessed April 11, 2022. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82404.

—. 2022d. *SPRAT Profile Ardenna pacifica — Wedge-tailed Shearwater*. Accessed April 11, 2022. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=84292.

—. 2022e. *SPRAT Profile Balaenoptera acutorostrata — Minke Whale*. Accessed April 11, 2022. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?showprofile=Y&taxon_id=33.

—. 2022h. *SPRAT Profile Balaenoptera edeni — Bryde's Whale*. Accessed April 11, 2022. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=35.

—. 2022o. *SPRAT Profile Carcharhinus longimanus — Oceanic Whitetip Shark*. https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=84108.

—. 2022b. *SPRAT Profile Neophema chrysogaster — Orange-bellied Parrot*. Accessed April 2022. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=747#:~:text=The%20orange%2Dbellied%20parrot%20is,of%20south%2Deast%20mainland%20Australia.

—. 2022j. *SPRAT Profile Physeter macrocephalus — Sperm Whale*. Accessed April 11, 2022. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59.

—. 2008. *SPRAT Profile: Chelonia mydas — Green Turtle.* https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1765.

—. 2002. *Thalassarche cauta (Shy Albatross) - Albatross Island, The Mewstone, Pedra Branca Listed Critical Habitat.* https://www.environment.gov.au/cgi-bin/sprat/public/publicshowcriticalhabitat.pl?id=4.

—. [n.d]. "The Introduction of Marine Pests to the Australian Environment via Shipping."

De Campos, L F, P M Paiva, P PGW Rodrigues, M IP Ferreira, and P Lugon Jnr. 2017. "Disposal of waste from cementing operations from offshore oil and gas wells building." *Ciencia natura* 39 (2): 413-422.

DEC. 2006. "Gould's Petrel (Pterodroma leucoptera leucoptera) Recovery Plan." Department of Environment and Conservation, Hurtsville. https://www.awe.gov.au/sites/default/files/documents/p-leucoptera.pdf.

DECC. 2007. "Lord Howe Island Biodiversity Management Plan." Department of Environment and Climate Change, Sydney. https://www.awe.gov.au/sites/default/files/documents/lord-howe-island.pdf.

DEH. 2006. *A Guide to the Integrated Marine and Coastal Regionalisation of Australia.* Department of the Environment and Heritage, Canberra.

DEH. 2002. "Indigenous Communities & the Environment. Indigenous Protected Areas: Preminghana Indigenous Protected Area." Department of the Environment and Heritage. http://ea.gov.au/indigenous/ipa/declared/preminghana.html.

DELWP. 2015. "Australian Grayling Action Statement." https://www.environment.vic.gov.au/__data/assets/pdf_file/0013/33034/Australian-Grayling_action-statement.pdf.

DELWP. 2017. *Flora and Fauna Guarantee Act 1988 Threatened List.* Department of Environment, Land, Water and Planning, Melbourne: DELWP.

DELWP. 2016. *National Recovery Plan for the Orange-bellied Parrot, Neophema chrysogaste.* Department of Environment, Land, Water and Planning, Canberra: Australian Government Department of Environment. https://www.awe.gov.au/sites/default/files/documents/national-recovery-plan-orange-bellied-parrot.pdf.

DELWP. 2016b. *National Recovery Plan for the Orange-bellied Parrot, Neophema chrysogaster.* Melbourne: Department of Environment, Land, Water and Planning.

Department of Natural Resources & Environment. 2022. *Operational Guide for the commercial Scalefish Fishery.* https://nre.tas.gov.au/Documents/Scalefish%20Management%20Guide%20-%20Info%20for%20licence%20holders.pdf.

DEWHA. 2008b. "Approved Conservation Advice for Dermochelys coriacea (Leatherback Turtle)." Department of the Environment, Water, Heritage and the Art, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/1768-conservation-advice.pdf.

DEWHA. 2008a. "Approved Conservation Advice for Raja sp. L (Maugean Skate)." Department of the Environment, Water, Heritage and the Arts, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/68451-conservation-advice.pdf.

DEWHA. 2009. "Approved Conservation Advice for Thalassarche chrysostoma (Grey-headed Albatross)." Department of the Environment, Water, Heritage and the Arts, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/66491-conservation-advice.pdf.

DEWHA. 2009. "Approved Conservation Advice for Thalassarche chrysostoma (Grey-headed Albatross)." Department of the Environment, Water, Heritage, and the Arts, Canberra. http://www.environment.gov.au/biodiversity/threatened/species/pubs/66491-conservation-advice.pdf.

DEWHA. 2010. "Approved Conservation Advice for Tyto novaehollandiae castanops (Tasmanian Masked Owl)." Department of the Environment, Water, Heritage and the Arts, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf.

DEWHA. 2012. "Marine bioregional plan for the North-west Marine Region." *Department of the Environment, Water, Heritage and the Arts, Australian Government, Canberra, Australian Capital Territory.*

DISER. 2022. "National Greenhouse Gas Inventory Quarterly Update: September 2021." Department of Industry, Science, Energy and Resources. https://www.industry.gov.au/data-and-publications/national-greenhouse-gas-inventory-quarterly-update-september-2021.

DNP. 2013. "South-East Commonwealth Marine Reserves Network Management Plan 2013–-23." Department of Environment Canberra. https://www.awe.gov.au/sites/default/files/env/pages/de2de49a-7eed-4a70-bfbb-463f8d00f2ca/files/se-networkmanagement-plan2013-23.pdf.

DNRE. 2002. "Corner Inlet Ramsar Site Strategic Management Plan, May 2002." Department of Natural Resources and Environment, Victoria.

DoE. 2014. "Approved Conservation Advice for Heleioporus australiacus (giant burrowing frog)." Department of the Environment, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/1973-conservation-advice.pdf.

DoE. 2014. "Approved Conservation Advice for Litoria aurea (green and golden bell frog)." Department of the Environment, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/1870-conservation-advice.pdf.

DoE. 2014a. "Conservation Advice hinornis rubricollis rubricollis." Department of the Environment, Canberra. https://www.environment.gov.au/biodiversity/threatened/species/pubs/66726-conservation-advice.pdf.

DoE. 2015. *Conservation Management Plan for the Blue Whale - A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999*. Department of the Environment, Canberra: Commonwealth of Australia. https://www.awe.gov.au/sites/default/files/documents/blue-whale-conservation-management-plan.pdf.

DoE. 2015d. "Conservation Management Plan for the Blue Whale. A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999." Department of the Environment, Canberra.

DoE. 2016. *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)*. Department of the Environment, Commonwealth of Australia. https://www.awe.gov.au/sites/default/files/documents/national-recovery-plan-regent-honeyeater.pdf.

DoE. 2017. *Recovery Plan for the Giant Freshwater Crayfish (Astacopsis gouldi)*. Department of the Environment and the Tasmanian Government, Canberra: Commonwealth of Australia. https://www.environment.gov.au/biodiversity/threatened/species/pubs/64415-conservation-advice-13072017.pdf.

DoE. 2014b. "Recovery Plan for the Grey Nurse Shark (Carcharias taurus)." Department of the Environment, Canberra. https://www.awe.gov.au/sites/default/files/documents/recovery-plan-grey-nurse-shark-carcharias-taurus.pdf.

DoE. 2014b. "Recovery Plan for the Grey Nurse Shark (Carcharias taurus)." Department of the Environment, Canberra. http://www.environment.gov.au/resource/recovery-plan-grey-nurse-sharkcarcharias-taurus.

DoE. 2015a. *South-east Marine Region Profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region.* Department of the Environment, Australian Government.

DOE. 2015. "Wildlife Conservation Plan for Migratory Shorebirds." *Department of the Environment, Australian Government, Canberra, Australian Capital Territory.* Available from: Wildlife Conservation Plan for Migratory Shorebirds (environment.gov.au).

DoEE. 2017. *Recovery Plan for Marine Turtles in Australia.* Department of the Environment and Energy, Canberra: Australian Government. https://www.awe.gov.au/sites/default/files/documents/recovery-plan-marine-turtles-2017.pdf.

DotEE. 1992. *National strategy for ecologically sustainable development.* Departnment of the Environment and Energy, Canberra: AGPS Press.

DPI. 2012. *A Review of Rebuilding Options for the Victorian Abalone Fishery.* Department of Primary Industries, State Government Victoria. https://www.environment.gov.au/system/files/pages/fb3d8568-f6d1-4fd4-bd78-180ea31d12eb/files/abalone-review.pdf.

DPI. 2008. *West Gippsland Fishery Management Plan 2008.* Fisheries Victoria Management Report Series No. 56.

DPIaW. 2006. "Fauna Recovery Plan: Forty-Spotted Pardalote 2006-2010." Department of Primary Industries and Water, Hobart. https://www.awe.gov.au/sites/default/files/documents/p-quadraginatus.pdf.

DPIaW. 2006. "Threatened Tasmanian Eagles Recovery Plan: 2006 - 2010." Department of Primary Industries and Water. https://www.awe.gov.au/sites/default/files/documents/tasmanian-wedge-tailed.pdf.

DPIPWE. 2020b. "Abalone Fishery." Department of Primary Industries, Parks, Water and Environment, Hobart. https://dpipwe.tas.gov.au/sea-fishingaquaculture/commercial-fishing/abalone-fishery.

DPIPWE. 2020h. "Commercial Dive Fishery." Department of Primary Industries, Parks, Water and Environment, Hobart. https://dpipwe.tas.gov.au/sea-fishingaquaculture/commercial-fishing/commercial-dive-fishery.

DPIPWE. 2020g. "Giant Crab Fishery." Department of Primary Industries, Parks, Water and Environment, Hobart. https://dpipwe.tas.gov.au/sea-fishingaquaculture/commercial-fishing/giant-crab-fishery.

DPIPWE. 2013. "King Island Biodiversity Management Plan." Department of Primary Industries, Parks, Water and Environment, Hobart.

DPIPWE. 2016. "Marine Life and Their Habitats." Department of Primary Industries, Water and Environment. http://dpipwe.tas.gov.au/conservation/the-marine-environment/fisheries-habitats.

DPIPWE. 2020c. "Rock Lobster Fishery." Department of Primary Industries, Parks, Water and Environment, Hobart. https://dpipwe.tas.gov.au/seafishingaquaculture/commercial-fishing/rock-lobster-fishery.

DPIPWE. 2020f. "Scalefish Fishery." Department of Primary Industries, Parks, Water and Environment, Hobart. https://dpipwe.tas.gov.au/sea-fishingaquaculture/commercial-fishing/scalefish-fishery.

DPIPWE. 2020a. "Scallop Fishery." Department of Primary Industries, Parks, Water and Environment, Hobart. https://dpipwe.tas.gov.au/sea-fishingaquaculture/commercial-fishing/scallop-fishery.

DPIPWE. 2020e. "Seaweed Fishery." Department of Primary Industries, Parks, Water and Environment, Hobart. https://dpipwe.tas.gov.au/seafishingaquaculture/commercial-fishing/seaweed-fishery.

DPIPWE. 2020d. "Shellfish Fishery." Department of Primary Industries, Parks, Water and Environment, Hobart. https://dpipwe.tas.gov.au/seafishingaquaculture/commercial-fishing/shellfish-fishery.

DPIW. 2006. "Tasmania Oiled Wildlife Response Plan (Wildplan)." Department of Primary Industries and Water Biodiversity Conservation Branch. https://epa.tas.gov.au/Documents/WildPlan_final.pdf.

DSE. 2009. "Action Statement: Leathery Turtle Dermochelys coriacea." https://www.environment.vic.gov.au/__data/assets/pdf_file/0025/32398/Leathery_Turtle_Dermochelys_coriacea.pdf.

DSE. 2008a. "Background and Implementation Information for the Australian Prototroctes maraena National Recovery Plan." Department of Sustainability and Environment, Melbourne.

DSE. 2008b. "National Recovery Plan for the Australian Grayling Prototroctes maraena." Department of Sustainability and Environment, Melbourne.

DSEWPaC. 2012b. "Approved Conservation Advice for Epinephelus daemelii (black cod)." Department of Sustainability, Environment, Water, Population and Communities. https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68449.

DSEWPaC. 2013b. "Approved Conservation Advice for Rostratula australis (Australian painted snipe)." Department of Sustainability, Environment, Water, Population and Communities. https://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-conservation-advice.pdf.

DSEWPaC. 2011b. *Background Paper Population Status and Threats to Albatrosses and Giant Petrels Listed as Threatened under the Environment Protection and Biodiversity Conservation Act 1999*. Department of Sustainability, Environment, Water, Population and Communities, Hobart: Commonwealth of Australia.

DSEWPaC. 2012b. "Conservation Management Plan for the Southern Right Whale 2011-21." Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPaC. 2012a. "Conservation Management Plan for the Southern Right Whale. A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 2011-2021." Department of Sustainability, Environment, Water, Population and Communities, Canberra. https://www.awe.gov.au/sites/default/files/documents/e-australis-2011-2021.pdf.

DSEWPaC. 2011. "National recovery plan for threatened albatrosses and giant petrels 2011-2016." Department of Sustainability, Environment, Water, Population and Communitites. https://www.awe.gov.au/sites/default/files/documents/albatrosses-and-giant-petrels-recovery-plan.pdf.

DSEWPaC. 2011a. "National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016." Department of Sustainability, Environment, Water, Population and Communities, Australian Antarctic Division, Canberra. https://www.awe.gov.au/sites/default/files/documents/albatrosses-and-giant-petrels-recovery-plan.pdf.

DSEWPaC. 2013a. "Recovery Plan for the White Shark (Carcharodon carcharias)." Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. https://www.environment.gov.au/system/files/resources/ce979f1b-dcaf-4f16-9e13-010d1f62a4a3/files/white-shark.pdf.

DSEWPaC. 2013. "Recovery Plan for the White Shark (Carcharodon carcharias)." Department of Sustainability, Environment, Water, Population and Communities. https://www.awe.gov.au/sites/default/files/documents/white-shark.pdf.

DSEWPC. 2012c. "Approved Conservation Advice for Epinephelus daemelii (black cod)." Department of Sustainability, Environment, Water, Population and Communities, Canberra. http://www.environment.gov.au/biodiversity/threatened/species/pubs/68449-conservation-advice.pdf.

Edmunds, M, A Judd, P Gilmour, K Stewart, P Pickett, J Monk, and J Crozier. 2006a. *Volume 8: Shallow Reefs.* Australian Marine Ecology Report 356, Melbourne: Report to Maunsell.

Edmunds, M, B Power, P Pickett, K Baker, M Wassnig, J Crozier, J Monk, et al. 2006b. *Volume 9: Deep Reef Biota.* Australian Marine Ecology Report 357, Melbourne.: Report to Maunsell.

EGCMA. 2015. *Gippsland Lakes Ramsar Site Management Plan.* Bairnsdale. Victoria: East Gippsland Catchment Management Authority.

EMV. 2016. *State Maritime Emergencies (non-search and rescue) Plan. Edition 1.* Emergency Management Victoria.

EMV. 2016. "State Maritime Emergencies (non-search and rescue) Plan. Edition 1." Emergency Management Victoria, Melbourne.

Engelhardt, F. 2009. "Petroleum effects on marine mammals." *Aquatic Toxicology* 601-653.

Engelhardt, F R. 1982. "Hydrocarbon metabolism and cortisol balance in oil-exposed ringed seals, Phoca hispida." *Comp. Biochem. Physiol* 72C: 133- 136.

Erbe, C, M A Ainslie, C A F de Jong, R Racca, and M Stocker. 2016. *The need for protocols and standards in research on underwater noise impacts on marine life.* Vol. 875, in *The Effects of Noise on Aquatic Life II*, by A N Hawkins, edited by Advances in Experimental Medicine and Biology, 1265–1271. Springer, New York.

Falconer, R, and D Linforth. 1972. *Winds and waves in Bass Strait.* Department of the Interior, Canberra: Bureau of Meteorology.

Finneran, J J, E E Henderson, D S Houser, K Jenkins, S Kotecki, and J Mulsow. 2017. "Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)." Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific), 183.

Fodrie, FJ, KW Able, F Galvez, KL Heck, OP Jensen, PC Lopez-Duarte, CW Martin, RE Turner, and A Whitehead. 2014. "Integrating Organismal and Population Responses of Estuarine Fishes in Macondo Spill Research." *BioScience, Volume 64, Issue 9* 778–788.

French-McCay, DP. 2009. "State-of-the-art and research needs for oil spill impact assessment modelling." *32nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar.* Canada, Ottawa. 601-653.

Fugro. 2007. "Report for The BassGas Offshore Pipeline and Jacket Inspection Survey." Volume 1 - Text & Appendices.

Gannier, A, V Drouot, and JC Gould. 2002. "Distribution and the relative abundance of Sperm Whales in the Mediterranean Sea." *Mar Ecol. Prog. Ser.* 243: 281 -293.

Garcia, JR, and DG St Aubin. 1988. *Synthesis of Effects of Oil on Marine Mammals.* Ventura, California.: Report to U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study.

Gavine, F M, B A Ingram, P Hardy-Smith, and M Doroudi. 2009. *Biosecurity Control Measures for Abalone Viral Ganglioneuritis: A Code of Practice.* Prepared as part of FRDC Project No. 2006/243.

Gavrilov, A. 2012. *Seismic signal transmission, pygmy blue whale abundance and passage and ambient noise measurements during and after the Bellerive seismic survey in Bass Strait, 2011.* Curtin University centre for Marine Science.

Gibbs, C F. 1992. "Oceanography of Bass Strait: Implications for the food supply of little penguins Eudyptula minor." *EMU* 91: 395-401.

Gibbs, C F, J R Tomczak, and A R Longmore. 1986. "The Nutrient Regime of Bass Strait." *Australian Journal of Marine and Freshwater Resources* 36.

Gill, P C. 2002. "A blue whale (Balaenoptera musculus) feeding ground in a southern Australian coastal upwelling zone." *Journal of Cetacean Research and Management* 4: 179-184.

Gill, P C, M G Morrice, B Page, R Pirz, A H Levings, and M Coyne. 2011. "Blue whale habitat selection and within season distribution in a regional upwelling system off southern Australia." *Marine Ecology Progress Series* 421: 243–263. http://www.intres.com/articles/meps_oa/m421p243.pdf.

Gill, P C, R Pirzl, M G Morrice, and K Lawton. 2015. *Cetacean diversity of the continental shelf and slope off southern Australia.* The Journal of Wildlife Management.

Gill, P, and M Morrice. 2003. *Cetacean Observations. Blue Whale Compliance Aerial Surveys.* Santos Ltd.

GLaWAC. 2019. *Annual Report.* Gunaikurnai L:and and Waters Aboriginal Corporation. https://gunaikurnai.org/wp-content/uploads/2021/07/GLaWAC-Annual-Report-2019-20-ONLINE.pdf.

Green, R H. 1969. "The birds of Flinders Island. Records of the Queen Victoria Museum." *Records of the Queen Victoria Museum* 34: 1 -32.

Hartley, J.P. 1996. *Environmental monitoring of offshore oil and gas drilling discharges – A caution on the use of barium as a tracer.* Mar. Pollut. Bull. 32:727-733.

Hartmann, Klaas, Rowan C Chick, Timothy Emery, Victorian Fisheries Authority, and Paul Rogers. 2021. *Status of Australia fish stocks report (Blue Warhou).* fish.gov. https://www.fish.gov.au/report/266-Blue-Warehou-2020#:~:text=Blue%20Warehou%20is%20highly%20mobile,2004%5D.

Hastie, GD, RJ Swift, JCD Gordon, G Slesser, and WR Turrell. 2003. "Sperm Whale Distribution and Seasonal Density in the Faroe Shetland Channel." *J Cetacean Res. Manage* 5(3): 247-252.

Hayes, K, C Sliwa, S Mugus, F McEnnulty, and P Dunstan. 2005. *National priority pests: Pt 2 Ranking of Australian marine pests.* CSIRO marine Research. http://www.marine.csiro.au/crimp/Reports/publications.html.

Heap, A D, and P T Harris. 2008. "Geomorphology of the Australian margin and adjacent seafloor." *Australian Journal of Earth Sciences* 55 (4): 555-585.

Hewitt, C L, R B Martin, C Sliwa, F R McEnnulty, N E Murphy, T Jones, and S Cooper. 2002. *National introduced marine pest information system.* http://www.marinepests.gov.au/Pages/default.aspx.

Higgens, P J. 1999. *Handbook of Australian, New Zealand and Antarctic Birds.* Vols. Volume Four - Parrots to Dollarbird. Melbourne: Oxford University Press.

Higgins, PJ, and SJJF Davies. 1996. *Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons.* Melbourne, Victoria: Oxford University Press.

Hinwood, J B, A E Poots, L R Dennis, J M Carey, H Houridis, R J Bell, J R Thomson, P Boudreau, and A M Ayling. 1994. *Environmental Implications of offshore oil and gas development in australia: findings of an independent scientific review.* Swan JM, Neff JM, Young PC. Edited by J M Swan, J M Neff and P C Young. Canberra: Australian Petroleum Production and Exploration Association.

Hirst, A, and N J Bott. 2016. *Marine pests in the Gippsland Lakes: Existing threats and future monitoring.* RMIT University, Centre for Environmental Sustainability and Remediation. doi:10.13140/RG.2.2.28197.70886.

Hjermann, D.Ø, A Melsom, JM Durant, GE Dingsor, AM Eikeset, LP Roed, G Ottersen, G Storvik, and N Stenseth. 2007. "Fish and oil in the Lofoten-Barents Sea system: synoptic review of the effect of oil spills on fish populations." *Mar. Ecol. Prog. Ser., 339 (2007)* 283-299.

Hobday, Allistair J, Karen Evans, J P Everson, Jessica H Farley, Jason R Hartog, Marinelle Basson, and Toby Alexander Patterson. 2015. "Distribution and Migration—Southern Bluefin Tuna (Thunnus maccoyii)." In *Biology and Ecology of Bluefin Tuna*, 189-210. doi:10.1201/b18714-12.

Hofmeyr, G, and N Gales. 2008. *Arctocephalus pusillus. In: IUCN 2011.* IUCN Red List of Threatened Species Version 2011.2.

Hook, S, G Batley, M Holloway, P Irving, and R Andrew. 2016. *Oil Spill Monitoring Handbook. CSIRO Publishing.* CSIRO Publishing. https://publications.csiro.au/rpr/download?pid=csiro:EP158596&dsid=DS2.

Horwood, J. 1987. "The sei whale: Population biology, ecology, and management." Croom Helm, Sydney.

Huertas, I E, M Rouco, V Lopez-Roda, and E Costas. 2011. "Warming will affect phytoplankton differently evidence through a mechanistic approach." *Proceedings of the Royal Society B. Published* 278 (1724). doi:https://doi.org/10.1098/rspb.2011.0160.

Huisman, J M. 2000. *Marine Plants of Australia.* University of Western Australia Press.

Hume, F, M A Hindell, D Pemberton, and R Gales. 2004. "Spatial and temporal variation in the diet of a high trophic level predator, the Australian fur seal (Arctocephalus pusillus doriferus)." *Marine biology* 144 (3): 407-415.

Hutchinson, N, T Hunt, and L Morris. 2010. *Seagrass and Reef Program for Port Phillip Bay: Temperate Reefs Literature Review.* Department of Primary Industries. Victoria, Fisheries Victoria Technical Report No.11.

Hyland, J, D Hardin, M Steinhauer, D Coats, R Green, and J Neff. 1994. "Environmental impact of offshore oil development on the outer continental shelf and slope off Point Arguello, California." *Marine Environmental Research* 37 (2): 195-229.

IFC. 2015. *Environmental, Health, And Safety Guidelines for Offshore Oil and Gas Development.* International Finance Corporation.

IMAS. 2021. *Tasmanian Octopus Fishery Assessment 2019/20.* https://www.imas.utas.edu.au/__data/assets/pdf_file/0009/1439595/Octopus-Assessment-2019-20.pdf.

IMCRA. 1998. *Interim Marine and Coastal Regionalisation for Australia: An ecosystem-based classification for marine and coastal environments.* IMCRA Technical Group. Version 3.3.

IMO. 2012. *Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species.* London, United Kingdom.: International Maritime Organization.

IOGP. 2016. *Environmental fates and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations.* Report 543, London: International Association of Oil & Gas Producers.

—. 2019. "IOGP Risk Assessment Data Directory Blowout Frequencies September 2019:." https://www.iogp.org/bookstore/product/risk-assessment-datadirectory-blowout-frequencies/.

IPCC. 2021. *"Summary for Policymakers." In Climate Science 2021: The Physical Science Basis, by Intergovernmental Panel on Climate Change.* Cambridge University Press.

IPIECA. 1995. *Biological Impacts of Oil Pollution: Rocky Shores.* London: International Petroleum Industry Environmental Conservation Association, No. 7. 209–215.

IPIECA. 1999. *Biological impacts of oil pollution: Sedimentary shores. International Petroleum Industry Environmental Conservation Association.* London: IPIECA Report Series. Volume Nine.

ITOPF. 2014. *Effects of oil pollution on fisheries and mariculture.* London, United Kingdom.: Technical Information Paper No. 11. The International Tanker Owners Pollution Federation Limited.

IWC. 2018. *Western South Atlantic Southern Right Whale Conservation Management Plan.* International Whaling Commission. https://iwc.int/right-whale.

JASCO. 2022. *Beach Energy Yolla Drilling Campaign: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. (Document 02741, Version 1.0 DRAFT).* Technical report by JASCO Applied Sciences for Beach Energy, JASCO Applied Sciences.

Jenkins, G, and L McKinnon. 2006. "Port Phillip Bay Channel Deepening Project: supplemental environmental effects statement – aquaculture and fisheries."

Jones, D OB, A R Gates, and B Lausen. 2012. "Recovery of deep-water megafaunal assemblages from hydrocarbon drilling disturbance in the Faroe–Shetland Channel." *Mar Ecol Prog Ser* 461: 71–82. doi:10.3354/meps09827.

Jones, D OB, I R Hudson, and B J Bett. 2006. "Effects of physical disturbance on the cold-water megafaunal communities of the Faroe-Shetland Channel." *Mar Ecol Prog Ser* 319: 43–54. doi:10.3354/meps319043.

Jones, F.V., C. Hood, and G. Moiseychenko. 1996. "International methods of evaluating the discharge of drilling fluids in marine environments." *SPE 46825. In: 1998 SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production.* Caracas, Venezuela,: 7-10 June 1998. Society of Petroleum Engineers, Inc. Richardson, TX. 18 pp.

Jones, I S.F. 1980. "Tidal and Wind-drive Currents in Bass Strait." *Aus. J. Mar. Freshwater Res* 31: 109-17.

Kamrowski, R L, C J Limpus, K Pendoley, and M Hamann. 2014. *Influence of industrial light pollution on the sea-finding behaviour of flatback turtle hatchlings.* Wildlife Research.

Kato, H. 2002. "Bryde's Whales Balaenoptera edeni and B. brydei." In *Encyclopedia of Marine Mammals*, by WF Perrin, B Wrsig and HGM Thewissen, 171-177. Academic Press.

Kimmerer, W J, and A D McKinnon. 1984. "Zooplankton Abundances in Bass Strait and WesteEnsco 102 Tasmanian Shelf Waters, March 1983."

King, DJ, RL Lyne, A Girling, DR Peterson, R Stephenson, and D Short. 1996. *Environmental risk assessment of petroleum substances: the hydrocarbon block method.* Prepared by members of CONCAWE's Petroleum Products Ecology Group, Report 95/62.

Kirkman, H. 1997. "Seagrasses of Australia." *State of the Environment, Technical Paper Series (Estuaries and the Sea)* (Environment Australia, Commonwealth of Australia.).

Kirkwood, R, D Pemberton, R Gales, A J Hoskins, T Mitchell, P D Shaughnessy, and J Arnould. 2010. "Continued population recovery by Australian fur seals." *Marine and Freshwater Research* 61: 695–701.

Kirkwood, R, R M Warneke, and J P Arnould. 2009. "Recolonization of Bass Strait, Australia, by the New Zealand fur seal, Arctocephalus forsteri." *Marine Mammal Science* 25 (2): 441-449.

Klimey, A P, and S D Anderson. 1996. "Residency patterns of White Sharks at the South Farrallone Islands, California." In *Great White Sharks: The biology of Carcharodon carcharias*, edited by A.P. Klimley & D.G. New York USA: Academic Press.

Laist, D W, A R Knowlton, J G Mead, A S Collet, and M Podesta. 2001. "Collisions between Ships and Whales." *Marine Mammal Science* 17 (1): 35-75.

Last, PR, and JD Stevens. 2009. *Sharks and Rays of Australia.* Collingwood: CSIRO Publishing.

Lee, K, TL King, B Robinson, Z Li, L Burridge, M Lyons, D WOng, et al. 2011. "Toxicity Effects of Chemically Dispersed Crude Oil on Fish." *nternational Oil Spill Conference Proceedings: March 2011, 2011(1).* 163.

Limpus, CJ. 2008. *A biological review of Australian Marine Turtles: 1. Loggerhead Turtle Caretta caretta (Linneaus).* Queensland Environment Protection Agency.

Loyn, R H, B A Lane, C Chandler, and G W Carr. 1986. "Ecology of Orange-bellied Parrots Neophema chrysogaster at their main remnant wintering site." *Emu* 86: 195-206.

MacGillivray, Alexander. 2018. "Underwater noise from pile driving of conductor casing at a deep-water oil platform." *The Journal of the Acoustical Society of America* 450.

Mackay, A I, F Bailleul, S Childerhouse, and D Donnelly. 2015. *Offshore migratory movement of southern right whales: informimg critical conservation and management needs.* SARDI Aquatics Sciences.

Manoukian, S, A Spagnolo, G Scarcella, E Punzo, R Angelini, and G Fabi. 2010. "Effects of two offshore gas platforms on soft-bottom benthic communities (northwestern Adriatic Sea, Italy)." *Marine Environmental Research* 70 (5): 402-410. doi:10.1016/j.marenvres.2010.08.004.

Marchant, S, and P J Higgins. 1990. *Handbook of Australian, New Zealand and Antarctic Birds.* Vol. 1. Oxford University Press, Australia.

Marchant, S, and PJ Higgins. 1993. *Handbook of Australian, New Zealand and Antarctic Birds. Vol. 2. Raptors to Lapwings.* Melbourne, Victoria: Oxford University Press.

Marine Pest Sectoral Committee. 2018. *National biofouling management guidelines for the petroleum production and exploration industry.* Australian Government, Canberra, Australian Capital Territory: Department of Agriculture and Water Resources.

McCauley, R D, A N Gavrilov, C D Jolliffe, R Ward, and P C Gill. 2018. "Pygmy blue and Antarctic blue whale presence, distribution and population parameters in southern Australia based on passive acoustics." *DeepSea Research Part II: Topical Studies in Oceanography* 157-158: 154-168.

McCauley, R D, J Fewtrell, A J Duncan, C Jenner, M N Jenner, J D Penrose, R I T Prince, A Adhitya, and J Murdoch. 2000a. "Marine seismic surveys: A study of environmental implications." *Australian Petroleum Production Exploration Association (APPEA)* 40 (1): 692-708. doi:https://doi.org/10.1071/AJ99048.

McCauley, R D, J Fewtrell, A J Duncan, C Jenner, M N Jenner, J D Penrose, R I T Prince, A Adhitya, and J Murdoch. 2000b. *Marine seismic surveys: Analysis and propagation of air gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid.* Western Australia: Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, 198. https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic-effects-2000.pdf.

McCauley, R.D. 1998. "Radiated underwater noise measured from the drilling rig ocean general, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia." *Prepared by Rob McCauley for Shell Australia.*

McClatchie, S, J Middleton, C Pattiaratchi, D Currie, and G Kendrick. 2006. *The South-west Marine Region: Ecosystems and Key Species Groups.* Department of the Environment and Water Resources, Australian Government.

McGurk, M D. 1986. “Natural mortality of marine pelagic fish eggs and larvae: role of spatial patchiness.” *Marine Ecology Progress Series* 34 (3): 227-242. doi:https://www.jstor.org/stable/24821275.

McIntyre, AD, JM Baker, AJ Southward, WRP Bourne, and SJ Hawkins. 1982. “The Long-Term Effects of Oil Pollution on Marine Populations, Communities and Ecosystems (Jun. 1, 1982).” *Gray Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences Vol. 297, No. 1087* 401-411.

McLeay, L J, S J Sorokin, P J Rogers, and T M Ward. 2003. “Benthic Protection Zone of the Great Australian Bight Marine Park: Literature Review.” Commonwealth Department of Environment and Heritage, South Australia Marine Research and Development Institute (Aquatic Sciences).

McLeay, L J, S J Sorokin, P J Rogers, and T M Ward. 2003. *Benthic Protection Zone of the Great Australian Bight Marine Park: Literature Review.* Commonwealth Department of Environment and Heritage, South Australia Marine Research and Development Institute (Aquatic Sciences).

MESA. 2015. *Mangroves of Australia – Distribution and Diversity.* Marine Education Society of Australasia. http://www.mesa.edu.au/mangroves/mangroves01.asp.

Middleton, J F, and K P Black. 1994. “The low frequency circulation in and around Bass Strait: a numerical study.” *Cont. Shelf Res* l4: 1495-1521.

Miller, BS, N Kelly, MC Double, S Childerhouse, N Laverick, and N Gales. 2012. “Cruise report on SORP 2012 blue whale voyages: development of acoustic methods.” *Paper SC/64/SH1 1.* IWC Scientific Committee.

Minton, C, and J Deleyev. 2001. “Analysis of recoveries of VWSG banded Caspian Terns.” *Victorian Wader Study Group Bulletin* 24:71-75.

Mollet, H F, G Cliff, H L Pratt Jr, and J D Stevens. 2000. “Reproductive Biology of the female shortfin mako, Isurus oxyrinchus Rafinesque, 1820, with comments on the embryonic development of lamnoids.” *Fish. Bull* 98: 299-318.

Morrice, M G, P C Gill, J Hughes, and A H Levings. 2004. *Summary of aerial surveys conducted for the Santos Ltd EPP32 seismic survey, 2-13 December 2003.* Whale Ecology Group-Southern Ocean, Deakin University. unpublished.

Museums Victoria. 2019. “Fishes of Australia database.” https://fishesofaustralia.net.au/.

Mustoe, S H. 2008. “Killer Whale (Orchinus orca) sightings in Victoria.” *Victorian Naturalist* 125 (3): 76-81.

National Oceanic and Atmospheric Administration. 2010. “Oil and sea turtles: biology planning and response.” *US Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration.*

Neff, J M. 2005. *Composition, environmental fates, and biological effects of water based drilling muds and cuttings discharged to the marine environment: a synthesis and annotated bibliography.* American Petroleum Institute, Washington DC: Petroleum Environmental Research Forum (PERF).

Neff, J M. 2010. *Fates and Effects of Water Based Drilling Muds and Cuttings in Cold-Water Environments.* Neff & Associates LLC for Shell Exploration and Production Company. https://s08.static-shell.com/content/dam/shellnew/local/country/usa/downloads/alaska/nefffinal-draftgs072010.pdf.

Neff, J M, M H Bothner, N J Maciolet, and J F Grassle. 1986. “Impacts of exploratory drilling for oil and gas on the benthic environment of Georges Bank.” *Marine Environmental Research* 27 (2): 77-114. doi:10.1016/0141-1136(89)90002-0.

Neff, J M, S Mckelvie, and R C Ayers Jr. 2000. *Environmental impacts of synthetic based drilling fluids.* OCS Study MMS, New Orleans: U.S. Department of the Interior Minerals Management Service Gulf of Mexico OCS Region. https://www.researchgate.net/publication/288875327_Environmental_impacts_of_synthetic_based_drilling_fluids.

Neptune. 2015. “Yolla-A Post Drill Spudcan Crater Survey Final Report.”

NERA. 2017. “Environment Plan Reference Case – Planned discharge of sewage, putrescible waste and grey-water.” Accessed December 2019. https://referencecases.nopsema.gov.au/assets/reference-case-project/2017-1001-Sewage-grey-water-and-putrescible-waste-discharges.pdf.

—. 2018. “Environment Plan Reference Case: Anchoring of Vessels and Floating Facilities.” https://www.nera.org.au/Attachment?Action=Download&Attachment_id=224.

NMFS. 2018. *Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Threshold Levels for Onset Permanent and Temporary Threshold Shifts.* U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. https://media.fisheries.noaa.gov/dam-migration/tech_memo_acoustic_guidance_(20)_(pdf)_508.pdf.

NOAA. 2021b. *Bryde’s Whale.* Accessed April 11, 2022. https://www.fisheries.noaa.gov/species/brydes-whale.

NOAA. 2019. “ESA Section 7 Consultation Tools for Marine Mammals on the West Coast (webpage), 27 Sep 2019.” National Oceanic and Atmospheric Administration (US). https://www.fisheries.noaa.gov/westcoast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west.

—. 2021a. *Oceanic Whitetip Shark.* https://www.fisheries.noaa.gov/species/oceanic-whitetip-shark.

NOO. 2002. *Ecosystems – Nature’s diversity: The South-east Regional Marine Plan Assessment Reports.* Hobart: National Oceans Office.

NOPSEMA. 2022. “Acceptance of Barossa Development Drilling and Completions Environment Plan.” *NOPSEMA.* 6 May. Accessed May 23 , 2022. https://docs.nopsema.gov.au/A842256.

NOPSEMA. 2015. “ALARP Guidance Note.” National Offshore Petroleum Safety and Environmental Management Authority. https://www.nopsema.gov.au/assets/Guidance-notes/A138249.pdf.

—. 2019. “Environment bulletin: Oil spill modelling.” https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf.

NOPSEMA. 2018. “Environment plan decision making guideline.” National Offshore Petroleum Safety and Environmental Management Authority. https://www.nopsema.gov.au/sites/default/files/documents/2021-03/A524696.pdf.

NPWS. 2003. *Nadgee Nature Reserve Plan of Management.* Department of Environment, Climate Change and Water, NSW National Park and Wildlife Service.

NRDA. 2012. “April 2012 Status Update for the Deepwater Horizon Oil Spill.” http://www.gulfspillrestoration.noaa.gov. Natural Resource Damage Assessment.

NRE Tas. 2021. “Marine Life and Their Habitats.” Department of Natural Resources and Environment Tasmania. https://nre.tas.gov.au/conservation/the-marine-environment/fisheries-habitats.

OEH. 2012. *National Recovery Plan for Eastern Bristlebird Dasyornis brachypterus.* Department of Premier and Cabinet, Sydney: Office of Environment and Heritage. https://www.awe.gov.au/sites/default/files/documents/eastern-bristlebird-recovery-plan.pdf.

OEH. 2022. *White-capped albatross profile.* NSW Government, Office of Environment and Heritage. https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20315.

OGUK. 2014. *The UK offshore oil and gas industry guidance on risk-related decision making. Oil and Gas UK*. Oil and Gas UK.

O'Hara, T, P E McShane, and M Norman. 1999. "cited in Andrew (1999)."

OSPAR. 2009. *Assessment of impacts of offshore oil and gas activities in the North-East Atlantic.* OSPAR Commission, 40.

Pade, N G, N Queiroza, N E Humphries, M J Witt, C S Jones, L R Noble, and D W Sims. 2009. "First results from satellite-linked archival tagging of porbeagle shark, Lamnanasus: Area fidelity, wider-scale movements and plasticity in diel depth changes." *Journal of Experimental Marine Biology and Ecology* 370 (1 –2): 64–74.

Parks Victoria. 2006a. *Bunurong Marine National Park, Bunurong Marine Park, Bunurong Coastal Reserve and Kilcunda-Harmers Haven Coastal Reserve Management Plan.* Melbourne: Parks Victoria.

Parks Victoria. 2006d. *Cape Howe Marine National Park Management Plan.* Melbourne: Parks Victoria.

Parks Victoria. 1996. *Croajingolong National Park.* Melbourne: Parks Victoria.

Parks Victoria. 2015. "Marine pests in Victoria - A quick reference guide." Parks Victoria, Melbourne. https://media.vrfish.com.au/wp-content/uploads/2018/11/02181116/Marine-pests-Victoria-reference-guide.pdf.

Parks Victoria. 2015. *NgootyoongGunditj Ngootyoong Mara South West Management Plan.* Melbourne: Parks Victoria. http://parkweb.vic.gov.au/explore/parks/discoverybay-coastal-park.

Parks Victoria. 2006c. *Point Hicks Marine National Park Management Plan.* Melbourne: Parks Victoria.

Parks Victoria. 2006b. "Wilsons Promontory Marine National Park and Wilsons Promontory Marine Park Management Plan, Parks Victoria." Melbourne.

Parks Victoria. 2002. *Wilsons Promontory National Park Management Plan.* Melbourne: Parks Victoria. https://parkweb.vic.gov.au/__data/assets/pdf_file/0006/313458/Wilsons-Promontory-National-ParkManagemetn-Plan.pdf.

Parry, G D, S J Campbell, and D K Hobday. 1990. "Marine resources off East Gippsland, Southeastern Australia." *Technical Report No. 72, Marine Science Laboratories. Queenscliff, Victoria.*

Parsons, K E. 2011. *Nowhere Else on Earth: Tasmania's Marine Natural Values.* Report for Environment Tasmania, Aquenal. https://d3n8a8pro7vhmx.cloudfront.net/marine/pages/609/attachments/original/1500603668/NowhereElseOnEarthReport.pdf?1500603668.

Patterson, Toby A, Karen Evans, Thor I Carter, and John S Gunn. 2008. "Movement and behaviour of large southern bluefin tuna (Thunnus maccoyii) in the Australian region determined using pop-up satellite archival tags." *Fisheries Oceanography* (CSIRO Marine and Atmospheric Research) 17 (5): 352-367. doi:10.1111/j.1365-2419.2008.00483.x.

Patterson, Toby A, Paige J Eveson, Jason R Hartog, Karen Evans, Scott Cooper, Matt Lansdell, Alistair J Hobday, and Campbell R Davies. 2018. "Migration dynamics of juvenile southern bluefin tuna." *Scientific Reports* 8: 14553. doi:https://doi.org/10.1038/s41598-018-32949-3.

Paulay, G K, G Lambert, and C Meyer. 2002. "Anthropogenic biotic interchange in a coral reef ecosystem: A case study from Guam." *Pacific Science* 56 (4): 403–422.

Peakall, DB, PG Wells, and D Mackay. 1987. "A hazard assessment of chemically dispersed oil spills and seabirds." *Marine Environmental Research* 91–106.

Pegler, J M. 1983. “A brief survey of the water birds in the Shoalhaven-Crookhaven estuary.” *Australian Birds* 17: 38-42.

Phalan, B, R Phillips, J Silk, V Afanasyev, A Fox, P Catry, H Higuchi, and J Croxall. 2007. “Foraging behavior of four albatross species by night and day.” *Marine Ecology-Progress Series* 340: 271-286.

Pirzl, R, N J Patenaude, S Burnell, and J Bannister. 2009. “Movements of southern right whales (Eubalaena australis) between Australian and subantarctic New Zealand populations.” *Marine Mammal Science* 25: 455-461.

Pizzey, G, and F Knight. 1999. *The Graham Pizzey and Frank Knight Field Guide to the Birds of Australia.* Pymble, Sydney: Angus and Robertson.

Plotkin, PT, MK Wicksten, and AF Amos. 1993. “Feeding ecology of the loggerhead sea turtle Caretta caretta in the northwestern Gulf of Mexico.” *Marine Biology* 115(1):1.

Poore, G C.B., R S Wilson, M Gomon, and C C Lu. 1985. *Museum of Victoria Bass Strait Survey, 1979-1984.* Melbourne: Museum of Victoria.

Popper, A N, A D Hawkins, R R Fay, D A Mann, S Bartol, T J Carlson, S Coombs, et al. 2014. “Sound exposure guidelines for fishes and sea turtles.” *Springer Briefs in Oceanography* 10 (1007): 978-983.

Ports Australia. 2020. “Trade Statistics Financial Year 2018 – 2019.” https://www.portsaustralia.com.au/resources/trade-statistics.

PWS. 2002. *Arthur-Pieman Conservation Area Management Plan.* Department of Primary Industries, Water and Environment, Hobart, Tasmania: Parks and Wildlife Service.

PWS. 2000. *Lavinia Nature Reserve (Ramsar Site) management plan : draft.* Department of Primary Industries, Water and Environment, Hobart: Parks and Wildlife Service.

PWS. 1999. *North East River Game Reserve, North East River Conservation Area : management plan.* Department of Primary Industries, Water and Environment, Hobart: Parks and Wildlife Service. https://nla.gov.au/nla.obj-1382296550/view.

PWS. 2000. *Small Bass Strait Island Reserves Management Plan (draft).* Department of Primary Industries, Water and Environment, Hobart: Parks and Wildlife Service. https://parks.tas.gov.au/Documents/bassstraitpdf.pdf.

PWS. 2003. *The Nut State Reserve Management Plan 2003.* Department of Primary Industries, Water and Environment, Hobart, Tasmania: Parks and Wildlife Service.

Reilly, S B, J L Bannister, P B Best, M Brown, R L Jr. Brownell, D S Butterworth, P J Clapham, et al. 2008. “Balaenoptera acutorostrata.”

Remplan. 2019. *Bass Coast economy profile.* Remplan Economy. https://www.economyprofile.com.au/basscoast/tourism/value-added.

Richardson, A J, R J Matear, and A Lenton. 2017. “Potential impacts on zooplankton of seismic surveys.” CSIRO, Australia, 34.

Richardson, W J, C R Greene, C I Malme, and D H Thomson. 1995. *Marine Mammals and Noise.* San Diego: Academic Press, 576.

Richardson, WJ, CR Greene, CJ Malme, and DH Thomson. 1995. “Marine Mammals and Noise.” *Academic Press, San Diego.*

Richardson, WJ, MA Fraker, B Wursig, and RS Wills. 1985. “Behaviour of bowhead whales (Balaena mysticetus), summering in the Beaufort Sea: Reactions to industrial activities.” *Biological Conservation. 32.* 195–230.

Roberts, J M, A Wheeler, A Freiwald, and S Carins. 2009. *Cold-Water Corals: The Biology and Geology of Deep Sea Coral Habitats.* Cambridge University Press, United States of America.

Robinson, S, R Gales, A Terauds, and M Greenwood. 2008. "Movements of fur seals following relocation from fish farms." *Aquatic Conservation: Marine and Freshwater Ecosystems* 18 (7): 1189-1199.

Rogers, P. 2011. "Habitat use, movement and dietary dynamics of pelagic sharks in coastal and shelf ecosystems off southern Australia." Doctorate of Philosophy Thesis, Flinders University, Adelaide, Australia, 148-205.

RPS. 2022. "Beach Energy - Yolla Platform MDO Spill: Oil Spill Modelling (MAQ1131J)."

RPS. 2020b. *Beach Yolla Platform Oil Spill Modelling Reprocessing (MAQ0925J).* Prepared by RPS for Aventus Consulting Pty Ltd. Queensland.

RPS. 2020a. *Beach Yolla Platform Produced Water Dispersion Far-Field Modelling Study (MAQ0975J).* Prepared by RPS for Beach Energy Ltd. Queensland.

Saddlier, S, and M Hammer. 2010. "National Recovery Plan for the Yarra Pygmy Perch (Nannoperca obscura)." Department of Sustainability and Environment, Melbourne. https://www.awe.gov.au/sites/default/files/documents/yarra-pygmy-perch.pdf.

Saddlier, S, and M Hammer. 2010. "National Recovery Plan for the Yarra Pygmy Perch (Nannoperca obscura)." Department of Sustainability and Environment, Melbourne. https://www.awe.gov.au/sites/default/files/documents/yarra-pygmy-perch.pdf.

Saddlier, S, J Jackson, and M Hammer. 2010. "National Recovery Plan for the Dwarf Galaxias (Galaxiella pusilla)." Department of Sustainability and Environment, Melbourne. https://www.awe.gov.au/sites/default/files/documents/dwarf-galaxias.pdf.

Saddlier, S, J Jackson, and M Hammer. 2010. "National Recovery Plan for the Dwarf Galaxias (Galaxiella pusilla)." Department of Sustainability and Environment, Melbourne. http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plandwarfgalaxias-galaxiella-pusilla.

Sanderson, J C. 1997. "Subtidal Macroalgal Assemblages in Temperate Australian Coastal Waters. Australia: State." *Australia: State of the Environment, Technical Paper Series (Estuaries and the Sea)* (Environment Australia, Commonwealth of Australia).

Sandery, P A, and J Kampf. 2005. "Winter Spring flushing of Bass Strait, South Eastern Australia; Numerical modelling study." *Estuarine and coastal shelf science* 63.

Santos. 2004. *Casino Gas Field Development Environment Report.* Hawthorn East, Victoria.: Prepared by Enesar Consulting Pty Ltd.

Saunders, D L, and C L Tzaros. 2011. *National Recovery Plan for the Swift Parrot Lathamus discolor.* Melbourne: Birds Australia. https://www.awe.gov.au/sites/default/files/documents/lathamus-discolor-swift-parrot.pdf.

Schaanning M.T., Ruus A., Bakke T., Hylland K., Olsgard F. 2002. "Bioavailability of metals in weight materials for drilling muds (2002)."

Shell. 2009. *Prelude Floating LNG Project Draft Environmental Impact Statement.* EPBC 2008/4146.

Shell. 2010. *Prelude Floating LNG Project EIS Supplement—Response to Submissions.* Perth: Western Australia: Shell Developments (Australia) Pty Ltd.

Skira, I J, N P Brothers, and D Pemberton. 1996. "Distribution, abundance and conservation status of Short-tailed Shearwaters Puffinus tenuirostrisin Tasmania." *Marine Ornithology* 24: 1-14.

Smith, J N, D Jones, K Travouillon, N Kelly, M Double, and J L Bannister. 2020. *Monitoring population Dynamics of 'Western' Right Whales off Southern Australia 2018–2021 Final Report on activities for 2019.* Report to the National Environmental Science Program, Western Australian Museum, Marine Biodiversity Hub. https://www.nespmarine.edu.au/system/files/Jones_Travouillon%20A7%20Monitoring%20population%20dynamics%20right%20whales%20Final%20report%20for%202019_Milestone%2012.pdf.

Southall, B L, A E Bowles, W T Ellison, J J Finneran, R L Gentry, C R Greene, D Kastak, D R Ketten, and J H Miller. 2007. "Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations." *Aquatic Mammals* 33 (4): 411-521. doi:https://doi.org/10.1080/09524622.2008.9753846.

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

Stamation, K, M Watson, P D Moloney, C Charlton, and J Bannister. 2020. "Population estimate and rate of increase of southern right whales Eubalaena australis in southeastern Australia." *Endangered Species Research* 41. doi:10.3354/esr01031.

Stephenson, LH. 1991. *Orange-bellied Parrot Recovery Plan: Management Phase.* Tasmania: Department of Parks, Wildlife and Heritage.

TAC. 2015. *Wybalenna Healthy Country Plan.* Hobart: Tasmanian Aboriginal Centre Incorperated. http://tacinc.com.au/wp-content/uploads/2015/07/Wybalena_17.4.15.pdf.

Taylor, A. 2021. "Media release – Australia's plan to reach our net zero target by 2050." Minister for Industry, Energy and Emissions Reduction. https://www.minister.industry.gov.au/ministers/taylor/media-releases/australias-plan-reach-our-net-zero-target-2050.

Thales Geosolutions. 2001. "BassGas Project: Offshore Shallow Geotechnical Survey Report." Report No. 3259C.

Thiele, D, E Chester, and P C Gill. 2000. "Cetacean distribution off Eastern Antarctica at (80 - 150°E) during the austral summer of 1995/96."

Thiele, K. 1977. "Sightings from land of the Sooty Albatross." *South Australian Ornithologist* 27: 259. https://birdssa.asn.au/images/saopdfs/Volume27/1977V27P259.pdf.

Tormosov, D D, Y A Mikhaliev, P B Best, V A Zemsky, K Sekiguchi, and R Brownell. 1998. "Soviet catches of southern right whales Eubalaena australis, 1951–1971. Biological data and conservation implications." *Biological Conservation* 86 (2): 185-197. doi:10.1016/S0006-3207(98)00008-1.

TPG. 2022. *TPG Pipeline About.* Accessed April 11, 2022. https://www.tasmaniangaspipeline.com.au/pipeline/.

TSSC. 2010. *Approved Conservation advice for Ceyx azureus diemenensis (Tasmanian Azure Kingfisher).* Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-conservation-advice.pdf.

TSSC. 2001. *Commonwealth Listing Advice on Carcharias taurus, Grey Nurse Shark (East Coast population).* Canberra: Threatened Species Scientific Committee. t http://www.environment.gov.au/biodiversity/threatened/species/c-taurus.html.

TSSC. 2009. *Commonwealth Listing Advice on Galeorhinus galeus*. Department of the Environment, Water, Heritage and the Arts., Threatened Species Scientific Committee. http://www.environment.gov.au/biodiversity/threatened/species/pubs/68453-listing-advice.pdf.

—. 2021. *Commonwealth Listing Advice on Raja sp. L (Maugean Skate)*. Accessed April 11, 2022. https://www.awe.gov.au/environment/biodiversity/threatened/assessments/maugean-skate.

TSSC. 2010. *Commonwealth Listing Advice on Thunnus maccoyii (Southern Bluefin Tuna)*. Threatened Species Scientific Committee. http://www.environment.gov.au/biodiversity/threatened/species/pubs/69402-listing-advice.pdf.

TSSC. 2015b. *Conservation Advice – Rhincodon typus (whale shark)*. Canberra: Threatened Species Scientific Committee. http://www.environment.gov.au/biodiversity/threatened/species/pubs/66680-conservationadvice01102015.pdf.

TSSC. 2015c. *Conservation Advice Balaenoptera borealis (sei whale)*. Department of the Environment, Canberra: Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf.

TSSC. 2015d. *Conservation Advice Balaenoptera physalus (fin whale)*. Department of the Environment, Canberra: Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf.

TSSC. 2019b. *Conservation Advice Botaurus poiciloptilus*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/1001-conservation-advice-18012019.pdf.

TSSC. 2016a. *Conservation Advice Calidris canutus*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/855-conservation-advice-05052016.pdf.

TSSC. 2015e. *Conservation Advice Calidris ferruginea*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice.pdf.

TSSC. 2016b. *Conservation Advice Calidris tenuirostris*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/862-conservation-advice-05052016.pdf.

TSSC. 2016c. *Conservation Advice Charadrius leschenaultia*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/877-conservation-advice-05052016.pdf.

TSSC. 2016d. *Conservation Advice Charadrius mongolus*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/879-conservation-advice-05052016.pdf.

TSSC. 2016e. *Conservation Advice Engaeus martigener*. Department of the Environment and Energy, Canberra: Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/67220-conservation-advice-16122016.pdf.

TSSC. 2020b. *Conservation Advice Falco hypoleucos*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/929-conservation-advice-09072020.pdf.

TSSC. 2015f. *Conservation Advice Grantiella picta*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conservation-advice.pdf.

TSSC. 2015g. *Conservation Advice Halobaena caerulea*. Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/1059-conservation-advice-01102015.pdf.

TSSC. 2019a. *Conservation Advice Hirundapus caudacutus.* Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/682-conservation-advice-04072019.pdf.

TSSC. 2016f. *Conservation Advice Limosa lapponica baueri.* threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/86380-conservation-advice-05052016.pdf.

TSSC. 2015. *Conservation Advice Megaptera novaeangliae.* Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf.

TSSC. 2015i. *Conservation Advice Numenius madagascariensis.* Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf.

TSSC. 2015h. *Conservation Advice Pachyptila tutur subantarctica.* Threatened species scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/64445-conservation-advice-01102015.pdf.

TSSC. 2015j. *Conservation Advice Platycercus caledonicus brownii green rosella (King Island).* Department of the Environment, Canberra: Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/67041-conservation-advice-31102015.pdf.

TSSC. 2015k. *Conservation Advice Pterodroma Mollis.* Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/1036-conservation-advice-01102015.pdf.

TSSC. 2015l. *Conservation Advice Rhincodon typus whale shark.* Department of the Environment, Canberra: Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/66680-conservation-advice-01102015.pdf.

TSSC. 2015m. *Conservation Advice Strepera fuliginosa colei.* Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/67113-conservation-advice-31102015.pdf.

TSSC. 2020a. *Conservation Advice Thalassarche cauta.* Threatened Species Scientific Committee. https://www.environment.gov.au/biodiversity/threatened/species/pubs/89224-conservation-advice-03072020.pdf.

TSSC. 2015a. *Megaptera novaeangliae (humpback whale) conservation advice.* Threatened Species Scientific Committee.

Tzioumis, V, and S Keable. 2007. *Description of Key Species Groups in the East Marine Region, Final Report.* Australian Museum.

Underwood, K A. 1991. “Patterns in shallow subtidal marine assemblages along the coast of New South Wales.” *Australian Journal of Ecology* (Australian Journal of Ecology) 6: 231 -249.

Victoria State Government. 2016. “Marine Pests and Disease, Abalone Disease, Background and Impact.” http://agriculture.vic.gov.au/fisheries/policy-and-planning/marinepests-and-diseases/abalonedisease/background-and-impact.

Volkman, JK, GJ Miller, AT Revill, and DW Connel. 2004. '*Oil spills.*' *In Environmental Implications of offshore oil and gas development in Australia – the findings of an independent scientific review.* Sydney: Australian Petroleum Exploration Association.

Wardle, C S, T J Carter, G G Urquhart, A D.F Johnstone, A M Ziolkowski, G Hampson, and D Mackie. 2001. "Effects of seismic air guns on marine fish." *Continental Shelf Research* 21.

Watson, C F, and M Y Chaloupka. 1982. *Zooplankton of Bass Strait: Species Composition, Systematics and Artificial key to Species.* Technical Report No. 1, Tasmanian Institute of Marine Science.

Watson, M, I Westhorpe, J Bannister, S Hedley, and R Harcourt. 2015. "Final report on the assessment of numbers and distribution of southern right whales in Southeast Australia." Report to the Australian Marine Mammal Centre.

WBG. 2015. *Environmental, health, and safety guidelines for offshore oil and gas development.* World Bank Group. http://documents.worldbank.org/curated/en/378221479466912449/Environmental-health-and-safety-guidelines-for-offshore-oil-and-gas-development.

WDCS. 2004. "Oceans of Noise: A WDCS Science report. Editors: Mark Simmonds, Sarah Dolman and Lindy Weilgart." *The Whale and Dolphin Conservation Society, Wiltshire P168.*

WDCS. 2006. *Vessel Collisions and Cetaceans: What happens when they don't miss the boat.* United Kingdom: Whale and Dolphin Society.

Weinrich, M. 2004. *A review of worldwide collisions between whales and fast ferries. Paper SC/56/BC9.* Sorrento, Italy: the IWC Scientific Committee.

WGCMA. 2014. *Corner Inlet Ramsar Site Management Plan.* West Gippsland CMA, Traralgon. http://www.wgcma.vic.gov.au/wpcontent/uploads/2015/01/WaterStrategy2014-2022-web-pt4.pdf.

Wiese, F K, W A Montevecci, G K Davoren, F Huettmann, A W Diamond, and J Linke. 2001. "Seabirds at risk around offshore oil platforms in the northwest Atlantic." *Marine Pollution Bulletin* 42: 1285–1290.

Williams, A., Bax, N.J., Kloser, R.J., Althaus, F., Barker, B., Keith, G. 2009. "Australia's deep-water reserve network: implications of falsehomogeneity for classifying abiotic surrogates of biodiversity." *ICES Journal of Marine Science* 66: 214-224.

Wilson, R S, and G C.B Poore. 1987. "The Bass Strait Survey: Biological Sampling Stations, 1979- 1984."

Woodhams, James, Matias Braccini, Victor Peddemors, Victorian Fisheries Authority, and Jeremy Lyle. 2021. *School Shark.* Fish.gov. https://www.fish.gov.au/report/302-School-Shark-2020.

Woodside Energy Ltd. 2014. *Browse FLNG Development, Draft Environmental Impact Statement. EPBC 2013/7079.* Perth, Western Australia: Woodside Energy.

WRI and WBCSD. 2013. *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition).* World Resources Institute and World Business Council for Sustainable Development.

Yoshihide, S. 2021. *Leaders Summit on Climate.* Tokyo: Prime Minister of Japan. https://www.mofa.go.jp/files/100181623.pdf.

Appendix A Beach Energy – Yolla Platform Oil Spill Modelling Reprocessing

BEACH ENERGY- YOLLA PLATFORM

Oil Spill Modelling Reprocessing

MAQ0925J
Beach Energy- Yolla Platform
OSM Reprocessing
Rev0
25 February 2020

www.rpsgroup.com/mst

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
Rev A	Draft issued for internal review	Dr Fernando Alvarez Jordan Glen	Dr Sasha Zigic Dr Ryan Dunn	Dr Sasha Zigic	24 February 2020
Rev 0	Final report issued to client	Dr Fernando Alvarez Jordan Glen	Dr Sasha Zigic Jeremie Bernard	Dr Sasha Zigic Jeremie Bernard	25 February 2020

Approval for issue

Dr. Sasha Zigic — 25 February 2020

This report was prepared by RPS within the terms of RPS' engagement with its client and in direct response to a scope of services. This report is supplied for the sole and specific purpose for use by RPS' client. The report does not account for any changes relating the subject matter of the report, or any legislative or regulatory changes that have occurred since the report was produced and that may affect the report. RPS does not accept any responsibility or liability for loss whatsoever to any third party caused by, related to or arising out of any use or reliance on the report.

Prepared by:

RPS

Fernando Alvarez
Coastal Engineer

Suite E1, Level 4, 140 Bundall Road
Bundall QLD 4217

T +61 7 5574 1112
E fernando.alvarez@rpsgroup.com

Prepared for:

Aventus Consulting Pty Ltd

Giulio Pinzone
Director & Principal Environmental Consultant

Suite 307, 75 Tulip Street
Cheltenham VIC 3192

T 0409 772 170
E g.pinzone@aventusconsulting.com.au

Contents

Tables

Figures

TERMS AND ABBREVIATIONS

°	Degrees
‘	Minutes
“	Seconds
µm	Micrometre (unit of length; 1 µm = 0.001 mm)
Actionable oil	Oil which is thick enough for the effective use of mitigation strategies
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
API	American Petroleum Institute gravity. A measure of how heavy or light a petroleum liquid is compared to water.
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASTM	American Society for Testing and Materials
bbl	Barrel (unit of volume; 1 bbl = 0.159 m^3)
bbl/d	Barrels per day
Beach	Beach Energy
BIA	Biologically Important Areas
Bonn Agreement	An agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983, includes: Governments of the Kingdom of Belgium, the Kingdom of Denmark, the French Republic, the Federal Republic of Germany, the Republic of Ireland, the Kingdom of the Netherlands, the Kingdom of Norway, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland and the European Union.
Boiling Point	The temperature at which the vapor pressure of the liquid is equal to the pressure exerted on it by the surrounding atmosphere
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
˚C	degree Celsius (unit of temperature)
CA	Conservation Area
CFSR	Climate Forecast System Reanalysis
cm	Centimetre (unit of length)
cP	Centipoise (unit of dynamic viscosity)
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.
Dynamic viscosity	The dynamic viscosity of a fluid expresses its resistance to shearing flows, where adjacent layers move parallel to each other with different speeds.
EP	Environmental Plan
g/m²	Grams per square meter (unit of surface area density)
GODAE	Global Ocean Data Assimilation Experiment
HYCOM	Hybrid Coordinate Ocean Model. A data-assimilative, three-dimensional ocean model

HYDROMAP	Advanced ocean/coastal tidal model used to predict tidal water levels, current speed and current direction.
IBRA	Interim Biogeographic Regionalisation of Australia
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IOA	Index of Agreement
ITOPF	International Tanker Owners Pollution Federation Limited
KEF	Key Ecological Feature
km	Kilometre (unit of length)
km^2	Square Kilometres (unit of area)
Knots	unit of speed (1 knot = 0.514 m/s)
Lightering	Transferal of goods between vessels of different size
LGA	Local Government Areas
m	Meter (unit of length)
m/s	Meter per Second (unit of speed)
m^3	Cubic meter (unit of volume)
MAE	Mean Absolute Error
MAHs	Monoaromatic Hydrocarbons
MDO	Marine diesel oil
MNP	Marine National Park
MP	Marine Park
MS	Marine Sanctuary
NASA	National Aeronautics and Space Administration (USA)
NCEP	National Centres for Environmental Prediction (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NP	National Park
NR	Nature Reserve
NRC	National Research Council
O	Observed variable
OPEP	Oil Pollution Emergency Plan
P	Model-predicted variable
PAH	Polynuclear Aromatic Hydrocarbons
Pour Point	The pour point of a liquid is the temperature below which the liquid loses its flow characteristics
ppm	Parts per million (concentration)
PSU	Practical Salinity Units
Ramsar	Ramsar Sites; sites listed under the Ramsar Convention on wetlands which is an international intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources.
RSB	Reefs, Shoals and Banks

scf	Standard cubic feet (defined as one cubic foot of gas at 15.56 °C and at normal sea level air pressure)
Sea surface exposure	Contact by floating oil on the sea surface at concentrations equal to or exceeding defined threshold concentrations. The consequence will vary depending on the threshold and the receptors
Shoreline contact	Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations. Shoreline contact is judged for floating oil arriving within a 2 km buffer zone from any shoreline as a conservative measure
SIMAP	Spill Impact Model Application Package. SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for surface or subsea releases
Single Oil spill modelling	Oil spill modelling involving a computer simulation of a single hypothetical oil spill event subject to a single sequence of wind, current and other sea conditions over time. Single oil spill modelling, also referred to as “deterministic modelling” provides a simulation of one possible outcome of a given spill scenario, subject to the metocean conditions that are imposed. Single oil spill modelling is commonly used to consider the fate and effects of ‘worst-case’ oil spill scenarios that are carefully selected in consideration of the nature and scale of the offshore petroleum activity and the local environment (NOPSEMA, 2017). Because the outcomes of a single oil spill simulation can only represent the outcome of that scenario under one sequence of metocean conditions, worst-case conditions are often identified from stochastic modelling. It is impossible to calculate the likelihood of any outcome from a single oil spill simulation. Single oil spill modelling is generally used for response planning, preparedness planning and for supporting oil spill response operations in the event of an actual spill
SRTM	Shuttle Radar Topography Mission
Stochastic Oil spill modelling	Stochastic oil spill modelling is created by overlaying and statistically analysing the outcomes of many single oil-spill simulations of a defined spill scenario, where each simulation was subject to a different sequence of metocean conditions, selected objectively (typically by random selection) from a long sequence of historic conditions for the study area. Analysis of this larger set of simulations provides a more accurate indication of the environment that maybe affected (EMBA) and indicates which locations are more likely to be affected (as well as other statistics). Stochastic oil spill modelling avoids biases that affect single oil spill modelling (due to the reliance on only one possible sequence of conditions). However, when interpreting stochastic modelling, which is based on a wide range of potential conditions that might happen to occur, it is essential to understand that calculations will encompass a much larger area than could be affected in any single spill event, where a more limited set of conditions will occur. Consequently, it is misleading to imply that the region derived from stochastic modelling indicate the outcomes expected from a single spill event (NOPSEMA, 2017) Stochastic modelling is generally used for risk assessment and preparedness planning by indicating locations that could be exposed and may require response or subsequent impact assessment
Sub-LGA	Sub Local Government Areas
TOPEX/Poseidon	A joint satellite mission between NASA and CNES to map ocean surface topography using an array of satellites equipped with detailed altimeters
USA	United States of America
US EPA	United States Environmental Protection Agency
US CG	United States Coast Guard
Viva Energy	Viva Energy Australia
WGS 1984	World Geodetic System 1984 (WGS84); reference coordinate system
X_{model}	Model predicted surface elevation
X_{obs}	Observed surface elevation

EXECUTIVE SUMMARY

Background

Beach Energy (Beach) are revising their Environmental Plan (EP) and Oil Pollution Emergency Plan (OPEP) for the Yolla field operations. The Yolla field is located within the production license T/L1 and is approximately 100 km offshore from mainland Victoria in the Bass Strait.

As part of Beach's due diligence, they are updating their spill modelling assessments to bring them into line with current regulatory requirements. Aventus Consulting commissioned RPS to investigate three plausible, yet hypothetical, scenarios:

- Scenario 1: 204, 250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform;
- Scenario 2: 300 m^3 surface release marine diesel oil (MDO) over 6 hours at 3 nm from the coast; and
- Scenario 3: 3,144.9 bbl (500 m^3) subsea pipeline rupture of Yolla condensate over 57.6 minutes at 3 nm from the coast.

Aventus Consulting requested that the stochastic assessments for each scenario be completed on an annual basis.

Methodology

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 CFSR 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 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 scenario simulation was subject to different wind and current conditions and, in turn, movement and weathering of the oil for an annual based assessment.

The SIMAP system, the methods and analysis presented herein, use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 "*Standard Practice for Development and Use of Oil Spill Models*".

Oil Properties

Yolla condensate has an API of 52.15 and a density of 770.6 kg/m^3 (at 15ºC) with a low viscosity (0.14 cP), classifying it as a Group I oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and US EPA/USCG classifications. The condensate comprises a significant portion of volatiles and semi to low volatiles (98.55% total) with very little residual components (1.45%). This means that the condensate will evaporate readily when on the water surface, with limited persistent components to remain on the water surface over time.

Marine diesel oil has an API of 37.6, density of 829.1 kg/m^3 (at 15 ºC) and a low viscosity of 4.0 cP at 25ºC, classifying it as a Group II oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and US EPA/USCG classifications. Marine diesel oil is characterised by a large mixture (95%) of low and semi- to low-volatiles and contains 5% persistent hydrocarbons. It is important to note that some heavy components contained in marine diesel oil have a strong tendency to physically entrain into the upper water column in the presence of moderate winds (i.e. >12 knots) and breaking waves, but can re-float to the surface if these energies abate.

Results

Scenario 1: 204,250 bbl Subsea Blowout of Yolla Condensate over 86 Days

- No moderate (10-50 g/m^2) or high (≥ 50 g/m^2) zones of potential oil exposure were predicted.
- Low levels of potential exposure (1-10 g/m^2) were centred around and were predicted to extend a maximum distance of 17.3 km (south-southeast) from the release location.
- No shoreline contact was predicted under the annual conditions modelled.
- The maximum distance of dissolved hydrocarbons at the low (10-50 ppb) and moderate (50-400 ppb) thresholds from the release location was predicted as 223 km (east-northeast) and 65 km (east-southeast), respectively. No dissolved hydrocarbon exposure was predicted at, or above, the high (400 ppb) threshold.
- In the surface layer (0-10 m), the Flinders IMCRA recorded the highest probability of low dissolved hydrocarbon exposure with 10%. Additionally, the White Shark – Foraging BIA and Boags AMP recorded a 7% and 6% probability of low dissolved hydrocarbon exposure, respectively. Dissolved hydrocarbons at the moderate threshold were only predicted at excluded receptors while no dissolved hydrocarbons were predicted at or above the high exposure threshold.
- The maximum distance of entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) thresholds from the release location was predicted as 495 km (east-northeast) and 43 km (west), respectively.
- In the surface layer (0-10 m), the Flinders IMCRA recorded the greatest probability of low exposure to entrained hydrocarbons with 85%, while the Beagle AMP and White Shark – Foraging BIA recorded 75% and 74% probabilities of low exposure to entrained hydrocarbons, respectively. Additionally, multiple receptors (Flinders IBRA, Twofold Shelf IMCRA, Kent Group NP, Kent Island Group and Tasmania State Waters) recorded a 67% probability of exposure to low entrained hydrocarbons. No receptors were predicted to be exposed to entrained hydrocarbons at or above the high threshold.

Scenario 2: 300 m^3 Surface Release of MDO over 6 Hours

- The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (≥ 50 g/m^2) exposure levels was 26.6 km (east-southeast),10.7 km (south) and 2.5 km (west), respectively.
- The highest probability of low sea surface exposure was recorded at Gippsland Plain IBRA with 35% and a predicted minimum time of 4 hours before exposure. Additionally, the Little Penguin – Foraging BIA, White Shark – Foraging BIA, Bass Coast and Kilcunda Sub-LGA were predicted to be exposed to low surface oil with probabilities of 33%, 32%, 34% and 30%, respectively. Bunurong Marine Park was predicted to be exposed to low exposure level surface oil with a probability of 7% and a predicted minimum time of 12 hours before (low level) exposure.
- The probability of contact to any shoreline at, or above, the low contact level (10-100 g/m^2) was 39% and the minimum time before shoreline contact at, or above, the low threshold was 10 hours. The maximum volume ashore for a single spill trajectory was 172 m^3 and the maximum length of shoreline contacted at the low threshold was 11 km.

- The maximum distance of dissolved hydrocarbons at the low (10-50 ppb) and moderate (50-400 ppb) thresholds from the release location was predicted as 97 km (southeast) and 9 km (east-southeast), respectively. No dissolved hydrocarbon exposure was predicted at, or above, the high (400 ppb) threshold.

- In the surface layer (0-10 m), Gippsland Plain IBRA, Bass Coast and Venus Bay Sub-LGA recorded the highest probability of low dissolved hydrocarbon exposure with 11%. Additionally, the Kilcunda Sub-LGA and Bunurong Marine Park recorded 10% and 9% probabilities of low dissolved hydrocarbon exposure. Moderate dissolved hydrocarbon exposure was predicted at Gippsland Plain IBRA, Bunurong Marine Park, Bass Coast and Kilcunda Sub-LGA with a predicted probability of 1%. No dissolved hydrocarbons were predicted at or above the high exposure threshold. No dissolved hydrocarbon exposure was predicted to occur below a depth of 10 m.

- The maximum predicted distance of entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) thresholds from the release location was 506 km (east-northeast) and 122 km (east-southeast), respectively.

- In the surface layer (0-10 m), the Gippsland Plain IBRA, the Bunurong MNP, and the Bass Coast all recorded the greatest probability of low exposure to entrained hydrocarbons with 81%. Additionally, Venus Bay Sub-LGA recorded an 80% probability of exposure to low entrained hydrocarbons and both the Bunurong Marine Park and Kilcunda Sub-LGA recorded a 79% probability of low entrained hydrocarbon exposure. At the high entrained hydrocarbon threshold, the Gippsland Plain IBRA, the Bass Coast and Kilcunda Sub-LGA recorded the highest probability of exposure with 56%.

- Entrained hydrocarbons at, or above the low exposure threshold were not predicted to occur below a depth of 10 m for this scenario.

Scenario 3: 3,144.9 bbl Pipeline Rupture of Yolla Condensate over 57.6 Minutes

- The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (≥ 50 g/m^2) exposure levels was 9.4 km (west-southwest),3 km (east-northeast) and 0.7 km (east-northeast), respectively.

- The highest probability of low sea surface exposure was recorded at the Little Penguin – Foraging BIA with 17% and a predicted minimum time of 4 hours before exposure. Additionally, the White Shark – Foraging BIA and Gippsland Plain IBRA were predicted to be exposed to low surface oil with probabilities of 17% and 7%, respectively. Bunurong Marine Park was predicted to be exposed to low surface oil with a probability of 1% and a minimum time of 29 hours before exposure.

- The probability of contact to any shoreline at, or above, the low level (10-100 g/m^2) was 8% and the minimum time before shoreline contact at, or above, the low threshold was 12 hours. The maximum volume ashore for a single spill trajectory was 21.3 m^3 and the maximum length of shoreline contacted at the low threshold was 5 km.

- The maximum distance of dissolved hydrocarbons at the low (10-50 ppb), moderate (50-400 ppb) and high (≥ 400 ppb) thresholds from the release location was predicted as 112 km (east-southeast), 83 km (east-southeast) and 3 km (east-southeast), respectively.

- In the surface layer (0-10 m), the Gippsland Plain IBRA, Bass Coast and Kilcunda Sub-LGA all recorded the highest probabilities at the low and moderate dissolved hydrocarbon thresholds with 65% and 25%, respectively. Additionally, Venus Bay Sub-LGA and the Bunurong Marine Park were predicted to be exposed to dissolved hydrocarbons at the low threshold with probabilities of 61% and 59%, respectively.

- The maximum predicted distances of entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) thresholds from the release location was 136 km (east-southeast) and 49 km (southeast), respectively.

- In the surface layer (0-10 m), the Gippsland Plain IBRA, the Bass Coast, the Kilcunda Sub-LGA and the Venus Bay Sub-LGA all recorded the greatest probability of low exposure to entrained hydrocarbons with 73%. Additionally, Venus Bay Sub-LGA recorded an 80% probability of exposure to low entrained hydrocarbons and both the Bunurong Marine Park and the Bunurong MNP recorded a 69% and 66% probability of exposure to entrained hydrocarbons at the low threshold. At the high entrained hydrocarbon threshold, the Gippsland Plain IBRA, the Bass Coast and Kilcunda Sub-LGA recorded the highest probability of exposure with 33%.

- Entrained hydrocarbons at, or above the low exposure threshold were not predicted to occur below a depth of 10 m for this scenario.

1 INTRODUCTION

1.1 Background

Beach Energy (Beach) are revising their Environmental Plan (EP) and Oil Pollution Emergency Plan (OPEP) for the Yolla field operations. The Yolla field is located within the production license T/L1 and is approximately 100 km offshore from mainland Victoria in the Bass Strait.

As part of Beach's due diligence, they are updating their spill modelling assessments to bring them into line with current regulatory requirements. Aventus Consulting commissioned RPS to investigate three plausible, yet hypothetical, scenarios:

- Scenario 1: 204, 250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform;
- Scenario 2: 300 m^3 surface release marine diesel oil (MDO) over 6 hours at 3 nm from the coast; and
- Scenario 3: 3,144.9 bbl (500 m^3) subsea pipeline rupture of Yolla condensate over 57.6 minutes at 3 nm from the coast.

Aventus Consulting requested that the stochastic assessments for each scenario be completed on an annual basis.

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

The SIMAP system, the methods and analysis presented herein, use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 "Standard Practice for Development and Use of Oil Spill Models".

Note that the modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that Origin propose to have in place during the operations. The modelling makes no allowance for intervention following a spill to reduce volumes and/or prevent hydrocarbons from reaching sensitive areas.

Table 1.1 Location of the release sites used for the dispersion modelling assessment.

Release site	Latitude	Longitude	Depth (m)
Yolla Platform	39° 50' 45.9" S	145° 49' 1.4" E	80
MDO and Pipeline	38° 37' 7.58" S	145° 27' 47.7" E	50

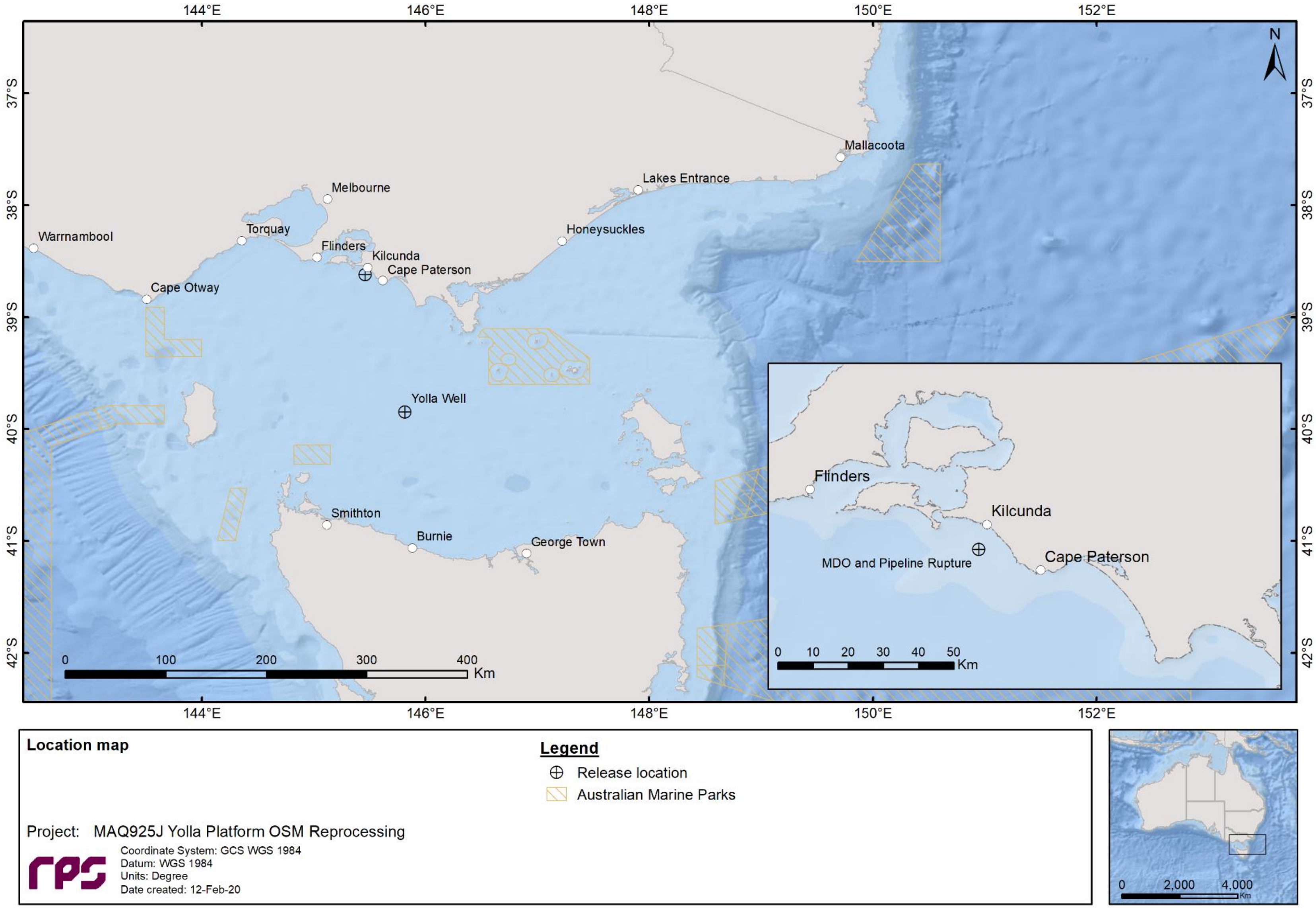


Figure 1.1 Location of the hypothetical spill release sites as used in the oil spill modelling.

2 SCOPE OF WORK

The scope of work included the following components:

- Generate five years of winds and three-dimensional currents from 2008 to 2012 (inclusive). The currents include the combined influence of tidal and ocean currents;
- Include the wind and current data and oil characteristics as input into the three-dimensional oil spill model SIMAP, to model the movement, spreading, weathering and shoreline contact by hydrocarbons over time;
- Use SIMAP's stochastic model (also known as a probability model) to calculate exposure to surround waters and shoreline. This involved running 100 randomly selected single trajectory simulations during each assessment period, for each scenario, with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start time. This ensured that each spill trajectory was subjected to varying wind and current conditions; and
- Review the stochastic model results and assess the spill trajectories that resulted in the worst outcomes with regard to: (i) largest swept area at, or above, 10 g/m^2 (actionable sea surface oil), (ii) minimum time to shore for visible sea surface oil(1 g/m^2), (iii) largest volume of oil ashore, and (iv) longest length of shoreline contacted at, or above, 100 g/m^2 (actionable shoreline oil).

3 REGIONAL CURRENTS

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area off the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the 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 varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 3.1 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

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

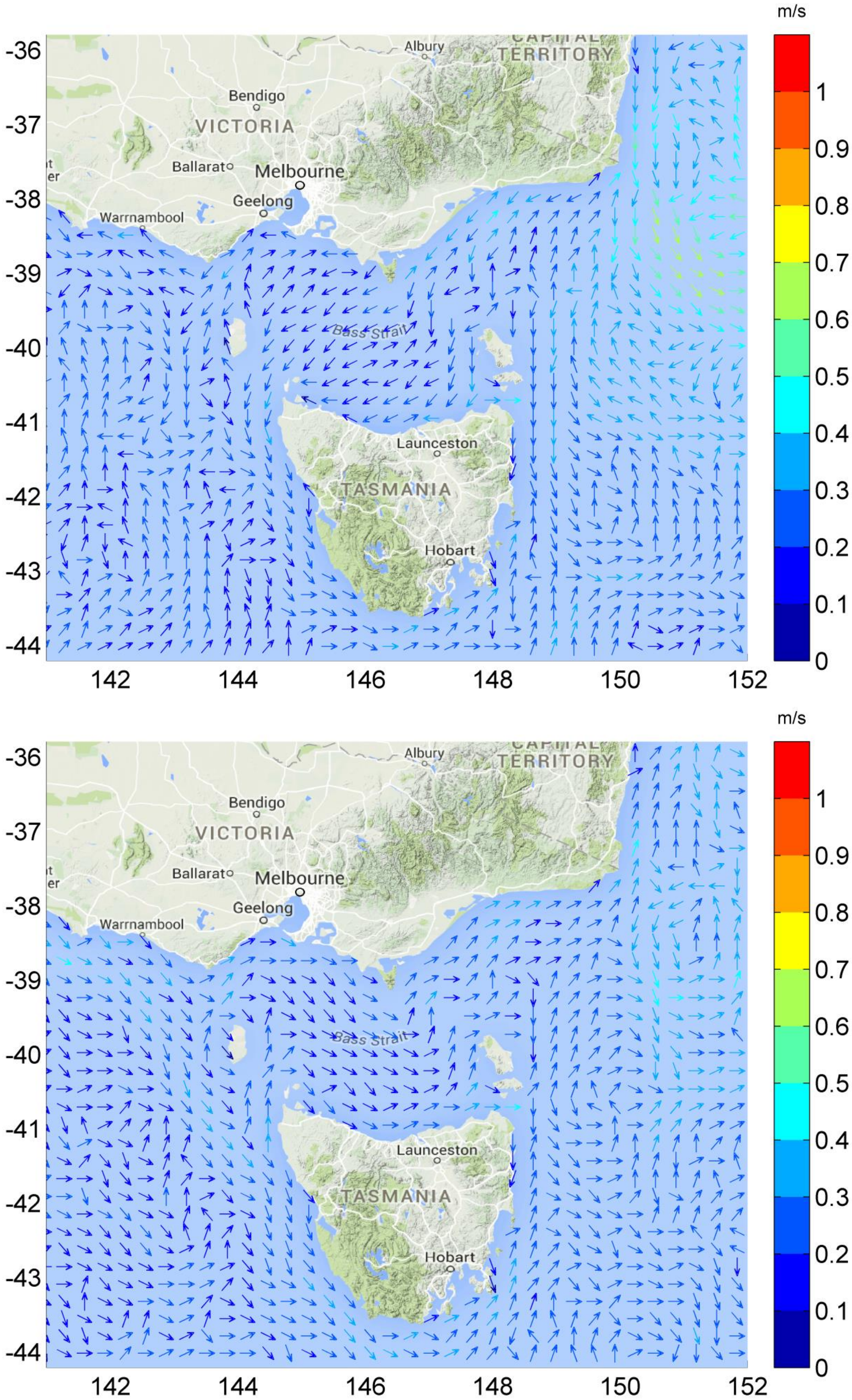


Figure 3.1 **HYCOM averaged seasonal surface drift currents during summer and winter.**

3.1 Tidal currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for more than 30 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

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

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

3.1.1 Grid Setup

RPS has a global tidal model with global coverage. The model is sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids are progressively allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3.2 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 3.3). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

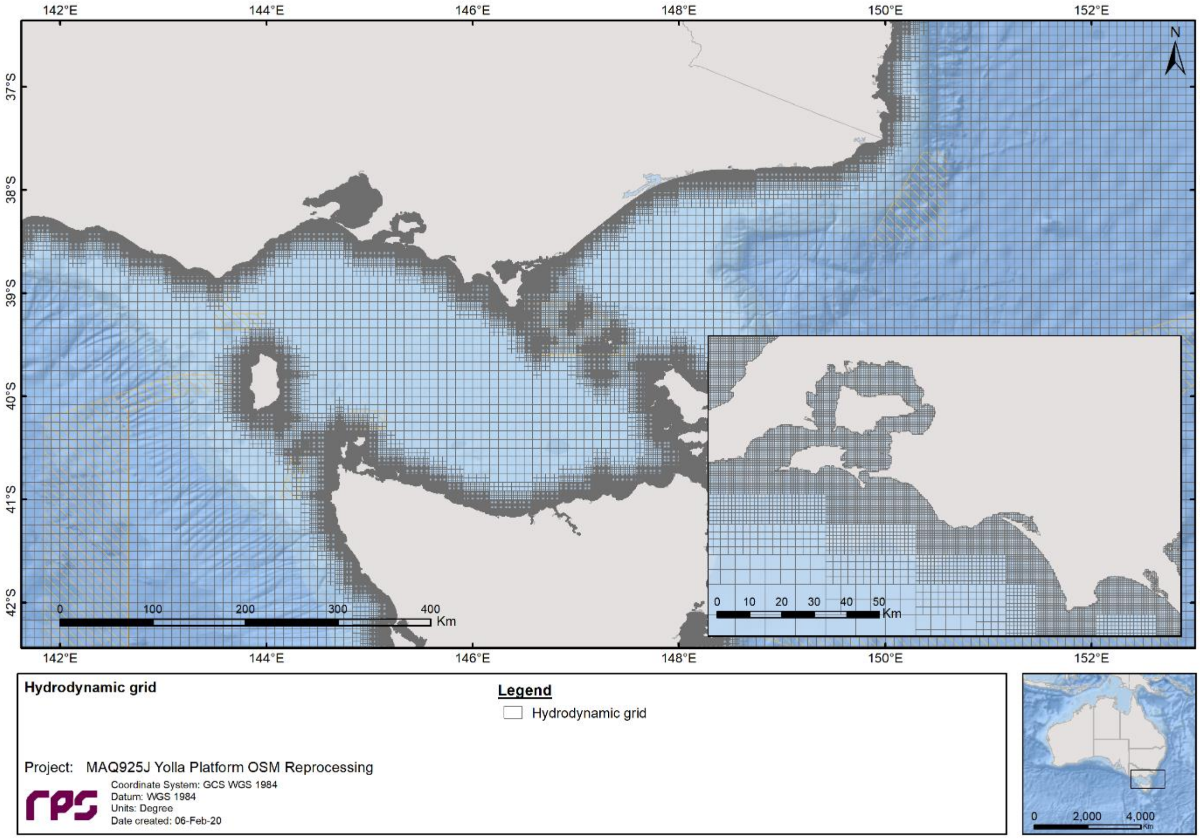


Figure 3.2 **Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.**

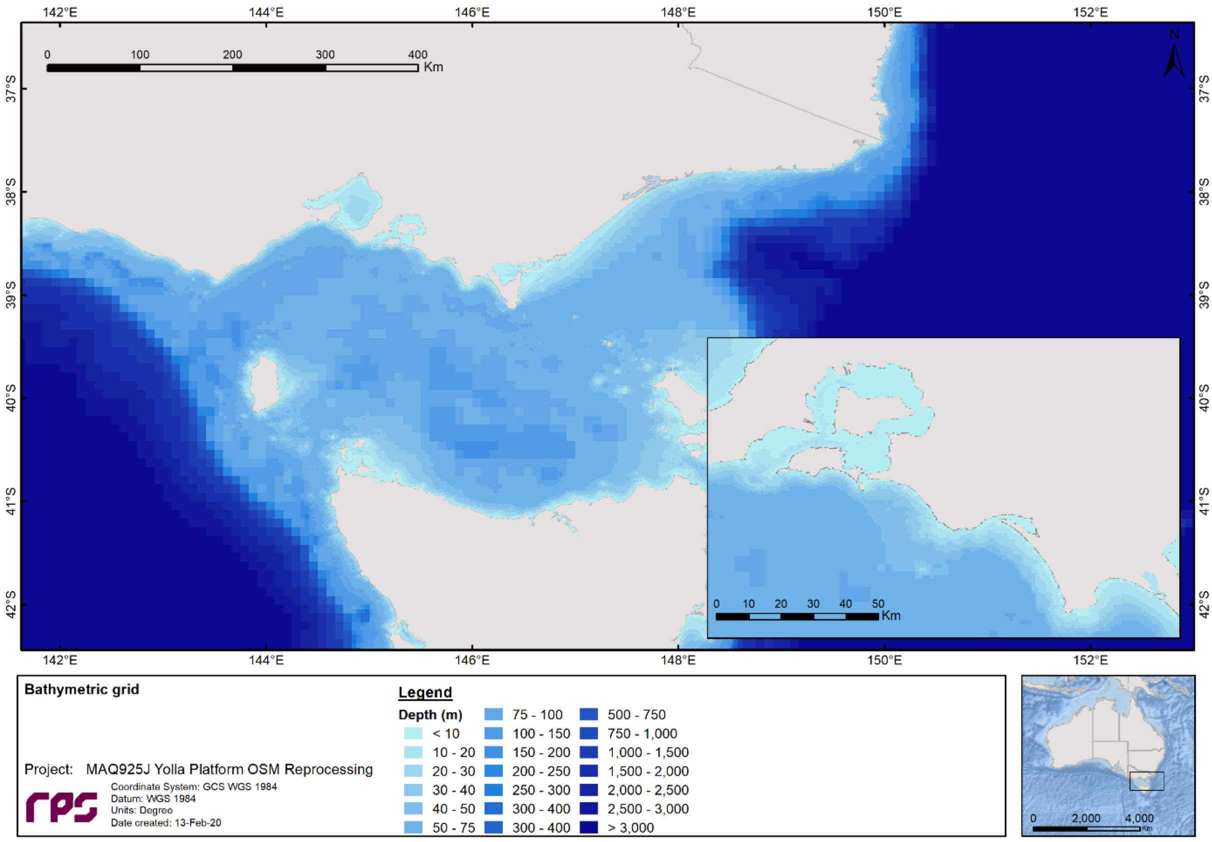


Figure 3.3 **Bathymetry defined throughout the tidal model domain.**

3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 8.0) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were K_2, S_2, M_2, N_2, K_1, P_1, O_1 and Q_1. Using the tidal data, time series surface heights were calculated along the open boundaries for the simulation period.

The Topex/Poseidon satellite data has a resolution of 0.25 degrees globally, with higher resolution in coastal regions, and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The data capturing satellites, equipped with two altimeters capable of taking sea level measurements accurate to less than ± 5 cm, measured oceanic surface elevations (and the resultant tides) for the period 1992–2005. In total these satellites carried out 62,000 orbits of the planet. The Topex-Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen 2010). The Topex/Poseidon tidal data is considered suitably accurate for this study.

3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at a location situated within the study area (Figure 3.4).

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

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

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

Where: N = Number of observations

P_i = Model predicted surface elevation

O_i = Observed surface elevation

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

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: X_{model} = Model predicted surface elevation

X_{obs} = Observed surface elevation

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

Figure 3.5 and Figure 3.6 illustrate a comparison of the predicted and observed surface elevations in February 2017. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

Table 3.1 shows the IOA and MAE values for the selected tide station locations indicating that the model is performing well.

Table 3.1 Statistical comparison between the observed and HYDROMAP predicted surface elevations.

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

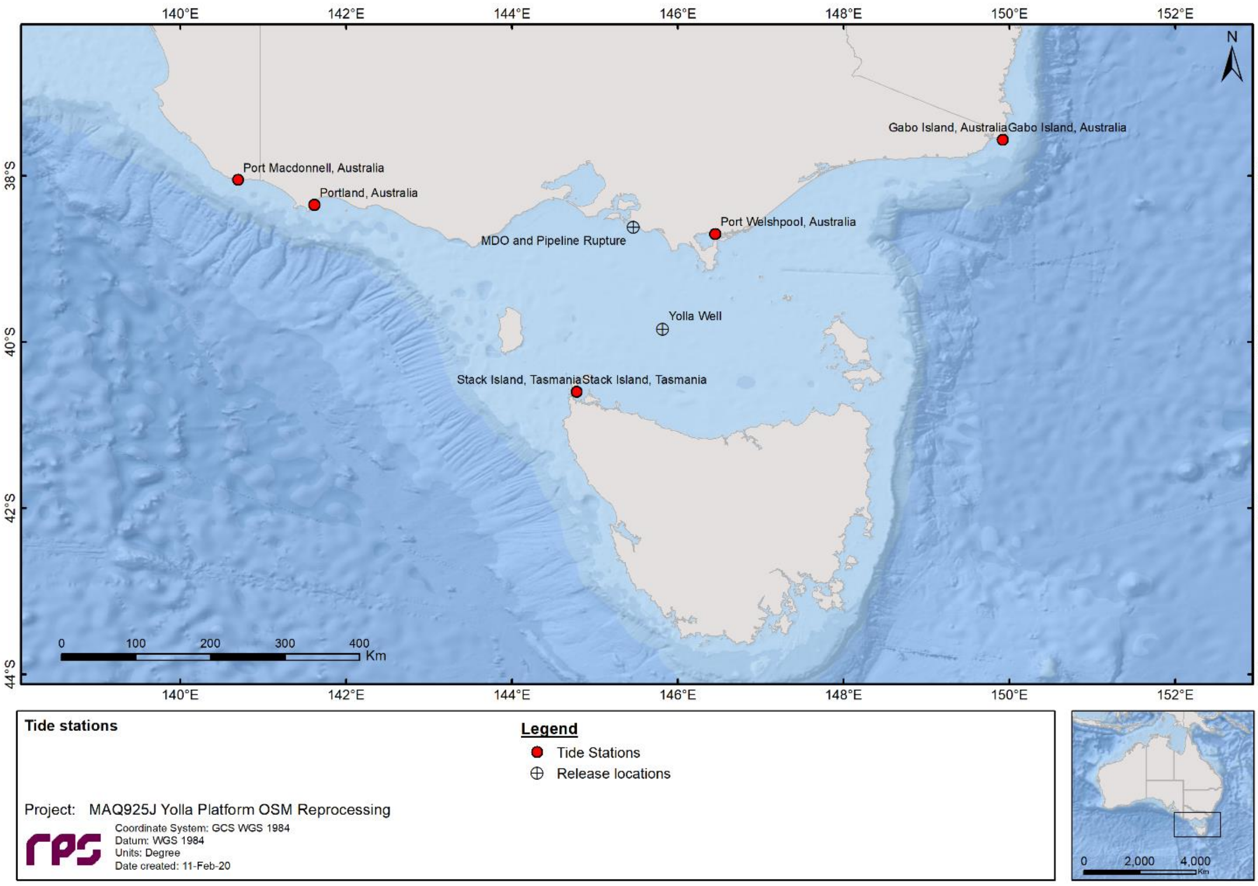


Figure 3.4 Location of the tide stations used in the surface elevation validation.

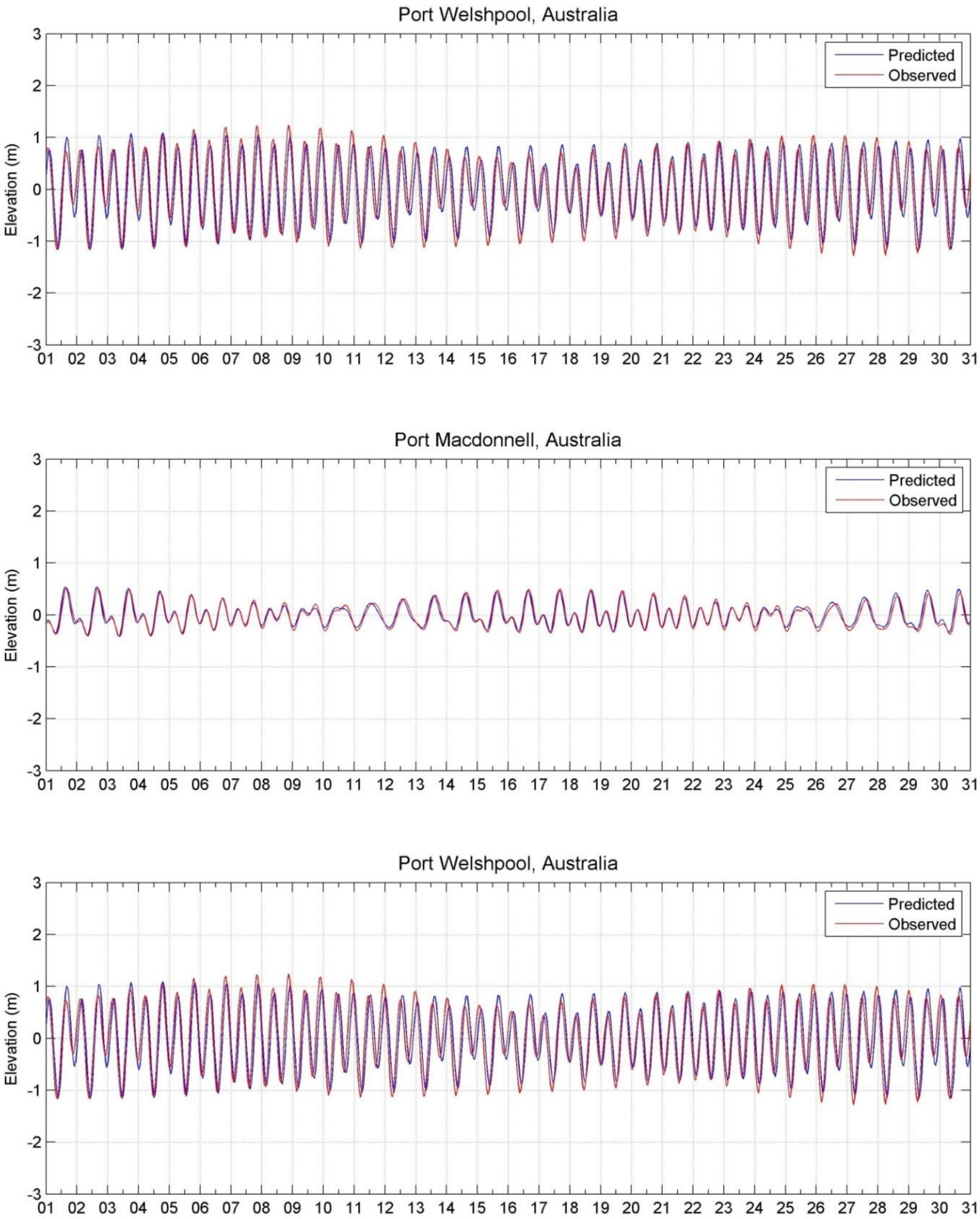
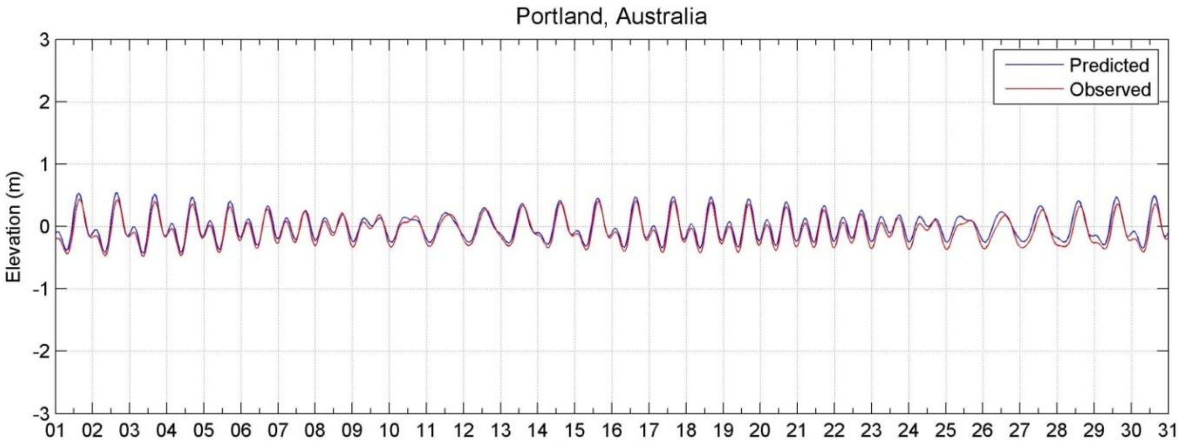


Figure 3.5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).



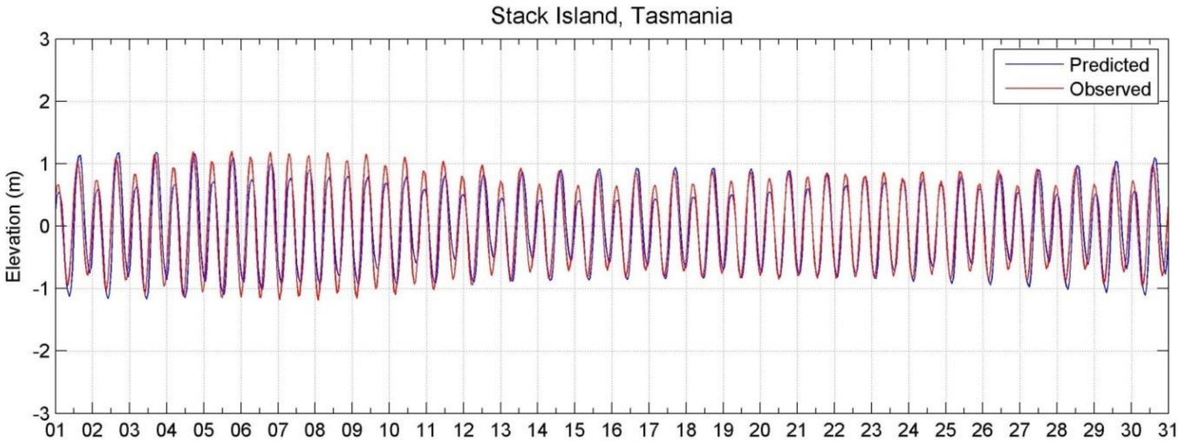


Figure 3.6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).

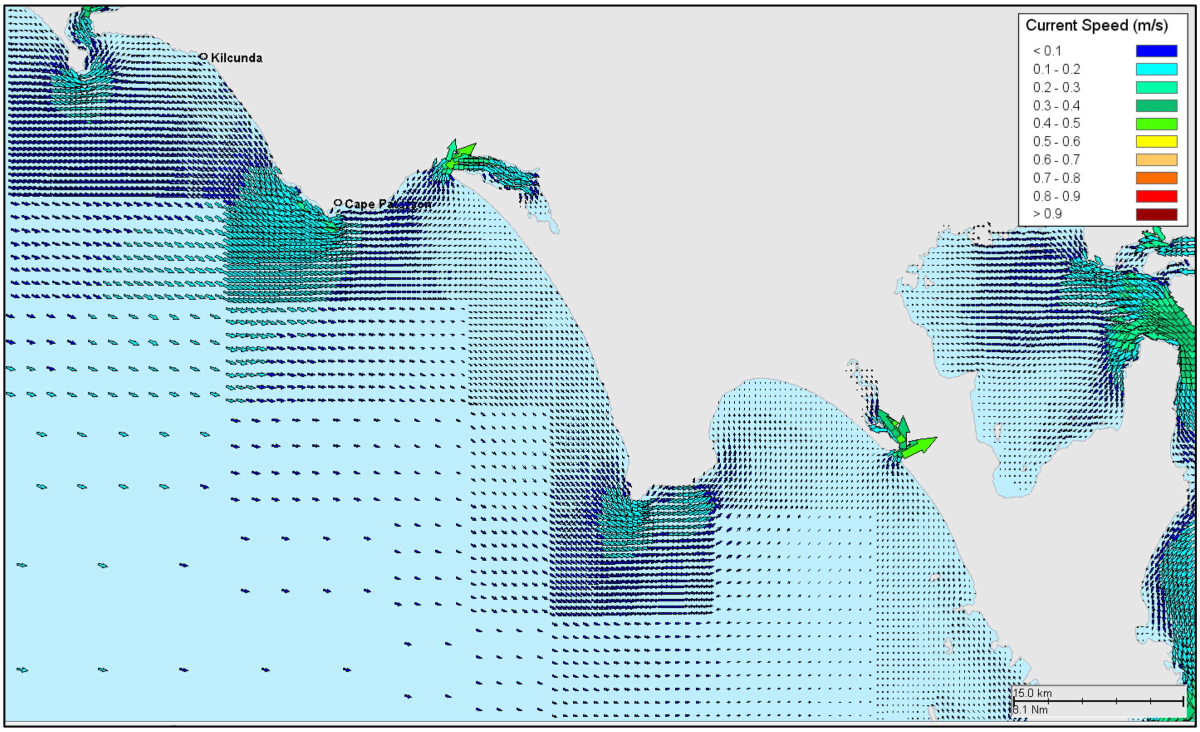


Figure 3.7 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and sholas. Colourations of individual vectors indicate current speed.

3.2 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12th 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 hindcast currents were obtained for the years 2008 to 2012 (inclusive). Figure 3.8 shows an example modelled surface ocean currents (HYCOM) during the study period.

Table 3.2 presents the average and maximum net current speeds from combined HYCOM and tidal currents nearby the Yolla release site. Current spends varied throughout the year with peak current speeds ranging between 0.48 m/s (January) and 1.02 m/s (July). The dominant direction of surface currents was predominantly eastward.

Figure 3.9 and Figure 3.10 show the monthly and total current rose distributions resulting from the combination of HYCOM ocean current data and HYDROMAP tidal data nearby the Yolla release site.

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

Table 3.2 Predicted monthly average and maximum surface current speeds nearby the Yolla release site. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2008–2012 (inclusive).

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction
January	0.16	0.48	Variable
February	0.18	0.66	Variable
March	0.18	0.68	East-northeast
April	0.17	0.98	East
May	0.16	0.73	East
June	0.19	0.85	East-southeast
July	0.20	1.02	East-southeast
August	0.22	0.99	East-southeast
September	0.21	0.73	East-southeast
October	0.16	0.54	East-northeast
November	0.17	0.61	East
December	0.18	0.48	East
Minimum	**0.16**	**0.48**	
Maximum	**0.22**	**1.02**	

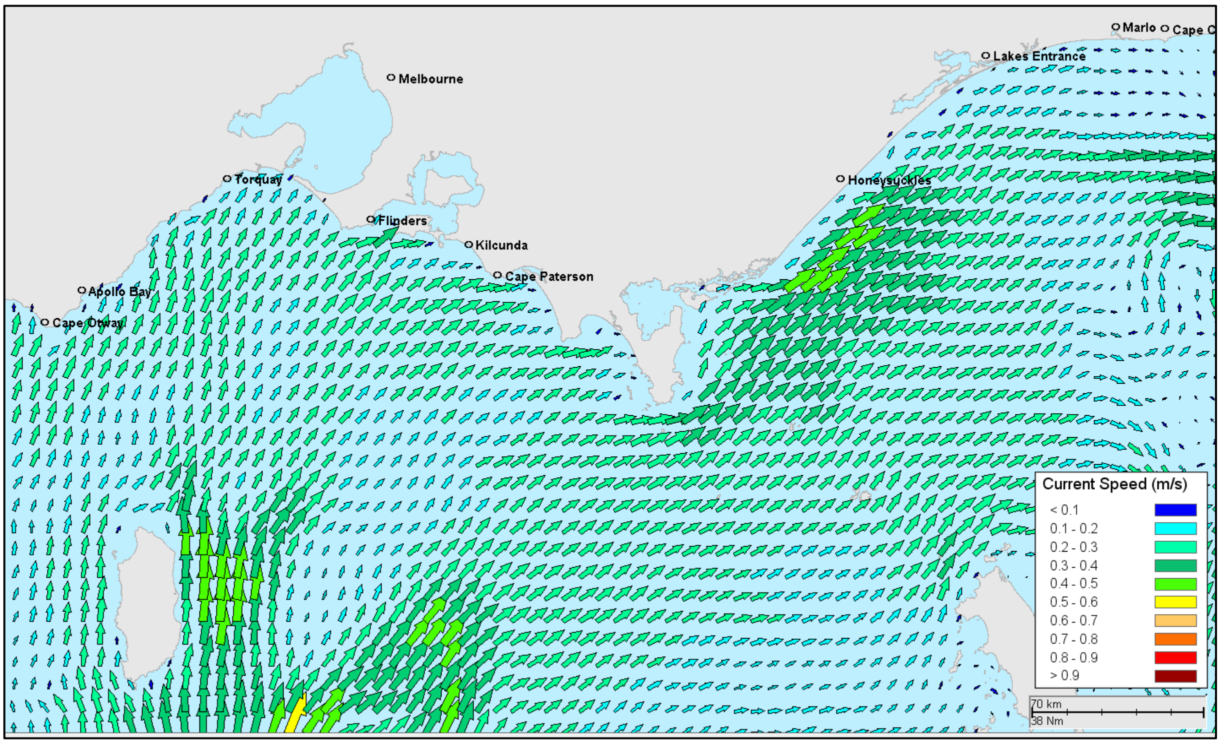


Figure 3.8 Modelled surface ocean currents presented for the 1st May 2012. Derived from the HYCOM ocean hindcast model. The colours of the vectors indicate current speed in m/s.

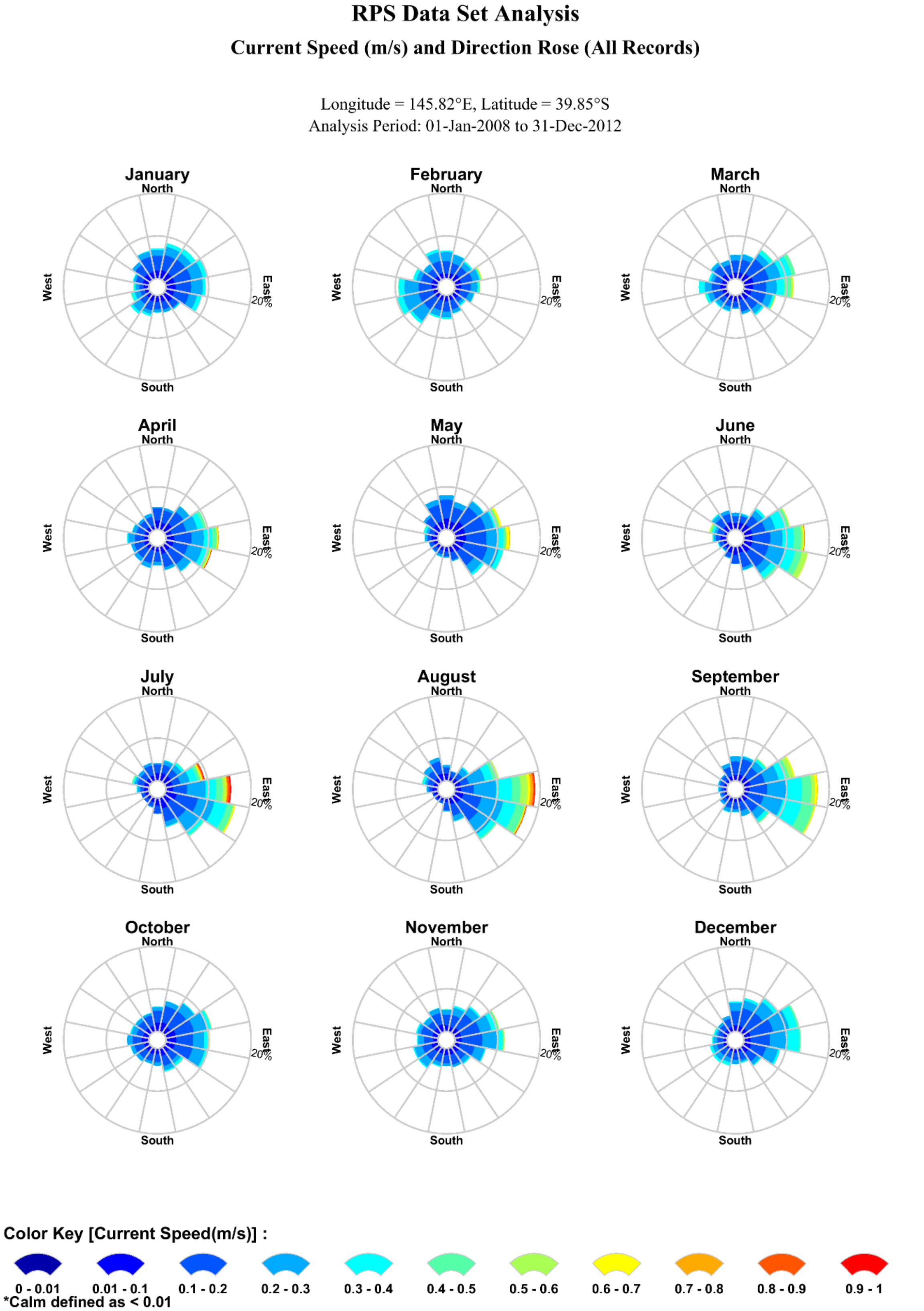


Figure 3.9 **Monthly surface current rose plots nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive).**

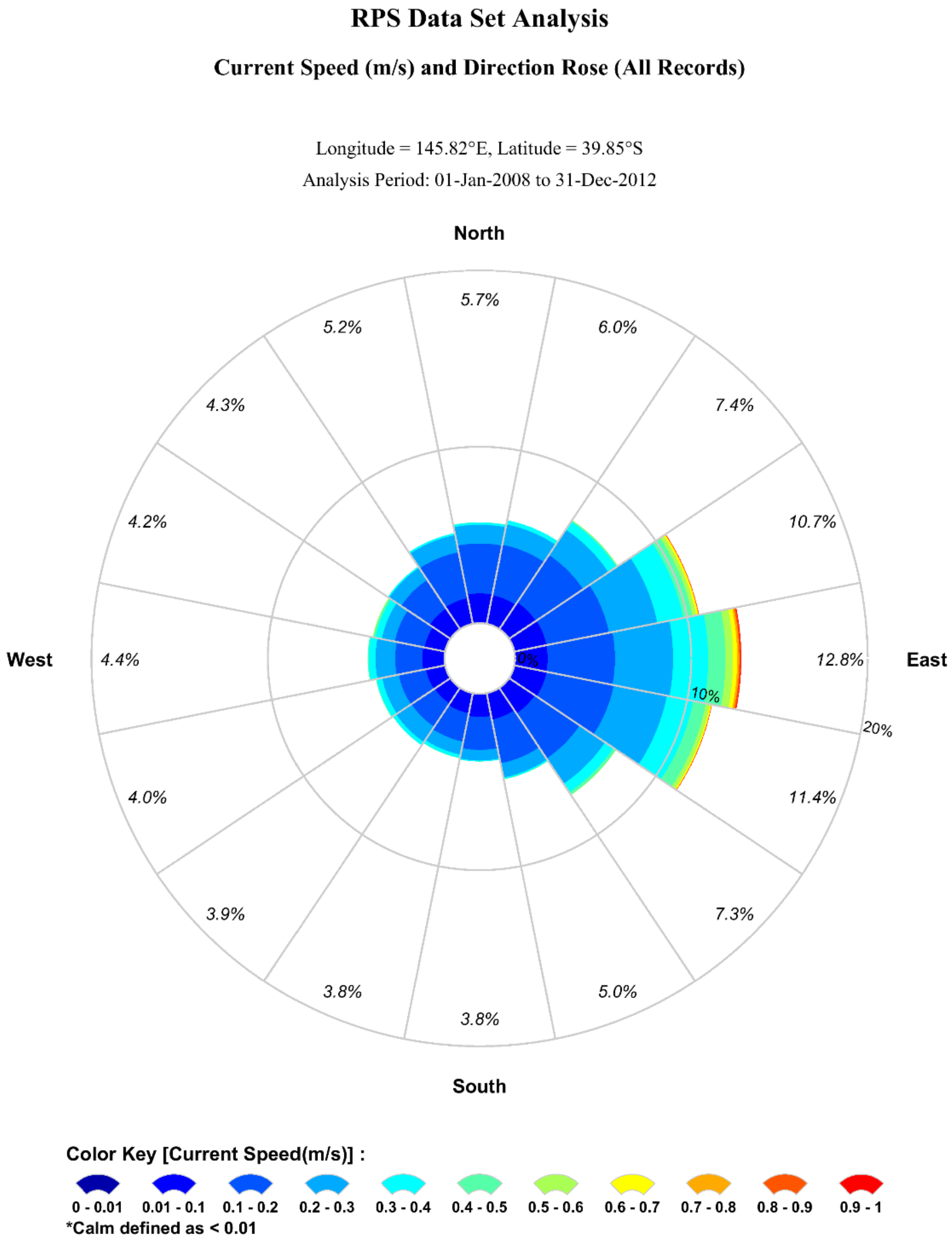


Figure 3.10 Modelled total surface current rose plot nearby the Yolla release site (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008–2012 (inclusive).

4 WIND DATA

High resolution wind data was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis dataset (CFSR; see Saha et al., 2010). The CFSR wind model is a fully coupled, data-assimilative hindcast model representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at ¼ of a degree resolution (~33 km) and 1-hourly time intervals.

The CFSR wind data for the years 2008–2012 (inclusive) was extracted across the entire current model domain for input into the oil spill model. Figure 4.1 shows the spatial resolution of the wind field used as input into the oil spill model. Table 4.1 presents the monthly average and maximum winds derived from a CFSR station nearby the Yolla release site.

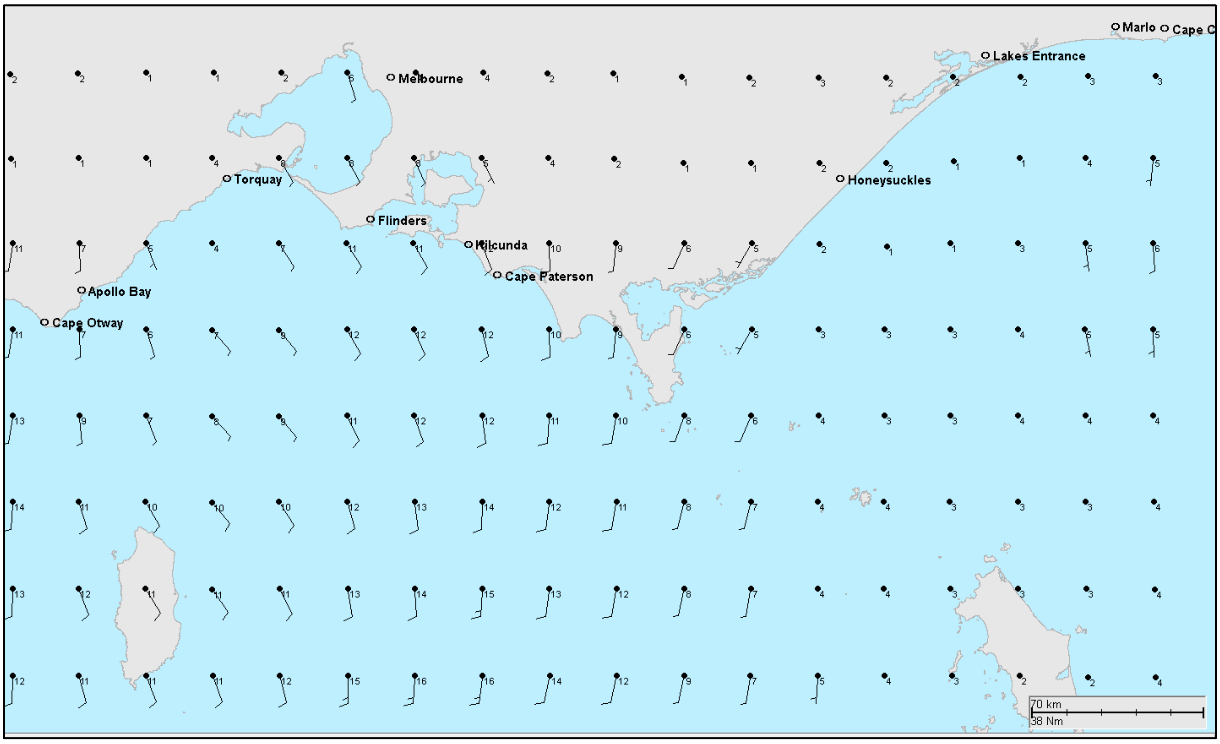


Figure 4.1 **Spatial resolution of the CFSR modelled wind data used as input into the oil spill model.**

Figure 4.2 and Figure 4.3 show the monthly and total wind rose distributions derived from the CFSR data for the nearest location to the Yolla release site. The wind data demonstrated average monthly wind speeds ranging from 15.0 knots (November) to 19.3 knots (August). Throughout June to September monthly average wind speeds exceeded 18 knots. The weakest monthly wind speeds occurred during January, October and November with monthly averages less than 16 knots.

Annually, winds from the southwest and west-southwest were the most common. There was an observable trend for wind directions to be split over a west-southwest/east-northeast axis.

Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows from, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 3 knots are predominantly used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

Table 4.1 Predicted average and maximum winds for the representative wind station nearby the Yolla release site. Data derived from CFSR hindcast model from 2008–2012 (inclusive).

Month	Average current speed (knots)	Maximum current speed (knots)	General direction
January	15.7	37.2	Southwest
February	16.4	42.3	East-northeast
March	16.4	44.6	Southwest
April	16.3	46.2	Southwest
May	16.3	40.7	Southwest
June	17.5	45.5	Variable
July	18.0	48.8	Variable
August	19.3	45.8	Variable
September	19.2	46.0	West-southwest
October	15.7	36.9	West-southwest
November	15.0	42.2	West-southwest
December	16.7	40.3	West-southwest
Minimum	**15.0**	**36.9**	
Maximum	**19.3**	**48.8**	

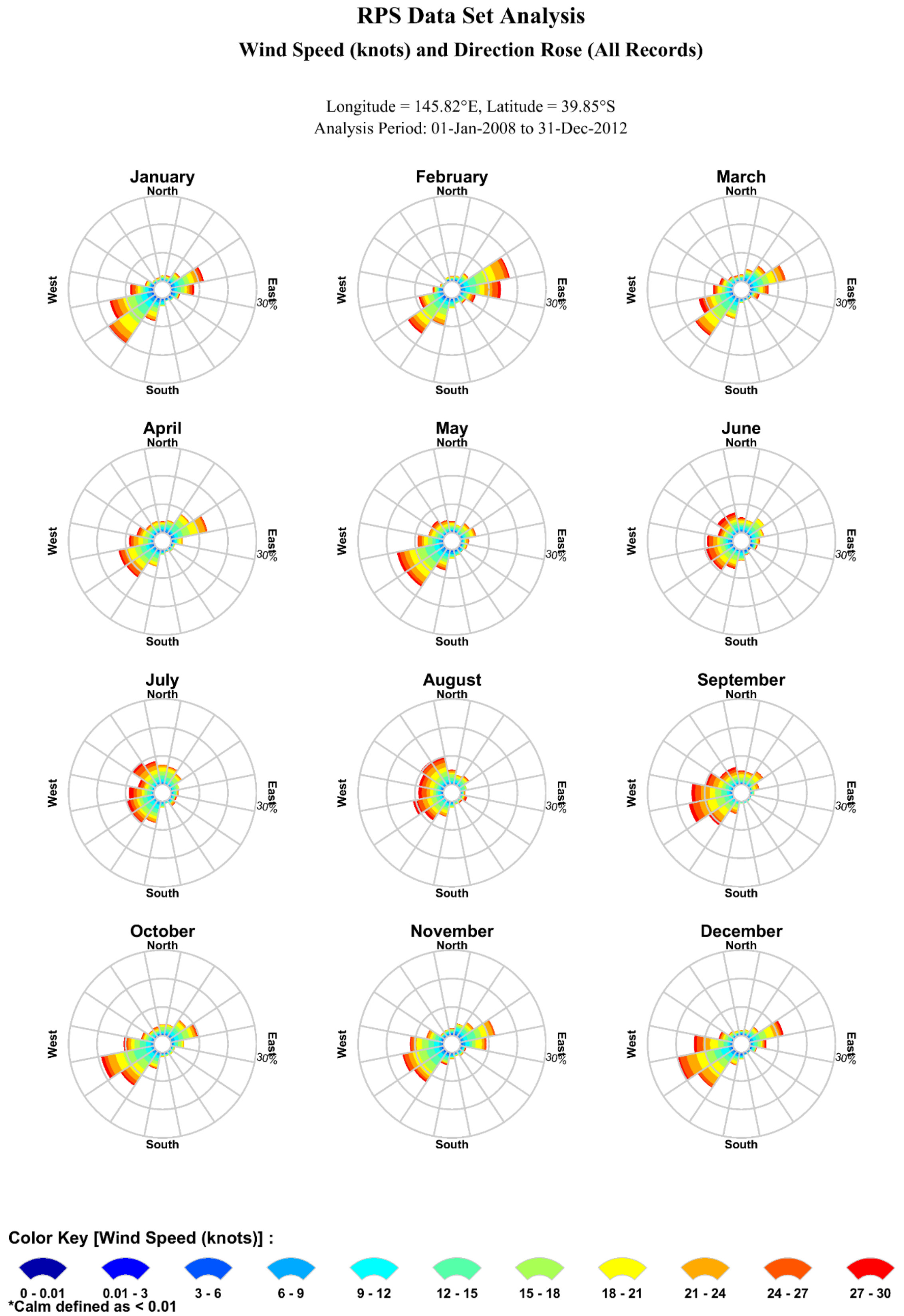


Figure 4.2 Modelled monthly wind rose distributions from 2008–2012 (inclusive), for the representative wind station nearby the Yolla release site.

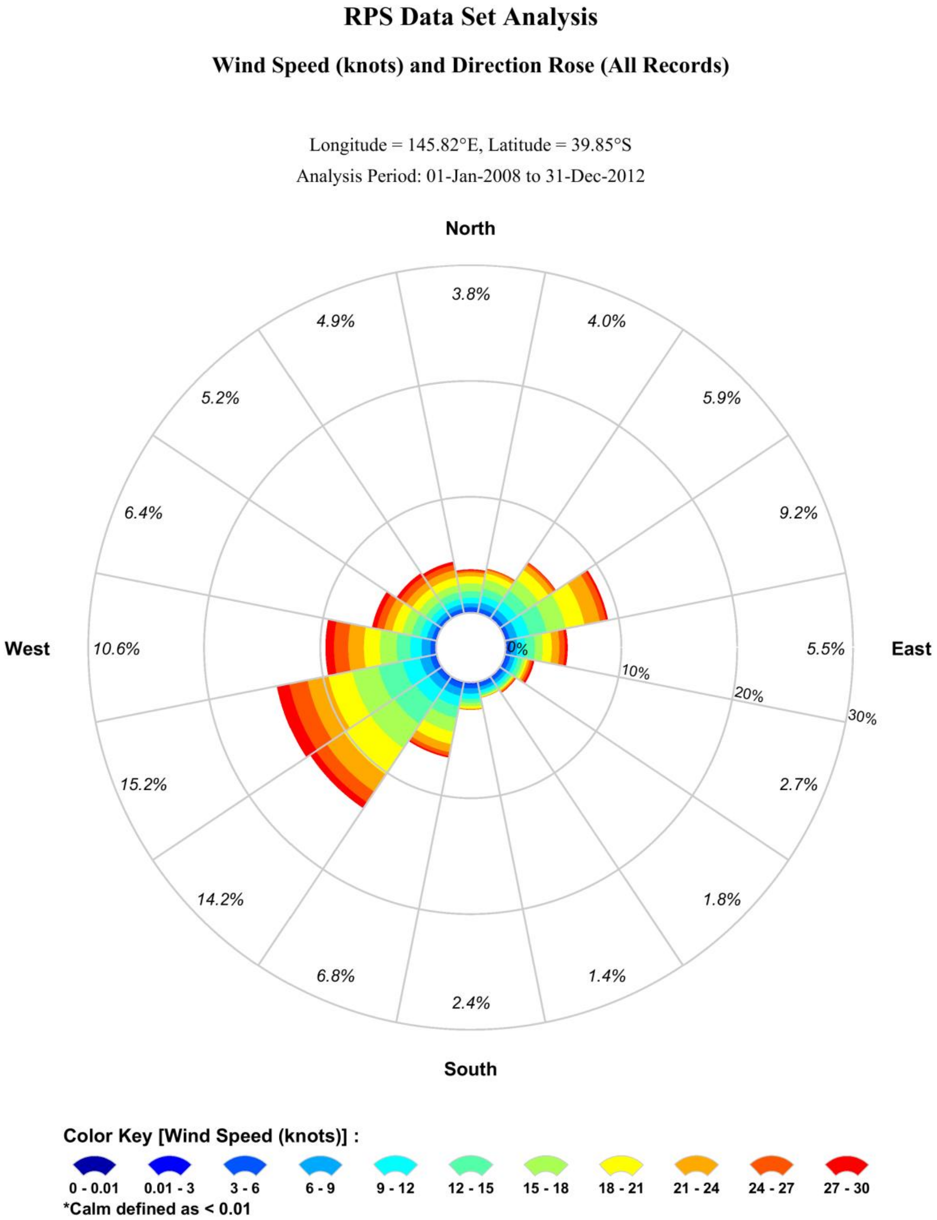


Figure 4.3 **Modelled total wind rose distributions from 2008–2012 (inclusive), for the representative wind station nearby the Yolla release site.**

5 WATER TEMPERATURE AND SALINITY

The monthly sea temperature and salinity profiles of the water column within the study was obtained from the World Ocean Atlas 2013 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Center for Oceanography (see Levitus et al., 2013).

To account for depth-varying sea temperature and salinity the modelling used monthly average sea temperature and salinity profiles. Table 5.1 presents the sea temperature and salinity of the surface layer nearby the release sites.

The monthly average sea surface temperatures ranged between 12.7°C and 18.1°C. The monthly average salinity values remain relatively consistent ranging between 24.9 and 35.5 psu.

These parameters were used as factors to inform the weathering, movement and evaporative loss of hydrocarbon spills in the surface and sub-surface layers.

Figure 5.1 illustrates the vertical profile of sea temperature and salinity nearby the release sites.

Table 5.1 Monthly average sea surface temperature and salinity in the study area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (ºC)	17.1	18.0	18.1	17.0	17.3	13.0	12.7	13.2	13.1	14.3	15.7	15.1
Salinity (PSU)	35.3	35.3	35.5	35.5	35.4	34.9	35.2	35.1	35.3	35.5	35.5	35.3

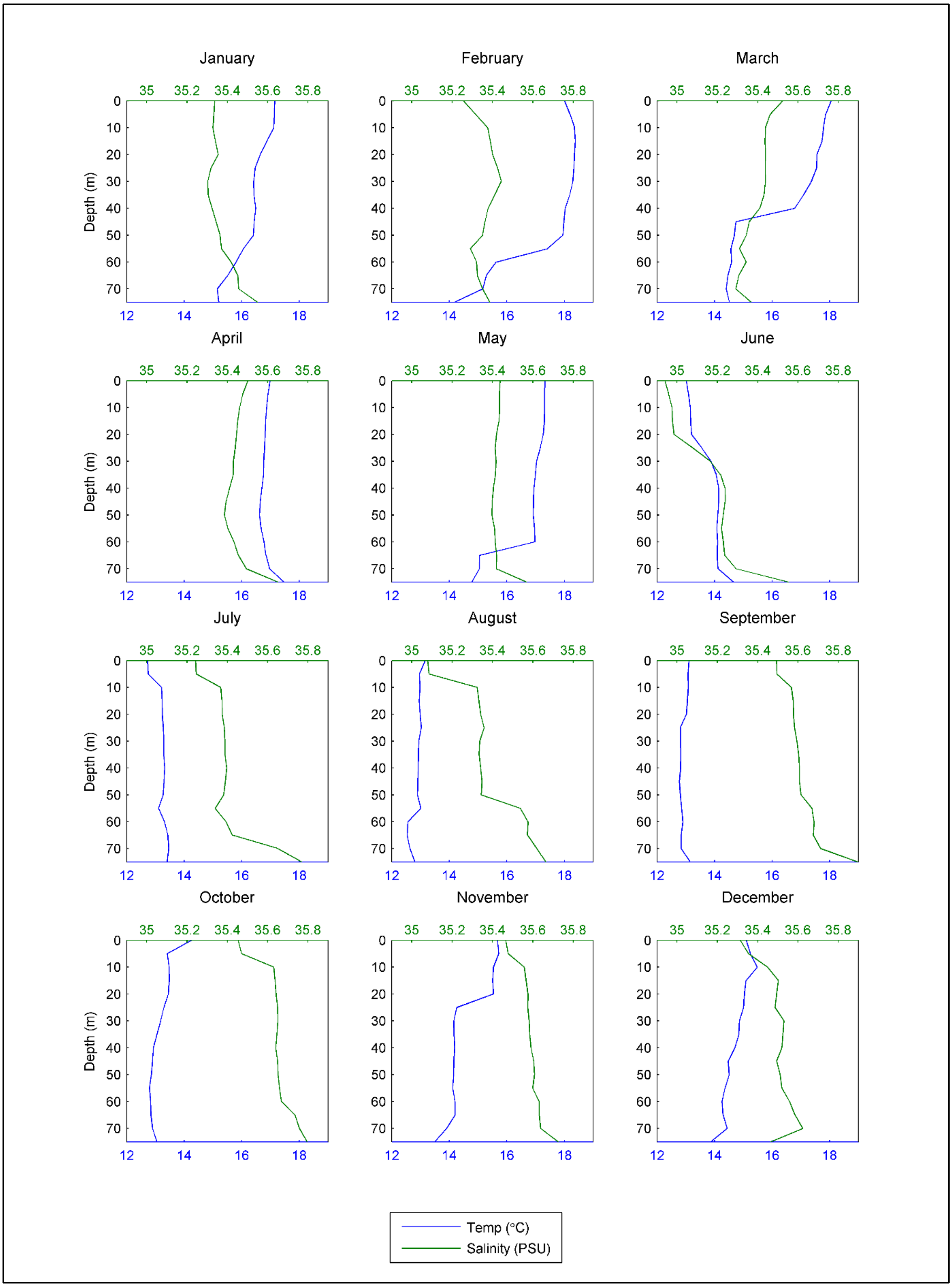


Figure 5.1 Temperature and salinity profiles nearby the release sites.

6 NEAR-FIELD SUBSEA PLUME MODELLING – OILMAP-DEEP

In the case of blowouts in relatively shallow water (<200 m), the rising column of gas and entrained water can lift oil to the surface at a substantially faster rate than would occur from the relative buoyancy of the oil alone. Near-field modelling was carried out to characterise this initial phase of the blowout release. The OILMAP-DEEP blowout model (developed by RPS) was applied to characterise the near-field behaviour of multi-phase gas-hydrocarbon plumes during their subsurface blowout phase.

Figure 6.1 illustrates the various stages of an example blowout plume. OILMAP-DEEP 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 subsurface release site and is predominately driven by the exit velocity. During this phase, the oil droplet size and distribution is 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 oil droplets.

More detail 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 releases of oil (Brandvik et al., 2013, 2014; Belore, 2014; Spaulding et al., 2015; Li et al., 2017a).

Table 6.1 presents the input parameters used in the near-field model OILMAP-DEEP. Both subsea releases are considered to be high energy releases due to the high gas volume; consequently, exit velocity is high and droplet sizes are relatively small. The maximum stable droplet size estimated using the Rayleigh-Taylor calculation (Li et al., 2017b) for the releases was 446 um and 200 μm for the blowout and pipeline respectively. This respective maximum stable droplet size was used to determine the size distribution (Delvigne & Sweeney, 1988).

Table 6.1 Location of the release site used for the dispersion modelling assessment.

Variable	Yolla blowout	Pipeline rupture
Depth (m)	80	50
Oil temperature (°C)	140	17.39
Hole diameter (inch)	7	13
Gas:Oil ratio (scf/bbl)	40,000	23,450

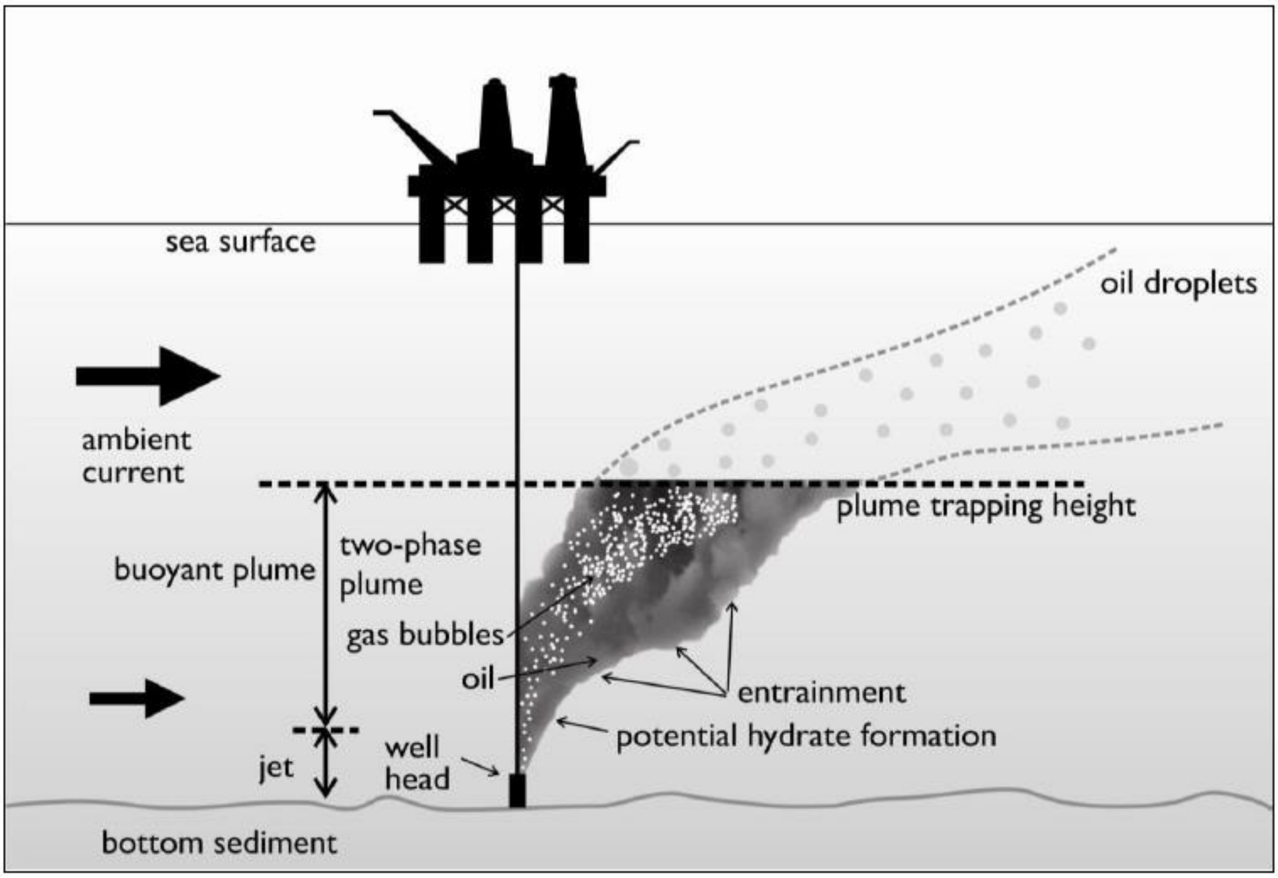


Figure 6.1 Example of a blowout plume illustrating the various stages of the plume in the water column (Source: Applied Science Associates, 2011).

7 OIL SPILL MODEL – SIMAP

Modelling of the trajectory and fate of oil was performed using the Spill Impact Mapping Analysis Program (SIMAP). SIMAP is designed to simulate the transport and weathering processes that affect the outcomes of spilled hydrocarbons for both the surface and subsurface releases, accounting for specific oil type, spill scenario, and prevailing wind and current patterns (Spaulding et al. 1994; French et al. 1999; French-McCay, 2003, 2004; French-McCay et al. 2004).

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

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

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

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

As spills can occur during any set of wind and current conditions, SIMAP's stochastic model was used to quantify the probability of exposure to the sea surface and shoreline contacts for the three oil spill scenarios over a 5-year period.

For this assessment, 100 single spills were simulated from each scenario (i.e. 300 in total). For each scenario, each simulation had the same spill information (i.e. spill volume, duration and oil type) but with varying start times, and in turn, the prevailing wind and current conditions. This approach ensures that the predicted transport and weathering of an oil slick is subject to a range of current and wind conditions.

During each spill trajectory, the model records the grid cells exposed to hydrocarbons, as well as the time elapsed. Once all the spill trajectories have been run, the results were overlaid (NOPSEMA, 2018, Figure 7.1) to determine:

- Maximum exposure (or load) observed on the sea surface;
- Minimum time before sea surface exposure;
- Probability of contact to any shorelines;
- Probability of contact to individual sections of shorelines;
- Maximum volume of oil that may contact shorelines from a single simulation; and
- Maximum load that an individual shoreline may experience.

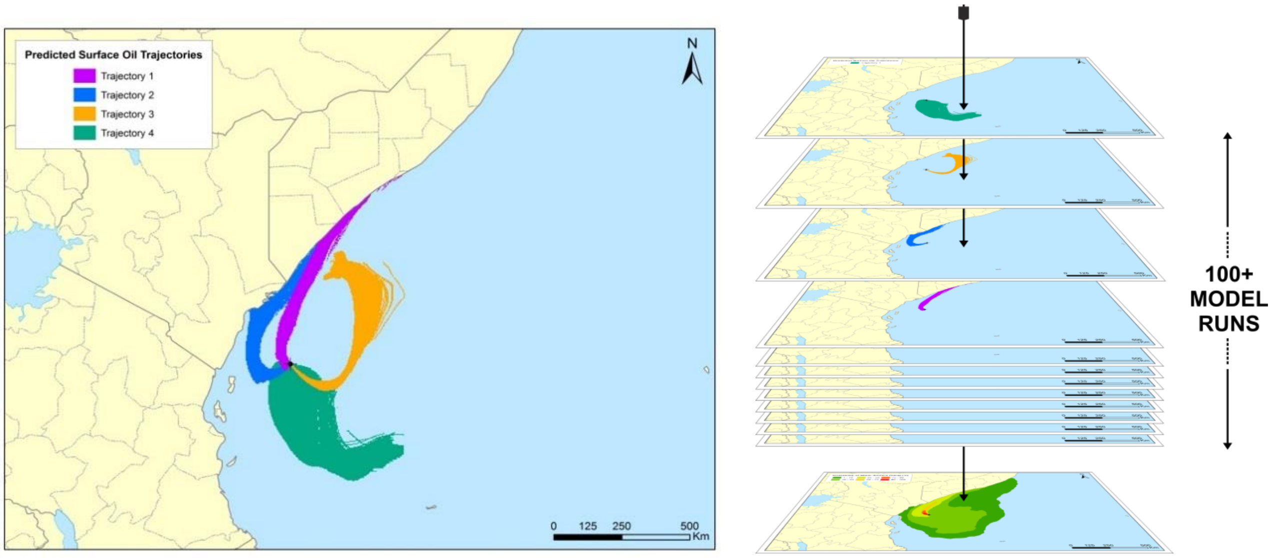


Figure 7.1 Predicted movement of four single oil spill simulations by SIMAP for the same scenario (left image). All model runs were overlain (right image) and the number of times that trajectories contact a given location at a concentration is used to calculate the probability (Source: NOPSEMA, 2018).

7.2 Sea Surface, Shoreline and In-water Thresholds

The thresholds described below for surface, shoreline, and in-water (entrained and dissolved) oil have been adopted according to low, moderate and high threshold levels, based on increasing concentrations of oiling:

Low thresholds are unlikely to affect species but would be visible and detectable by instrumentation and may trigger socioeconomic impacts, such as temporary closures of areas such as fishing grounds as a precautionary measure.

Moderate thresholds represent moderate concentrations of oil exposure/contact which are anticipated to result in behavioural changes and sub-lethal effects to biota (effects that may result in changes in reproduction or growth) and are unlikely to result in lethal effects (representing potential death of individuals) although lethality may occur if ingestion occurs.

High thresholds represent high concentrations of oil that are expected to result in sub-lethal and lethal effects to at least some species (representing potential death of individuals).

Reporting threshold values (based on the scientific literature) represent potential effects ranging from possible social and economic effects, degradation of water quality as well as possible effects on the behaviour, survival and recruitment success on biota. The changes in the state of the oil over time, in addition to a wide range of sensitivities and in turn potential effects on marine life, does not make it possible to strictly assign single specific effect thresholds. Instead, the analysis presented herein is presented for ranges of low, moderate and high threshold levels, with separate analysis for oil floating at the sea surface, stranded on shoreline, dissolved in the water column and suspended in the water column.

Moderate levels were defined based on available evidence that indicated the potential for low-level sub-lethal effects on some biota, or else evidence of reduced survival rates of sensitive species. This level can be considered a lower ecological threshold. The higher threshold was defined on the assumption that there would be more potential for reduced survivorship of less sensitive species.

Supporting justifications of the adopted thresholds applied during the study and additional context relating to the survey area are also provided in Sections 7.2.1, 7.2.2 and 7.2.3. It is important to note that the thresholds herein are based on NOPSEMA (2019).

7.2.1 Sea-surface Thresholds

In accordance with NOPSEMA (2019) the reporting of low (1-10 g/m^2), moderate (10-50 g/m^2) and high (≥ 50 g/m^2) sea surface exposure values were applied in this study (Table 7.1).

Table 7.1 Oil exposure thresholds on the sea surface used in this report (in alignment with NOPSEMA, 2019).

Threshold level	Floating oil threshold (g/m^2)	Description
Low	1	Approximates range of socioeconomic effects and establishes planning area for scientific monitoring
Moderate	10*	Approximates lower limit for harmful exposures to birds and marine mammals
High	50	Approximates surface oil slick and informs response planning

* 10 g/m^2 also used to define the threshold for actionable sea surface oil.

The lowest sea surface exposure threshold used was 1 g/m^2, which approximately equates to an average thickness of 1 µm, referred to as visible oil. Oil of this thickness is described as rainbow sheen in appearance, according to the Bonn Agreement Oil Appearance Code (Bonn Agreement 2009) (see Table 7.2). Figure 7.2 shows photographs highlighting the difference in appearance between a silvery sheen, rainbow sheen and metallic sheen. This threshold is considered below levels which would cause environmental harm and it is more indicative of the areas perceived to be affected due to its visibility on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. Table 7.2 provides a description of the appearance in relation to exposure thresholds.

Ecological impact has been estimated to occur at or above 10 g/m^2 (a film thickness of approximately 10 µm or 0.01 mm) according to French et al. (1996) and French-McCay (2009) as this level of fresh oiling has been observed to mortally impact some birds through adhesion of oil to their feathers, exposing them to secondary effects such as hypothermia. The appearance of oil at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009). Concentrations above 10 g/m^2 are also considered the lower actionable threshold, whereby 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). For this study the high exposure threshold was set to 50 g/m^2 and above based on NOPSEMA (2019).

Figure 7.2 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 7.2 The Bonn Agreement Oil Appearance Code.

Code	Description Appearance	Layer thickness interval (g/m^2 or µm)	Litres per km^2
1	*Sheen (silvery/grey)*	0.04 – 0.30	40 – 300

2	*Rainbow*	0.30 – 5.0	300 – 5,000
3	*Metallic*	5.0 – 50	5,000 – 50,000
4	*Discontinuous True Oil Colour*	50 – 200	50,000 – 200,000
5	*Continuous True Oil Colour*	200 –>	200,000 –>

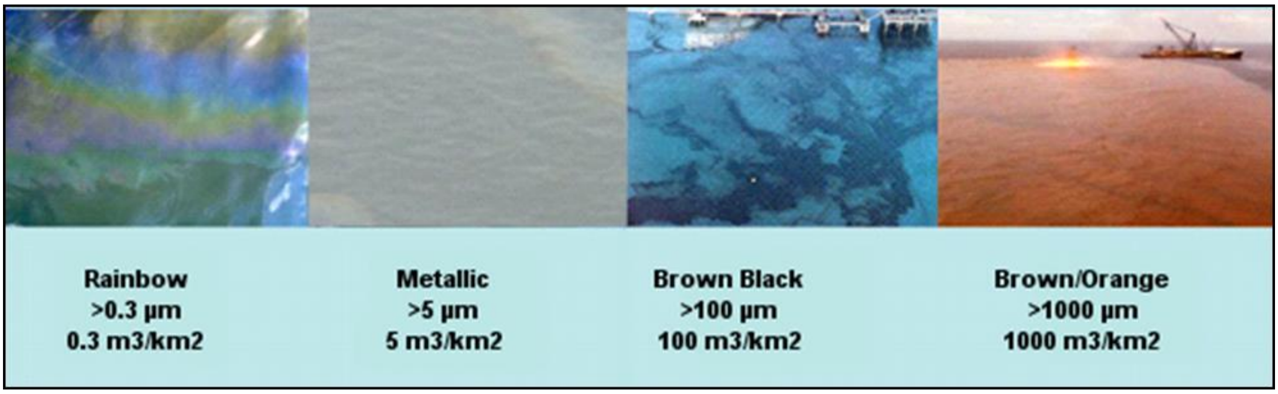


Figure 7.2 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oil SpillSolutions.org, 2015).

7.2.2 Shoreline Contact Thresholds

There are many different types of shorelines, ranging from cliffs, rocky beaches, sandy beaches, mud flats and mangroves, and each of these influence the volume of oil that can remain stranded ashore and its thickness before the shoreline saturation point occurs. For instance, a sandy beach may allow oil to percolate through the sand, thus increasing its ability to hold more oil ashore over tidal cycles and various wave actions than an equivalent area of water; hence oil can increase in thickness onshore over time. A sandy beach shoreline was assumed as the default shoreline type for the modelling herein, as it allows for the highest carrying capacity of oil (of the available open/exposed shoreline types). Hence, the results contained herein would be indicative of a worst-case scenario, where the highest volume of oil may be stranded on the shoreline (when compared to other shoreline types, such as exposed rocky shores).

The minimum thresholds for shoreline contact were 10 g/m^2 (low), 100 g/m^2 (moderate) and above 1000 g/m^2 (high). Table 7.3 shows the number of weathered oil patches per square meter on the shoreline for corresponding thresholds, if each patch was a sphere that was 1 inch in diameter.

The lower threshold (10 g/m^2) was applied as the reporting 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 contact.

French et al. (1996) and French-McCay (2009) define a shoreline oil threshold of 100 g/m^2, or above, would potentially harm shorebirds and wildlife (furbearing aquatic mammals and marine reptiles on or along the shore) based on studies for sub-lethal and lethal impacts. This threshold has been used in previous environmental risk assessment studies (see French-McCay, 2003; French-McCay et al., 2004, French-McCay et al., 2011; 2012; NOAA, 2013). Additionally, a shoreline concentration of 100 g/m^2, or above, is the minimum limit that the oil can be effectively cleaned according the AMSA (2015) guideline. This threshold equates to approximately ½ a cup of oil per square meter of shoreline contacted. 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 &

Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m^2 of oil during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing oil impacts on mangroves (Grant et al., 1993; Suprayogi & Murray, 1999). This concentration equates to approximately 1 litre or 4 ¼ cups of fresh oil per square meter of shoreline contacted. The appearance is described as an oil cover.

Table 7.3 Thresholds for oil accumulation on shorelines (in alignment with NOPSEMA, 2019).

Exposure level	Shoreline oil threshold (g/m^2)	Description
Low	10	Predicts potential for some socio-economic impact
Moderate	100*	Loading predicts area likely to require clean-up effort
High	1,000	Loading predicts area likely to require intensive clean-up effort

* 100 g/m^2 also used to define the threshold for actionable shoreline oil.

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; Mackay et al., 1992; McCarty, 1986; McCarty et al., 1992a, 1992b; 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).

Thresholds of 10, 50 or 400 ppb over a 1 hour timestep (see Table 7.4) were applied to indicate increasing potential for sub-lethal to lethal toxic effects (or low to high), based on NOPSEMA (2019).

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 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.

Exposure to entrained oil at 10 ppb 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 and 100 ppb were applied over a 1 hour time exposure (Table 7.4), to cover the range of thresholds outlined in the ANZECC (2000) water quality guidelines and recommended in NOPSEMA (2019).

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.

Table 7.4 Dissolved and entrained hydrocarbon exposure values assessed over a 1-hour time step, as per NOPSEMA (2019).

	Exposure level	In-water threshold (ppb)	Description
Disolved hydrocarbons	Low	10	Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers
	Moderate	50	Approximates potential toxic effects, particularly sublethal effects to sensitive species
	High	400	Approximates toxic effects including lethal effects to sensitive species
Entrained hydrocarbons	Low	10	Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers
	High	100	As appropriate given oil characteristics for informing risk evaluation

8 OIL PROPERTIES

8.1 Yolla Condensate

Yolla condensate has an API of 52.15, density of 770.6 kg/m^3 (at 15ºC) with low viscosity (0.14 cP) (refer to **Error! Reference source not found.**), classifying it as a Group I oil according to the International Tankers O wners Pollution Federation (ITOPF, 2014) and US EPA/US CG classifications. The condensate comprises a significant portion of volatiles and semi to low volatiles (98.55% total) with very little residual components (≤ 1.45%) (refer to Table 8.2). This means that the condensate will evaporate readily when on the water surface, with limited persistent components to remain on the water surface over time.

Figure 8.1 and Figure 8.2 display the weathering of Yolla condensate during three static wind conditions. Figure 8.1 is based on a 2,375 bbl (~378 m^3) spill of Yolla condensate released over 24 hours, tracked for 10 days, representative of the Yolla blowout scenario, while Figure 8.2 is based on a 3,144.9 bbl (~500 m^3) spill of Yolla condensate released over 57.6 minutes, tracked for 10 days, representative of the pipeline rupture scenario. Rapid evaporation occurs during the simulation (while the condensate is still releasing in the blowout scenario) under all static wind conditions. Additionally, the condensate is predicted to readily entrain into the water column under wind speeds greater than 10 knots. Due to the high volatility of the condensate, little is predicted to remain on the water surface after the spill ceases.

8.2 Marine Diesel Oil

Marine diesel oil (MDO) was used for the surface release scenario from a loss of vessel containment. Marine diesel oil has an API of 37.6, density of 829 kg/m3 (at 15 ºC) and a low viscosity of 4.0 cP at 25ºC (refer to **Error! Reference source not found.**), classifying it as a Group II oil according to the International Tankers O wners Pollution Federation (ITOPF, 2014) and US EPA/US CG classifications. Marine diesel oil is characterised by a large mixture (95%) of low and semi- to low-volatiles and contains 5% persistent hydrocarbons (refer toTable 8.2). It is important to note that some heavy components contained in marine diesel oil have a strong tendency to physically entrain into the upper water column in the presence of moderate winds (i.e. >12 knots) and breaking waves but can re-float to the surface if these energies abate.

Figure 8.3 illustrates the weathering graph of marine diesel oil under 3 static wind conditions. The graphs illustrate greater persistence of MDO on the sea surface with decreasing wind speeds, which correlates to increasing volumes of MDO occurring in the water column with increasing wind speeds. Additionally, evaporative losses over the 20 day period were greatest during the 5 knot wind conditions when the occurrence of MDO on the sea surface was greatest.

Table 8.1 Physical characteristics for the oil types used in this modelling assessment.

Characteristic	Yolla Condensate	Marine diesel oil
Density (kg/m^3)	770.6 at 15ºC	829.1 at 25ºC
API	52.15	37.60
Dynamic viscosity (cP)	0.14 at 25ºC	4.0 at 25ºC
Pour Point (ºC)	-3	-14
Oil Property Category	Group I	Group II
Oil Persistence Classification	Non-persistent oil	Light-persistent oil

Table 8.2 Boiling point ranges for the oil types used in this modelling assessment.

Characteristic	Volatiles (%)	Semi-volatiles (%)	Low volatiles (%)	Residual (%)
Boiling point (°C)	**<180**	**180 – 265**	**265 – 380**	**>380**
Yolla condensate	80.0	12.0	6.55	1.45
Marine diesel oil	6.0	34.6	54.4	5.0
		Non-persistent		*Persistent*

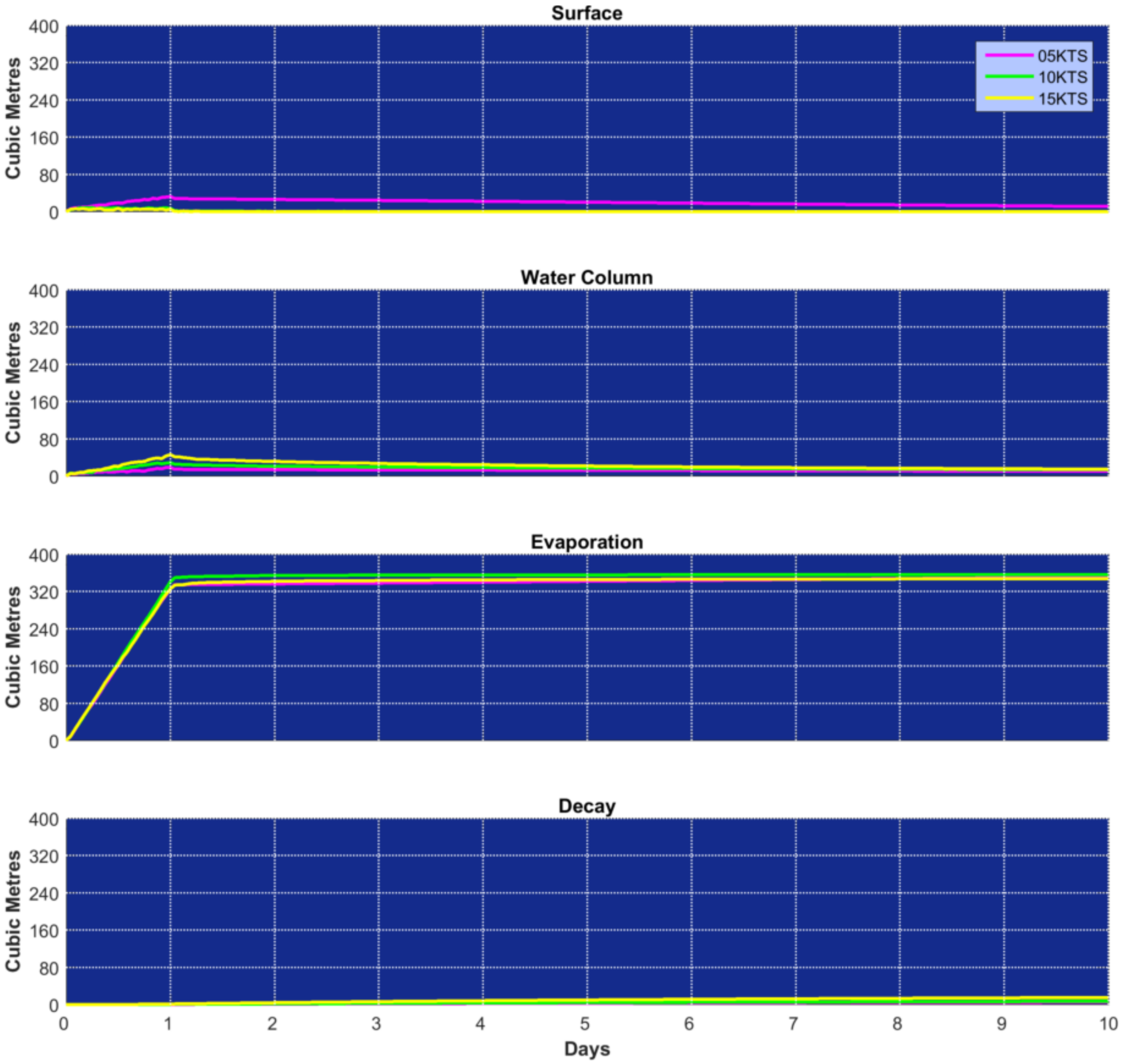


Figure 8.1 Weathering of Yolla condensate under three static wind conditions. The results are based on a 2,375 bbl (~378 m^3) spill of Yolla condensate released over 24 hours, tracked for 10 days, representative of the Yolla blowout scenario.

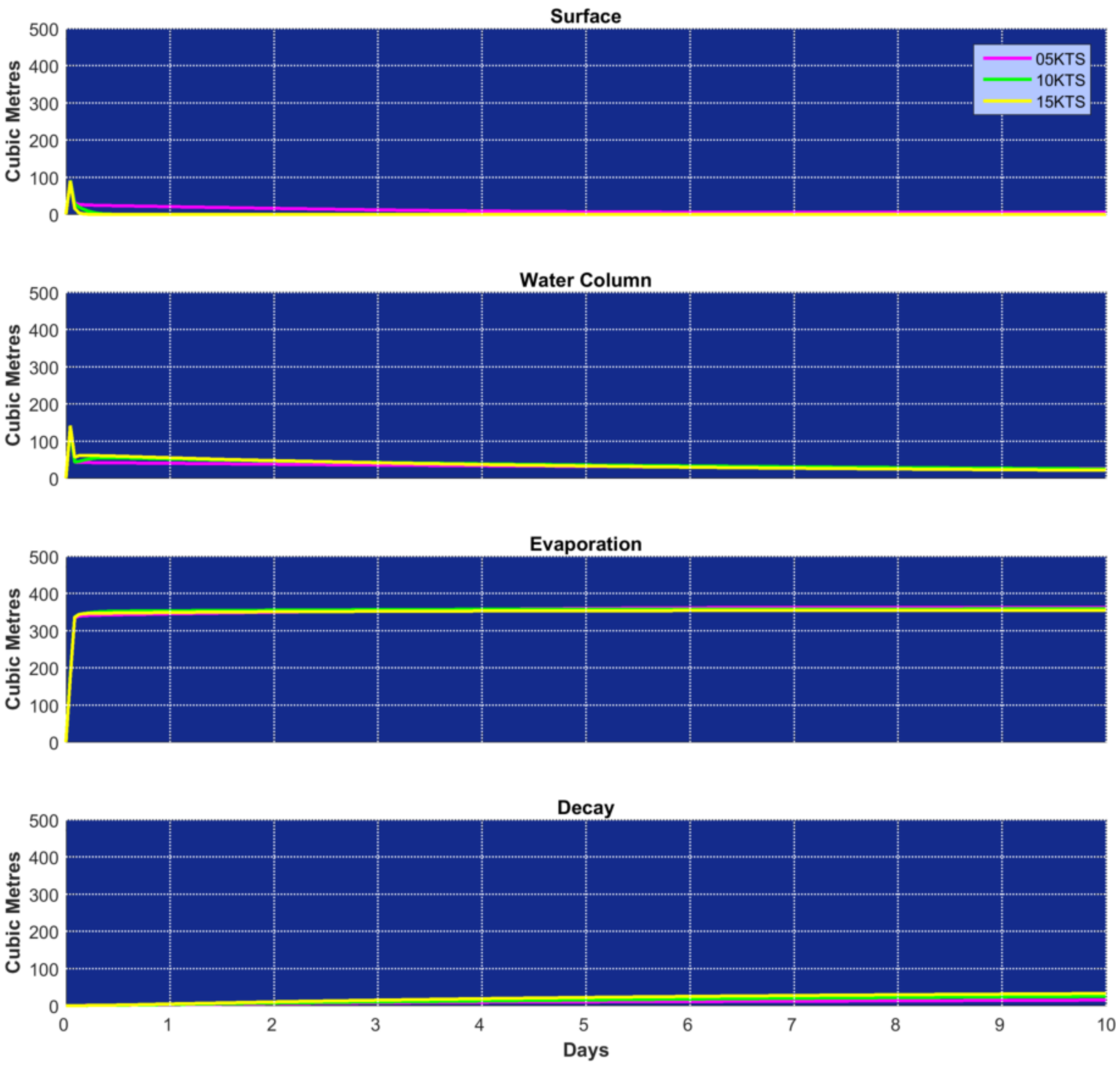


Figure 8.2 Weathering of Yolla condensate under three static wind conditions. The results are based on a 3,144.9 bbl (~500 m^3) spill of Yolla condensate released over 57.6 minutes, tracked for 10 days, representative of the pipeline rupture scenario.

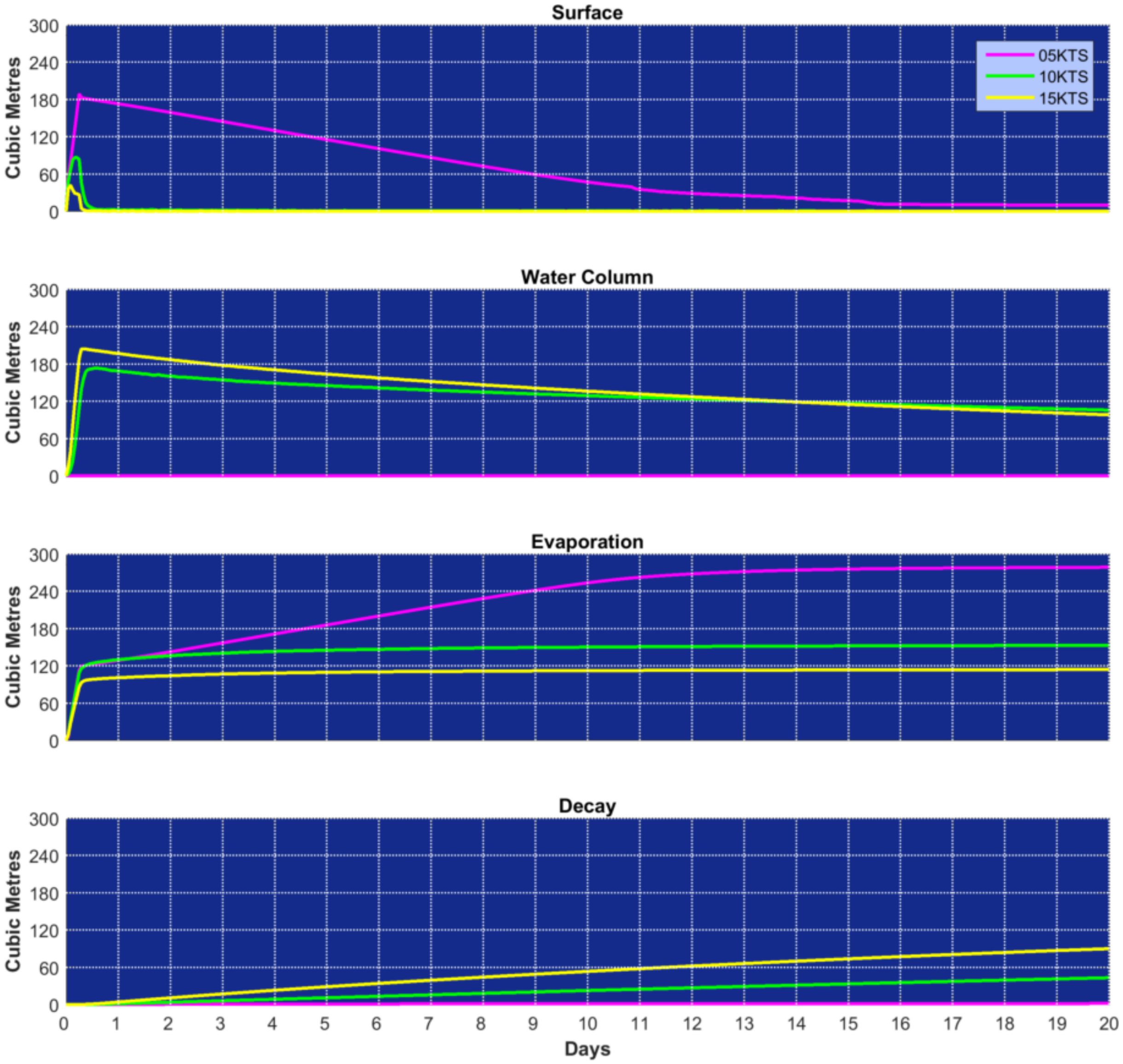


Figure 8.3 **Weathering of marine diesel oil under three static wind conditions. The results are based on a 300 m^3 spill of marine diesel oil released over 6 hours, tracked for 20 days.**

9 MODEL SETTINGS

The modelling study assessed the following spill scenarios:

- Scenario 1: 204, 250 bbl (32,472 m^3) subsea release of Yolla condensate over 86 days at the Yolla platform;
- Scenario 2: 300 m^3 surface release marine diesel oil (MDO) over 6 hours at 3 nm from the coast; and
- Scenario 3: 3,144.9 bbl (500 m^3) subsea pipeline rupture of Yolla condensate over 57.6 minutes at 3 nm from the coast.

The stochastic assessments for each scenario be completed on an annual basis.

Table 9.1 provides a summary of the oil spill model settings. The table also shows the thresholds that were used. It should be noted that concentrations above 10 g/m^2 on the sea surface (or moderate threshold) is considered the lower threshold, whereby oil may be thick enough for containment and recovery as well as surface dispersant treatment (AMSA, 2015).

Table 9.1 Summary of the oil spill model settings used in this assessment.

Parameter	Scenario 1	Scenario 2	Scenario 3
Description	Blowout	MDO release	Pipe rupture
Number of randomly selected spill start times for each scenario	100	100	100
Model period	Annual	Annual	Annual
Oil type	Yolla condensate	Marine Diesel Oil	Yolla condensate
Spill volume (m^3)	204,250 bbl (32,472 m^3)	300 m^3	3,144.9 bbl (500 m^3)
Release type	subsea	surface	subsea
Release duration	86 days	6 hours	57.6 minutes
Simulation length (days)	100	20	10
Surface oil concentration thresholds (g/m^2)	1 (low exposure) 10 (moderate exposure) 50 (high exposure)		
Shoreline load thresholds (g/m^2)	10 (low contact) 100 (moderate contact) 1,000 (high contact)		
Dissolved exposure thresholds (ppb; 1h exposure)	10 (low exposure) 50 (moderate exposure) 400 (high exposure)		
Entrained exposure thresholds (ppb; 1h exposure)	10 (low exposure) 100 (high exposure)		

10 PRESENTATION AND INTERPRETION OF MODEL RESULTS

The modelling results are presented as several tables and figures, which aim to provide an understanding of the exposure to surrounding waters and shoreline contact.

10.1 Single Spill Analysis

The stochastic results were reviewed for each scenario (see Sections **Error! Reference source not found.**, REF _Ref33517352 \r \h 11.1, 12.1, and 13.1 to identify the spill simulations that resulted in the maximum volume of oil contacting shorelines. These results are presented for each scenario in Sections 11.2, 12.2 and 13.2.

A figure illustrating the oil exposure on the sea surface (over the entire simulation length) and shoreline contact (if any) along with commentary regards the movement is presented. The corresponding weathering and fates graphs are also presented.

10.2 Stochastic Analysis

The stochastic analysis provides a summary, based on the collective behaviour of all 100 spill simulations, for each scenario assessed. Results are presented in both tabulated format in addition to contour plots.

The results are based on the following principles:

- The ***greatest distance of sea surface exposure*** - The maximum distance by the simulations from the release location to a specified exposure threshold (i.e. low, moderate or high) along with the corresponding direction of travel from the release location.

- The ***probability of oil exposure on the sea surface (or shoreline contact)*** – is calculated by dividing the number of spill simulations passing over a given model grid cell (above the low exposure threshold) by 100 spill simulations per season. For example, a cell with a probability of 21%, indicates that of the 100 individual spill simulations, 21 passed over that model grid cell equal to or above the low exposure threshold.

- The ***minimum time before oil exposure on the sea surface (or shoreline contact)*** – is determined by ordering the length of time (generally in days) from the start of the spill before sea surface exposure to a given location/grid cell (above the low exposure threshold) for the 100 spill simulations/season. The minimum time from all 100 single spill simulations calculated is presented within each grid cell.

- The ***potential zones of sea surface exposure*** – is presented based on the highest predicted threshold of exposure (i.e. low exposure: rainbow to metallic sheen; moderate exposure: metallic sheen and high exposure: metallic sheen to continuous true oil colour) for any given grid cell based on the 100 spill simulations per season.

- The ***average volume of oil ashore for a single spill*** – is determined by calculating the average of the summed predicted oil ashore along all shoreline grid cells for each of the single spill simulations, which were predicted to make shoreline contact.

- The ***maximum volume of oil ashore from a spill simulation*** – is determined by summing the predicted oil ashore along all shoreline grid cells for the 100 spill simulations, with the maximum volume being presented.

- The ***maximum potential oil loading on shorelines*** – is determined by identifying the maximum loading (concentration) for shoreline contact predicted for any given location/grid cell above each of the three contact thresholds (i.e. low contact: stain/film; moderate contact: coat and high contact: cover) for the 100 spill simulations per season, with the maximum loading being presented.

- The ***average length of shoreline contacted by oil*** – above a given threshold – is determined by calculating the average of the length of shoreline (measured as grid cells) contacted by oil above each of the three contact thresholds (i.e. low contact: stain/film; moderate contact: coat and high contact: cover) for the 100 spill simulations, which were predicted to make shoreline contact.
- The ***maximum length of shoreline contacted by oil above a given threshold*** – is calculated by summing the length of shoreline (measured as grid cells) contacted by oil above each of the three contact thresholds (i.e. low contact: stain/film; moderate contact: coat and high contact: cover) for each of the spill simulations, which were predicted to make shoreline contact, with the maximum shoreline length being presented.
- The ***instantaneous dissolved and entrained hydrocarbon exposure*** – reporting of the highest concentration in each grid cell.

10.2.1 Receptors Assessed

A range of environmental receptors and shorelines were assessed for sea surface exposure, shoreline contact and water column exposure as part of the study (see Table 10.1). The receptors are geographically represented in Figure 10.1 to Figure 10.13. Multiple receptors were excluded from tabulated results (see Table 10.2) due to the release locations residing within their boundaries which resulted in these receptors recording 100% probabilities of exposure for sea surface and water column assessments.

Note, due to the volume and geographical extent of Biologically Important Areas (BIAs) predicted to receive potential impacts from spilled hydrocarbon, it is recommended to use the following website to obtain detailed maps on all BIAs assessed: http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf.

Table 10.1 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/Marine Park	NP & MP	✓	✓	✗
Conservation Area, Nature Reserve, Marine Sanctuary	CA, NR, MS	✓	✓	✗
Integrated Marine and Coastal Regionalisation of Australia	IMCRA	✓	✓	✗
Interim Biogeographic Regionalisation of Australia	IBRA	✓	✓	✗
Key Ecological Feature	KEF	✓	✓	✗
Reefs, Shoals and Banks	RSB	✓	✓	✗
Ramsar Sites	Ramsar	✓	✓	✗
State Waters	State Waters	✓	✓	✗
Sub Local Government Areas	Sub-LGA	✓	✓	✗
Shoreline	Shore & Nearshore	✓ (Reported as: Nearshore)	✓ (Reported as: Nearshore)	✓ (Reported as: Shore)

Biologically Important Areas	BIA	✓	✓	✗

Table 10.2 Summary of receptors excluded from analysis due to release locations residing within their boundaries. A cross represents exclusion from tabulated results while a tick symbolizes inclusion of the receptor for the corresponding scenario.

Receptor Category	Acronym	Scenario		
		1	2	3
Australian Exclusive Economic Zone	EEZ	✗	✗	✗
Black-browed Albatross - Foraging	BIA	✗	✗	✗
Campbell Albatross – Foraging		✗	✗	✗
Common Diving Petrel - Foraging		✗	✗	✗
Indian Yellow-nosed Albatross – Foraging		✗	✗	✗
Pygmy Blue Whale - Distribution		✗	✗	✗
Short-tailed Shearwater - Foraging		✗	✗	✗
Shy Albatross - Foraging		✗	✗	✗
Southern Right Whale - Migration		✗	✗	✗
Wandering Albatross - Foraging		✗	✗	✗
White Shark - Distribution		✗	✗	✗
White-faced Storm-petrel - Foraging		✗	✗	✗
Central Victoria	IMCRA	✓	✗	✗
Central Bass Strait		✗	✓	✓
Victoria State Waters	State Waters	✓	✗	✗

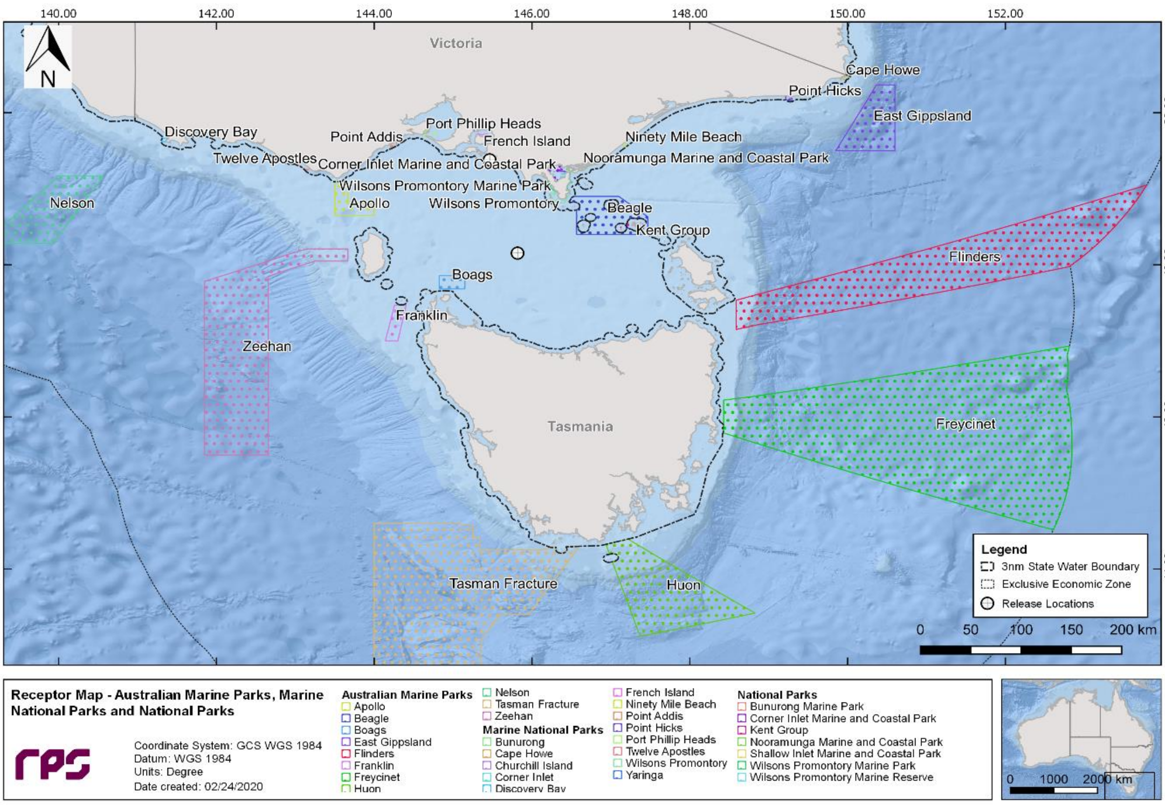


Figure 10.1 Receptor map for Australian Marine Parks (AMP), Marine National Parks (MNP) and National Parks (NP).

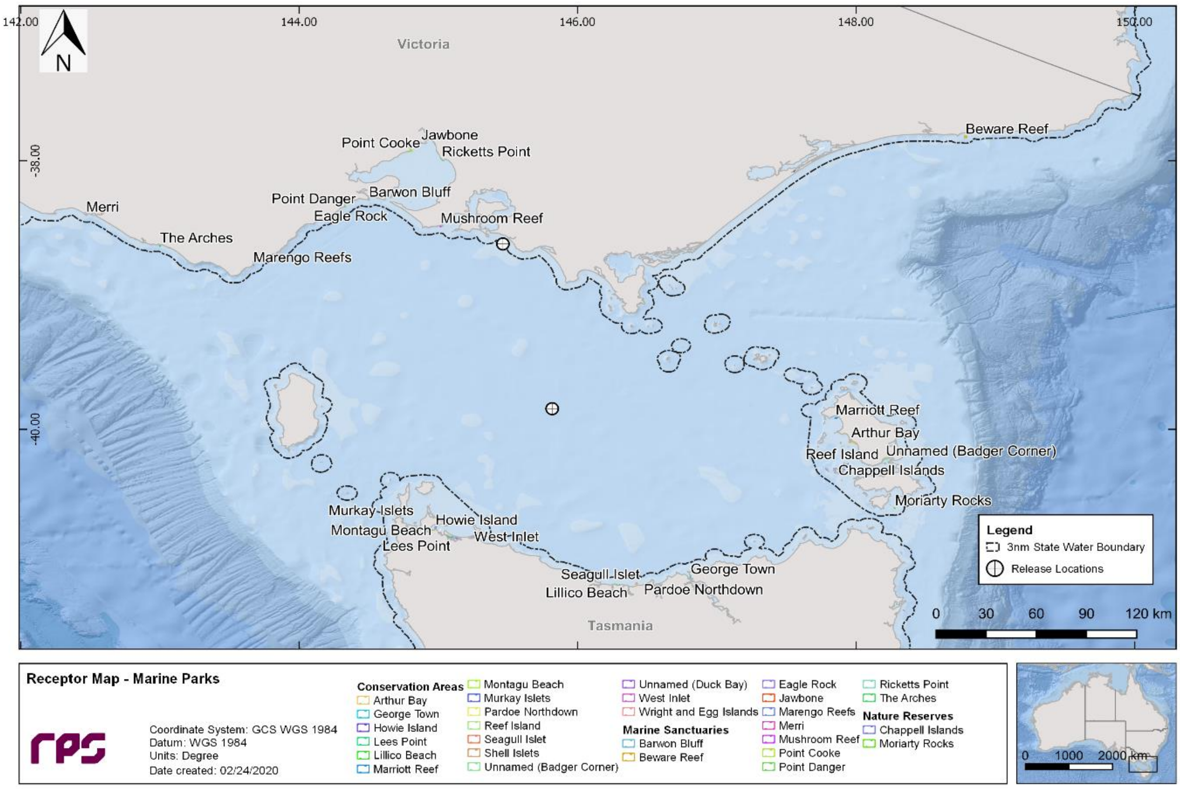


Figure 10.2 Receptor map for Conservation Areas (CA), Marine Sanctuaries (MS) and Nature Reserves (NR).

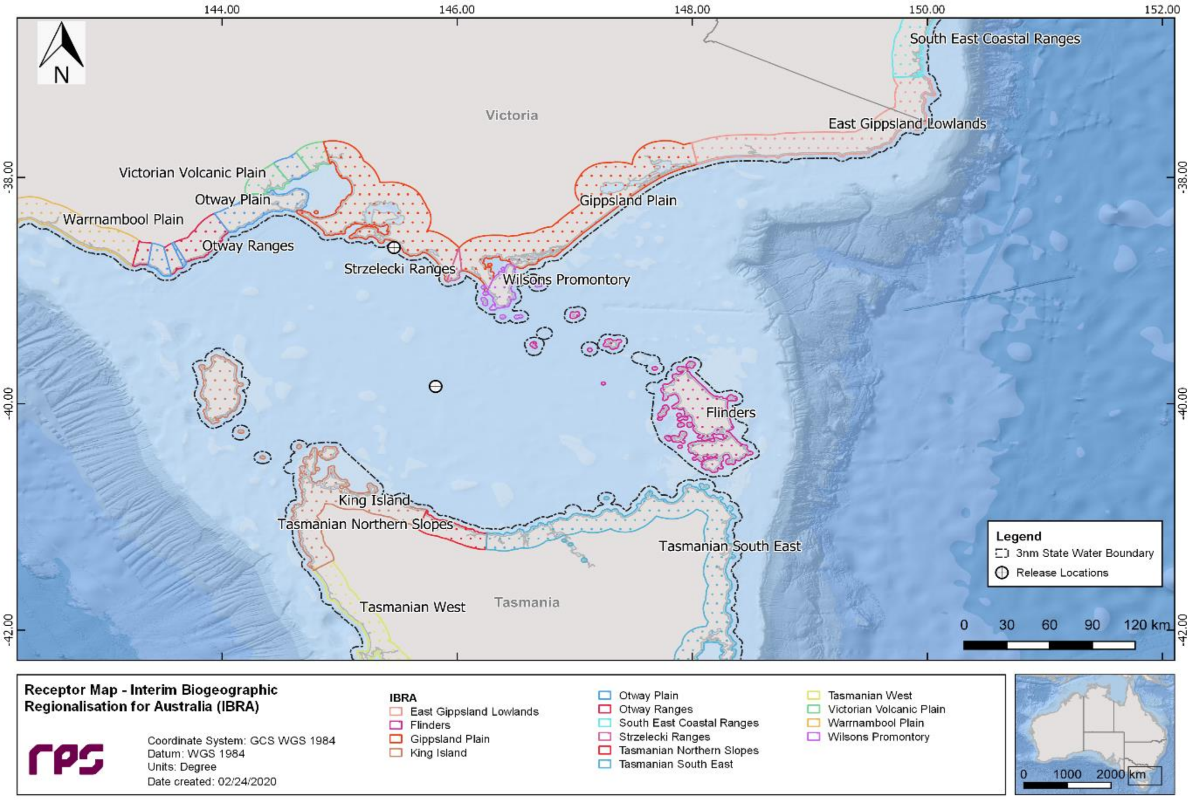


Figure 10.3 Receptor map for Interim Biogeographic Regionalisation for Australia (IBRA).

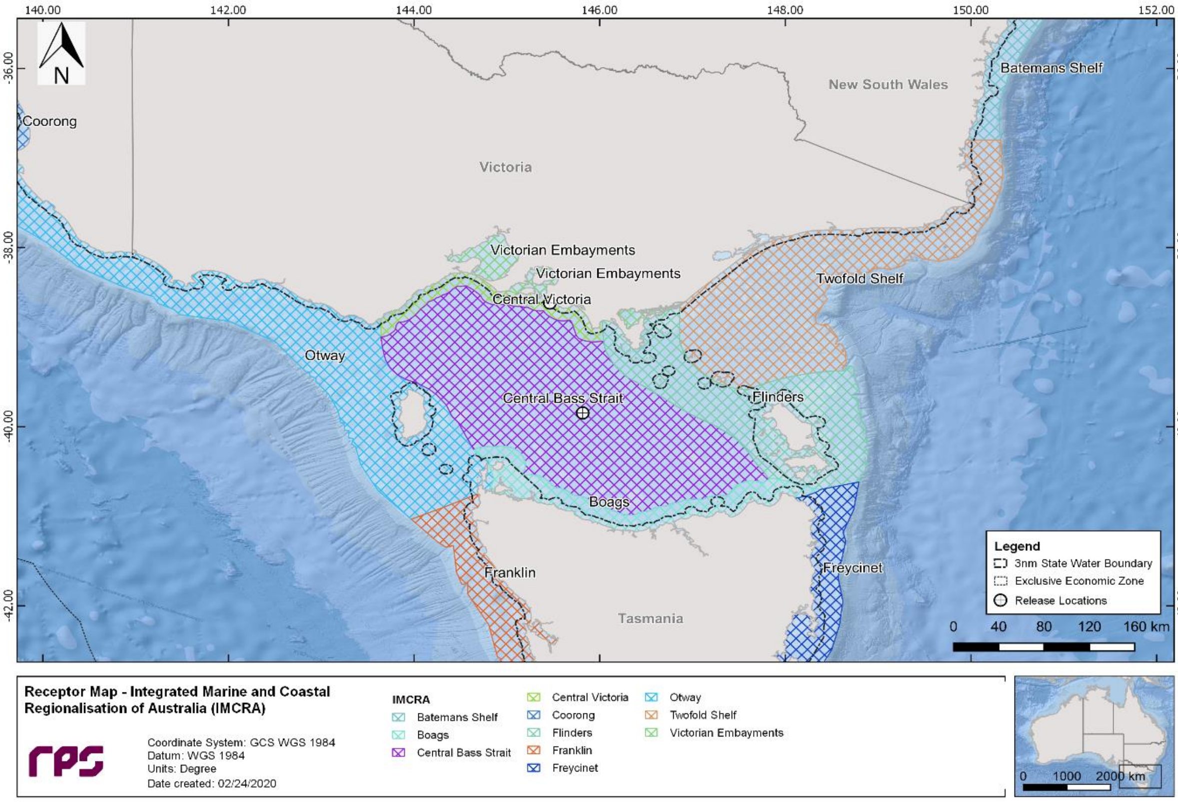


Figure 10.4 Receptor map for Integrated Marine and Coastal Regionalisation of Australia (IMCRA).

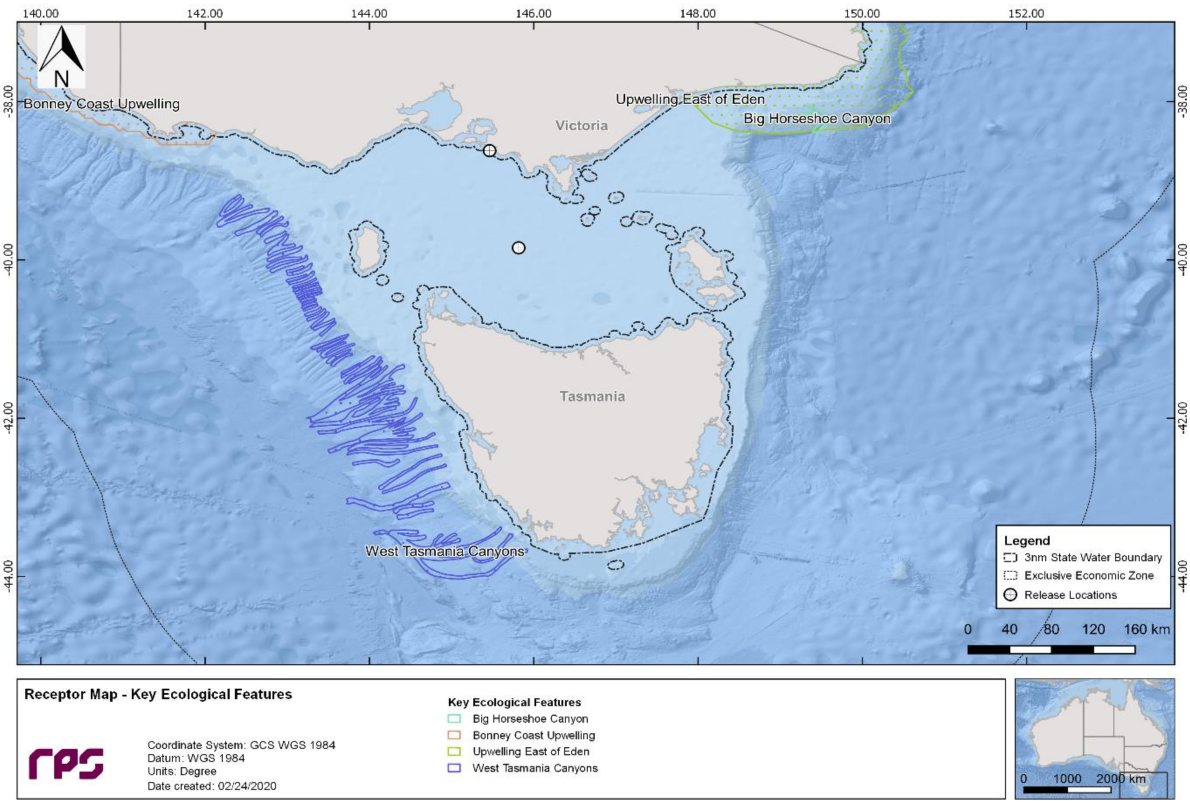


Figure 10.5 Receptor map for Key Ecological Features (KEF).

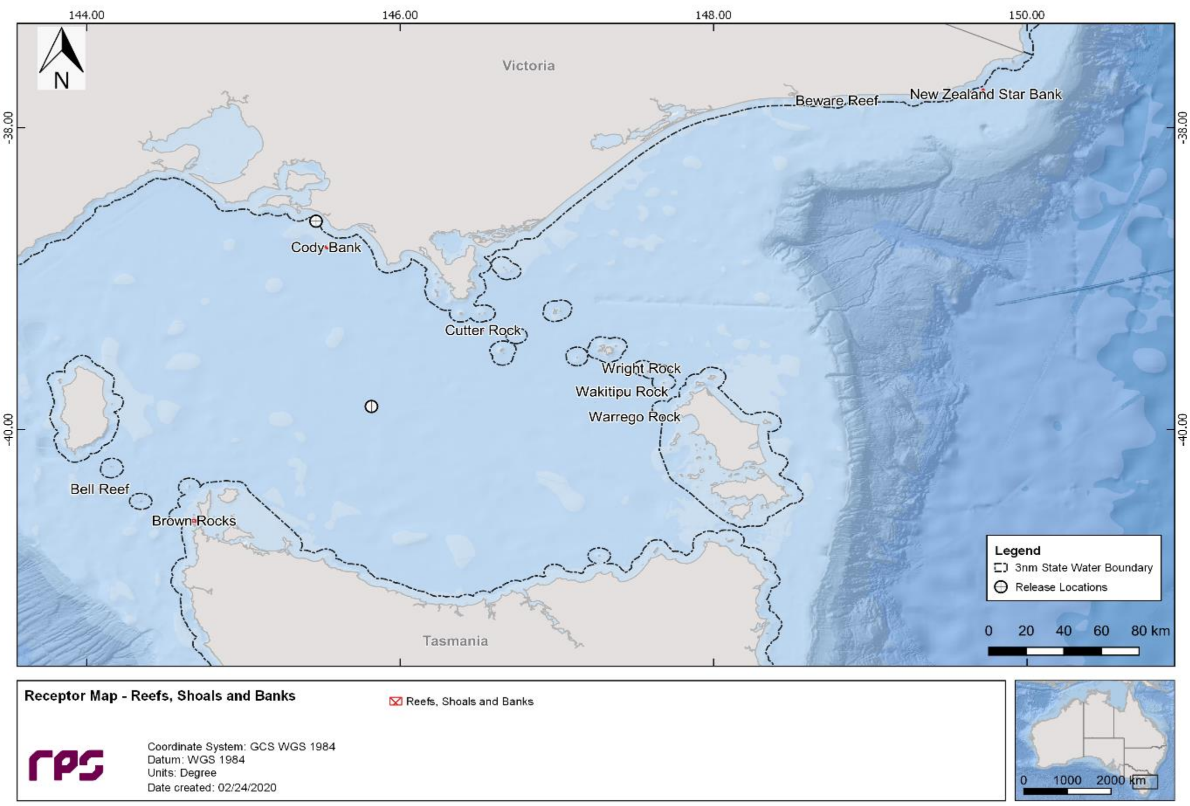


Figure 10.6 Receptor map for Reefs, Shoals and Banks (RSB).

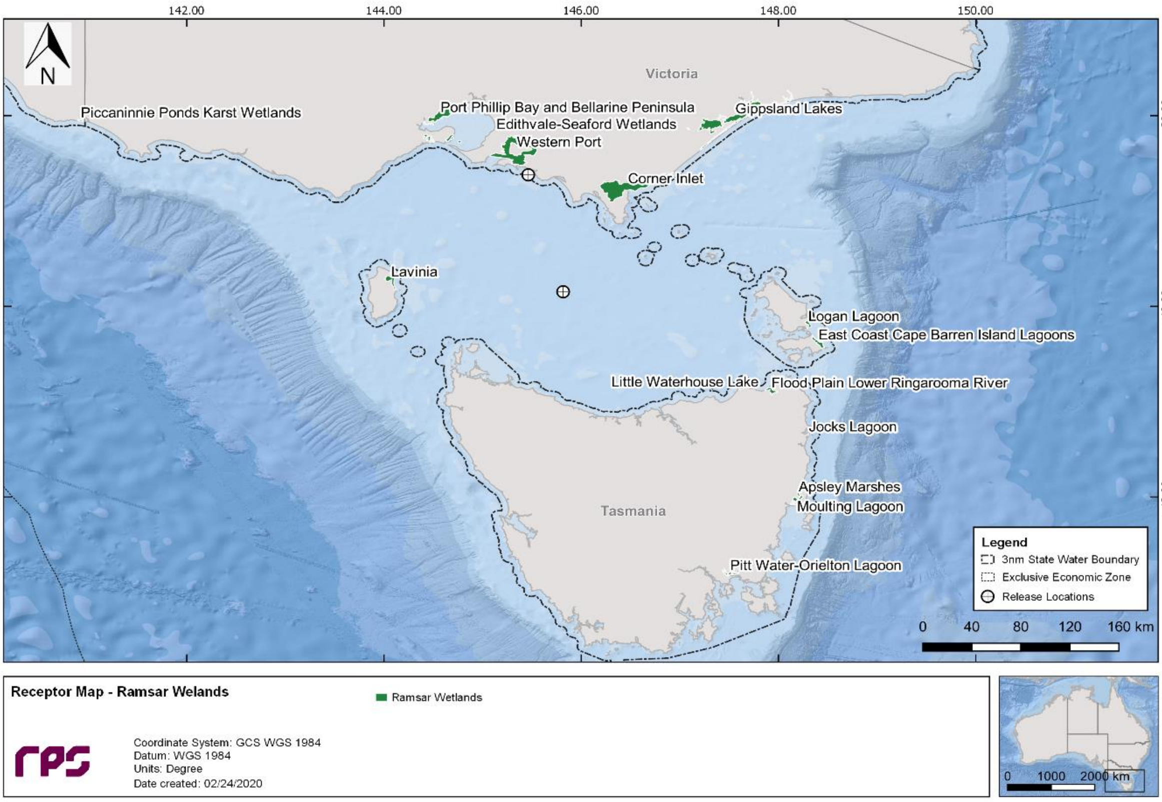


Figure 10.7 Receptor map for Ramsar sites.

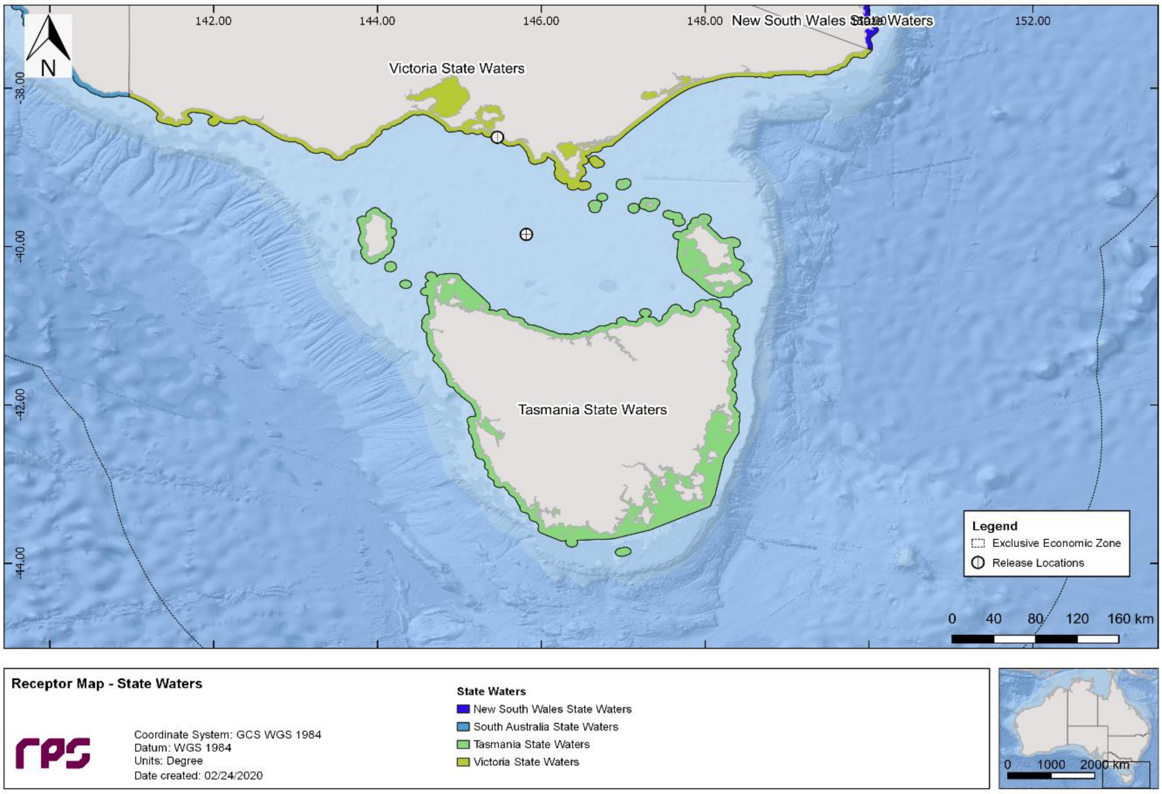


Figure 10.8 Receptor map for State Waters.

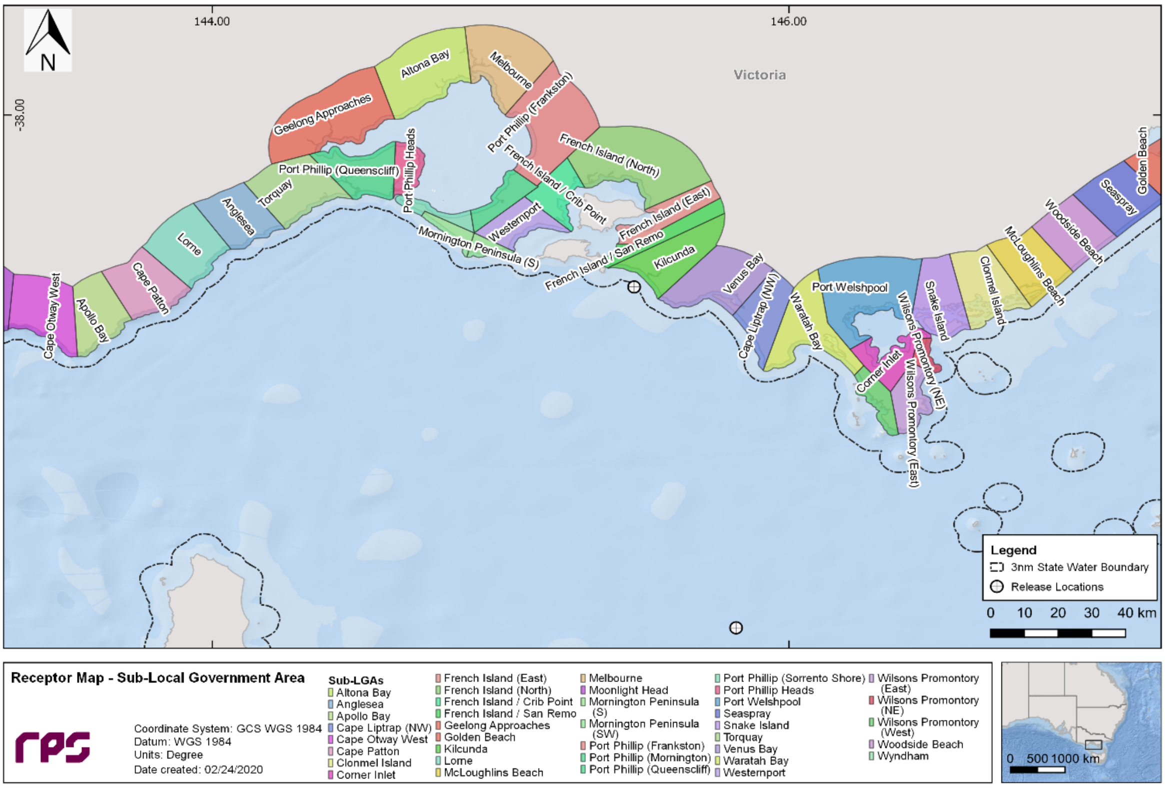


Figure 10.9 Receptor map for Sub Local Government Areas (Sub-LGA) (1 of 2).

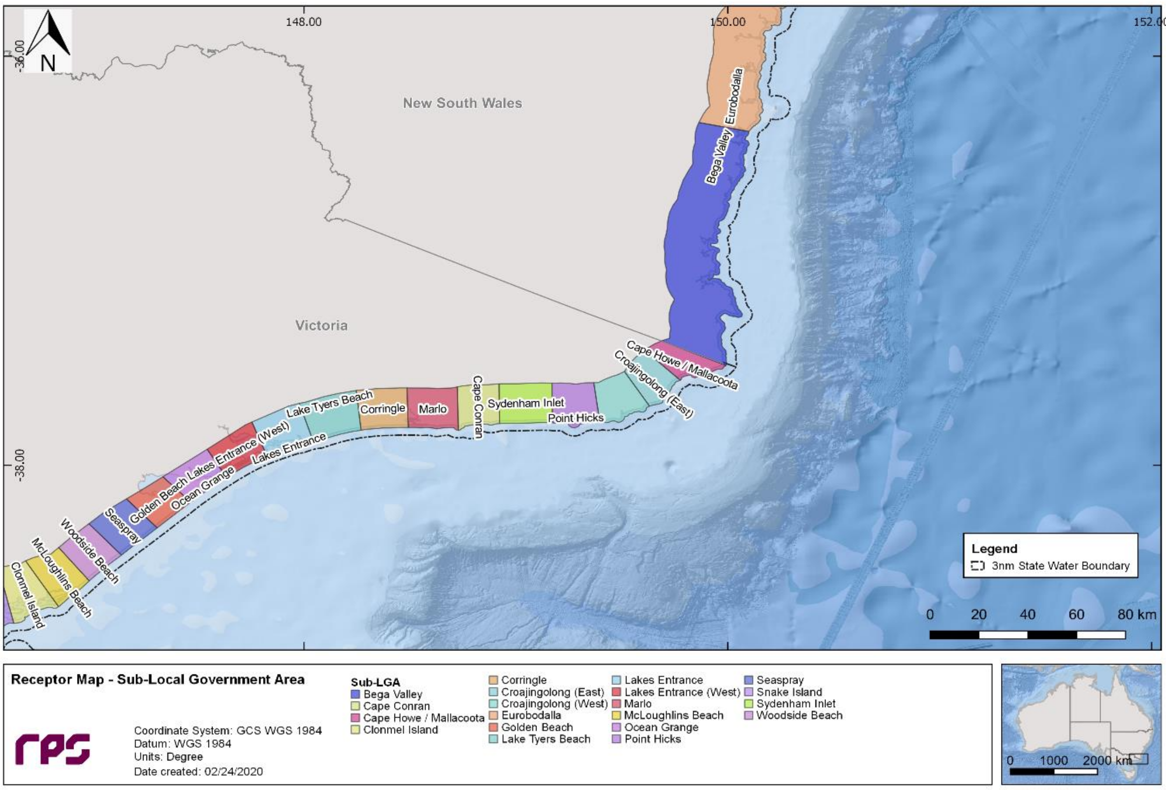


Figure 10.10 Receptor map for Sub Local Government Areas (Sub-LGA) (2 of 2).

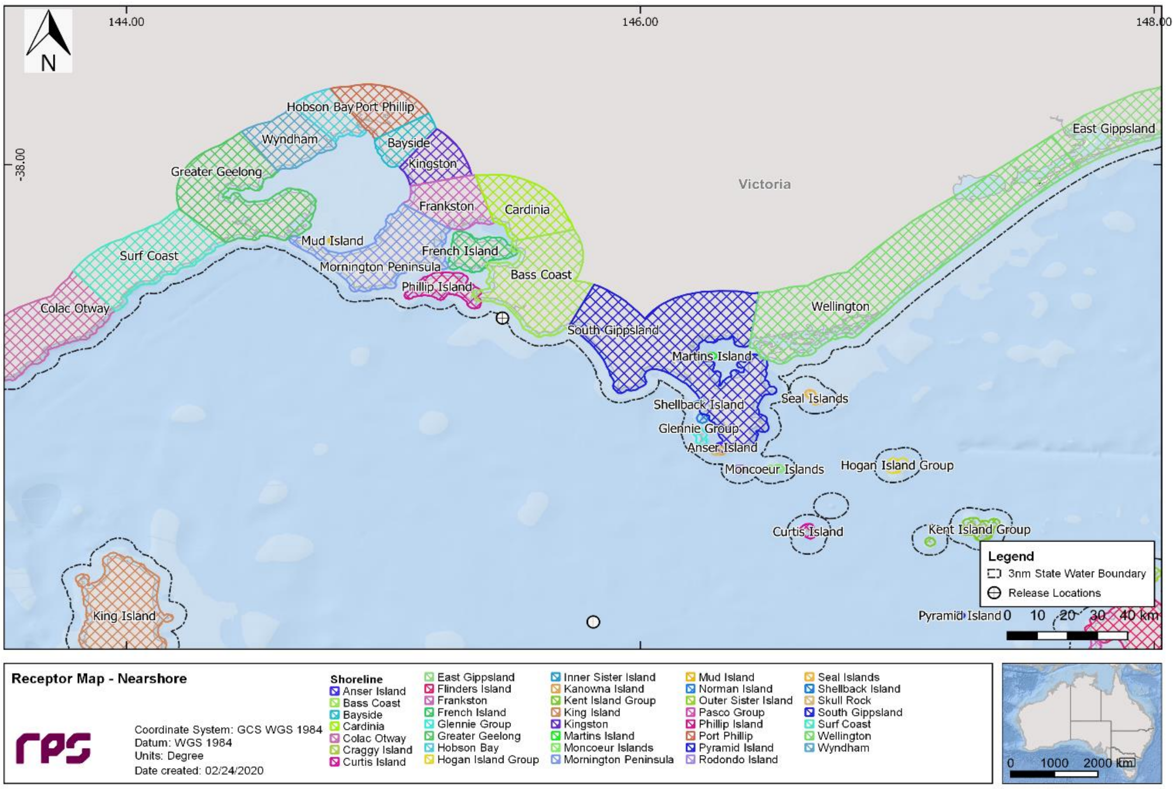


Figure 10.11 Receptor map for Nearshore Waters (1 of 2).

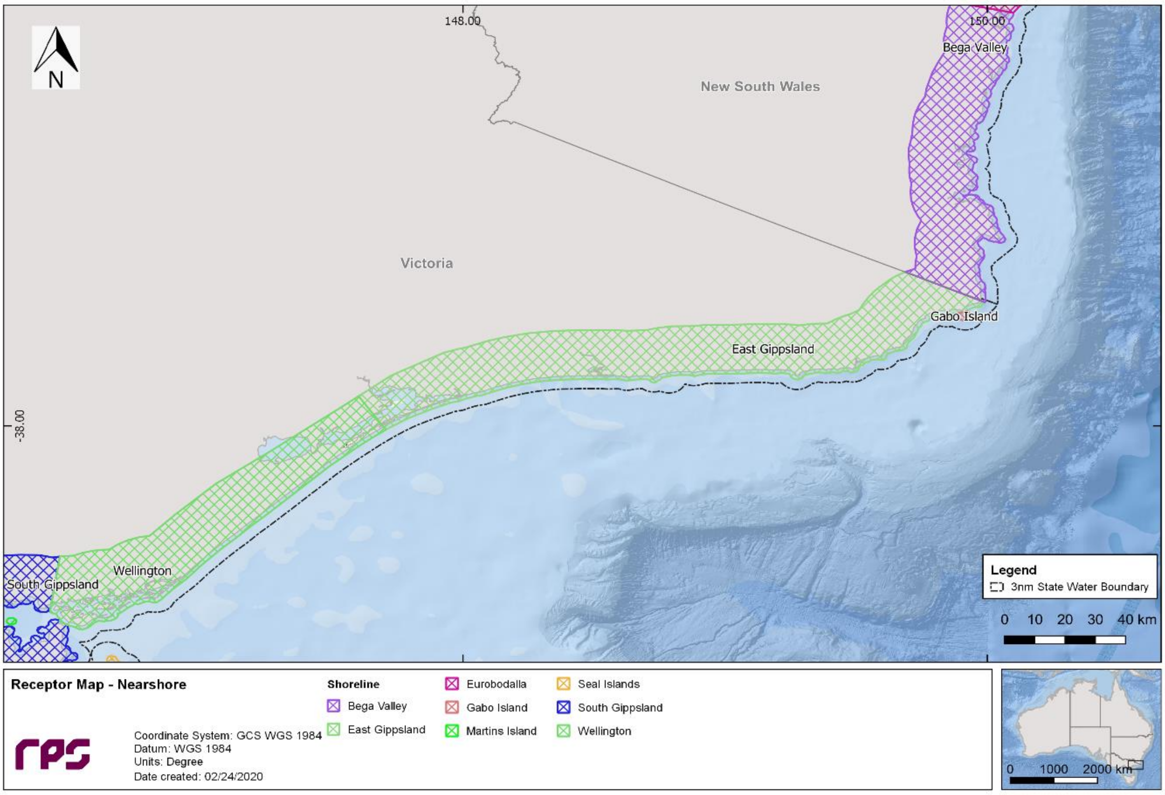


Figure 10.12 Receptor map for Nearshore Waters (2 of 2).

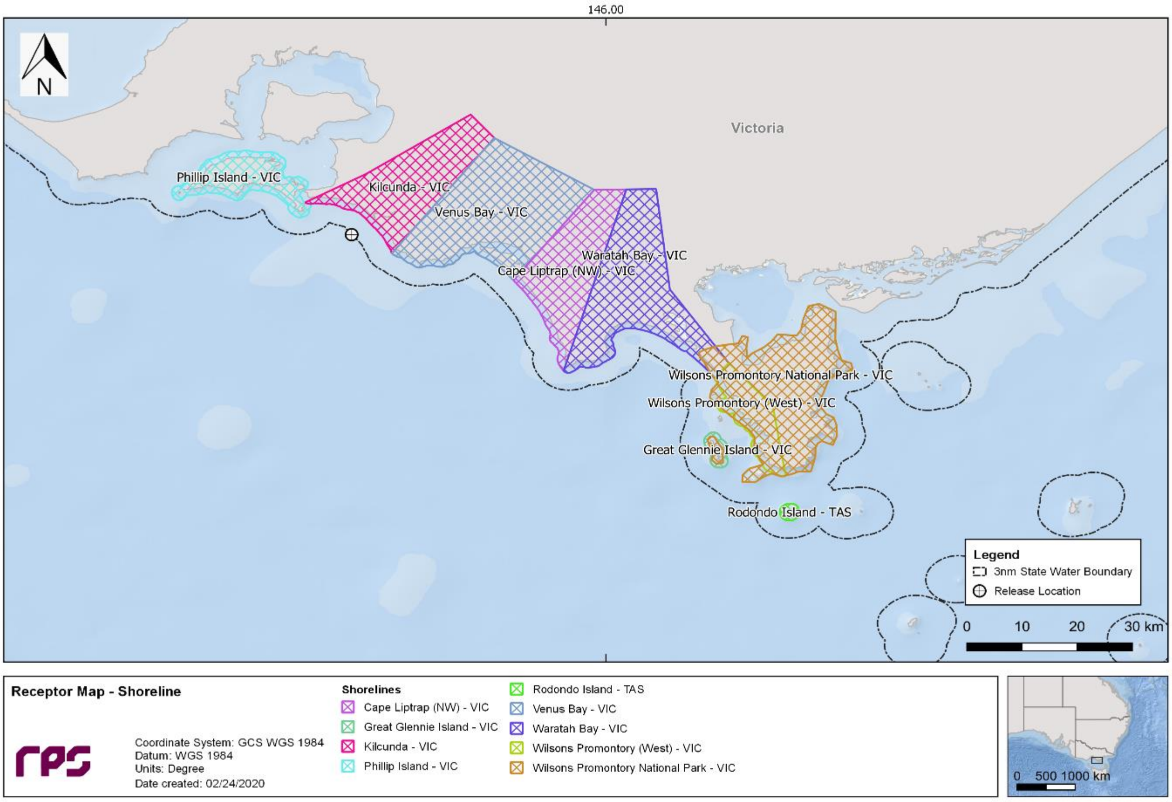


Figure 10.13 Receptor map for Shorelines.

11 RESULTS – SCENARIO 1: 204,250 BBL SUBSEA BLOWOUT OF YOLLA CONDENSATE OVER 86 DAYS

This scenario examined an 86-day subsea release of 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) of Yolla condensate following a well blowout incident at the Yolla platform, tracked for a period of 100 days. A total of 100 spill trajectories were simulated on an annual basis.

The stochastic results were reviewed (Section11.1) and a deterministic analysis was undertaken (see Section 11.2).

11.1 Stochastic Analysis

Section 11.1.1 presents the potential exposure to the sea surface and shoreline contact. Additionally, Section 11.1.2 presents the potential in-water exposure.

For the modelling study each spill trajectory was tracked to the following minimum thresholds:

- Visible sea surface oil – 1 g/m^2
- Shoreline oil contact – 10 g/m^2
- Dissolved hydrocarbons – 10 ppb
- Entrained hydrocarbons – 10 ppb

11.1.1 Sea Surface Exposure and Shoreline Contact

Table 11.1 details the maximum distance travelled by oil on the sea surface at each threshold. No moderate (10-50 g/m^2) or high (≥ 50 g/m^2) zones of potential oil exposure were predicted. Low levels of potential exposure (1-10 g/m^2) were centred around the release site with low exposure surface oil predicted to extend a maximum distance of 17.3 km (south-southeast) from the release location.

Figure 11.1 presents the zones of potential oil exposure on the sea surface for the annual modelling assessment.

It should be noted that multiple receptors were predicted to be impacted by sea surface oil at the low threshold however, these are not presented in tabularised form as the release location resides within each receptor's boundaries (i.e. all receptors recorded a 100% probability of exposure). Please refer to Table 10.2 for the list of receptors.

No shoreline contact was predicted under the annual conditions modelled.

Table 11.1 Potential zones of oil exposure on the sea surface, at each threshold. Results are based on a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories.

Distance and direction travelled	Zones of potential sea surface exposure		
	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (≥50 g/m^2)
Maximum distance (km) from the release location	17.3	-	-
Maximum distance from release site (km) (99th percentile)	16.2	-	-
Direction	South-southeast	-	-

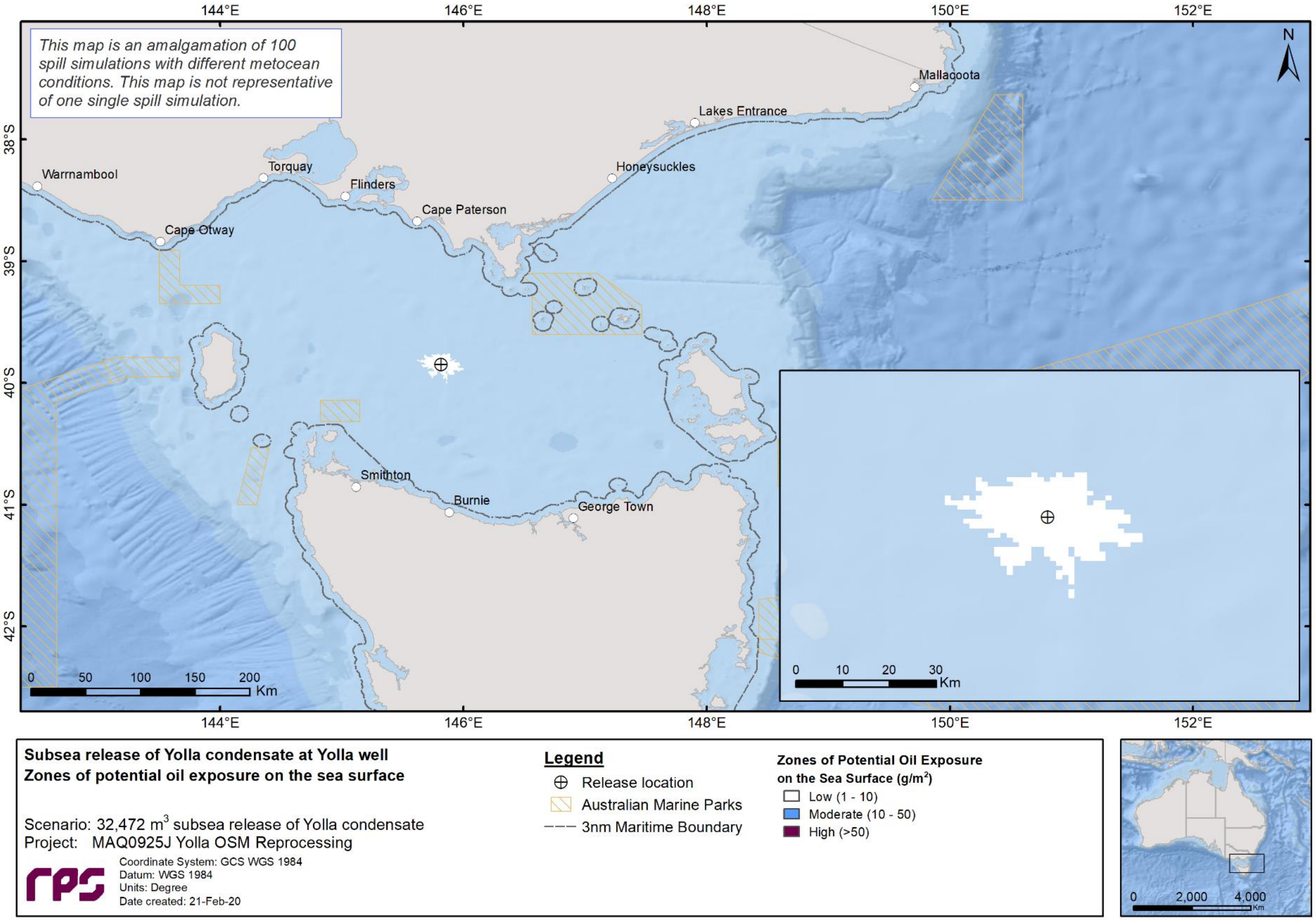


Figure 11.1 Zones of potential oil exposure on the sea surface, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

11.1.2 In-water exposure

11.1.2.1 Dissolved Hydrocarbons

Table 11.2 summarises the maximum distance and direction from the release location to dissolved hydrocarbons in the 0-10 m depth layer at the low (10-50 ppb), moderate (50-400 ppb) and high (≥ 400 ppb) exposure levels (NOPSEMA, 2019). The maximum distance of dissolved hydrocarbons at the low and moderate thresholds from the release location was predicted as 223 km (east-northeast) and 65 km (east-southeast), respectively. No dissolved hydrocarbon exposure was predicted at, or above, the high threshold.

Table 11.3 summarises the probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m and 10-20 m depth layer for the annualised assessment.

In the surface layer (0-10 m), the Flinders IMCRA recorded the highest probability of low dissolved hydrocarbon exposure with 10%. Additionally, the White Shark – Foraging BIA and Boags AMP recorded a 7% and 6% probability of low dissolved hydrocarbon exposure, respectively. Dissolved hydrocarbons at the moderate threshold were only predicted at excluded receptors (see Table 10.2) while no dissolved hydrocarbons were predicted at or above the high exposure threshold.

In the 10-20 m depth layer, both the Flinders IMCRA and the White Shark – Foraging BIA recorded the highest probability of low dissolved hydrocarbon exposure with 2%. No dissolved hydrocarbon exposure was predicted at or above the moderate threshold for this scenario below a depth of 10 m.

Figure 11.2 and Figure 11.3 presents the zones of potential dissolved hydrocarbon exposure for the 0-10 m and 10-20 m depth layers at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels.

Figure 11.4 presents the potential zones of dissolved hydrocarbon exposure in the benthic layer for the annual assessment at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels.

Figure 11.5 to Figure 11.8 depict potential zones of dissolved hydrocarbon exposure through the water column along transects oriented along cardinal directions for the annual assessment.

Figure 11.9 to Figure 11.12 also present the potential zones of dissolved aromatic exposure along transects but for a single trajectory, rather than the annual results which are a composite of 100 runs. These images illustrate the potential impact for the spill trajectory that affected the largest volume of water at the low exposure level (10-50 ppb).

Table 11.2 Maximum distance and direction from the release location to dissolved hydrocarbon exposure (0–10m). Results are based on the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill simulations per season.

Distance and direction travelled	Zones of potential dissolved hydrocarbon exposure		
	Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb
Maximum distance (km) from the release location	223	65	-
Direction	East-northeast	East-southeast	-

Table 11.3 Probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m and 10–20 m depth layers. Results are based on the event of a 204,250 bbl (2,375 bbl/d; 32,472 m³ total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories per season.

Receptor		0 - 10 m				10 - 20 m			
		Maximum instantaneous dissolved hydrocarbon exposure	Probability of instantaneous hydrocarbon exposure			Maximum instantaneous dissolved hydrocarbon exposure	Probability of instantaneous dissolved hydrocarbon exposure		
			Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb		Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb
AMP	Beagle	29.89	4	-	-	19.26	1	-	-
	Boags	41.42	6	-	-	11.76	1	-	-
	Franklin	14.73	1	-	-	6.81	-	-	-
BIA	Antipodean Albatross - Foraging	14.73	1	-	-	11.42	1	-	-
	Australasian Gannet - Foraging	17.53	2	-	-	9.73	-	-	-
	Little Penguin - Foraging	20.68	3	-	-	11.72	1	-	-
	White Shark - Foraging	29.89	7	-	-	20.68	2	-	-
IBRA	Flinders	23.97	4	-	-	10.64	1	-	-
	King Island	14.63	1	-	-	7.27	-	-	-
IMCRA	Boags	21.63	3	-	-	11.26	1	-	-
	Flinders	43.79	10	-	-	20.68	2	-	-
	Franklin	11.43	1	-	-	6.34	-	-	-
	Otway	20.68	2	-	-	9.73	-	-	-
	Twofold Shelf	23.97	4	-	-	19.26	1	-	-
NP	Kent Group	23.97	4	-	-	14.44	1	-	-
Nearshore	Albatross Island	12.92	1	-	-	7.27	-	-	-
	Curtis Island	14.86	1	-	-	10.64	1	-	-
	Hunter Island	14.63	1	-	-	1.62	-	-	-
	Kent Island Group	23.97	4	-	-	10.50	1	-	-
State Waters	Tasmania State Waters	24.71	4	-	-	16.18	1	-	-

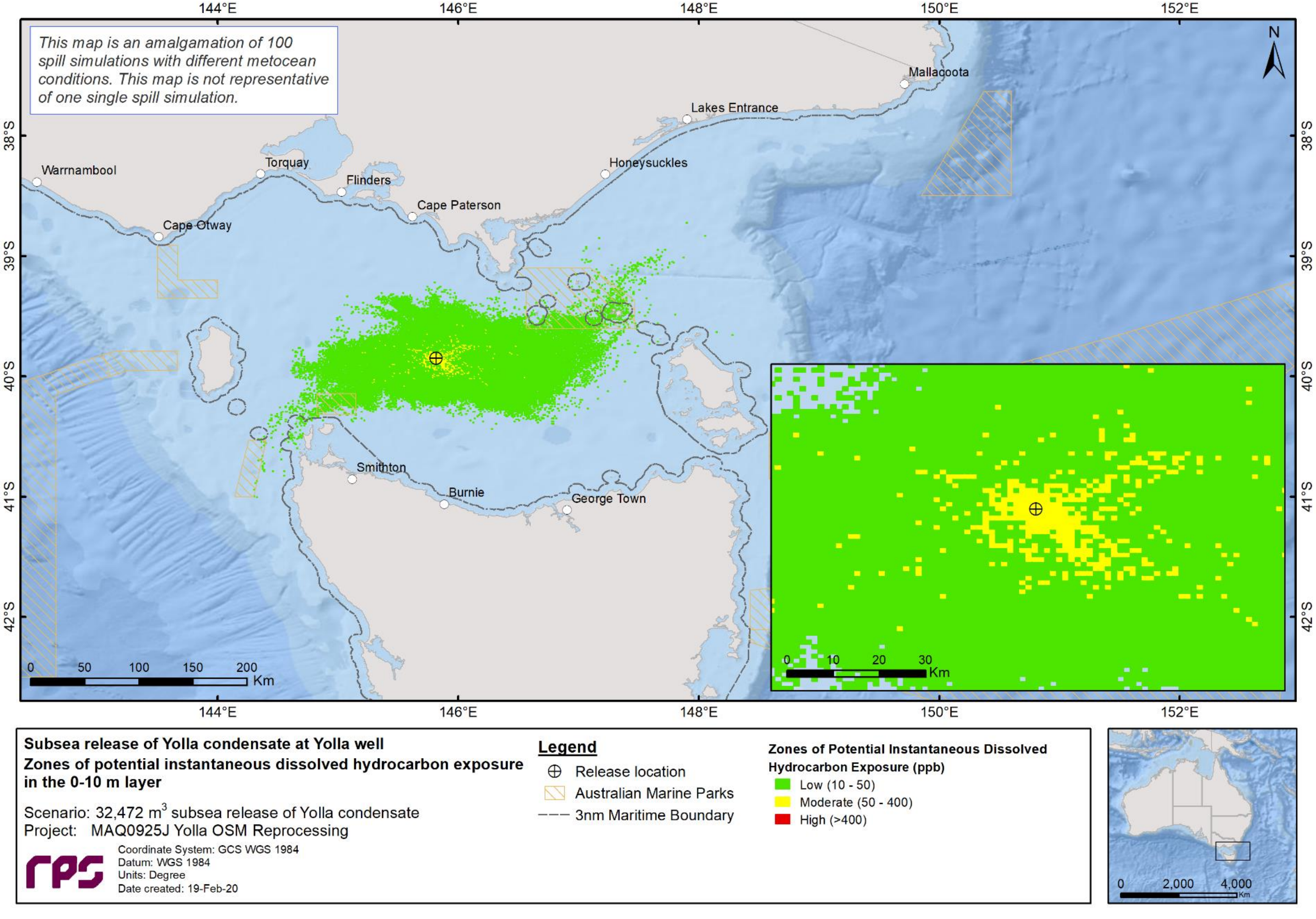


Figure 11.2 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

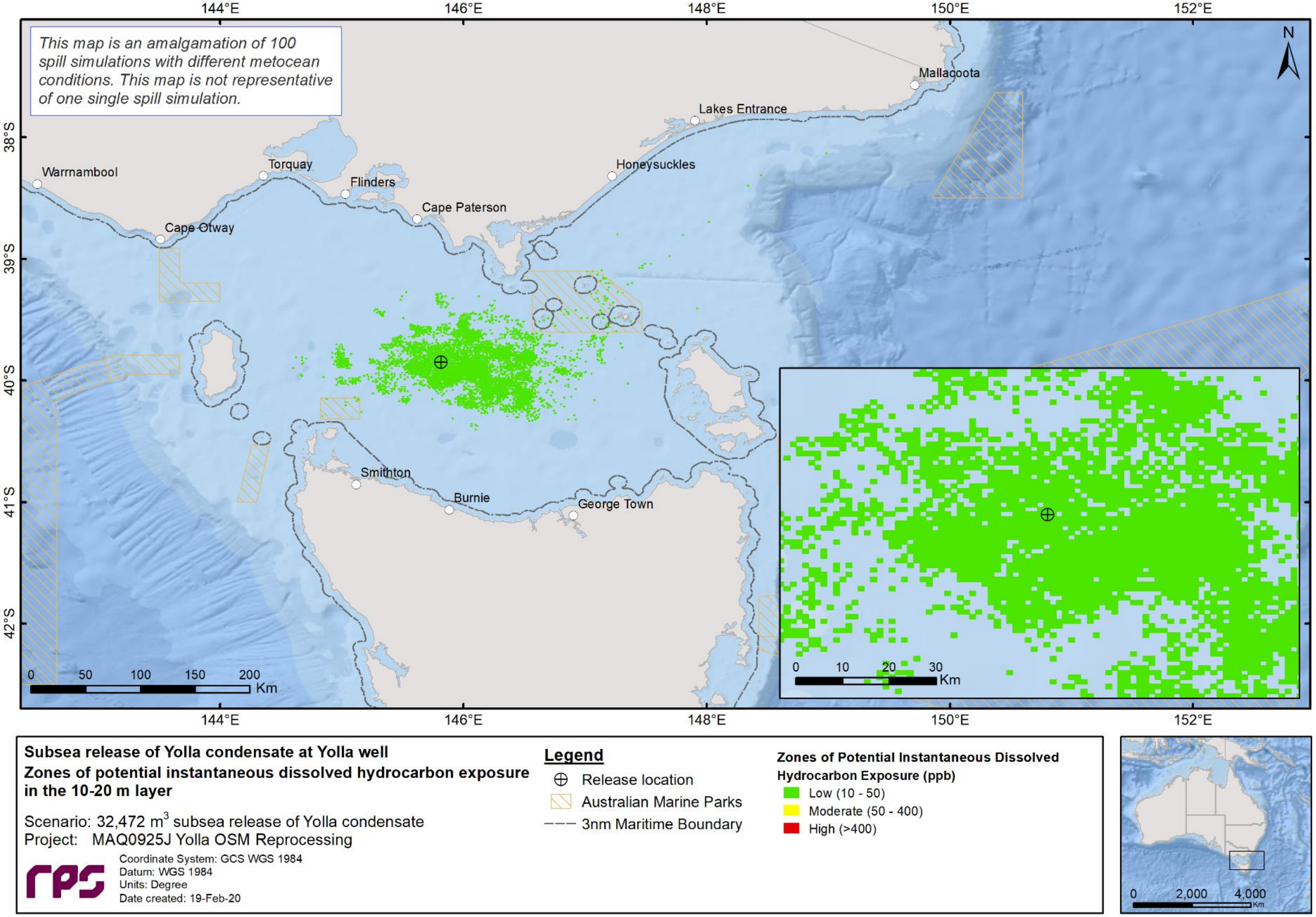


Figure 11.3 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m³ total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

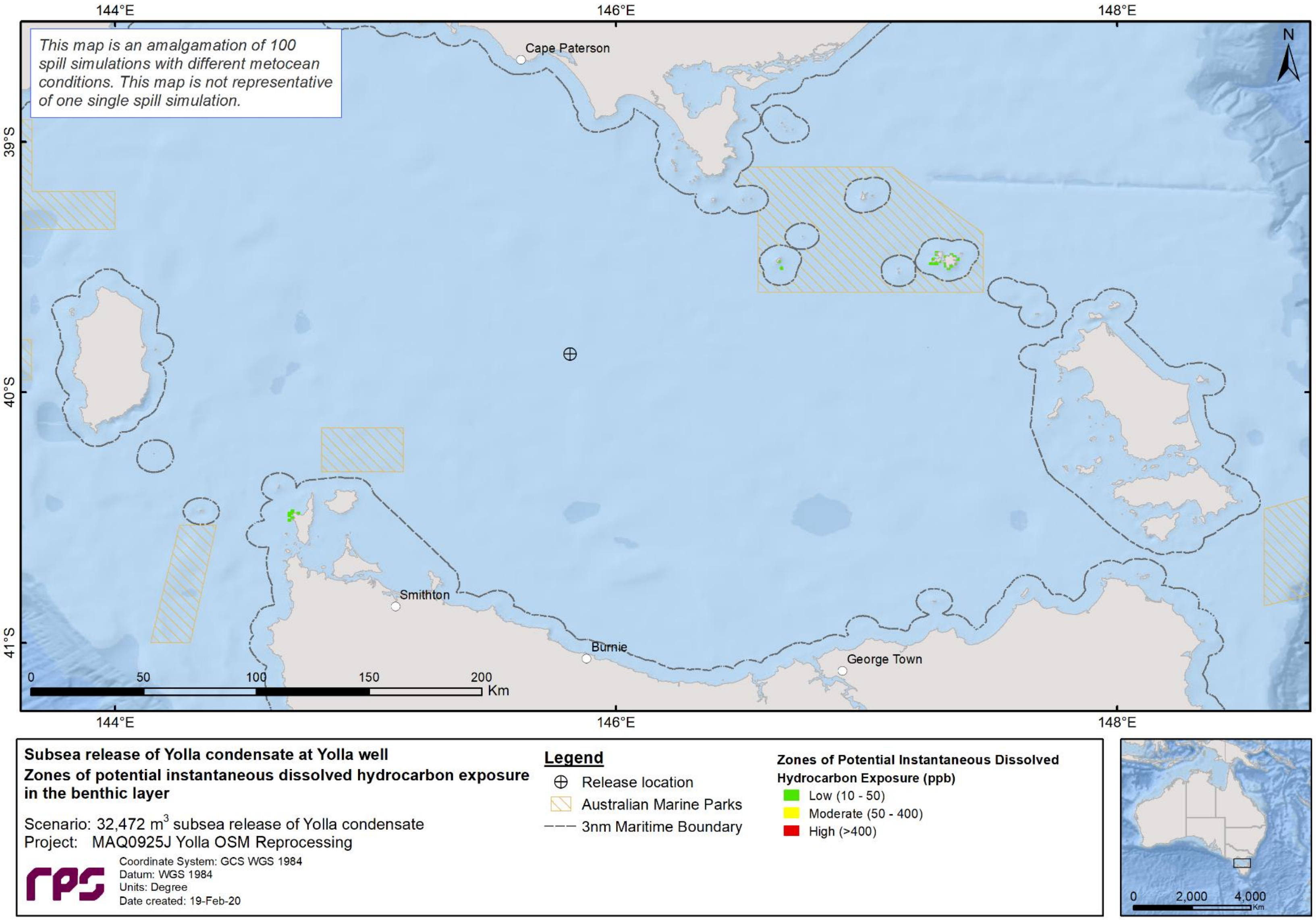


Figure 11.4 Benthic interaction of zones of potential instantaneous dissolved hydrocarbon exposure, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

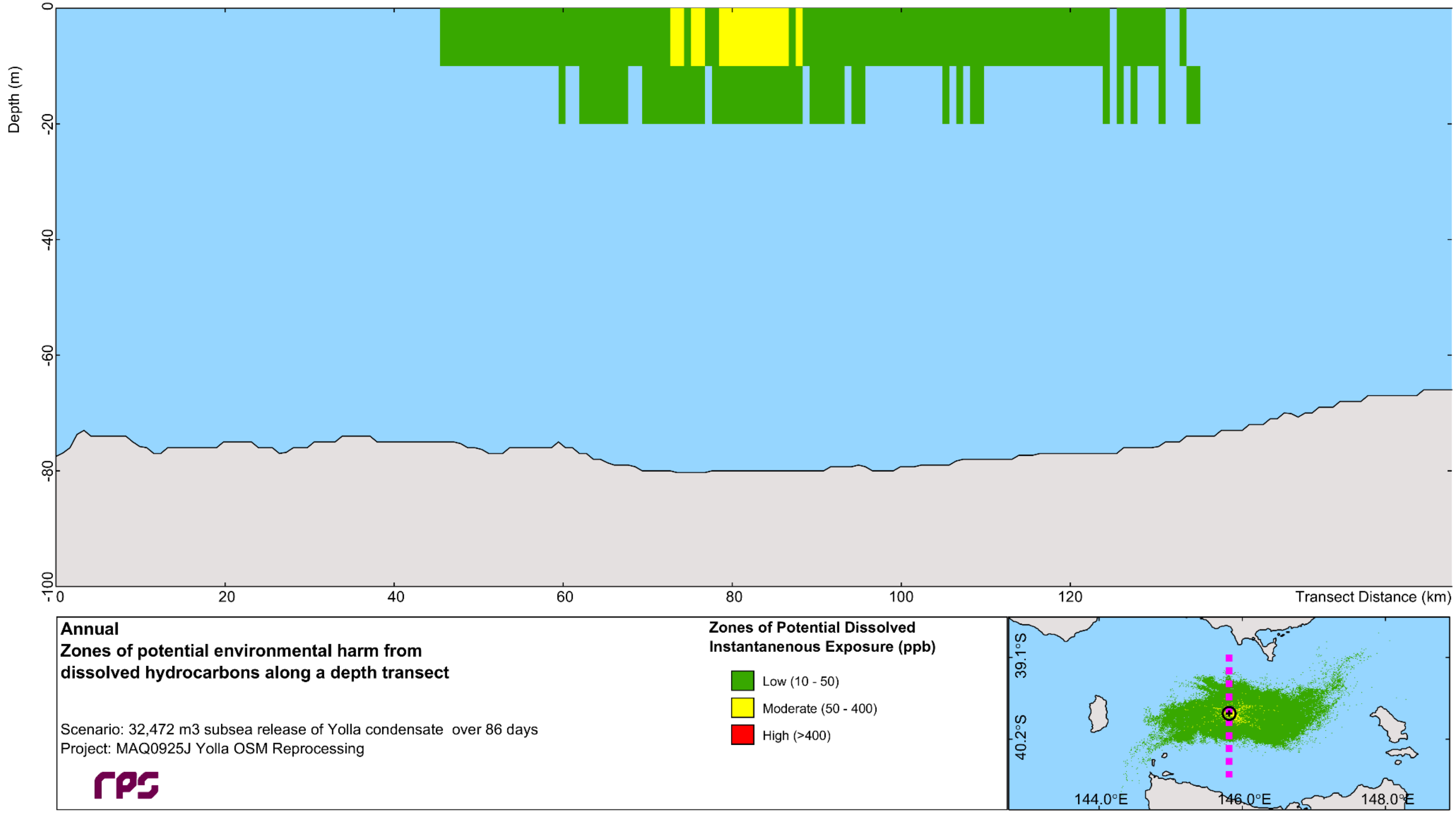


Figure 11.5 Transect plot (north to south) illustrating zones of potential instantaneous dissolved hydrocarbons exposure through the water column, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

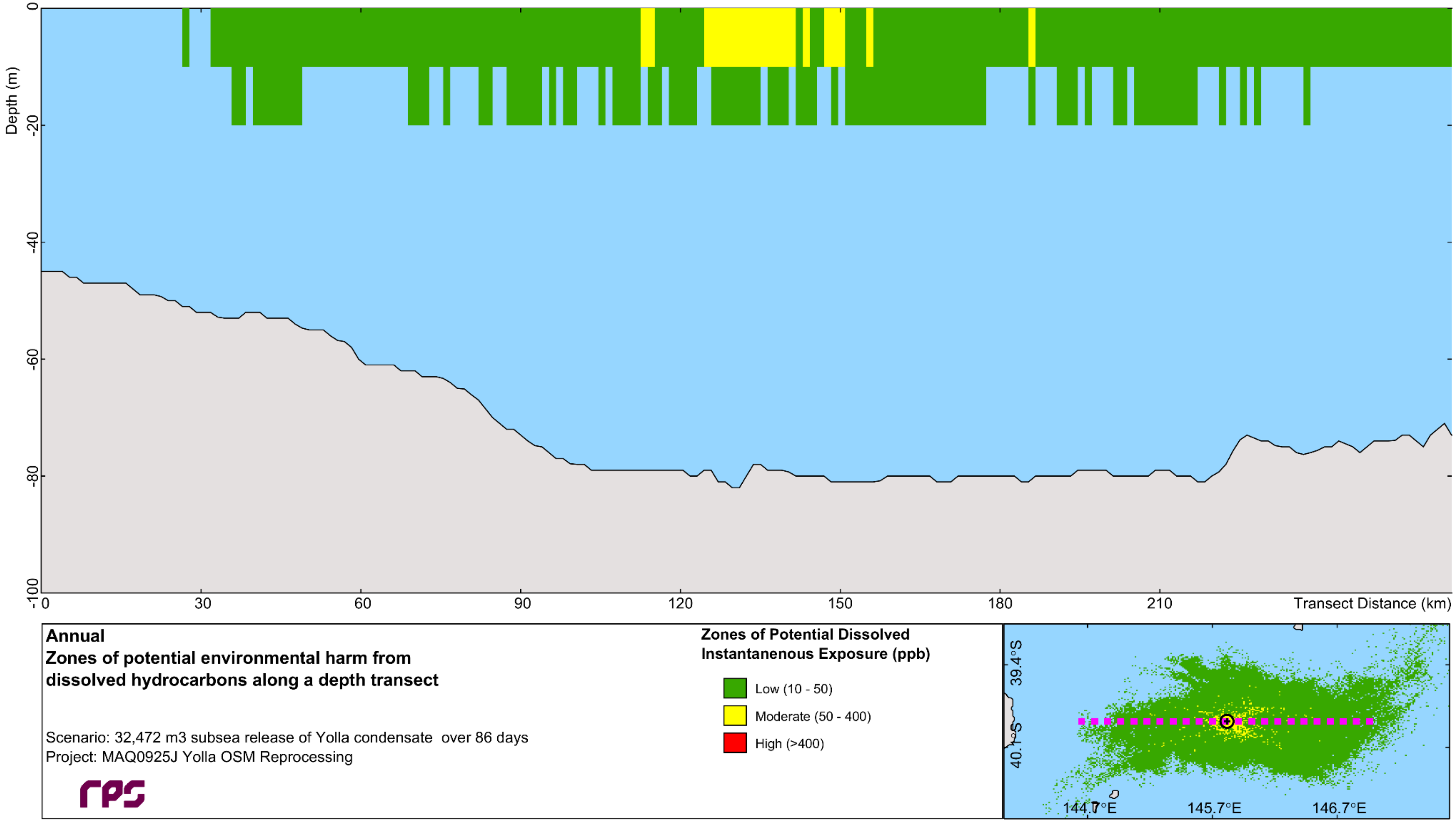


Figure 11.6 Transect plot (west to east) illustrating zones of potential instantaneous dissolved hydrocarbons exposure through the water column, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

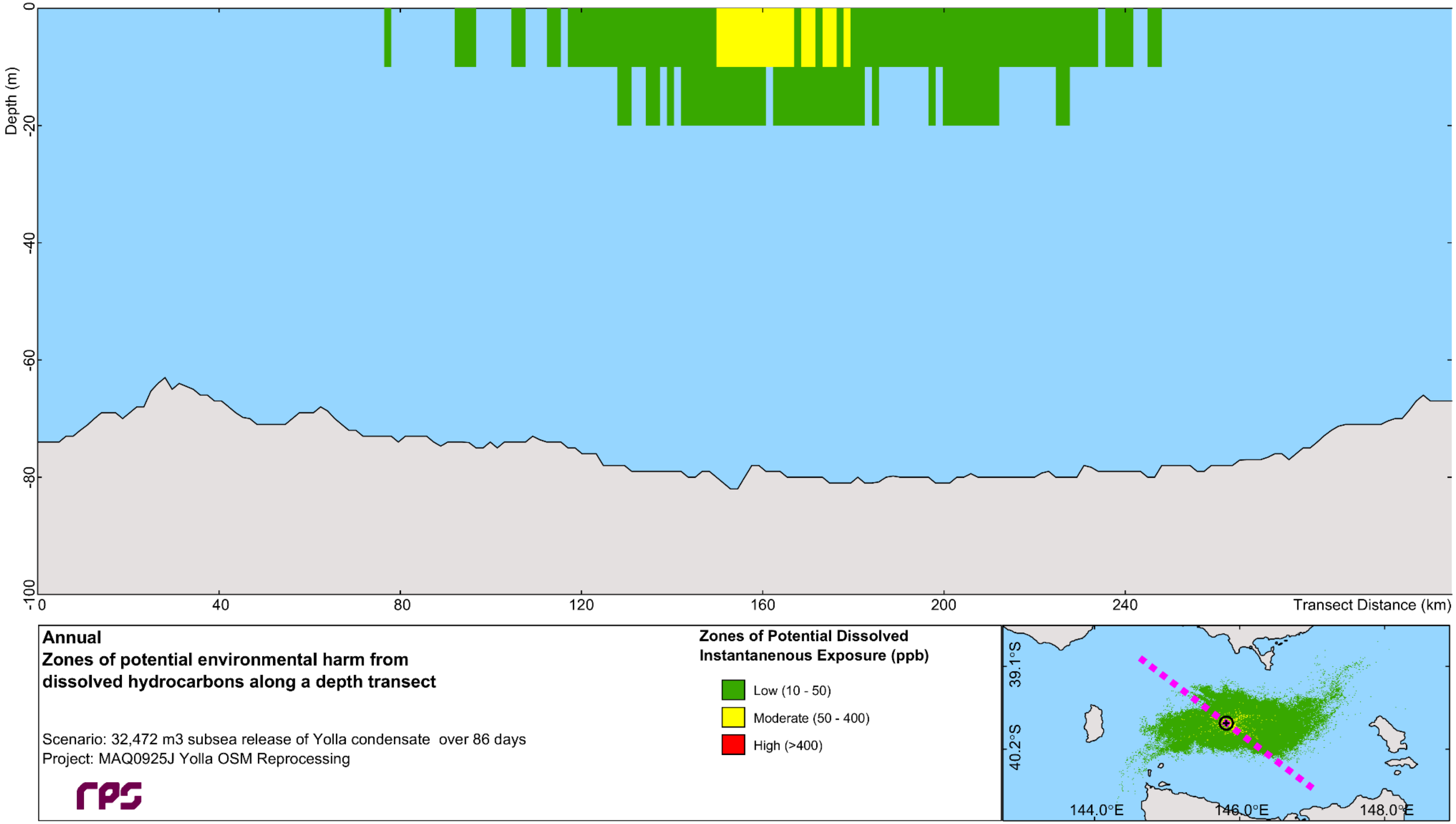


Figure 11.7 Transect plot (northwest to southeast) illustrating zones of potential instantaneous dissolved hydrocarbons exposure through the water column, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

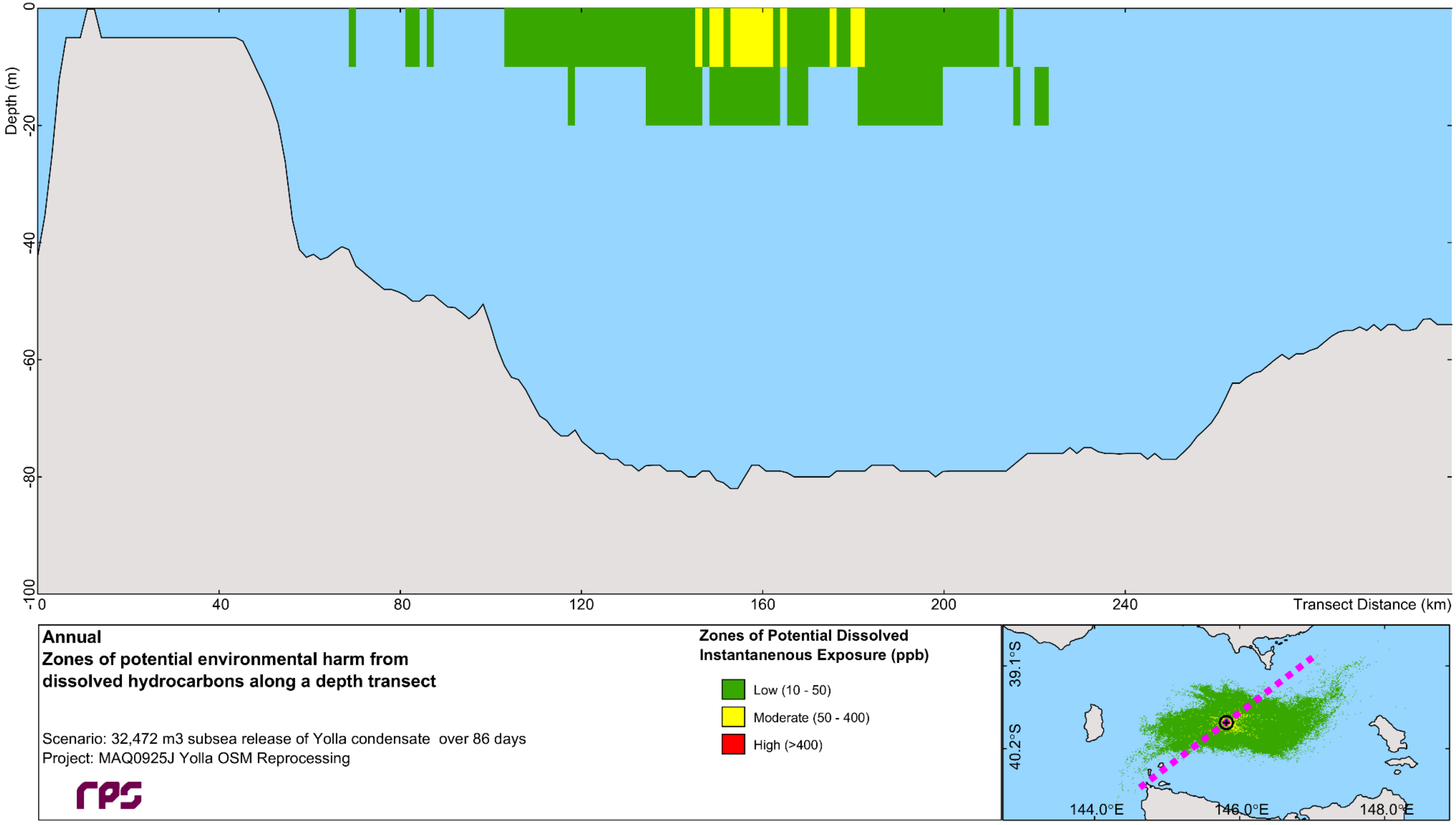


Figure 11.8 Transect plot (northeast to southwest) illustrating zones of potential instantaneous entrained hydrocarbons exposure through the water column, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

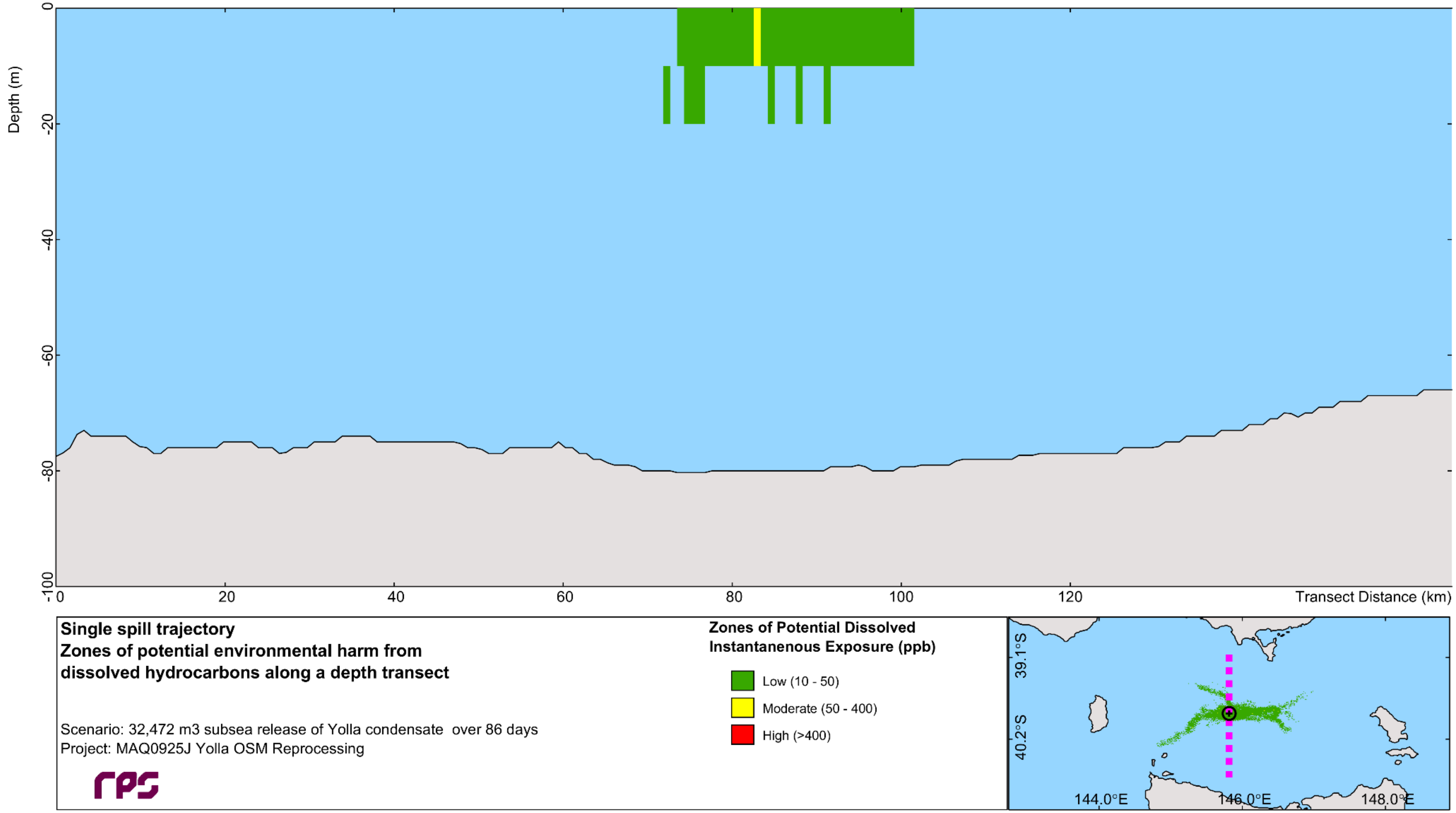


Figure 11.9 **Transect plot (north to south) illustrating zones of potential instantaneous entrained hydrocarbons exposure through the water column for a <u>single spill trajectory</u>, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days.**

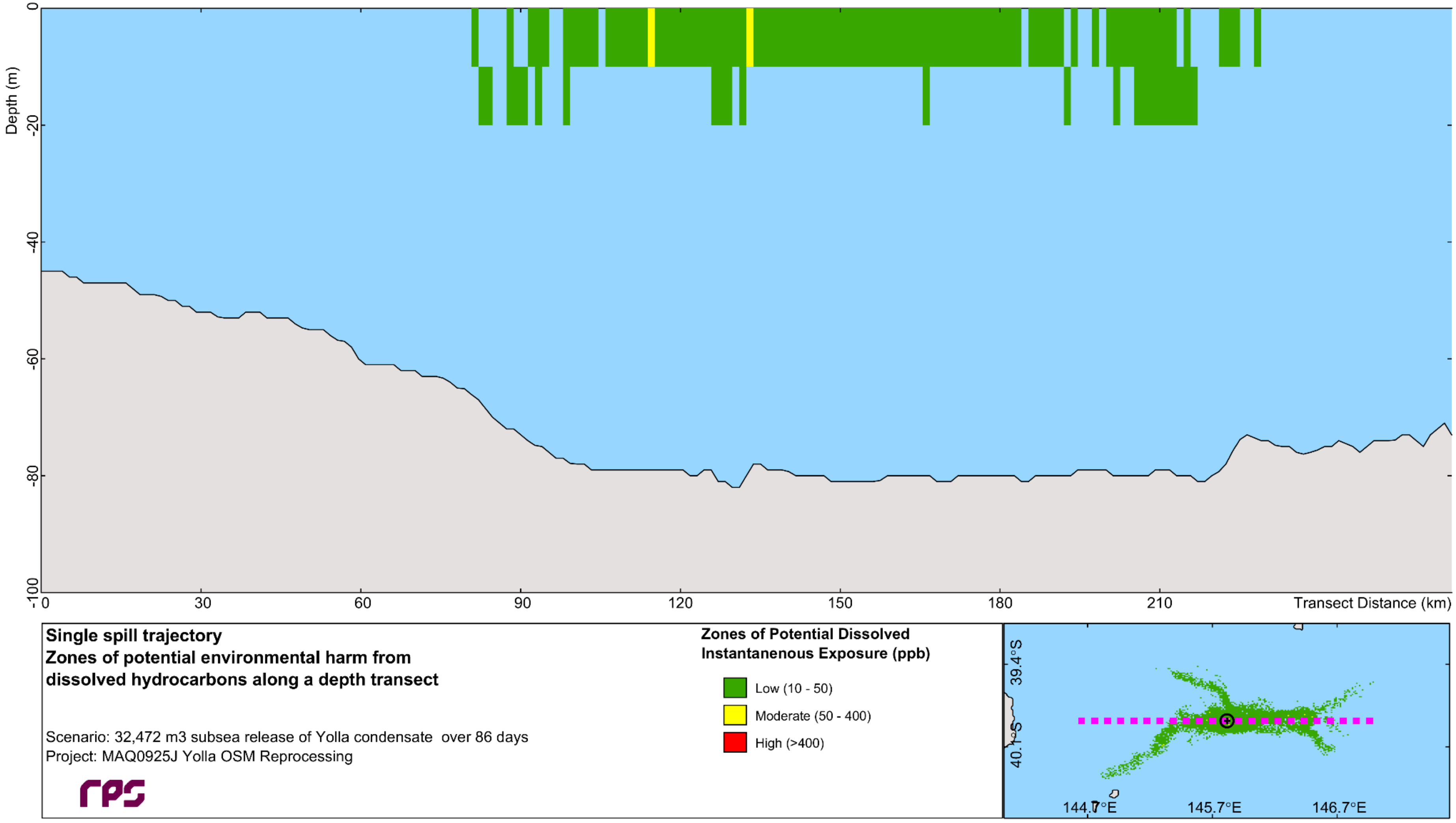


Figure 11.10 **Transect plot (west to east) illustrating zones of potential instantaneous entrained hydrocarbons exposure through the water column for a <u>single spill trajectory</u>, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days.**

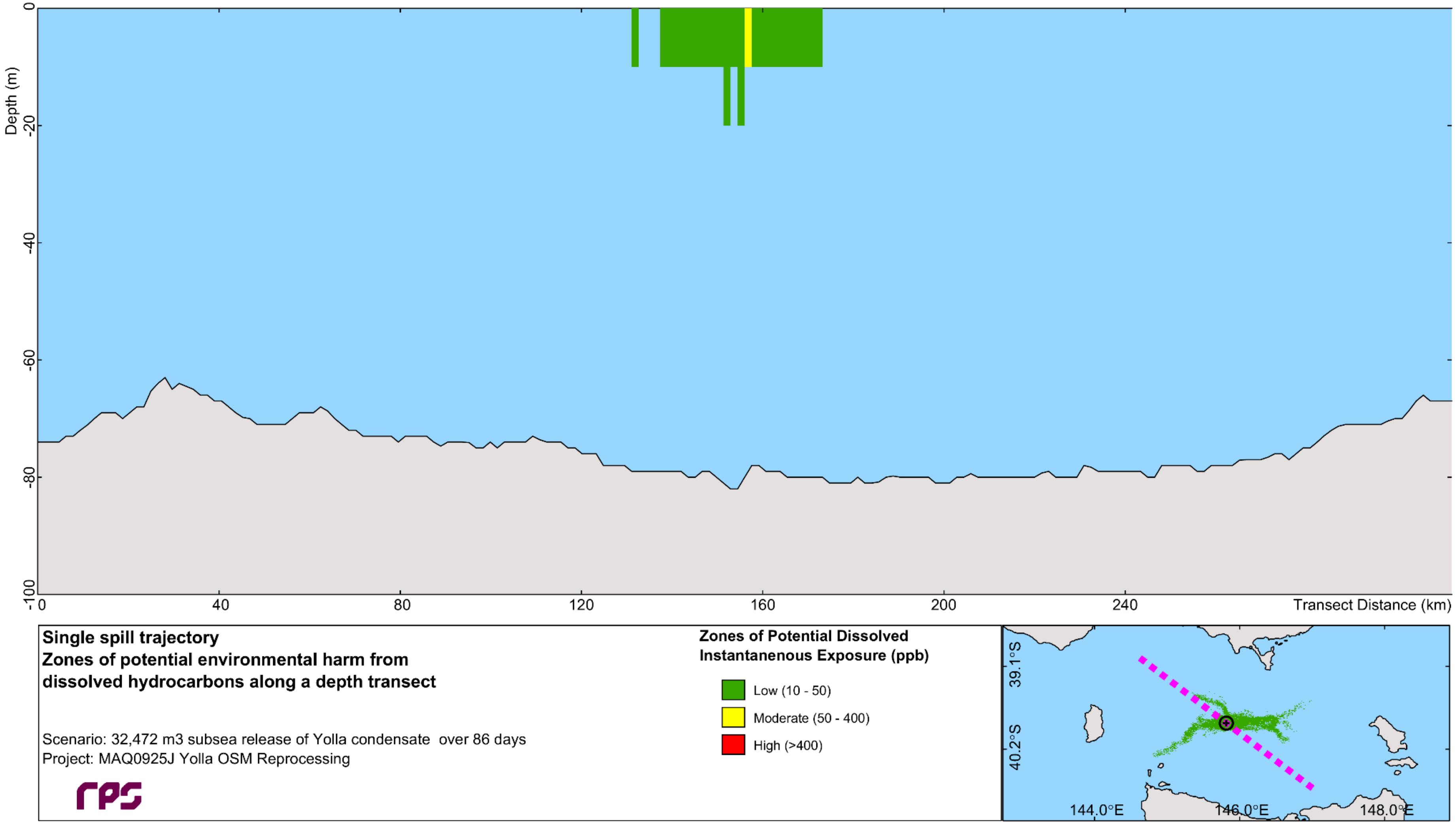


Figure 11.11 Transect plot (northwest to southeast) illustrating zones of potential instantaneous entrained hydrocarbons exposure through the water column for a single spill trajectory, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days.

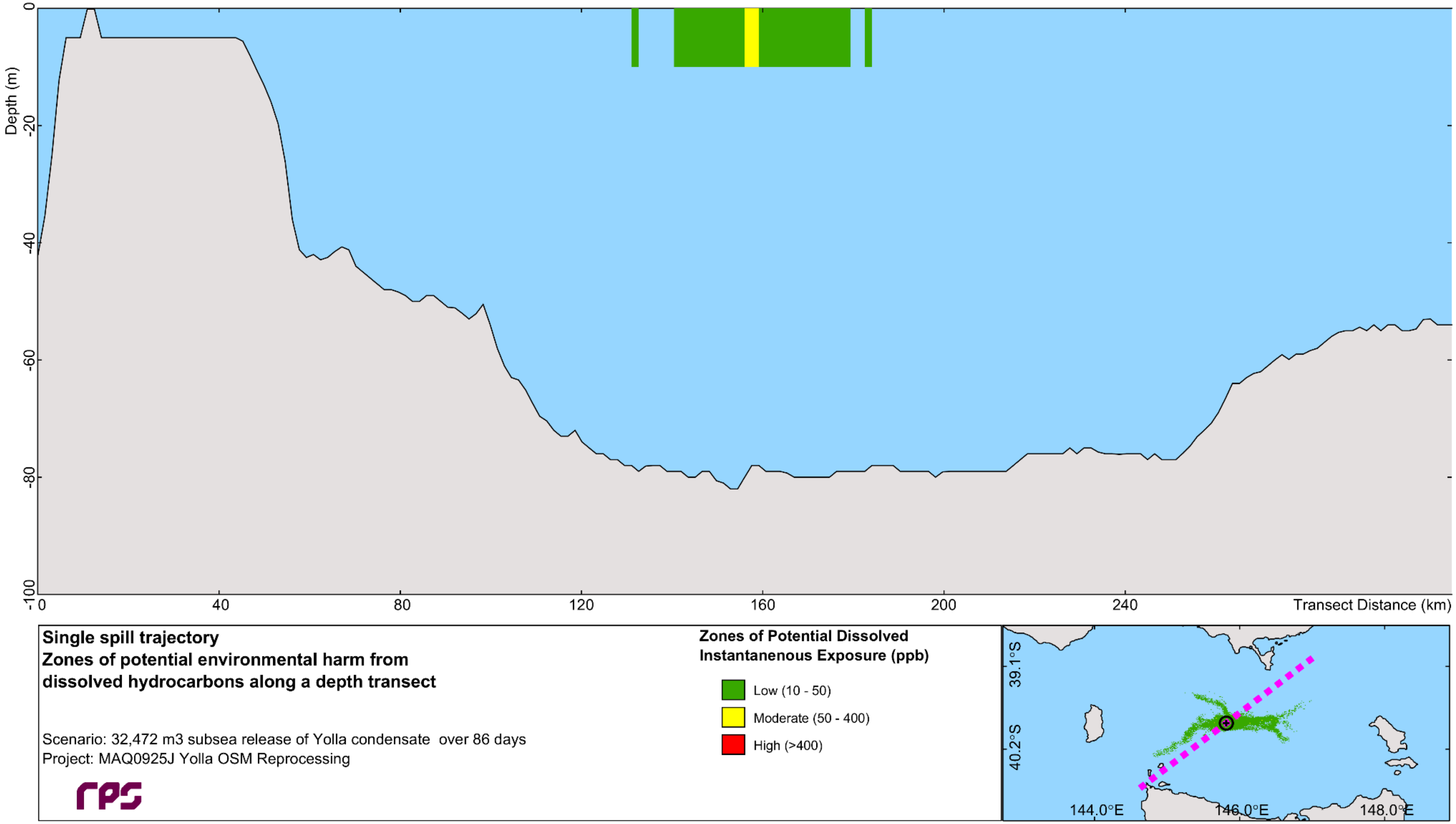


Figure 11.12 Transect plot (northeast to southwest) illustrating zones of potential instantaneous entrained hydrocarbons exposure through the water column for a single spill trajectory, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days.

11.1.2.2 Entrained Hydrocarbons

Table 11.4 summarises the maximum distance and direction from the release location to entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) exposure levels (NOPSEMA, 2019). The maximum distance of entrained hydrocarbons at the low and high thresholds from the release location was predicted as 495 km (east-northeast) and 43 km (west), respectively.

Table 11.5 presents the probability of exposure to individual receptors from entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) exposure levels in the 0-10 m depth layer for the annualised assessment.

In the surface layer (0-10 m), the Flinders IMCRA recorded the greatest probability of low exposure to entrained hydrocarbons with 85%, while the Beagle AMP and White Shark – Foraging BIA recorded 75% and 74% probabilities of low exposure to entrained hydrocarbons, respectively. Additionally, multiple receptors (Flinders IBRA, Twofold Shelf IMCRA, Kent Group NP, Kent Island Group and Tasmania State Waters) recorded a 67% probability of exposure to low entrained hydrocarbons. No receptors were predicted to be exposed to entrained hydrocarbons at or above the high threshold (other than excluded receptors, see Table 10.2).

Entrained hydrocarbons at, or above, the low exposure threshold were not predicted to occur below a depth of 10 m for this scenario.

Figure 11.13 illustrates the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer at the low (10-100 ppb) and high (≥100 ppb) exposure levels.

Figure 11.14 presents the potential zones of entrained hydrocarbon exposure in the benthic layer for the annual assessment at the low (10-100 ppb) and high (≥100 ppb) exposure levels.

Figure 11.15 to Figure 11.18 depict potential zones of entrained hydrocarbon exposure through the water column along transects oriented along cardinal directions for the annual assessment.

Table 11.4 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill simulations per season.

Distance and direction travelled	Zones of potential entrained hydrocarbon exposure	
	Low 10-100 ppb	High ≥100 ppb
Maximum distance (km) from the release location	495	43
Direction	East-northeast	West

Table 11.5 Probability of low, moderate and high exposure to marine based receptors from entrained hydrocarbons at 0–10 m below the sea surface. Results are based on the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories per season.

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
AMP	Beagle	33.72	75	-
	Boags	71.31	47	-
	East Gippsland	14.03	4	-
	Franklin	26.98	15	-
BIA	Antipodean Albatross - Foraging	36.22	18	-
	Australasian Gannet - Foraging	53.97	26	-
	Humpback Whale - Foraging	14.71	6	-
	Little Penguin - Breeding	23.24	6	-
	Little Penguin - Foraging	53.97	56	-
	Short-tailed Shearwater - Breeding	23.24	19	-
	Shy Albatross - Breeding	50.21	15	-
	Soft-plumaged Petrel - Foraging	18.74	6	-
	Southern Right Whale - Connecting Habitat	22.39	19	-
	Wedge-tailed Shearwater - Foraging	15.36	6	-
	White Shark - Breeding	18.38	4	-
	White Shark - Foraging	43.31	74	-
	White-fronted Tern - Foraging	13.67	5	-
CA	Arthur Bay	10.11	1	-
IBRA	East Gippsland Lowlands	14.70	4	-
	Flinders	32.44	67	-
	Gippsland Plain	17.61	7	-
	King Island	50.21	20	-
	Tasmanian West	18.32	5	-
	Wilsons Promontory	27.18	12	-
IMCRA	Boags	55.70	40	-
	Central Victoria	23.11	6	-

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
	Flinders	47.46	85	-
	Franklin	24.43	16	-
	Otway	53.97	28	-
	Twofold Shelf	29.57	67	-
KEF	Upwelling East of Eden	19.04	10	-
	West Tasmania Canyons	16.48	5	-
MNP	Cape Howe	11.63	1	-
	Point Hicks	15.28	6	-
	Wilsons Promontory	24.77	12	-
NP	Kent Group	28.77	67	-
	Wilsons Promontory Marine Park	18.13	9	-
NR	Chappell Islands	12.10	3	-
Ramsar	Lavinia	11.48	1	-
RSB	Bell Reef	16.04	5	-
	Brown Rocks	22.41	8	-
	Cutter Rock	22.18	16	-
	New Zealand Star Bank	14.90	9	-
	Wakitipu Rock	18.98	45	-
	Warrego Rock	17.80	21	-
	Wright Rock	17.12	34	-
Nearshore	Albatross Island	50.21	19	-
	Anser Island	22.78	12	-
	Badger Island	13.67	6	-
	Bega Valley	10.02	1	-
	Big green Island	11.14	2	-
	Black Pyramid	30.11	20	-
	Chalky Island	11.58	1	-
	Circular Head	42.03	11	-

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
	Craggy Island	30.39	34	-
	Curtis Island	27.68	48	-
	East Gippsland	14.70	4	-
	Flinders Island	18.96	14	-
	Gabo Island	11.11	2	-
	Glennie Group	20.66	10	-
	Goose Island	10.57	2	-
	Hogan Island Group	27.14	29	-
	Hunter Island	41.57	13	-
	Inner Sister Island	20.19	22	-
	Kanowna Island	22.78	12	-
	Kent Island Group	28.67	67	-
	King Island	14.31	2	-
	Moncoeur Islands	27.18	11	-
	Mount Chappell Island	13.30	5	-
	Norman Island	18.29	9	-
	Outer Sister Island	16.60	13	-
	Pasco Group	16.13	12	-
	Prime Seal Island	18.18	11	-
	Pyramid Island	32.44	65	-
	Reef Island	10.17	1	-
	Reid Rock	12.71	1	-
	Robbins Island	11.72	3	-
	Rodondo Island	22.18	10	-
	Seal Islands	10.31	1	-
	Shellback Island	15.19	6	-
	Skull Rock	20.74	12	-
	South Gippsland	20.35	10	-

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
	Three Hummock Island	28.45	10	-
	Wellington	12.45	2	-
	West Coast	18.32	5	-
State Waters	Tasmania State Waters	53.97	67	-
	Victoria State Waters	34.35	14	-
Sub-LGA	Bega Valley	10.02	1	-
	Cape Conran	10.08	1	-
	Cape Howe / Mallacoota	11.63	1	-
	Croajingolong (East)	12.11	2	-
	Croajingolong (West)	14.70	3	-
	Golden Beach	10.42	1	-
	Ocean Grange	12.45	2	-
	Point Hicks	13.71	4	-
	Sydenham Inlet	10.12	1	-
	Waratah Bay	11.26	1	-
	Wilsons Promontory (East)	17.64	7	-
	Wilsons Promontory (West)	20.35	10	-

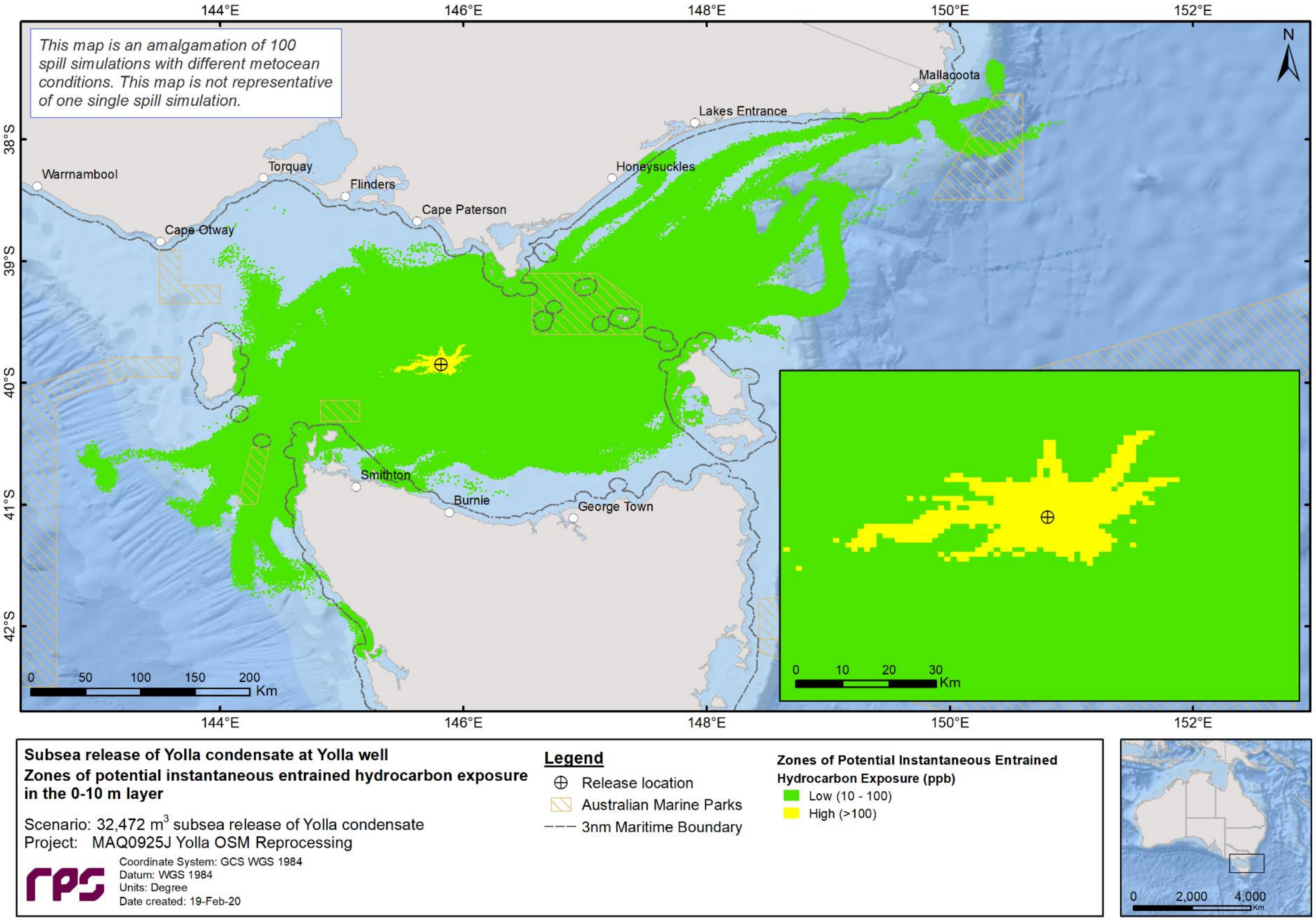


Figure 11.13 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

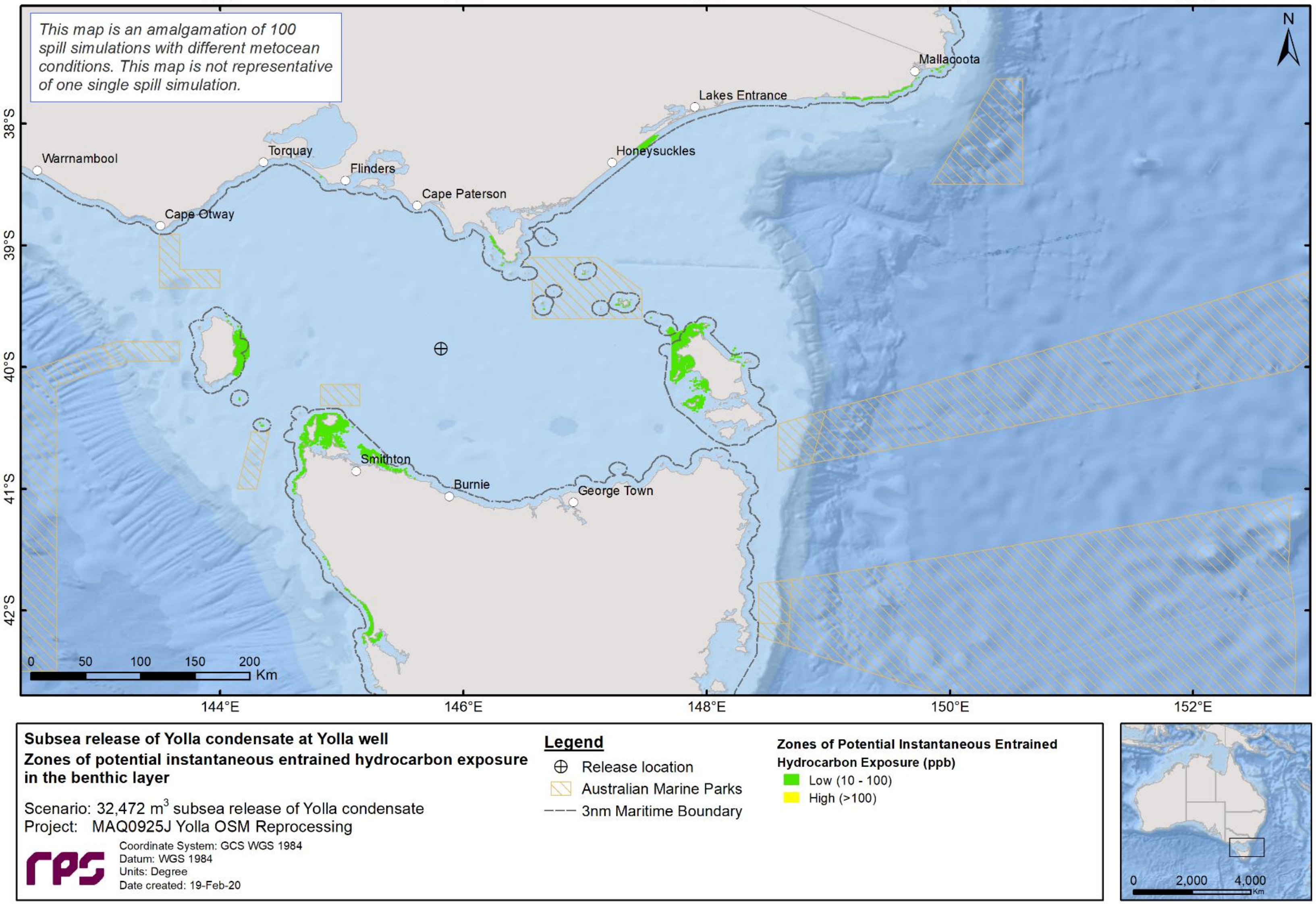


Figure 11.14 Benthic interaction of zones of potential instantaneous entrained hydrocarbon exposure, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

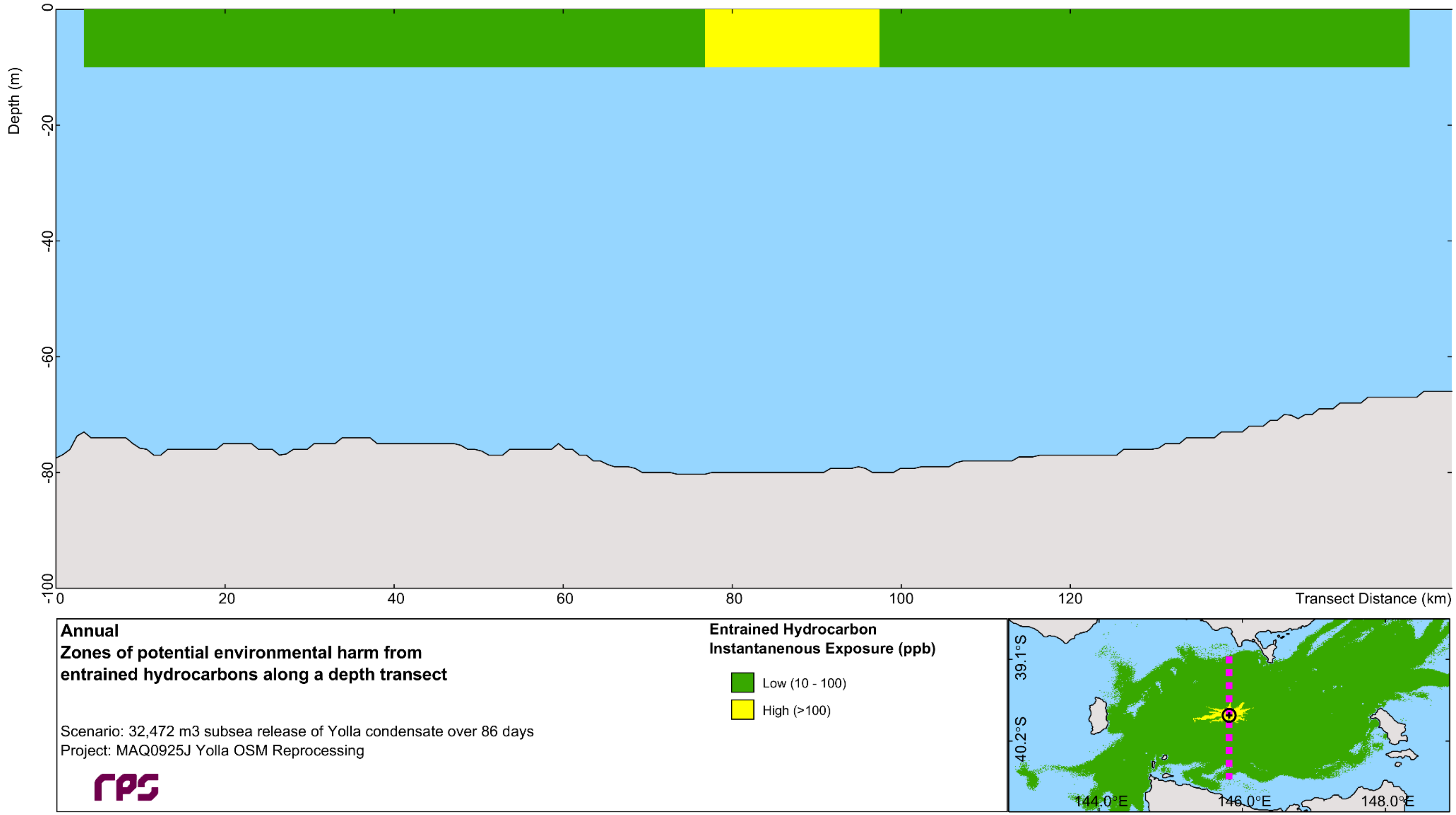


Figure 11.15 Transect plot (north to south) illustrating zones of potential instantaneous entrained hydrocarbon exposure through the water column, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

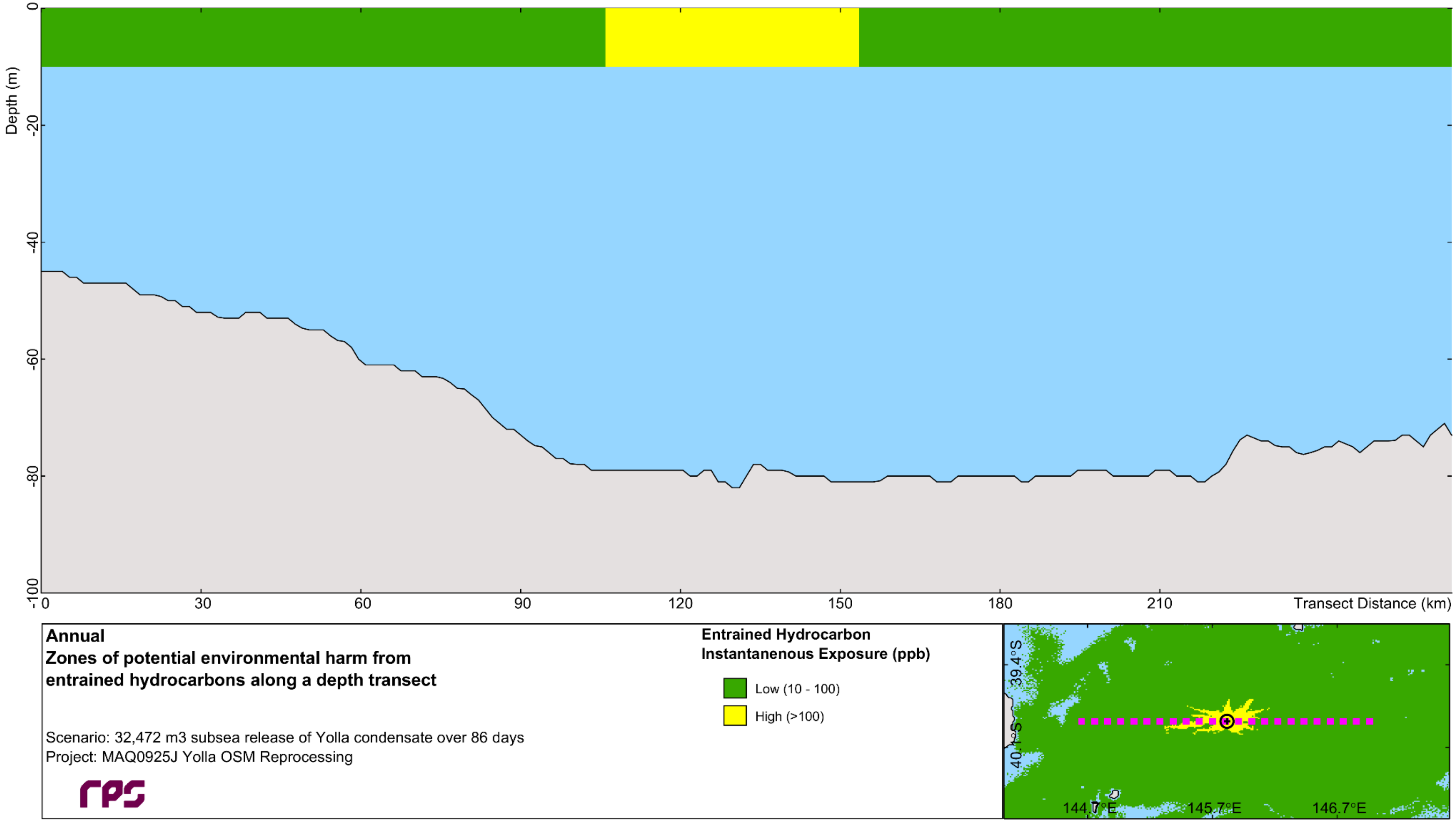


Figure 11.16 Transect plot (west to east) illustrating zones of potential instantaneous dissolved hydrocarbon exposure through the water column, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

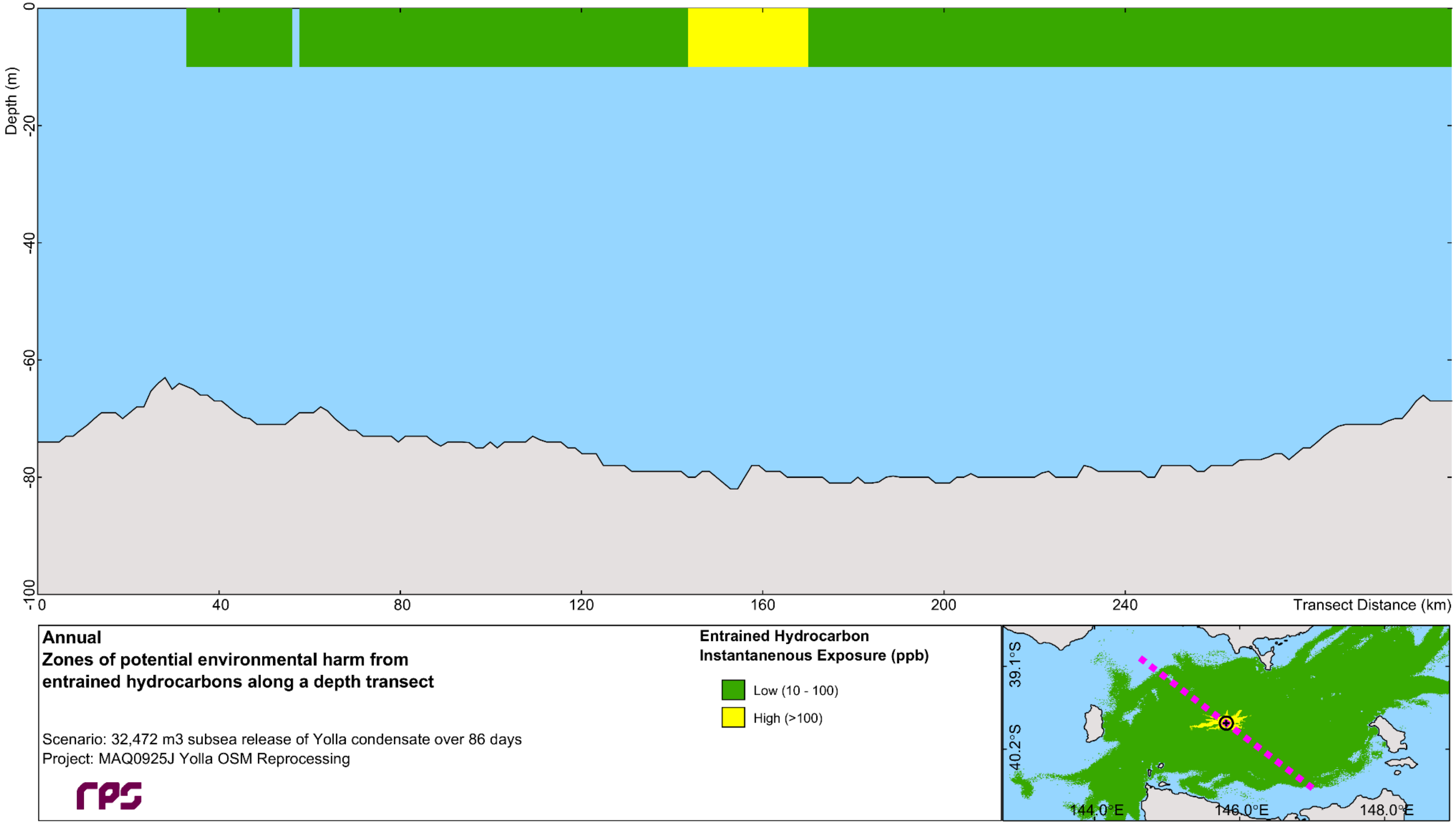


Figure 11.17 Transect plot (northwest to southeast) illustrating zones of potential instantaneous dissolved hydrocarbon exposure through the water column, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions

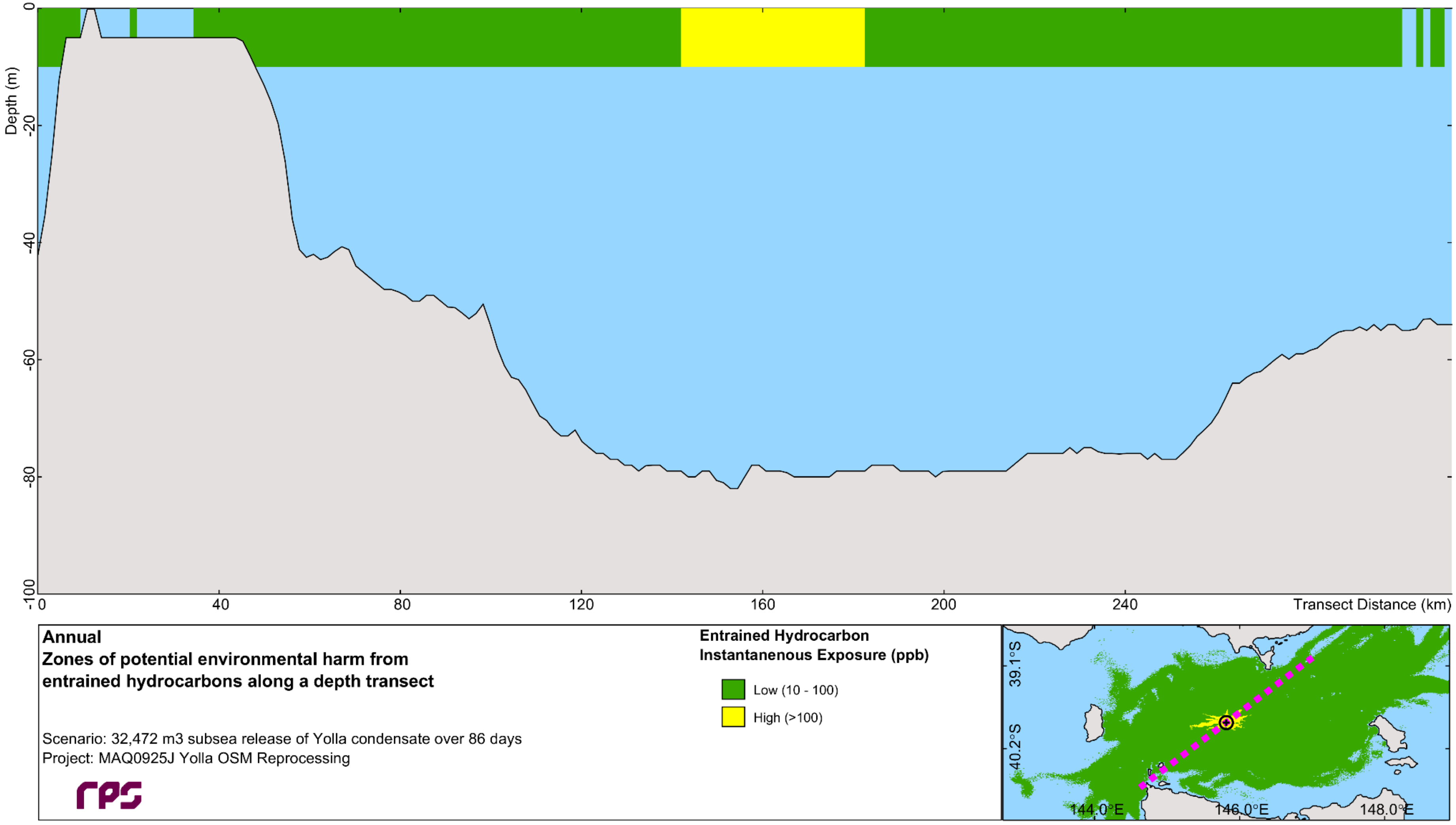


Figure 11.18 Transect plot (northeast to southwest) illustrating zones of potential instantaneous dissolved hydrocarbon exposure through the water column, in the event of a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days. The results were calculated from 100 spill trajectories during annual conditions.

11.2 Deterministic Analysis

There were four metrics used select single spill trajectories for the deterministic analysis from the 100 simulations for the annualised analysis:

- Largest swept area at or above 10 g/m^2 (actionable sea surface oil);
- Minimum time to shore for visible sea surface oil (1 g/m^2);
- Largest volume of oil ashore, and
- Longest length of shoreline contacted at or above 100 g/m^2 (actionable shoreline oil).

For this scenario there were no swept areas containing actionable sea surface oil (10 g/m^2), nor shoreline contact, therefore none of the above metric criteria were met. As such, a single spill trajectory was selected based on largest swept area of low (1-10 g/m^2) exposure. The results are included in Section 11.2.1.

11.2.1 Largest Swept Area

The deterministic trajectory that had the largest swept area of moderate (10-50 g/m^2) oil exposure on the sea surface commenced at 3:00 am 26th May 2011.

Figure 11.19 presents the potential zone of low (1-10 g/m^2) exposure from sea surface oil, over the entire simulation (swept area). Zones of low (1-10 g/m^2) sea surface exposure were predicted to travel a maximum of 16.5 km from the release site towards the southeast. No zones of actionable (≥10 g/m^2) sea surface oil were predicted.

Figure 11.20 displays a time series of the actionable oil on the sea surface (≥10 g/m^2) and visible (1-10 g/m^2) oil exposure on the sea surface over the 100-day simulation. The maximum area of coverage of visible (1-10 g/m^2) oil on the sea surface (~12 km^2) occurred on day 73 of the release.

Figure 11.21 presents the fates and weathering graph for the corresponding single spill trajectory. A significant portion of the spilled oil was lost to the atmosphere through evaporation, at a constant rate, during the 86-day release duration. Consequently, there was minimal oil on the sea surface throughout the scenario. At the completion of the 100-day model period 95% of the spill volume was lost due to evaporative processes. The second highest weathering and fates portion for the spill trajectory was the decay component (biodegradation and natural decay), which was predicted to be 3% (or ~962 m^3) of the release volume, whilst a smaller portion was predicted to remain entrained within the water column, 1% (or 356 m^3), at the end of the scenario.

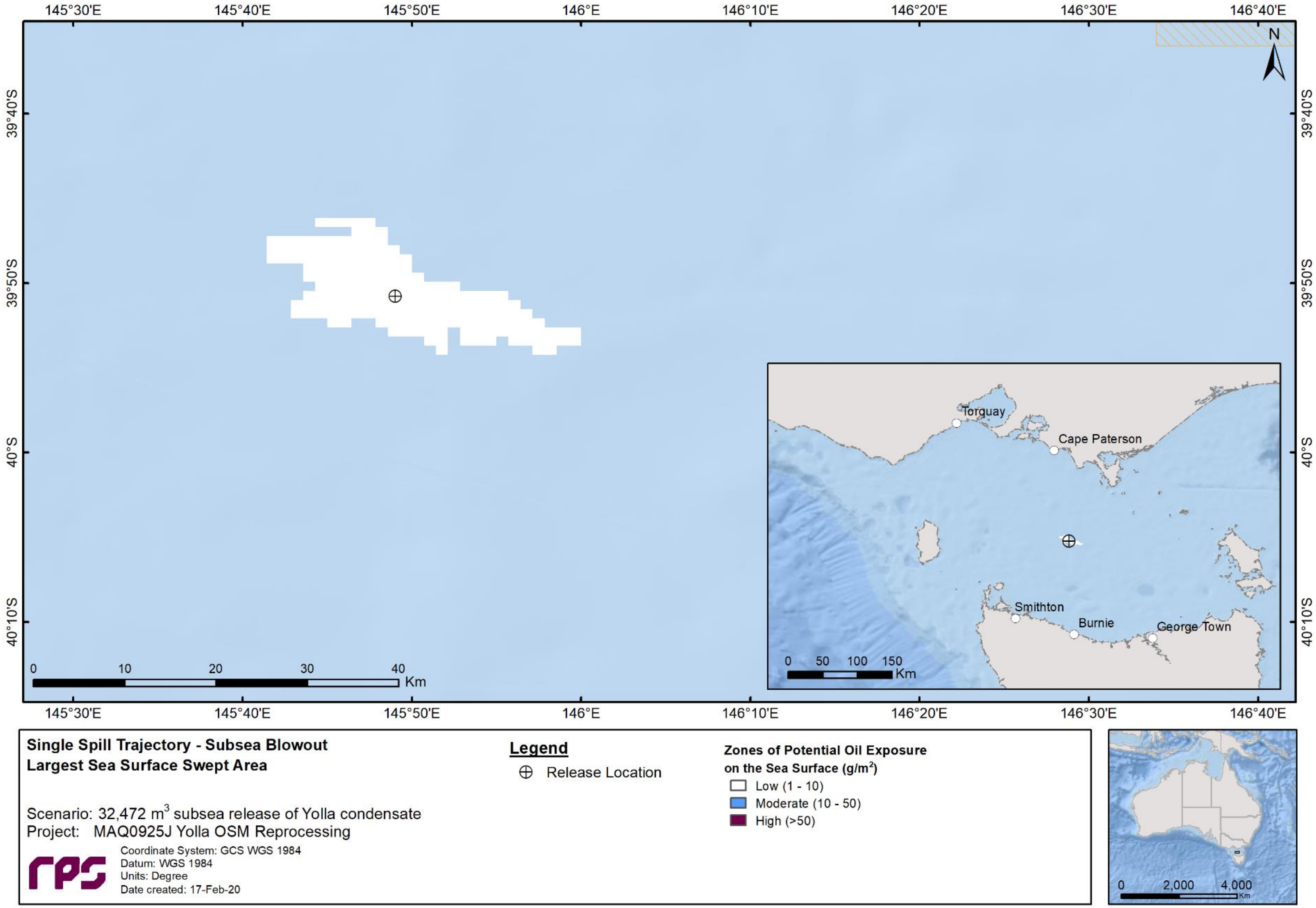


Figure 11.19 Zones of potential oil exposure on the sea surface over the entire simulation for the identified deterministic trajectory. Results are based on a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days, starting 3:00 am 26th May 2011.

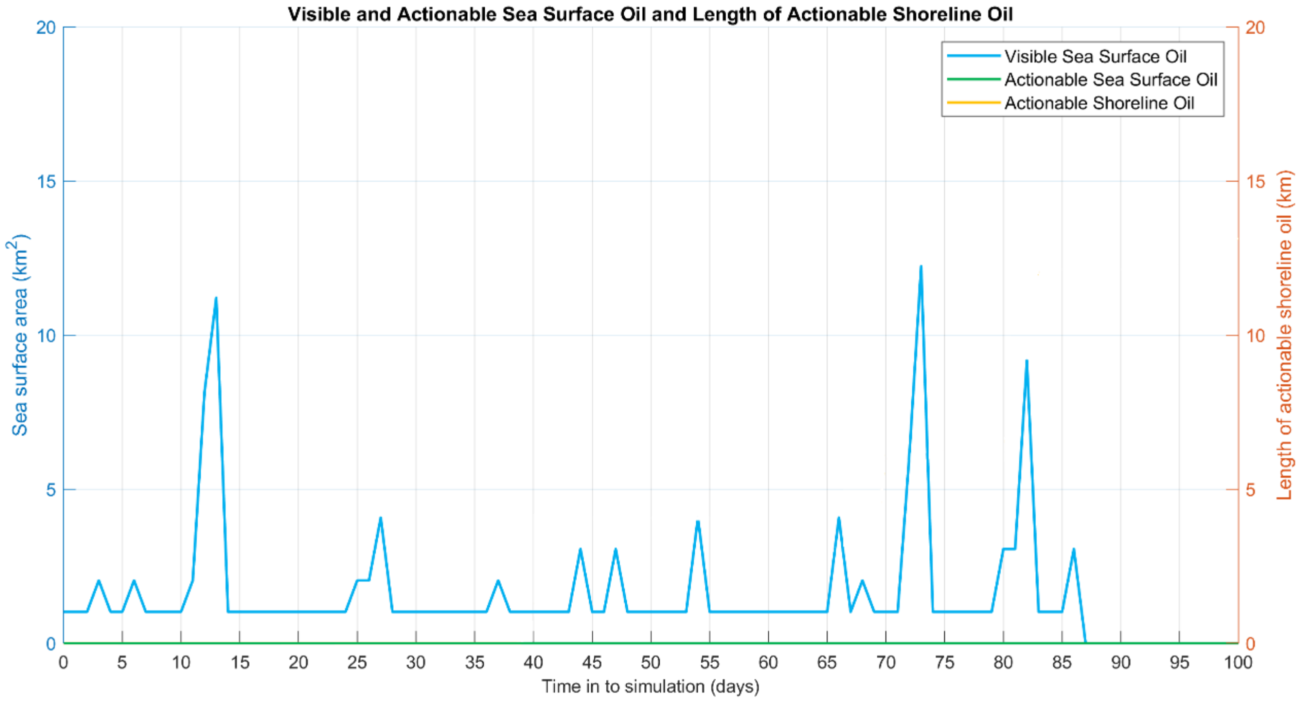


Figure 11.20 Time series of area of visible oil on the sea surface above the low threshold (1 g/m^2), and actionable oil on the sea surface above the moderate threshold (10 g/m^2). Results are based on a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days, starting 3:00 am 26th May 2011.

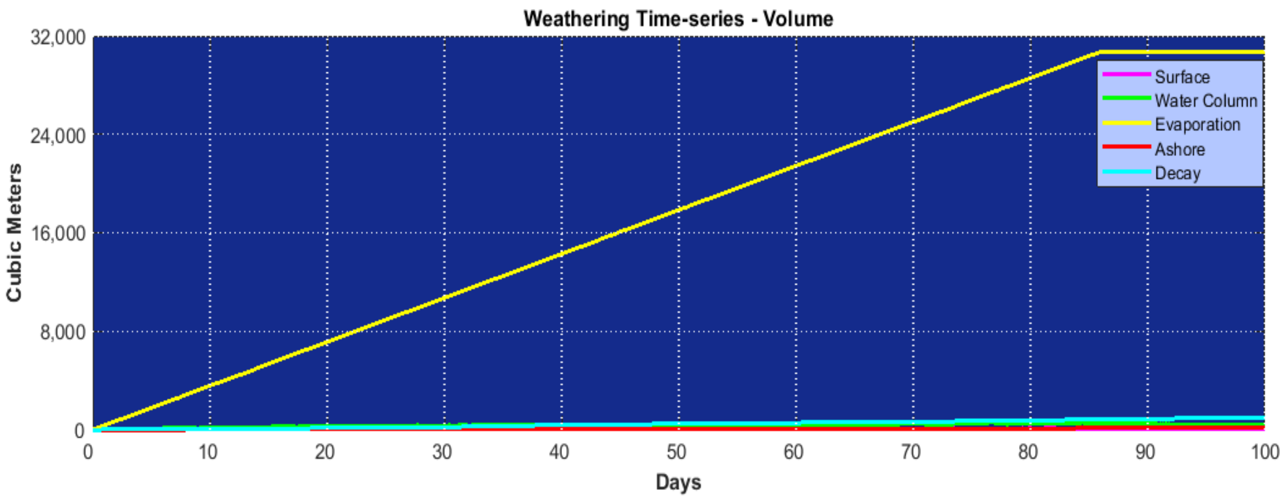


Figure 11.21 Predicted weathering and fates graph for the single spill trajectory. Results are based on a 204,250 bbl (2,375 bbl/d; 32,472 m^3 total) subsea release of Yolla condensate over 86 days at the Yolla platform, tracked for 100 days, starting 3:00 am 26th May 2011.

12 RESULTS – SCENARIO 2: 300 M^3 SURFACE RELEASE OF MDO OVER 6 HOURS

This scenario examined a 6-hour surface release of MDO following a vessel incident at a release site 3 nm from the coastline, tracked for a period of 20 days. A total of 100 spill trajectories were simulated on an annual basis.

The stochastic results were reviewed (Section 12.1) and a deterministic analysis was undertaken (see Section 12.2).

12.1 Stochastic Analysis

Section 12.1.1 presents the potential exposure to the sea surface and shoreline contact. Additionally, Section 12.1.2 presents the potential subsurface exposure.

For the modelling study each spill trajectory was tracked to the following minimum thresholds:

- Visible sea surface oil – 1 g/m^2
- Shoreline oil contact – 10 g/m^2
- Dissolved hydrocarbons – 10 ppb
- Entrained hydrocarbons – 10 ppb

12.1.1 Sea Surface Exposure and Shoreline Contact

Table 12.1 summarises the maximum distance travelled by oil on the sea surface at each threshold. The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (> 50 g/m^2) exposure levels was 26.6 km (east-southeast),10.7 km (south) and 2.5 km (west), respectively.

Table 12.3 summarises the potential sea surface exposure to individual receptors at each threshold. The highest probability of low sea surface exposure was recorded at Gippsland Plain IBRA with 35% and a predicted minimum time of 4 hours before exposure. Additionally, the Little Penguin – Foraging BIA, White Shark – Foraging BIA, Bass Coast and Kilcunda Sub-LGA were predicted to be exposed to low surface oil with probabilities of 33%, 32%, 34% and 30%, respectively. Bunurong Marine Park was predicted to be exposed to low exposure level surface oil with a probability of 7% and a predicted minimum time of 12 hours before (low level) exposure.

It should be noted that multiple receptors were predicted to be impacted by sea surface oil at the low threshold, however these are not presented in tabularised form as the release location resides within each receptor's boundaries (i.e. all receptors recorded a 100% probability of exposure). Please refer to Table 10.2 for the list of receptors.

Figure 12.1 presents the zones of potential oil exposure on the sea surface for the annual modelling assessment. Zones of oil exposure were predicted to extend in all directions from the release location with coastal waters between Kilcunda and Cape Paterson predicted to be exposed.

Table 12.2 presents a summary of the predicted shoreline contact. The probability of contact to any shoreline at, or above, the low contact level (10-100 g/m^2) was 39% and the minimum time before shoreline contact at, or above, the low threshold was 10 hours. The maximum volume ashore for a single spill trajectory was 172 m^3 and the maximum length of shoreline contacted at the low threshold was 11 km.

Table 12.2 summarises the shoreline contact to individual receptors assessed. The shoreline assessment identified the Kilcunda (VIC) shoreline as the receptor with the greatest probability of low (10-100 g/m^2), moderate (100-1,000 g/m^2) and high (>1,000 g/m^2) shoreline contact, which were 34%, 31% and 7%, respectively. Additionally, Venus Bay (VIC) was the shoreline receptor which demonstrated the second greatest probability of exposure based on the low (10 g/m^2), moderate (100-1,000 g/m^2) and high (>1,000 g/m^2) shoreline contact level with probabilities of 13%, 12% and 3%, respectively. Both Kilcunda (VIC) and Venus Bay (VIC) recorded the minimum time before contact at the low threshold where oil was predicted to take 9 hours before reaching the shorelines.

The maximum potential shoreline loading above the low, moderate and high shoreline thresholds are presented in Figure 12.2.

Table 12.1 Potential zones of oil exposure on the sea surface, at each threshold. Results are based on a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

Distance and direction travelled	Zones of potential sea surface exposure		
	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (≥50 g/m^2)
Maximum distance (km) from the release location	26.6	10.7	2.5
Maximum distance from release site (km) (99th percentile)	23.1	10.1	2.5
Direction	East-southeast	South	West

Table 12.2 Summary of shoreline contact above 10 g/m^2, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

Shoreline Statistics	MDO surface release over 6 hours (Scenario 2)
Probability of contact to any shoreline at or above the low threshold (%)	39
Absolute minimum time before contact at or above the low threshold (hours)	10
Maximum volume of hydrocarbons ashore (m^3) from a single simulation	172
Average volume of hydrocarbons ashore across all simulations reaching the shorelines (m^3)	24
Maximum length of the shoreline at **10 g/m^2** (km)	11.0
Average shoreline length (km) at **10 g/m^2** (km)	4.9
Maximum length of the shoreline at **100 g/m^2** (km)	7.0
Average shoreline length (km) at **100 g/m^2** (km)	2.9
Maximum length of the shoreline at **1,000 g/m^2** (km)	4.0
Average shoreline length (km) at **1,000 g/m^2** (km)	1.8

Table 12.3 Summary of the potential sea surface exposure to individual receptors. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

Receptor		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (hours)		
		Low (1-10 g/m²)	Moderate (10-50 g/m²)	High (≥ 50 g/m²)	Low (1-10 g/m²)	Moderate (10-50 g/m²)	High (≥ 50 g/m²)
BIA	Little Penguin - Foraging	33	15	-	4	6	-
	White Shark - Foraging	32	12	-	4	7	-
IBRA	Gippsland Plain	35	7	-	8	11	-
MNP	Bunurong	1	-	-	28	-	-
NP	Bunurong Marine Park	7	1	-	12	30	-
Nearshore	Bass Coast	34	7	-	8	11	-
	Phillip Island	1	-	-	19	-	-
Sub-LGA	Kilcunda	30	7	-	8	11	-
	Venus Bay	4	-	-	12	-	-

Table 12.4 Summary of oil contact to individual shorelines. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

Shoreline Receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	>10 g/m²	>100 g/m²	>1,000 g/m²	>10 g/m²	>100 g/m²	>1,000 g/m²	Mean	Peak	Mean	Peak	>10 g/m²	>100 g/m²	>1,000 g/m²	>10 g/m²	>100 g/m²	>1,000 g/m²
Cape Liptrap (NW) - VIC	3	2	-	38	55	-	165.4	510.6	4.3	7.9	2.0	2.0	-	3.0	2.0	-
Kilcunda - VIC	34	31	7	10	12	17	263.6	6759.2	21.8	172.6	4.3	2.7	2.1	11.0	7.0	4.0
Phillip Island - VIC	1	1	-	20	24	-	74.3	155.2	2.6	2.6	2.0	1.0	-	2.0	1.0	-
Venus Bay - VIC	13	12	3	10	18	31	340.6	1340.6	12.6	26.7	2.8	2.0	1.0	6.0	4.0	1.0
Waratah Bay - VIC	1	1	-	70	106	-	494.8	554.5	11.6	11.6	2.0	2.0	-	2.0	2.0	-

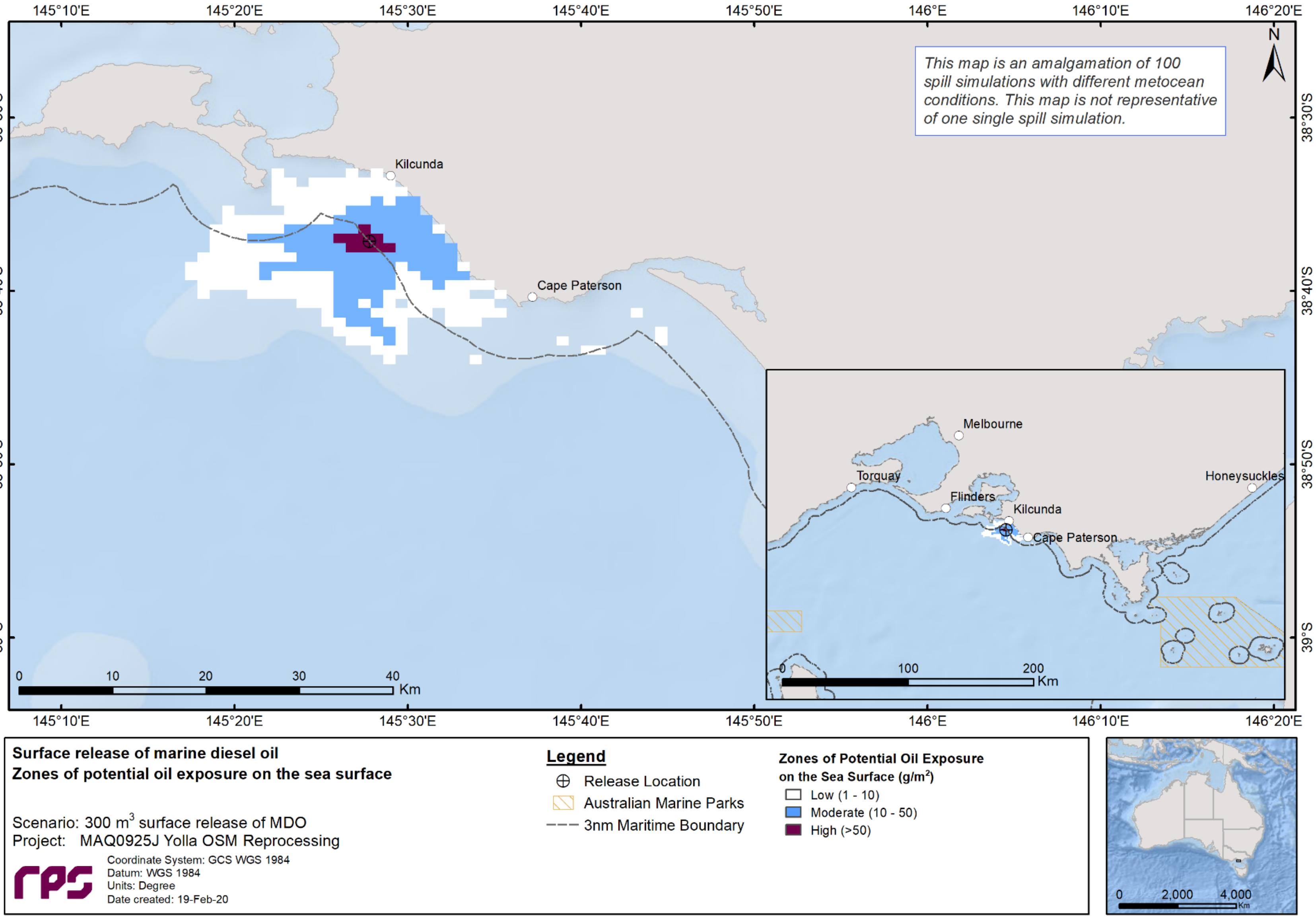


Figure 12.1 Zones of potential oil exposure on the sea surface, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

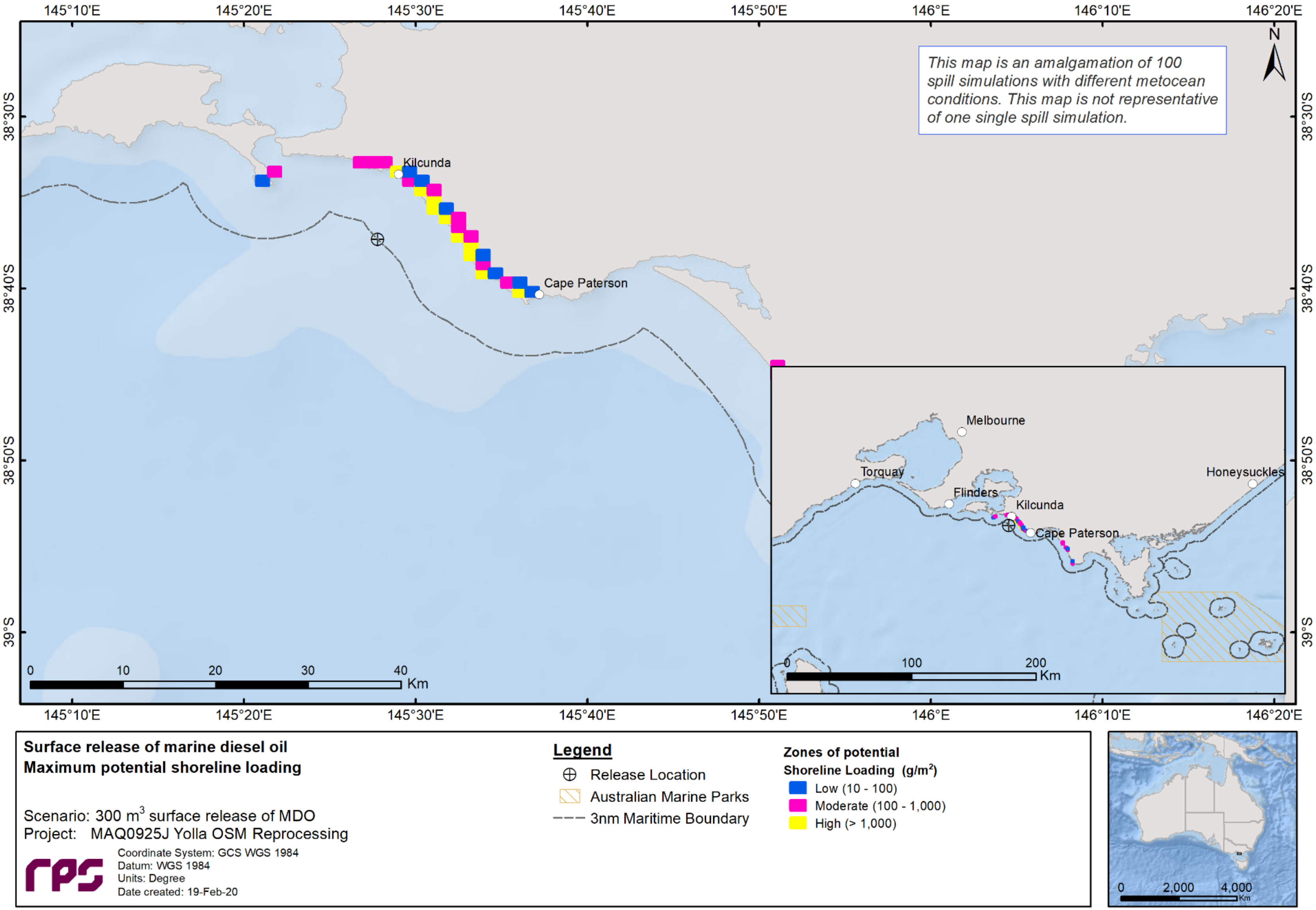


Figure 12.2 Maximum potential shoreline loading, in in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

12.1.2 In-water exposure

12.1.2.1 Dissolved Hydrocarbons

Table 12.5 summarises the maximum distance and direction from the release location to dissolved hydrocarbons in the 0-10 m depth layer at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels (NOPSEMA, 2019). The maximum distance of dissolved hydrocarbons at the low and moderate thresholds from the release location was predicted as 97 km (southeast) and 9 km (east-southeast), respectively. No dissolved hydrocarbon exposure was predicted at, or above, the high threshold.

Table 12.6 summarises the probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m depth layer for the annualised assessment.

In the surface layer (0-10 m), Gippsland Plain IBRA, Bass Coast and Venus Bay Sub-LGA recorded the highest probability of low dissolved hydrocarbon exposure with 11%. Additionally, the Kilcunda Sub-LGA and Bunurong Marine Park recorded 10% and 9% probabilities of low dissolved hydrocarbon exposure. Moderate dissolved hydrocarbon exposure was predicted at Gippsland Plain IBRA, Bunurong Marine Park, Bass Coast and Kilcunda Sub-LGA with a predicted probability of 1%. Dissolved hydrocarbons at the moderate threshold were predicted at excluded receptors (see Table 10.2) while no dissolved hydrocarbons were predicted at or above the high exposure threshold. No dissolved hydrocarbon exposure was predicted to occur below a depth of 10 m.

Figure 12.3 presents the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels.

Figure 12.4 presents the potential zones of dissolved hydrocarbon exposure in the benthic layer for the annual assessment at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels.

Figure 12.5 to Figure 12.8 depict potential zones of dissolved hydrocarbon exposure, on an annual basis, through the water column along transects oriented along cardinal directions.

Figure 12.9 to Figure 12.12 also present the potential zones of dissolved aromatic exposure along transects but for a single trajectory, rather than the annual results which are a composite of 100 runs. These images illustrate the potential impact for the spill trajectory that affected the largest volume of water at the low exposure level (10-50 ppb).

Table 12.5 Maximum distance and direction from the release location to dissolved hydrocarbon exposure (0 – 10m). Results are based on the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

Distance and direction travelled	Zones of potential dissolved hydrocarbon exposure		
	Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb
Maximum distance (km) from the release location	97	9	-
Direction	Southeast	East-southeast	-

Table 12.6 Probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m depth layer. Results are based on the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

Receptor		0 - 10 m			
		Maximum instantaneous dissolved hydrocarbon exposure	Probability of instantaneous hydrocarbon exposure		
			Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb
BIA	Little Penguin - Foraging	39.67	8	-	-
	White Shark - Foraging	39.67	7	-	-
IBRA	Gippsland Plain	64.19	11	1	-
	Strzelecki Ranges	13.14	1	-	-
	Wilsons Promontory	10.47	1	-	-
IMCRA	Central Bass Strait	19.20	1	-	-
	Flinders	12.88	1	-	-
MNP	Bunurong	36.05	6	-	-
	Wilsons Promontory	10.72	1	-	-
NP	Bunurong Marine Park	51.24	9	1	-
Nearshore	Bass Coast	64.19	11	1	-
	Kanowna Island	10.47	1	-	-
	Phillip Island	10.04	1	-	-
	Skull Rock	10.47	1	-	-
	South Gippsland	24.86	5	-	-
Sub-LGA	Cape Liptrap (NW)	24.86	5	-	-
	Kilcunda	64.19	10	1	-
	Venus Bay	39.96	11	-	-
	Waratah Bay	19.73	2	-	-

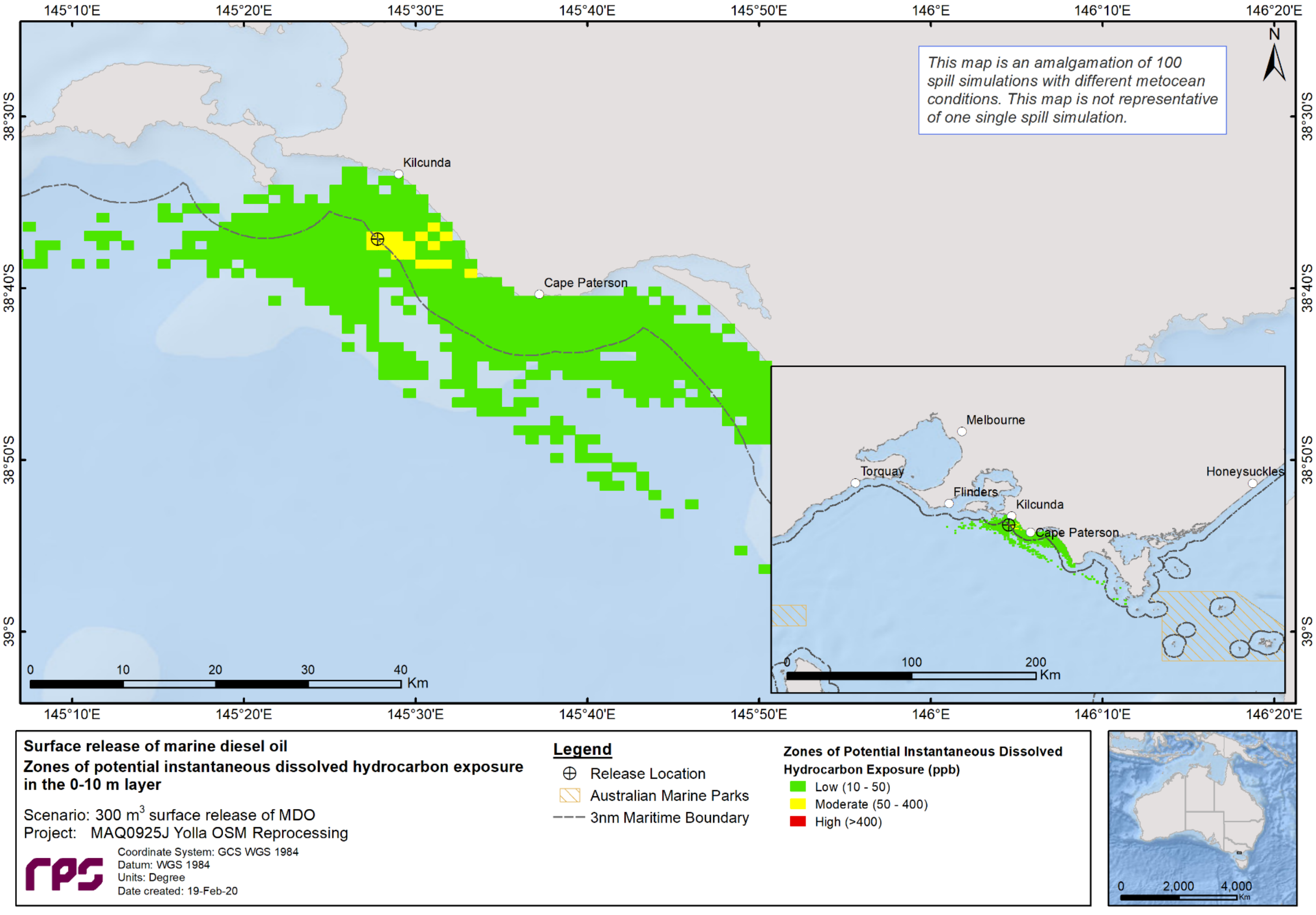


Figure 12.3 **Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.**

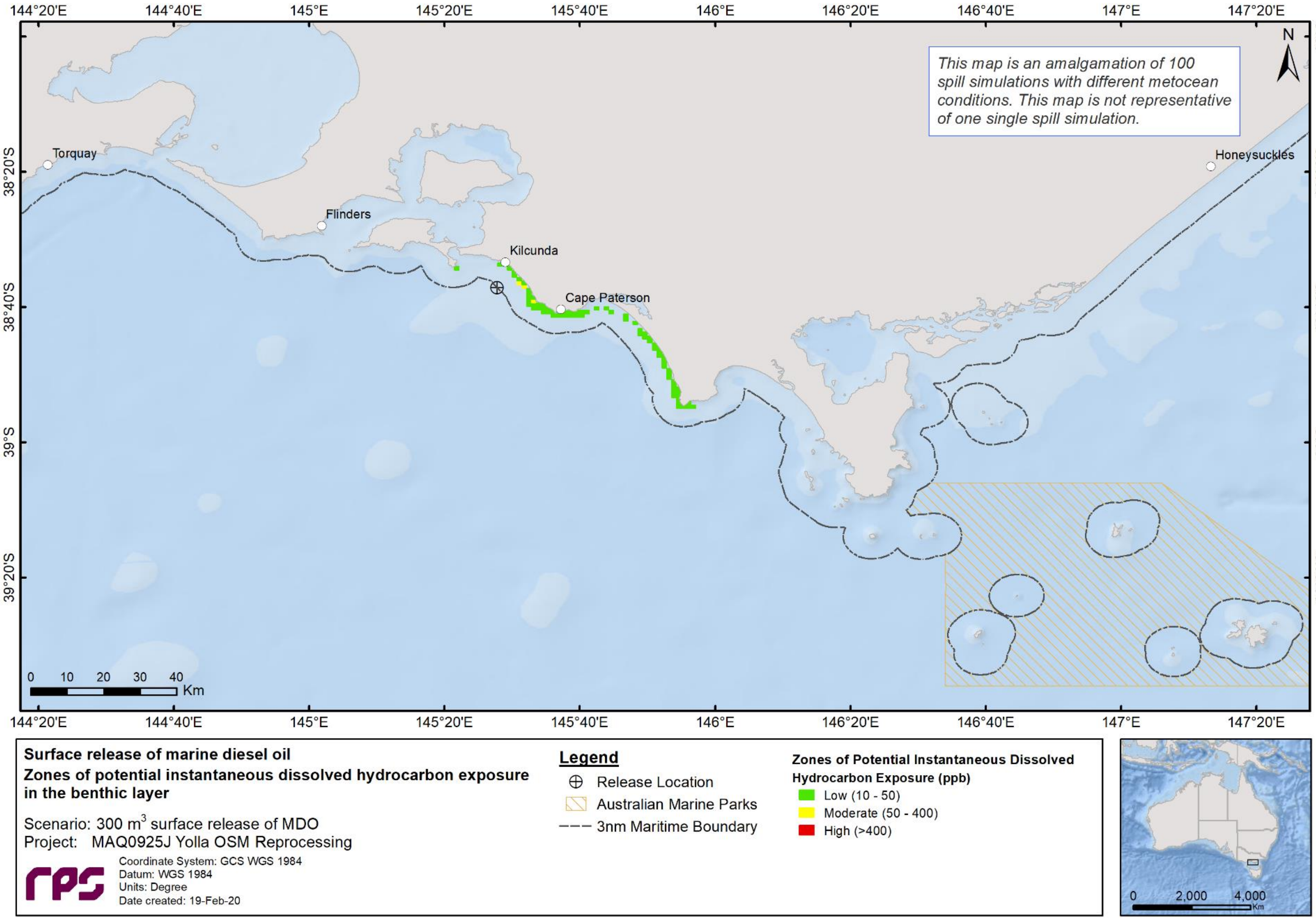


Figure 12.4 **Benthic interaction of zones of potential dissolved hydrocarbon exposure, in the event of a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.**

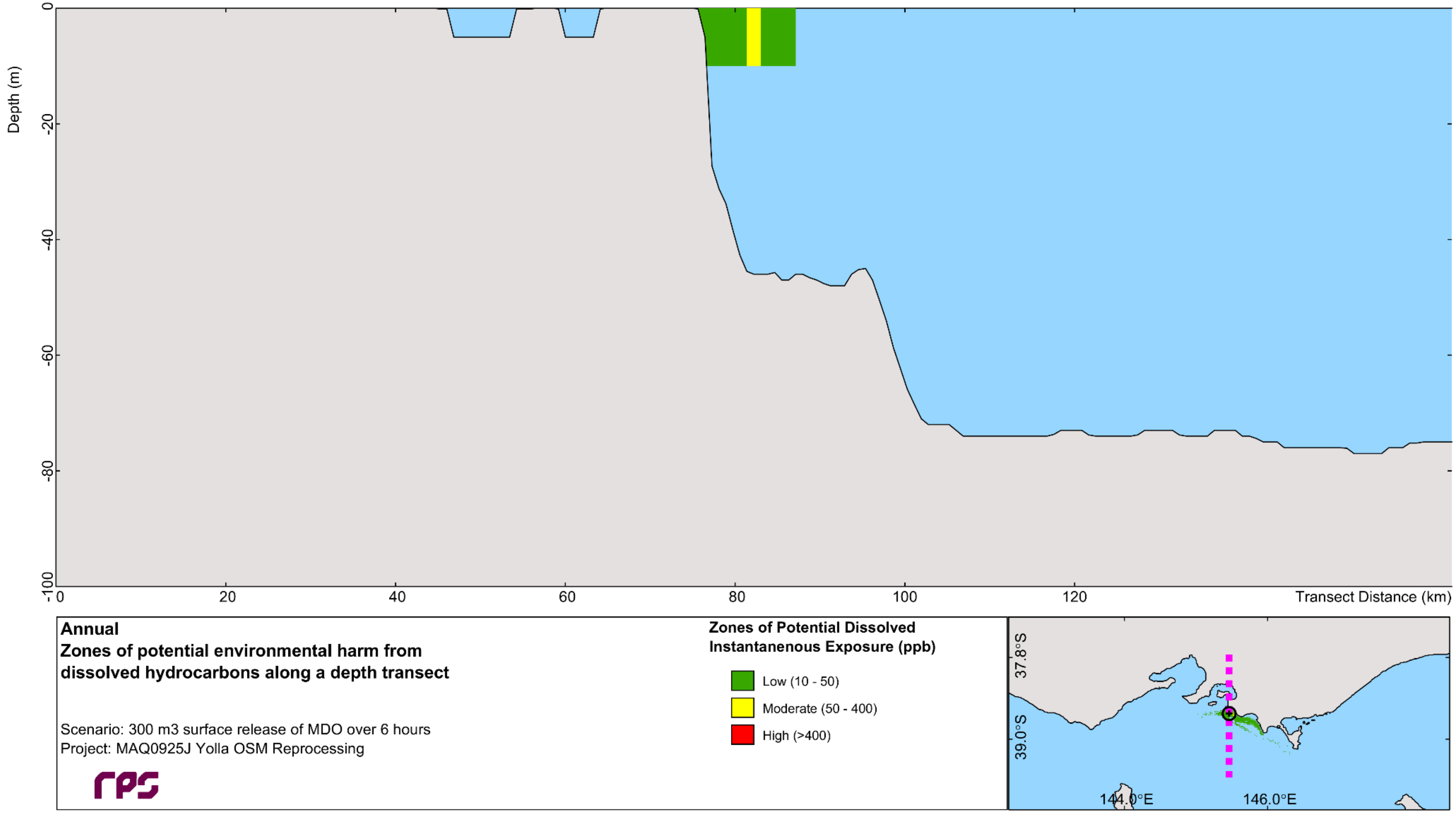


Figure 12.5 Transect plot (north to south) illustrating zones of potential dissolved hydrocarbon exposure through the water column, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

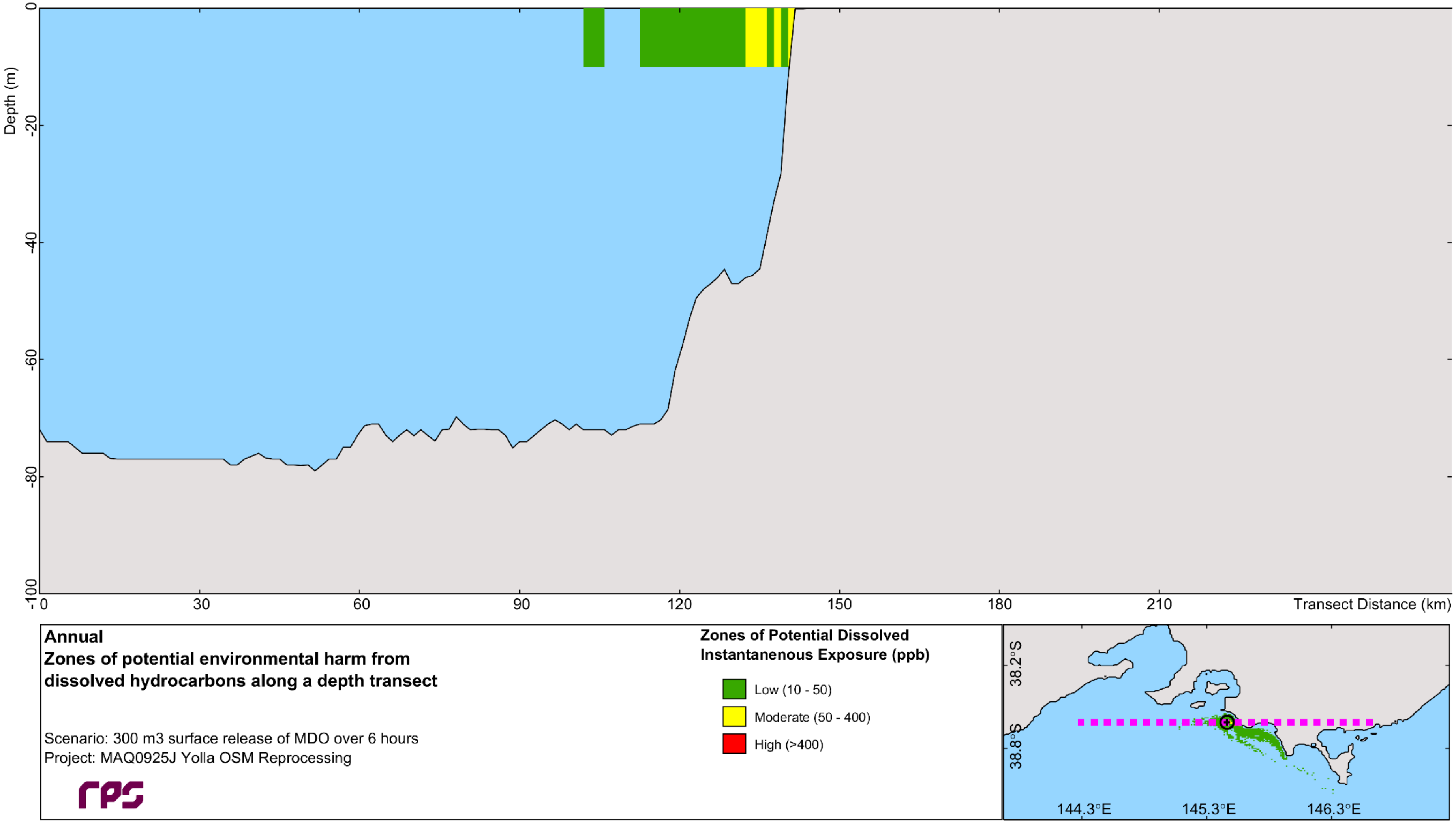


Figure 12.6 **Transect plot (west to east) illustrating zones of potential dissolved hydrocarbon exposure through the water column, in the event of a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.**

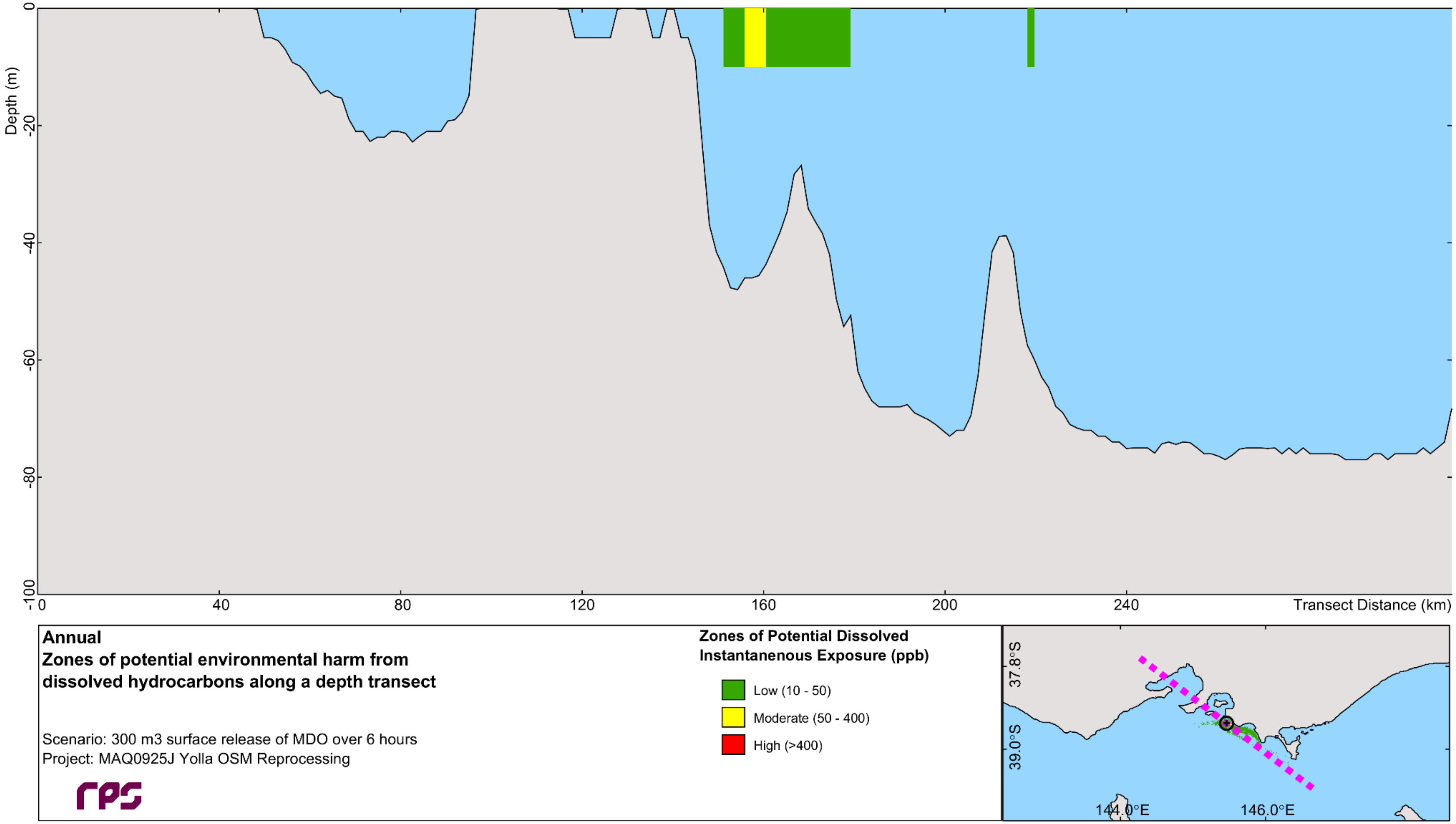


Figure 12.7 Transect plot (northwest to southeast) illustrating zones of potential dissolved hydrocarbon exposure through the water column, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

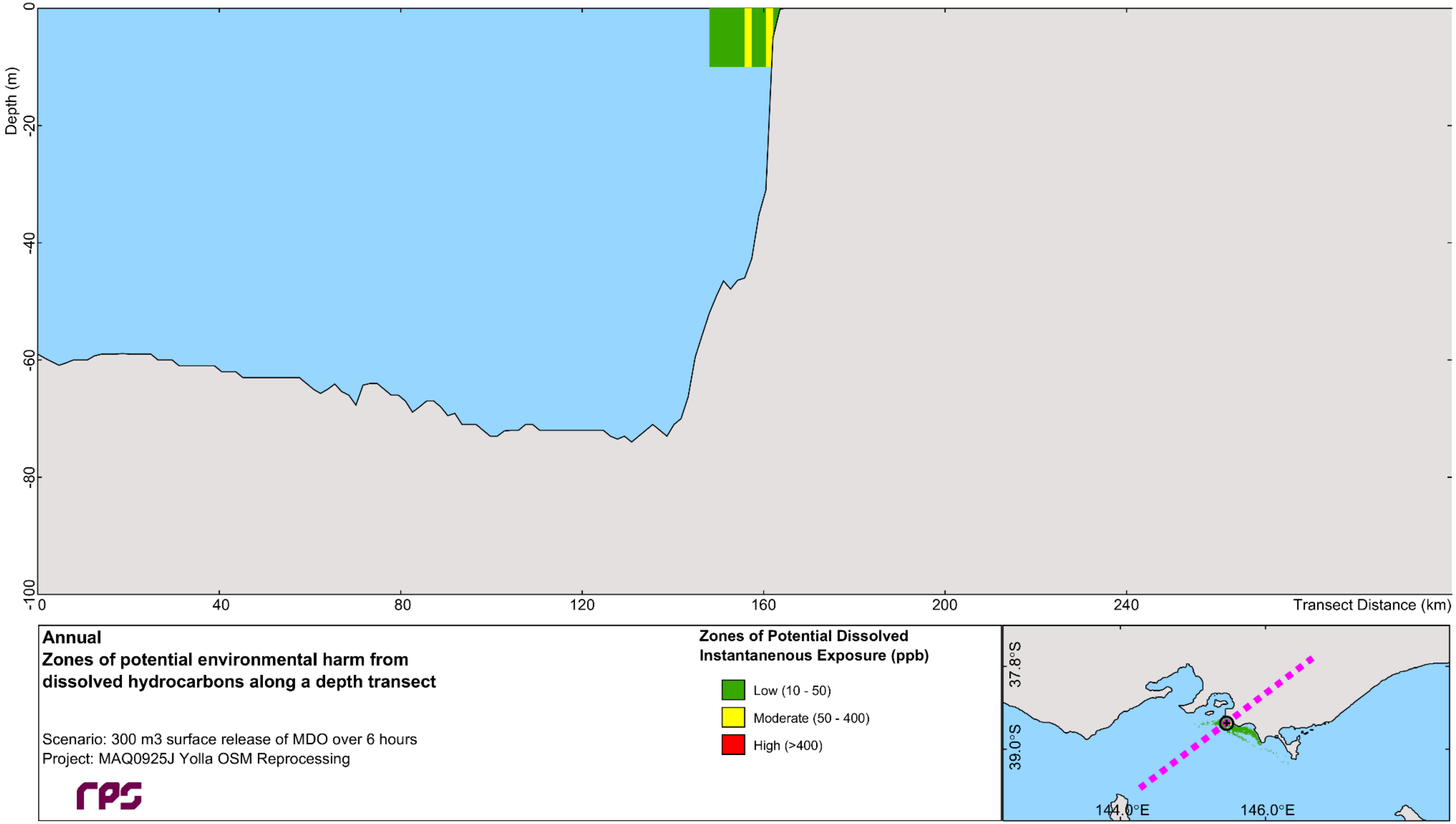


Figure 12.8 **Transect plot (northeast to southwest) illustrating zones of potential dissolved hydrocarbon exposure through the water column, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.**

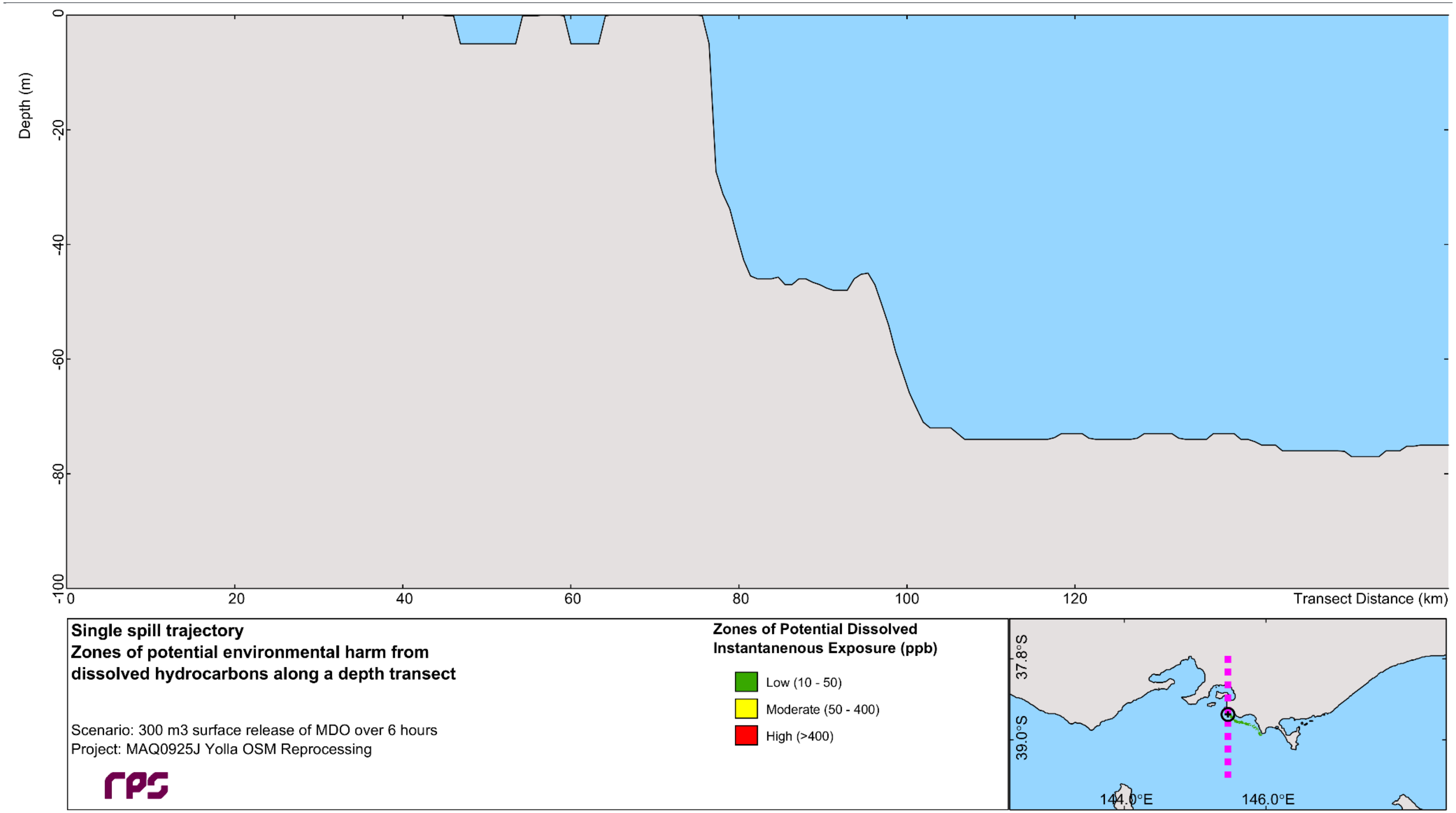


Figure 12.9 Transect plot (north to south) illustrating zones of potential dissolved hydrocarbon exposure through the water column for a single spill trajectory, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days.

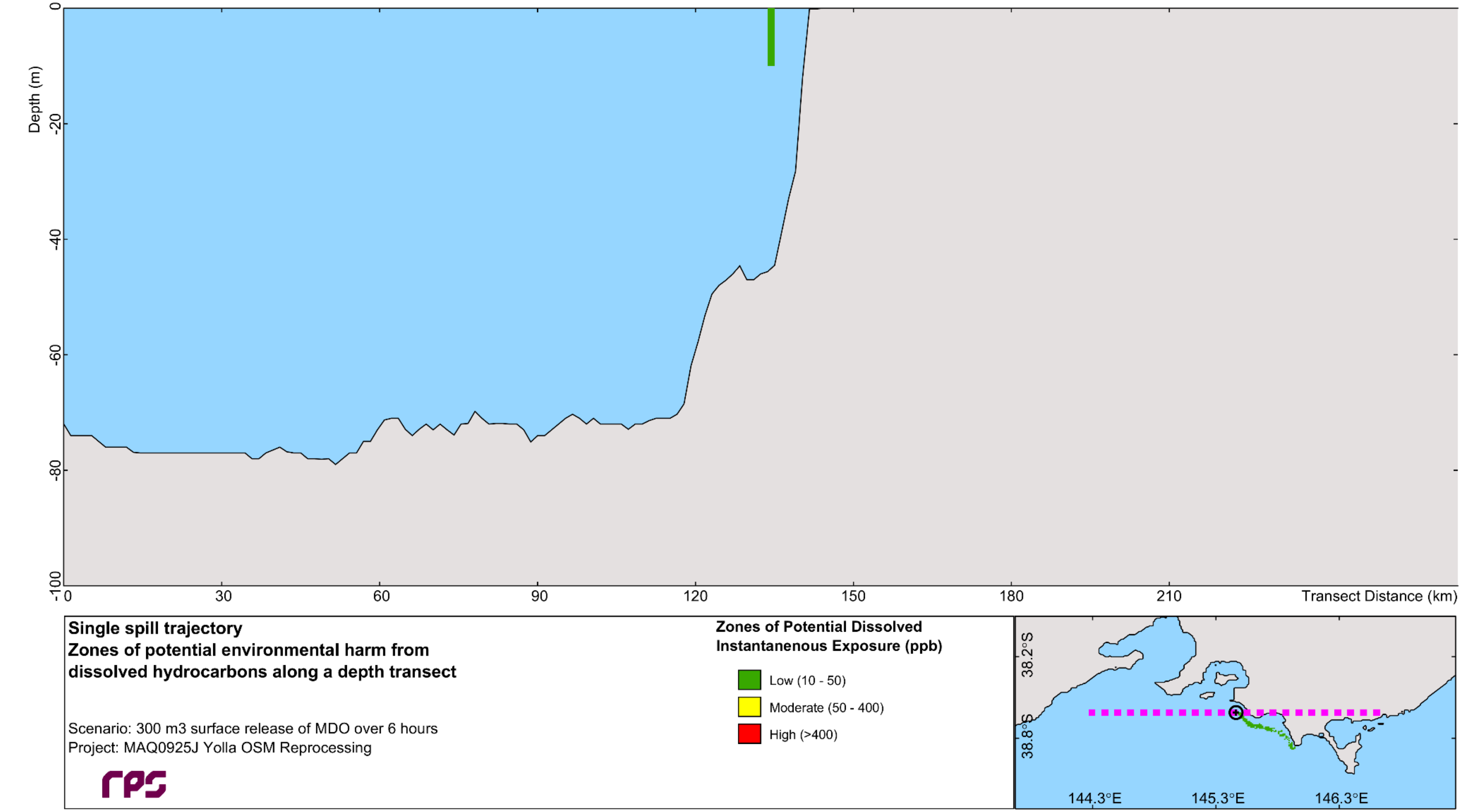


Figure 12.10 Transect plot (west to east) illustrating zones of potential dissolved hydrocarbon exposure through the water column for a <u>single spill trajectory</u>, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days.

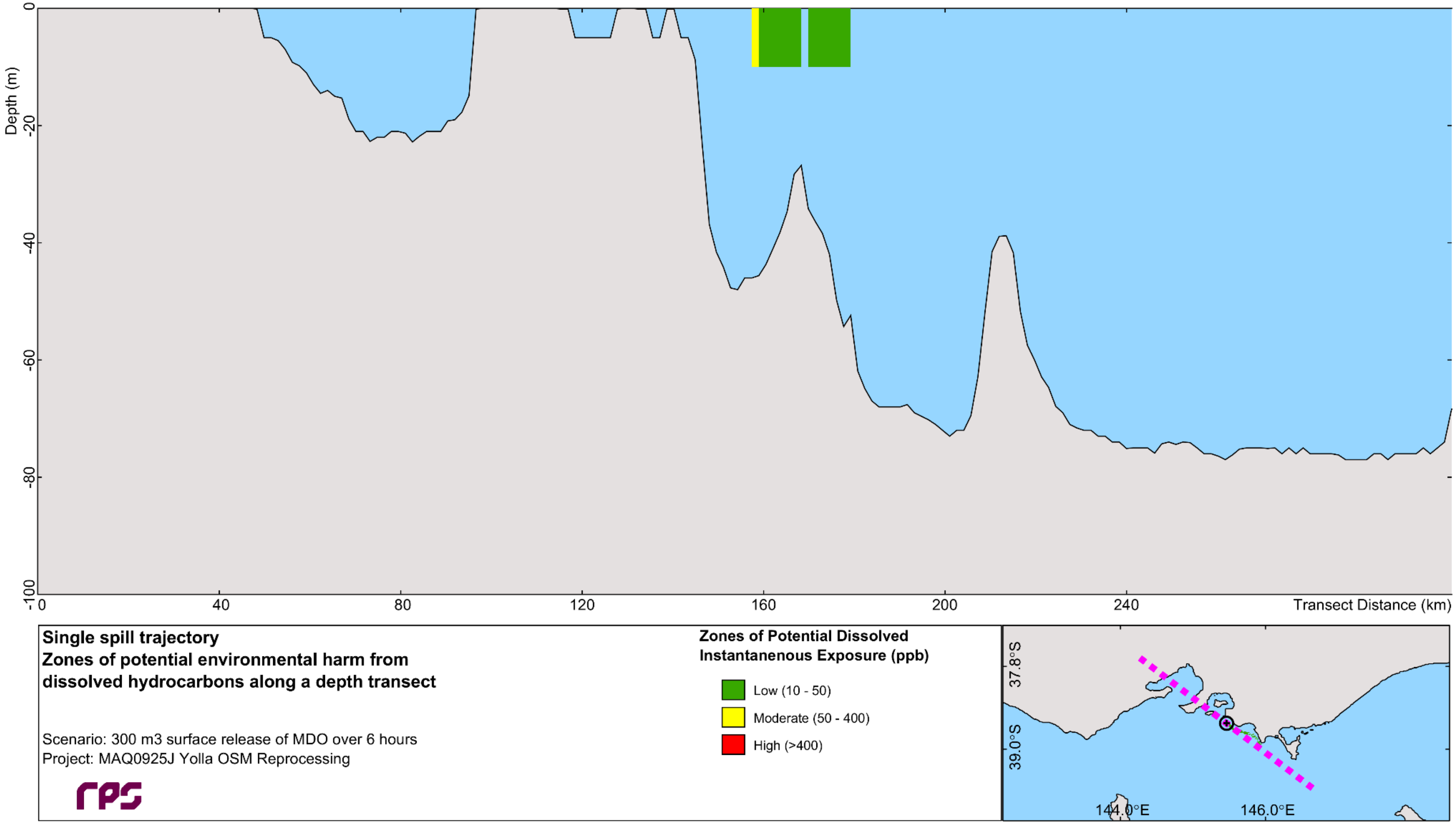


Figure 12.11 Transect plot (northwest to southeast) illustrating zones of potential dissolved hydrocarbon exposure through the water column for a <u>single spill trajectory</u>, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days.

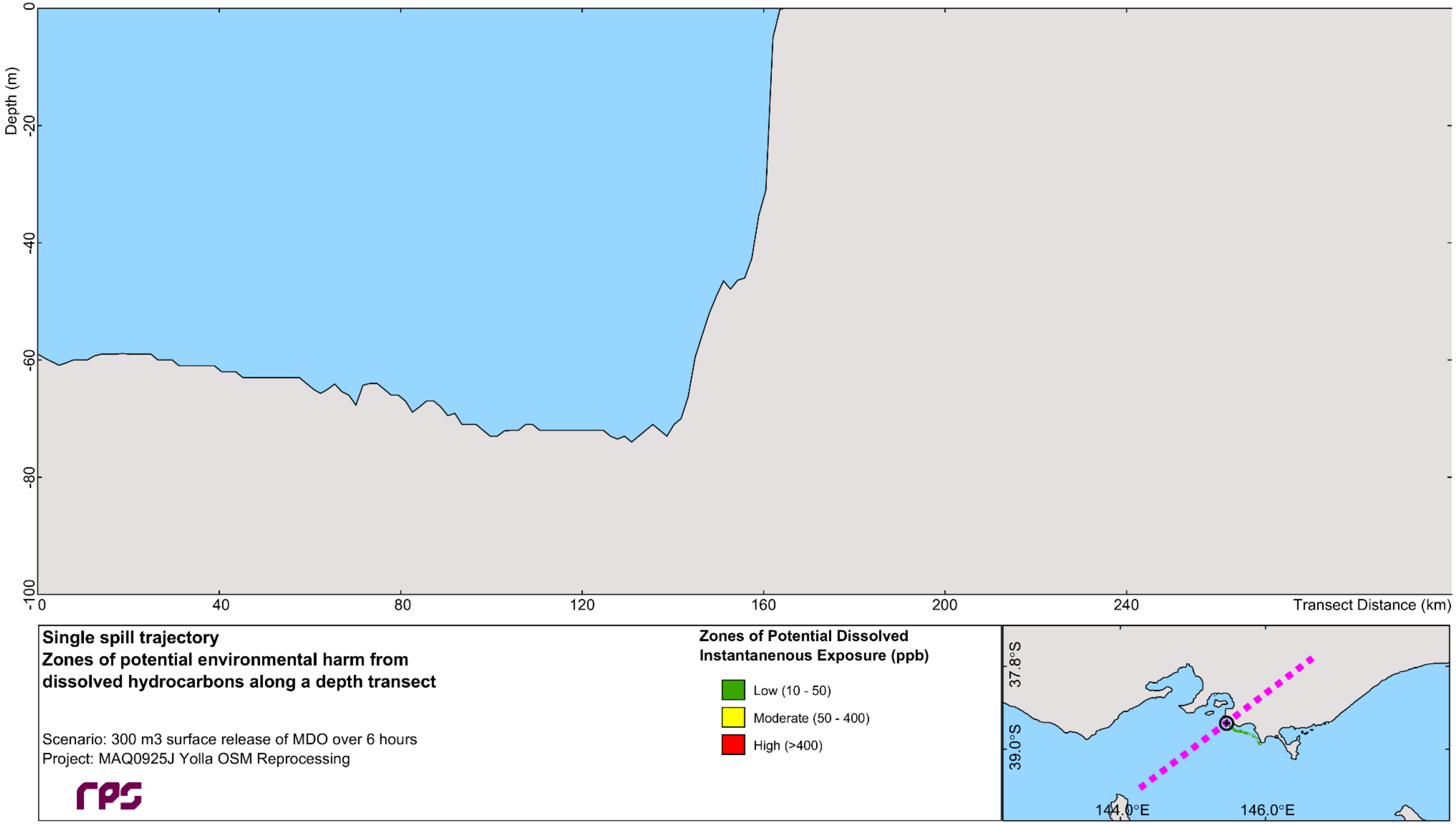


Figure 12.12 Transect plot (northeast to southwest) illustrating zones of potential dissolved hydrocarbon exposure through the water column for a <u>single spill trajectory</u>, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days.

12.1.2.2 Entrained Hydrocarbons

Table 12.7 summarises the maximum distance and direction from the release location to entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) exposure levels (NOPSEMA, 2019). The maximum predicted distance of entrained hydrocarbons at the low and high thresholds from the release location was 506 km (east-northeast) and 122 km (east-southeast), respectively.

Table 12.8 presents the probability of exposure to individual receptors from entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) exposure levels in the 0-10 m depth layer for the annualised assessment.

In the surface layer (0-10 m), the Gippsland Plain IBRA, the Bunurong MNP, and the Bass Coast all recorded the greatest probability of low exposure to entrained hydrocarbons with 81%. Additionally, Venus Bay Sub-LGA recorded an 80% probability of exposure to low entrained hydrocarbons and both the Bunurong Marine Park and Kilcunda Sub-LGA recorded a 79% probability of low entrained hydrocarbon exposure. At the high entrained hydrocarbon threshold, the Gippsland Plain IBRA, the Bass Coast and Kilcunda Sub-LGA recorded the highest probability of exposure with 56%.

It should be noted that multiple receptors were predicted to be exposed to entrained hydrocarbons at or above the low threshold but were excluded from tabulated results due to the release location residing within their boundaries (i.e. all receptors recorded a 100% probability of exposure, refer to Table 10.2).

Entrained hydrocarbons at, or above the low exposure threshold were not predicted to occur below a depth of 10 m for this scenario.

Figure 12.13 illustrates the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer at the low (10-100 ppb) and high (≥100 ppb) exposure levels.

Figure 12.14 presents the potential zones of entrained hydrocarbon exposure in the benthic layer for the annual assessment at the low (10-100 ppb) and high (≥100 ppb) exposure levels.

Figure 12.15 to Figure 12.18 depict potential zones of entrained hydrocarbon exposure, on an annual basis, through the water column along transects oriented along cardinal directions.

Table 12.7 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

Distance and direction travelled	Zones of potential entrained hydrocarbon exposure	
	Low 10-100 ppb	High ≥100 ppb
Maximum distance (km) from the release location	506	122
Direction	East-northeast	East-northeast

Table 12.8 Probability of low, moderate and high exposure to marine based receptors from entrained hydrocarbons at 0–10 m below the sea surface. Results are based on the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
AMP	Apollo	21.54	1	-
	Beagle	129.59	17	1
BIA	Antipodean Albatross - Foraging	47.70	2	-
	Australasian Gannet - Foraging	19.75	2	-
	Black Petrel - Foraging	40.65	1	-
	Crested Tern - Foraging	14.17	1	-
	Flesh-footed Shearwater - Foraging	40.65	1	-
	Great-winged Petrel - Foraging	40.65	1	-
	Grey Nurse Shark - Foraging	40.16	1	-
	Grey Nurse Shark - Migration	45.85	1	-
	Humpback Whale - Foraging	47.70	1	-
	Indo-Pacific/Spotted Bottlenose Dolphin - Breeding	31.00	1	-
	Little Penguin - Breeding	116.88	16	2
	Little Penguin - Foraging	2,706.17	59	41
	Northern Giant Petrel - Foraging	40.65	1	-
	Short-tailed Shearwater - Breeding	180.09	27	3
	Southern Giant Petrel - Foraging	40.65	1	-
	Wedge-tailed Shearwater - Foraging	47.70	2	-
	White Shark - Breeding	76.71	11	-
	White Shark - Foraging	2,112.16	59	38
	White-capped Albatross - Foraging	40.65	1	-
	White-faced Storm-petrel - Breeding	47.70	1	-
	Wilsons Storm Petrel - Migration	40.65	1	-
IBRA	East Gippsland Lowlands	19.04	1	-
	Flinders	48.75	7	-
	Gippsland Plain	2,782.88	81	56

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
	Otway Plain	15.69	1	-
	Otway Ranges	13.09	1	-
	Strzelecki Ranges	228.79	69	18
	Wilsons Promontory	204.70	46	2
IMCRA	Batemans Shelf	45.85	1	-
	Central Bass Strait	666.36	49	13
	Flinders	328.61	58	5
	Otway	23.74	1	-
	Twofold Shelf	56.00	7	-
	Victorian Embayments	137.65	16	2
	Victorian Embayments	18.99	4	-
KEF	Canyons on the eastern continental slope	36.88	1	-
	Upwelling East of Eden	47.70	2	-
MNP	Bunurong	925.35	81	39
	Cape Howe	25.10	1	-
	Churchill Island	40.08	5	-
	Point Hicks	20.87	1	-
	Wilsons Promontory	122.94	44	3
MS	Mushroom Reef	16.81	1	-
NP	Bunurong Marine Park	1,789.57	79	46
	Corner Inlet Marine and Coastal Park	24.08	5	-
	Shallow Inlet Marine and Coastal Park	39.90	8	-
	Wilsons Promontory Marine Park	154.10	42	2
	Wilsons Promontory Marine Reserve	34.89	5	-
Ramsar	Corner Inlet	24.08	5	-
	Western Port	67.09	10	-
RSB	Cody Bank	387.41	39	9
	Cutter Rock	38.36	4	-

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
	New Zealand Star Bank	26.78	1	-
Nearshore	Anser Island	115.94	33	1
	Bass Coast	2,782.88	81	56
	Bega Valley	20.20	1	-
	Colac Otway	15.69	1	-
	Curtis Island	29.73	1	-
	East Gippsland	14.63	1	-
	French Island	13.49	1	-
	Gabo Island	11.62	1	-
	Glennie Group	170.03	46	2
	Hogan Island Group	48.75	7	-
	Kanowna Island	122.26	29	1
	Moncoeur Islands	129.41	11	2
	Mornington Peninsula	18.60	2	-
	Norman Island	204.70	46	3
	Phillip Island	556.11	25	8
	Rodondo Island	168.40	14	2
	Seal Islands	43.80	4	-
	Shellback Island	164.45	44	2
	Skull Rock	122.26	29	1
	South Gippsland	685.38	78	32
State Waters	New South Wales	31.00	1	-
	Tasmania State Waters	50.15	8	-
	Victoria State Waters	15.69	1	-
Sub-LGA	Apollo Bay	20.20	1	-
	Bega Valley	14.63	1	-
	Cape Howe / Mallacoota	652.83	78	32
	Cape Liptrap (NW)	12.19	1	-

Receptor	Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
		Low 10-100 ppb	High ≥100 ppb
Cape Otway West	24.08	5	-
Corner Inlet	12.82	1	-
Croajingolong (West)	14.96	2	-
French Island (East)	12.67	1	-
French Island / Crib Point	137.65	18	2
French Island / San Remo	2,782.88	79	56
Kilcunda	22.97	2	-
Mornington Peninsula (S)	10.04	1	-
Point Hicks	1,388.54	80	53
Venus Bay	228.79	69	18
Waratah Bay	12.84	2	-
Westernport	54.07	21	-
Wilsons Promontory (East)	179.71	44	2
Wilsons Promontory (West)	21.54	1	-

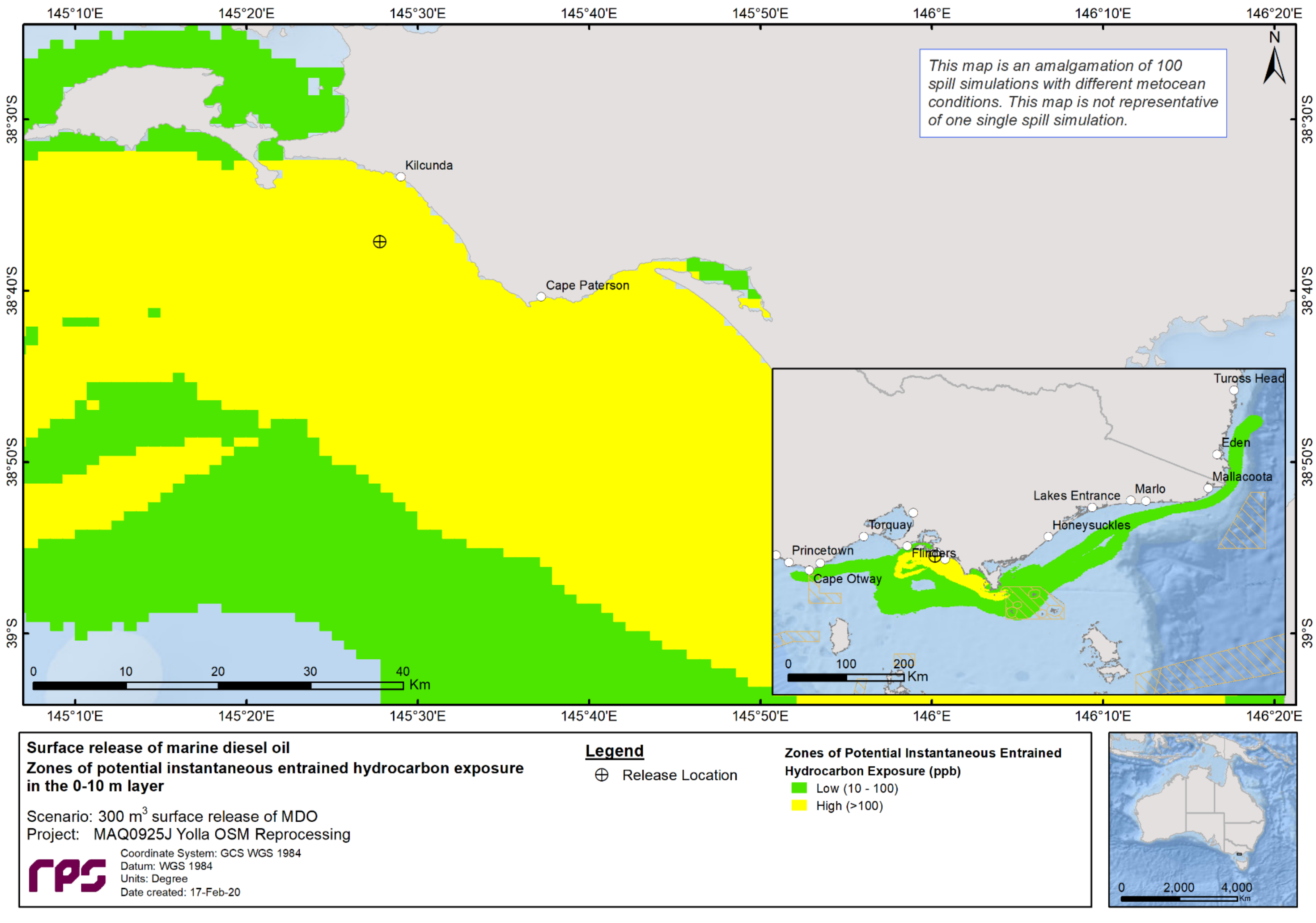
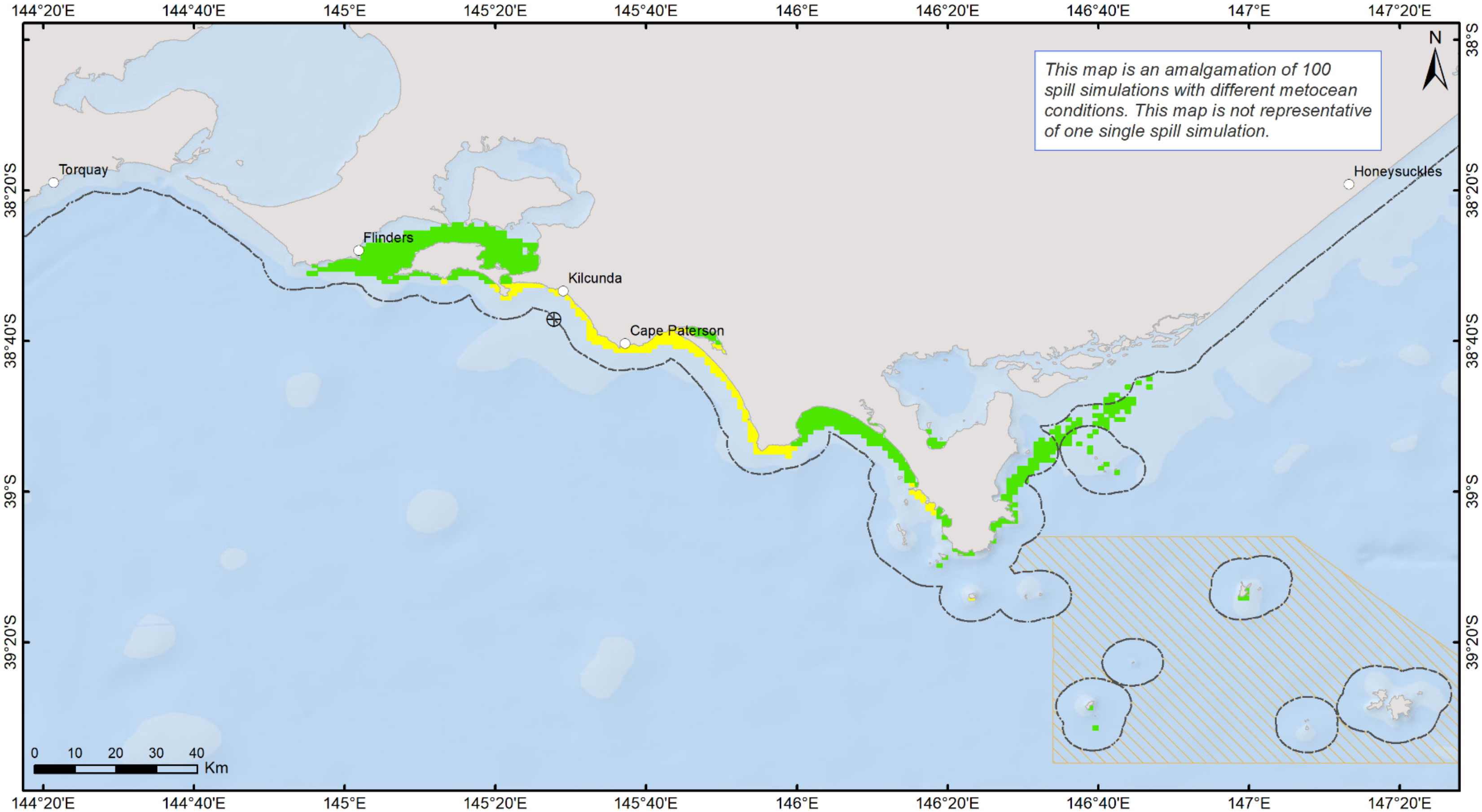


Figure 12.13 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.



Surface release of marine diesel oil
Zones of potential instantaneous entrained hydrocarbon exposure in the benthic layer

Scenario: 300 m³ surface release of MDO
Project: MAQ0925J Yolla OSM Reprocessing

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
Date created: 19-Feb-20

Legend
- Release Location
- Australian Marine Parks
- 3nm Maritime Boundary

Zones of Potential Instantaneous Entrained Hydrocarbon Exposure (ppb)
- Low (10 - 100)
- High (>100)

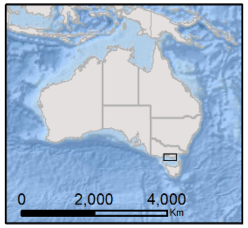


Figure 12.14 Benthic interaction of zones of potential instantaneous entrained hydrocarbon exposure in the event of a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

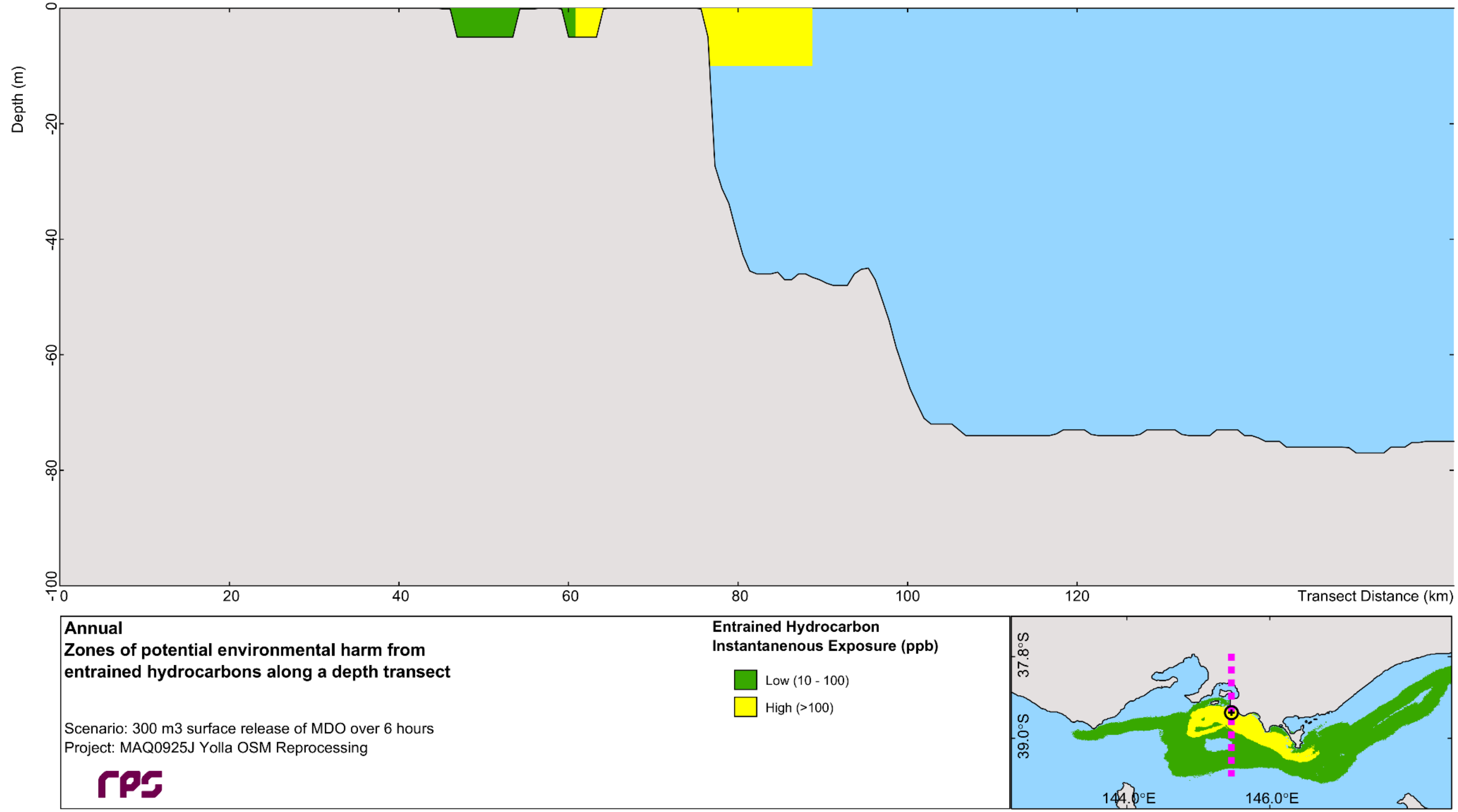


Figure 12.15 **Transect plot (north to south) illustrating zones of potential instantaneous entrained hydrocarbon exposure through the water column, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.**

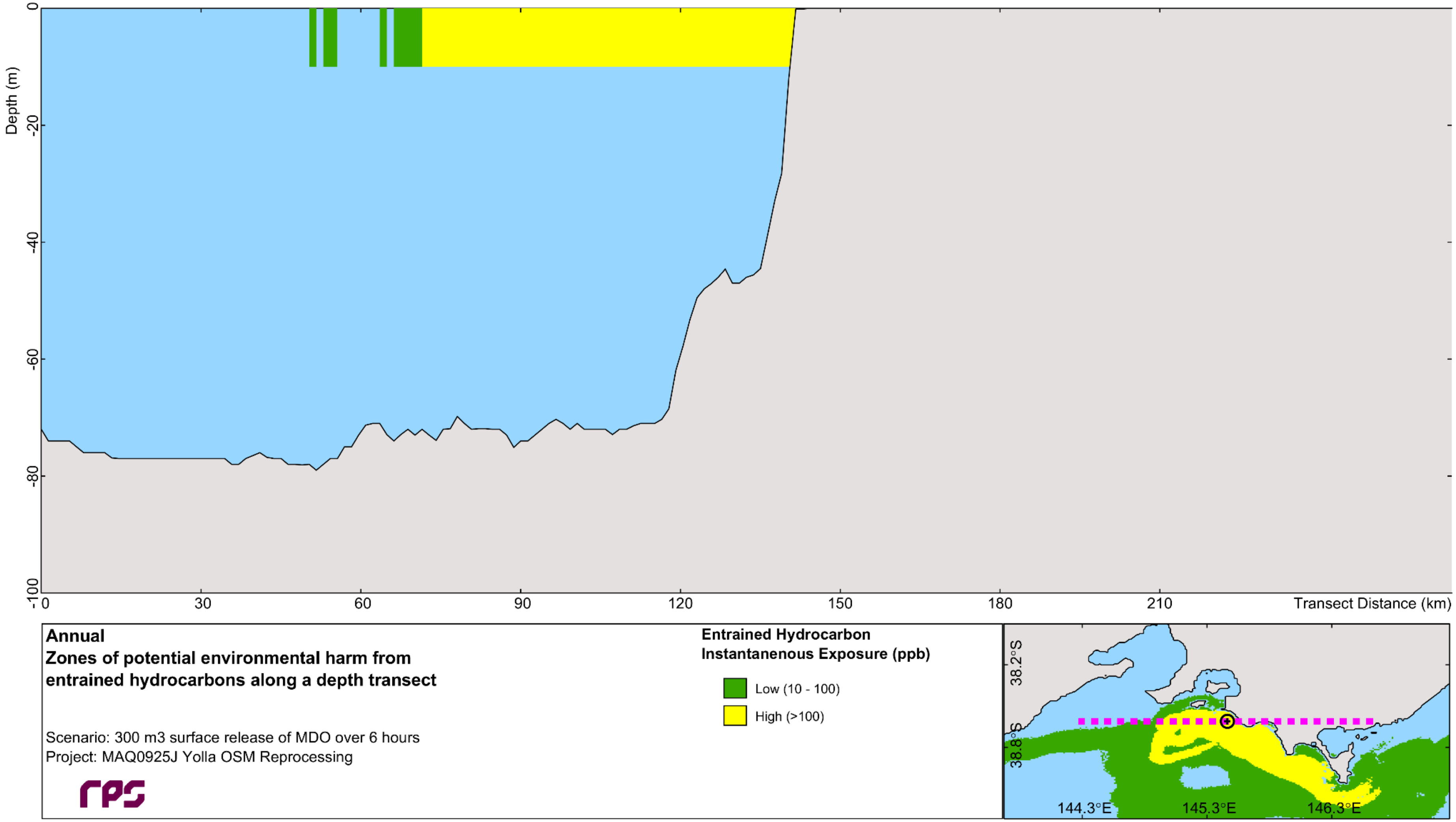


Figure 12.16 Transect plot (west to east) illustrating zones of potential instantaneous entrained hydrocarbon exposure through the water column, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

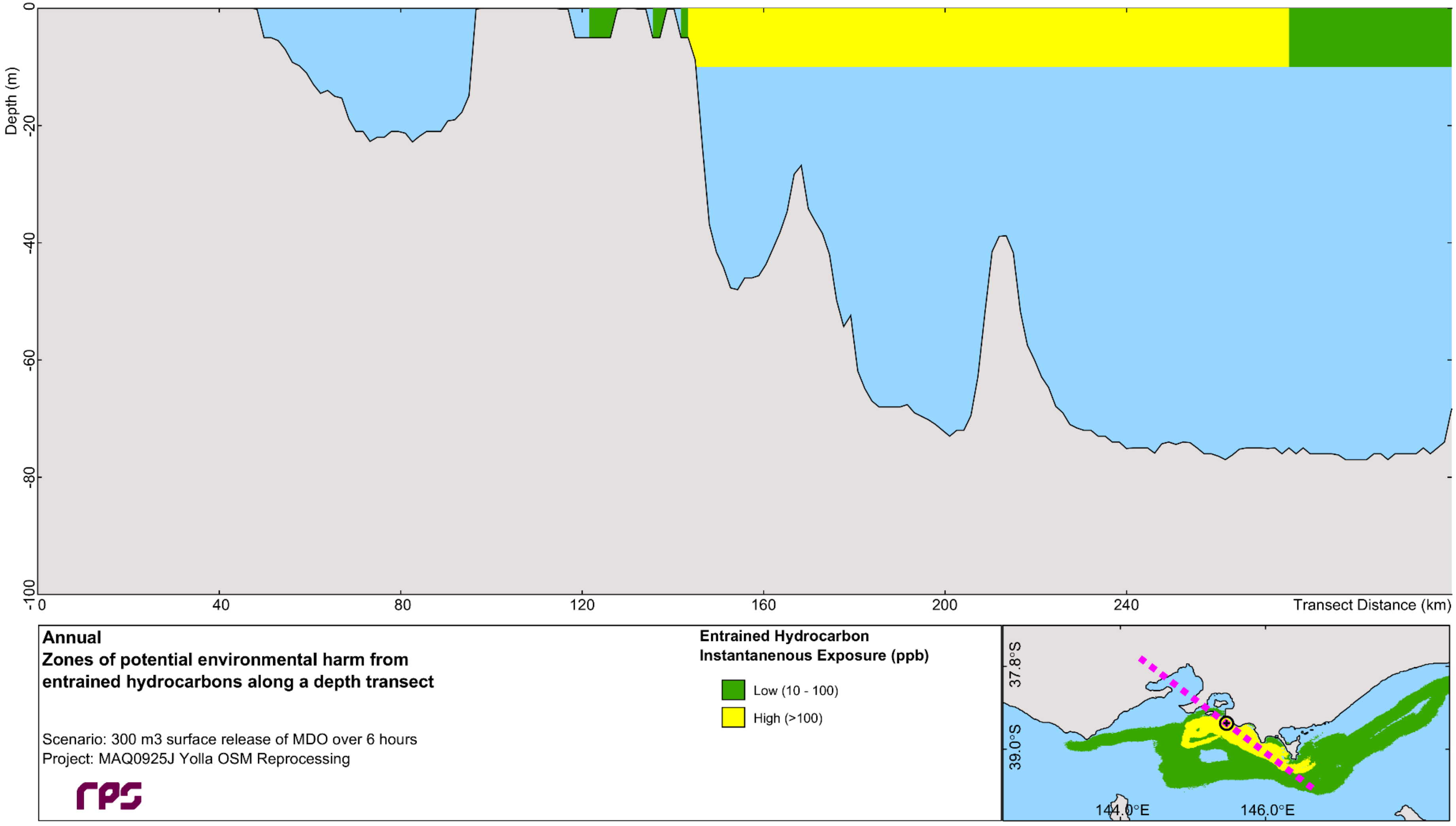


Figure 12.17 Transect plot (northwest to southeast) illustrating zones of potential instantaneous entrained hydrocarbon exposure through the water column, in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

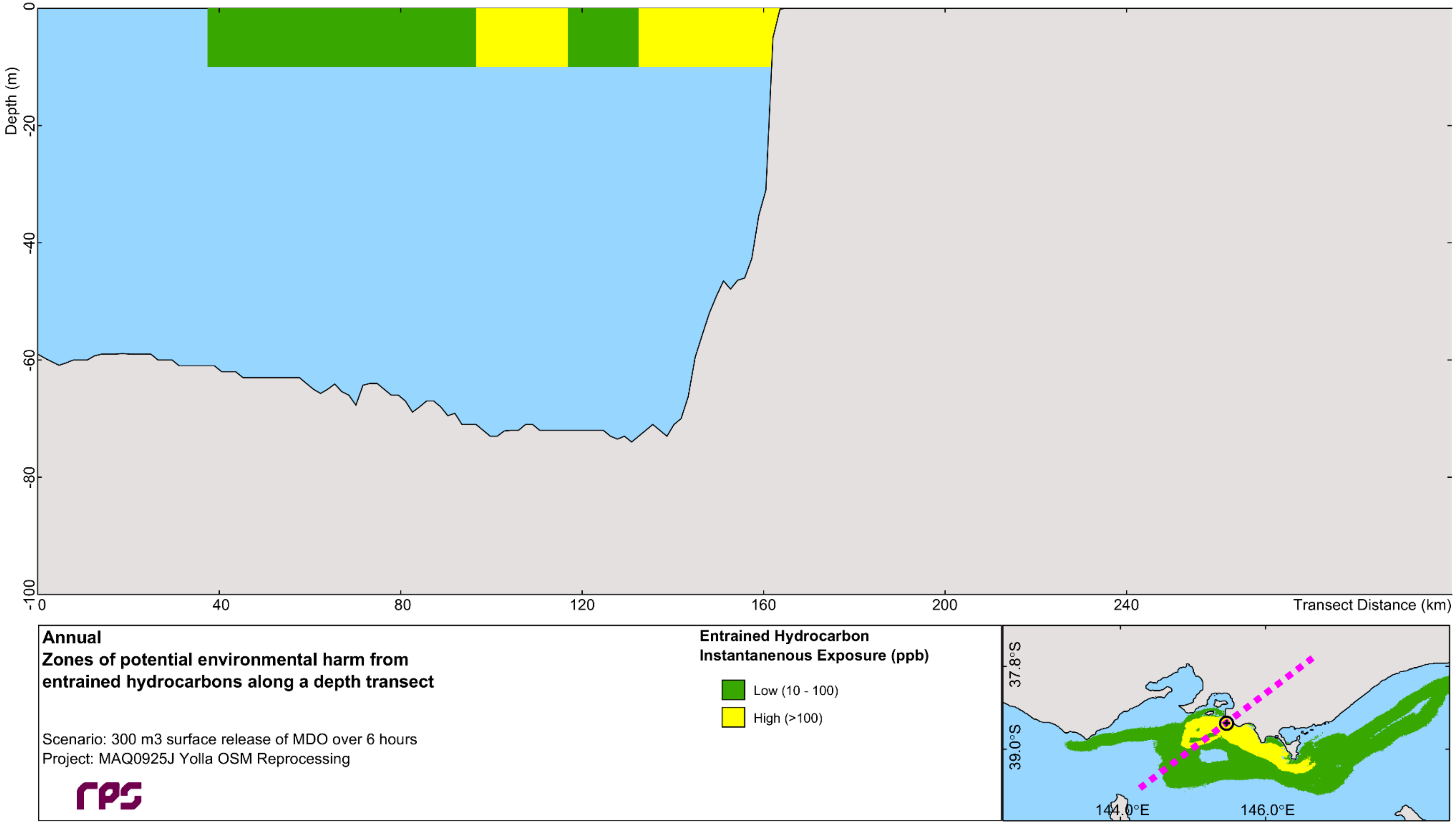


Figure 12.18 Transect plot (northeast to southwest) illustrating zones of potential instantaneous entrained hydrocarbon exposure through the water column in the event of a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories.

12.2 Deterministic Analysis

There were four metrics used select single spill trajectories for the deterministic analysis from the 100 simulations for the annualised analysis:

- Largest swept area at or above 10 g/m^2 (actionable sea surface oil);
- Minimum time to shore for visible sea surface oil (1 g/m^2);
- Largest volume of oil ashore, and
- Longest length of shoreline contacted at or above 100 g/m^2 (actionable shoreline oil).

12.2.1 Largest Swept Area

The deterministic trajectory that had the largest swept area of low (1-10 g/m^2) oil exposure on the sea surface commenced at 5:00 pm 20th May 2010.

Figure 12.19 presents the potential zone of low (1-10 g/m^2) exposure from sea surface oil, over the entire simulation (swept area). Zones of low (1-10 g/m^2) sea surface exposure were predicted to extend a maximum of ~13 km from the release site towards the south. Similarly, zones of moderate (or actionable oil ≥10 g/m^2) exposure extended ~11 km south from the release location.

Figure 12.20 displays a time series of the actionable oil on the sea surface (≥10 g/m^2) and visible (1-10 g/m^2) oil exposure on the sea surface over the 20-day simulation. The maximum area of coverage of visible (1-10 g/m^2) oil on the on the sea surface was ~16 km^2, whilst the maximum coverage of actionable (≥10 g/m^2) oil was 3 km^2. No shoreline oil was predicted for this trajectory.

Figure 12.21 presents the fates and weathering graph for the corresponding single spill trajectory. As marine diesel oil contains a high quantity of volatile hydrocarbons, a significant portion of the spilled diesel was lost to the atmosphere through evaporation. At the completion of the simulation period 45% (or 135 m^3) was predicted to have evaporated, whilst 47% (or 141 m^3) was predicted to remain in the water column. The decayed proportion of oil at the end of the model period was 8% (or ~25 m^3). No oil was predicted to remain on the sea surface at the completion of the 20-day modelling period.

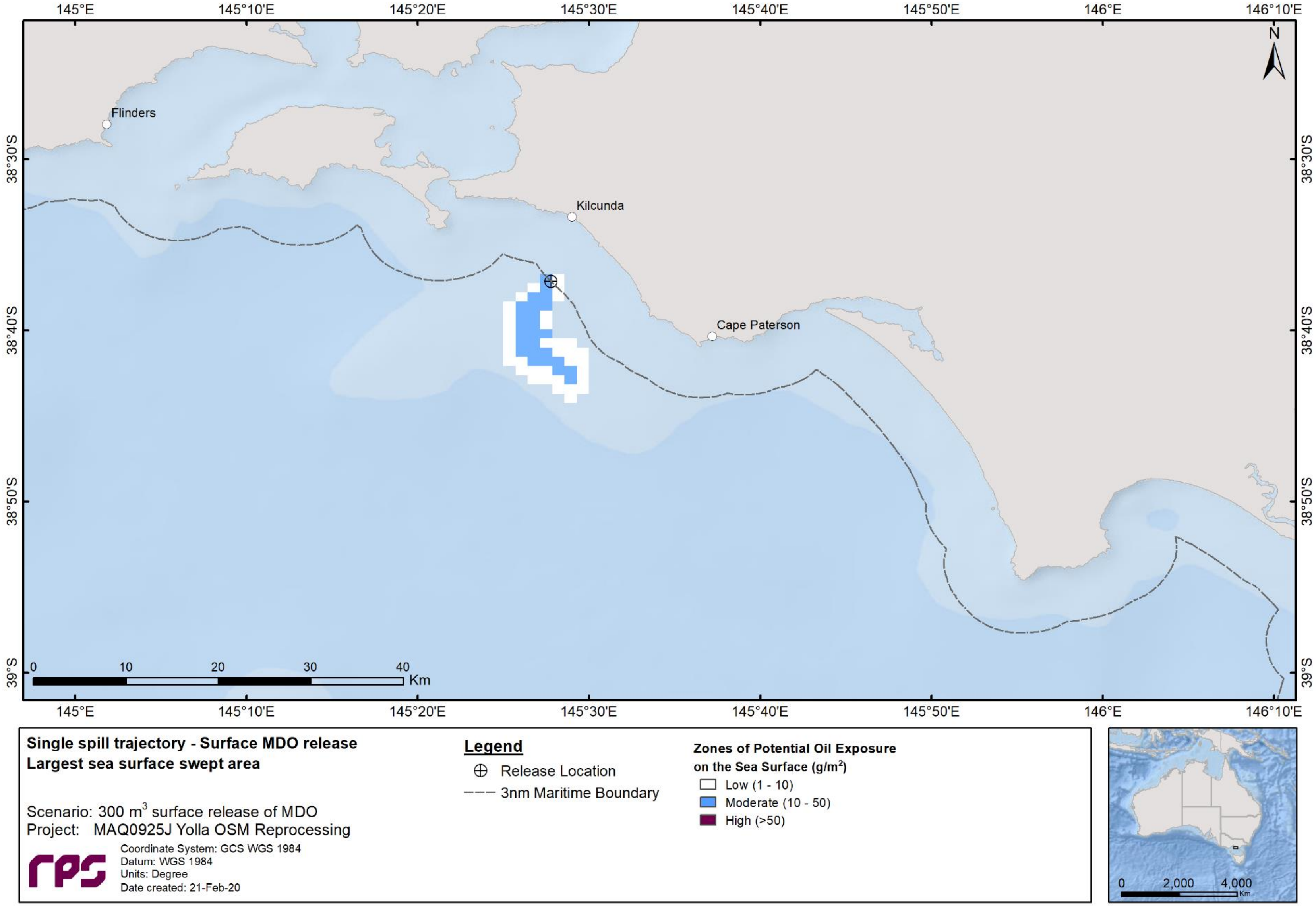


Figure 12.19 **Zones of potential oil exposure on the sea surface over the entire simulation for the identified deterministic trajectory. Results are based on a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days, starting 5:00 pm 20th May 2010.**

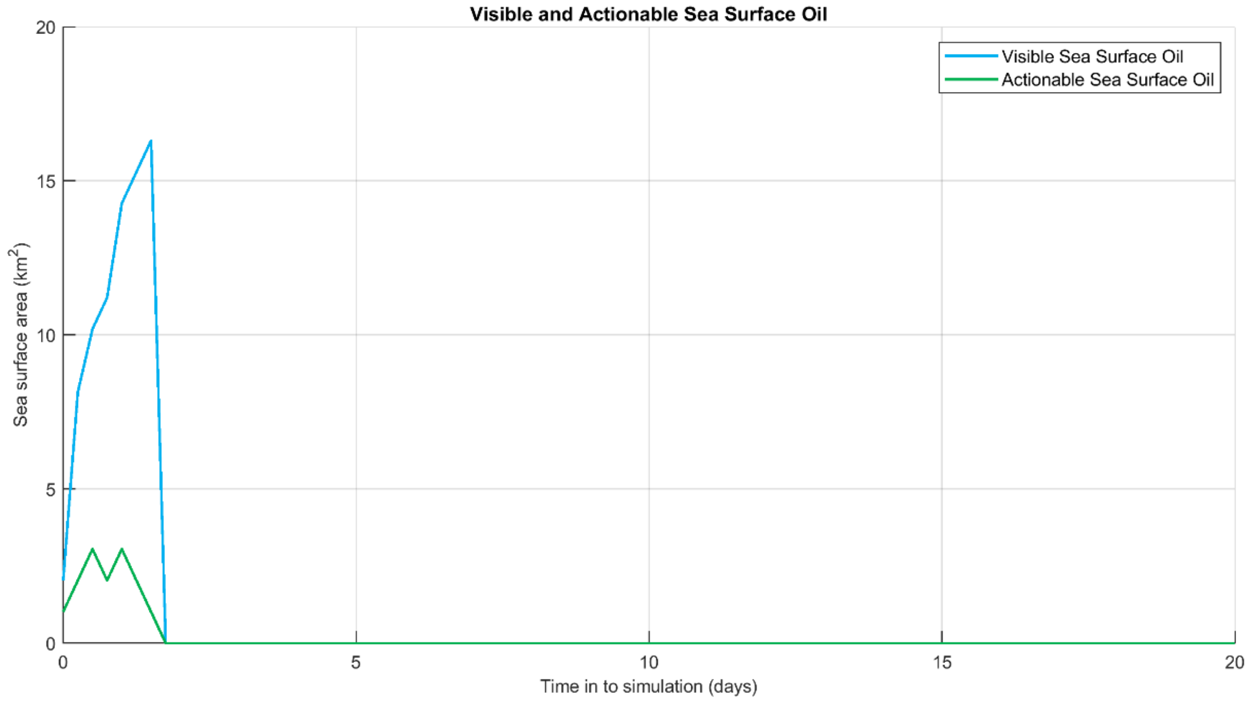


Figure 12.20 Time series of area of visible oil on the sea surface above the low threshold (1 g/m²), and actionable oil on the sea surface above the moderate threshold (10 g/m²). Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 5:00 pm 20th May 2010.

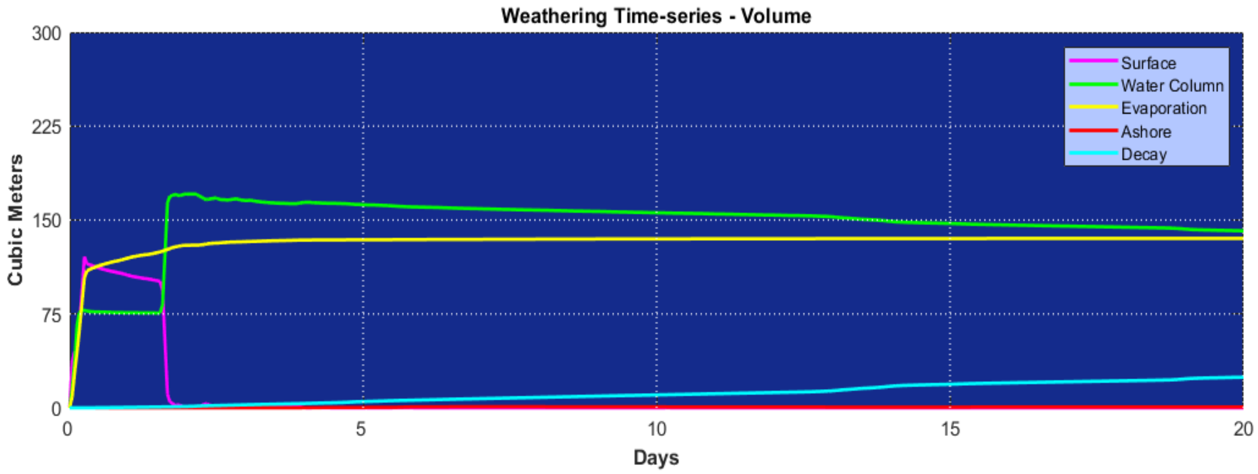


Figure 12.21 Predicted weathering and fates graph for the single spill trajectory. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 5:00 pm 20th May 2010.

12.2.2 Minimum Time to Shore for Visible Oil

The deterministic trajectory that resulted in the minimum time before shoreline contact above the low threshold (10 g/m^2) commenced at 5:00 pm 20th May 2010. The earliest shoreline contact predicted for this scenario was 10 hours following the spill start.

Figure 12.22 presents the potential zones of exposure (swept area) and shoreline loading, over the entire simulation. Zones of low (1-10 g/m^2) sea surface exposure (visible sea surface oil) occurred a maximum distance of 13 km (southeast) from the release site. No surface oil above the actionable (≥10 g/m^2) threshold was predicted to occur for this trajectory.

Figure 12.23 displays a time series of the actionable oil on the sea surface (≥10 g/m^2), visible (1-10 g/m^2) oil on the sea surface, and length of actionable (100 g/m^2) shoreline oil over the 20-day simulation. The maximum area of coverage of visible (1-10 g/m^2) oil on the sea surface at was 10 km^2, whilst the maximum coverage of actionable (≥10 g/m^2) oil was 5 km^2. The maximum length of actionable shoreline oil (100 g/m^2) was 1 km, occurring between the latter stages of day 1 to day 20.

Figure 12.24 is a time series of the mass on shore at the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Figure 12.25 presents the fates and weathering graph for the corresponding single spill trajectory. A significant portion of the spilled diesel was lost to the atmosphere through evaporation. At the completion of the simulation period 45% (or 135 m^3) was predicted to have evaporated, whilst 47% (or 141m^3) was predicted to remain in the water column. The decayed proportion of oil at the end of the model period was 8% (or 25 m^3). No oil was predicted to remain on the sea surface at the completion of the 20-day modelling period.

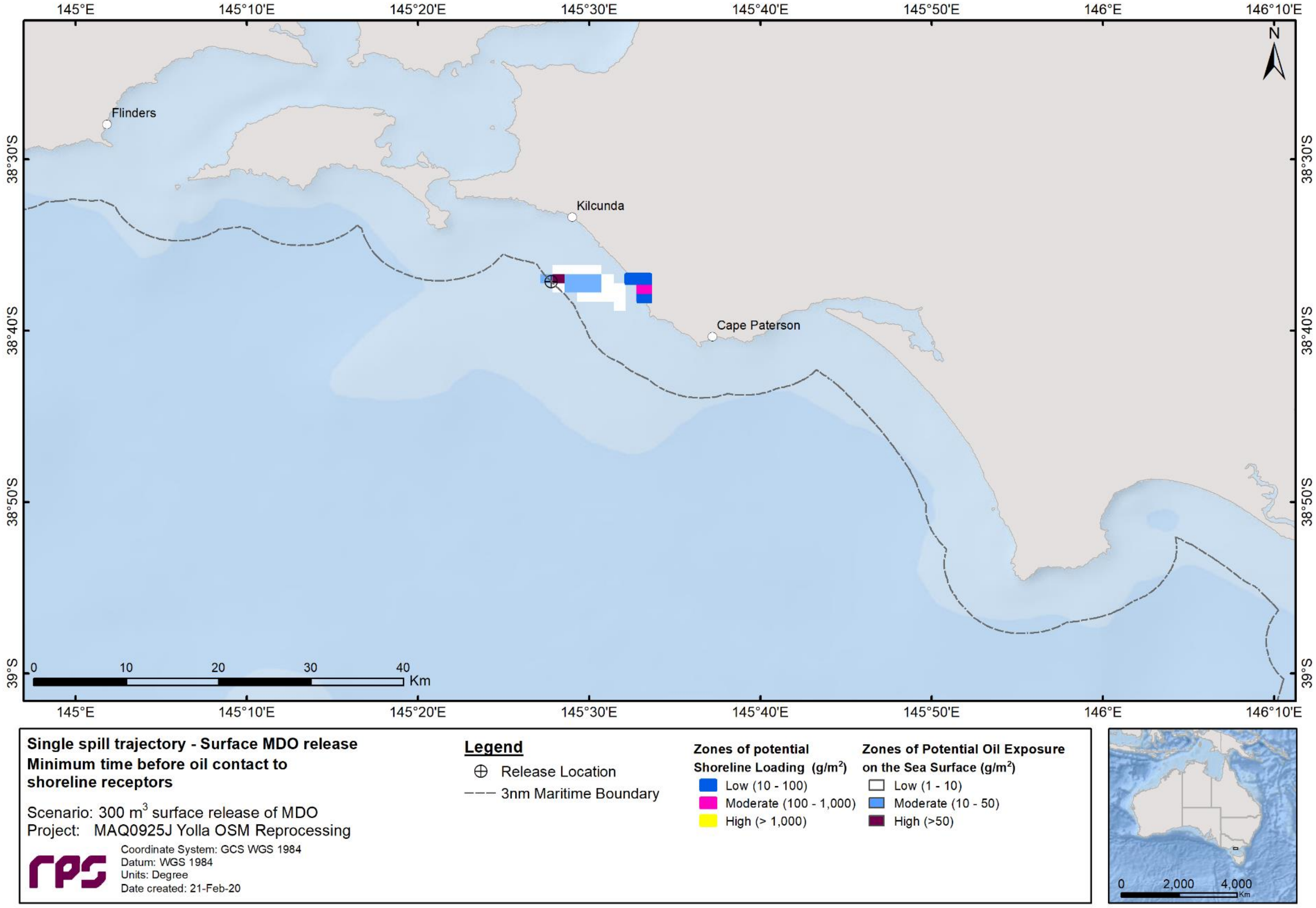


Figure 12.22 Zones of potential oil exposure on the sea surface over the entire simulation for the identified deterministic trajectory. Results are based on a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days, starting 8:00 pm 30th June 2008.

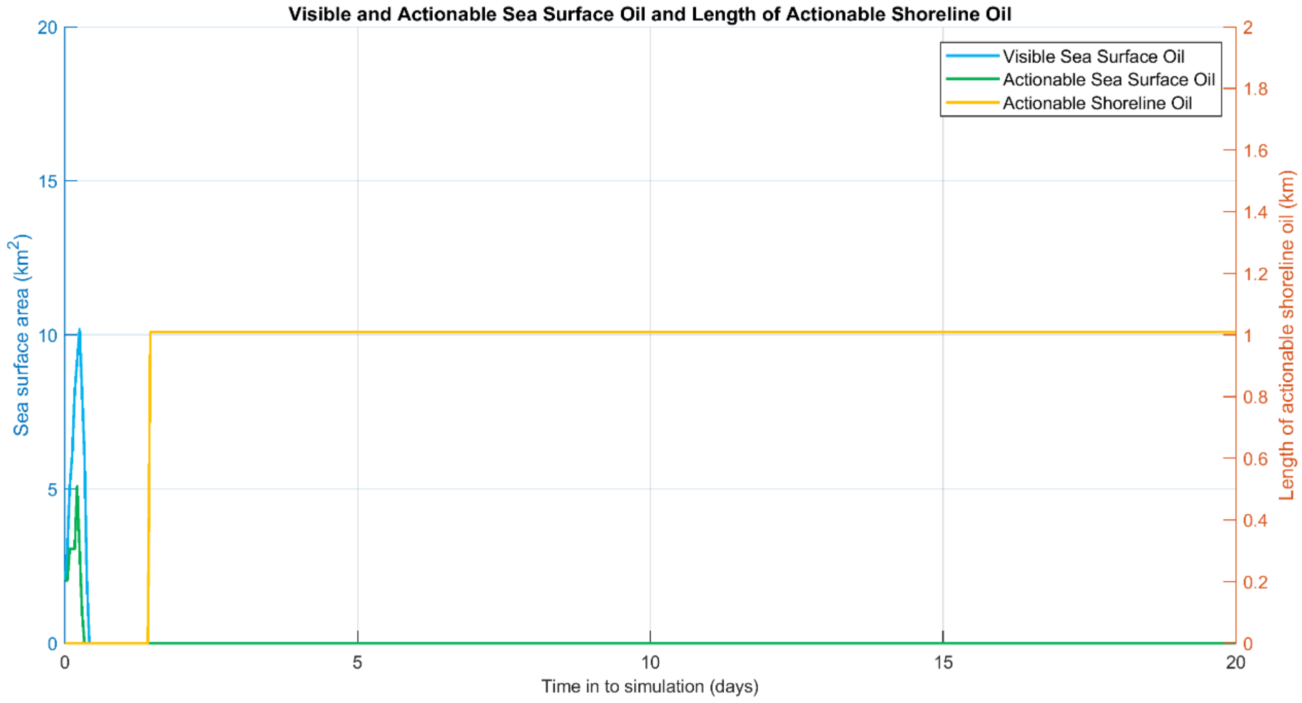


Figure 12.23 Time series of area of visible oil on the sea surface above the low threshold (1 g/m²), and actionable oil on the sea surface above the moderate threshold (10 g/m²). Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 8:00 pm 30th June 2008.

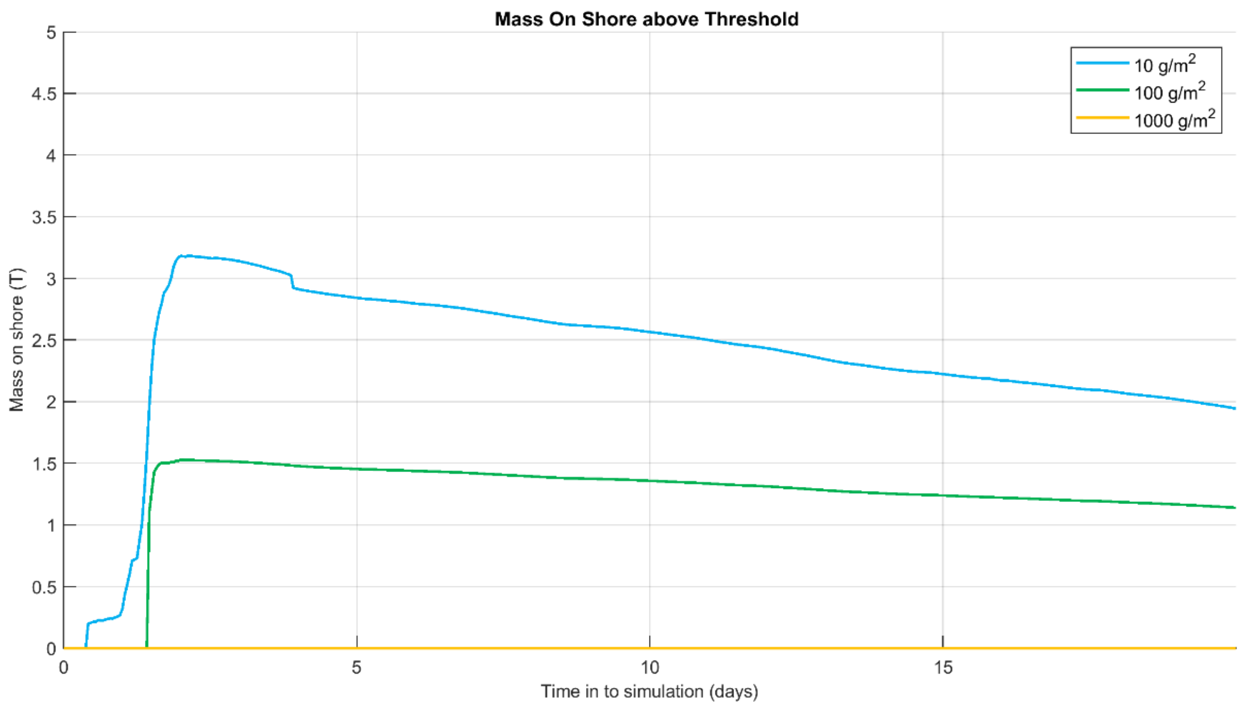


Figure 12.24 Time series of mass (T) on shore above the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²). shoreline thresholds. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 8:00 pm 30th June 2008.

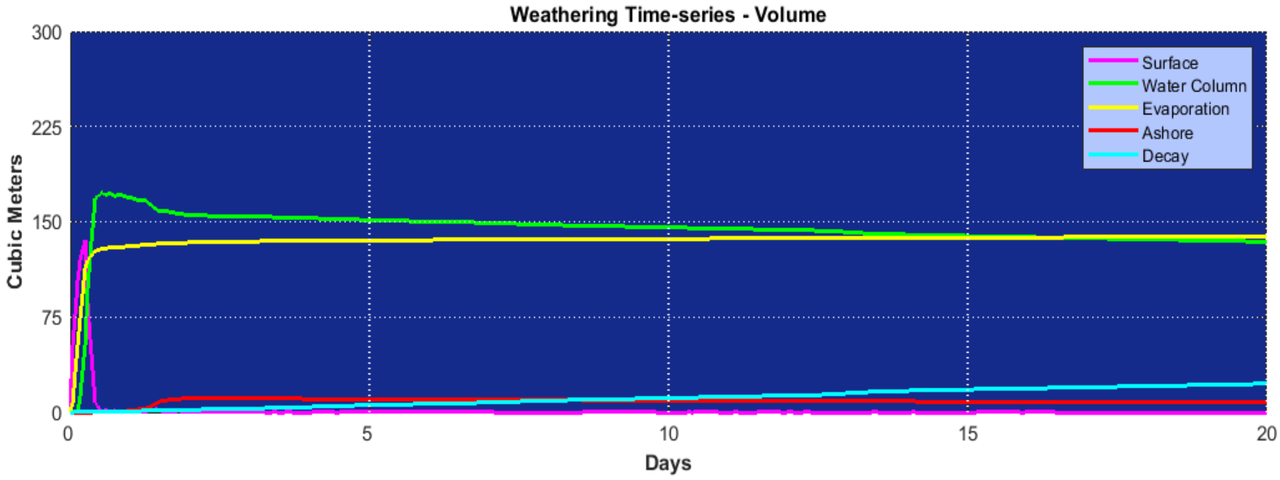


Figure 12.25 Predicted weathering and fates graph for the single spill trajectory. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 8:00 pm 30th June 2008.

12.2.3 Largest Volume of Oil Ashore

The deterministic trajectory that resulted in the largest volume ashore commenced at 3:00 pm 18th October 2010. The largest volume of oil ashore predicted for this scenario was 172 m³.

Figure 12.26 presents the potential zones of exposure (swept area) and shoreline loading, over the entire simulation. Zones of low (1-10 g/m²) sea surface exposure (visible sea surface oil) occurred a maximum distance of ~6.5 km (east) from the release site in coastal waters immediately adjacent to the shoreline. Moderate exposure (or actionable oil ≥10 g/m²) from sea surface oil was also predicted to occur in coastal waters immediately adjacent the shoreline, northeast of the release site. High (≥50 g/m²) exposure sea surface oil was only predicted immediately adjacent to the release site.

Figure 12.27 displays a time series of the actionable oil on the sea surface (≥10 g/m²), visible (1-10 g/m²) oil exposure on the sea surface, and length of actionable (100 g/m²) shoreline oil over the 20-day simulation. The maximum area of coverage of visible (1-10 g/m²) oil on the on the sea surface was ~13 km², whilst the maximum coverage of actionable (≥10 g/m²) oil was 6 km². The maximum length of actionable (100 g/m²) shoreline oil was ~6 km, occurring from the latter stages of day 1 to day 20.

Figure 12.28 presents the time series of mass on shore above the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²) shoreline thresholds.

Figure 12.29 presents the fates and weathering graph for the corresponding single spill trajectory. Initial shoreline contact occurred 12 hours from the commencement of the spill and by day 2, 172 m³ was predicted to have contacted shorelines. At the completion of the simulation period 55% (or 165 m³) was predicted to remain ashore, while 45% (or 134 m³) was predicted to have been lost through evaporative processes. No oil was predicted to remain on the sea surface at the completion of the 20-day modelling period.

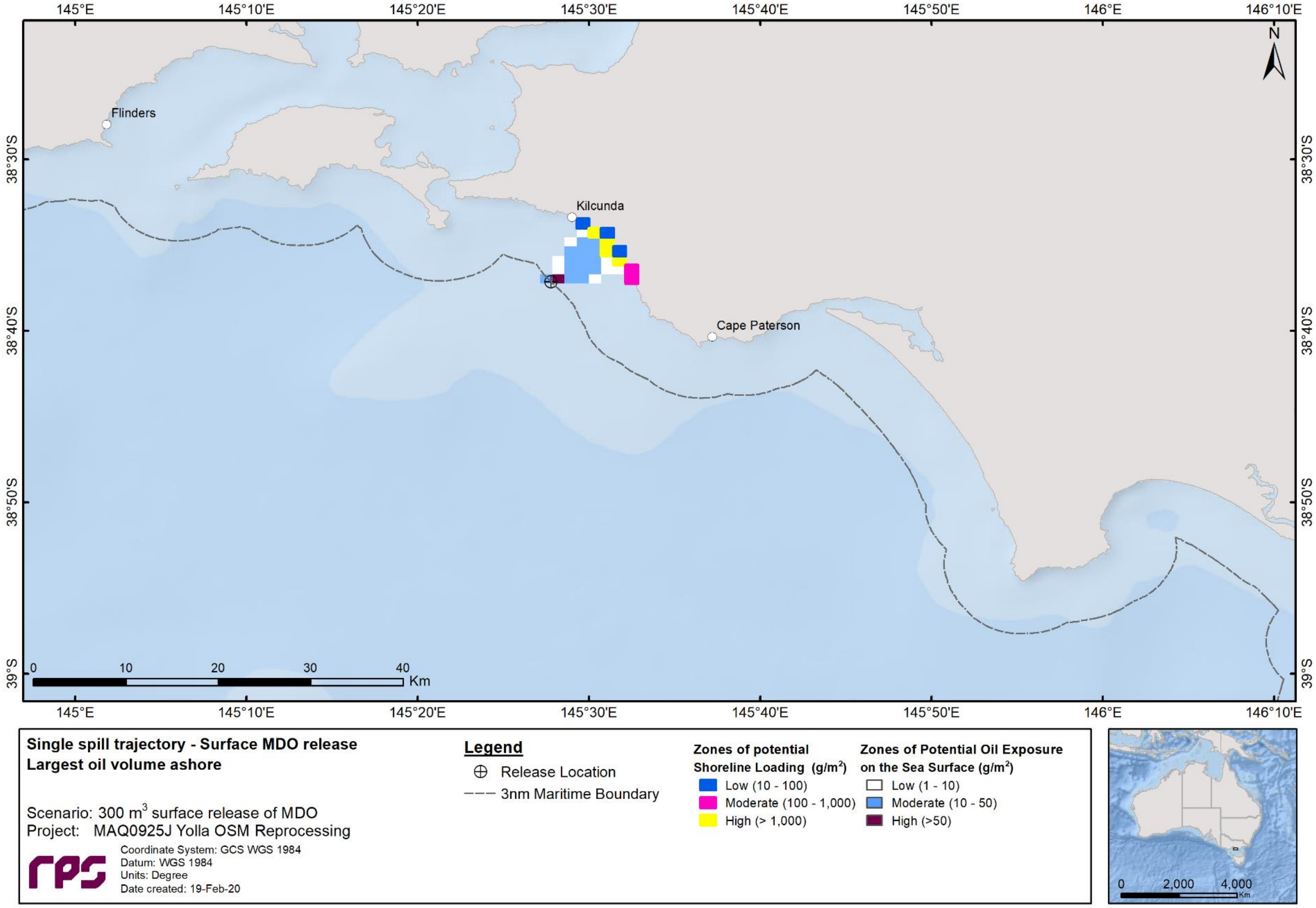


Figure 12.26 **Zones of potential oil exposure on the sea surface over the entire simulation for the identified deterministic trajectory. Results are based on a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days, starting 3:00 pm 18th October 2010.**

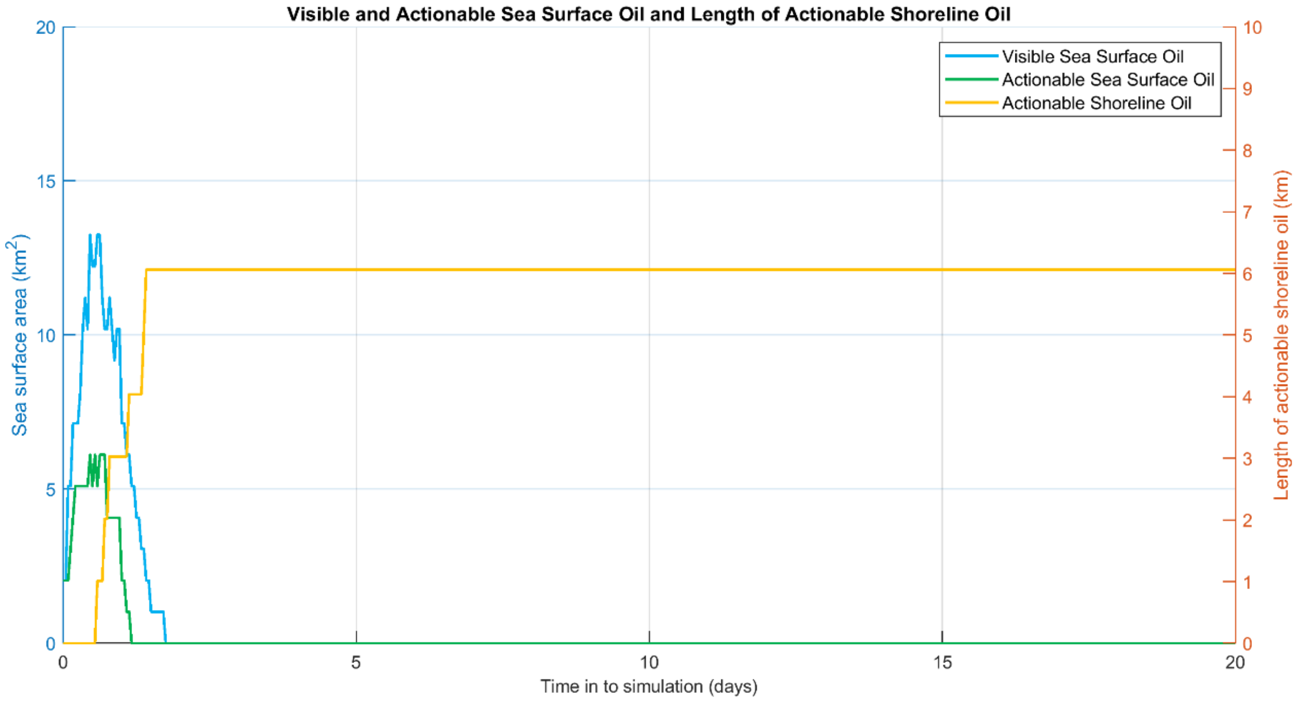


Figure 12.27 Time series of area of visible oil on the sea surface above the low threshold (1 g/m²), and actionable oil on the sea surface above the moderate threshold (10 g/m²). Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 3:00 pm 18th October 2010.

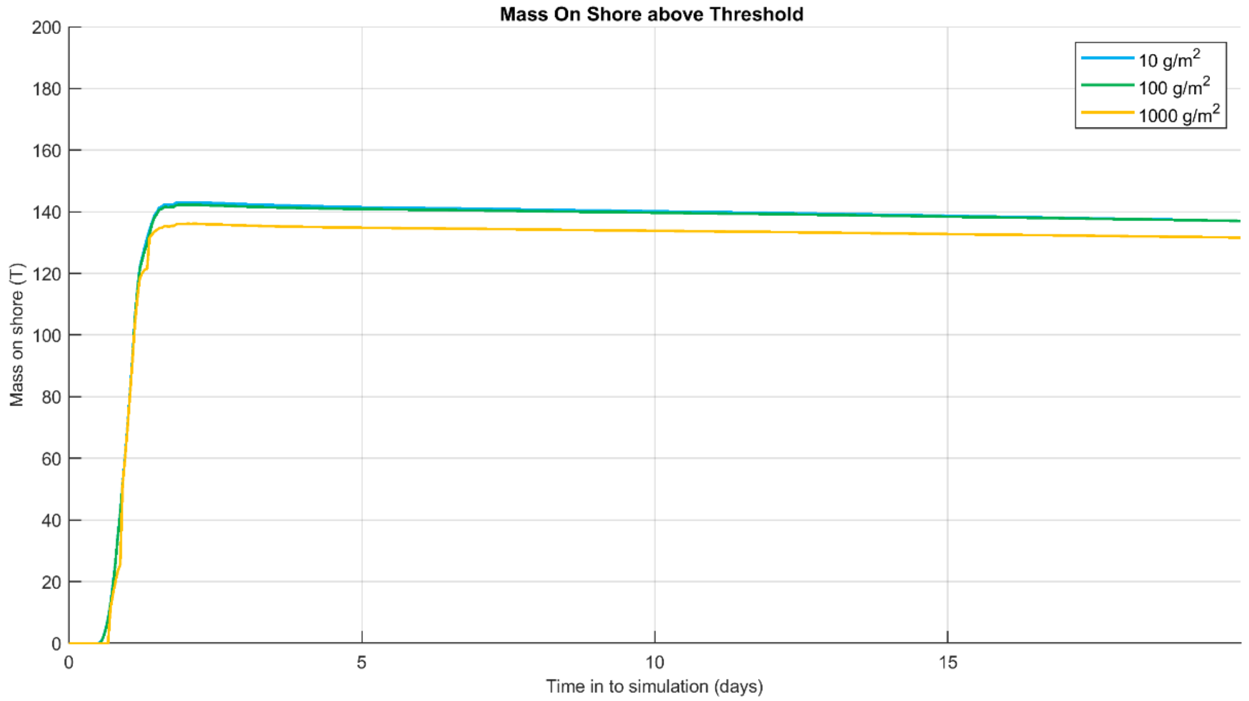


Figure 12.28 Time series of mass (T) on shore above the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²). shoreline thresholds. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 3:00 pm 18th October 2010.

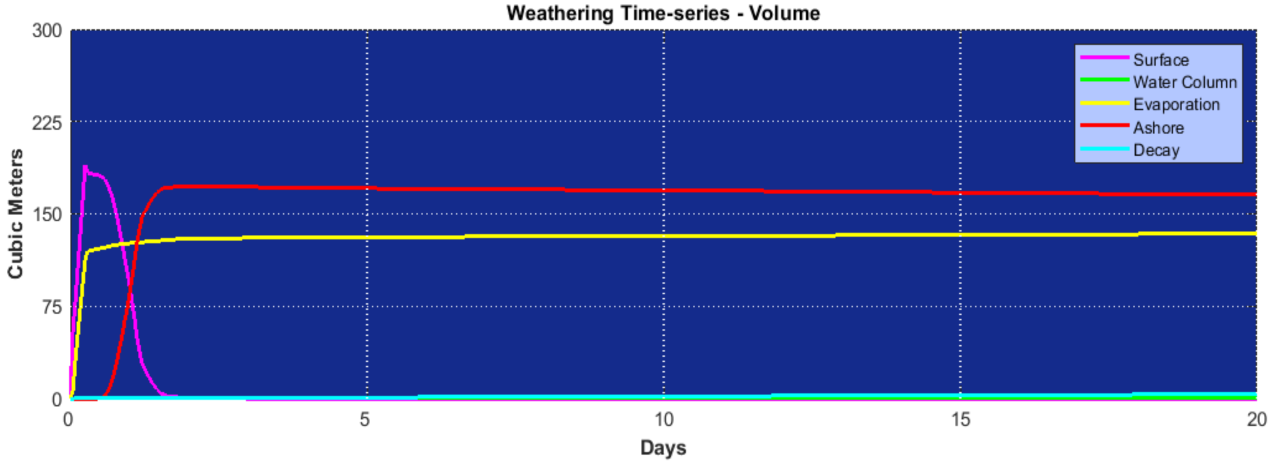


Figure 12.29 Predicted weathering and fates graph for the single spill trajectory. Results are based on a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days, starting 3:00 pm 18th October 2010.

12.2.4 Longest Length of Shoreline Contacted

The deterministic trajectory that resulted in the longest length of shoreline contacted at or above actionable shoreline oil (100 g/m^2) commenced at 3:00 am 1st November 2009. The longest length of shoreline predicted to be contacted by oil above 100 g/m^2 was 7 km.

Figure 12.30 presents the potential zones of exposure (swept area) and shoreline loading, over the entire simulation. Zones of low (1-10 g/m^2) sea surface exposure (visible sea surface oil) occurred a maximum distance of ~6.5 km (east) from the release site in coastal waters immediately adjacent the shoreline. Moderate oil exposure (or actionable oil ≥10 g/m^2) was also predicted to occur in coastal waters immediately adjacent the shoreline. High (≥50 g/m^2) exposure sea surface oil was only predicted immediately adjacent to the release site.

Figure 12.31 displays a time series of the actionable oil on the sea surface (≥10 g/m^2), visible (1-10 g/m^2) oil exposure on the sea surface, and length of actionable (100 g/m^2) shoreline oil over the 20-day simulation. The maximum area of coverage of visible (1-10 g/m^2) oil on the on the sea surface at was ~14 km^2, whilst the maximum coverage of actionable (≥10 g/m^2) oil was 6 km^2. The maximum length of actionable (100 g/m^2) shoreline oil was ~7 km, occurring from the latter stages of day 1 to day 20.

Figure 12.32 presents the time series of mass on shore above the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) shoreline thresholds.

Figure 12.33 presents the fates and weathering graph for the corresponding single spill trajectory. Initial shoreline contact occurred 16 hours following the commencement of the spill and by day 2, 129 m^3 was predicted to have contacted shorelines. At the completion of the simulation period 41% (or 123 m^3) was predicted to remain ashore, while 46% (or 137 m^3) was predicted to have been lost through evaporative processes. Additionally, 12% of the release volume, 35 m^3, was predicted to remain in the water column at the completion of the 20-day modelling period.

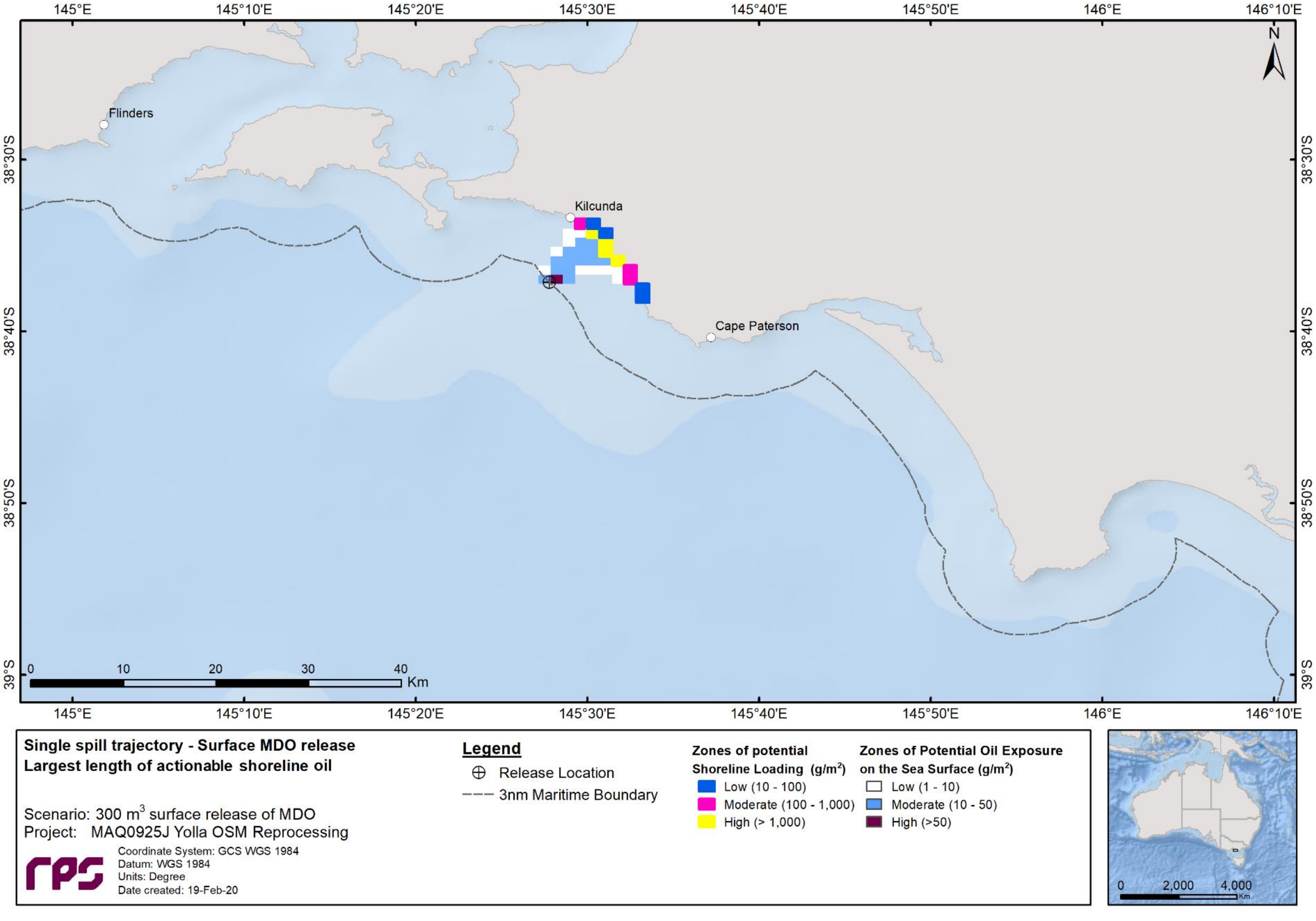


Figure 12.30 Zones of potential oil exposure on the sea surface over the entire simulation for the identified deterministic trajectory. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 3:00 am 01st November 2009.

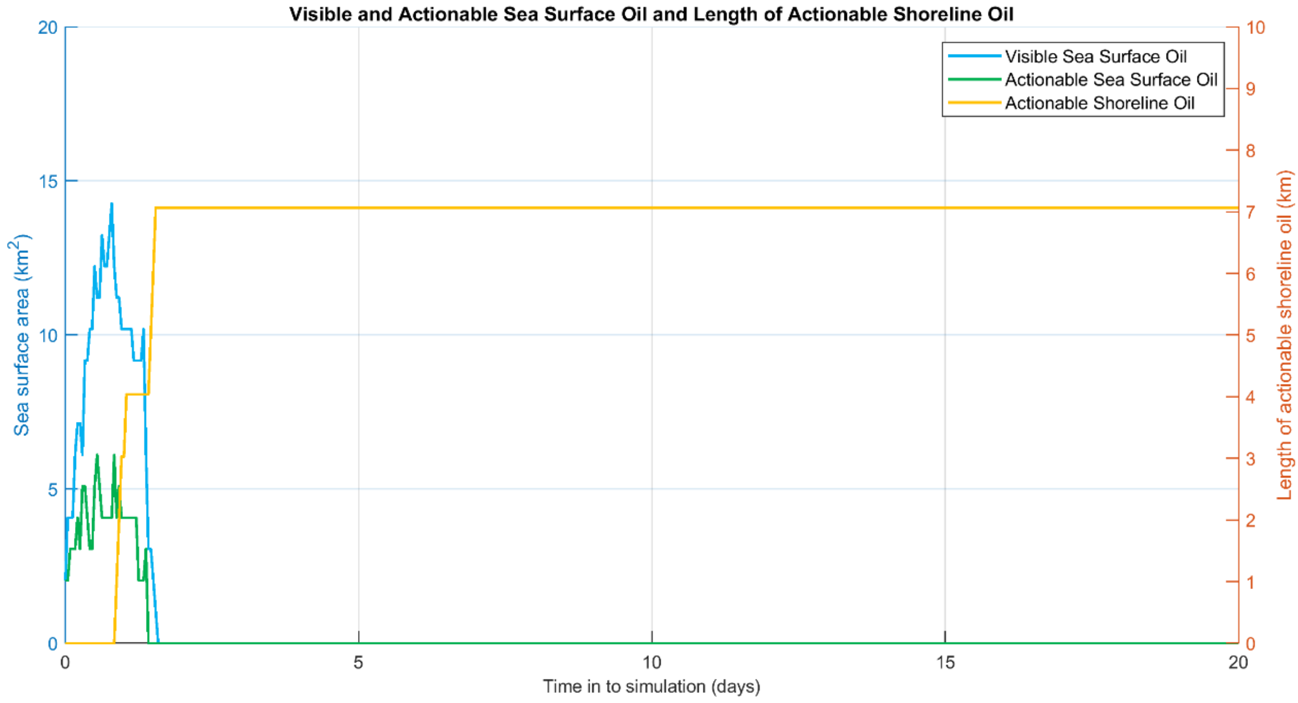


Figure 12.31 Time series of area of visible oil on the sea surface above the low threshold (1 g/m²), and actionable oil on the sea surface above the moderate threshold (10 g/m²). Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 3:00 am 01st November 2009.

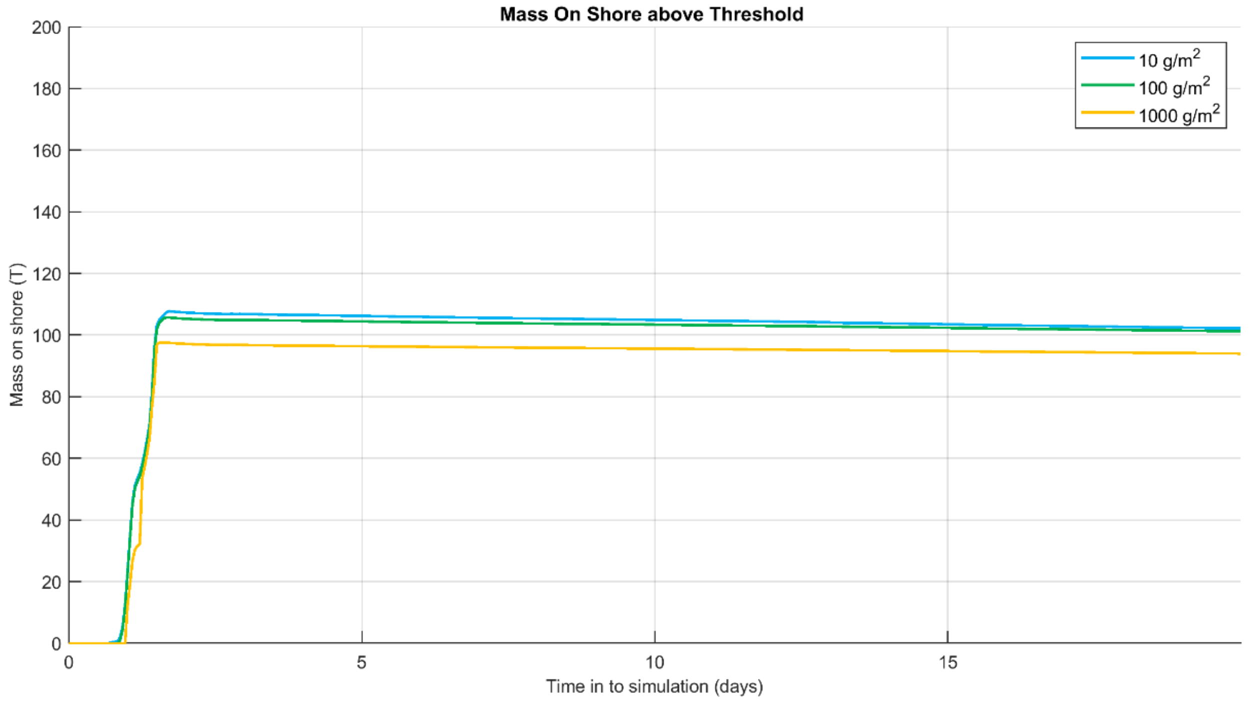


Figure 12.32 Time series of mass (T) on shore above the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²). shoreline thresholds. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days, starting 3:00 am 01st November 2009.

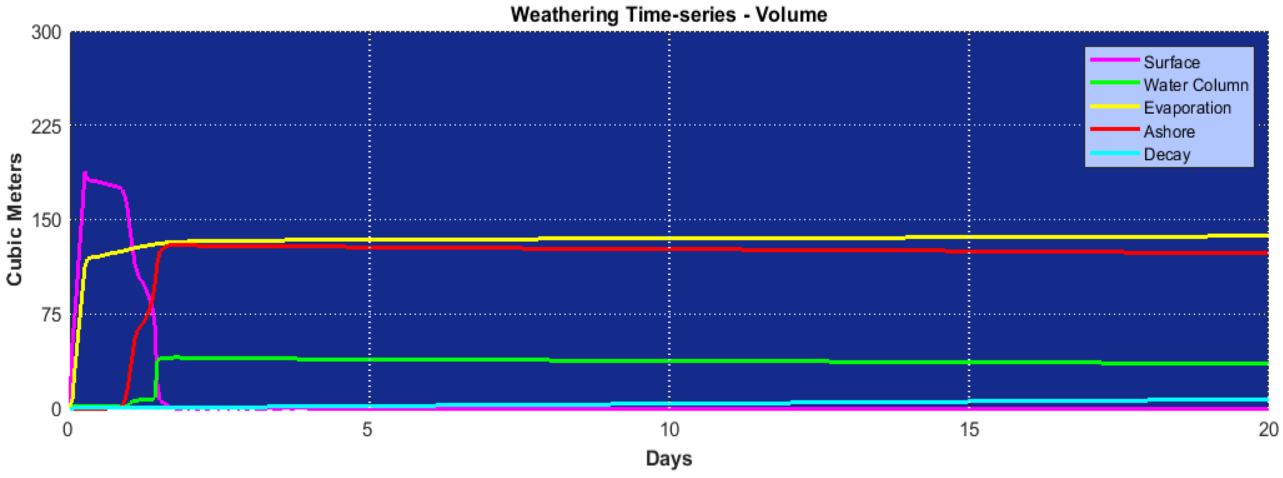


Figure 12.33 Predicted weathering and fates graph for the single spill trajectory. Results are based on a 300 m^3 surface release of MDO over 6 hours, tracked for 20 days, starting 3:00 am 01st November 2009.

13 RESULTS – SCENARIO 3: 3,144.9 BBL PIPELINE RUPTURE OF YOLLA CONDENSATE OVER 57.6 MINUTES

This scenario examined a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for a period of 10 days. A total of 100 spill trajectories were simulated on an annual basis.

The stochastic results were reviewed (Section 13.1) and a deterministic analysis was undertaken (see Section 13.2).

13.1 Stochastic Analysis

Section 13.1.1 presents the potential exposure to the sea surface and shoreline contact. Additionally, Section 13.1.2 presents the potential subsurface exposure.

For the modelling study each spill trajectory was tracked to the following minimum thresholds:

- Visible sea surface oil – 1 g/m^2
- Shoreline oil contact – 10 g/m^2
- Dissolved hydrocarbons – 10 ppb
- Entrained hydrocarbons – 10 ppb

13.1.1 Sea Surface Exposure and Shoreline Contact

Table 13.1 summarises the maximum distance travelled by oil on the sea surface at each threshold. The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (> 50 g/m^2) exposure levels was 9.4 km (west-southwest),3 km (east-northeast) and 0.7 km (east-northeast), respectively.

Table 13.3 summarises the potential sea surface exposure to individual receptors at each threshold. The highest probability of low sea surface exposure was recorded at the Little Penguin – Foraging BIA with 17% and a predicted minimum time of 4 hours before exposure. Additionally, the White Shark – Foraging BIA and Gippsland Plain IBRA were predicted to be exposed to low surface oil with probabilities of 17% and 7%, respectively. Bunurong Marine Park was predicted to be exposed to low surface oil with a probability of 1% and a minimum time of 29 hours before exposure.

It should be noted that multiple receptors were predicted to be impacted by sea surface oil at the low threshold however, these are not presented in tabularised form as the release location resides within each receptor's boundaries (i.e. all receptors recorded a 100% probability of exposure). Please refer to Table 10.2 for the list of receptors.

Figure 13.1 presents the zones of potential oil exposure on the sea surface for the annual modelling assessment. Zones of oil exposure were predicted to extend in all directions from the release location with coastal waters between Kilcunda and Cape Paterson predicted to be exposed.

Table 13.2 presents a summary of the predicted shoreline contact. The probability of contact to any shoreline at, or above, the low level (10-100 g/m^2) was 8% and the minimum time before shoreline contact at, or above, the low threshold was 12 hours. The maximum volume ashore for a single spill trajectory was 21.3 m^3 and the maximum length of shoreline contacted at the low threshold was 5 km.

Table 13.4 summarises the shoreline contact to individual receptors assessed. The shoreline assessment identified the Kilcunda (VIC) shoreline as the receptor with the greatest probability of low (10-100 g/m^2) and moderate (100-1,000 g/m^2) shoreline contact, which were 8% and 6%, respectively. Additionally, Venus Bay (VIC) was predicted to receive oil contact with probabilities of 1% at both the low and moderate shoreline thresholds. Kilcunda (VIC) recorded the minimum time before contact at the low threshold where oil was predicted to take 12 hours before reaching the shorelines. No shoreline contact was predicted at the high threshold for this scenario.

The maximum potential shoreline loading above the low, moderate and high shoreline thresholds are presented in Figure 13.2.

Table 13.1 Potential zones of oil exposure on the sea surface, at each threshold. Results are based on a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories.

Distance and direction travelled	Zones of potential sea surface exposure		
	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (≥50 g/m^2)
Maximum distance (km) from the release location	9.4	3.0	0.7
Maximum distance from release site (km) (99th percentile)	9.1	3.0	0.7
Direction	West-southwest	East-northeast	East-northeast

Table 13.2 Summary of shoreline contact above 10 g/m^2, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. Data was calculated from 100 single spill trajectories.

Shoreline Statistics	Yolla condensate subsurface release over 57.6 minutes (Scenario 3)
Probability of contact to any shoreline at or above the low threshold (%)	8
Absolute minimum time before contact at or above the low threshold (hours)	12
Maximum volume of hydrocarbons ashore (m^3) from a single simulation	21.3
Average volume of hydrocarbons ashore across all simulations reaching the shorelines (m^3)	6.8
Maximum length of the shoreline at **10 g/m^2** (km)	5.0
Average shoreline length (km) at **10 g/m^2** (km)	3.1
Maximum length of the shoreline at **100 g/m^2** (km)	4.0
Average shoreline length (km) at **100 g/m^2** (km)	2.1
Maximum length of the shoreline at **1,000 g/m^2** (km)	-
Average shoreline length (km) at **1,000 g/m^2** (km)	-

Table 13.3 Summary of the potential sea surface exposure to individual receptors. Results are based on a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill.

Receptor		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (hours)		
		Low (1-10 g/m2)	Moderate (10-50 g/m2)	High (≥ 50 g/m2)	Low (1-10 g/m2)	Moderate (10-50 g/m2)	High (≥ 50 g/m2)
BIA	Little Penguin - Foraging	17	-	-	4	-	-
	White Shark - Foraging	14	-	-	4	-	-
IBRA	Gippsland Plain	7	-	-	9	-	-
NP	Bunurong Marine Park	1	-	-	29	-	-
Nearshore	Bass Coast	6	-	-	9	-	-
Sub-LGA	Kilcunda	6	-	-	9	-	-

Table 13.4 Summary of condensate contact to individual shorelines. Results are based on a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill.

Shoreline Receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	>10 g/m^2	>100 g/m^2	>1,000 g/m^2	>10 g/m^2	>100 g/m^2	>1,000 g/m^2	Mean	Peak	Mean	Peak	>10 g/m^2	>100 g/m^2	>1,000 g/m^2	>10 g/m^2	>100 g/m^2	>1,000 g/m^2
Kilcunda - VIC	8	6	-	12	15	-	95.6	920.0	6.5	21.3	2.9	2.3	-	5.0	4.0	-
Venus Bay - VIC	1	1	-	29	31	-	122.7	167.7	3.1	3.1	2.0	1.0	-	2.0	1.0	-

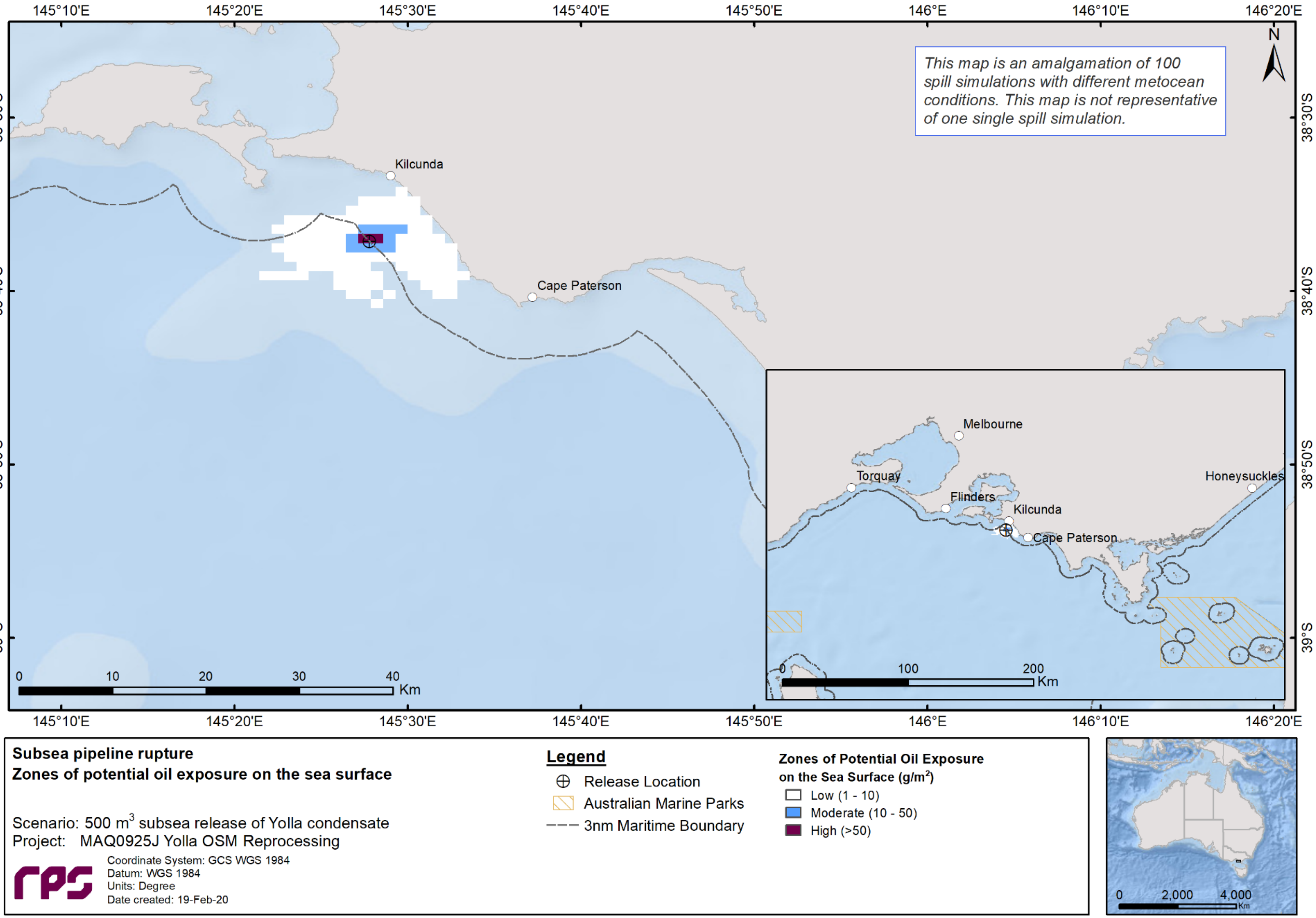
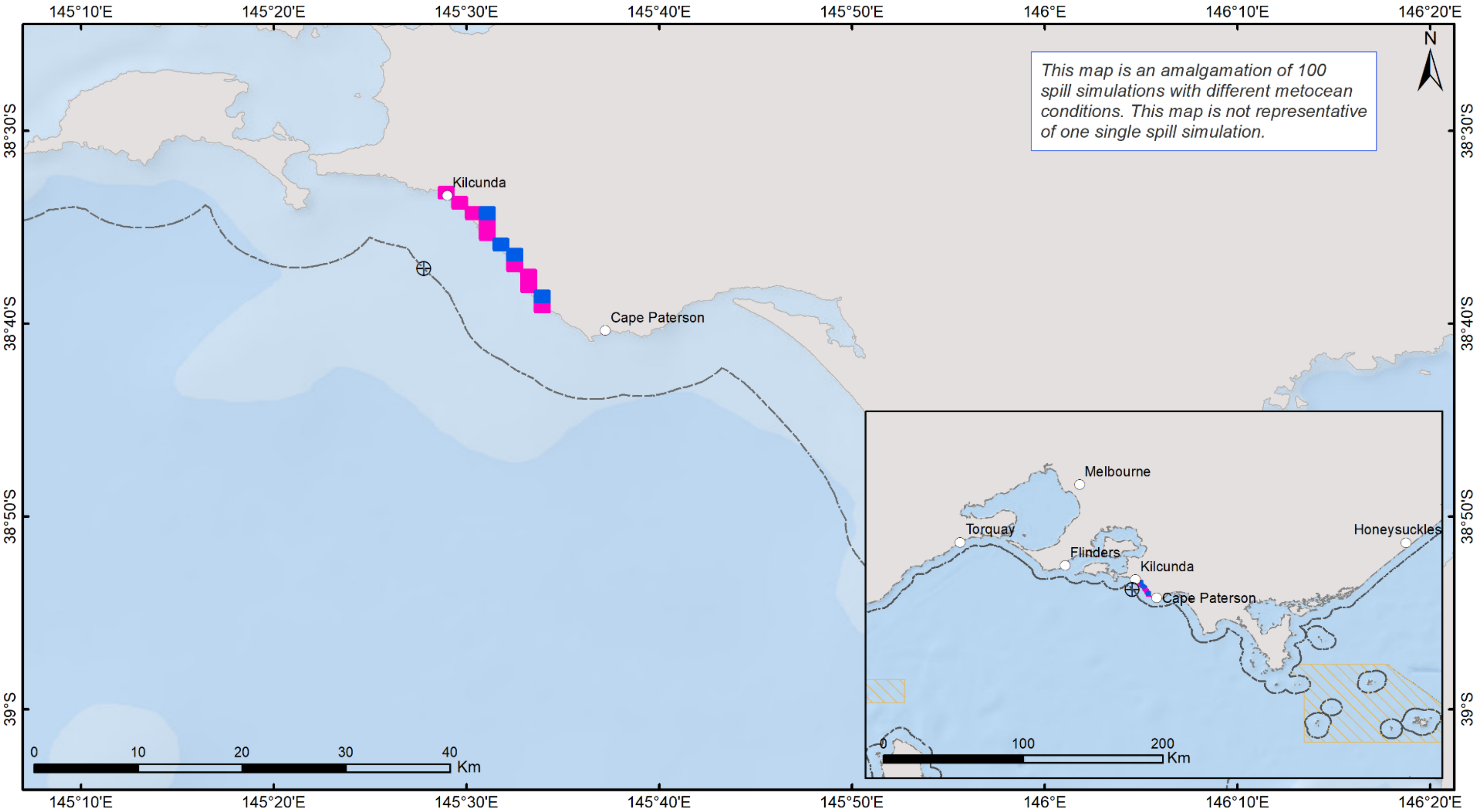


Figure 13.1 Zones of potential oil exposure on the sea surface, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.



Subsea pipeline rupture
Maximum potential shoreline loading

Scenario: 500 m^3 subsea release of Yolla condensate
Project: MAQ0925J Yolla OSM Reprocessing

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
Date created: 19-Feb-20

Legend
- Release Location
- Australian Marine Parks
- 3nm Maritime Boundary

Zones of potential Shoreline Loading (g/m^2)
- Low (10 - 100)
- Moderate (100 - 1,000)
- High (> 1,000)

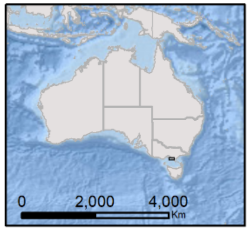


Figure 13.2 Maximum potential shoreline loading, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

13.1.2 In-water exposure

13.1.2.1 Dissolved Hydrocarbons

Table 13.5 summarises the maximum distance and direction from the release location to dissolved hydrocarbons in the 0-10 m depth layer at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels (NOPSEMA, 2019). The maximum distance of dissolved hydrocarbons at the low, moderate and high thresholds from the release location was predicted as 112 km (east-southeast), 83 km (east-southeast) and 3 km (east-southeast), respectively.

Table 13.6 summarises the probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m depth layer, and the 10-20 m depth layer for the annualised assessment.

In the surface layer (0-10 m), the Gippsland Plain IBRA, Bass Coast and Kilcunda Sub-LGA all recorded the highest probabilities at the low and moderate dissolved hydrocarbon thresholds with 65% and 25%, respectively. Additionally, Venus Bay Sub-LGA and the Bunurong Marine Park were predicted to be exposed to dissolved hydrocarbons at the low threshold with probabilities of 61% and 59%, respectively. Dissolved hydrocarbons at the high threshold were only predicted at excluded receptors (see Table 10.2).

In the 10-20 m depth layer, the Gippsland Plain IBRA, Bass Coast and Kilcunda Sub-LGA all recorded the highest probability of low dissolved hydrocarbon exposure with 5%. Exposure to dissolved hydrocarbons at the moderate threshold was only predicted at the Gippsland Plain IBRA, Bass Coast and the Venus Bay Sub-LGA with predicted probabilities of 1%. No dissolved hydrocarbon exposure was predicted at or above the high threshold for this scenario below a depth of 10 m.

Figure 13.3 and Figure 13.4 presents the zones of potential dissolved hydrocarbon exposure for the 0-10 m and 10-20 m depth layers at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels.

Figure 13.5 presents the potential zones of dissolved hydrocarbon exposure in the benthic layer for the annual assessment at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels.

Figure 13.6 and Figure 13.9 depict potential zones of dissolved hydrocarbon exposure, on an annual basis, through the water column along transects oriented along cardinal directions.

Figure 13.10 to Figure 13.13 also present the potential zones of dissolved aromatic exposure along transects but for a single trajectory, rather than the annual results which are a composite of 100 runs. These images illustrate the potential impact for the spill trajectory that affected the largest volume of water at the low exposure level (10-50 ppb).

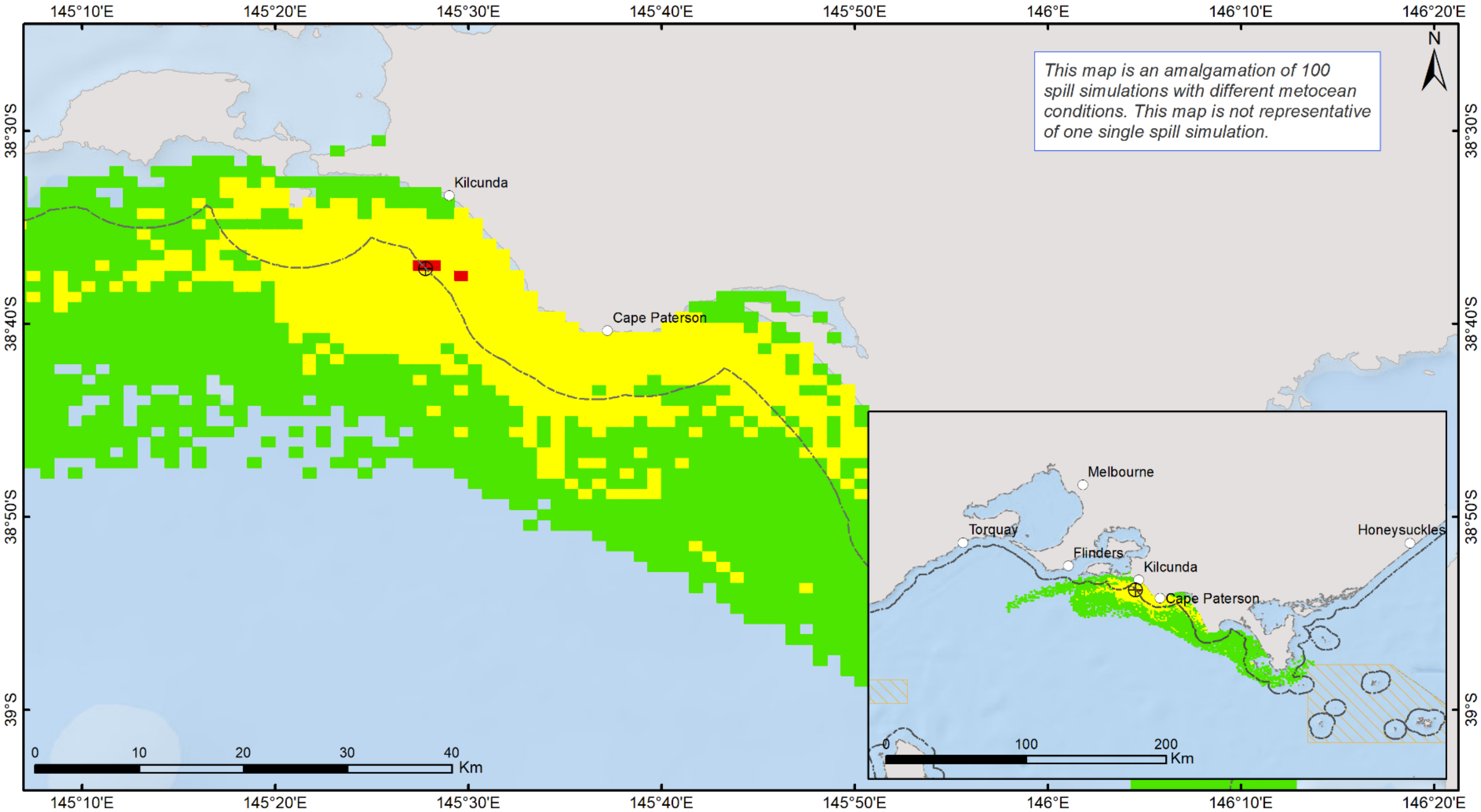
Table 13.5 Maximum distance and direction from the release location to dissolved hydrocarbon exposure (0 – 10m). Results are based on a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill simulations.

Distance and direction travelled	Zones of potential dissolved hydrocarbon exposure		
	Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb
Maximum distance (km) from the release location	112	83	3
Direction	East-southeast	East-southeast	East-southeast

Table 13.6 Probability of exposure to receptors from dissolved hydrocarbons in the 10–20 m depth layer. Results are based on a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories.

Receptor		0 - 10 m Maximum instantaneous dissolved hydrocarbon exposure	0 - 10 m Probability of instantaneous hydrocarbon exposure: Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb	10 - 20 m Maximum instantaneous dissolved hydrocarbon exposure	10 - 20 m Probability of instantaneous dissolved hydrocarbon exposure: Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb
AMP	Beagle	19.21	2	-	-	5.85	-	-	-
BIA	Little Penguin - Breeding	31.51	3	-	-	7.57	-	-	-
	Little Penguin - Foraging	218.97	42	23	-	27.01	1	-	-
	Short-tailed Shearwater - Breeding	52.47	3	1	-	20.60	1	-	-
	White Shark - Breeding	13.28	1	-	-	3.81	-	-	-
	White Shark - Foraging	189.76	38	22	-	30.14	2	-	-
IBRA	Gippsland Plain	189.59	65	25	-	62.10	5	1	-
	Strzelecki Ranges	48.58	16	-	-	12.91	1	-	-
	Wilsons Promontory	32.23	3	-	-	30.14	1	-	-
IMCRA	Central Bass Strait	103.41	4	1	-	26.15	1	-	-
	Flinders	55.31	6	1	-	30.14	2	-	-
	Victorian Embayments	14.60	3	-	-	6.35	-	-	-
MNP	Bunurong	141.05	50	9	-	47.65	3	-	-
	Wilsons Promontory	23.20	2	-	-	30.14	1	-	-
NP	Bunurong Marine Park	189.59	59	19	-	39.44	4	-	-
	Wilsons Promontory Marine Park	24.00	3	-	-	2.93	-	-	-
RAMSAR	Western Port	12.19	1	-	-	0.57	-	-	-
RSB	Cody Bank	12.30	3	-	-	1.81	-	-	-
SHORE	Anser Island	21.14	1	-	-	30.14	1	-	-
	Bass Coast	189.59	65	25	-	62.10	5	1	-
	Glennie Group	32.23	1	-	-	5.38	-	-	-
	Kanowna Island	16.08	1	-	-	21.88	1	-	-
	Norman Island	21.86	3	-	-	5.82	-	-	-
	Phillip Island	81.55	8	2	-	21.14	1	-	-
	Rodondo Island	22.29	1	-	-	3.50	-	-	-

Receptor		0 - 10 m Maximum instantaneous dissolved hydrocarbon exposure	0 - 10 m Probability of instantaneous hydrocarbon exposure: Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb	10 - 20 m Maximum instantaneous dissolved hydrocarbon exposure	10 - 20 m Probability of instantaneous dissolved hydrocarbon exposure: Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb
	Shellback Island	25.06	2	-	-	3.88	-	-	-
	Skull Rock	23.34	2	-	-	20.08	1	-	-
	South Gippsland	101.04	29	3	-	24.14	2	-	-
Sub-LGA	Cape Liptrap (NW)	83.02	29	3	-	21.08	2	-	-
	French Island / San Remo	18.28	3	-	-	5.19	-	-	-
	Kilcunda	180.25	65	25	-	39.44	5	-	-
	Venus Bay	189.59	61	22	-	62.10	3	1	-
	Waratah Bay	48.58	16	-	-	12.91	1	-	-
	Wilsons Promontory (East)	10.46	1	-	-	12.83	1	-	-
	Wilsons Promontory (West)	24.30	3	-	-	24.14	1	-	-



Subsea pipeline rupture
Zones of potential instantaneous dissolved hydrocarbon exposure in the 0-10 m layer

Scenario: 500 m^3 subsea release of Yolla condensate
Project: MAQ0925J Yolla OSM Reprocessing

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
Date created: 19-Feb-20

Legend
- Release Location
- Australian Marine Parks
- 3nm Maritime Boundary

Zones of Potential Instantaneous Dissolved Hydrocarbon Exposure (ppb)
- Low (10 - 50)
- Moderate (50 - 400)
- High (>400)

Figure 13.3 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 3,144.9 bbl (500 m³) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

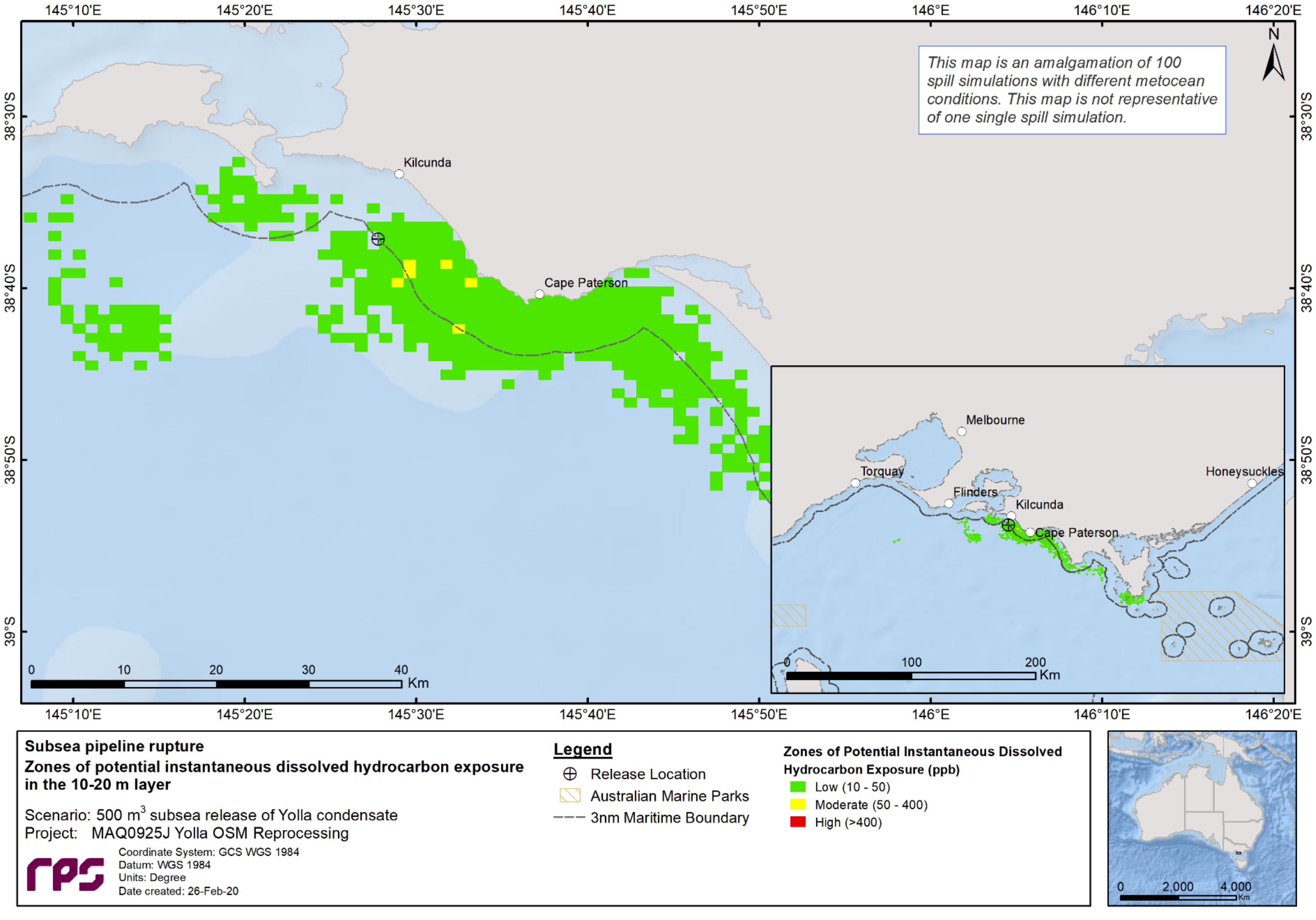


Figure 13.4 Zones of potential dissolved hydrocarbon exposure at 10-20 m below the sea surface, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

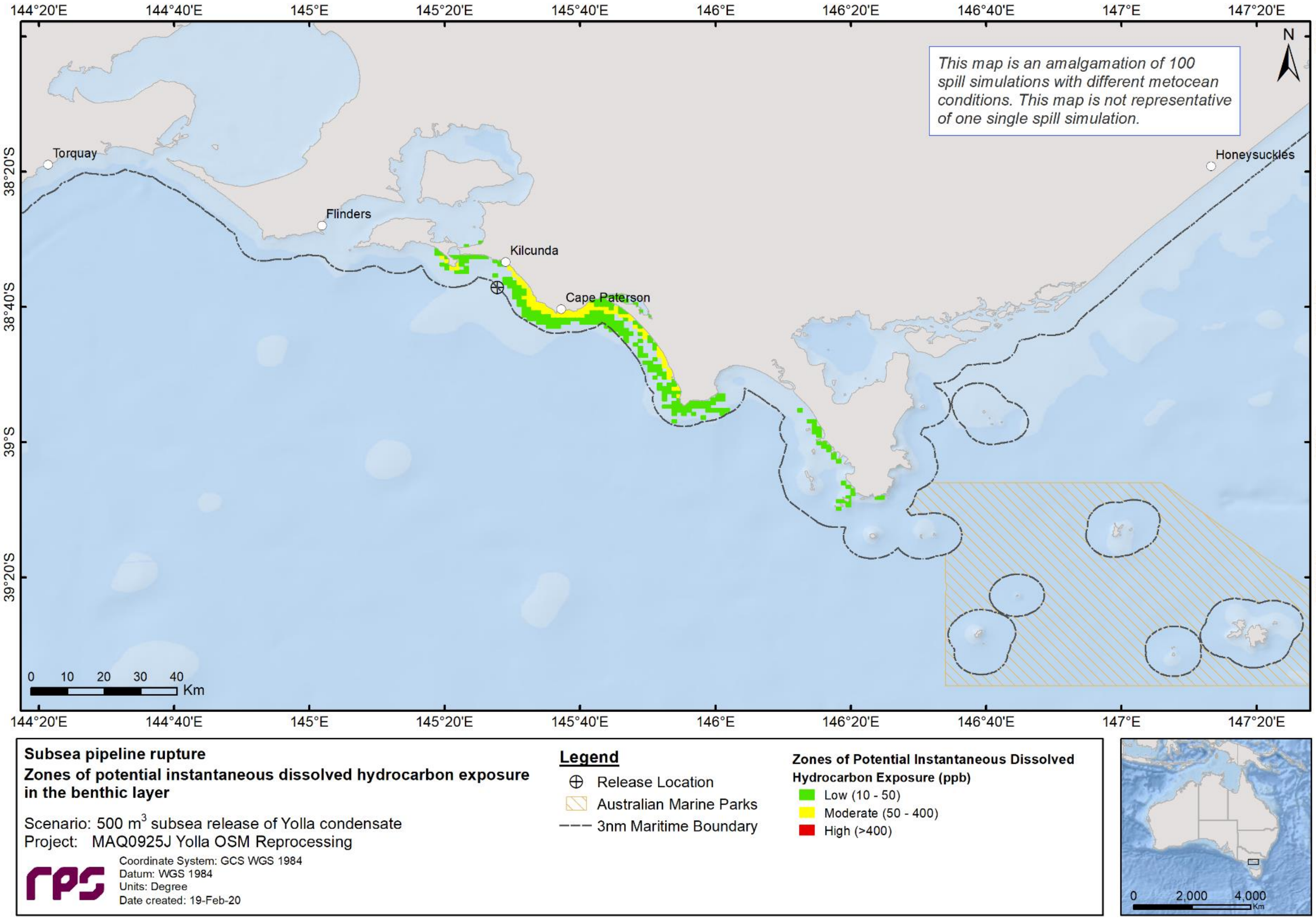


Figure 13.5 **Benthic interaction of zones of potential dissolved hydrocarbon exposure, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.**

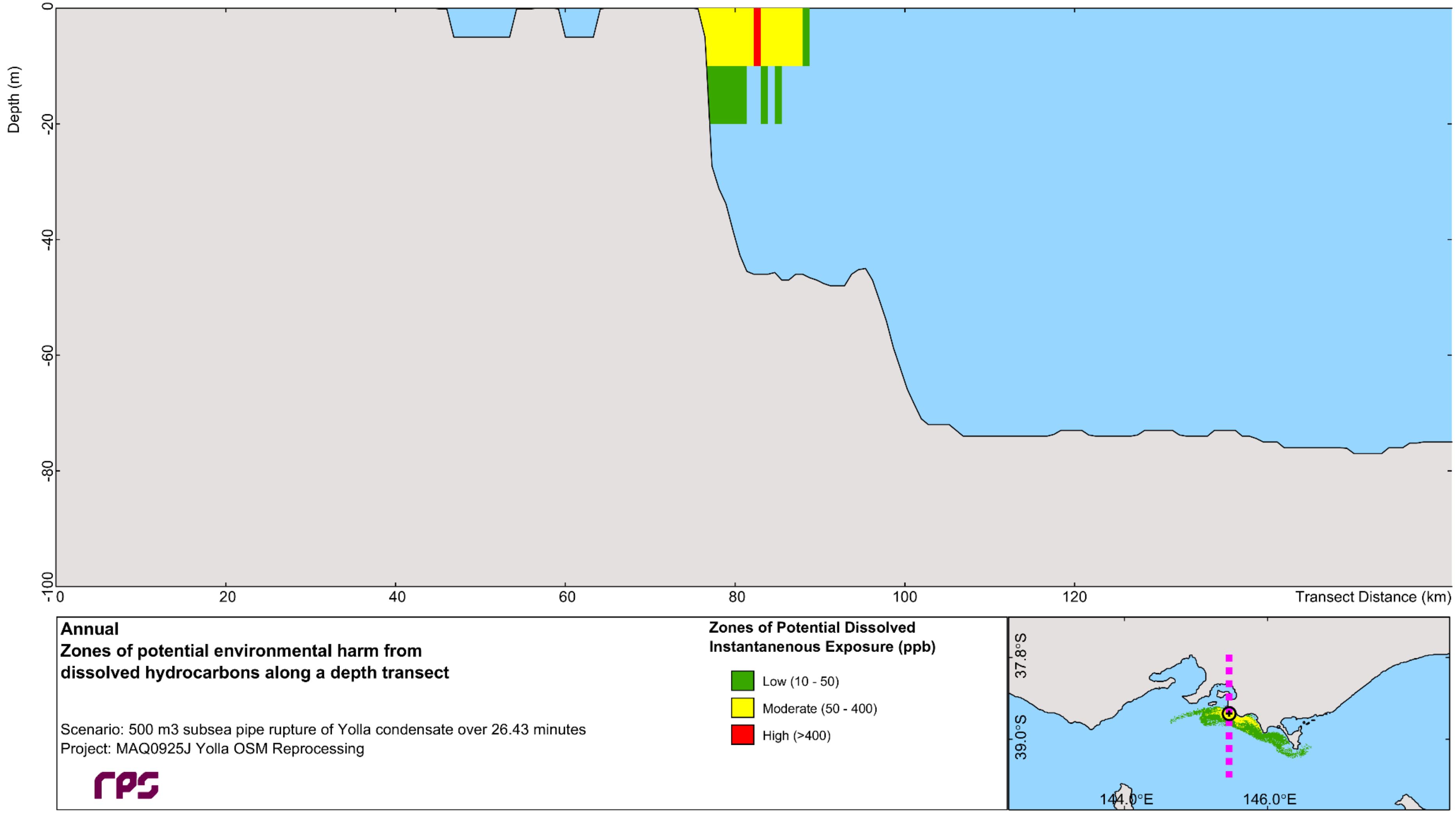


Figure 13.6 Transect plot (north to south) illustrating zones of potential dissolved hydrocarbon exposure through the water column, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

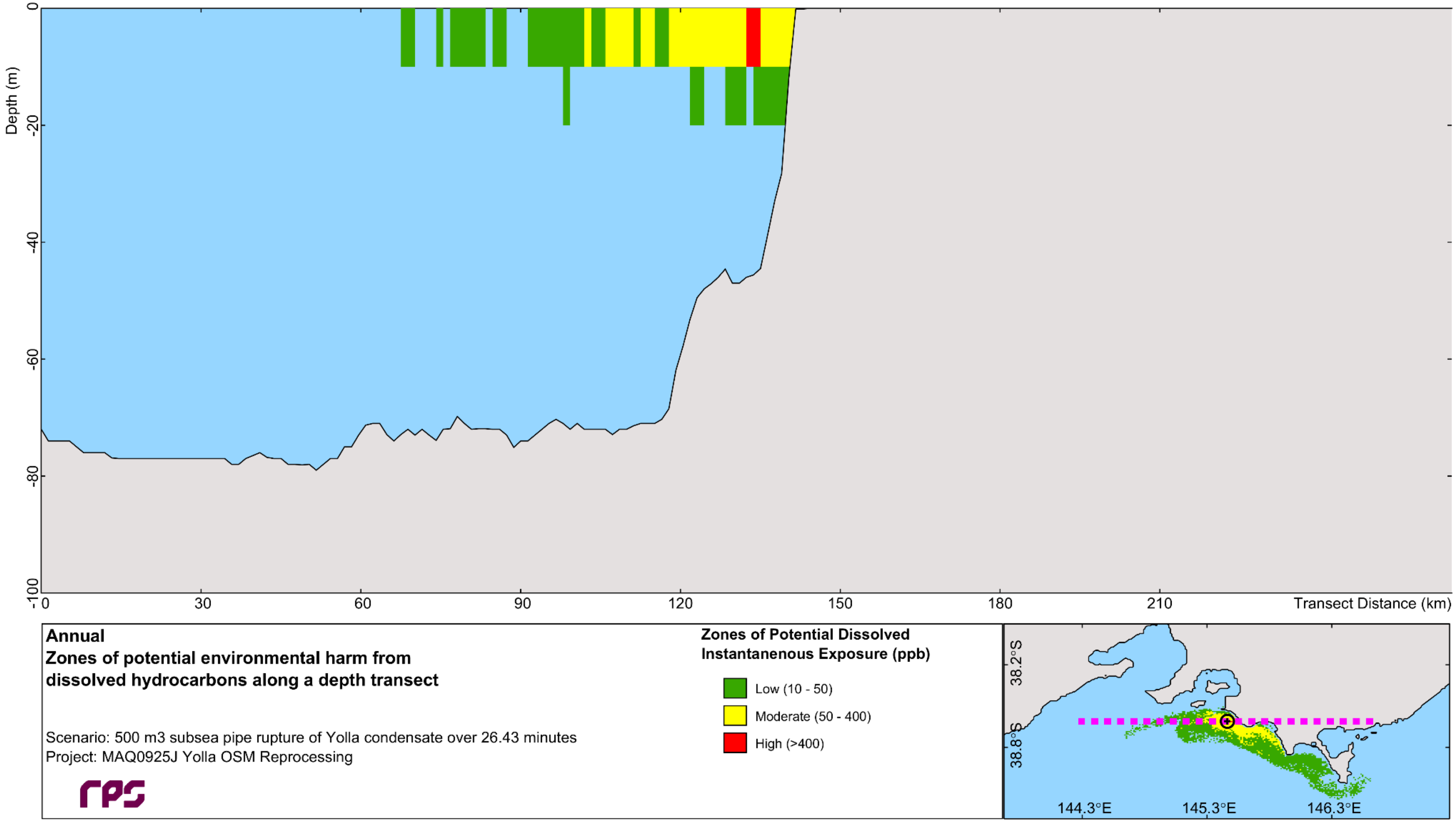


Figure 13.7 **Transect plot (west to east) illustrating zones of potential dissolved hydrocarbon exposure through the water column, in the event of a 3,144.9 bbl (500 m³) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.**

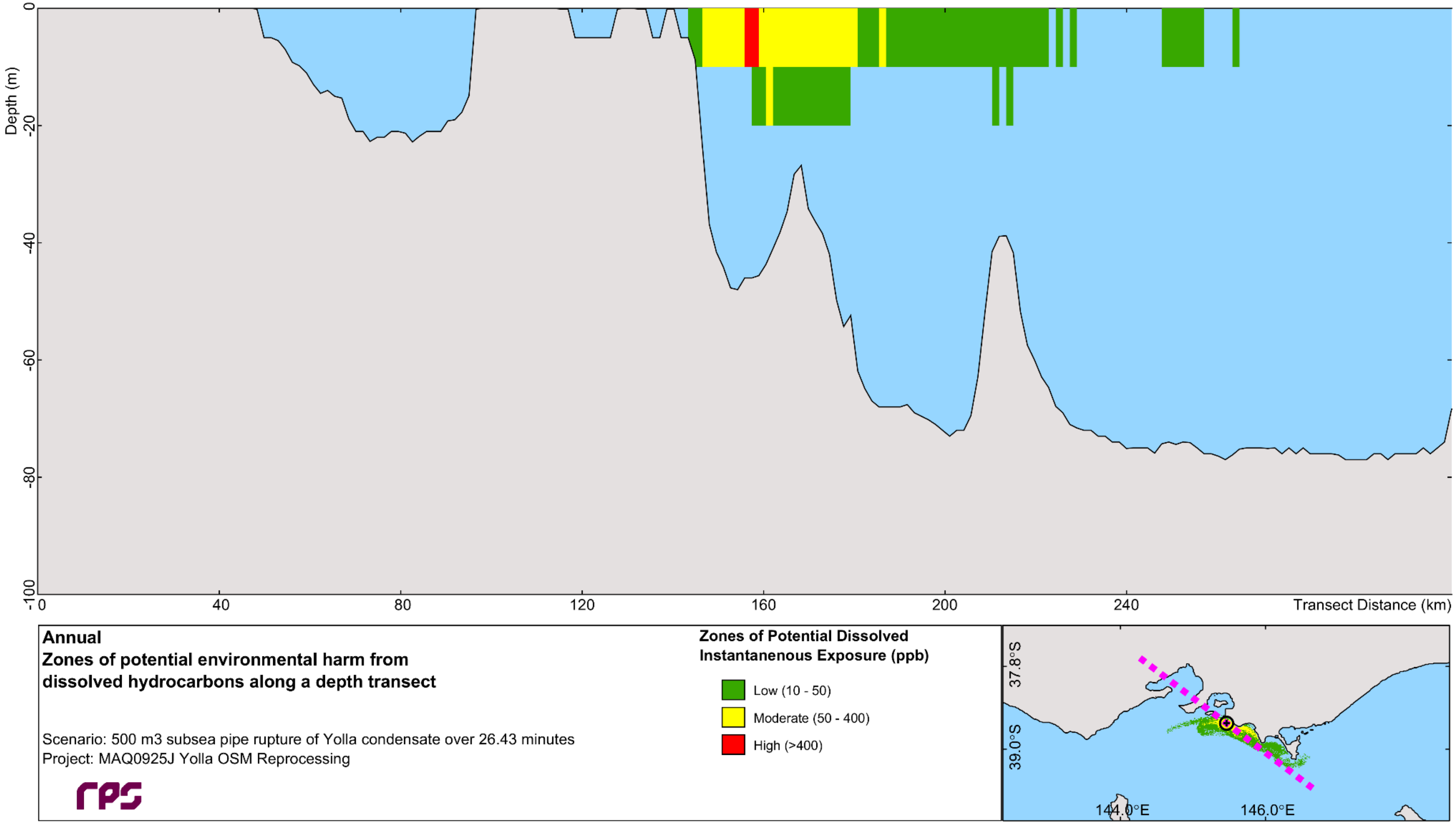


Figure 13.8 Transect plot (northwest to southeast) illustrating zones of potential dissolved hydrocarbon exposure through the water column, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions

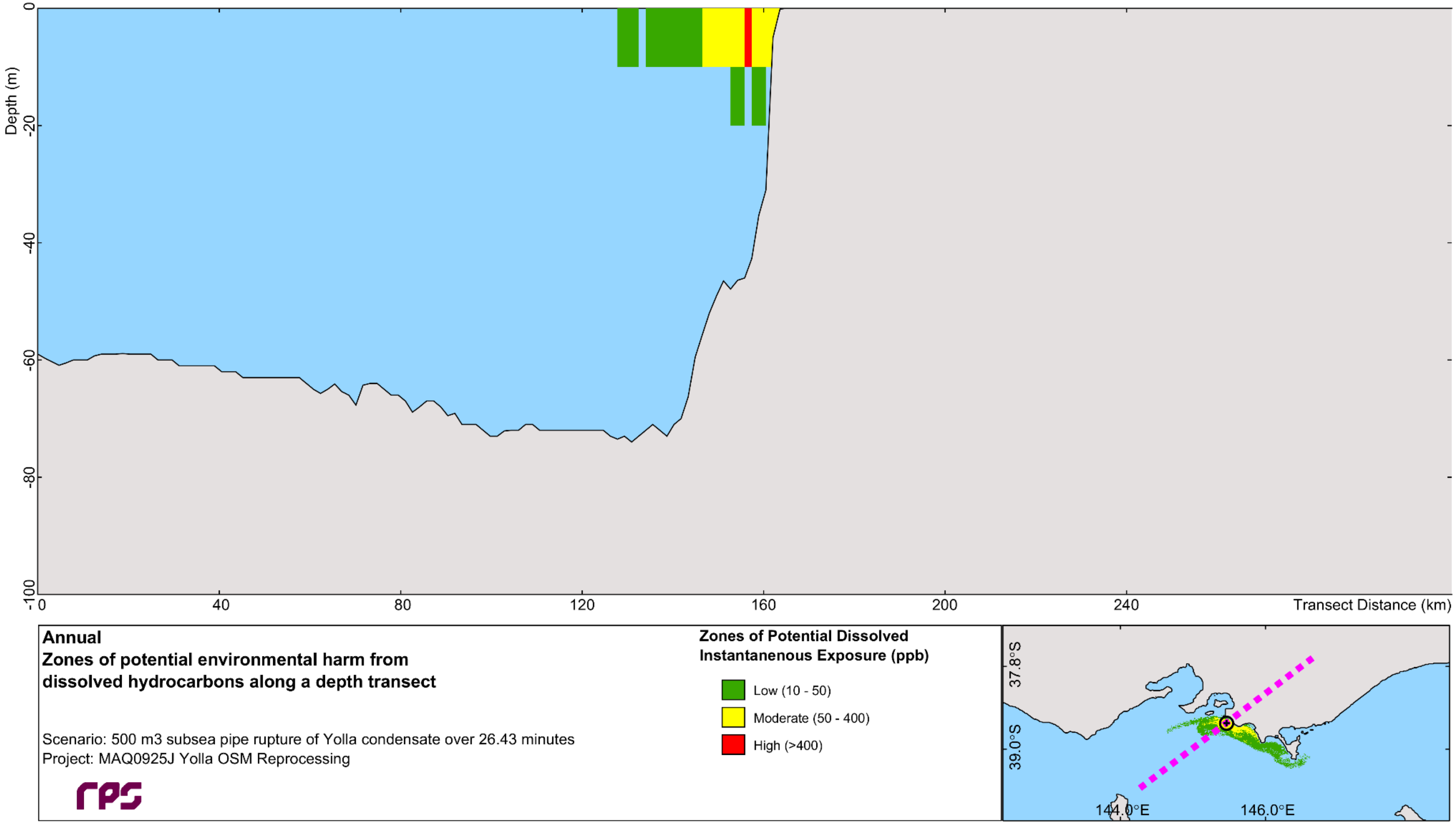


Figure 13.9 Transect plot (northeast to southwest) illustrating zones of potential dissolved hydrocarbon exposure through the water column, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

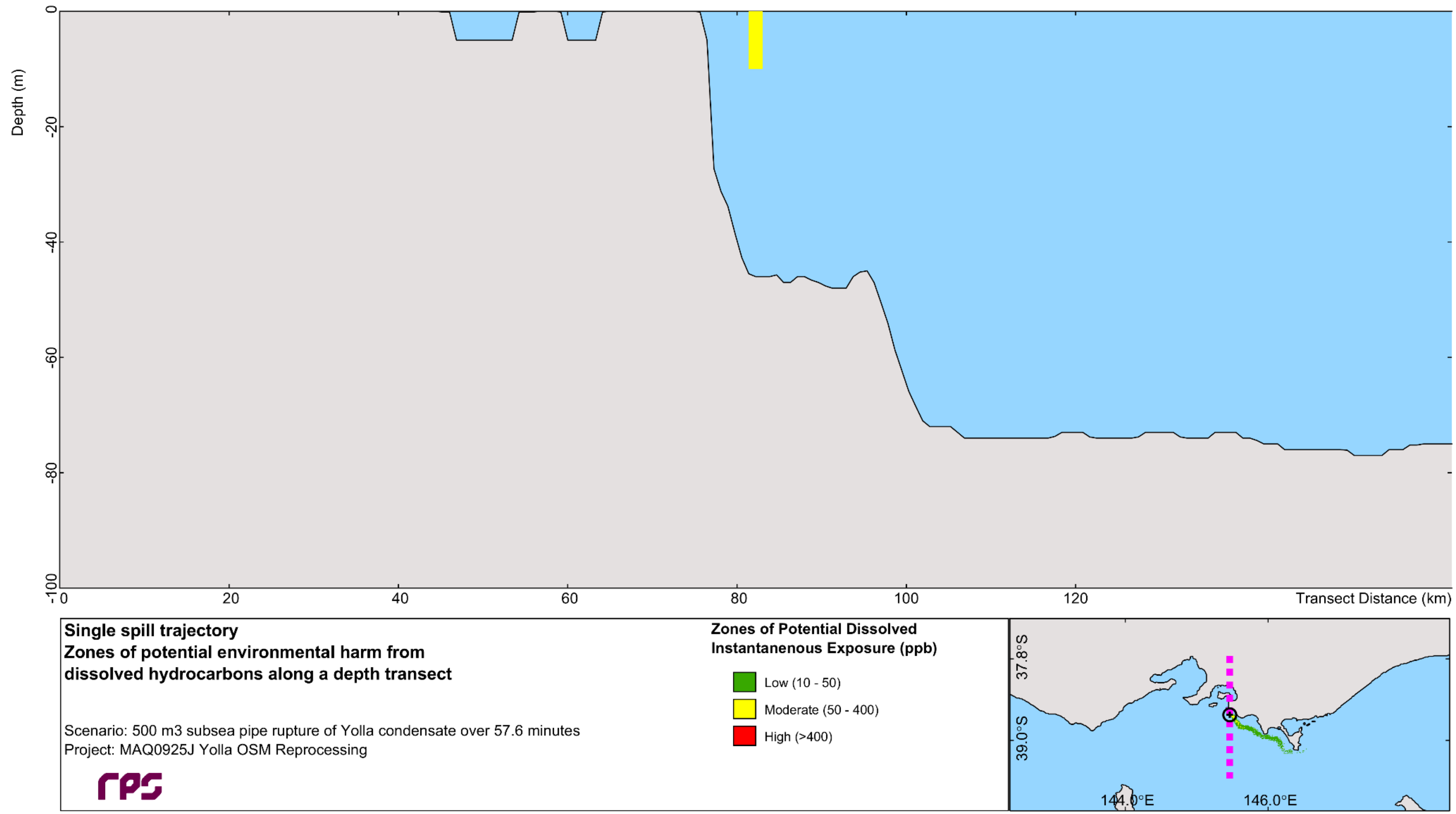


Figure 13.10 Transect plot (north to south) illustrating zones of potential dissolved hydrocarbon exposure through the water column for a <u>single spill trajectory</u>, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days.

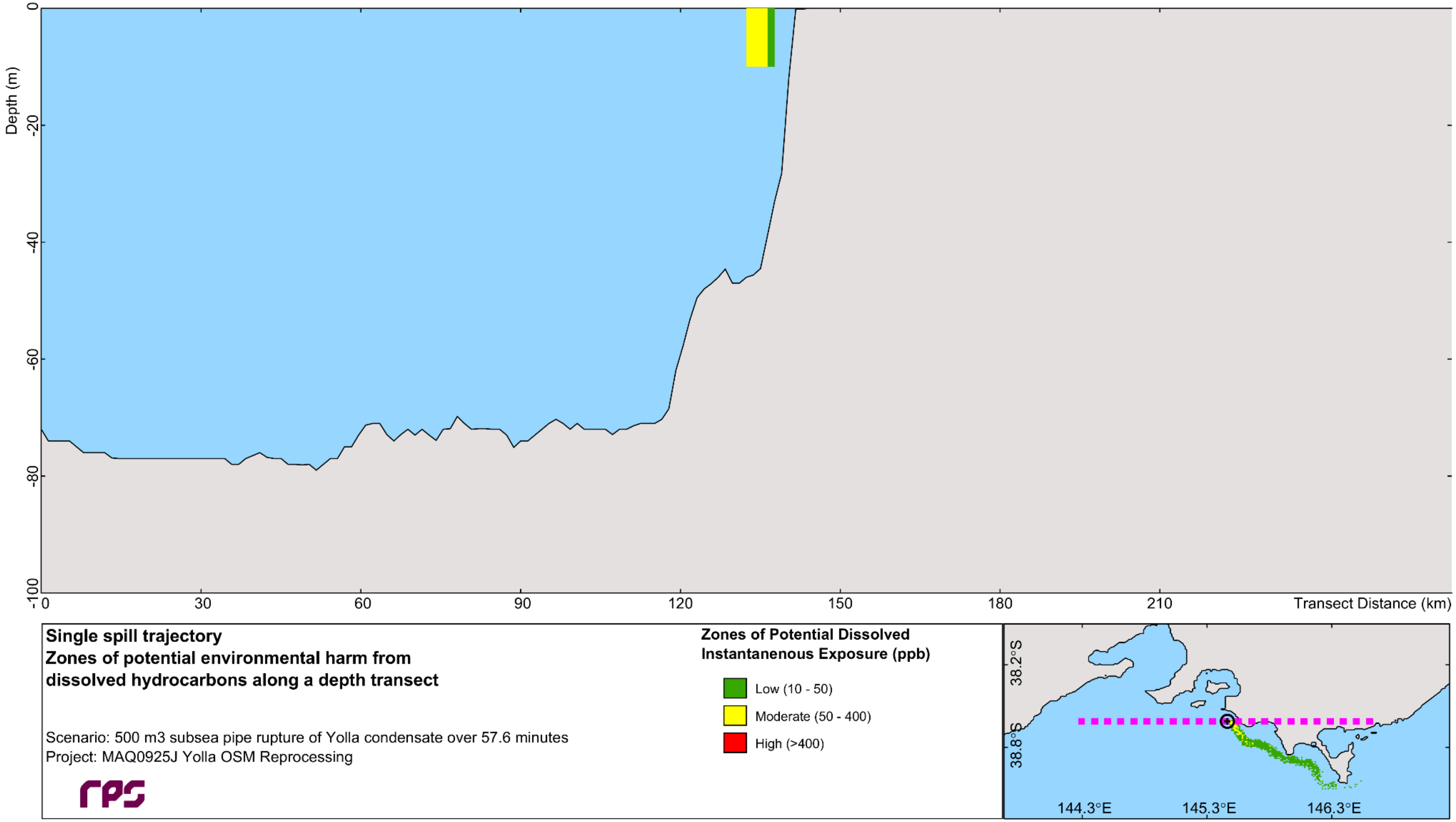


Figure 13.11 Transect plot (west to east) illustrating zones of potential dissolved hydrocarbon exposure through the water column for a <u>single spill trajectory</u>, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days.

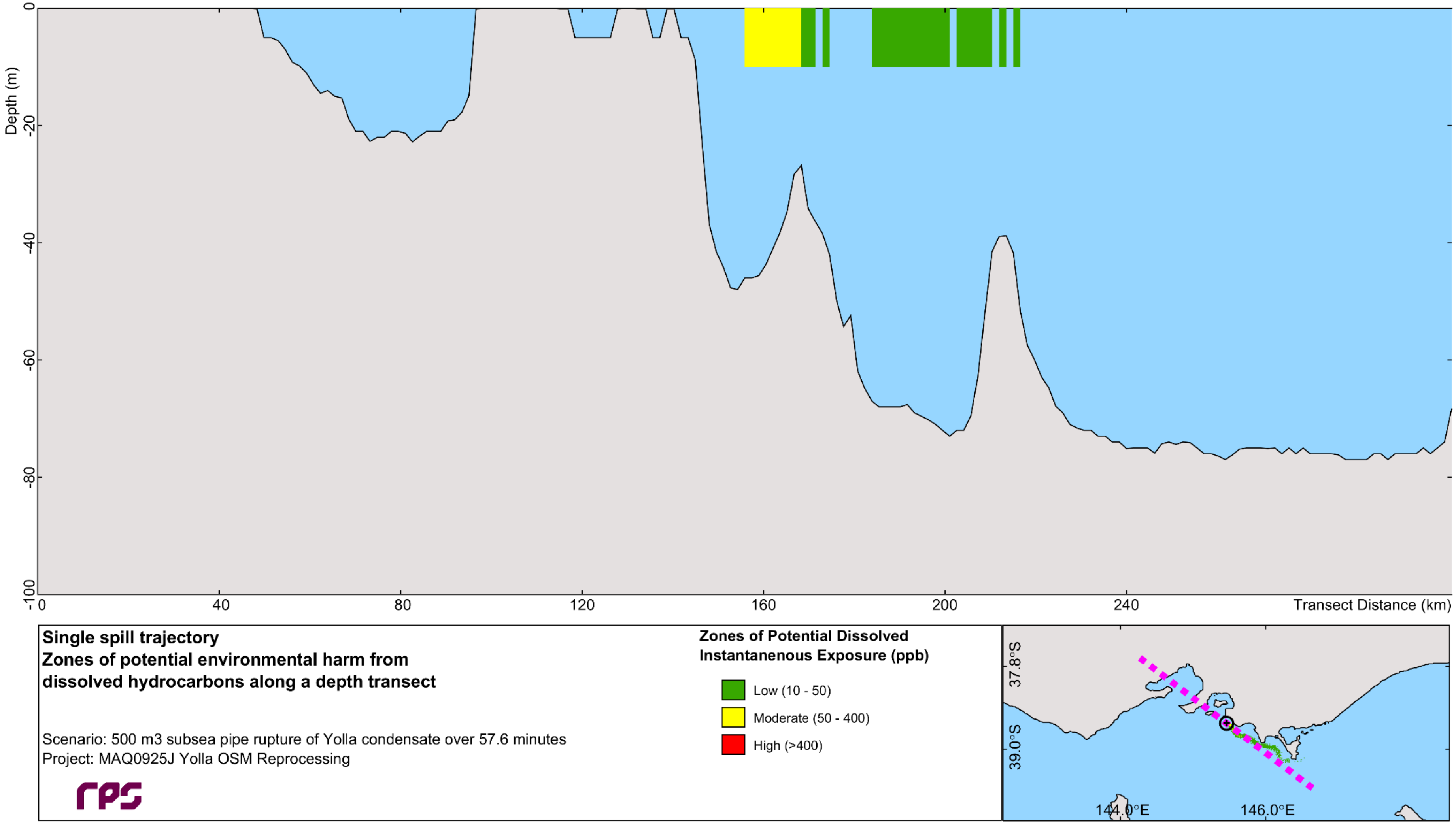


Figure 13.12 Transect plot (northwest to southeast) illustrating zones of potential dissolved hydrocarbon exposure through the water column for a <u>single spill trajectory</u>, in the event of a 3,144.9 bbl (500 m³) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days.

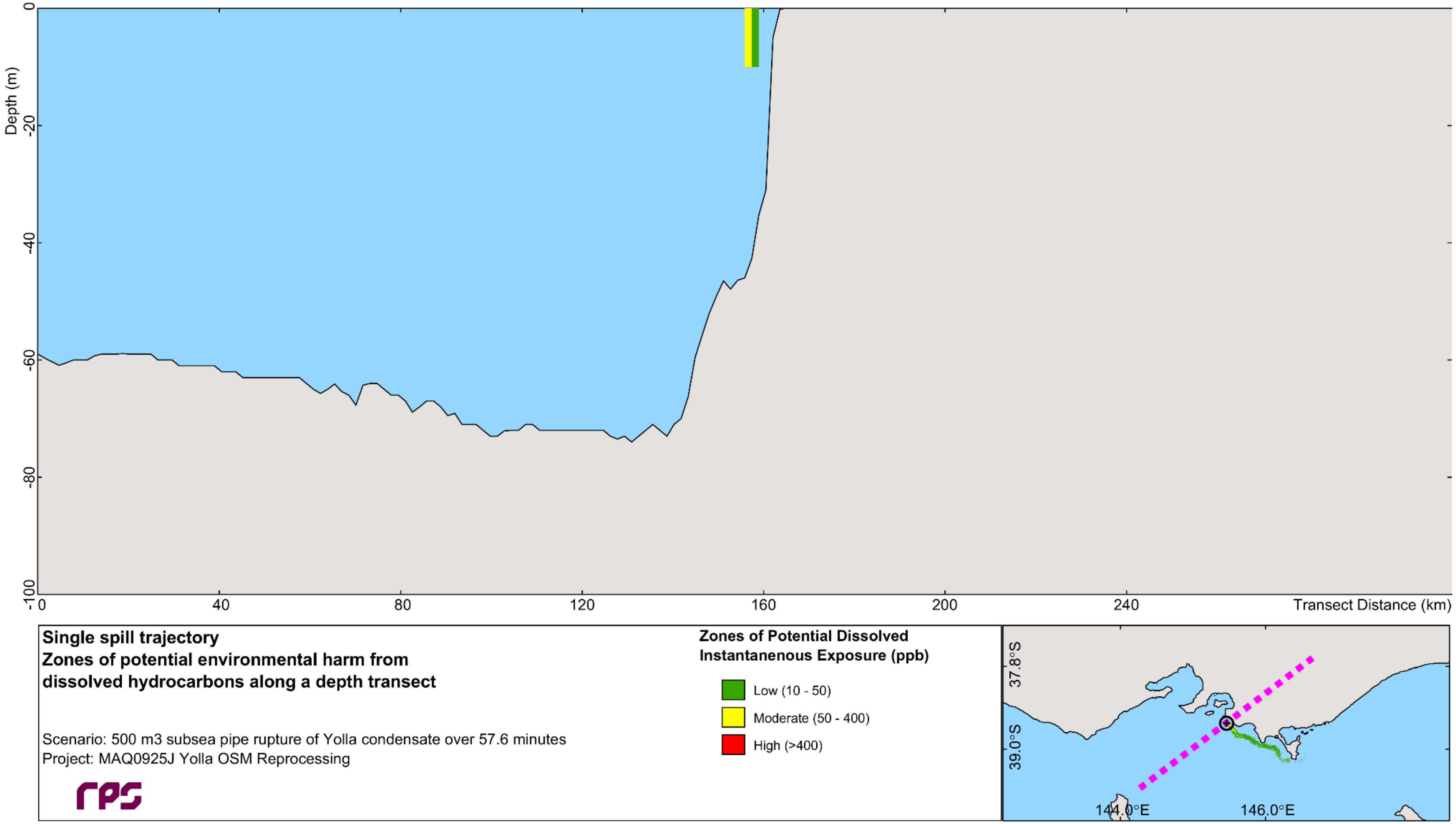


Figure 13.13 Transect plot (northeast to southwest) illustrating zones of potential dissolved hydrocarbon exposure through the water column for a <u>single spill trajectory</u>, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days.

13.1.2.2 Entrained Hydrocarbons

Table 13.7 summarises the maximum distance and direction from the release location to entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) exposure levels (NOPSEMA, 2019). The maximum predicted distances of entrained hydrocarbons at the low and high thresholds from the release location was 136 km (east-southeast) and 49 km (southeast), respectively.

Table 13.8 presents the probability of exposure to individual receptors from entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) exposure levels in the 0-10 m depth layer for the annualised assessment.

In the surface layer (0-10 m), the Gippsland Plain IBRA, the Bass Coast, the Kilcunda Sub-LGA and the Venus Bay Sub-LGA all recorded the greatest probability of low exposure to entrained hydrocarbons with 73%. Additionally, Venus Bay Sub-LGA recorded an 80% probability of exposure to low entrained hydrocarbons and both the Bunurong Marine Park and the Bunurong MNP recorded a 69% and 66% probability of exposure to entrained hydrocarbons at the low threshold. At the high entrained hydrocarbon threshold, the Gippsland Plain IBRA, the Bass Coast and Kilcunda Sub-LGA recorded the highest probability of exposure with 33%.

It should be noted that multiple receptors were predicted to be exposed to entrained hydrocarbons at or above the low threshold but were excluded from tabulated results due to the release location residing within their boundaries (i.e. all receptors recorded a 100% probability of exposure, refer to Table 10.2).

Entrained hydrocarbons at, or above the low exposure threshold were not predicted to occur below a depth of 10 m for this scenario.

Figure 13.14 illustrates the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer at the low (10-100 ppb) and high (≥100 ppb) exposure levels.

Figure 13.15 presents the potential zones of entrained hydrocarbon exposure in the benthic layer for the annual assessment at the low (10-100 ppb) and high (≥100 ppb) exposure levels.

Figure 13.16 to Figure 13.19 depict potential zones of entrained hydrocarbon exposure through the water column along transects oriented along cardinal directions for the annual assessment.

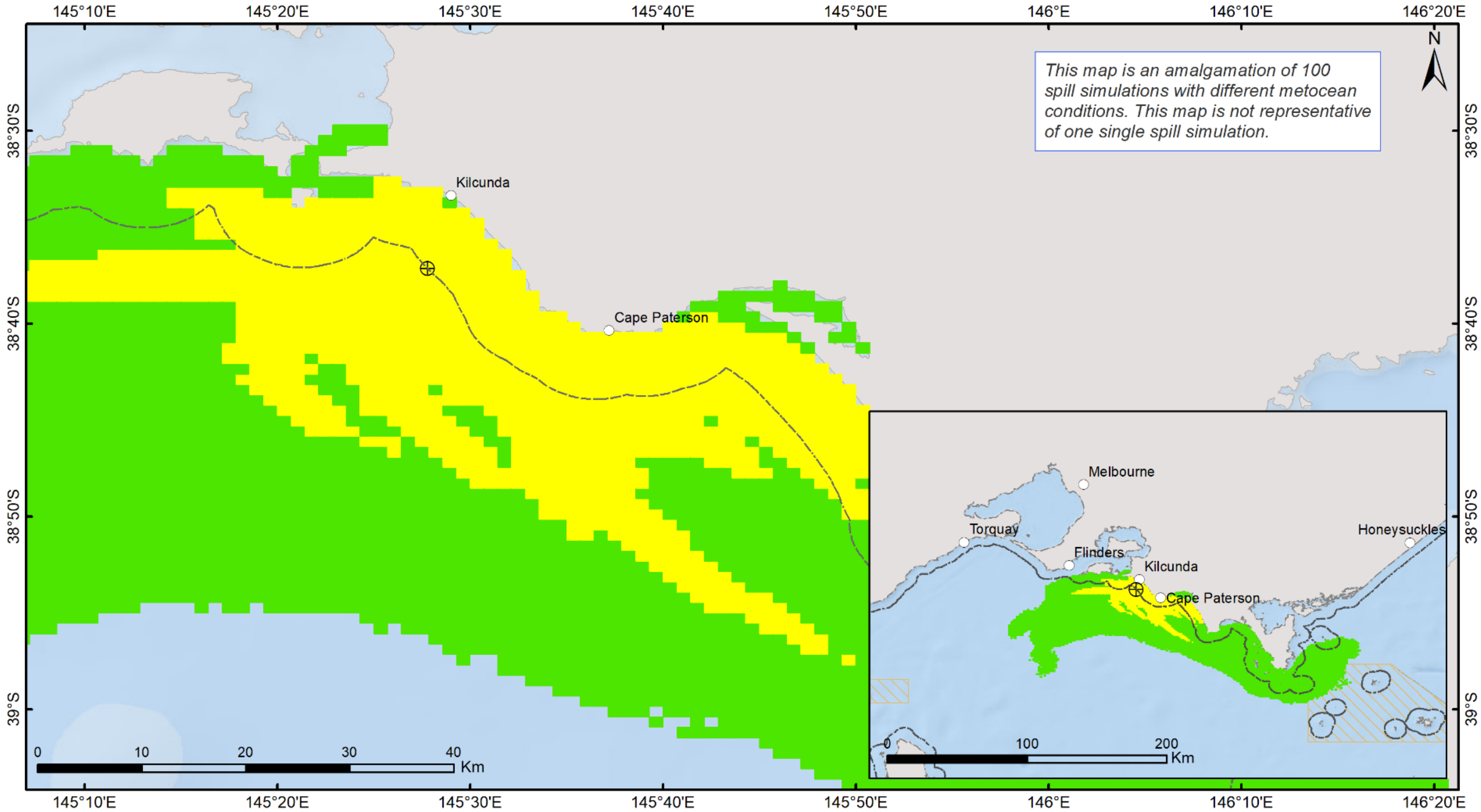
Table 13.7 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill simulations during annual conditions.

Distance and direction travelled	Zones of potential entrained hydrocarbon exposure	
	Low 10-100 ppb	High ≥100 ppb
Maximum distance (km) from the release location	136	49
Direction	East-southeast	Southeast

Table 13.8 Probability of low, moderate and high exposure to marine based receptors from entrained hydrocarbons at 0–10 m below the sea surface. Results are based on a 3,144.9 bbl (500 m³) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
AMP	Beagle	33.47	3	-
BIA	Little Penguin - Breeding	41.27	8	-
	Little Penguin - Foraging	1,120.94	53	29
	Short-tailed Shearwater - Breeding	79.16	9	-
	White Shark - Breeding	25.68	2	-
	White Shark - Foraging	870.81	49	24
IBRA	Gippsland Plain	776.67	73	33
	Strzelecki Ranges	69.45	35	-
	Wilsons Promontory	60.28	9	-
IMCRA	Central Bass Strait	181.86	18	3
	Flinders	86.75	18	-
	Twofold Shelf	13.85	1	-
	Victorian Embayments	48.28	9	-
MNP	Bunurong	414.77	66	17
	Wilsons Promontory	42.07	8	-
NP	Bunurong Marine Park	657.68	69	23
	Shallow Inlet Marine and Coastal Park	13.20	2	-
	Wilsons Promontory Marine Park	41.44	7	-
Ramsar	Western Port	21.59	3	-
RSB	Cody Bank	110.99	16	1
	Cutter Rock	11.47	1	-
Nearshore	Anser Island	32.76	3	-
	Bass Coast	776.67	73	33
	Glennie Group	45.32	9	-
	Kanowna Island	35.93	3	-
	Moncoeur Islands	38.38	3	-

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low 10-100 ppb	High ≥100 ppb
	Norman Island	60.28	9	-
	Phillip Island	169.95	17	3
	Rodondo Island	48.24	3	-
	Seal Islands	13.71	1	-
	Shellback Island	38.82	10	-
	Skull Rock	35.94	3	-
	South Gippsland	199.24	52	10
Sub-LGA	Cape Liptrap (NW)	199.24	52	9
	French Island / San Remo	48.28	9	-
	Kilcunda	776.67	73	33
	Venus Bay	657.68	73	28
	Waratah Bay	69.45	37	-
	Wilsons Promontory (East)	14.88	1	-
	Wilsons Promontory (West)	46.48	8	-



Subsea pipeline rupture

Zones of potential instantaneous entrained hydrocarbon exposure in the 0-10 m layer

Scenario: 500 m³ subsea release of Yolla condensate

Project: MAQ0925J Yolla OSM Reprocessing

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
Date created: 19-Feb-20

Legend

- Release Location
- Australian Marine Parks
- 3nm Maritime Boundary

Zones of Potential Instantaneous Entrained Hydrocarbon Exposure (ppb)

- Low (10 - 100)
- High (>100)

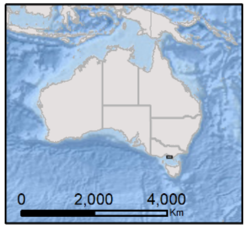


Figure 13.14 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 3,144.9 bbl (500 m³) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

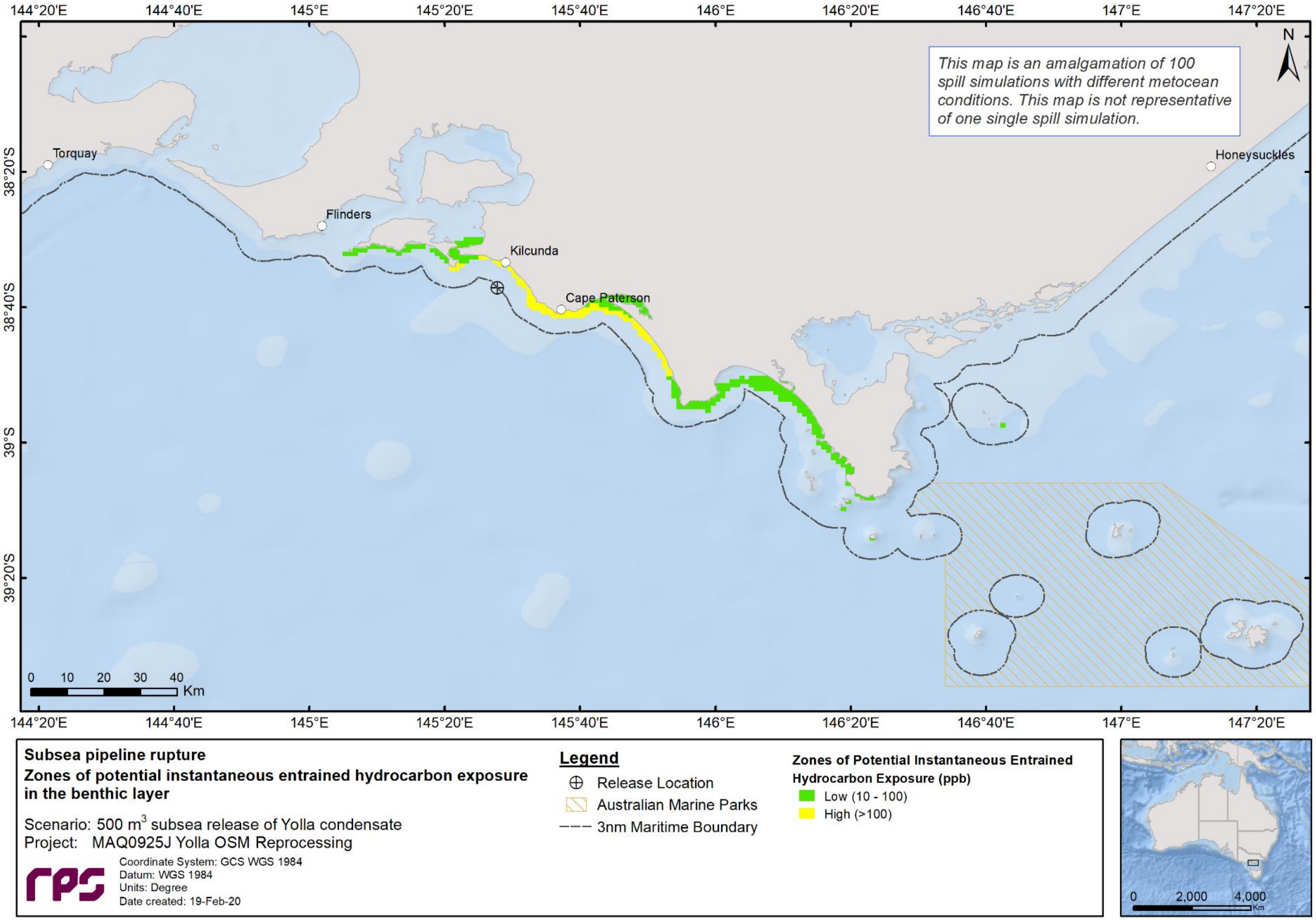


Figure 13.15 Benthic interaction of zones of potential instantaneous entrained hydrocarbon exposure, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

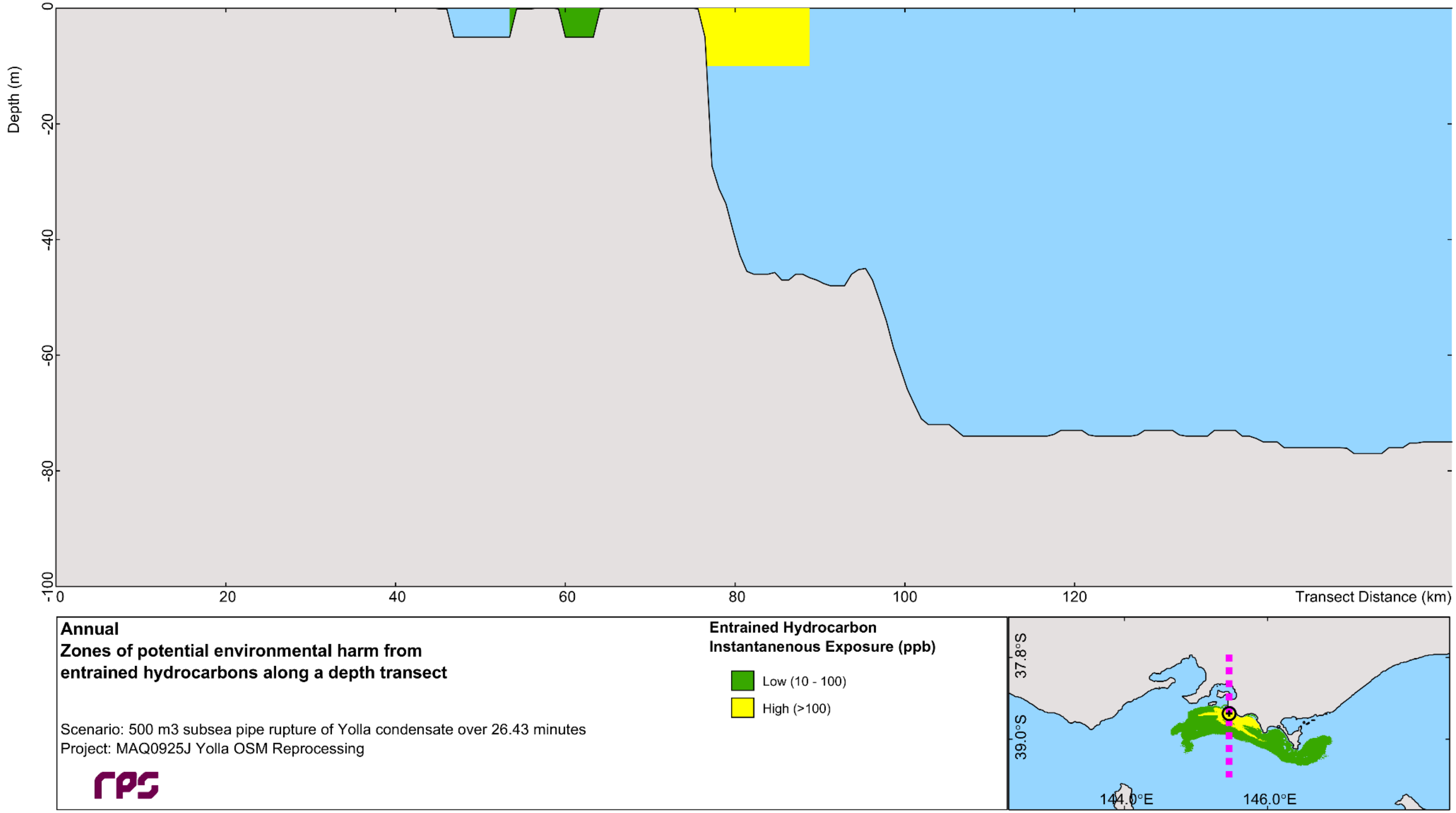


Figure 13.16 Transect plot (north to south) illustrating zones of potential instantaneous entrained hydrocarbon exposure through the water column, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

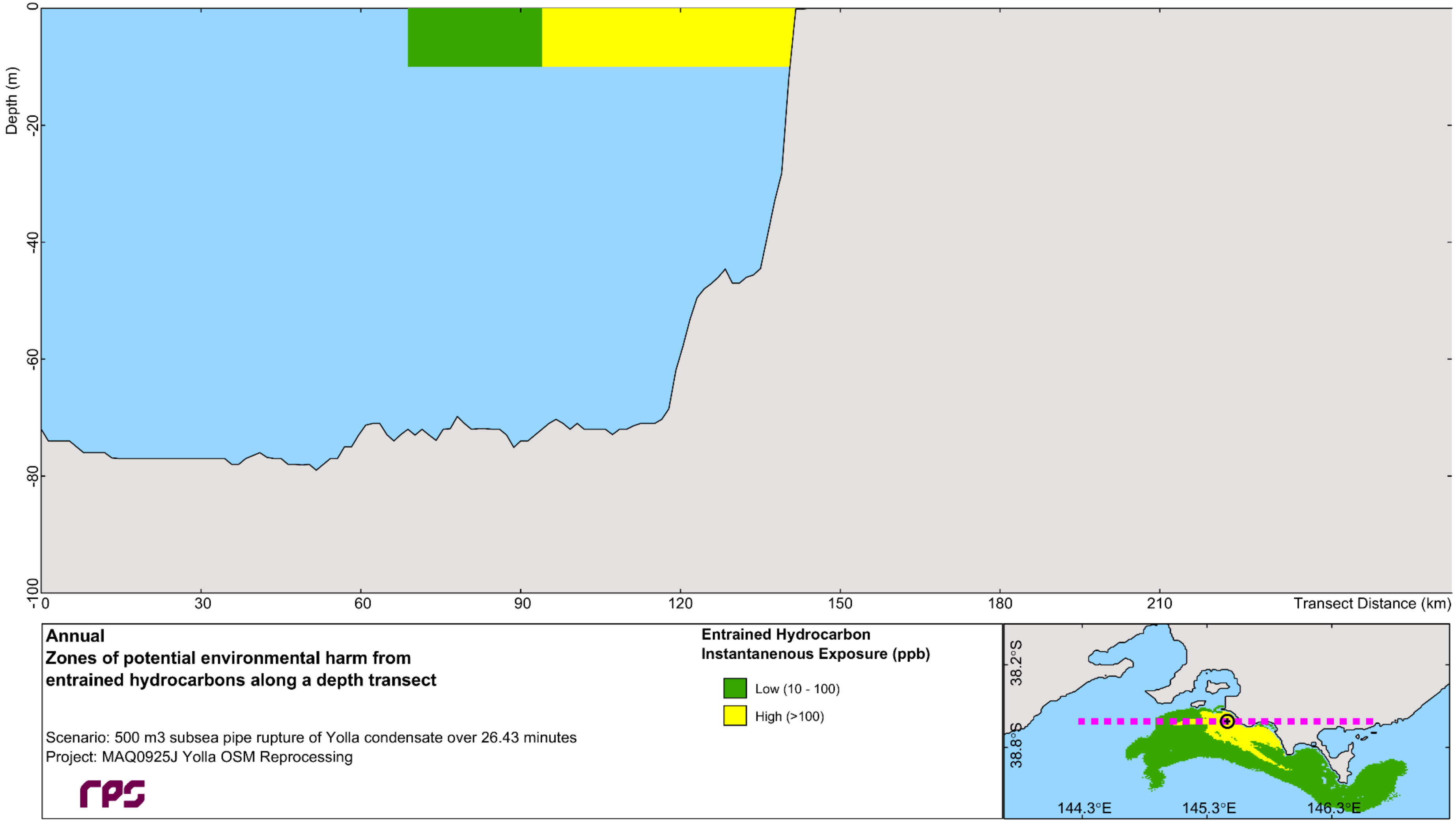


Figure 13.17 Transect plot (west to east) illustrating zones of potential instantaneous dissolved hydrocarbon exposure through the water column, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

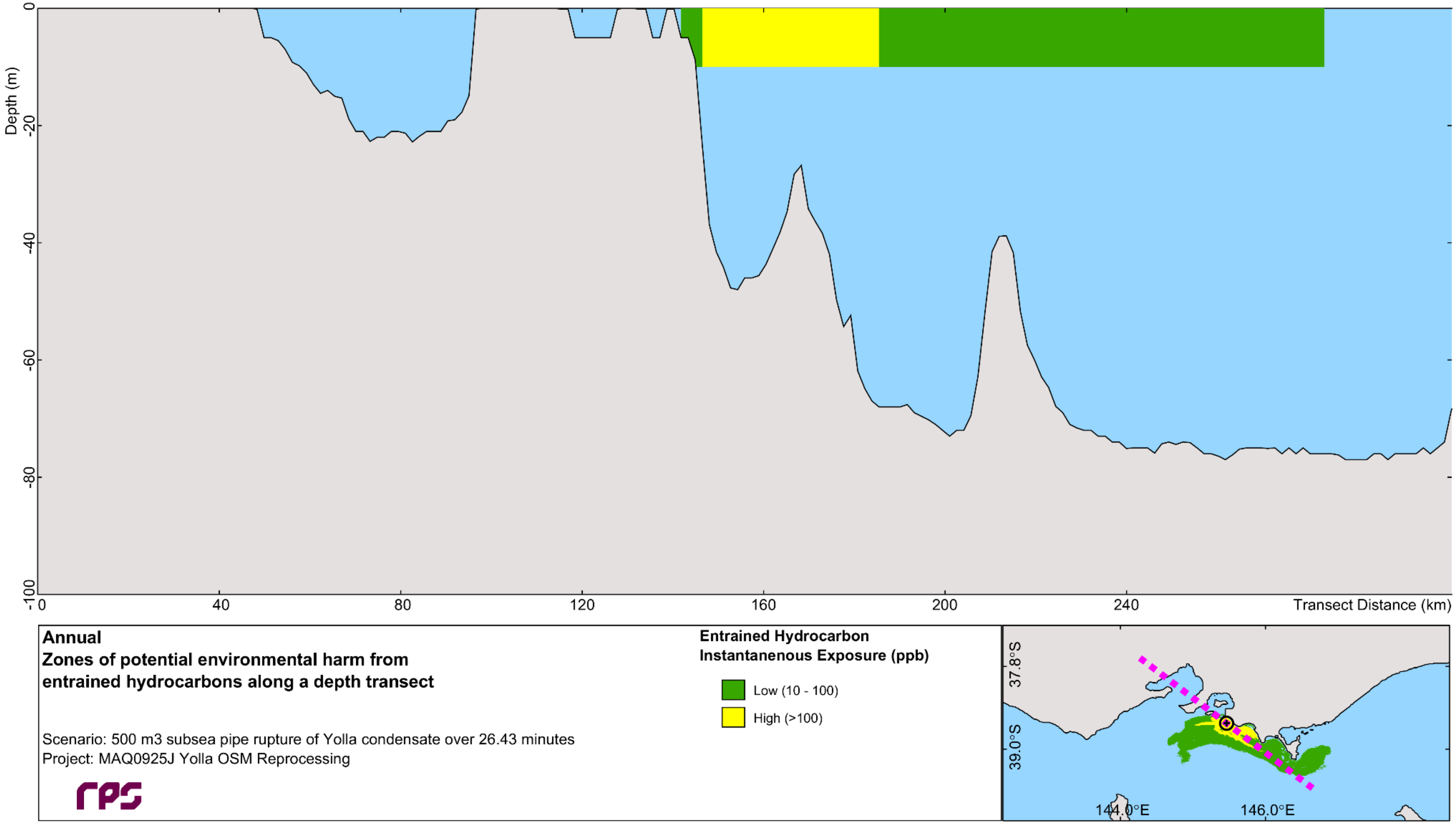


Figure 13.18 Transect plot (northwest to southeast) illustrating zones of potential instantaneous dissolved hydrocarbon exposure through the water column, in the event of a 3,144.9 bbl (500 m³) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

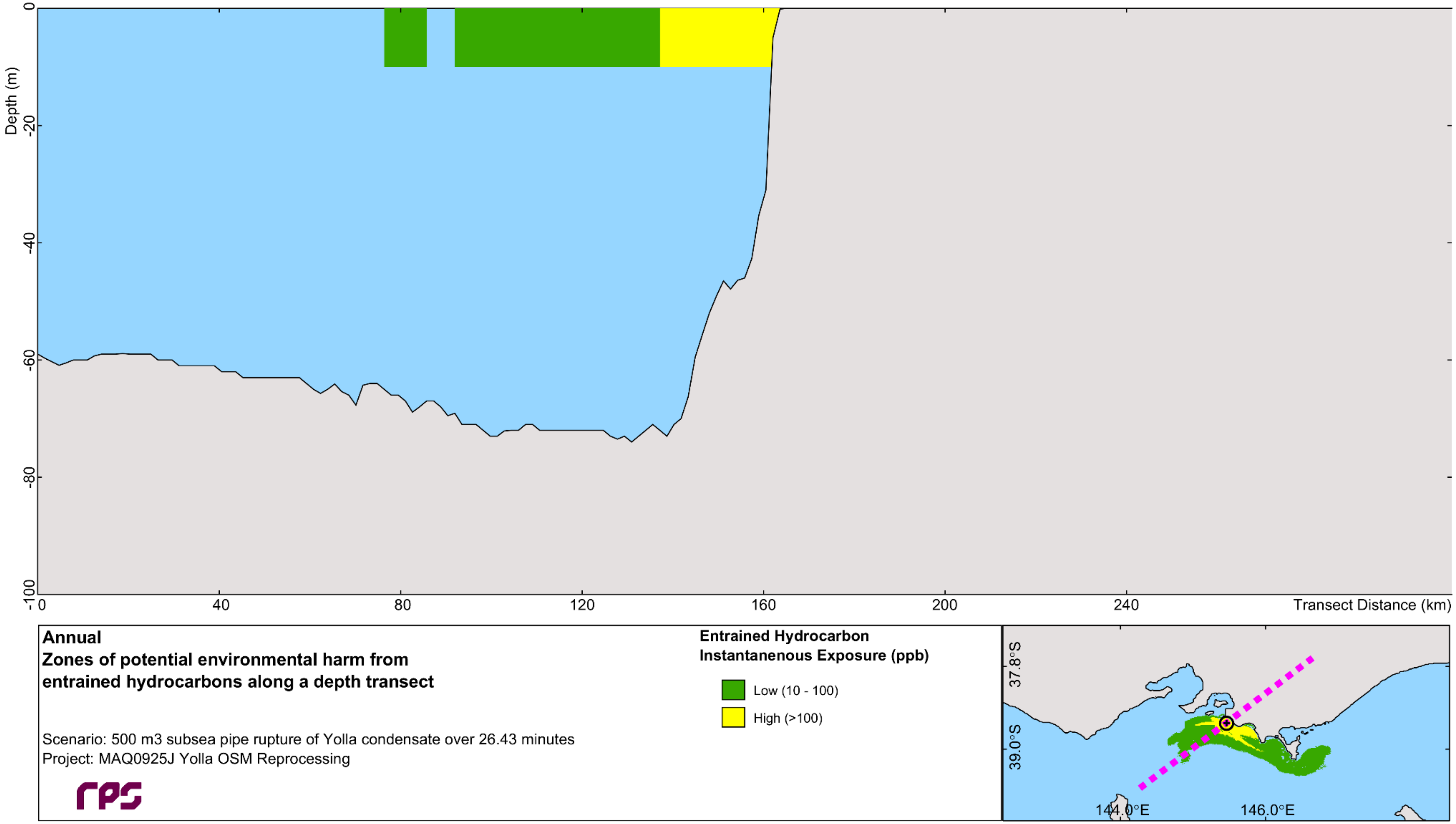


Figure 13.19 Transect plot (northeast to southwest) illustrating zones of potential instantaneous dissolved hydrocarbon exposure through the water column, in the event of a 3,144.9 bbl (500 m^3) pipeline rupture of Yolla condensate over 57.6 minutes, tracked for 10 days. The results were calculated from 100 spill trajectories during annual conditions.

13.2 Deterministic Analysis

There were four metrics used select single spill trajectories for the deterministic analysis from the 100 simulations across both seasons:

- Largest swept area at or above 10 g/m^2 (actionable sea surface oil);
- Minimum time to shore for visible sea surface oil (1 g/m^2);
- Largest volume of oil ashore, and
- Longest length of shoreline contacted at or above 100 g/m^2 (actionable shoreline oil).

The trajectory that resulted in the largest volume of oil shore was also the trajectory with the minimum time to shore for visible sea surface oil (1 g/m^2), hence it is only presented once in Section 13.2.2.

13.2.1 Largest Swept Area

The deterministic trajectory that had the largest swept area at or above 10 g/m^2 (actionable sea surface oil) commenced at 8:00 pm 24th December 2008.

Figure 13.20presents the potential zones of exposure (swept area) over the entire simulation. Zones of low (1-10 g/m^2) sea surface exposure (visible sea surface oil) occurred a maximum distance of ~5 km north-northeast from the release site, south of Kilcunda. Additionally, moderate exposure or actionable (≥10 g/m^2) sea surface oil was predicted to occur 3 km east of the release site. No high (≥50 g/m^2) sea surface exposure was predicted for this trajectory.

Figure 13.21 displays a time series of the actionable oil on the sea surface (≥10 g/m^2) and visible (1-10 g/m^2) oil exposure on the sea surface over the 10-day simulation. The maximum area of coverage of visible (1-10 g/m^2) oil on the on the sea surface at was ~4 km^2, whilst the maximum coverage of actionable (≥10 g/m^2) oil was 2 km^2.

Figure 13.22 presents the fates and weathering graph for the corresponding single spill trajectory. A significant portion of the spilled volume was lost to the atmosphere through evaporation. At the completion of the model period 84% was predicted to have evaporated. Of the remaining volume at the end of the model period, 7% was predicted to remain in the water column and 4% to decay. No oil was predicted to remain on the sea surface at the completion of the 10-day modelling period.

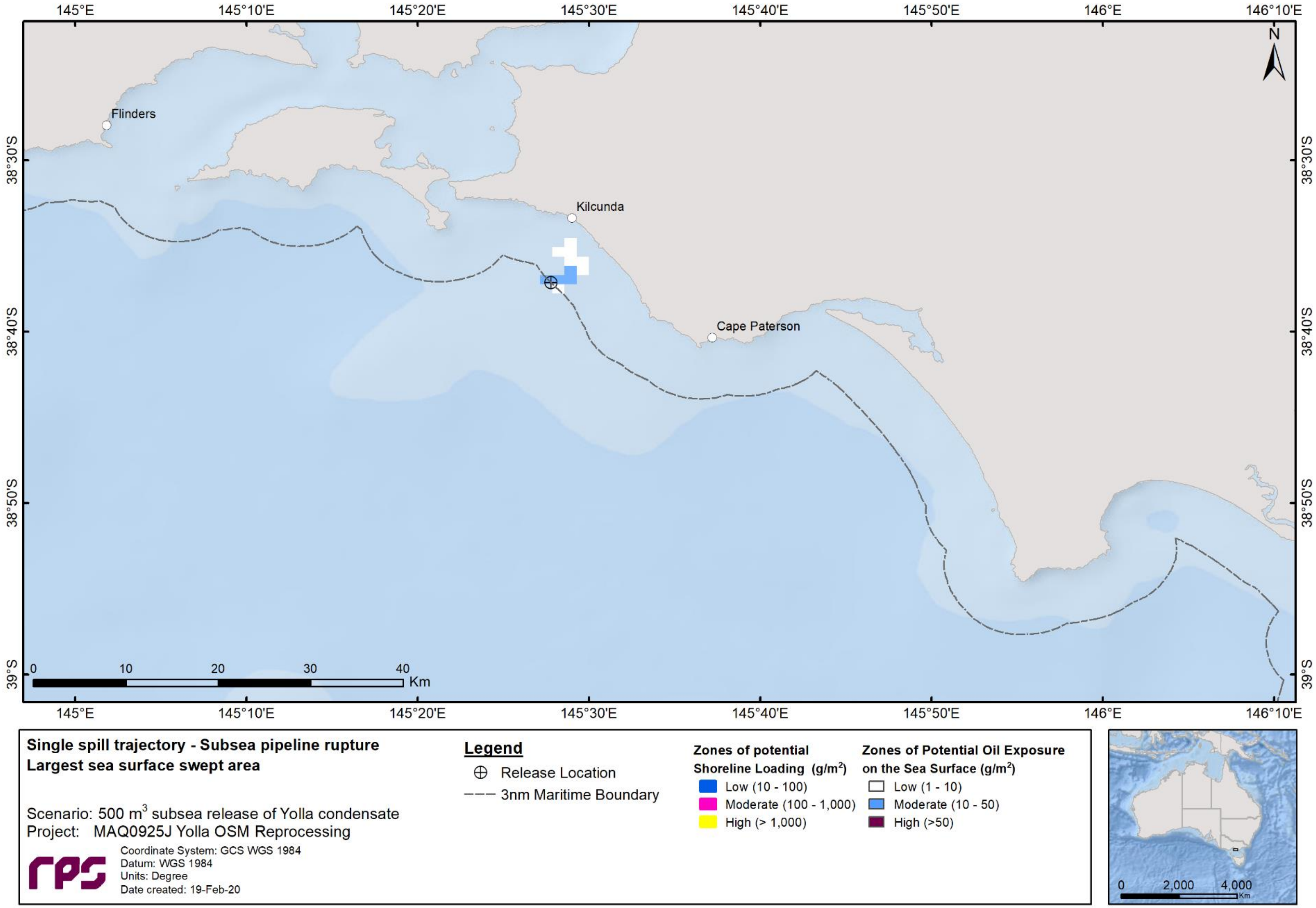


Figure 13.20 Zones of potential oil exposure on the sea surface over the entire simulation for the identified deterministic trajectory. Results are based on a 500 m^3 subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 8:00 pm 24th December 2008.

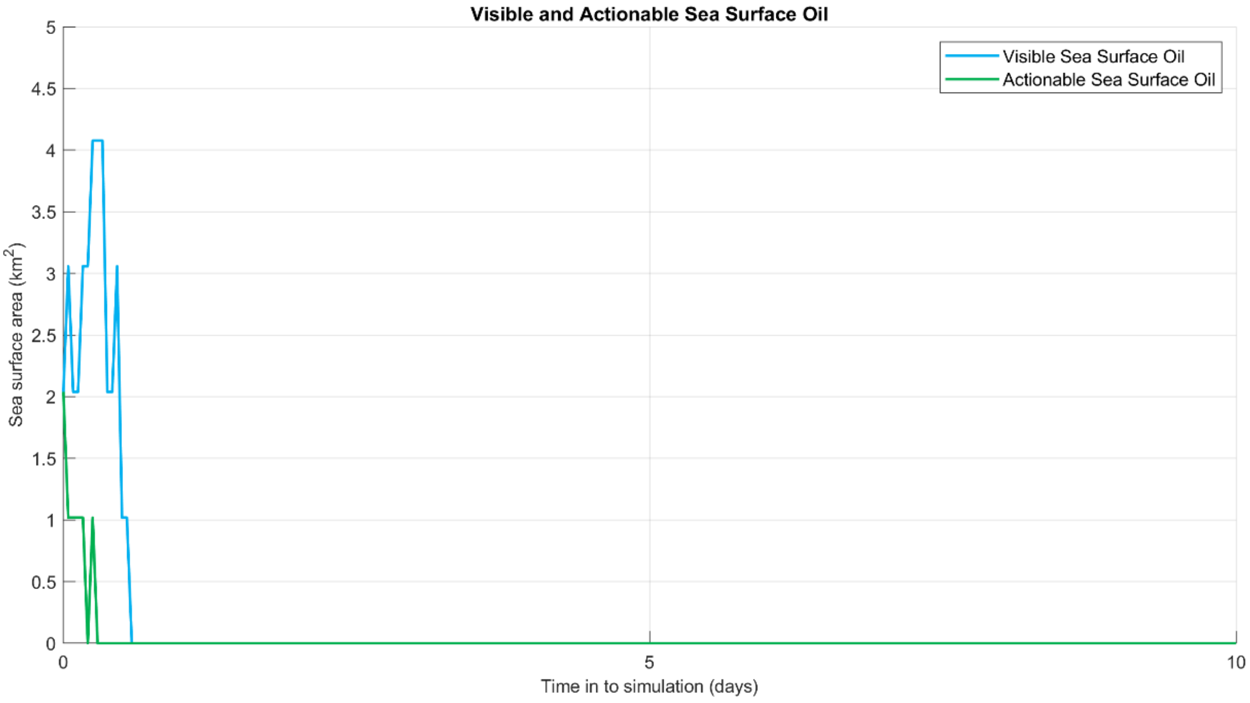


Figure 13.21 Time series of area of visible oil on the sea surface above the low threshold (1 g/m²), and actionable oil on the sea surface above the moderate threshold (10 g/m²). Results are based on a 500 m³ subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 8:00 pm 24th December 2008.

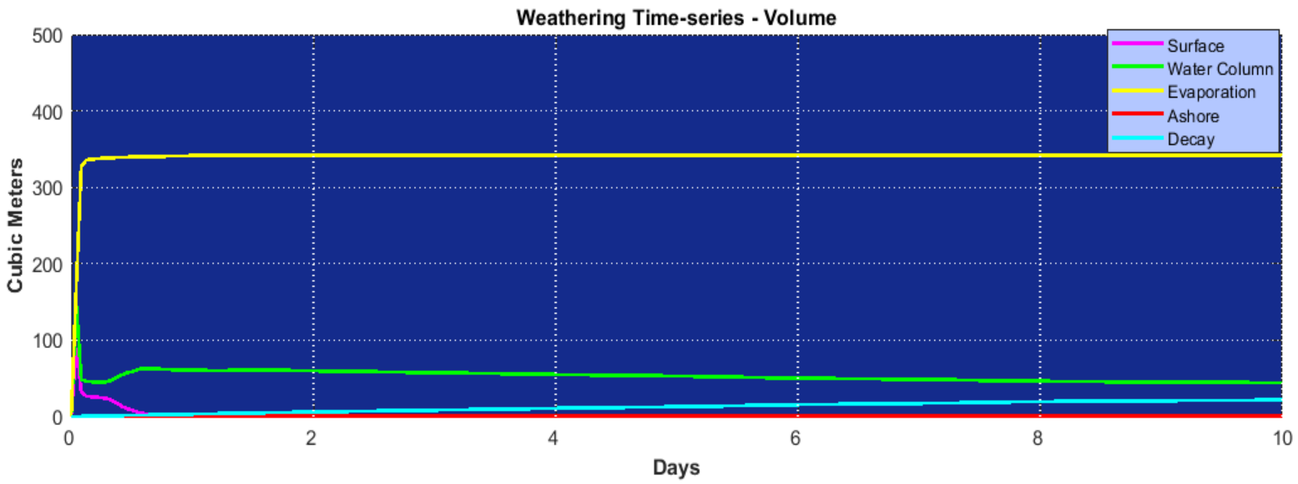


Figure 13.22 Predicted weathering and fates graph for the single spill trajectory. Results are based on a 500 m³ subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 8:00 pm 24th December 2008.

13.2.2 Largest Volume of Oil Ashore and Minimum Time to Shore

The deterministic trajectory that resulted in the largest volume ashore commenced at 3:00 pm 18th October 2010. The largest volume of oil ashore predicted for this scenario was approximately 21 m^3.

Additionally, the same trajectory (run number 43) was also identified as the single trajectory with the minimum time to shore for visible sea surface oil (1 g/m^2). The minimum time to shore predicted for this scenario was 12 hours following the spill start.

Figure 13.23 presents the potential zones of exposure (swept area) and shoreline loading, over the entire simulation. Zones of low (1-10 g/m^2) sea surface exposure (visible sea surface oil) occurred a maximum distance of ~6 km north-northeast from the release site in coastal waters immediately adjacent the shoreline. Zones of moderate exposure or actionable (≥10 g/m^2) exposure sea surface oil was predicted to occur up to ~3.5 km east of the release site. No high (≥50 g/m^2) exposure sea surface oil was predicted to occur for this trajectory.

Figure 13.24 displays a time series of the actionable oil on the sea surface (≥10 g/m^2), visible (1-10 g/m^2) oil exposure on the sea surface, and length of actionable (100 g/m^2) shoreline oil over the 10-day simulation. The maximum area of coverage of visible (1-10 g/m^2) oil on the on the sea surface was ~5 km^2, whilst the maximum coverage of actionable (≥10 g/m^2) oil was 2 km^2. The maximum length of actionable (100 g/m^2) shoreline oil was ~3 km.

Figure 13.25 presents the time series of mass on shore above the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) shoreline thresholds.

Figure 13.26 presents the fates and weathering graph for the corresponding single spill trajectory. A significant portion of the spilled volume was lost to the atmosphere through evaporation. At the completion of the model period 84% was predicted to have evaporated. Of the remaining volume at the end of the model period, 7% was predicted to remain in the water column and 4% to decay. Additionally, 5% was predicted to remain ashore at the end of the 10-day model period and no oil was predicted to remain on the sea surface at the completion of the 10-day modelling period.

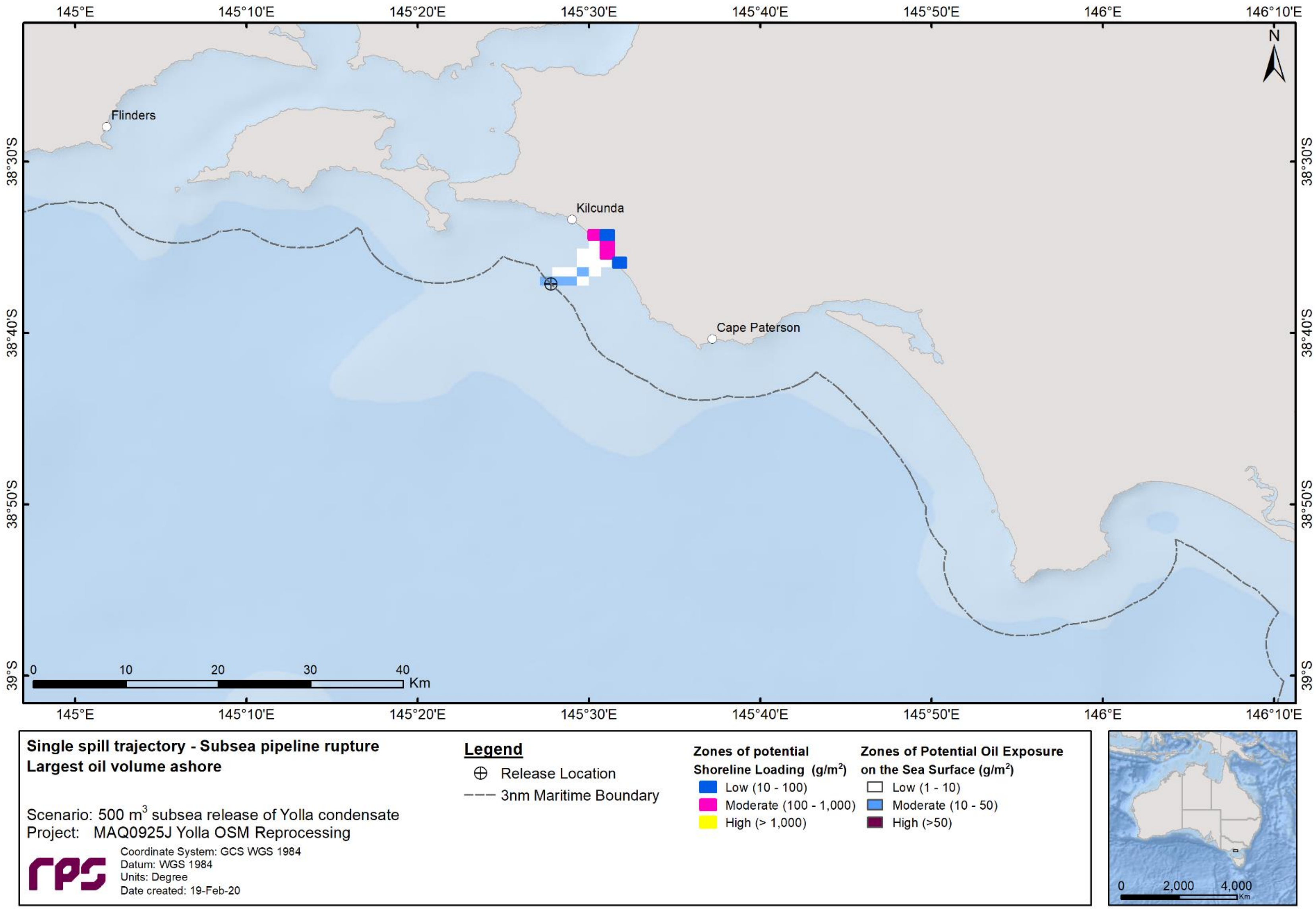


Figure 13.23 **Zones of potential oil exposure on the sea surface over the entire simulation for the identified deterministic trajectory. Results are based on a 500 m³ subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 3:00 pm 18th November 2010.**

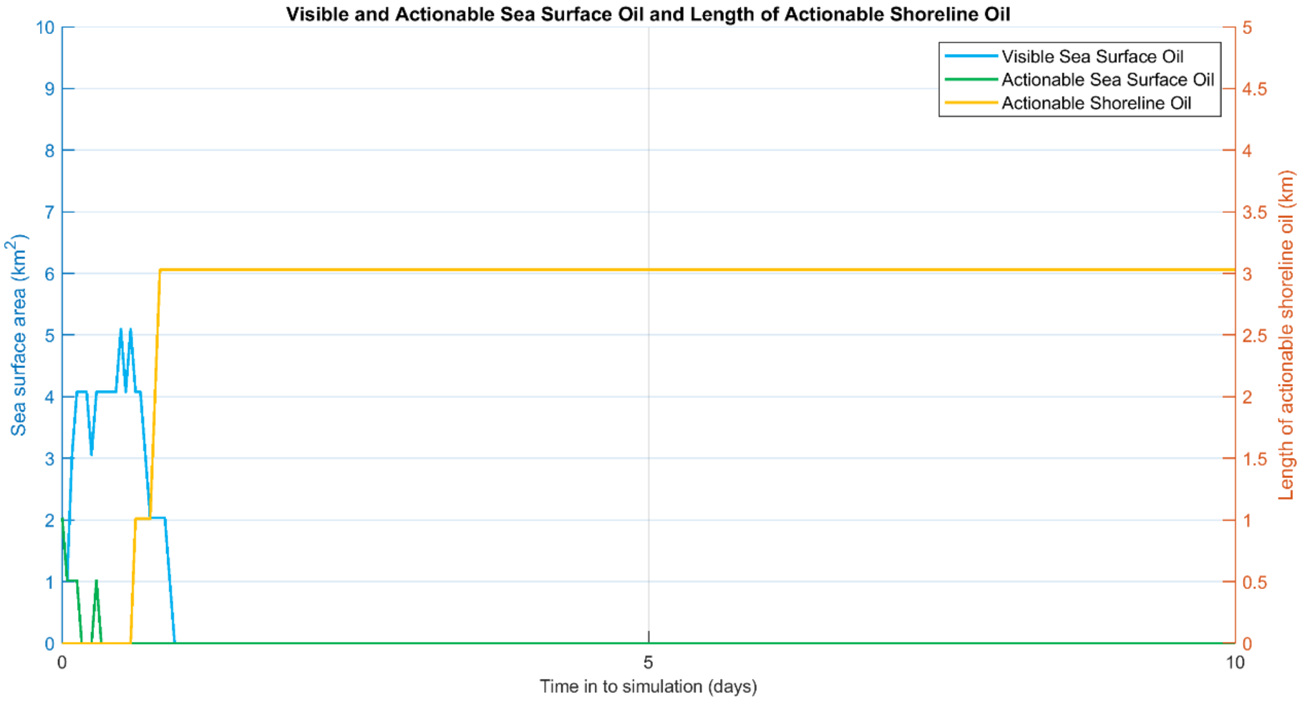


Figure 13.24 Time series of area of visible oil on the sea surface above the low threshold (1 g/m²), and actionable oil on the sea surface above the moderate threshold (10 g/m²). Results are based on a 500 m³ subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 3:00 pm 18th November 2010.

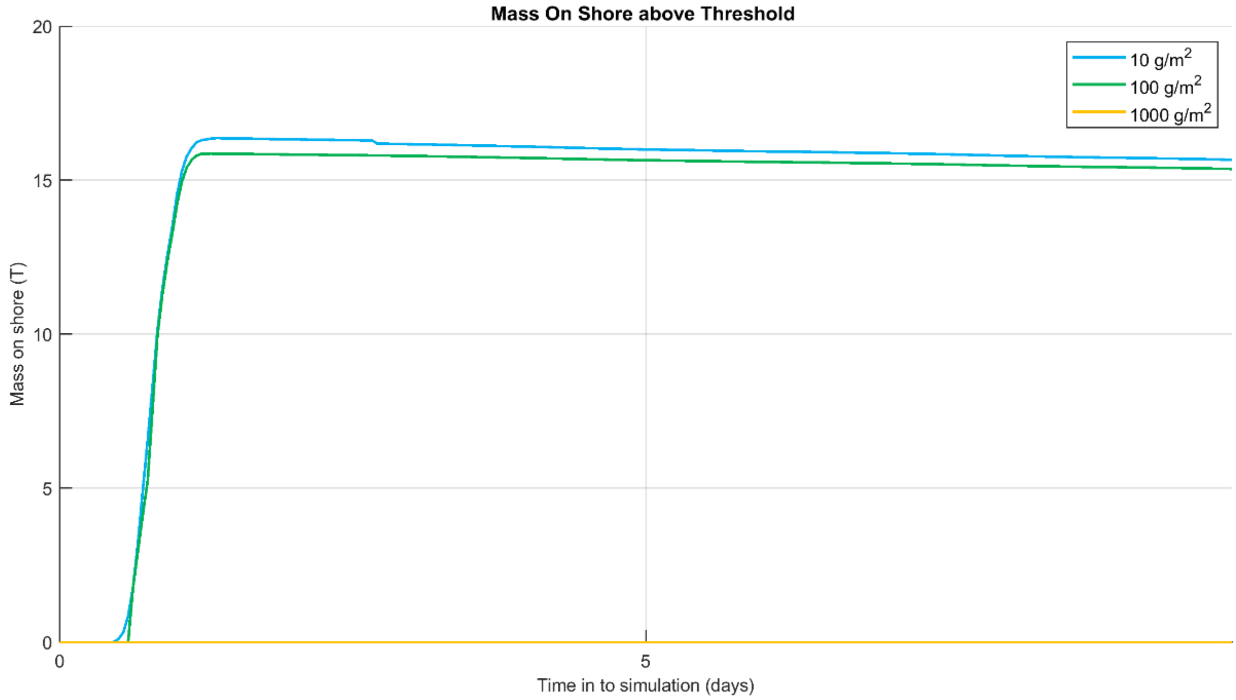


Figure 13.25 Time series of mass (T) on shore above the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²). shoreline thresholds. Results are based on a 500 m³ subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 3:00 pm 18th November 2010.

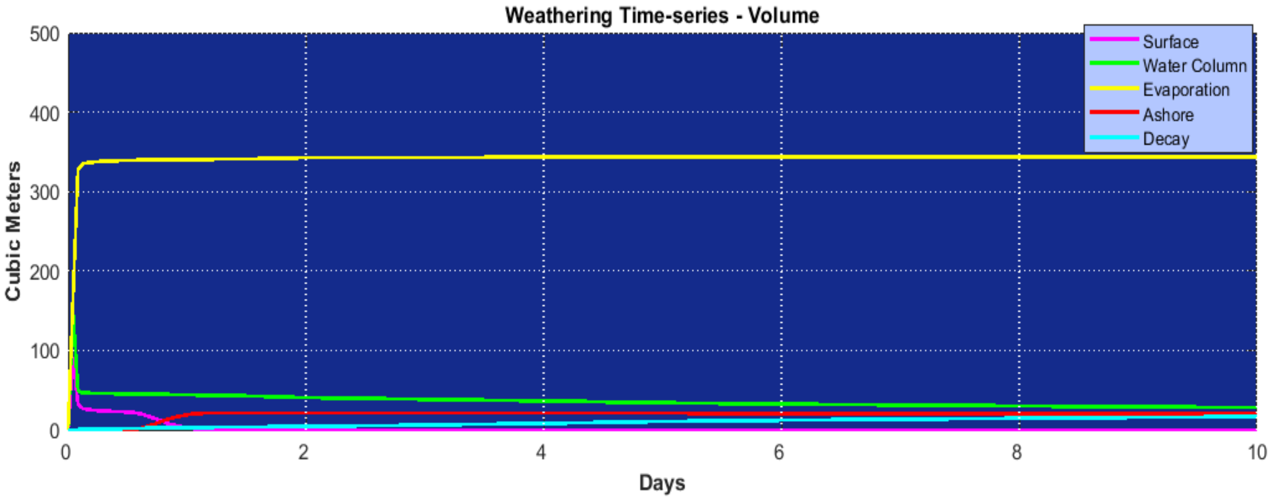


Figure 13.26 Predicted weathering and fates graph for the single spill trajectory. Results are based on a 500 m^3 subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 3:00 pm 18th November 2010.

13.2.3 Longest Length of Shoreline Contacted

The deterministic trajectory that resulted in the longest length of shoreline contacted at or above actionable shoreline oil (100 g/m^2) commenced at 3:00 am 1st November 2009. The longest length of shoreline predicted to be contacted by oil above 100 g/m^2 was 4 km.

Figure 13.27 presents the potential zones of exposure (swept area) and shoreline loading, over the entire simulation. Zones of low (1-10 g/m^2) sea surface exposure (visible sea surface oil) occurred a maximum distance of ~6.5 km (northeast) from the release site in coastal waters immediately adjacent the shoreline. Moderate oil exposure (or actionable oil ≥10 g/m^2) was predicted to travel a maximum distance of ~2 km from the release location. High (≥50 g/m^2) exposure sea surface oil was only predicted immediately adjacent to the release site.

Figure 13.28 displays a time series of the actionable oil on the sea surface (≥10 g/m^2), visible (1-10 g/m^2) oil exposure on the sea surface, and length of actionable (100 g/m^2) shoreline oil over the 10-day simulation. The maximum area of coverage of visible (1-10 g/m^2) oil on the on the sea surface at was ~6 km^2, whilst the maximum coverage of actionable (≥10 g/m^2) oil was 1 km^2. The maximum length of actionable (100 g/m^2) shoreline oil was ~4 km, occurring from 27 hours after the initial release until day 20.

Figure 13.29 presents the time series of mass on shore above the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) shoreline thresholds.

Figure 13.30 presents the fates and weathering graph for the corresponding single spill trajectory. Initial shoreline contact occurred 16 hours following the commencement of the spill and after 35 hours, 18 m^3 was predicted to have contacted shorelines. At the completion of the simulation period 4% was predicted to remain ashore, while 84% was predicted to have been lost through evaporative processes. Additionally, 7% of the release volume was predicted to remain in the water column at the completion of the 10-day modelling period.

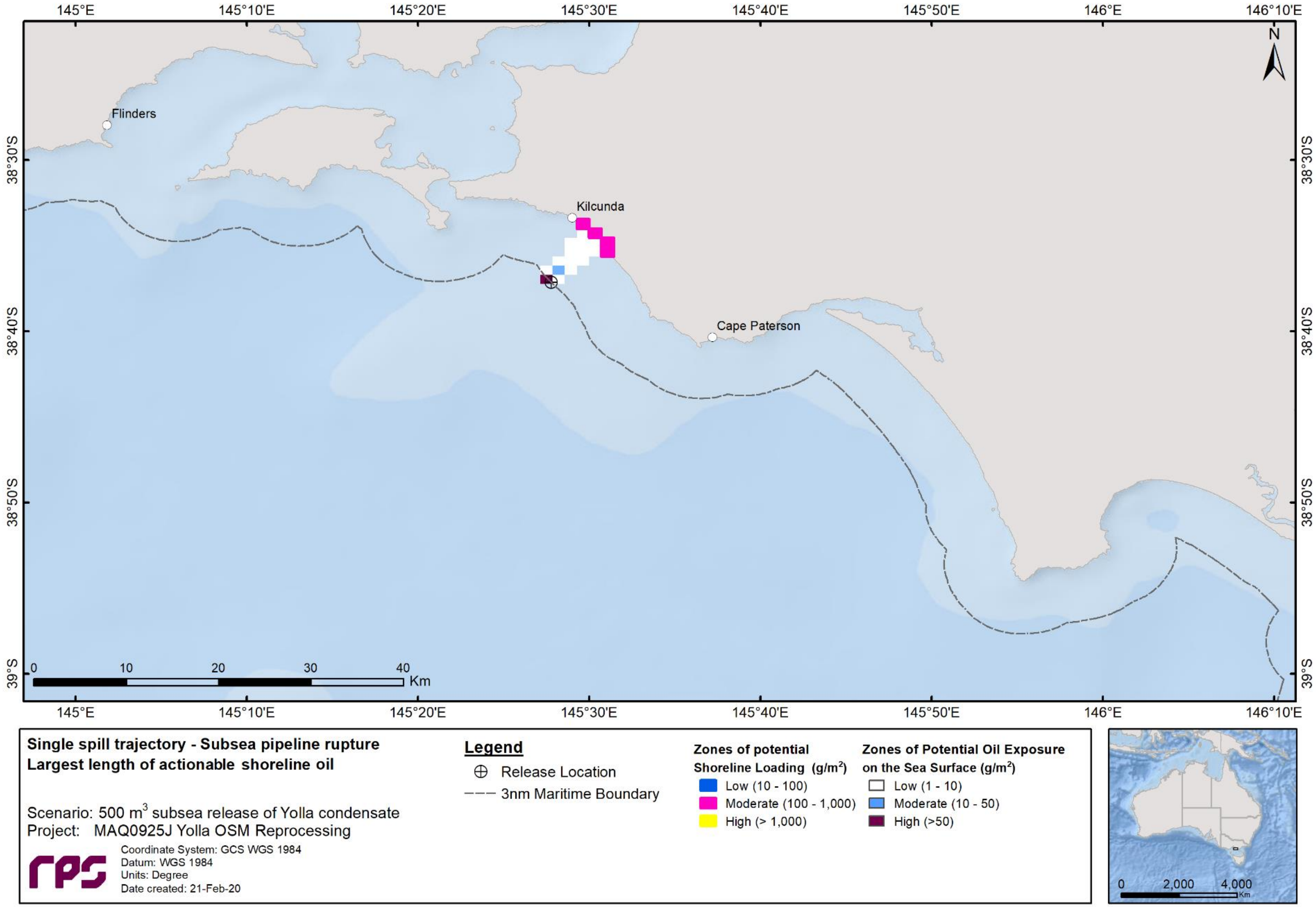


Figure 13.27 **Zones of potential oil exposure on the sea surface over the entire simulation for the identified deterministic trajectory. Results are based on a 500 m^3 subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 3:00 am 1st November 2009.**

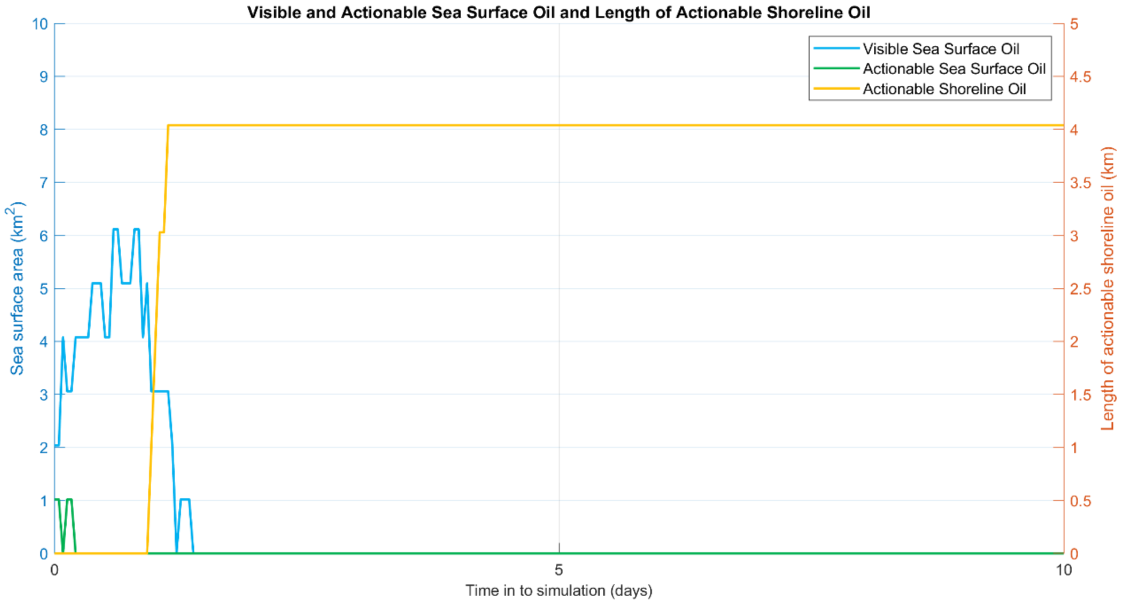


Figure 13.28 Time series of area of visible oil on the sea surface above the low threshold (1 g/m^2), and actionable oil on the sea surface above the moderate threshold (10 g/m^2). Results are based on a 500 m^3 subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 3:00 am 1st November 2009.

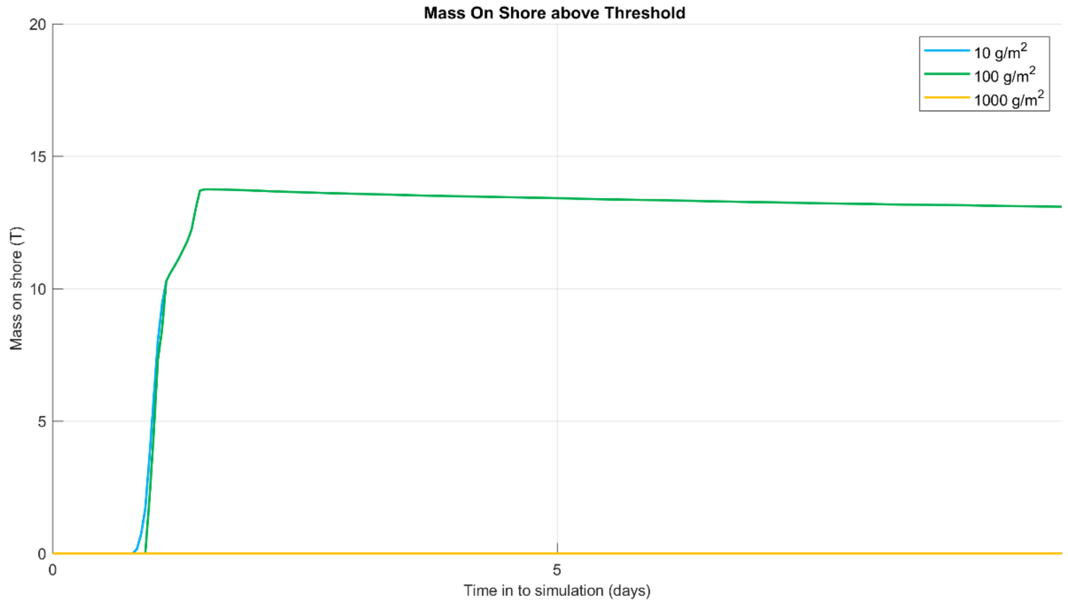


Figure 13.29 Time series of mass (T) on shore above the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2). shoreline thresholds. Results are based on a 500 m^3 subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 3:00 am 1st November 2009.

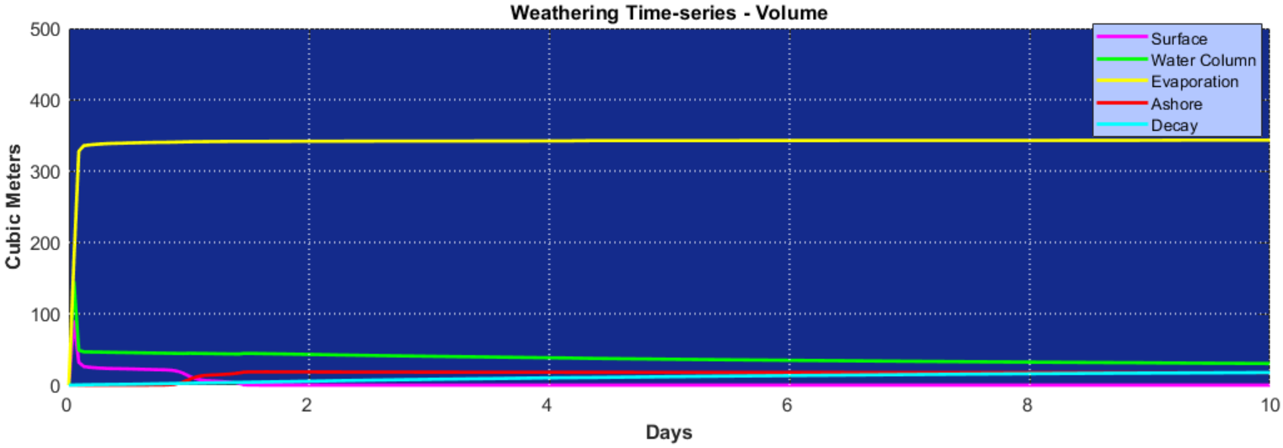


Figure 13.30 Predicted weathering and fates graph for the single spill trajectory. Results are based on a 500 m^3 subsea release of Yolla condensate in the event of pipe rupture 57.6 minutes, tracked for 10 days, starting 3:00 am 1st November 2009.

14 REFERENCES

American Society for Testing and Materials (ASTM) 2013. F2067-13 Standard Practice for Development and Use of Oil-Spill Trajectory Models, ASTM International, West Conshohocken (PA).

Applied Science Associates 2011, 'OILMAP-DEEP: Blowout Plume Model Technical Manual', Applied Science Associates Inc., South Kingstown, USA.

Australian Maritime Safety Authority (AMSA) 2007, 'Foreshore Assessment, Termination of Clean-up and Rehabilitation Monitoring', viewed 12 February 2014, https://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/ESC/documents/Foreshore_Assessment_and_Termination.pdf

Australian Maritime Safety Authority (AMSA) 2012, 'Australian Maritime Safety Authority Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities Australian Maritime Safety Authority', viewed 15 January 2015, https://www.amsa.gov.au/forms-and-publications/Publications/AMSA413_Contingency_Planning_Guidelines.pdf

Australian Maritime Safety Authority (AMSA) 2015, 'Australian Maritime Safety Authority Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities Australian Maritime Safety Authority', viewed 20 June 2017, https://www.amsa.gov.au/forms-and-publications/Publications/AMSA413_Contingency_Planning_Guidelines.pdf

Anderson JW, Neff JM, Cox BA, Tatem HE & Hightower GM 1974, 'Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish', *Marine Biology*, vol. 27, no. 1, pp. 75–88.

Anderson JW, Riley R, Kiesser S & Gurtisen J 1987, 'Toxicity of dispersed and undispersed Prudhoe Bay crude oil fractions to shrimp and fish', Proceedings of the 1987 International Oil Spill Conference, American Petroleum Institute, pp. 235–240.

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

Australian and New Zealand Environment and Conservation Council (ANZECC) 2000, 'Australian and New Zealand guidelines for fresh and marine water quality Volume 1, The guidelines (National water quality management strategy; no.4)', Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

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

Belore, UC 2014, 'Subsea chemical dispersant research', *Proceedings of the 37th AMOP Technical Seminar on Environmental Contamination and Response*, Environmental Canada, Canmore, Alberta, Canada pp 618–650.

Blum DJ & Speece RE 1990, 'Determining chemical toxicity to aquatic species', *Environmental Science & Technology*, vol. 24, no. 3, pp. 284–293.

Bonn Agreement 2009, 'Bonn Agreement aerial operations handbook, 2009 - Publication of the Bonn Agreement', viewed 13 January 2015, http://www.bonnagreement.org/site/assets/files/3947/ba-aoh_revision_2_april_2012.pdf

Brandvik, PJ, Johansen, O, Leirvik, F, Farooq, U & Daling PS 2013, 'Droplet Breakup in subsurface oil releases – Part 1: Experimental study of droplet breakup and effectiveness of dispersant injection', *Marine Pollution Bulletin*, vol. 73, no. 1, pp 319–326.

Brandvik, PJ, Johansen, O, Farooq, U, Angell, G & Leirvik, F 2014, 'Sub-surface oil releases – Experimental study of droplet distributions and different dispersant injection techniques- version 2. A scaled experimental approach using the SINTEF Tower basin', SINTEF report no: A25122. Trondheim Norway.

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

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

Clark, RB, 1984 'Impact of oil pollution on seabirds', *Environmental Pollution*, vol. 33, no.1, pp. 1–22.

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

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

Delvigne, GAL & Sweeney, CE 1988, 'Natural dispersion of oil', *Oil and Chemical Pollution*, vol. 4, no. 4, pp. 281–310.

Di Toro, DM, McGrath, JA & Stubblefield, WA 2007, 'Predicting the toxicity of neat and weathered crude oil: Toxic potential and the toxicity of saturated mixtures', *Environmental Toxicology and Chemistry*, vol. 26, no. 1, pp. 24–36.

Engelhardt, FR 1983, 'Petroleum effects on marine mammals', *Aquatic Toxicology*, vol. 4, no.3, pp. 199–217.

European Chemicals Agency 2008, 'Chapter R.10 - Characterisation of dose [concentration] -response for environment', In: Guidance on information requirements and chemcial safety assessment, ECHA, pp. 26–29.

French, D, Reed, M, Jayko, K, Feng, S, Rines, H, Pavignano, S, Isaji, T, Puckett, S, Keller, A, French III, FW, Gifford, D, McCue, J, Brown, G, MacDonald, E, Quirk, J, Natzke, S, Bishop, R, Welsh, M, Phillips, M & Ingram, BS 1996, '*The CERCLA Type A natural resource damage assessment model for coastal and* *marine environments (NRDAM/CME), Technical Documentation, Volume I - Model Description, Final Report*,' Office of Environmental Policy and Compliance, U.S. Department of the Interior, Washington DC.

French, D, Schuttenberg, H & Isaji, T 1999, 'Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light', *Proceedings of the 22nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar,* Environment Canada, Alberta, pp. 243–270.

French-McCay, DP 2002, 'Development and application of an oil toxicity and exposure model, OilToxEx', *Environmental Toxicology and Chemistry*, vol. 21, no. 10, pp. 2080-2094.

French-McCay, DP 2003, 'Development and application of damage assessment modelling: example assessment for the North Cape oil spill', *Marine Pollution Bulletin*, *vol.* 47, no. 9, pp. 9–12.

French-McCay, DP 2004, 'Spill impact modelling: development and validation', *Environmental Toxicology and Chemistry, vol.* 23, no.10, pp. 2441–2456.

French-McCay, DP 2009, 'State-of-the-art and research needs for oil spill impact assessment modelling', *Proceedings of the 32nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar*, Environment Canada, Ottawa, pp. 601–653.

French-McCay, D, Rowe, JJ, Whittier, N, Sankaranarayanan, S, & Etkin, DS 2004, 'Estimate of potential impacts and natural resource damages of oil', *Journal of Hazardous Materials*, vol. 107, no. 1, pp. 11–25.

French-McCay, D, Reich, D, Rowe, J, Schroeder, M & Graham, E 2011, 'Oil spill modeling input to the offshore environmental cost model (OECM) for US-BOEMRE's spill risk and costs evaluations', *Proceedings of the 34th Arctic and Marine Oil Spill Program (AMOP) Technical Siminar, Environment Canada,* Ottawa.

French-McCay, D, Reich, D, Michel, J, Etkin, DS, Symons, L, Helton, D, & Wagner J 2012, 'Oil spill consequence analysis of potentially-polluting shipwrecks', Proceedings of the 35th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa.

French-McCay, D, Jayko, K, Li, Z, Horn, M, Kim, Y, Isaji, T, Crowley, D, Spaulding, M, Decker, L, Turner, C, Zamorski, S, Fontenault, J, Schmmkler, R & Rowe, J 2015, 'Technical Reports for Deepwater Horizon Water Column Injury Assessment: WC_TR.14: Modeling Oil Fate and Exposure Concentrations in the Deepwater Plume and Rising Oil Resulting from the Deepwater Horizon Oil Spill' RPS ASA, South Kingston, Rhode Island.

French-McCay, D, Li, Z, Horn, M, Crowley, D, Spaulding, ML & Turner, C 2016, 'Modeling oil fate and subsurface expsoure concentrations from the Deepwater Horizon oil spill', Proceedings of the 39th *Arctic and Marine Oil Spill Program (AMOP) Technical Siminar, Environment and Climate Chage Canada,* Ottawa

Geraci, JR, & St. Aubin, DJ 1988, *Synthesis of effects of oil on marine mammals*. 292. Ventura, CA, USA: US Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study, MMS 880049.

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

Grant, DL, Clarke, PJ & Allaway, WG 1993, 'The response of grey mangrove (*Avicennia marina* (Forsk.) Vierh) seedlings to spills of crude oil,' *The Journal of Experimental Marine Biological Ecology*, *vol.* 171, no. 2, pp. 273–295.

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

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

International Tankers Owners Pollution Federation (ITOPF) 2014, 'Technical Information Paper 2 - Fate of Marine Oil Spills*',* International Tankers Owners Pollution Federation td, UK.

Jenssen, BM 1994, 'Review article: Effects of Oil Pollution, Chemically Treated Oil, and Cleaning on the Thermal Balance of Birds', *Environmental Pollution*, vol.86, no. 2, pp. 207–215.

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

Koops, W, Jak, RG & van der Veen, DPC 2004, 'Use of dispersants in oil spill response to minimise environmental damage to birds and aquatic organisms', *Proceedings of the Interspill 2004: Conference and Exhibition on Oil Spill Technology,* Trondheim, presentation 429.

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

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

Li, Z, Spaulding, M, French-McCay, D, Crowley, D & Payne JR 2017a, 'Development of a unified oil droplet size distribution model with application to surface breaking waves and subsea blowout releases considering dispersant effects', *Marine Pollution Bulletin,* vol. 114, no. 1, pp 247–257.

Li, Z, Spaulding, M & French-McCay, D 2017b, 'An algorithm for modeling entrainment and naturally and chemically dispersed oil droplet size distribution under surface breaking wave conditions', *Marine Pollution Bulletin,* vol. 119, no. 1, p. 145–152..

Lin, Q & Mendelssohn, IA 1996, 'A comparative investigation of the effects of south Louisiana crude oil on the vegetation of fresh, brackish and Salt Marshes', *Marine Pollution Bulletin*, vol. 32, no. 2, pp. 202–209.

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

Mackay, D. and Southwood, J.M., 1992. Modelling the fate of organochlorine chemicals in pulp mill effluents. *Water Quality Research Journal*, vol. 27, no. 3, pp. 509–538.

Malins DC & Hodgins HO 1981, ‘Petroleum and marine fishes: a review of uptake, disposition, and effects’, *Environmental Science & Technology*, vol. 15, no. 11, pp.1272–1280.

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

McAuliffe CD 1987, ‘Organism exposure to volatile/soluble hydrocarbons from crude oil spills – a field and laboratory comparison’, Proceedings of the 1987 International Oil Spill Conference, *American Petroleum Institute*, pp. 275–288.

McCarty LS 1986, ‘The relationship between aquatic toxicity QSARs and bioconcentration for some organic chemicals’, *Environmental Toxicology and Chemistry*, vol. 5, no. 12, pp. 1071–1080.

McCarty LS, Dixon DG, MacKay D, Smith AD & Ozburn GW 1992a, ‘Residue-based interpretation of toxicity and bioconcentration QSARs from aquatic bioassays: Neutral narcotic organics’, *Environmental Toxicology and Chemistry: An International Journal*, vol. 11, no. 7, pp.917–930.

McCarty LP, Flannagan DC, Randall SA & Johnson KA 1992b, ‘Acute toxicity in rats of chlorinated hydrocarbons given via the intratracheal route’, *Human & Experimental Toxicology*, vol. 11, no. 3, pp.173–117.

McCarty LS & Mackay D 1993, ‘Enhancing ecotoxicological modelling and assessment. Body residues and modes of toxic action’, *Environmental Science & Technology*, vol. 27, no. 9, pp. 1718–1728.

McGrath JA, & Di Toro DM 2009, ‘Validation of the target lipid model for toxicity assessment of residual petroleum constituents: monocyclic and polycyclic aromatic hydrocarbons’, *Environmental Toxicology and Chemistry*, vol. 28, no. 6, pp. 1130–1148.

Middleton, JF & Bye AT 2007, ‘A review of shelf-slope circulation along Australia’s southern shelves: Cape Leeuwin to Portland’, *Progress in Oceanography* vol. 75: 1-41

National Oceanic and Atmospheric Administration (NOAA) 2013, Screening level risk assessment package Gulf state, Office of National Marine Sanctuaries & Office of Response and Restoration, Washington DC.

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2018, ‘At a glance: Oil spill modelling’, viewed 15 November 2018, https://www.nopsema.gov.au/assets/Publications/A626200.pdf

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2019, ‘Environment bulletin: Oil spill modelling’, viewed 4 February 2020, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

National Research Council (NRC) 2003, ‘Oil in the sea III: Inputs, fates and effects’, The National Academic Press, Washington D.C.

Neff JM & Anderson JW 1981, 'Response of marine animals to petroleum and specific petroleum hydrocarbons' United States Department of Energy, United States.

Nirmalakhandan N & Speece RE 1988, 'ES&T Critical Review: Structure-activity relationships. Quantitative techniques for predicting the behaviour of chemicals in the ecosystem', *Environmental Science & Technology*, vol. 22, no. 6, pp. 606–615.

Organisation for Economic Co-operation and Development (OECD) 2002, 'Chapter 4: Initial Assessment of Data', In: OECD, Manual for Investigation of HPV Chemicals, OECD, Paris, pp. 1-11.

Oil Spill Solutions 2015, 'Evaluation - The Theory of Oil Slick Appearances', viewed 6 January 2015, http://www.oilspillsolutions.org/evaluation.htm

OSPAR Commission (OSPAR) 2012, 'OSPAR guidelines in support of recommendation 2012/5 for risk-based approach to the management of produced water discharges from offshore installations', OSPAR Commission, p. 21.

Owen, A 1980, 'A three-dimensional model of the Bristol Channel', *Journal of Physical Oceanography*, vol. 10, pp. 1290–1302.

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

Saha, S, Moorthi, S, Pan, H-L, Wu, X, Wang, J & Nadiga, S 2010, 'The NCEP Climate Forecast System Reanalysis', *Bulletin of the American Meteorological Society*, vol. 91, no. 8, pp. 1015–1057.

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

Scholten, MCTh, Kaag, NHBM, Dokkum, HP van, Jak, R.G., Schobben, HPM & Slob, W 1996, *Toxische effecten van olie in het aquatische milieu*, TNO report TNO-MEP – R96/230, Den Helder.

Smit, MG, Bechmann, RK, Hendriks, AJ, Skadsheim, A, Larsen, BK, Baussant, T, Shaw, B & Sanni, S 2009, 'Relating biomarkers to whole-organism effects using species sensitivity distributions: A pilot study for marine species exposed to oil', *Environmental Toxicology and Chemistry*, vol. 28, no. 5, pp. 1104-1109.

Solbakken, JE, Ingebrigtsen, K & Palmork, KH 1984, 'Comparative study on the fates of the polychlorinated biphenyl 2, 4, 5, 20, 40, 50-hexachlorobiphenyl and the polycyclic aromatic hydrocarbon phenanthrene in flounder (*Platichthys flesus*) determined by scintillation counting and autoradiography', *Marine Biology,* vol. 83, pp. 239-246.

Spaulding, MS, Mendelsohn, D, Crowley, D, Li, Z, & Bird A 2015, 'Technical Reports for Deepwater Horizon Water Column Injury Assessment- WC_TR.13: Application of OILMAP DEEP to the Deepwater Horizon Blowout', RPS APASA, 55 Village Square Drive, South Kingstown, RE 02879.

Suprayogi, B & Murray, F 1999, 'A field experiment of the physical and chemical effects of two oils on mangroves', *Environmental and Experimental Botany*, vol. 42, no. 3, pp. 221–229.

Swartz RC, Schults DW, Ozretich RJ, Lamberson JO, Cole FA, Ferraro SP, Dewitt TH & Redmond MS 1995, ‘ΣPAH: A Model to predict the toxicity of polynuclear aromatic hydrocarbon mixtures in field-collected sediments’, *Environmental Toxicology and Chemistry*, vol. 14, no. 11, pp. 1977–1187.

Tsvetnenko, Y 1998, ‘Derivation of Australian tropical marine water quality criteria for protection of aquatic life from adverse effects of petroleum hydrocarbons’, *Environmental Toxicology and Water Quality*, vol.13, no. 4, pp. 273–284.

Verhaar, HJ, Van Leeuwen, CJ & Hermens, JL 1992, ‘Classifying environmental pollutants’, *Chemosphere*, vol. 25, no. 4, pp. 471-491.

Verhaar, HJ, de Wolf, W, Dyer, S, Legierse, KC, Seinen, W & Hermens, JL 1999, ‘An LC_{50} vs time model for the aquatic toxicity of reactive and receptor-mediated compounds. Consequences for bioconcentration kinetics and risk assessment’, *Environmental science & technology*, vol. 33, no. 5, pp.758-763.

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

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

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

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

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

Zigic, S, Zapata, M, Isaji, T, King, B, & Lemckert, C 2003, *Modelling of Moreton Bay using an ocean/coastal circulation model*, Auckland, NZ: Proceedings of the Coasts and Ports Australasian Conference.

Appendix B Beach Energy –Vessel spill modelling

BEACH ENERGY – YOLLA PLATFORM MDO SPILL

Oil Spill Modelling

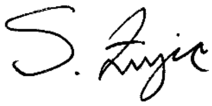
MAQ1131J
Beach Energy – Yolla Platform MDO Spill
Rev1
17 March 2022

www.rpsgroup.com/mst

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
Rev A	Draft issued for internal review	Jeremie Bernard Fernando Alvarez			9 March 2022
Rev 0	Draft issued for client review		Jeremie Bernard Fernando Alvarez	Dr. Sasha Zigic	11 March 2022
Rev 1	Final report issued to client		Jeremie Bernard	Dr. Sasha Zigic	17 March 2022

Approval for issue

Dr. Sasha Zigic		17 March 2022

This report was prepared by RPS within the terms of RPS' engagement with its client and in direct response to a scope of services. This report is supplied for the sole and specific purpose for use by RPS' client. The report does not account for any changes relating the subject matter of the report, or any legislative or regulatory changes that have occurred since the report was produced and that may affect the report. RPS does not accept any responsibility or liability for loss whatsoever to any third party caused by, related to or arising out of any use or reliance on the report.

Prepared by:

RPS

Jeremie Bernard
Senior Coastal Engineer

Lakeside Corporate Space, Suite 425
Level 2, 34-38 Glenferrie Drive
Robina, QLD, 4226

T +61 7 5574 1112
E jeremie.bernard@rpsgroup.com

Prepared for:

Beach Energy Ltd

Phil Wemyss
Principal Environment Advisor

80 Flinders Street,
Adelaide, SA, 5001

T +61 8 8433 2394
E Phil.Wemyss@beachenergy.com.au

Contents

Tables

Figures

TERMS AND ABBREVIATIONS

°	Degrees
‘	Minutes
“	Seconds
µm	Micrometre (unit of length; 1 µm = 0.001 mm)
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
API	American Petroleum Institute gravity. A measure of how heavy or light a petroleum liquid is compared to water.
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASTM	American Society for Testing and Materials
bbl	Barrel (unit of volume; 1 bbl = 0.159 m^3)
Beach	Beach Energy
BIA	Biologically Important Areas
Bonn Agreement	An agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983, includes: Governments of the Kingdom of Belgium, the Kingdom of Denmark, the French Republic, the Federal Republic of Germany, the Republic of Ireland, the Kingdom of the Netherlands, the Kingdom of Norway, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland and the European Union.
BMSL	Below Mean Sea Level
BP	Boiling point. The temperature at which the vapor pressure of the liquid is equal to the pressure exerted on it by the surrounding atmosphere
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
˚C	degree Celsius (unit of temperature)
CFSR	Climate Forecast System Reanalysis
cm	Centimetre (unit of length)
cP	Centipoise (unit of dynamic viscosity)
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.
Dynamic viscosity	The dynamic viscosity of a fluid expresses its resistance to shearing flows, where adjacent layers move parallel to each other with different speeds.
EP	Environmental Plan
Floating oil exposure	Contact by floating oil on the sea surface at concentrations equal to or exceeding defined threshold concentrations. The consequence will vary depending on the threshold and the receptors
g/m^2	Grams per square meter (unit of surface area density)
GODAE	Global Ocean Data Assimilation Experiment
HYCOM	Hybrid Coordinate Ocean Model. A data-assimilative, three-dimensional ocean model
HYDROMAP	Advanced ocean/coastal tidal model used to predict tidal water levels, current speed and current direction.

IOA	Index of Agreement
ITOPF	International Tanker Owners Pollution Federation Limited
KEF	Key Ecological Feature
km	Kilometre (unit of length)
km^2	Square Kilometres (unit of area)
Knots	unit of speed (1 knot = 0.514 m/s)
LGA	Local Government Areas
m	Meter (unit of length)
m/s	Meter per Second (unit of speed)
m^3	Cubic meter (unit of volume)
MAE	Mean Absolute Error
MAHs	Monoaromatic Hydrocarbons
MDO	Marine diesel oil
MNP	Marine National Park
MP	Marine Park
MS	Marine Sanctuary
N	Number of observations
NASA	National Aeronautics and Space Administration (USA)
NCEP	National Centres for Environmental Prediction (USA)
nm	Nautical mile
NOAA	National Oceanic and Atmospheric Administration (USA)
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NP	National Park
NR	Nature Reserve
O	Observed variable
O_i	Observed surface elevation
P	Model-predicted variable
P_i	Model predicted surface elevation
PAH	Polynuclear Aromatic Hydrocarbons
Pour Point	The pour point of a liquid is the temperature below which the liquid loses its flow characteristics
ppb	Parts per billion (concentration)
psu	Practical salinity nits
RSB	Reefs, Shoals and Banks
Shoreline contact	Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations. Shoreline contact is judged for floating oil arriving within a 2 km buffer zone from any shoreline as a conservative measure
SIMAP	Spill Impact Model Application Package. SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for surface or subsea releases
Single Oil spill modelling	Oil spill modelling involving a computer simulation of a single hypothetical oil spill event subject to a single sequence of wind, current and other sea conditions over time. Single oil spill modelling, also referred to as “deterministic modelling” provides a simulation of one possible outcome of a

	given spill scenario, subject to the metocean conditions that are imposed. Single oil spill modelling is commonly used to consider the fate and effects of 'worst-case' oil spill scenarios that are carefully selected in consideration of the nature and scale of the offshore petroleum activity and the local environment (NOPSEMA, 2017). Because the outcomes of a single oil spill simulation can only represent the outcome of that scenario under one sequence of metocean conditions, worst-case conditions are often identified from stochastic modelling. It is impossible to calculate the likelihood of any outcome from a single oil spill simulation. Single oil spill modelling is generally used for response planning, preparedness planning and for supporting oil spill response operations in the event of an actual spill
SRTM	Shuttle Radar Topography Mission
Stochastic oil spill modelling	Stochastic oil spill modelling is created by overlaying and statistically analysing the outcomes of many single oil-spill simulations of a defined spill scenario, where each simulation was subject to a different sequence of metocean conditions, selected objectively (typically by random selection) from a long sequence of historic conditions for the study area. Analysis of this larger set of simulations provides a more accurate indication of the environment that maybe affected (EMBA) and indicates which locations are more likely to be affected (as well as other statistics). Stochastic oil spill modelling avoids biases that affect single oil spill modelling (due to the reliance on only one possible sequence of conditions). However, when interpreting stochastic modelling, which is based on a wide range of potential conditions that might happen to occur, it is essential to understand that calculations will encompass a much larger area than could be affected in any single spill event, where a more limited set of conditions will occur. Consequently, it is misleading to imply that the region derived from stochastic modelling indicate the outcomes expected from a single spill event (NOPSEMA, 2017) Stochastic modelling is generally used for risk assessment and preparedness planning by indicating locations that could be exposed and may require response or subsequent impact assessment
Sub-LGA	Sub-Local Government Areas
TOPEX/Poseidon	A joint satellite mission between NASA and CNES to map ocean surface topography using an array of satellites equipped with detailed altimeters
USA	United States of America
US EPA	United States Environmental Protection Agency
US CG	United States Coast Guard
VIC	Victoria (State of Australia)
World Ocean Atlas	A collection of physicochemical parameters (e.g. temperature, salinity, oxygen, phosphate, silicate, and nitrate) based on profile data from the World Ocean Database (NCEI, 2021) established by NOAA's National Centers for Environmental Information (NCEI)
WGS 1984	World Geodetic System 1984 (WGS84); reference coordinate system
X_{model}	Model predicted surface elevation
X_{obs}	Observed surface elevation

EXECUTIVE SUMMARY

Background

Beach Energy (Beach) is preparing the Environmental Plan (EP) for the Yolla field operations. The Yolla gas field is located in Bass Strait, 147 km south of Kilcunda, Victoria, in Production License T/L1.

In order to support the development of EP Beach had commissioned a detailed oil spill modelling study assessing the following hypothetical scenario:

- **Scenario**: A 300 m³ surface release of marine diesel oil (MDO) over 6 hours following a vessel collision.

The purpose of the modelling is to provide an understanding of a conservative 'outer envelope' of the potential area that may be affected in the unlikely event of hydrocarbon spill. The modelling does not take into consideration any of the spill prevention, mitigation and response 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 Model Application Program (SIMAP). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

Methodology

The modelling study was carried out in several stages. Firstly, a ten-year wind and current dataset (2010–2019) was generated and the currents included the combined influence of three-dimensional large-scale ocean currents and tidal currents. Secondly, the currents, winds and detailed hydrocarbon characteristics were used as inputs in the three-dimensional oil spill model (SIMAP) to simulate the drift, spread, weathering and fate of the spilled oil.

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 initiated using the same release information (spill volume, duration and composition of the oil) at random start times. This ensured that each simulation was subject to different wind and current conditions and, in turn, movement and weathering of the oil for an annual based assessment.

The SIMAP system, the methods and analysis presented herein, use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 "*Standard Practice for Development and Use of Oil Spill Models*".

Oil Properties

The MDO has an API of 37.6 and a density of 829.1 kg/m^3 (at 25ºC) with a viscosity value (4.0 cP) classifying it as a Group II (light-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and US EPA/USCG classifications. Six percent of the oil mass should evaporate within the first 12 hours (BP < 180 C); a further 34.6% should evaporate within the first 24 hours (180°C < BP < 160°C); and a further 54.4% should evaporate over several days (160°C < BP < 380°C). Approximately 5.0% of the oil is shown to be persistent.

Results

Scenario: 300 m³ loss of containment caused by vessel collision

- No shoreline oil accumulation above the low (10-100 g/m^2) shoreline contact threshold was predicted for the scenario.
- The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (> 50 g/m^2) exposure levels was 59.8 km (east), 13.8 km (south) and 1.9 km (south), respectively.
- A total of 13 BIAs, the Australian EEZ and the Central Bass Strait IMCRA were predicted to be exposed to floating oil at or above the low threshold during annualised conditions. The release location resides within all the exposed receptors. No other receptors were exposed to floating oil.
- In the surface (0-10 m) depth layer, a total of 13 BIAs, the Australian EEZ and the Central Bass Strait IMCRA were predicted to be exposed to dissolved hydrocarbons at, or above, the low threshold during the annualised assessment as the release location resides within all the exposed receptors. No other receptors were exposed to dissolved hydrocarbons. The probability of exposure at the low and moderate thresholds were predicted to be 65% and 5% respectively, for all receptors.
- Within the surface (0-10 m) depth layer, low and high entrained hydrocarbon exposures were predicted for BIA and IMCRA receptors. The highest concentration for a receptor which did not surround the release location was Flinders IMCRA (167 ppb) and the corresponding probabilities of exposure based on the low and high thresholds were 19% and 2% respectively.

1 INTRODUCTION

1.1 Background

Beach Energy (Beach) is preparing the Environmental Plan (EP) for the Yolla field operations. The Yolla gas field is located in Bass Strait, 147 km south of Kilcunda, Victoria in Production License T/L1.

In order to support the development of EP Beach had commissioned a detailed oil spill modelling study assessing the following hypothetical scenario:

- **Scenario**: A 300 m³ surface release of marine diesel oil (MDO) over 6 hours following a vessel collision.

Table 1-1 presents the coordinates of the release location and a location map is presented in Figure 1-1.

The results for the scenario are presented on an annual basis.

The purpose of the modelling is to provide an understanding of a conservative ‘outer envelope’ of the potential area that may be affected in the unlikely event of hydrocarbon spill. The modelling does not take into consideration any of the spill prevention, mitigation and response 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 Model Application Program (SIMAP). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

Note that the oil spill model, the method and analysis presented herein uses modelling algorithms which have been anonymously peer reviewed and published in international journals. Furthermore, 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 1-1 Coordinates for the release location used in this study (WGS84).

Release Location	Latitude	Longitude	Depth (m BMSL)
Yolla Platform	39° 50.633' S	145° 49.083' E	~70

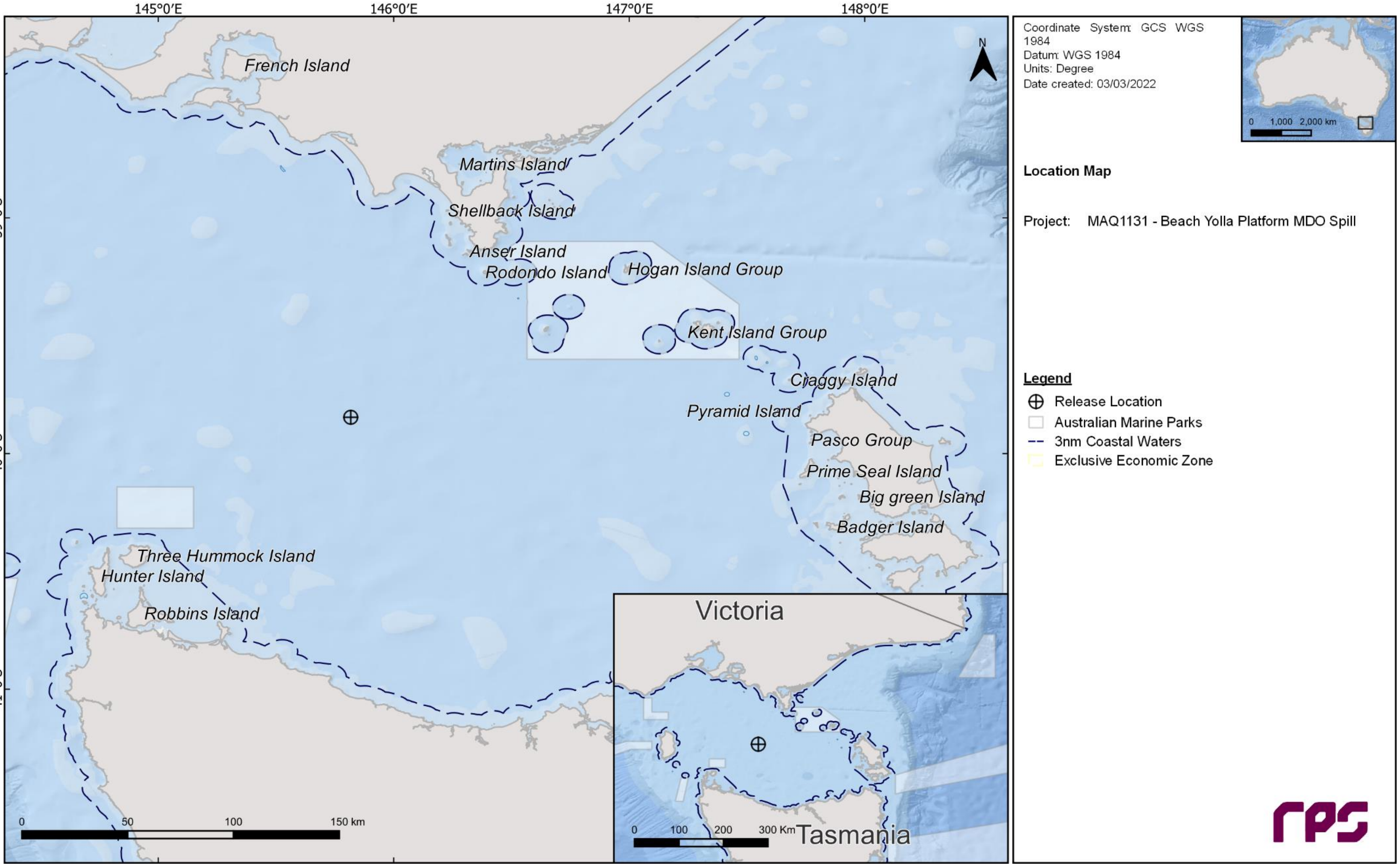


Figure 1-1 Map of the release location.

1.2 What is Oil Spill Modelling?

Oil spill modelling is a valuable tool widely used for risk assessment, emergency response and contingency planning where it can be particularly helpful to proponents and decision makers. By modelling a series of the most likely oil spill scenarios, decisions concerning suitable response measures and strategic locations for deploying equipment and materials can be made, and the locations at most risk can be identified. The two types of oil spill modelling often used are stochastic (Section 1.2.1) and deterministic (Section 1.2.2) modelling.

1.2.1 Stochastic Modelling (Multiple Spill Simulations)

Stochastic oil spill modelling is created by overlaying a great number (often hundreds) of individual, computer-simulated hypothetical spills (NOPSEMA, 2018; Figure 1.2).

Stochastic modelling is a common means of assessing the potential risks from oil spills related to new projects and facilities. Stochastic modelling typically utilises hydrodynamic data for the location in combination with historic wind data. Typically, 100 iterations of the model will be run utilising the data that is most relevant to the season or timing of the project.

The outcomes are often presented as a probability of exposure and is primarily used for risk assessment purposes in view to understand the range of environments that may be affected or impacted by a spill. Elements of the stochastic modelling can also be used in oil spill preparedness and planning.

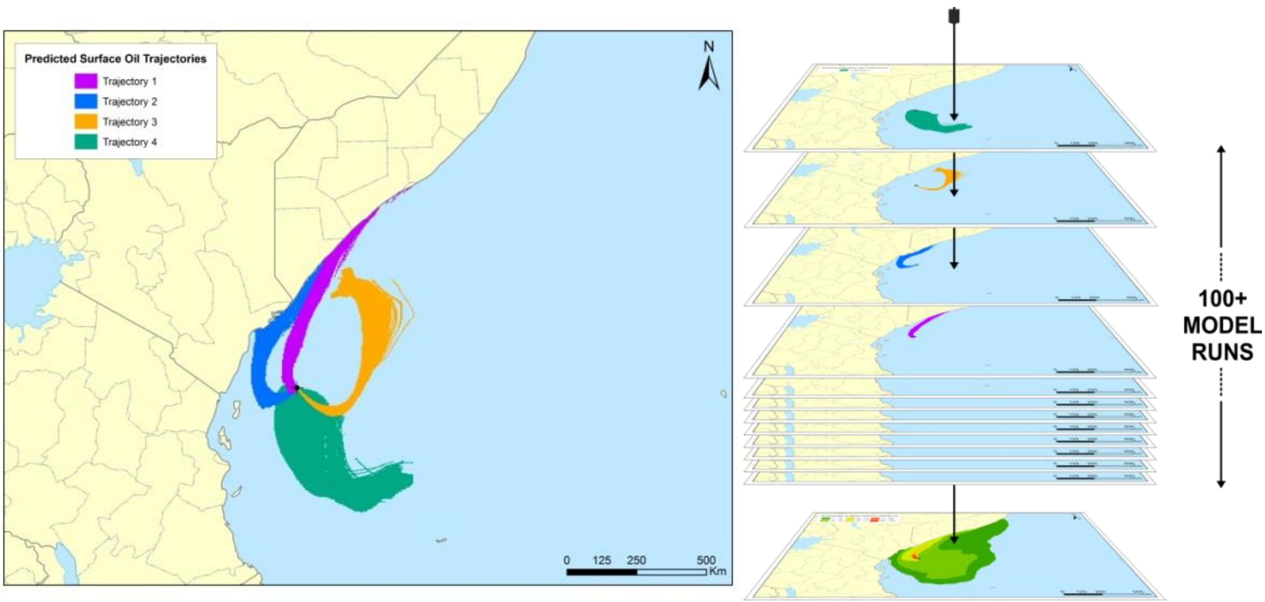


Figure 1-2 Examples of four individual spill trajectories (four replicate simulations) predicted by SIMAP for a spill scenario. The frequency of contact with given locations is used to calculate the probability of impacts during a spill. Essentially, all model runs are overlain (shown as the stacked runs on the right) and the number of times that trajectories contact a given location at a concentration is used to calculate the probability.

1.2.2 Deterministic Modelling (Single Spill Simulation)

Deterministic modelling is the predictive modelling of a single incident subject to a single sample of wind and weather conditions over time (NOPSEMA, 2018; Figure 1-3).

Deterministic modelling is often paired with stochastic modelling to place the large stochastic footprint into perspective. This deterministic analysis is generally a single run selected from the stochastic analysis and serves as the basis for developing the plans and equipment needs for a realistic spill response. Deterministic spills can be selected on several basis such as minimum time to shoreline, largest swept area, maximum volume ashore, longest length of shoreline contacted by oil or largest area of entrained or dissolved hydrocarbons.

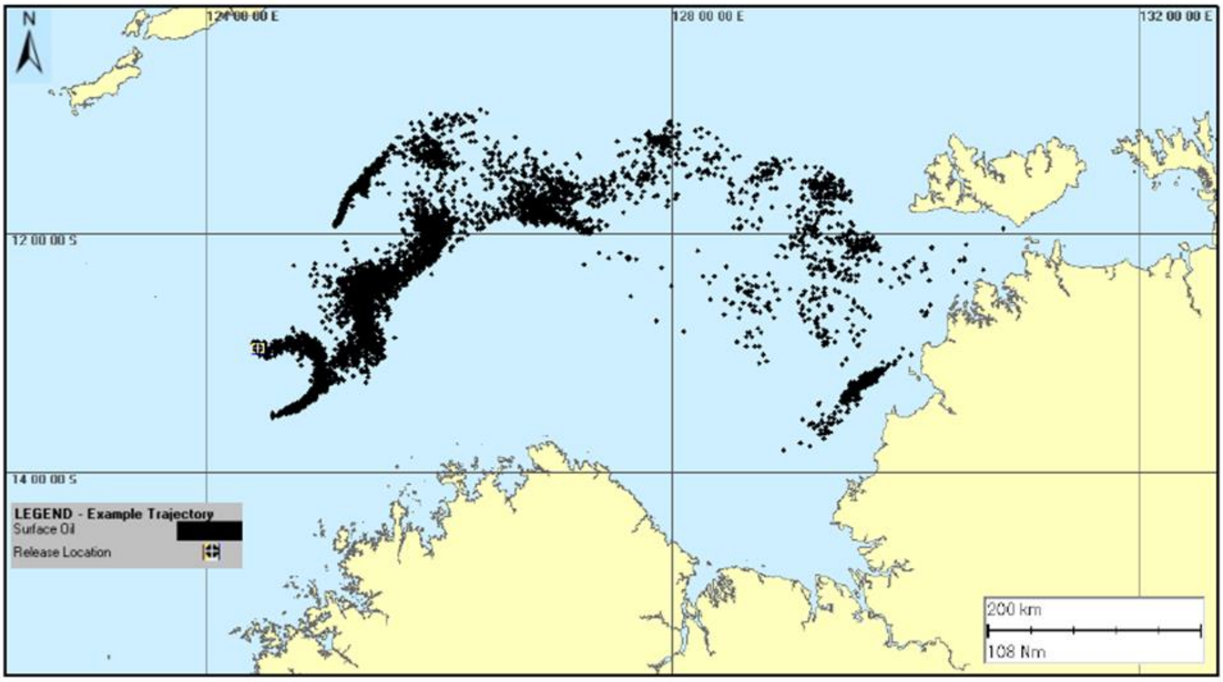


Figure 1-3 Example of an individual spill trajectory predicted by SIMAP for a spill scenario. Note, this image represents surface oil as spillets and do not take any thresholds into consideration.

2 SCOPE OF WORK

The scope of work included the following components:

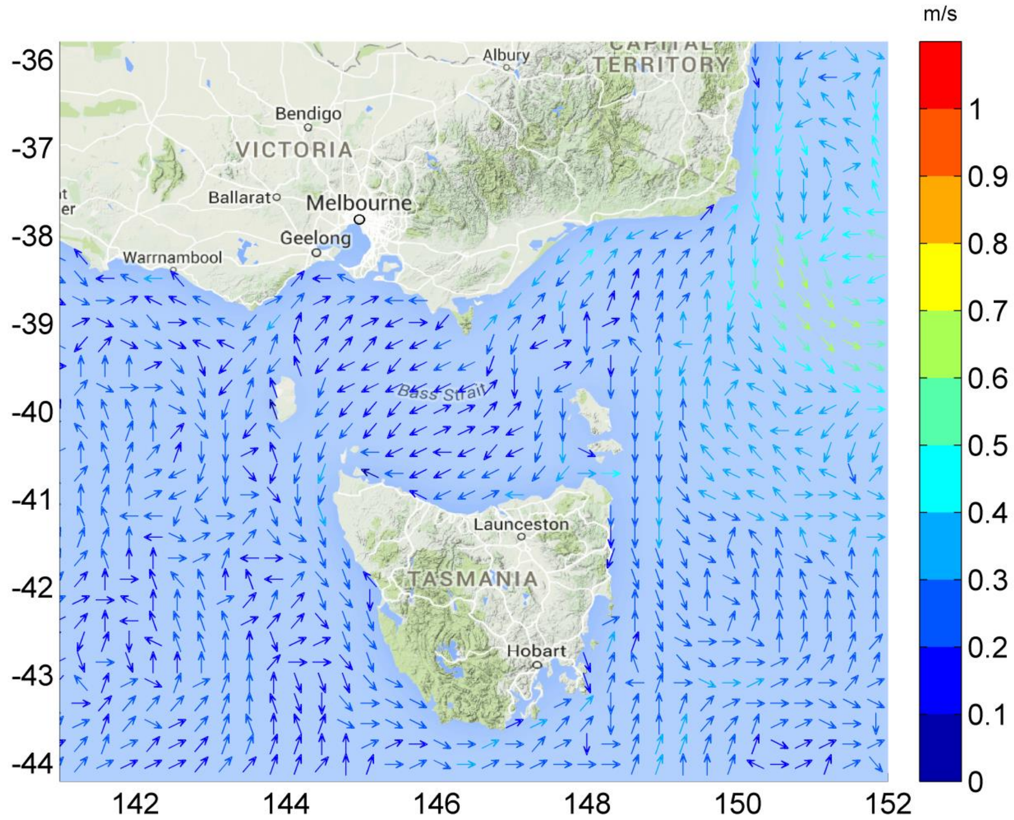
- Generate 10 years of winds and three-dimensional currents from 2010 to 2019 (inclusive). The currents included the combined influence of tidal and ocean currents;
- Include the wind and current data and characteristics of the MDO as input into the three-dimensional oil spill model SIMAP, to model the movement, spreading, weathering and shoreline contact by hydrocarbons over time;
- Use SIMAP's stochastic model (also known as a probability model) to calculate exposure to surround waters and shorelines. This involved running 100 randomly selected single trajectory simulations, with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This ensured that each spill simulation was subject to a unique set of wind and current conditions; and
- The stochastic modelling results were reviewed and the "worst case" deterministic runs were identified and presented based on the following criteria (if applicable):
    a. Largest swept area of floating oil above 1 g/m^2 (visible floating oil);
    b. Minimum time before shoreline accumulation above 10 g/m^2;
    c. Largest volume of oil ashore;
    d. Longest length of oil accumulation on shorelines above 10 g/m^2;
    e. Largest area of entrained hydrocarbon exposure above 10 ppb; and
    f. Largest area of dissolved hydrocarbon exposure above 10 ppb.

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 varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 3-1 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf, 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

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



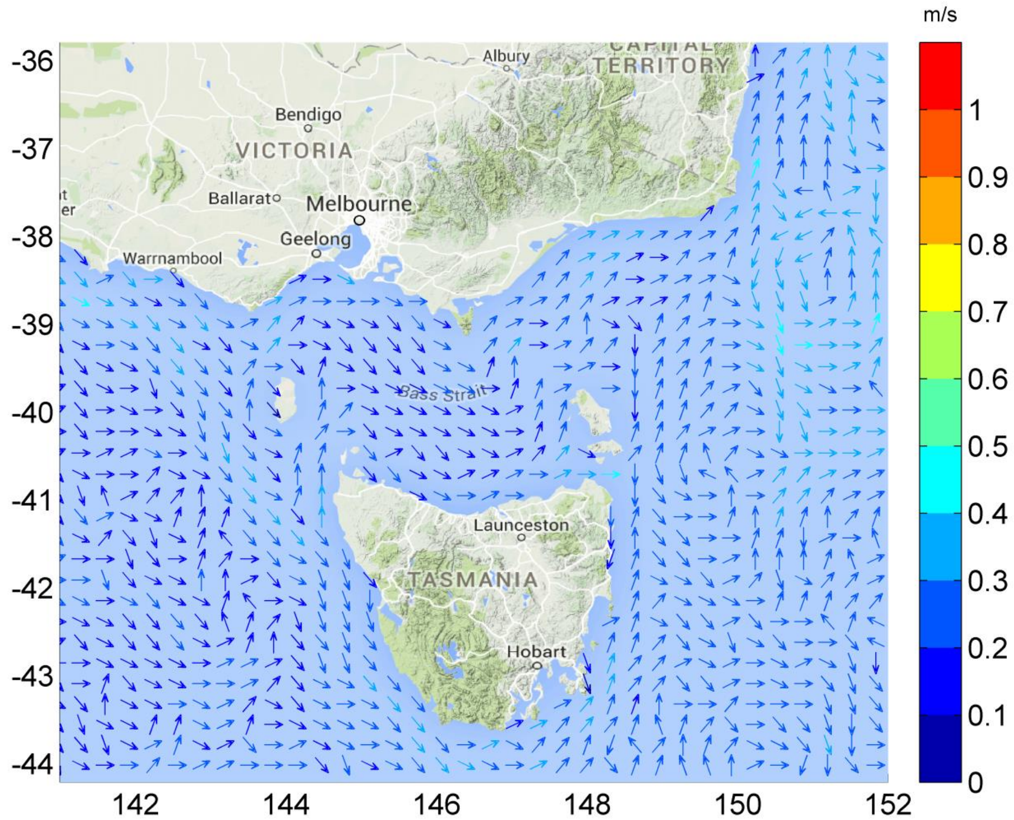


Figure 3-1 HYCOM averaged seasonal surface drift currents during summer (upper image) and winter (lower image).

3.1 Tidal currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for more than 30 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

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

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

3.1.1 Grid Setup

The tidal model domain is sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids are progressively allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3-2 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 3-3). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

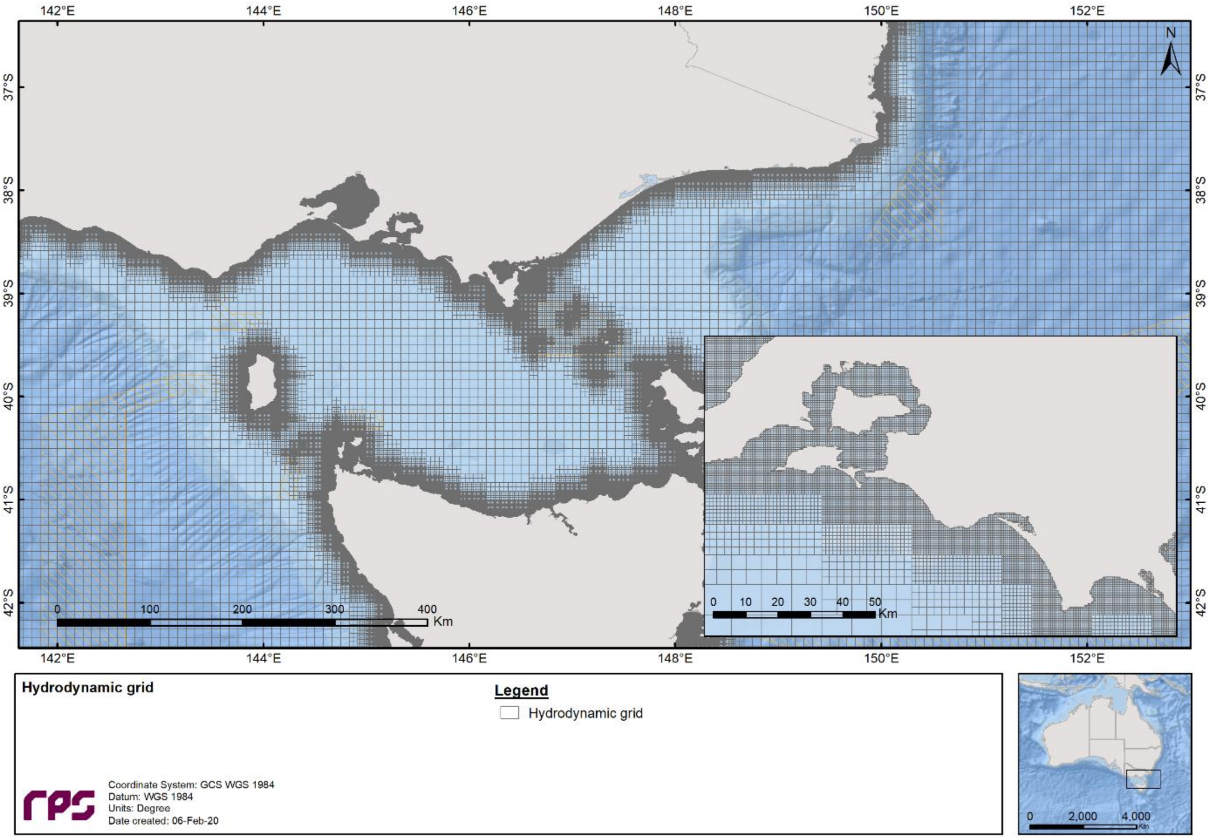


Figure 3-2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

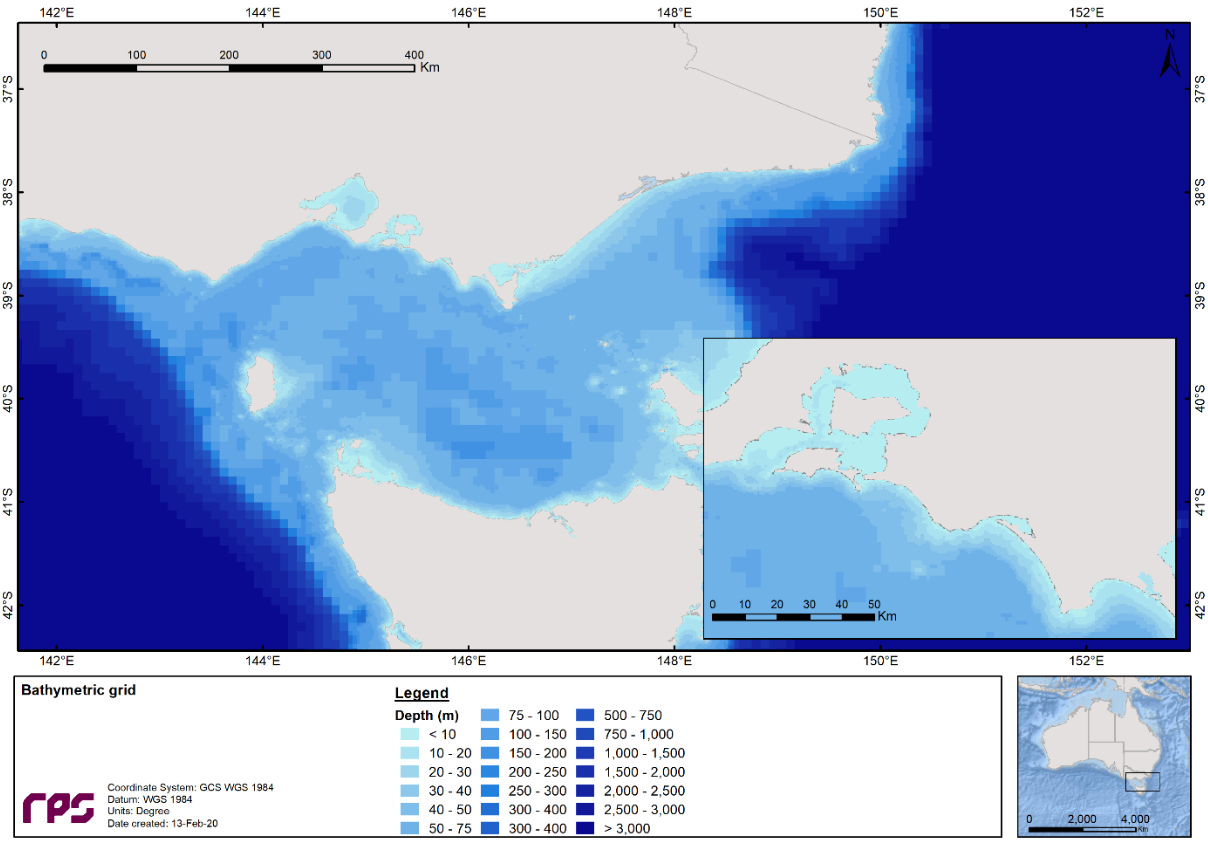


Figure 3-3 Bathymetry defined throughout the tidal model domain.

3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 8.0) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were K_2, S_2, M_2, N_2, K_1, P_1, O_1 and Q_1. Using the tidal data, time series surface heights were calculated along the open boundaries for the simulation period.

The Topex/Poseidon satellite data has a resolution of 0.25 degrees globally, with higher resolution in coastal regions, and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The data capturing satellites, equipped with two altimeters capable of taking sea level measurements accurate to less than ± 5 cm, measured oceanic surface elevations (and the resultant tides) for the period 1992–2005. In total these satellites carried out 62,000 orbits of the planet. The Topex-Poseidon tidal data has been widely used amongst the oceanographic community, being refereced in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen 2010). The Topex/Poseidon tidal data is considered suitably accurate for this study.

3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at a location situated within the study area (Figure 3-4).

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

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

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

Where: N = Number of observations

P_i = Model predicted surface elevation

O_i = Observed surface elevation

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

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: X_{model} = Model predicted surface elevation

X_{obs} = Observed surface elevation

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

Figure 3-5 and Figure 3-6 illustrate a comparison of the predicted and observed surface elevations in February 2017. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

Table 3-1 shows the IOA and MAE values for the selected tide station locations indicating that the model is performing well.

Table 3-1 Statistical comparison between the observed and HYDROMAP predicted surface elevations.

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

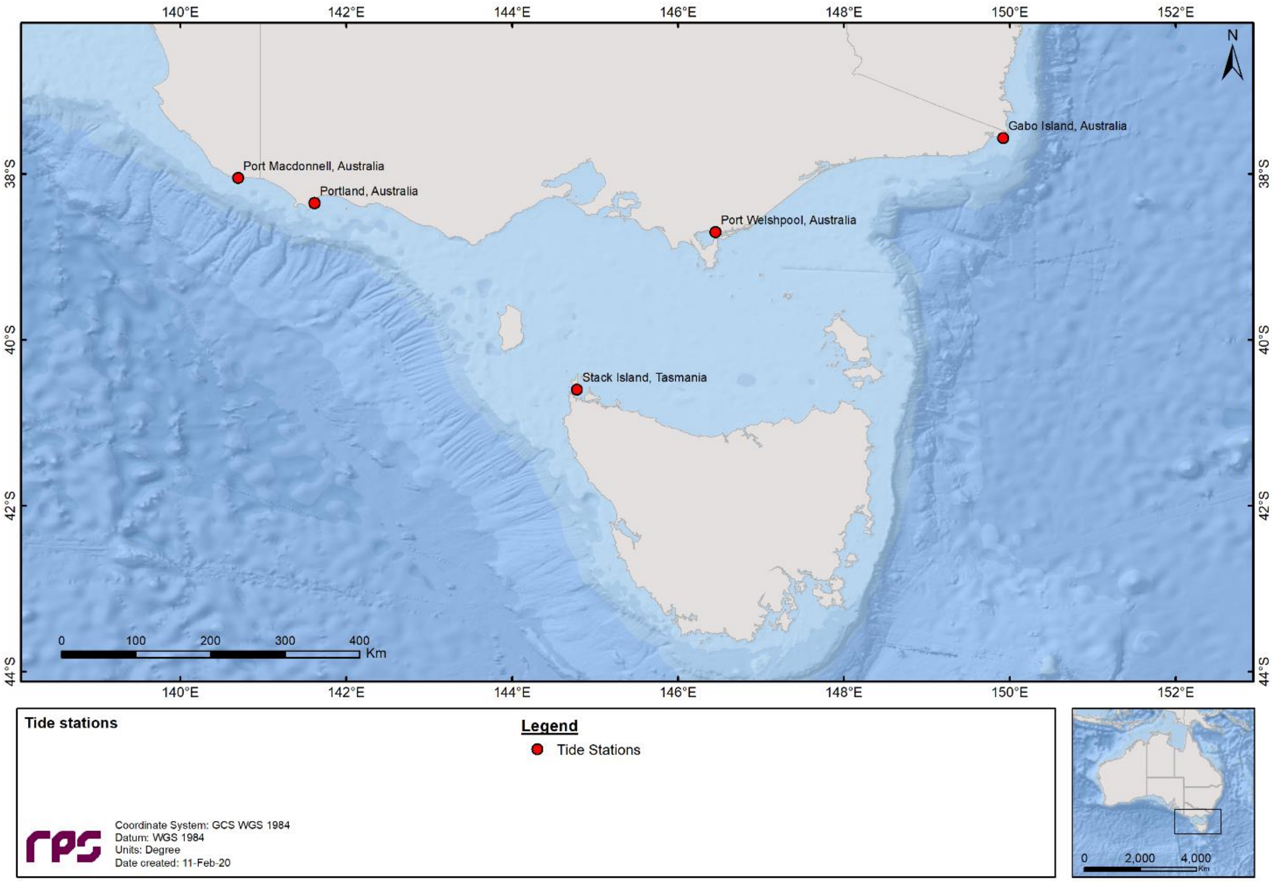


Figure 3-4 Location of the tide stations used in the surface elevation validation.

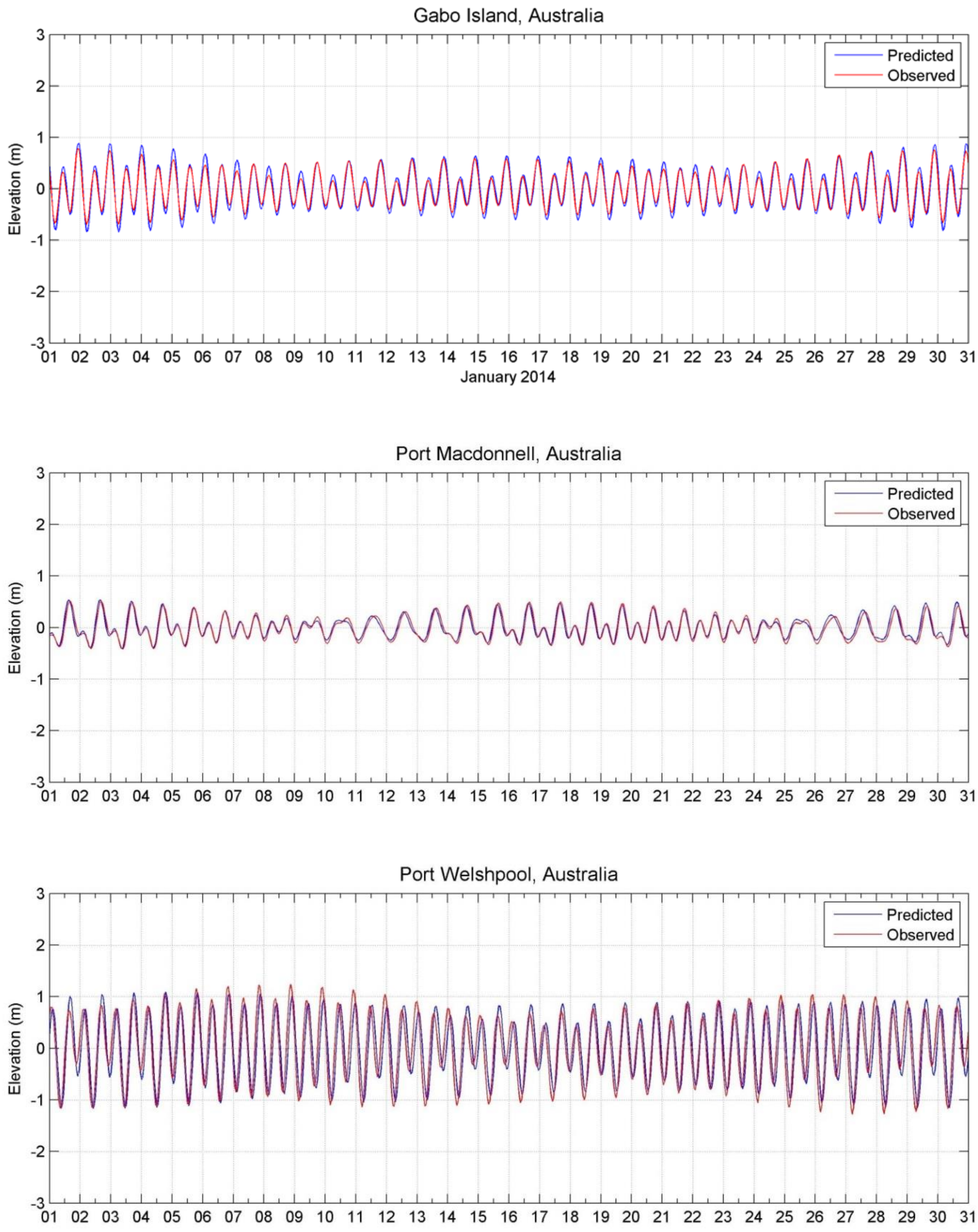


Figure 3-5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).

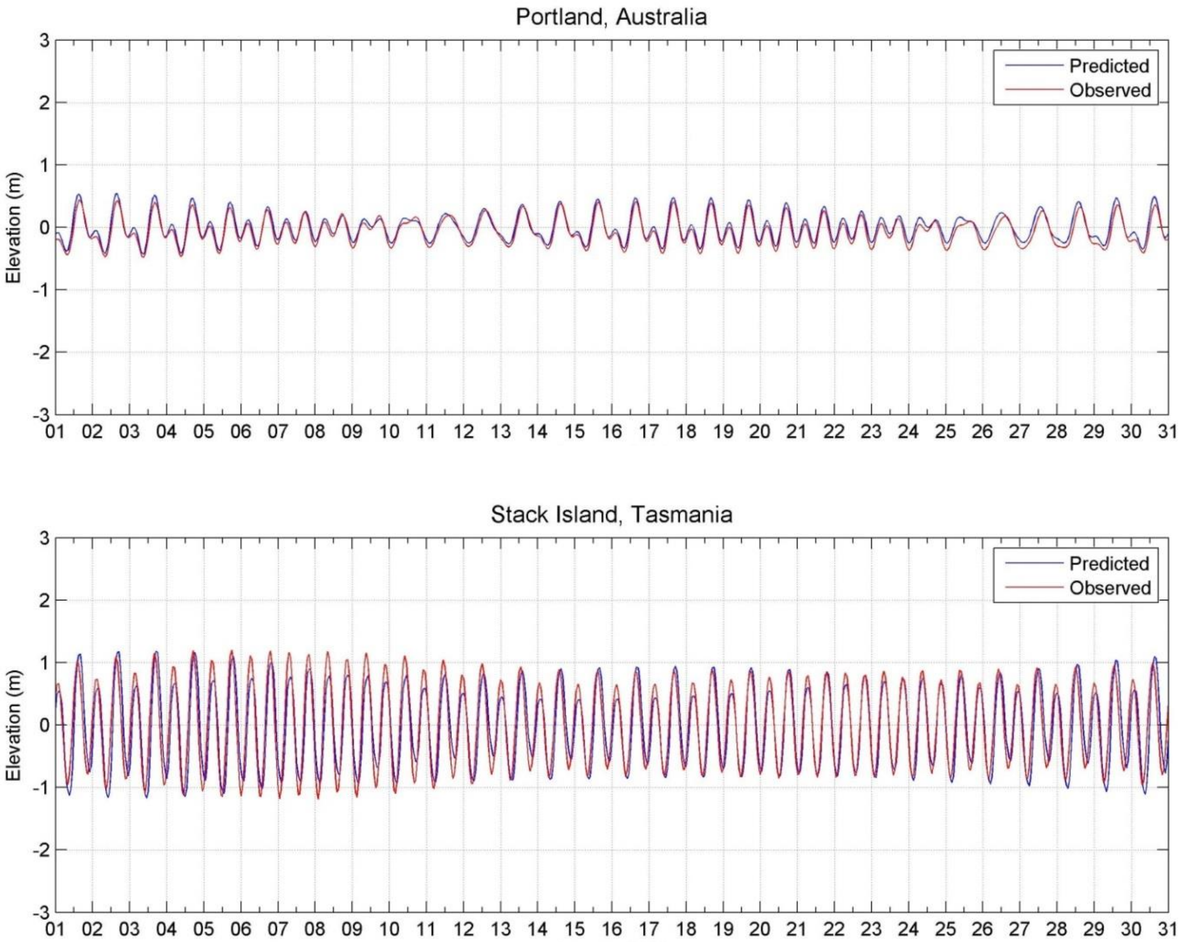


Figure 3-6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).

3.2 Ocean Currents

Data describing the flow of ocean currents was for the years 2010 to 2019 (inclusive) 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. Figure 3-7 illustrates the spatial resolution of HYCOM currents.

For this study, the HYCOM hindcast currents were obtained.

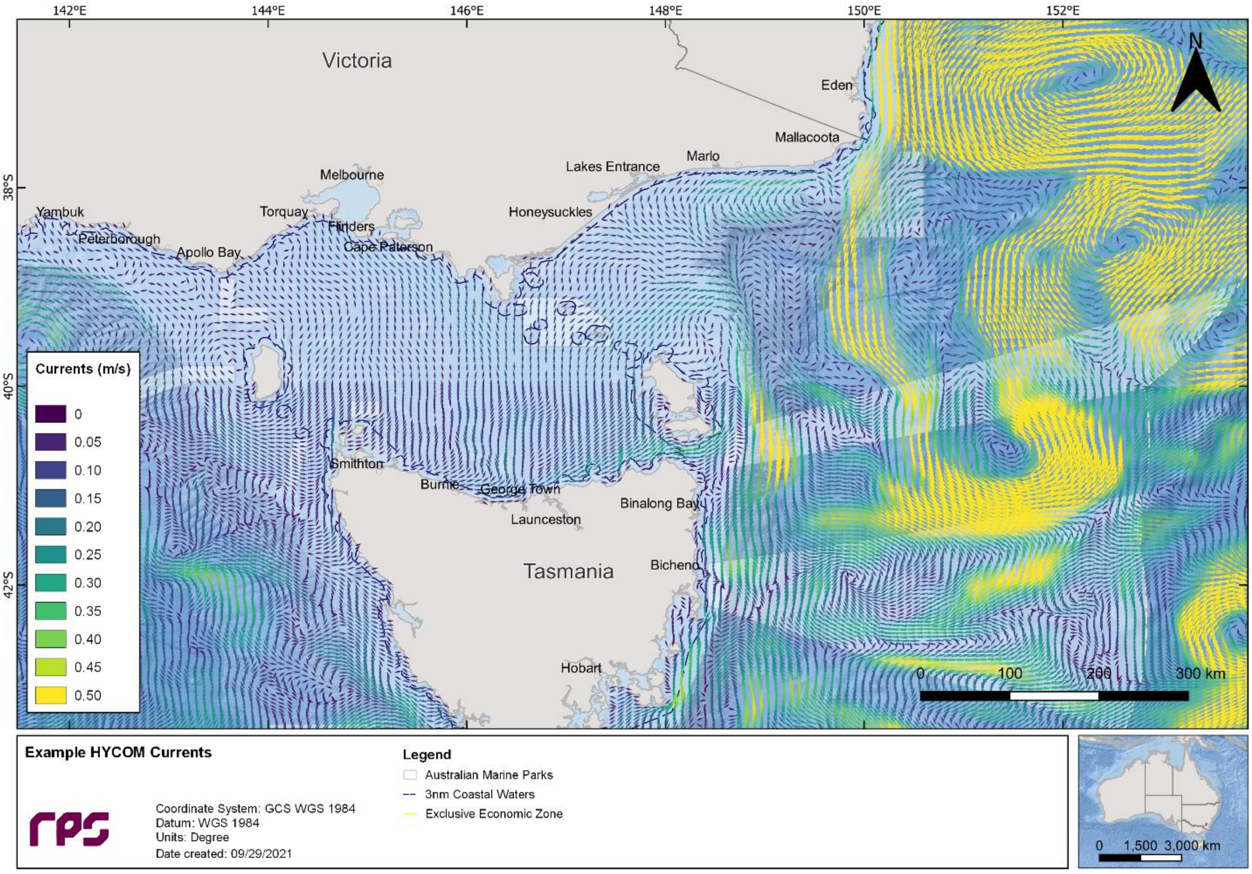


Figure 3-7 Map illustrating the spatial resolution of HYCOM currents.

3.3 Surface Currents

Table 3-2 presents the average and maximum net surface current speeds nearby the release location by combining the ocean and tidal currents. Current speeds varied throughout the year with peak current speeds ranging between approximately 0.61 m/s (December) and 0.96 m/s (July). The dominant direction between May to September was east, while no dominant current directions was observed between October to March.

Figure 3-8 and Figure 3-9 show the monthly and total surface current rose distributions nearby the release location.

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

Table 3-2 Predicted monthly average and maximum surface current speeds nearby the release location. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2010–2019 (inclusive).

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction(s) (Towards)
January	0.18	0.66	Variable
February	0.17	0.70	Variable
March	0.17	0.75	Variable
April	0.16	0.73	Variable
May	0.19	0.87	East
June	0.19	0.70	East & Northwest
July	0.22	0.96	East
August	0.20	0.95	East
September	0.19	0.81	East
October	0.18	0.64	Variable
November	0.17	0.63	Variable
December	0.17	0.61	Variable
Minimum	**0.16**	**0.61**	
Maximum	**0.22**	**0.96**	

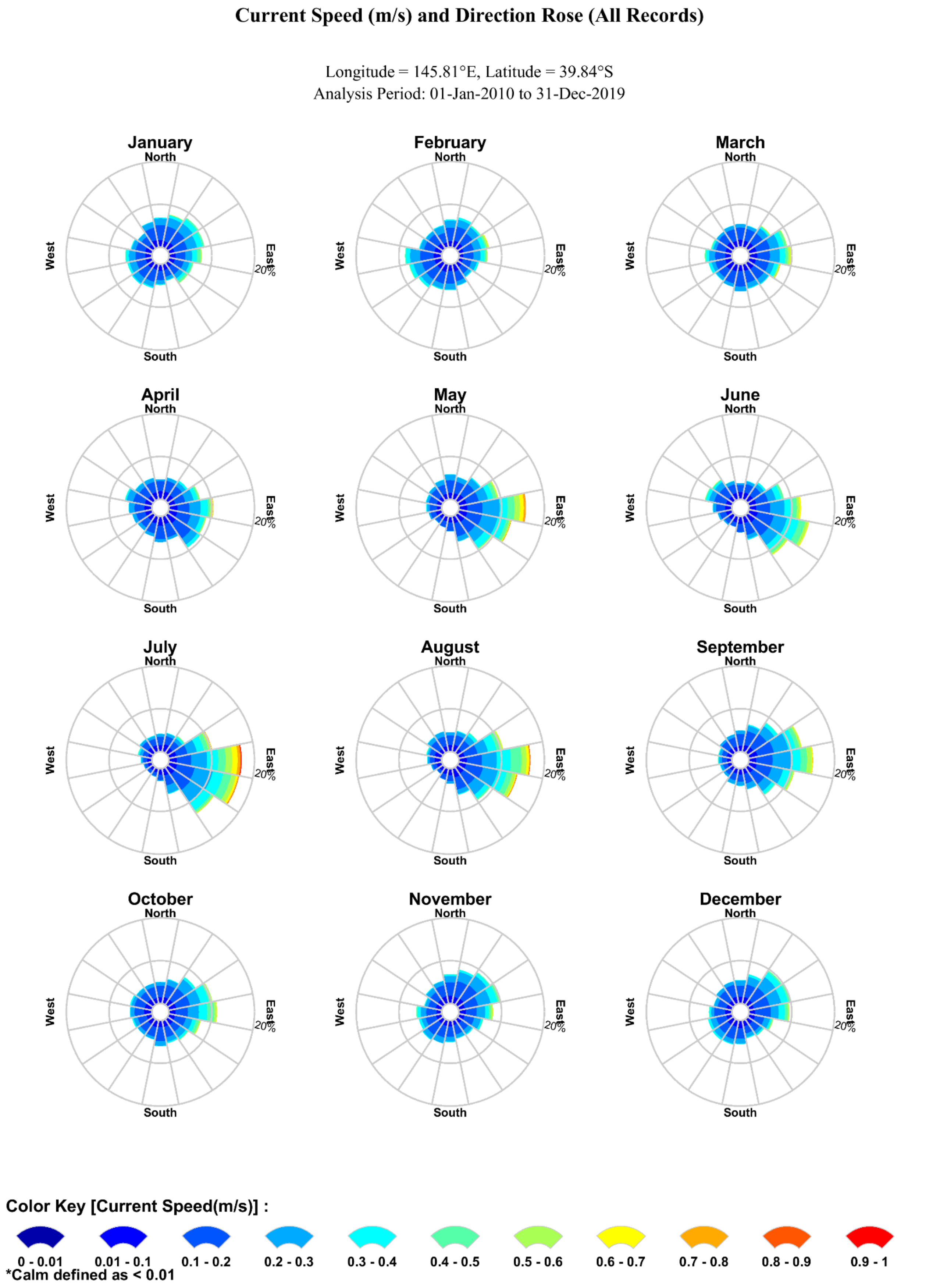


Figure 3-8 Monthly surface current rose plots nearby the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

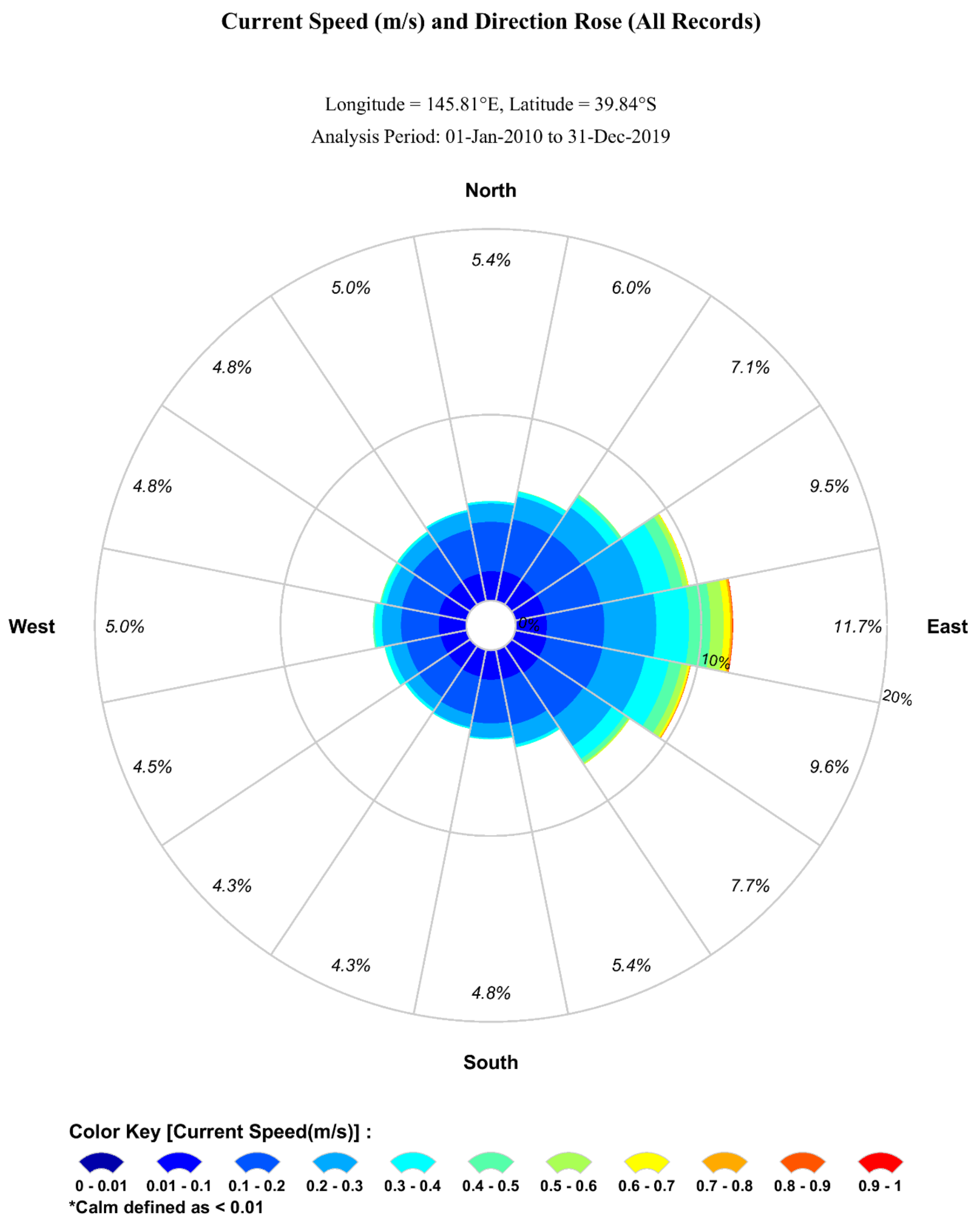


Figure 3-9 Total surface current rose plot nearby the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

4 WIND DATA

High resolution wind data for the years 2010–2019 (inclusive) was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis dataset (CFSR; see Saha et al., 2010). The CFSR wind model is a fully coupled, data-assimilative hindcast model representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at ¼ of a degree resolution (~33 km) and 1-hourly time intervals. Figure 4-1 shows the spatial resolution of the wind field used as input into the oil spill model.

Table 4-1 presents the monthly average and maximum winds derived from a CFSR station nearby the release location. The wind data demonstrated average monthly wind speeds ranging from 15.5 knots (January) to 19.6 knots (July) with maximums oscillating between 39.1 knots (January) and 50.2 knots (July). The wind direction between November to March was generally southwest and northeast, while the winds were mostly blowing from the west during May to October.

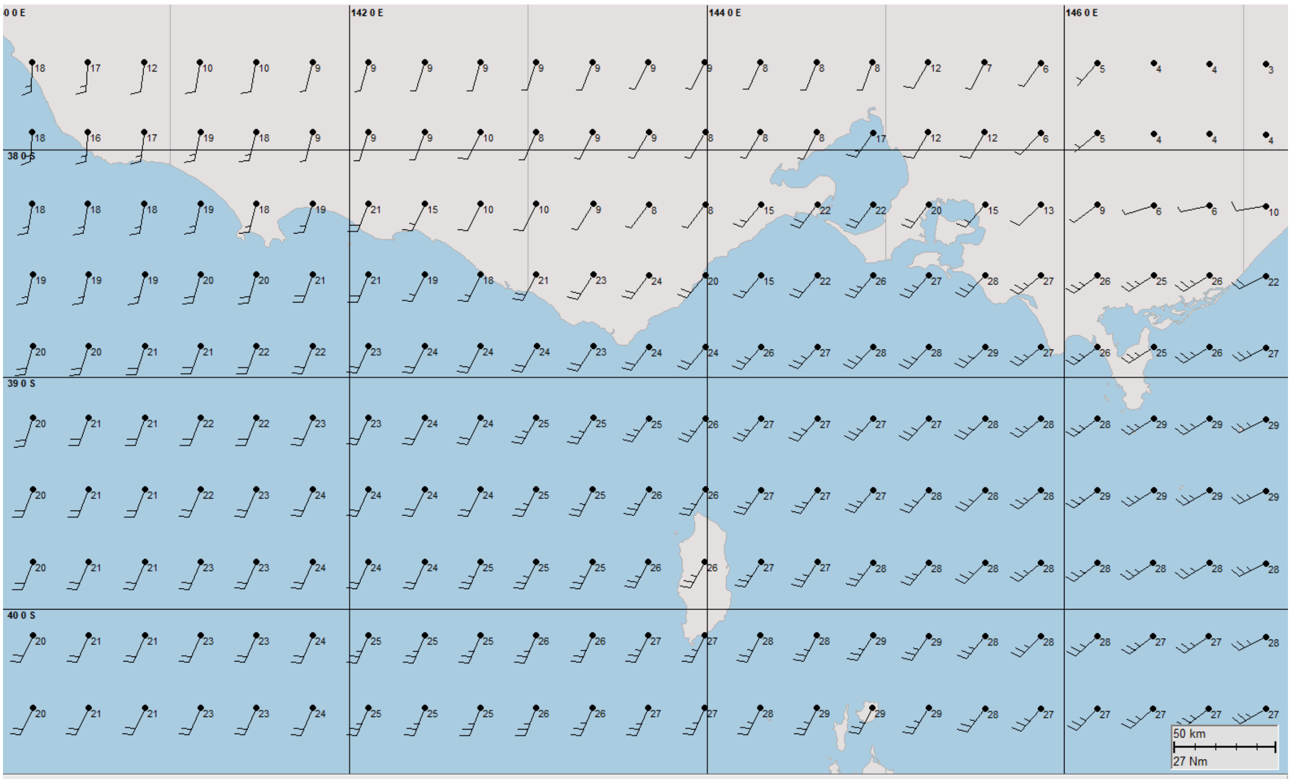


Figure 4-1 Spatial resolution of the CFSR modelled wind data used as input into the oil spill model.

Figure 4-2 and Figure 4-3 show the monthly and total wind rose distributions derived from the CFSR data for the nearest wind node to the release location.

Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows from, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 3 knots are predominantly used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

Table 4-1 Predicted average and maximum winds for the representative wind station nearby the release location. Data derived from CFSR hindcast model from 2010–2019 (inclusive).

Month	Average wind speed (knots)	Maximum wind speed (knots)	General direction (From)
January	15.6	39.1	Southwest - Northeast
February	15.9	42.3	Southwest - Northeast
March	15.9	43.1	Southwest - Northeast
April	15.5	44.4	Southwest - Northeast
May	17.9	48.7	West
June	17.3	45.4	West
July	19.6	50.2	West
August	18.7	44.2	West
September	18.0	45.4	West
October	16.7	45.8	West
November	16.3	40.7	Southwest - Northeast
December	16.0	42.2	Southwest - Northeast
Minimum	**15.5**	**39.1**	
Maximum	**19.6**	**50.2**	

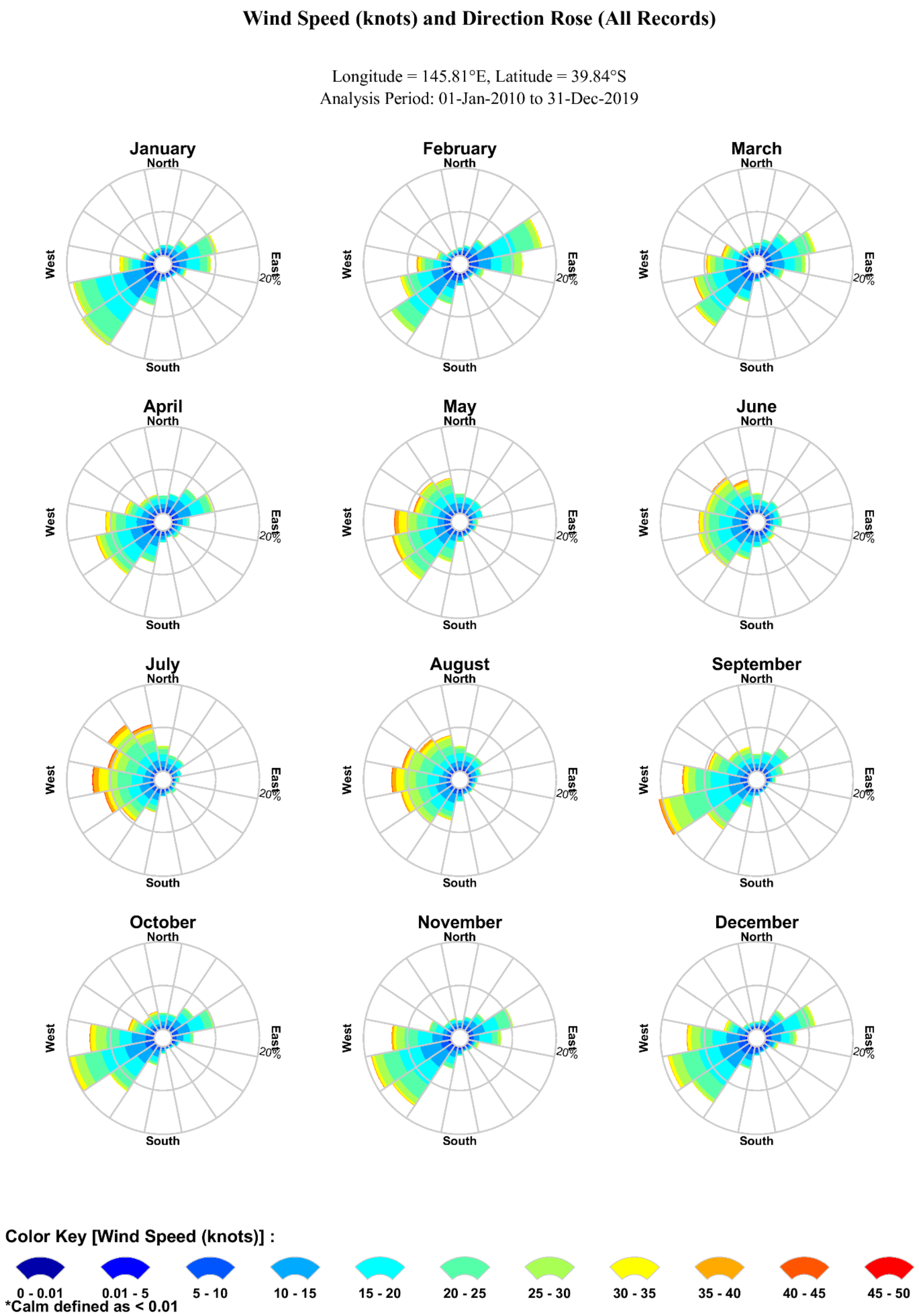


Figure 4-2 Modelled monthly wind rose distributions from 2010–2019 (inclusive), for the representative wind station nearby the release location.

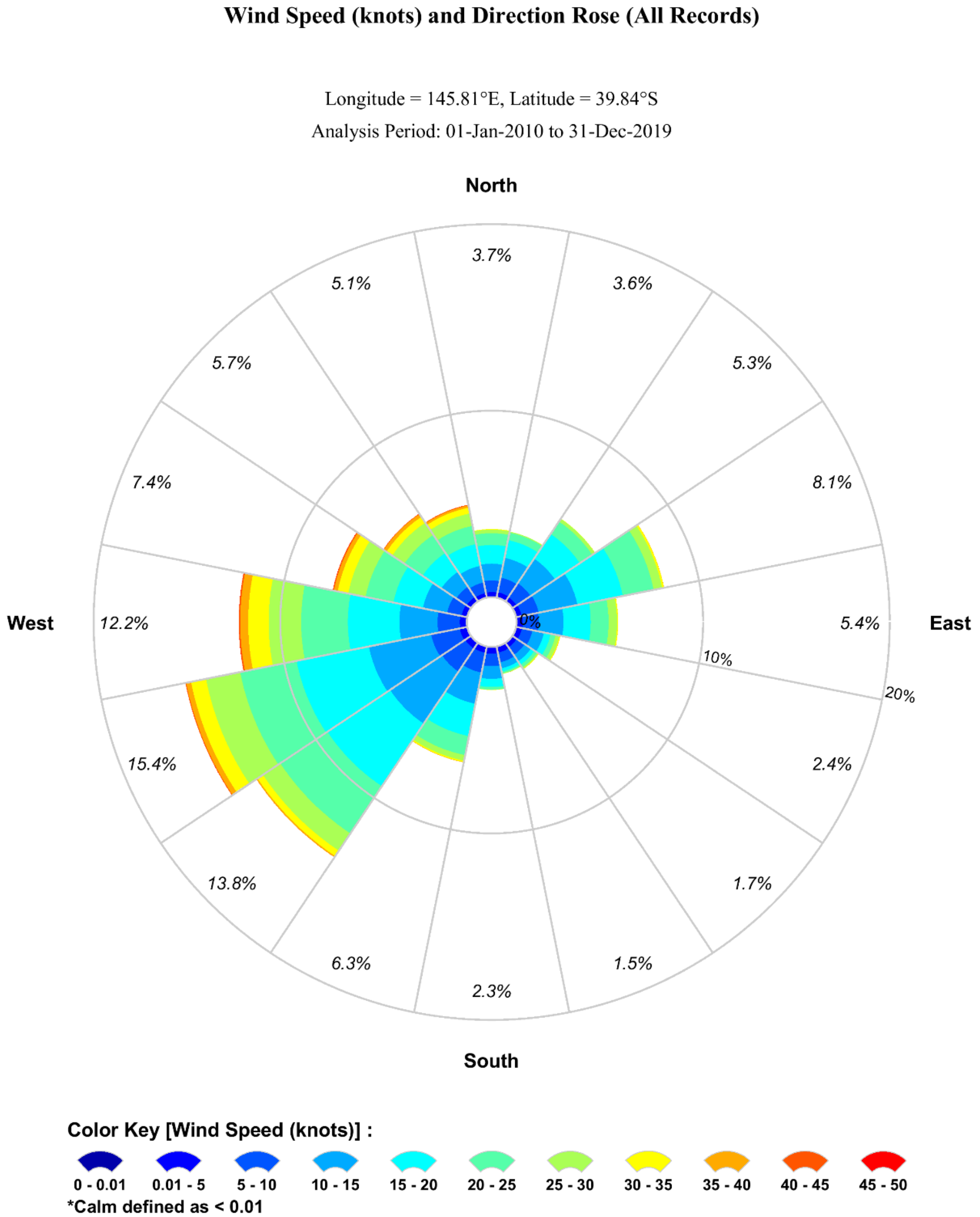


Figure 4-3 Modelled total wind rose distributions from 2010–2019 (inclusive), for the representative wind station nearby the release location.

5 WATER TEMPERATURE AND SALINITY

The monthly sea temperature and salinity profiles of the water column within the study was obtained from the World Ocean Atlas 2013 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Center for Oceanography (see Levitus et al., 2013). These parameters were used as factors to inform the weathering, movement and evaporative loss of hydrocarbon spills in the surface and sub-surface layers.

Figure 5-1 illustrates the vertical profile of sea temperature and salinity nearby the release location.

Table 5-1 presents the sea temperature and salinity of the surface layer nearby the release sites. The monthly average sea surface temperatures ranged between 12.7°C and 18.1°C. The monthly average salinity values remain relatively consistent ranging between 34.9 and 35.5 psu.

Table 5-1 Monthly average sea surface temperature and salinity in the study area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (ºC)	17.1	18.0	18.1	17.0	17.3	13.0	12.7	13.2	13.1	14.3	15.7	15.1
Salinity (psu)	35.3	35.3	35.5	35.5	35.4	34.9	35.2	35.1	35.3	35.5	35.5	35.3

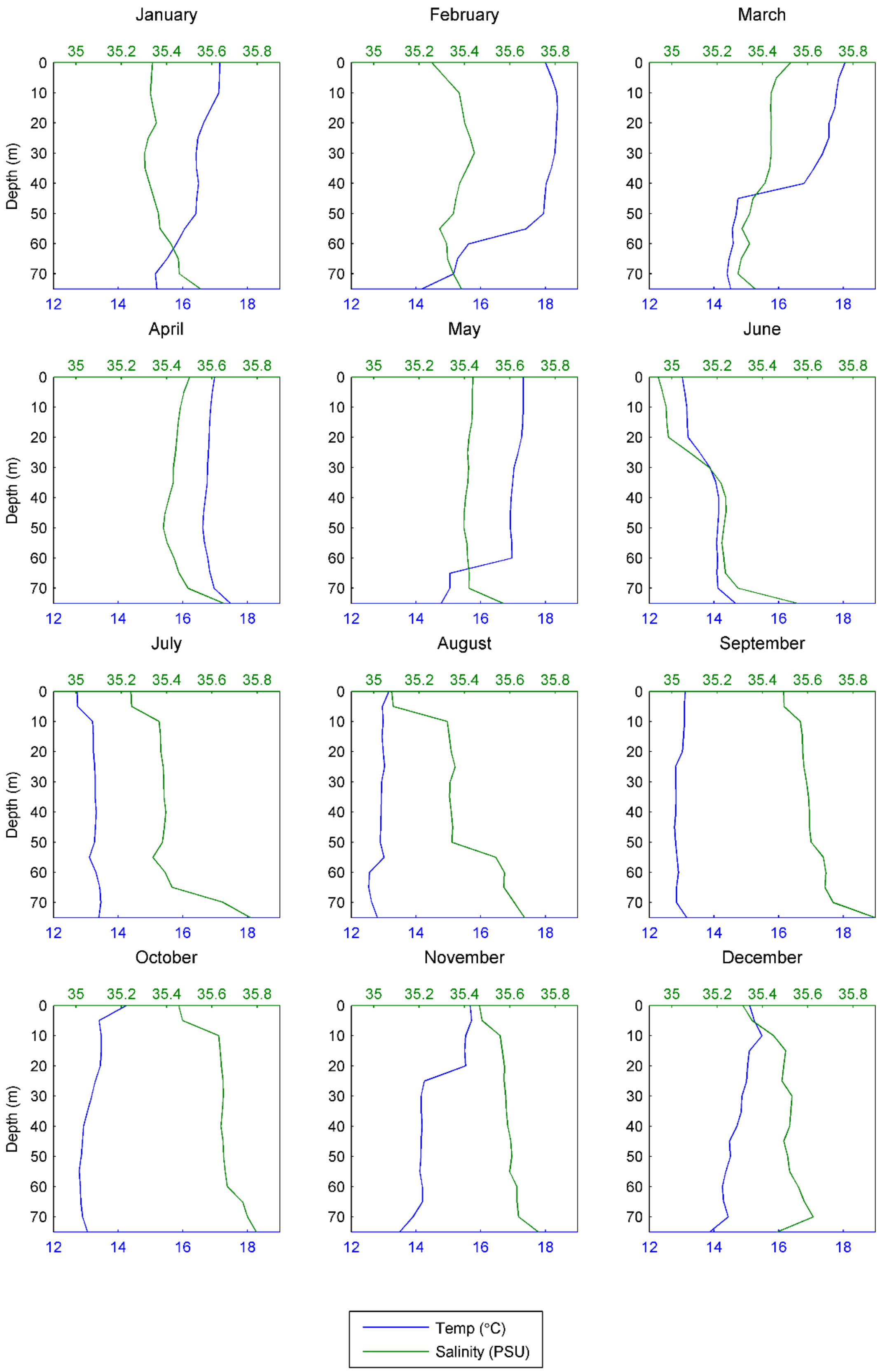


Figure 5-1 Temperature and salinity profiles nearby the release site.

6 OIL SPILL MODEL – SIMAP

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

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

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

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

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

Biodegradation is included in the oil spill model. In the 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.

6.1 Stochastic Modelling

For the stochastic modelling presented herein, **100 oil spills** were modelled the scenario 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 annualised 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;
- Exposure (instantaneous and/or over a specified duration) to dissolved hydrocarbons in the water column; and
- Exposure (instantaneous and/or over a specified duration) to entrained hydrocarbons in the water column.

6.1 Floating, Shoreline and In-Water Thresholds

The thresholds and their relationship to exposure for the sea surface, shoreline and water column (entrained and dissolved hydrocarbons) are presented in Sections 6.1.1 to 6.1.3. 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 herein are based on NOPSEMA (2019).

6.1.1 Floating Oil Exposure Thresholds

The modelling results can be presented to any levels; therefore, thresholds have been specified (based on scientific literature) to record floating oil exposure to the sea-surface at meaningful levels only, described in the following paragraphs.

The low threshold to assess the potential for floating oil exposure, was 1 g/m^2, which equates approximately to an average thickness of 1 µm, referred to as visible oil. Oil of this thickness is described as rainbow sheen in appearance, according to the Bonn Agreement Oil Appearance Code (Bonn Agreement, 2009; AMSA, 2014) (see Table 6-1). Figure 6-1 shows photographs highlighting the difference in appearance between a silvery sheen, rainbow sheen and metallic sheen. This threshold is considered below levels which would cause environmental harm and it is more indicative of the areas perceived to be affected due to its visibility on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. Table 6-1 provides a description of the appearance in relation to exposure zone thresholds used to classify the zones of floating oil exposure.

Ecological impact has been estimated to occur at 10 g/m^2 (a film thickness of approximately 10 µm or 0.01 mm) according to French et al. (1996) and French-McCay (2009) as this level of fresh oiling has been observed to mortally impact some birds through adhesion of oil to their feathers, exposing them to secondary effects such as hypothermia. The appearance of oil at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009).

Scholten et al. (1996) and Koops et al. (2004) indicated that at oil concentrations on the sea surface of 25 g/m^2 (or greater), would be harmful for all birds that have landed in an oil film due to potential contamination of their feathers, with secondary effects such as loss of temperature regulation and ingestion of oil through preening. The appearance of oil at this thickness is also described as metallic sheen (Bonn Agreement, 2009). For this study the high exposure threshold was set to 50 g/m^2 and above based on NOPSEMA (2019). This threshold can also be used to inform response planning.

Table 6-2 defines the thresholds used to classify the zones of floating oil exposure reported herein.

Table 6-1 The Bonn Agreement Oil Appearance Code.

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

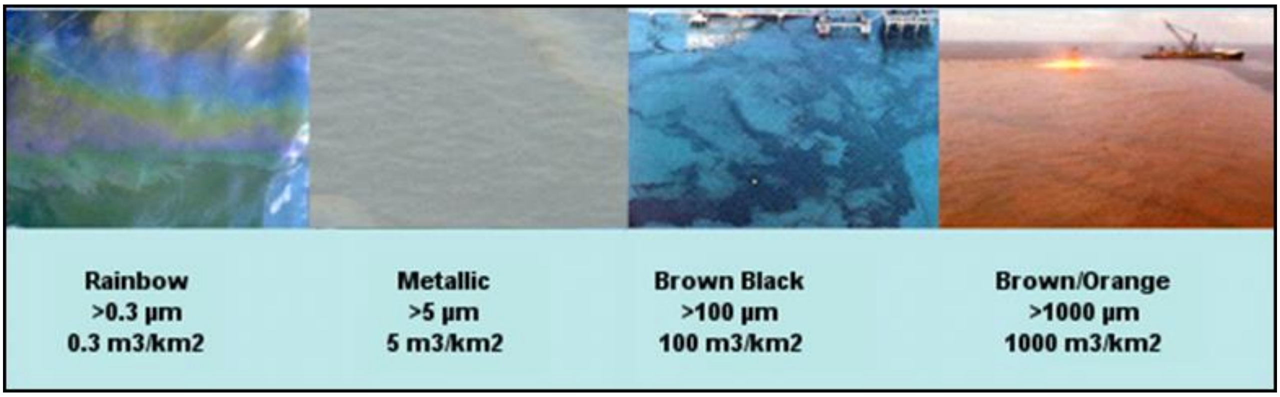


Figure 6-1 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oilspillsolutions.org, 2015).

Table 6-2 Floating oil exposure thresholds used in this report (in alignment with NOPSEMA (2019)).

Threshold level	Floating oil (g/m^2)	Description
Low	1	Approximates range of socioeconomic effects and establishes planning area for scientific monitoring
Moderate	10	Approximates lower limit for harmful exposures to birds and marine mammals
High	50*	Approximates surface oil slick and informs response planning

6.1.2 Shoreline Accumulation Thresholds

There are many different types of shorelines, ranging from cliffs, rocky beaches, sandy beaches, mud flats and mangroves, and each of these influences the volume of oil that can remain stranded ashore and its thickness before the shoreline saturation point occurs. For instance, a sandy beach may allow oil to percolate through the sand, thus increasing its ability to hold more oil ashore over tidal cycles and various wave actions than an equivalent area of water; hence oil can increase in thickness onshore over time. A sandy beach shoreline was assumed as the default shoreline type for the modelling herein, as it allows for the highest carrying capacity of oil (of the available open/exposed shoreline types). Hence the results contained herein would be indicative of a worst-case scenario, where the highest volume of oil may be stranded on the shoreline (when compared to other shoreline types, such as exposed rocky shores).

In previous risk assessment studies, French-McCay et al. (2005a; 2005b) used a threshold of 10 g/m^2 to assess the potential for shoreline accumulation. This is a conservative threshold used to define regions of socio-economic impact, such as triggering temporary closures of adjoining fisheries or the need for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). It would equate to approximately 2 teaspoons of hydrocarbon per square meter of shoreline accumulation. The appearance is described as a stain/film. On that basis, the 10 g/m^2 shoreline accumulation threshold has been selected to define the zone of potential “low shoreline accumulation”.

French et al. (1996) and French-McCay (2009) define a shoreline oil accumulation threshold of 100 g/m^2, or above, would potentially harm shorebirds and wildlife (furbearing aquatic mammals and marine reptiles on or along the shore) based on studies for sub-lethal and lethal impacts. This threshold has been used in previous environmental risk assessment studies (see French-McCay, 2003; French-McCay et al., 2004, French-McCay et al., 2011; 2012; NOAA, 2013). Additionally, a shoreline concentration of 100 g/m^2, or above, is the minimum limit that the oil can be effectively cleaned according to the AMSA (2015) guideline. This threshold equates to approximately ½ a cup of oil per square meter of shoreline accumulation. The appearance is described as a thin oil coat. Therefore, 100 g/m^2 has been selected to define the zone of potential “moderate shoreline accumulation”.

Observations by Lin & Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m^2 of hydrocarbon during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing hydrocarbon impacts on mangroves (Grant et al., 1993; Suprayogi & Murray, 1999). Hence, 1,000 g/m^2 has been selected to define the zone of potential “high shoreline accumulation”. It equates to approximately 1 litre of hydrocarbon per square meter of shoreline accumulation. The appearance is described as a hydrocarbon cover.

It is worth noting that the shoreline accumulation thresholds derived from extensive literature review (outlined in Table 6-3) agree with the commonly used threshold values for oil spill modelling specified in NOPSEMA (2019).

Table 6-3 Thresholds used to assess shoreline accumulation.

Threshold level	Shoreline concentration (g/m^2)	Description
Low (socioeconomic/sublethal)	10	Predicts potential for some socio-economic impact
Moderate	100	Loading predicts area likely to require clean-up effort
High	> 1,000	Loading predicts area likely to require intensive clean-up effort

6.1.3 In-water Exposure Thresholds

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

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

6.1.3.1 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 and Di Toro, 2009). Of the soluble compounds, the greatest contributor to toxicity for water-column and benthic organisms are the lower-molecular-weight aromatic compounds, which are both volatile and soluble in water. Although they are not the most water-soluble hydrocarbons within most oil types, the polynuclear aromatic hydrocarbons (PAHs) containing 2-3 aromatic ring structures typically exert the largest narcotic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant accumulation to occur (Anderson et al., 1974, 1987; Neff & 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 10, 50 or 400 ppb over a 1 hour timestep (see Table 6-4) was applied to indicate increasing potential for sub-lethal to lethal toxic effects (or low to high), based on NOPSEMA (2019).

6.1.3.2 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 and 100 ppb were applied over a 1 hour time exposure (Table 6-4), to cover the range of thresholds outlined in ANZECC, (2000) water quality guidelines, the incremental change for greater potential effect and is per NOPSEMA (2019).

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.

Table 6-4 Dissolved and entrained hydrocarbon exposure values assessed over a 1-hour time step, as per NOPSEMA (2019).

Threshold level	Dissolved hydrocarbon concentration (ppb)	Entrained hydrocarbon concentrations (ppb)
Low	10	10
Moderate	50	-
High	400	100

7 OIL PROPERTIES

7.1 Oil Characteristics

7.1.1 Overview

Table 7-1 and Table 7-2 present the physical properties and boiling point ranges of the MDO used in this study.

Table 7-1 Physical properties for MDO.

Characteristic	Marine Diesel Oil (MDO)
Density (kg/m^3)	829.1 (at 25 °C)
API	37.6
Dynamic viscosity (cP)	4.0 (at 25 °C)
Pour point (°C)	-14
Hydrocarbon property category	Group II
Hydrocarbon property classification	Light - Persistent

Table 7-2 Boiling point ranges for MDO.

Oil Type	Component	Volatile (%)	Semi-volatile (%)	Low-volatility (%)	Residual (%)
	Boiling point (°C)	<180 C_4 to C_{10}	180-265 C_{11} to C_{15}	265-380 C_{16} to C_{20}	>380 >C_{20}
MDO	% of total	6.0	34.6	54.4	5.0

The boiling points (BP) are dictated by the length of the carbon chains, with the longer and more complex compounds having a higher boiling point, and therefore lower volatility and evaporation rate.

Typical evaporation times once the hydrocarbons reach the surface and are exposed to the atmosphere are:

- Up to 12 hours for the C_4 to C_{10} compounds (or less than 180°C BP).
- Up to 24 hours for the C_{11} to C_{15} compounds (180-265°C BP).
- Several days for the C_{16} to C_{20} compounds (265-380°C BP).
- Not applicable for the residual compounds (BP > 380°C), which will resist evaporation, persist in the marine environment for longer periods, and be subject to relatively slow degradation.

The actual fate of oil will depend greatly on the amount that reaches the surface.

7.1.2 Marine Diesel Oil

The MDO has an API of 37.6 and a density of 829.1 kg/m^3 (at 25ºC) with a viscosity value (4.0 cP) classifying it as a Group II (light-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and US EPA/USCG classifications.

The MDO is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 6.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C); a further 34.6% should evaporate within the first 24 hours (180°C < BP < 265°C); and a further 54.4% should evaporate over several days (265°C < BP < 380°C). Approximately 5.0% of the oil is shown to be persistent.

7.2 Weathering Characteristics

7.2.1 Overview

A series of model weather tests were conducted to illustrate the potential behaviour of the MDO when exposed to idealised and representative environmental conditions:

- A 25 m^3 surface release over 1-hour under calm wind conditions (constant 5 knots), assuming low seasonal water temperature (15°C) and ambient tidal and drift currents.

- A 50 m^3 surface release over 1-hour under variable wind conditions (1-12 knots, drawn from representative data files), assuming low seasonal water temperature (15°C) and ambient tidal and drift currents.

The first case is indicative conditions that would not generate entrainment, while the second case may represent conditions that could cause a minor degree of entrainment. Both scenarios provide examples of potential behaviour during a spill once the oil reaches the surface.

7.2.2 MDO Mass Balance Forecasts

The mass balance for the MDO under the constant 5 knot (~2.5 m/s) wind case (Figure 7-1) shows that 40.3% of the oil is predicted to evaporate within 24 hours. Under calm conditions, the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation shall cease when the residual compounds remain, and they will be subject to more gradual decay through biological and photochemical processes.

Under the variable-wind case (Figure 7-2), where the winds are of greater strength on average, entrainment of MDO into the water column is predicted to increase. Approximately 24 hours after the spill, 60.1% of the oil mass is forecast to have entrained and a further 38.4% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<0.1%).

The increased level of entrainment in the variable-wind case result in a higher percentage decaying at an approximate rate of 1.5% per day with or ~10.5% after 7 days, compared to <0.1% per day and a total of 0.9% after 7 days for the constant-wind case. Given the proportion of entrained oil and the tendency for it to remain mixed in the water column, the remaining hydrocarbons will decay over time scales of several weeks.

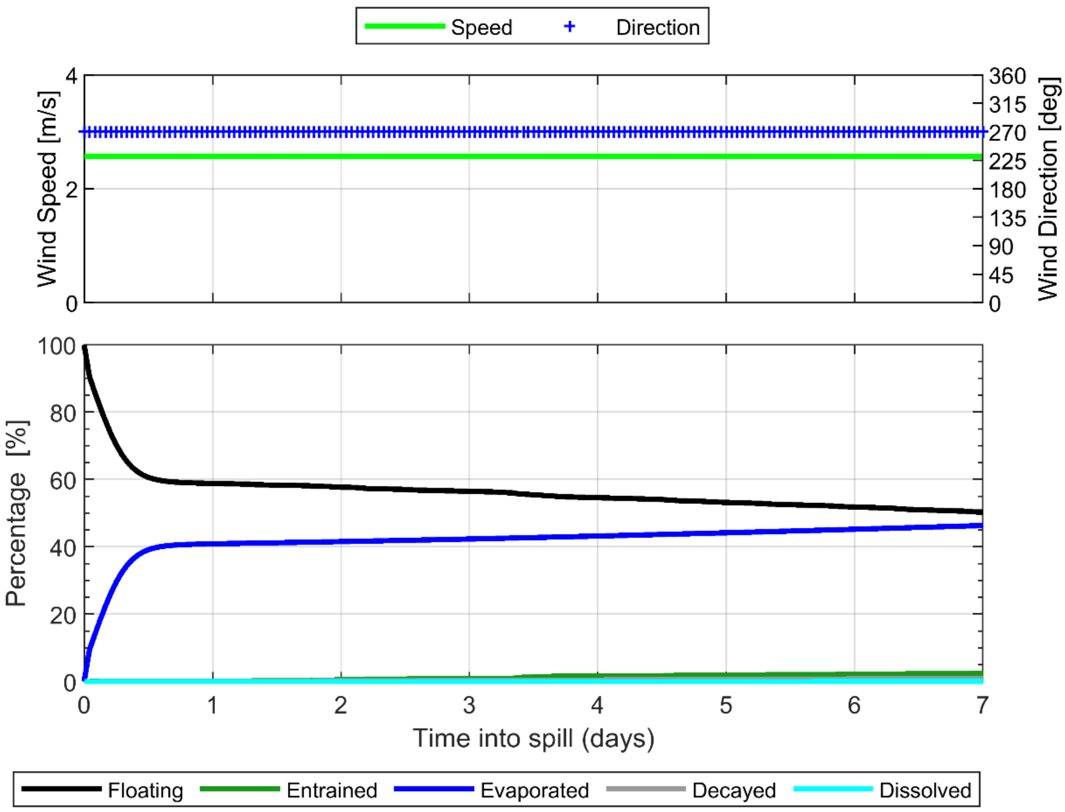


Figure 7-1 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature and 20°C air temperature.

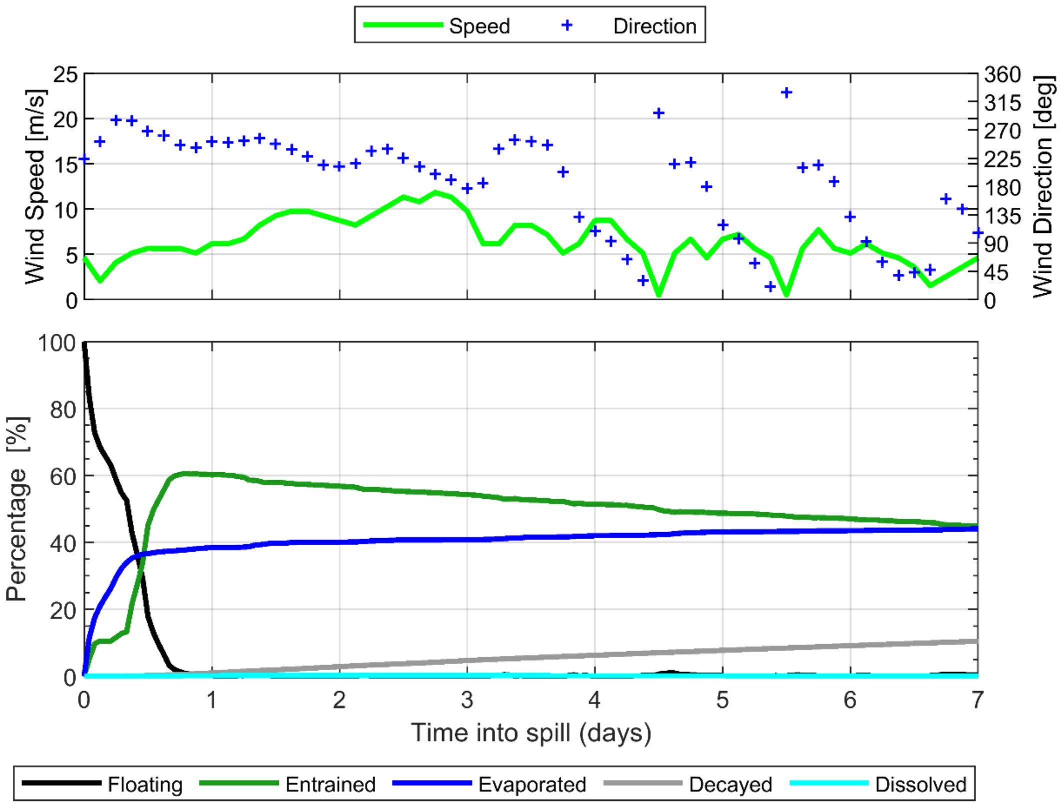


Figure 7-2 Proportional mass balance plot representing the weathering of MDO spilled onto the water over 1 hour and subject to variable wind speeds (1-12 knots) at 15°C water temperature and 20°C air temperature.

8 MODEL SETTINGS

Table 8-1 provides a summary of the oil spill model settings.

Table 8-1 Summary of the oil spill model settings and thresholds used in this assessment.

Parameter	Scenario
Description	Vessel collision
Number of randomly selected spill start times for scenario	100
Model period	Annual
Oil type	MDO
Spill volume (m^3)	300
Release type	Surface
Release duration	6 hours
Simulation length (days)	20
Surface oil concentration thresholds and exposure risk (g/m^2) ^	1 (low); 10 (moderate); 50 (high)
Shoreline oil accumulation thresholds and exposure risk (g/m^2) ^	10 (low); 100 (moderate); 1,000 (high)
Dissolved hydrocarbon concentrations and exposure risk (ppb) ^	10 (low); 50 (moderate); 400 (high)
Entrained hydrocarbon concentrations and exposure risk (ppb) ^	10 (low); 100 (high)

^Thresholds based on NOPSEMA (2019)

9 PRESENTATION AND INTERPRETION OF MODEL RESULTS

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

9.1 Annual Analysis

9.1.1 Statistics

The statistics are based on the following principles:

- The ***greatest distance travelled by a spill trajectory*** – is determined by a) recording the maximum and b) second greatest distance travelled (or 99th percentile) by a single trajectory, within a scenario, from the release location to the identified exposure thresholds.
- The ***probability of oil exposure to a receptor*** – is determined by recording the number of spill trajectories to reach a specified sea surface or subsea threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.
- The ***minimum time before oil exposure to a receptor*** – is determined by ranking the elapsed time before sea surface exposure, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.
- The ***probability of oil accumulation at a receptor*** – is determined by recording the number of spill trajectories to reach a specified shoreline accumulation threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.
- The ***maximum potential oil loading within a receptor*** – is determined by identifying the maximum loading to any grid cell within a receptor polygon, for a scenario.
- The ***dissolved and entrained hydrocarbon exposure*** – is determined by recording the maximum instantaneous concentrations at each grid cell by applying a 96-hour time-based averaging.

9.2 Deterministic Trajectories

The stochastic modelling results were assessed for each scenario, and the deterministic runs were identified and are presented in the result section based on the following criteria;

a. Largest volume of oil ashore;

b. Longest length of oil accumulation above 10 g/m^2;

c. Minimum time before shoreline accumulation above 10 g/m^2;

d. Largest swept area of floating oil above 1 g/m^2 (visible floating oil);

e. Largest area of entrained hydrocarbon exposure above 10 ppb; and

f. Largest area of dissolved hydrocarbon exposure above 10 ppb.

9.2.1 Receptors Assessed

A range of environmental receptors and shorelines were assessed for floating oil exposure, shoreline contact and water column exposure as part of the study (see Figure 9-1 to Figure 9-10). Receptor categories (see Table 9-1) include sections of shorelines which are defined by local government areas (LGAs), sub-LGAs and offshore islands. All other sensitive receptors other than submerged reefs, shoals and banks (RSB) were sourced from Australian Government Department of Agriculture, Water and the Environment (http://www.environment.gov.au/). Risks of exposure were separately calculated for each sensitive receptor area and have been tabulated. Note, due to the volume and geographical extent of Biologically Important Areas (BIAs) predicted to receive potential impacts from spilled hydrocarbon, it is recommended to use the following website to obtain detailed maps on all BIAs assessed: http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf.

Table 9-2 summarises the receptors that the release locations reside within.

Table 9-1 Summary of receptors used to assess floating oil, shoreline and in-water exposure to hydrocarbons.

Receptor Category	Acronym	Hydrocarbon Exposure Assessment		
		Water Column	Floating oil	Shoreline
Australian Marine Park	AMP	✓	✓	✗
Biologically Important Areas	BIA	✓	✓	✗
Interim Biogeographic Regionalisation for Australia bioregions	IBRA	✓	✓	✗
Integrated marine and coastal regionalisation areas	IMCRA	✓	✓	✗
Marine Park	MP	✓	✓	✗
Marine Sanctuary	MS	✓	✓	✗
Nature Reserve	NR	✓	✓	✗
RAMSAR Sites	Ramsar	✓	✓	✗
Reefs, Shoals and Banks	RSB	✓	✓	✗
Key Ecological Feature	KEF	✓	✓	✗
State Waters	State Waters	✓	✓	✗
Local and Sub-Local Government Area	LGA and Sub-LGA	✓ (Reported as: Nearshore Waters)	✓ (Reported as: Nearshore Waters)	✓ (Reported as: Shore)

Table 9-2 Summary of the receptors that the release locations reside within.

Acronym	Receptor
BIA	Black-browed Albatross - Foraging
	Bullers Albatross - Foraging
	Campbell Albatross - Foraging
	Common Diving-petrel - Foraging
	Indian Yellow-nosed Albatross - Foraging
	Pygmy Blue Whale - Distribution
	Pygmy Blue Whale - Foraging
	Short-tailed Shearwater - Foraging
	Shy Albatross - Foraging
	Southern Right Whale - Migration
	Wandering Albatross - Foraging
	White Shark - Distribution
	White-faced Storm-petrel - Foraging
EEZ	Australian Exclusive Economic Zone
IMCRA	Central Bass Strait

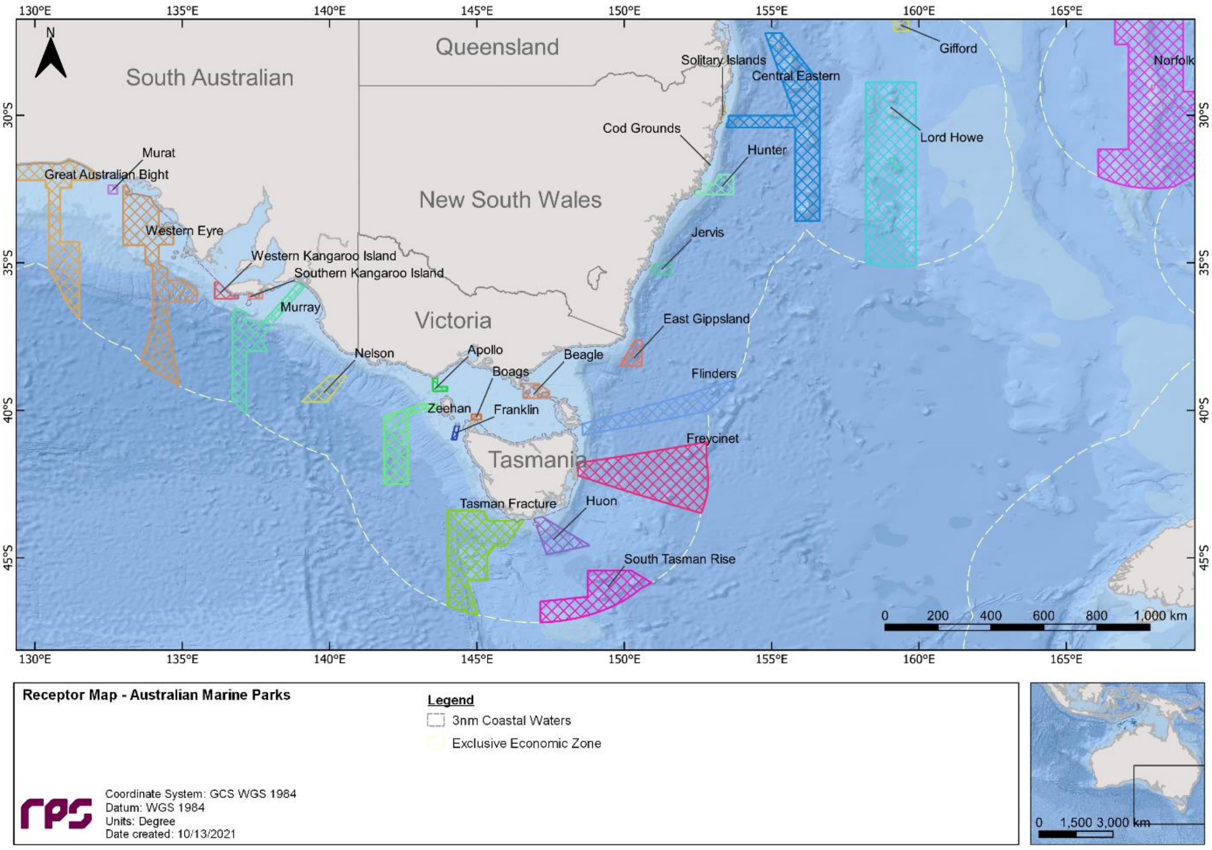


Figure 9-1 Receptor map for Australian Marine Parks (AMP).

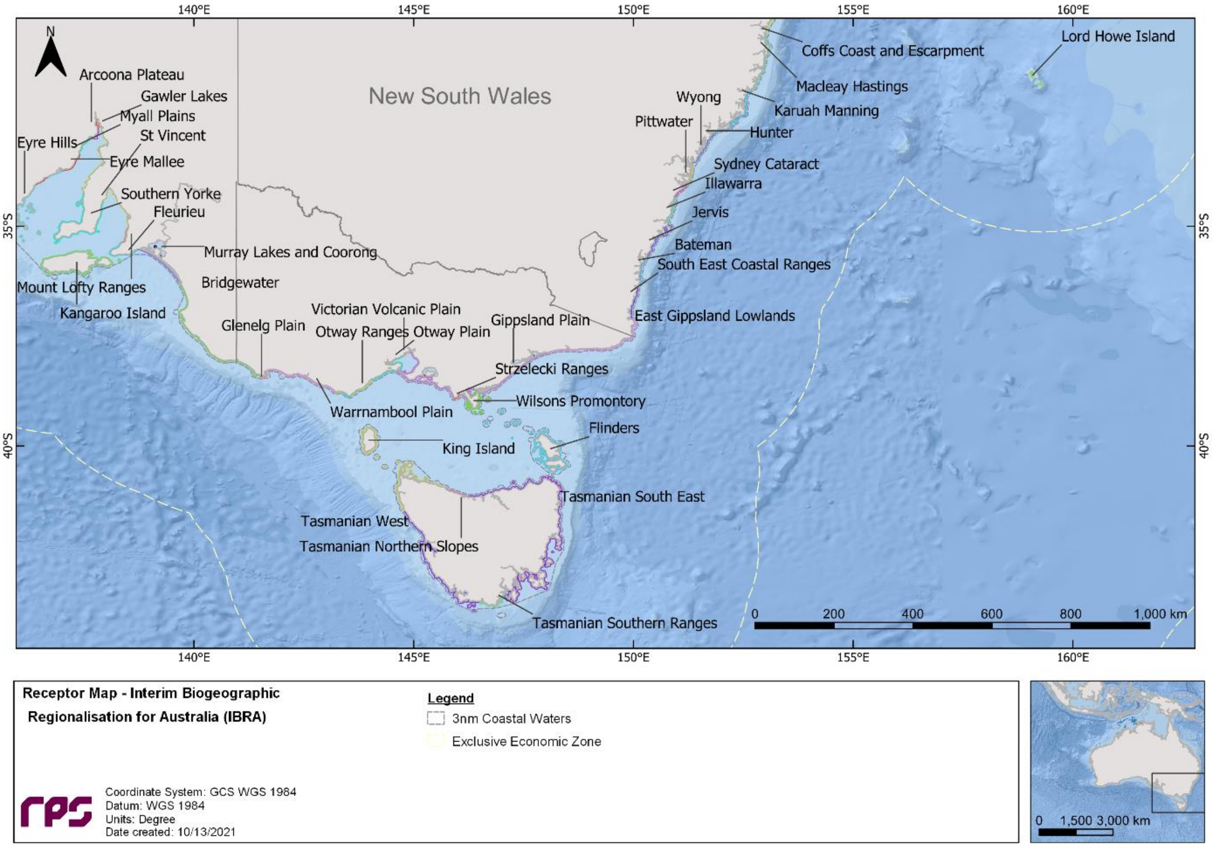


Figure 9-2 Receptor map for the Interim Biogeographic Regionalisation for Australia (IBRA) bioregions.

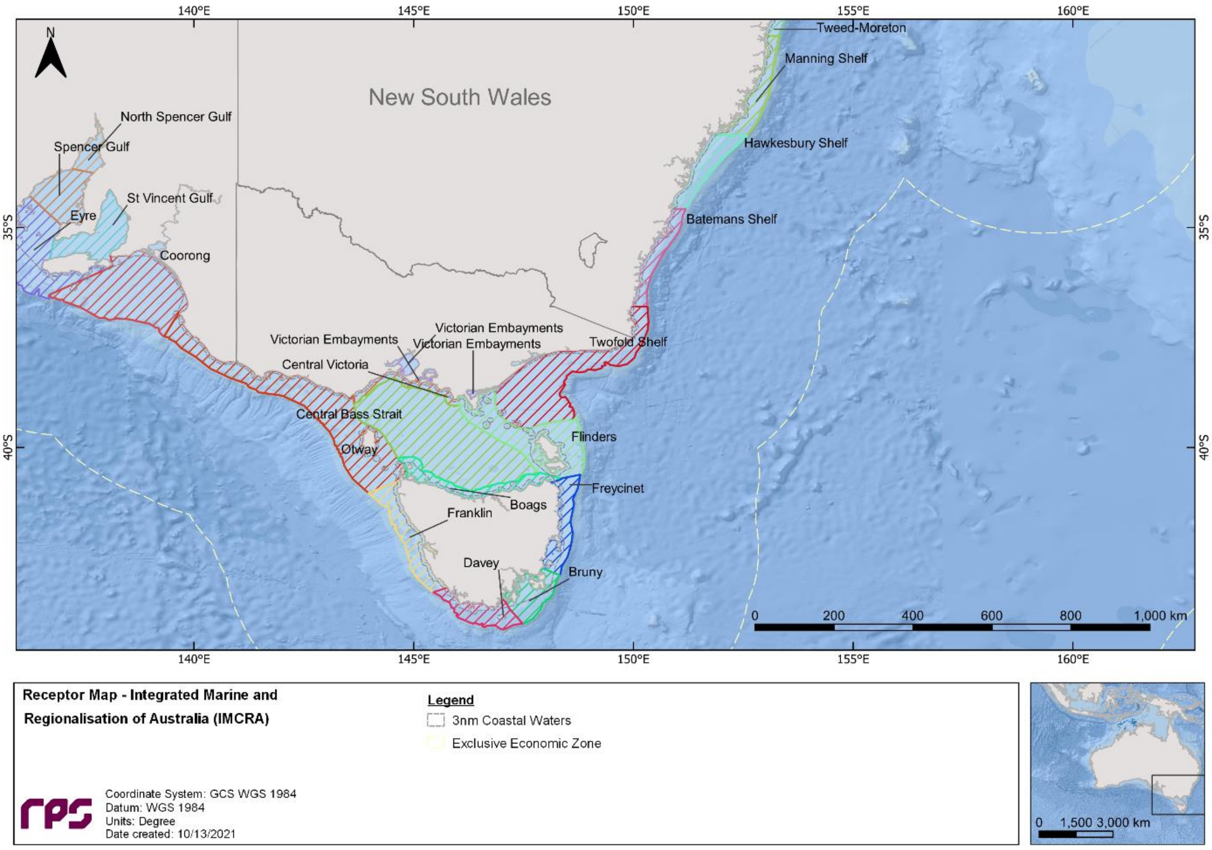


Figure 9-3 Receptor map for integrated marine and coastal regionalisation (IMCRA) areas.

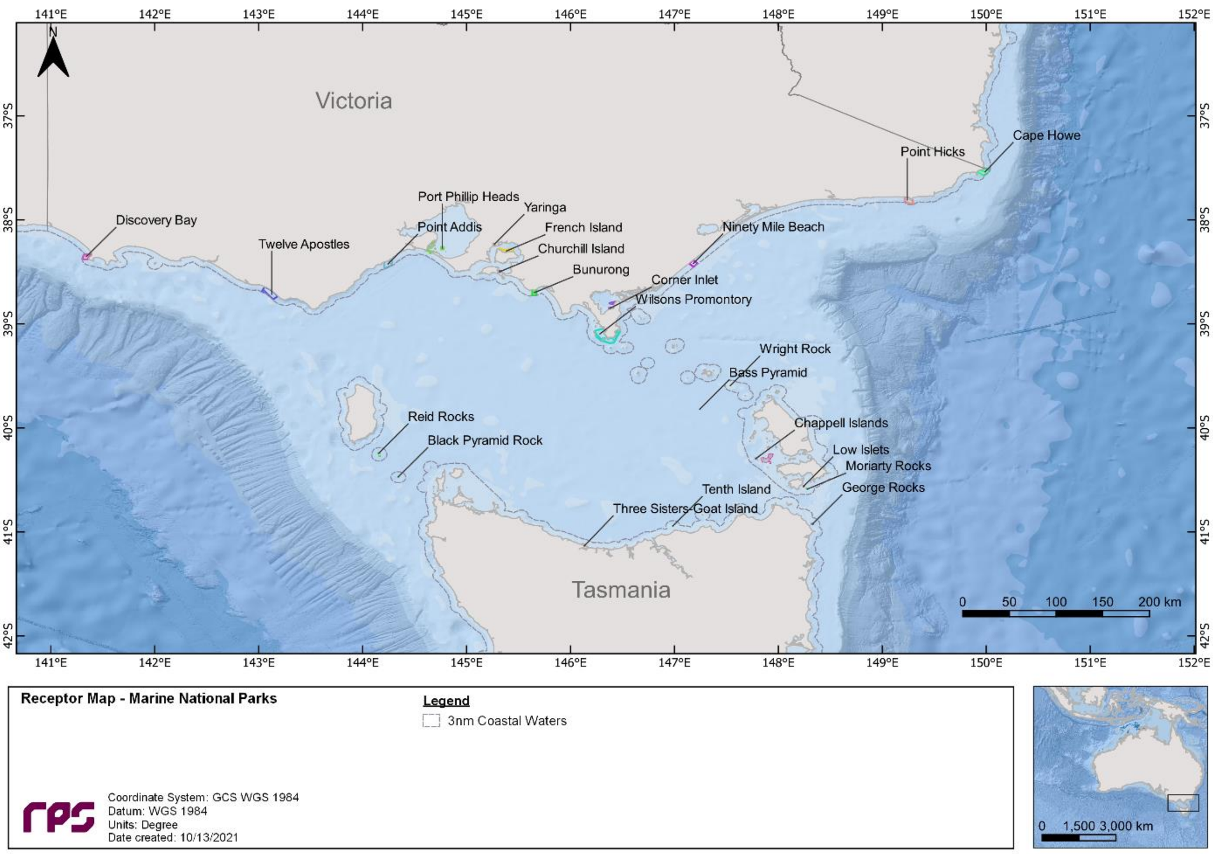


Figure 9-4 Receptor map for Marine National Parks (MNP).

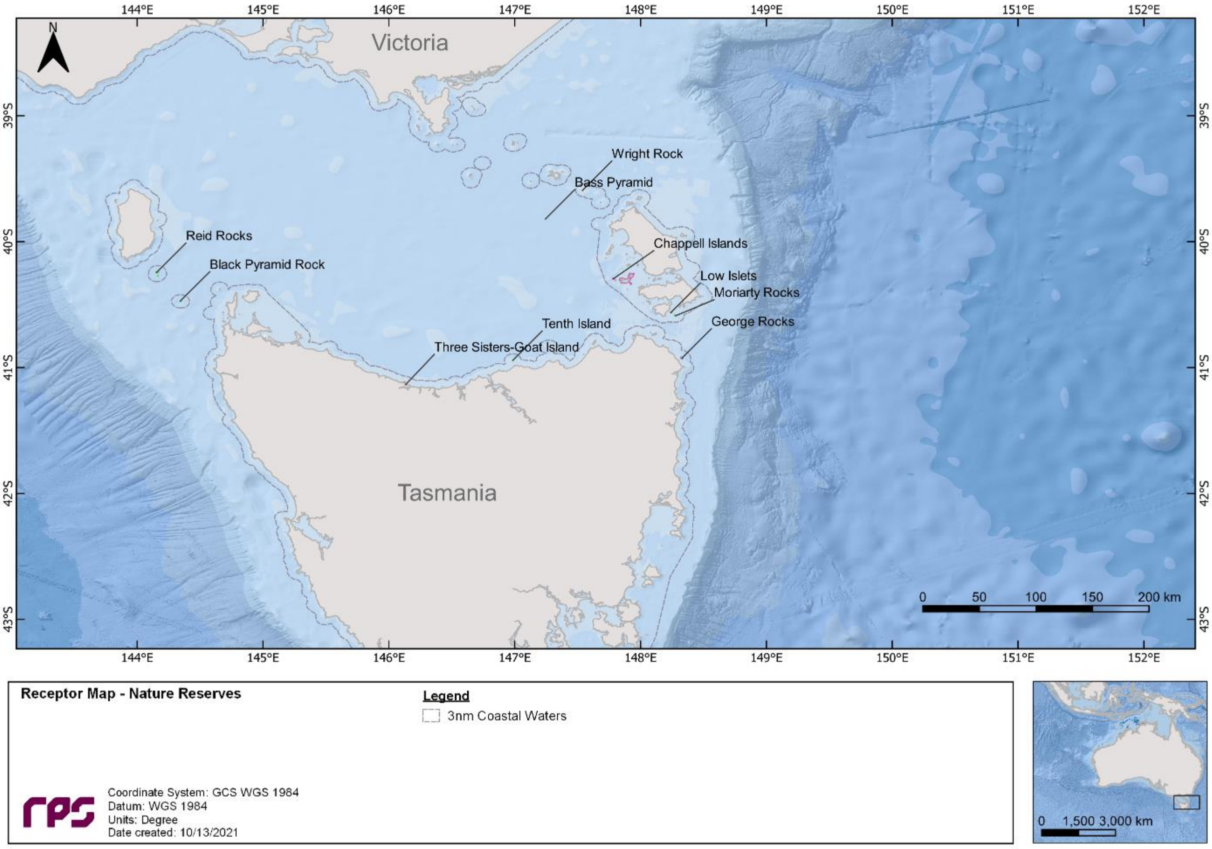


Figure 9-5 Receptor map for Nature Reserves (NR).

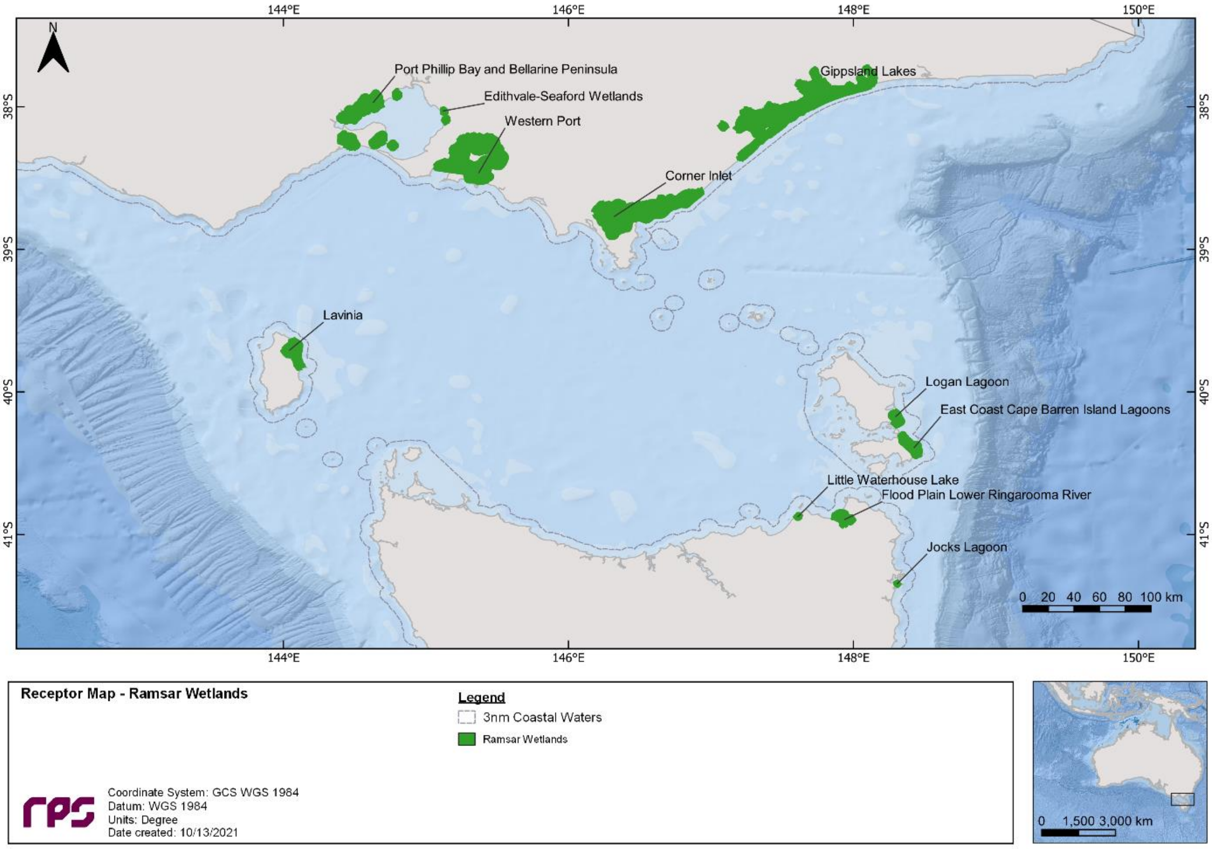


Figure 9-6 Receptor map for Ramsar Sites (RAMSAR).

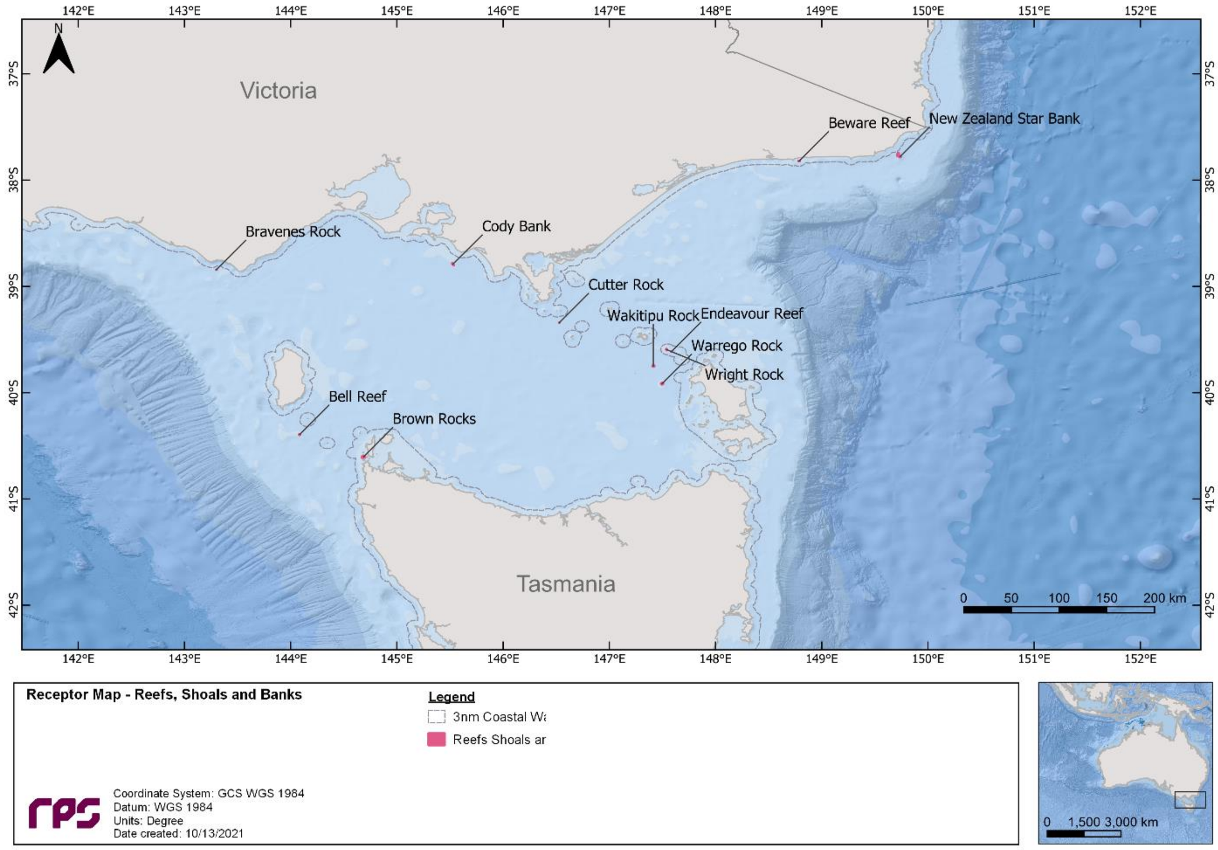


Figure 9-7 Receptor map for Reefs, Shoals and Banks (RSB).

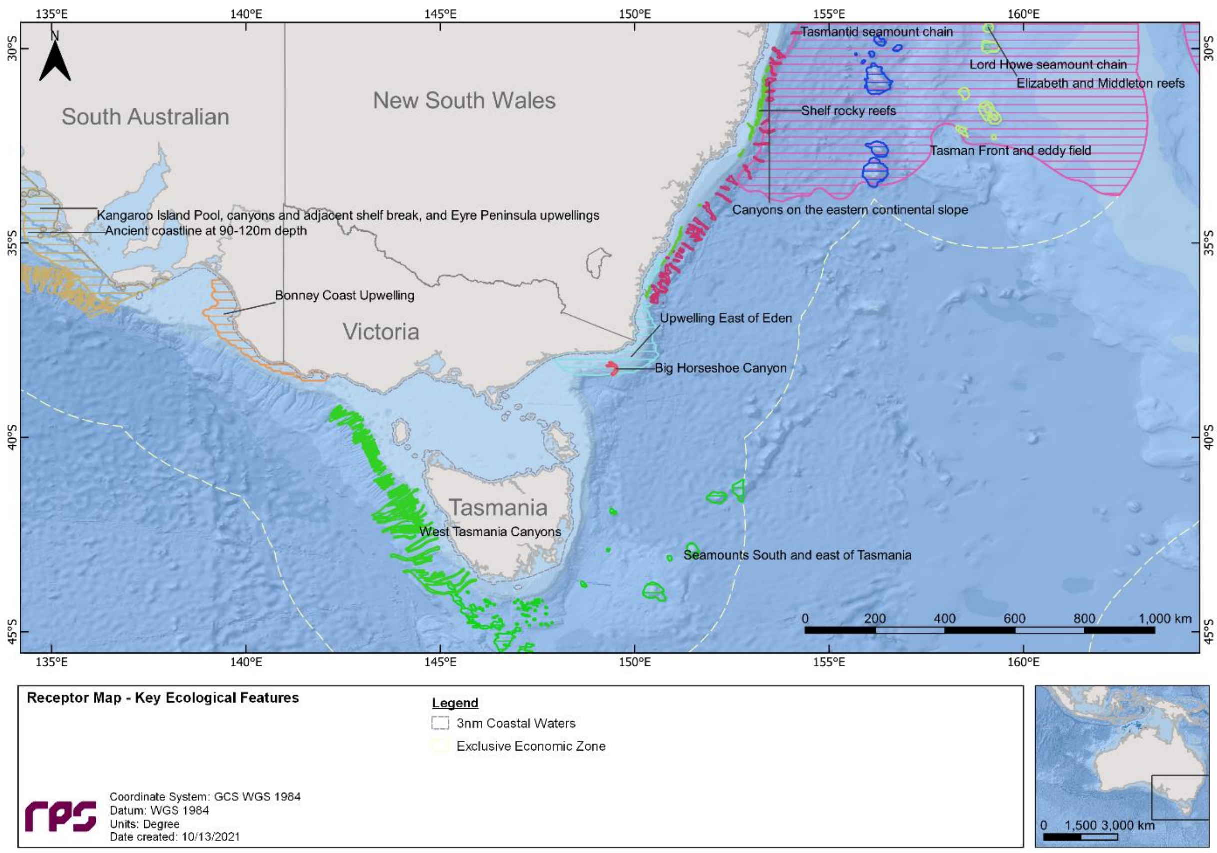


Figure 9-8 Receptor map for Key Ecological Features (KEF).

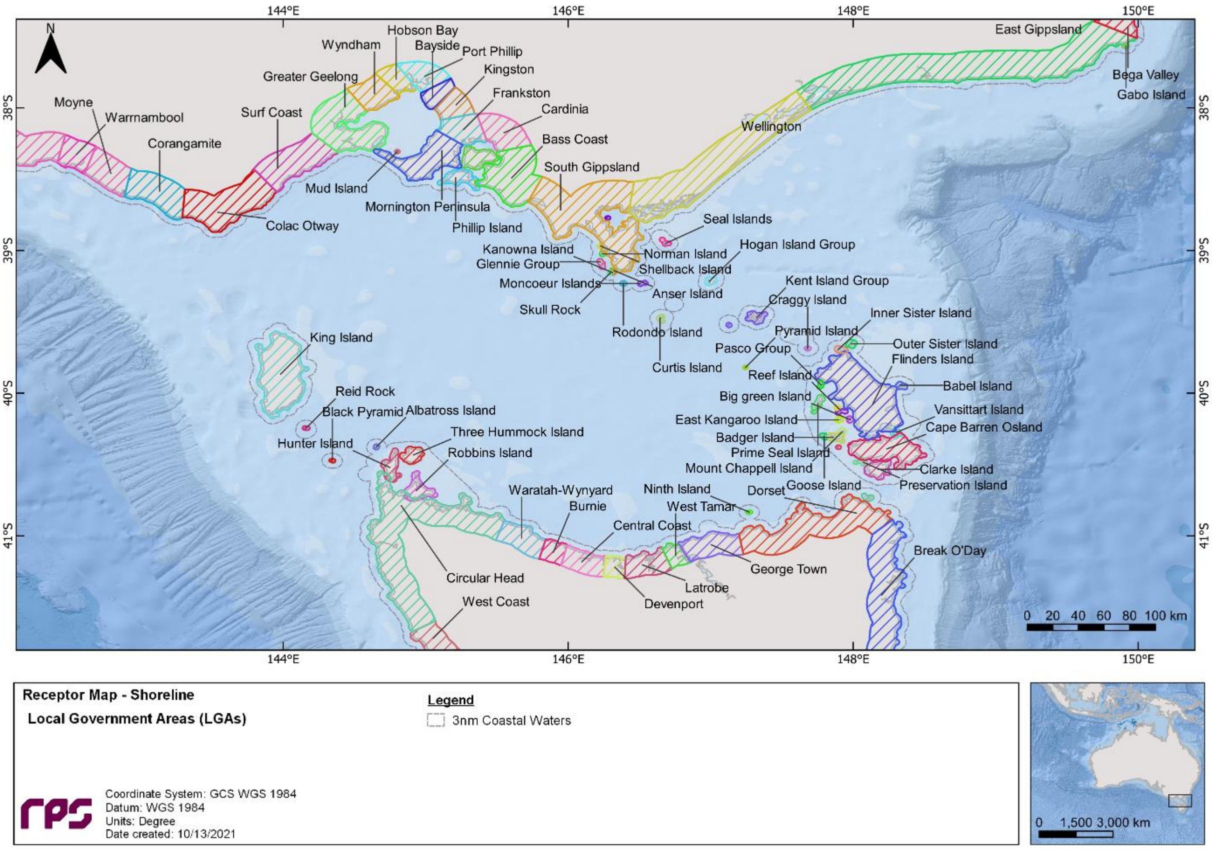


Figure 9-9 Receptor map for Local Government Areas (LGA).

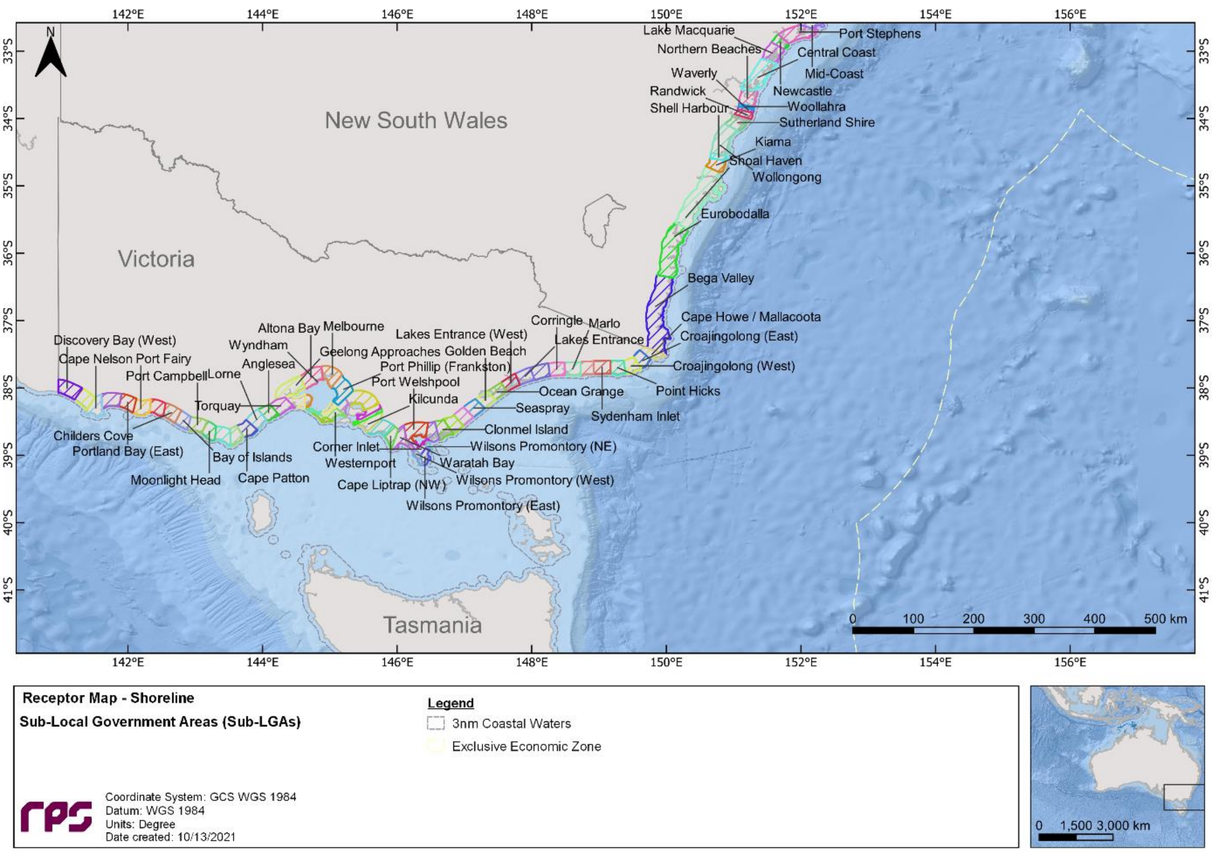


Figure 9-10 Receptor map for Sub Local Government Areas (Sub-LGA).

10 RESULTS – 300 M³ LOSS OF CONTAINMENT CAUSED BY VESSEL COLLISION

This scenario examined a 300 m³ surface release of MDO over 6 hours to represent a loss of containment caused by vessel collision. A total of 100 spill simulations were run and tracked for 20 days. The results for all 100 simulations were combined and are presented on an annual basis.

Sections 10.1 and 10.2 present the annual stochastic analysis and deterministic analysis results, respectively.

10.1 Stochastic Analysis

10.1.1 Floating Oil Exposure

Table 10-1 summarises the maximum distance travelled by floating oil on the sea surface at each threshold. The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (> 50 g/m^2) exposure levels was 59.8 km (east), 13.8 km (south) and 1.9 km (south), respectively.

Table 10-2 summarises the potential floating oil exposure to individual receptors during annual conditions.

A total of 13 BIAs, the Australian EEZ and the Central Bass Strait IMCRA were predicted to be exposed to floating oil at or above the low threshold during annualised conditions. The release location resides within all the exposed receptors. No other receptors were exposed to floating oil.

Figure 10-1 presents the zones of potential floating oil exposure for the thresholds under annualised conditions.

Table 10-1 Maximum distance and direction from the release location to floating oil exposure on the sea surface. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill simulations and presented for annual conditions.

Distance and direction travelled	Zones of potential floating oil exposure		
	Low	Moderate	High
Maximum distance (km) from the release location	59.8	13.8	1.9
Maximum distance (km) from release site (99th percentile)	37.8	12.9	1.9
Direction	East	South	South

Table 10-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill trajectories during annual conditions.

Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
BIA	Black-browed Albatross – Foraging*	100	100	9	0.04	0.04	-
	Bullers Albatross - Foraging*	100	100	9	0.04	0.04	-
	Campbell Albatross - Foraging*	100	100	9	0.04	0.04	-
	Common Diving-petrel - Foraging*	100	100	9	0.04	0.04	-
	Indian Yellow-nosed Albatross - Foraging*	100	100	9	0.04	0.04	-
	Pygmy Blue Whale - Distribution*	100	100	9	0.04	0.04	-
	Pygmy Blue Whale - Foraging*	100	100	9	0.04	0.04	-
	Short-tailed Shearwater - Foraging*	100	100	9	0.04	0.04	-
	Shy Albatross - Foraging*	100	100	9	0.04	0.04	-
	Southern Right Whale - Migration*	100	100	9	0.04	0.04	-
	Wandering Albatross - Foraging*	100	100	9	0.04	0.04	-
	White Shark - Distribution*	100	100	9	0.04	0.04	-
	White-faced Storm-petrel - Foraging*	100	100	9	0.04	0.04	-
EEZ	Australian Exclusive Economic Zone*	100	100	9	0.04	0.04	-
IMCRA	Central Bass Strait*	100	100	9	0.04	0.04	-

*The release location resides within the receptor boundaries.

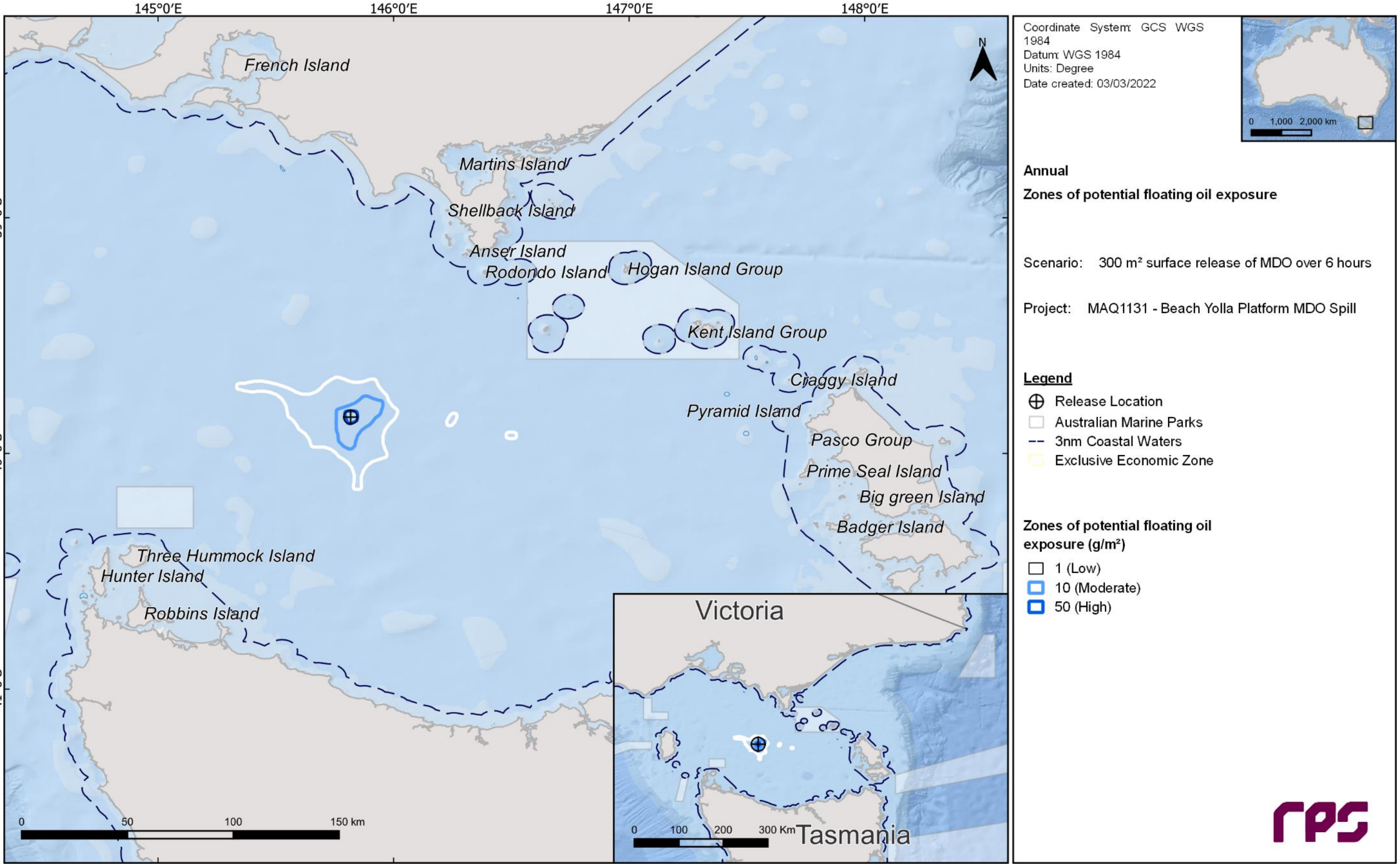


Figure 10-1 Zones of potential floating oil exposure in the event of a 300 m³ of MDO containment loss over 6 hours tracked for 20 days. The results were calculated from 100 spill simulations and presented for annual conditions.

10.1.2 Shoreline Accumulation

No shoreline oil accumulation above the low shoreline contact threshold was predicted for the scenario.

10.1.3 In-water exposure

10.1.3.1 Dissolved Hydrocarbons

Table 10-3 summarises the maximum distance and direction from the release location to dissolved hydrocarbon exposure in the 0-10 m depth layer at the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) thresholds levels. The maximum distances to the low and moderate thresholds from the release location was predicted as 80.0 km (east-southeast) and 15.2 km (north), respectively. Note, no high exposure to dissolved hydrocarbons was recorded.

Table 10-4 summarises the probability of exposure to individual receptors from dissolved hydrocarbons in the 0-10 m layer for the annualised assessment.

A total of 13 BIAs, the Australian EEZ and the Central Bass Strait IMCRA were predicted to be exposed at, or above, the low threshold during the annualised assessment as the release location resides within all the exposed receptors. No other receptors were exposed to dissolved hydrocarbons. The probability of exposure at the low and moderate thresholds were predicted to be 65% and 5% respectively, for all receptors.

Figure 10-2 presents the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed.

Table 10-3 Maximum distance and direction from the release location to dissolved hydrocarbon exposure thresholds in the 0 – 10 m depth layer, based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

Distance and direction travelled	Zones of potential dissolved hydrocarbon exposure		
	Low	Moderate	High
Maximum distance (km) from the release location	80.0	15.2	-
Maximum distance (km) from release location (99th percentile)	60.1	15.2	-
Direction	East-southeast	North	-

Table 10-4 Probability of dissolved hydrocarbons exposure to marine based receptors in the 0–10 m dept. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill simulations and presented for annual conditions.

Receptor		Maximum instantaneous dissolved hydrocarbon exposure	Probability of instantaneous hydrocarbon exposure		
			Low	Moderate	High
BIA	Black-browed Albatross – Foraging*	86	65	5	-
	Bullers Albatross - Foraging*	86	65	5	-
	Campbell Albatross - Foraging*	86	65	5	-
	Common Diving-petrel - Foraging*	86	65	5	-
	Indian Yellow-nosed Albatross - Foraging*	86	65	5	-
	Pygmy Blue Whale - Distribution*	86	65	5	-
	Pygmy Blue Whale - Foraging*	86	65	5	-
	Short-tailed Shearwater - Foraging*	86	65	5	-
	Shy Albatross - Foraging*	86	65	5	-
	Southern Right Whale - Migration*	86	65	5	-
	Wandering Albatross - Foraging*	86	65	5	-
	White Shark - Distribution*	86	65	5	-
	White-faced Storm-petrel - Foraging*	86	65	5	-
EEZ	Australian Exclusive Economic Zone*	86	65	5	-
IMCRA	Central Bass Strait*	86	65	5	-

*The release location resides within the receptor boundaries.

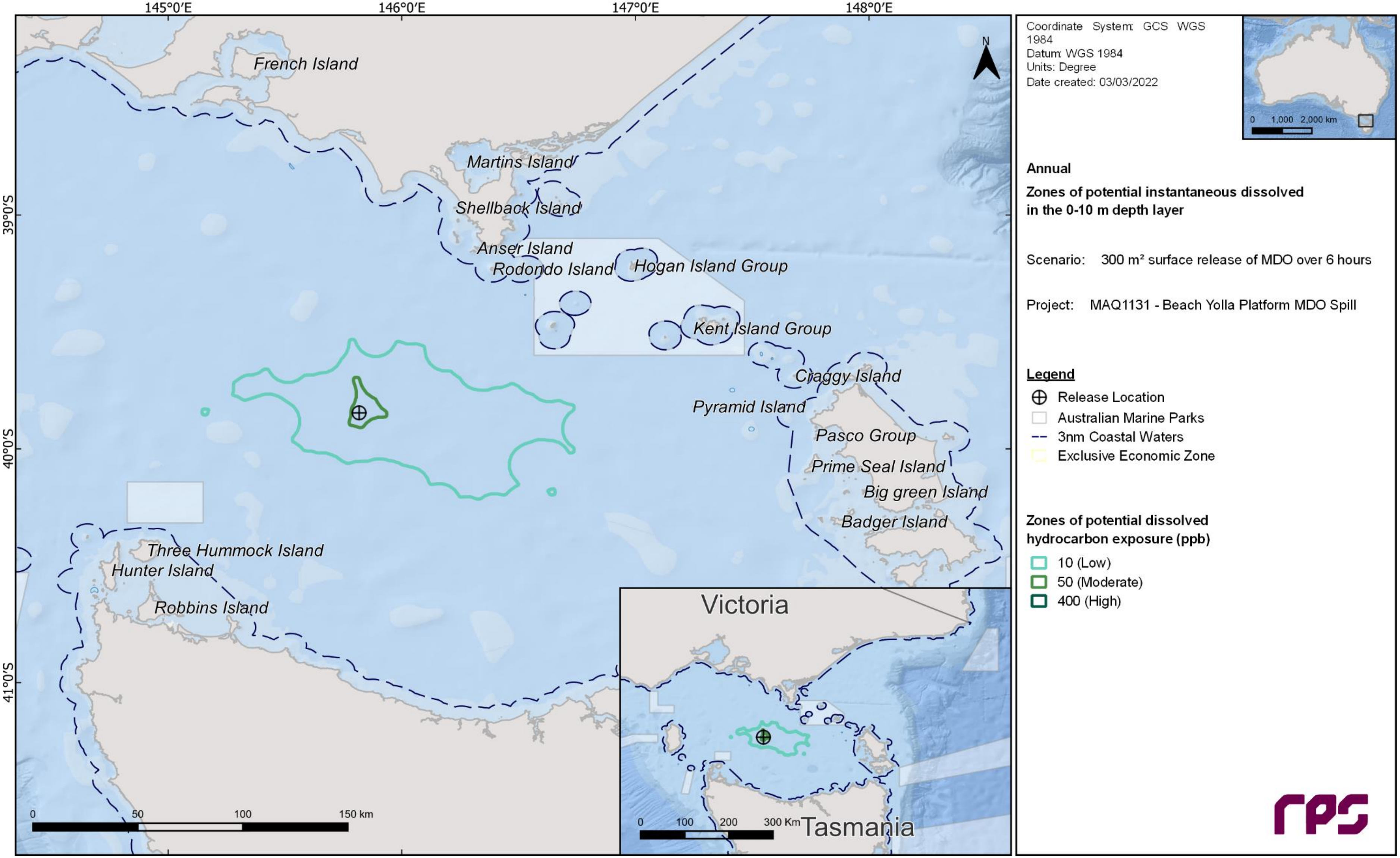


Figure 10-2 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 300 m³ of MDO containment loss over 6 hours tracked for 20 days. The results were calculated from 100 spill simulations and presented for annual conditions.

10.1.3.2 Entrained Hydrocarbons

Table 10-5 summarises the maximum distance and direction from the release location to entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) exposure levels. The maximum distances to the low and high thresholds from the release location was 492.4 km (east-northeast) and 120.4 km (east-southeast), respectively.

Table 10-6 presents the probability of exposure to individual receptors from entrained hydrocarbons in the 0-10 m depth layer for the annualised assessment.

Low and high entrained hydrocarbon exposures were predicted for BIA and IMCRA receptors. Receptors demonstrating the greatest entrained hydrocarbons concentrations of 8,557 ppb contained the release location. The highest concentration for a receptors which did not surround the release location was Flinders IMCRA (167 ppb) and the probability of exposure based on the low and high thresholds was 19% and 2% respectively.

Figure 10-3 illustrate the zones of potential entrained hydrocarbon exposure for the 0-10 m depth.

Table 10-5 Maximum distance and direction from the release location to entrained hydrocarbon exposure thresholds in the 0 – 10 m depth layer. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

Distance and direction travelled	Zones of potential entrained hydrocarbon exposure	
	Low	High
Maximum distance (km) from the release location	492.4	120.4
Maximum distance (km) from release location (99th percentile)	318.7	104.0
Direction	East northeast	East-southeast

Table 10-6 Probability of entrained hydrocarbons exposure to marine based receptors in the 0–10 m depth layer. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days. The results were calculated from 100 spill simulations and presented for annual conditions.

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low	High
AMP	Beagle	53	12	-
AMP	Boags	73	8	-
AMP	Franklin	37	3	-
BIA	Antipodean Albatross - Foraging	37	3	-
BIA	Australasian Gannet - Foraging	43	4	-
BIA	Black-browed Albatross – Foraging*	8,557	96	94
BIA	Black-faced Cormorant - Foraging	34	3	-
BIA	Bullers Albatross – Foraging*	8,557	96	94
BIA	Campbell Albatross – Foraging*	8,557	96	94
BIA	Common Diving-petrel - Foraging	8,557	96	94
BIA	Humpback Whale - Foraging	13	1	-
BIA	Indian Yellow-nosed Albatross – Foraging*	8,557	96	94
BIA	Little Penguin - Foraging	54	11	-
BIA	Pygmy Blue Whale – Distribution*	8,557	96	94
BIA	Pygmy Blue Whale – Foraging*	8,557	96	94
BIA	Short-tailed Shearwater – Foraging*	8,557	96	94
BIA	Shy Albatross - Breeding	32	2	-
BIA	Shy Albatross – Foraging*	8,557	96	94
BIA	Southern Right Whale - Connecting Habitat	16	1	-
BIA	Southern Right Whale – Migration*	8,557	96	94
BIA	Wandering Albatross – Foraging*	8,557	96	94
BIA	Wedge-tailed Shearwater - Foraging	14	1	-
BIA	White Shark - Breeding	14	1	-
BIA	White Shark – Distribution*	8,557	96	94
BIA	White Shark - Foraging	118	15	1
BIA	White-faced Storm-petrel – Foraging*	8,557	96	94
EEZ	Australian Exclusive Economic Zone*	8,557	96	94

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low	High
IBRA	Flinders	72	12	-
	King Island	34	3	-
	Wilsons Promontory	37	1	-
IMCRA	Boags	48	5	-
	Central Bass Strait*	8,557	96	94
	Central Victoria	15	1	-
	Flinders	167	19	2
	Franklin	32	2	-
	Otway	48	4	-
	Twofold Shelf	48	12	-
KEF	Big Horseshoe Canyon	12	1	-
	Upwelling East of Eden	15	2	-
NP	Kent Group	37	10	-
RSB	Bell Reef	21	1	-
	Cutter Rock	14	2	-
	Endeavour Reef	25	7	-
	Wakitipu Rock	40	9	-
	Warrego Rock	41	5	-
	Wright Rock	28	11	-
Shoreline (LGA)	Albatross Island	32	3	-
	Black Pyramid	33	2	-
	Chalky Island	12	1	-
	Craggy Island	37	6	-
	Curtis Island	52	9	-
	Flinders Island	14	1	-
	Hogan Island Group	22	2	-
	Hunter Island	17	2	-
	Kent Island Group	34	7	-
	Moncoeur Islands	37	1	-
	Outer Sister Island	15	1	-

Receptor		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low	High
	Pasco Group	15	1	-
	Prime Seal Island	16	1	-
	Pyramid Island	72	12	-
	Reid Rock	34	1	-
	Rodondo Island	15	1	-
	Seal Islands	11	1	-
	Three Hummock Island	14	1	-
State Waters	Tasmania State Waters	54	12	-
	Victoria State Waters	39	1	-

*The release location resides within the receptor boundaries.

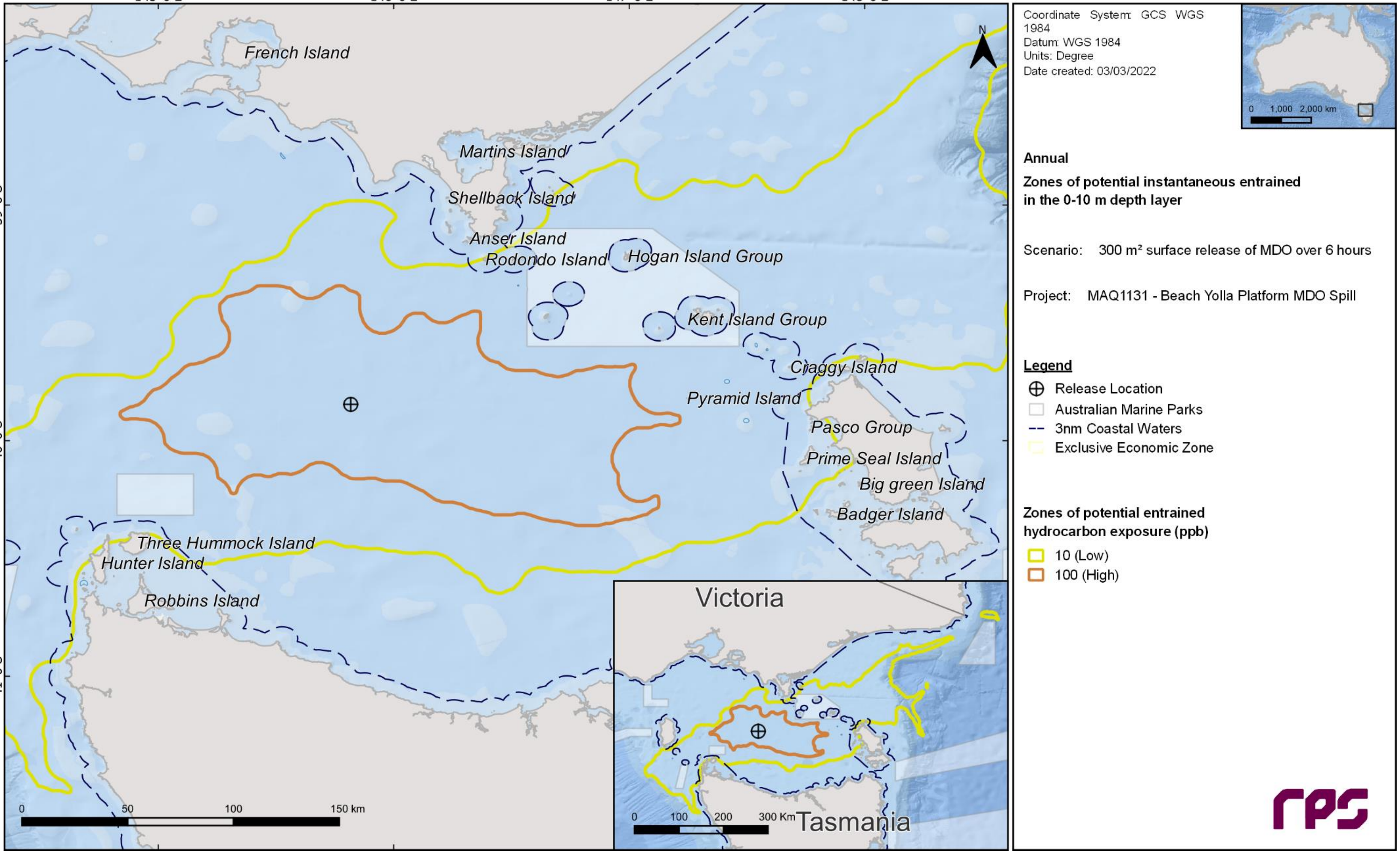


Figure 10-3 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 300 m³ of MDO containment loss over 6 hours tracked for 20 days. The results were calculated from 100 spill simulations and presented for annual conditions.

10.2 Deterministic Analysis

The stochastic modelling results were assessed, and the “worst case” deterministic runs were identified and presented below see Section 10.2.1 to Section 10.2.3.

Table 10-7 presents a summary of floating oil, shoreline accumulation, entrained hydrocarbon and dissolved hydrocarbon values at the assessed thresholds for the identified deterministic simulations.

Note, no shoreline contacts above the low shoreline contact threshold was predicted for the scenario, hence shoreline results are not presented in this section.

Table 10-7 Summary of the deterministic analysis. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

Variable	Threshold	Deterministic Analysis Criteria					
		Largest swept area of floating oil above 1 g/m²	Minimum time before shoreline accumulation above 10 g/m²	Largest volume of oil ashore	Longest length of shoreline accumulation above 10 g/m²	Largest area of entrained hydrocarbons above 10 ppb	Largest area of dissolved hydrocarbons above 10 ppb
Run Number		74	-	-	-	82	28
Total area of floating Oil exposure (km²)	1 g/m²	111.9	-	-	-	19.6	6.5
	10 g/m²	48.2	-	-	-	5.7	0.8
	50 g/m²	1.6	-	-	-	-	-
Total length of shoreline accumulation (km)	10 g/m²	-	-	-	-	-	-
	100 g/m²	-	-	-	-	-	-
	1,000 g/m²	-	-	-	-	-	-
Minimum time before accumulation on any shoreline (days)	10 g/m²	NC	-	-	-	NC	NC
	100 g/m²	NC	-	-	-	NC	NC
	1,000 g/m²	NC	-	-	-	NC	NC
Maximum volume of oil ashore (m³)		NC	-	-	-	NC	NC
Total area of entrained hydrocarbon exposure (km²)	10 ppb	2,777	-	-	-	7,871	4,834
	100 ppb	402	-	-	-	437	975
Total area of dissolved hydrocarbon exposure (km²)	10 ppb	-	-	-	-	2	168
	50 ppb	-	-	-	-	-	-
	400 ppb	-	-	-	-	-	-
Start Date		25th January 2011	-	-	-	24th April 2015	2nd May 2018

NC = No contact at, or above the specified shoreline accumulation threshold.

10.2.1 Deterministic Case: Largest swept area of floating oil above 1 g/m^2

The deterministic trajectory that resulted in the largest swept area of floating oil above 1 g/m^2 (low threshold and visible floating oil) was identified as run number 74, which started on 25th January 2011. Figure 10-4 is a map illustrating the floating oil exposure over the 20 days.

Figure 10-5 displays the time series of the swept area of low (1 g/m^2), moderate (10 g/m^2) and high (50 g/m^2) floating oil over the 20-day simulation.

Figure 10-6 presents the fates and weathering graph for the corresponding single spill trajectory and Table 10-8 summarises the mass balance at the peak and at end of the simulation.

Table 10-8 Summary of the mass balance for the trajectory that resulted in the largest swept area of floating oil above 1 g/m^2. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

Exposure Metrics	Peak Volume	Day of occurrence	Volume at day 20
Surface (m^3)	191.9	0.25	0.0
Entrained (m^3)	171.4	1.25	90.9
Dissolved (m^3)	0.3	2.33	0.1
Evaporation (m^3)	151.2	20.00	151.2
Decay (m^3)	61.0	20.00	61.0
Ashore (m^3)	0.0	0.0	0.0

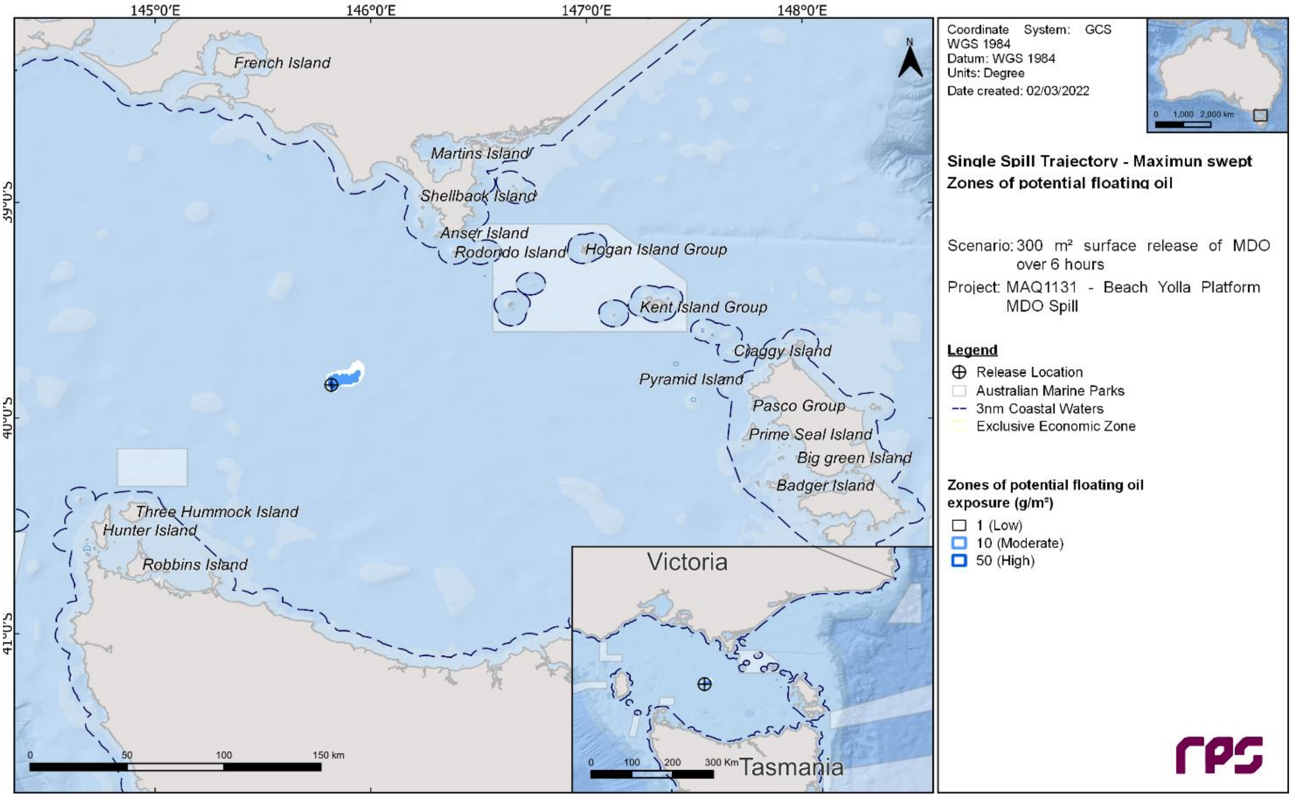


Figure 10-4 Zones of potential floating oil exposure over the 20-day simulation for the trajectory with the largest swept area of floating oil above 1 g/m^2. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

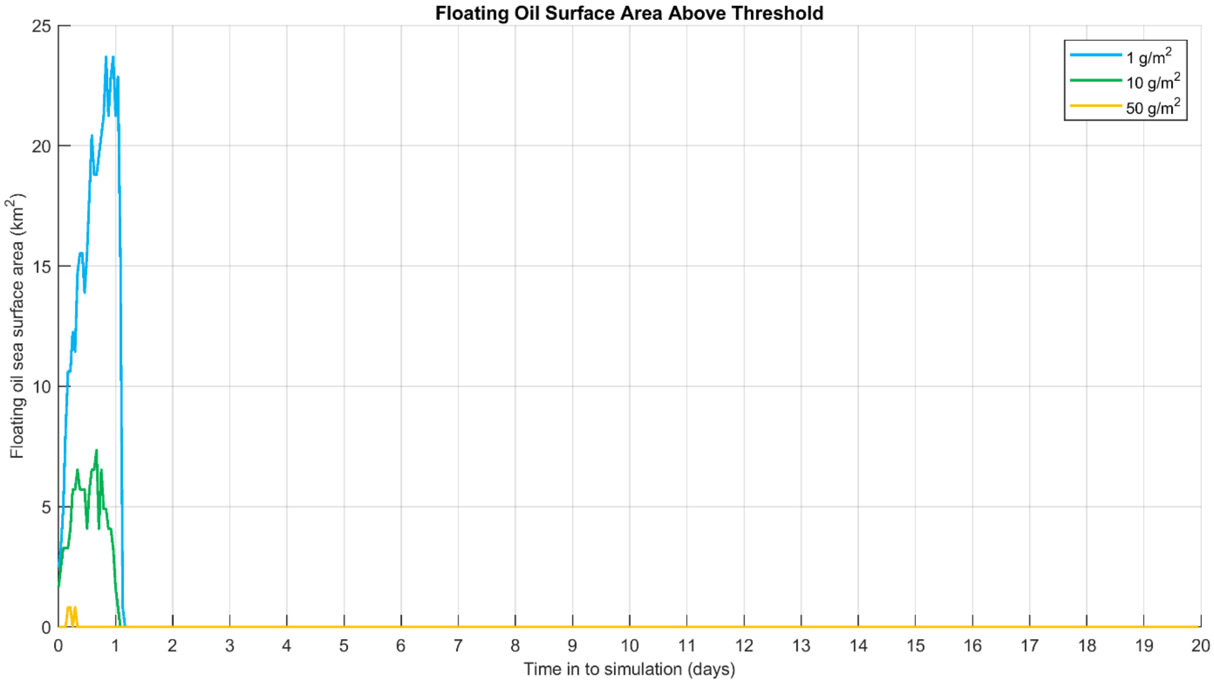


Figure 10-5 Time series of the area of floating oil for the trajectory with the largest swept area of floating oil above 1 g/m^2. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

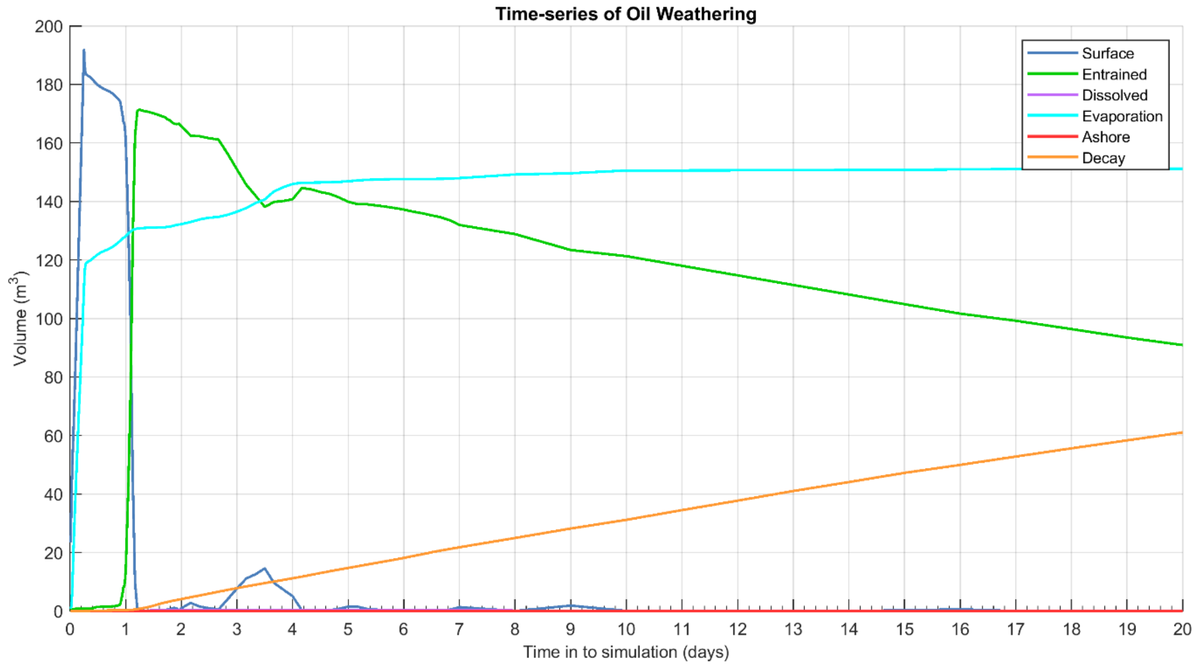


Figure 10-6 Predicted weathering and fates graph for the trajectory with the largest swept area of floating oil above 1 g/m^2. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

10.2.2 Deterministic Case: Largest area of entrained hydrocarbons above 10 ppb

The deterministic trajectory that resulted in the largest area of entrained hydrocarbons above 10 ppb (low threshold) was identified as run number 82, which started on the 24th April 2015. Figure 10-7 presents the zones of potential entrained hydrocarbon exposure.

Figure 10-8 displays the time series of the area of entrained hydrocarbons at the low (10 ppb) and moderate (100 ppb) thresholds over the 20-day simulation.

Figure 10-9 presents the fates and weathering graph for the corresponding single spill trajectory and Table 10-9 summarises the mass balance at the peak and at end of the simulation.

Table 10-9 Summary of the mass balance for the trajectory that resulted in the largest area of entrained hydrocarbons above 10 ppb. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

Exposure Metrics	Peak Volume	Day of occurrence	Volume at day 20
Surface (m^3)	113.8	0.25	0.0
Entrained (m^3)	187.6	0.50	94.7
Dissolved (m^3)	0.7	1.46	0.1
Evaporation (m^3)	129.8	20.00	129.8
Decay (m^3)	78.7	20.00	78.7
Ashore (m^3)	0.0	0.0	0.0

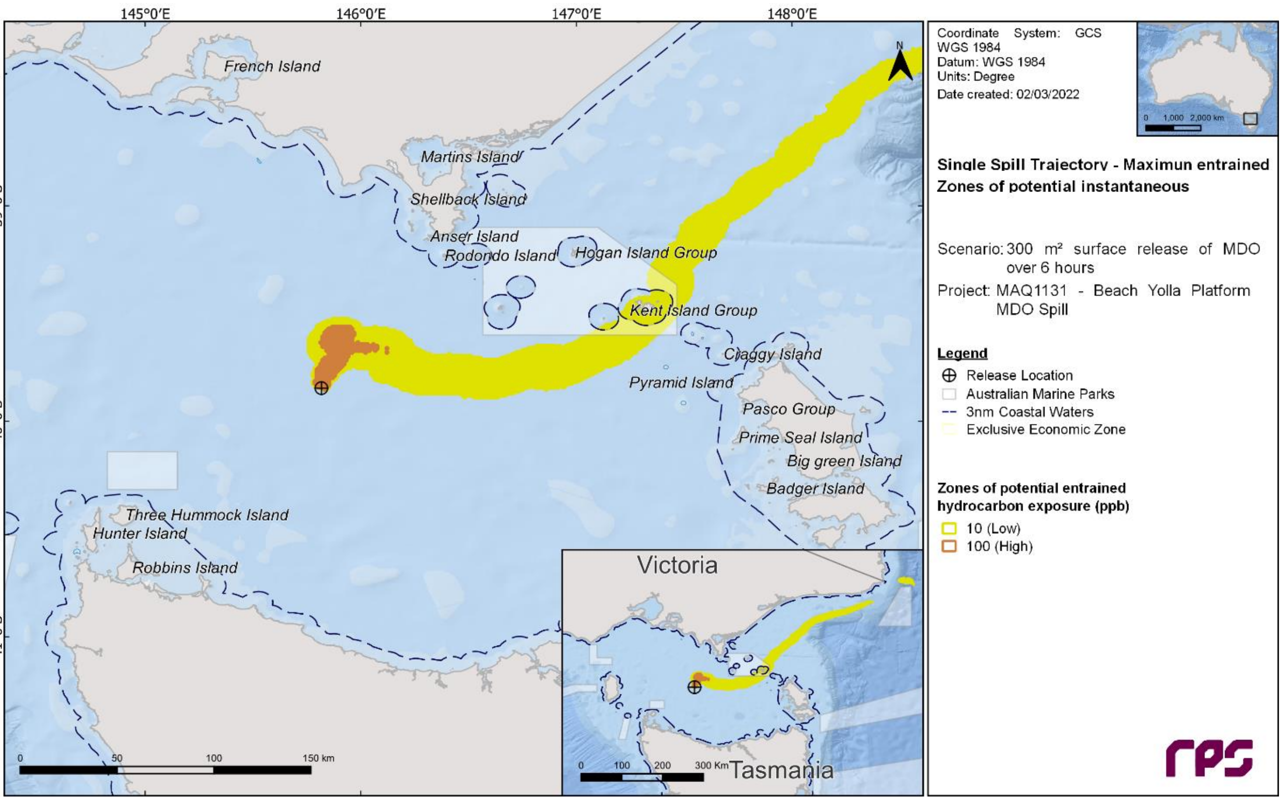


Figure 10-7 Zones of potential entrained hydrocarbon exposure, for the trajectory with the largest area of entrained hydrocarbons above 10 ppb. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

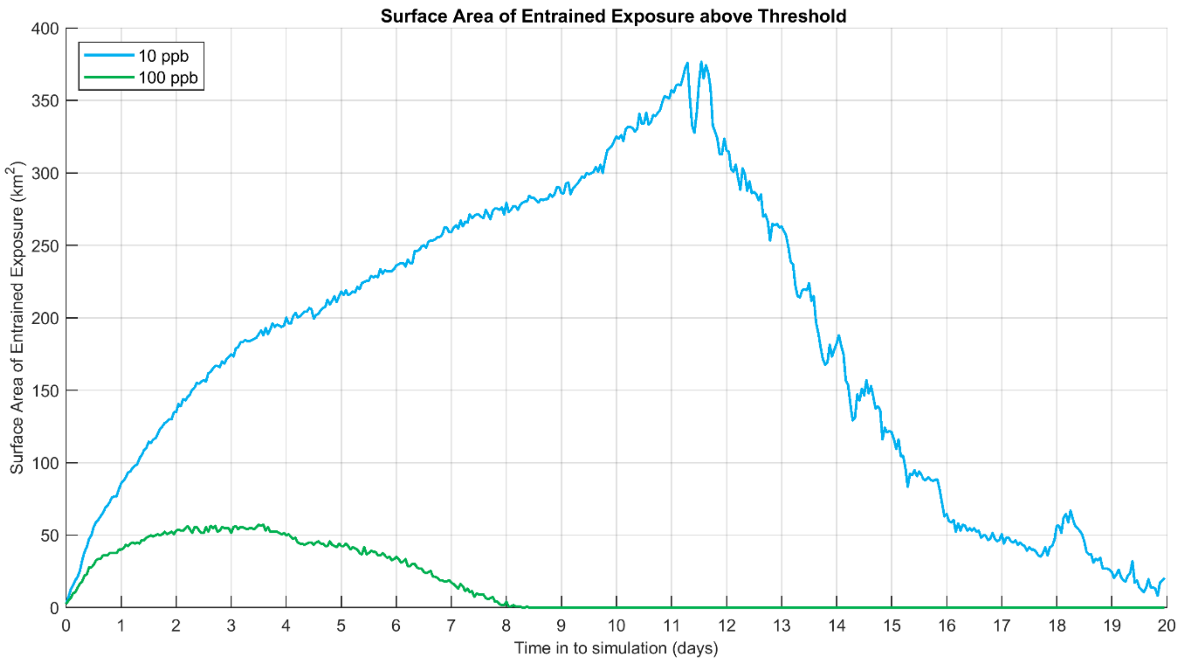


Figure 10-8 Time series of the predicted area of entrained hydrocarbon exposure for the trajectory with the largest area of entrained hydrocarbons above 10 ppb. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

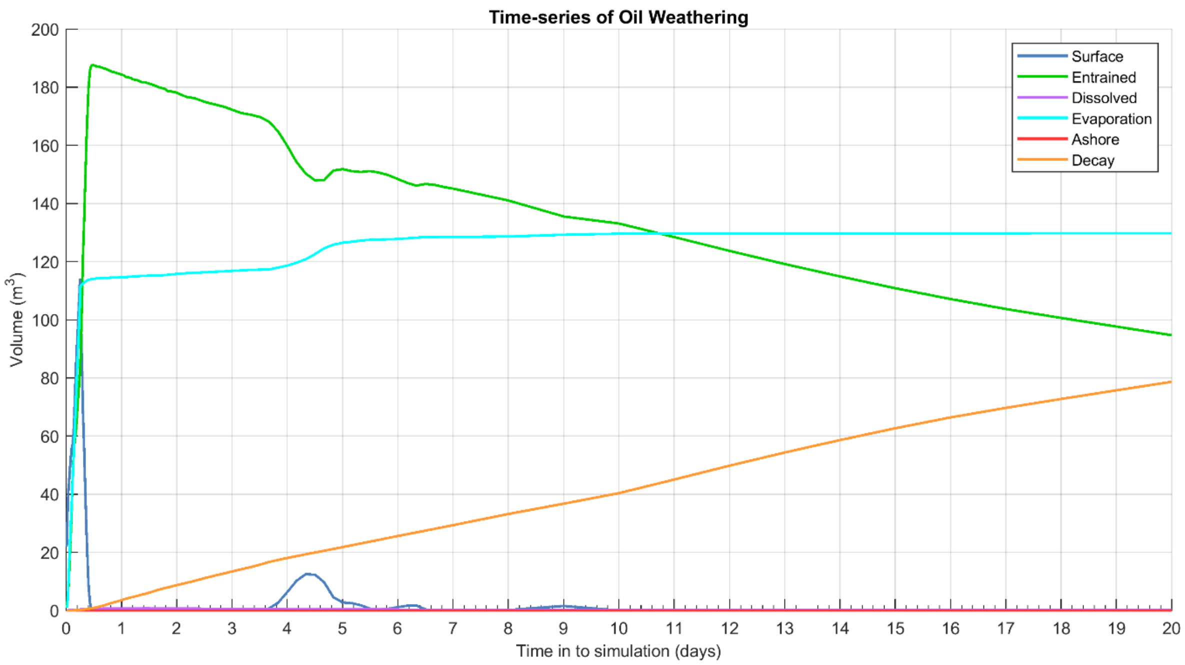


Figure 10-9 Predicted weathering and fates graph for the trajectory with the largest area of entrained hydrocarbon exposure above 10 ppb. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

10.2.3 Deterministic Case: Largest area of dissolved hydrocarbons above 10 ppb

The deterministic trajectory that resulted in the largest area of dissolved hydrocarbons above 10 ppb (low threshold) was identified as run number 28, which started on 2nd May 2018. Figure 10-10 map illustrates the zones of potential dissolved hydrocarbon exposure.

Figure 10-11 displays the time series of the area of dissolved hydrocarbons at the low (10 ppb), moderate (50 ppb) and high (400 g/m^2) thresholds over the 20-day simulation.

Figure 10-12 presents the fates and weathering graph for the corresponding single spill trajectory and Table 10-10 summarises the mass balance at the peak and at end of the simulation.

Table 10-10 Summary of the mass balance for the trajectory that resulted in the largest area of dissolved hydrocarbon exposure above 10 ppb. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

Exposure Metrics	Peak Volume	Day of occurrence	Volume at day 20
Surface (m^3)	36.1	0.07	0.0
Entrained (m^3)	220.0	0.29	87.8
Dissolved (m^3)	2.1	0.65	0.1
Evaporation (m^3)	131.3	20.00	131.3
Decay (m^3)	84.2	20.00	84.2
Ashore (m^3)	0.0	0.0	0.0

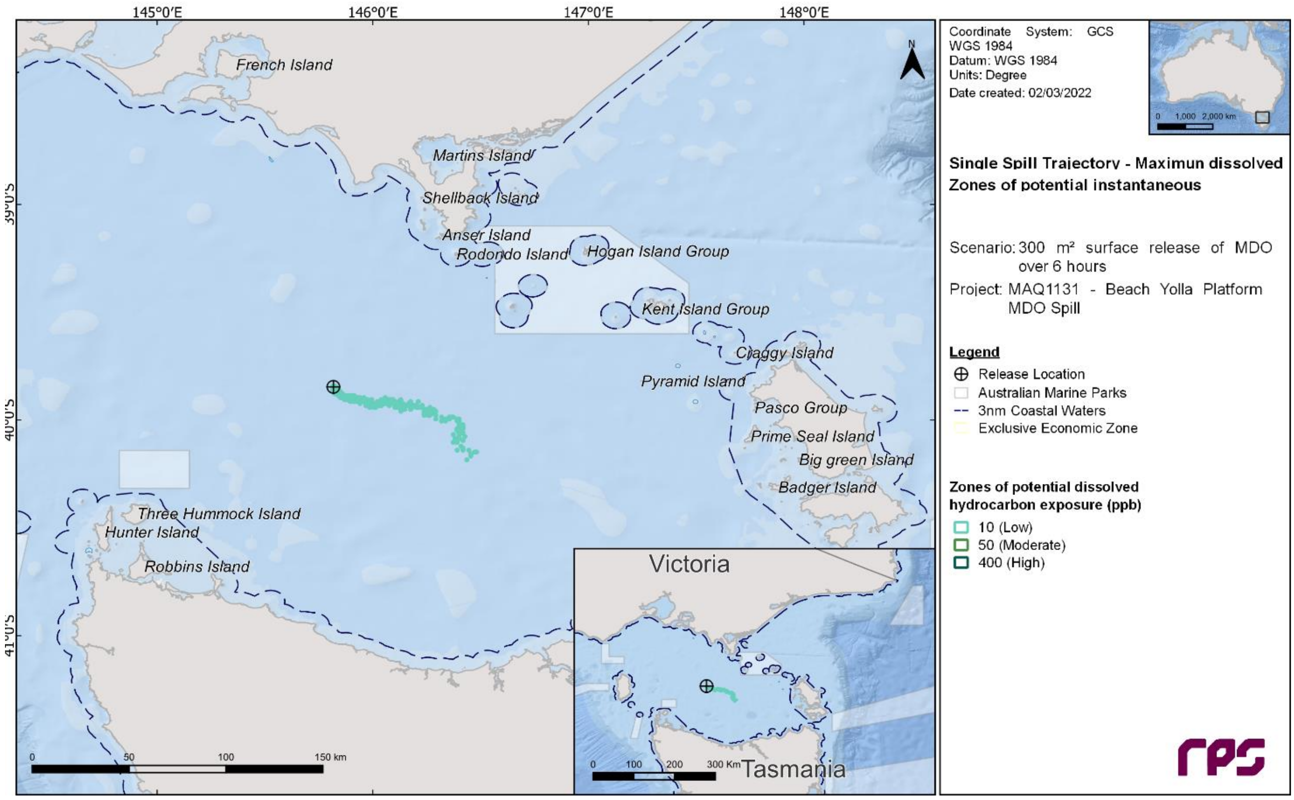


Figure 10-10 Zones of potential dissolved hydrocarbon exposure for the trajectory with the largest area of dissolved hydrocarbons above 10 ppb. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

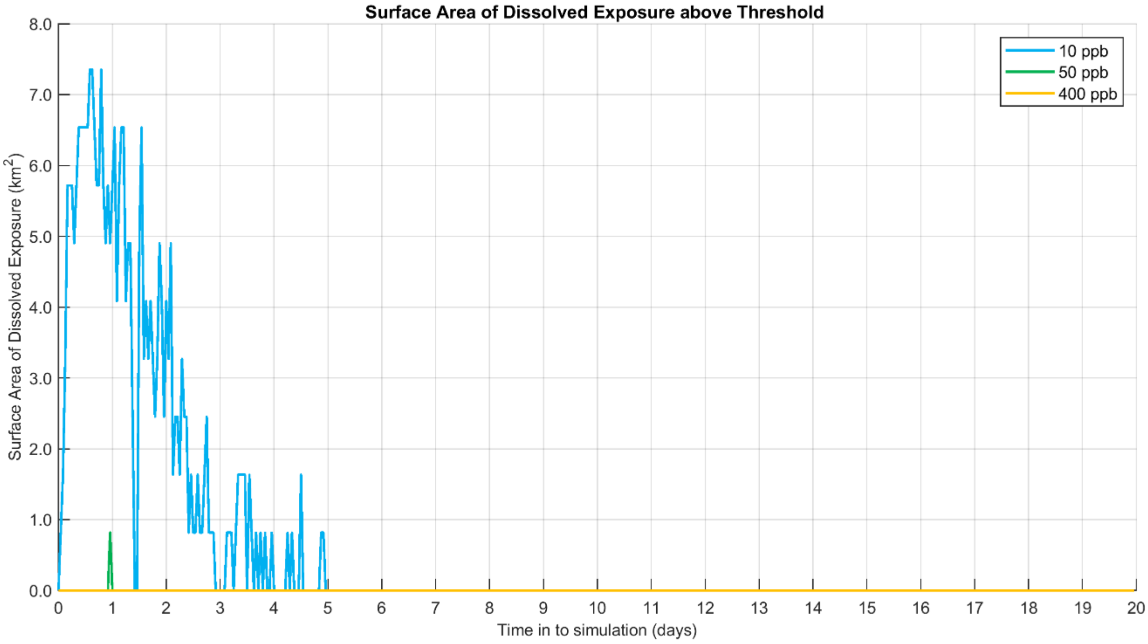


Figure 10-11 Time series of the area of dissolved hydrocarbon exposure for the trajectory with the largest area of dissolved hydrocarbons above 10 ppb. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

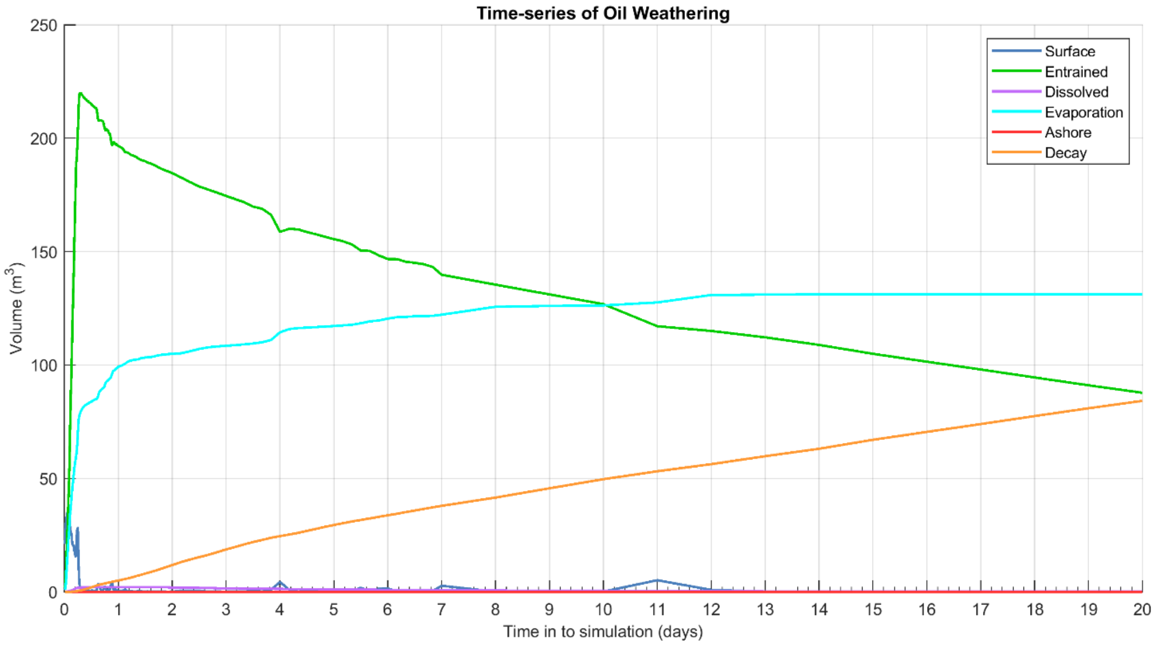


Figure 10-12 Predicted weathering and fates graph for the trajectory with the largest area of dissolved hydrocarbons above 10 ppb. Results are based on a 300 m³ surface release of MDO over 6 hours, tracked for 20 days.

11 REFERENCES

American Society for Testing and Materials (ASTM) 2013. F2067-13 Standard Practice for Development and Use of Oil-Spill Trajectory Models, ASTM International, West Conshohocken (PA).

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

Anderson JW, Neff JM, Cox BA, Tatem HE & Hightower GM 1974, 'Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish', *Marine Biology*, vol. 27, no. 1, pp. 75–88.

Anderson JW, Riley R, Kiesser S & Gurtisen J 1987, 'Toxicity of dispersed and undispersed Prudhoe Bay crude oil fractions to shrimp and fish', Proceedings of the 1987 International Oil Spill Conference, American Petroleum Institute, pp. 235–240.

Applied Science Associates 2011, 'OILMAP-DEEP: Blowout Plume Model Technical Manual', Applied Science Associates Inc., South Kingstown, USA.

Asia-Pacific ASA, 2010. Montara well release monitoring study S7.2. Oil fate and effects assessment: modelling of chemical dispersant operation. Prepared for PTTEP Australasia.

Australian Maritime Safety Authority (AMSA) 2014, 'Identification of oil on water: Aerial observations and identification guide', viewed 4 June 2020, https://www.amsa.gov.au/sites/default/files/2014-01-mp-amsa22-identification-oil-on-water.pdf

Australian Maritime Safety Authority (AMSA) 2015, 'Australian Maritime Safety Authority Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities Australian Maritime Safety Authority', viewed 20 June 2017, https://www.amsa.gov.au/forms-and-publications/Publications/AMSA413_Contingency_Planning_Guidelines.pdf

Australian and New Zealand Environment and Conservation Council (ANZECC) 2000, 'Australian and New Zealand guidelines for fresh and marine water quality Volume 1, The guidelines (National water quality management strategy; no.4)', Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

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

Blum DJ & Speece RE 1990, 'Determining chemical toxicity to aquatic species', *Environmental Science & Technology*, vol. 24, no. 3, pp. 284–293.

Bonn Agreement 2009, 'Bonn Agreement aerial operations handbook, 2009 - Publication of the Bonn Agreement', viewed 13 January 2015, http://www.bonnagreement.org/site/assets/files/3947/ba-aoh_revision_2_april_2012.pdf

Carls, M.G., Holland, L., Larsen, M., Collier, T.K., Scholz, N.L. and Incardona, J.P., 2008. Fish embryos are damaged by dissolved PAHs, not oil particles. *Aquatic toxicology*, 88(2), pp.121–127.

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

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

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

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

French, D, Reed, M, Jayko, K, Feng, S, Rines, H, Pavignano, S, Isaji, T, Puckett, S, Keller, A, French III, FW, Gifford, D, McCue, J, Brown, G, MacDonald, E, Quirk, J, Natzke, S, Bishop, R, Welsh, M, Phillips, M & Ingram, BS 1996, '*The CERCLA Type A natural resource damage assessment model for coastal and marine environments (NRDAM/CME), Technical Documentation, Volume I - Model Description, Final Report*,' Office of Environmental Policy and Compliance, U.S. Department of the Interior, Washington DC.

French, D, Schuttenberg, H & Isaji, T 1999, 'Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light', *Proceedings of the 22nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar,* Environment Canada, Alberta, pp. 243–270.

French-McCay, DP 2002, 'Development and application of an oil toxicity and exposure model, OilToxEx', *Environmental Toxicology and Chemistry*, vol. 21, no. 10, pp. 2080-2094.

French-McCay, DP 2003, 'Development and application of damage assessment modelling: example assessment for the North Cape oil spill', *Marine Pollution Bulletin*, *vol.* 47, no. 9, pp. 9–12.

French-McCay, DP 2004, 'Spill impact modelling: development and validation', *Environmental Toxicology and Chemistry, vol.* 23, no.10, pp. 2441–2456.

French-McCay, DP 2009, 'State-of-the-art and research needs for oil spill impact assessment modelling', *Proceedings of the 32nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar*, Environment Canada, Ottawa, pp. 601–653.

French-McCay, D, Rowe, JJ, Whittier, N, Sankaranarayanan, S, & Etkin, DS 2004, 'Estimate of potential impacts and natural resource damages of oil', *Journal of Hazardous Materials*, vol. 107, no. 1, pp. 11–25.

French-McCay, D, Whittier, N, Dalton, C, Rowe, J, Sankaranarayanan, S & Aurand, D 2005a, 'Modeling the fates of hypothetical oil spills in Delaware, Florida, Texas, California, and Alaska waters, varying response options including use of dispersants', Proceedings of the International Oil Spill Conference 2005, American Petroleum Institute, Washington DC, paper 399.

French-McCay, D, Whittier, N, Rowe, J, Sankaranarayanan, S, Kim, H-S & Aurand, D 2005b, 'Use of probabilistic trajectory and impact modeling to assess consequences of oil spills with various response strategies,' Proceedings of the 28th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, pp. 253–271.

French-McCay, D, Reich, D, Rowe, J, Schroeder, M & Graham, E 2011, 'Oil spill modeling input to the offshore environmental cost model (OECM) for US-BOEMRE's spill risk and costs evaluations', *Proceedings of the 34th Arctic and Marine Oil Spill Program (AMOP) Technical Siminar, Environment Canada,* Ottawa.

French-McCay, D, Reich, D, Michel, J, Etkin, DS, Symons, L, Helton, D, & Wagner J 2012, 'Oil spill consequence analysis of potentially-polluting shipwrecks', Proceedings of the 35th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa.

French-McCay, D, Jayko, K, Li, Z, Horn, M, Kim, Y, Isaji, T, Crowley, D, Spaulding, M, Decker, L, Turner, C, Zamorski, S, Fontenault, J, Schmmkler, R & Rowe, J 2015, 'Technical Reports for Deepwater Horizon Water Column Injury Assessment: WC_TR.14: Modeling Oil Fate and Exposure Concentrations in the Deepwater Plume and Rising Oil Resulting from the Deepwater Horizon Oil Spill' RPS ASA, South Kingston, Rhode Island.

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

Grant, DL, Clarke, PJ & Allaway, WG 1993, 'The response of grey mangrove (*Avicennia marina* (Forsk.) Vierh) seedlings to spills of crude oil,' *The Journal of Experimental Marine Biological Ecology*, *vol.* 171, no. 2, pp. 273–295.

International Tankers Owners Pollution Federation (ITOPF) 2014, 'Technical Information Paper 2 - Fate of Marine Oil Spills*',* International Tankers Owners Pollution Federation td, UK.

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

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

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

Koops, W, Jak, RG & van der Veen, DPC 2004, 'Use of dispersants in oil spill response to minimise environmental damage to birds and aquatic organisms', *Proceedings of the Interspill 2004: Conference and Exhibition on Oil Spill Technology,* Trondheim, presentation 429.

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

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

Lin, Q & Mendelssohn, IA 1996, ‘A comparative investigation of the effects of south Louisiana crude oil on the vegetation of fresh, brackish and Salt Marshes’, *Marine Pollution Bulletin*, vol. 32, no. 2, pp. 202–209.

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

Malins DC & Hodgins HO 1981, ‘Petroleum and marine fishes: a review of uptake, disposition, and effects’, *Environmental Science & Technology*, vol. 15, no. 11, pp.1272–1280.

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

McAuliffe CD 1987, ‘Organism exposure to volatile/soluble hydrocarbons from crude oil spills – a field and laboratory comparison’, Proceedings of the 1987 International Oil Spill Conference, *American Petroleum Institute*, pp. 275–288.

McCarty LS 1986, ‘The relationship between aquatic toxicity QSARs and bioconcentration for some organic chemicals’, *Environmental Toxicology and Chemistry*, vol. 5, no. 12, pp. 1071–1080.

McCarty LS, Dixon DG, MacKay D, Smith AD & Ozburn GW 1992a, ‘Residue-based interpretation of toxicity and bioconcentration QSARs from aquatic bioassays: Neutral narcotic organics’, *Environmental Toxicology and Chemistry: An International Journal*, vol. 11, no. 7, pp.917–930.

McCarty LP, Flannagan DC, Randall SA & Johnson KA 1992b, ‘Acute toxicity in rats of chlorinated hydrocarbons given via the intratracheal route’, *Human & Experimental Toxicology*, vol. 11, no. 3, pp.173–117.

McCarty LS & Mackay D 1993, ‘Enhancing ecotoxicological modelling and assessment. Body residues and modes of toxic action’, *Environmental Science & Technology*, vol. 27, no. 9, pp. 1718–1728.

McGrath JA, & Di Toro DM 2009, ‘Validation of the target lipid model for toxicity assessment of residual petroleum constituents: monocyclic and polycyclic aromatic hydrocarbons’, *Environmental Toxicology and Chemistry*, vol. 28, no. 6, pp. 1130–1148.

Middleton, JF & Bye AT 2007, ‘A review of shelf-slope circulation along Australia’s southern shelves: Cape Leeuwin to Portland’, *Progress in Oceanography* vol. 75, pp. 1–41.

National Centers for Environmental Information (NCEI) 2021, ‘World Ocean Atlas’ viewed 20 July 2021, https://www.ncei.noaa.gov/products/world-ocean-atlas

National Oceanic and Atmospheric Administration (NOAA) 2013, Screening level risk assessment package Gulf state, Office of National Marine Sanctuaries & Office of Response and Restoration, Washington DC.

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2018, 'At a glance: Oil spill modelling', viewed 15 November 2018, https://www.nopsema.gov.au/assets/Publications/A626200.pdf

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2019, 'Environment bulletin: Oil spill modelling', viewed 4 February 2020, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

National Research Council (NRC) 2003, 'Oil in the sea III: Inputs, fates and effects', National Research Council, The National Academic Press, Washington DC.

National Research Council (NRC) 2005, 'Oil Spill Dispersants Efficacy and Effects. Committee on Oil Spill Dispersants: Efficacy and Effects', National Research Council, The National Academies Press, Washington DC.

Neff JM & Anderson JW 1981, 'Response of marine animals to petroleum and specific petroleum hydrocarbons' United States Department of Energy, United States.

Nirmalakhandan N & Speece RE 1988, 'Quantitative techniques for predicting the behaviour of chemicals in the ecosystem', *Environmental Science & Technology*, vol. 22, no. 6, pp. 606–615.

Nordtug, T., Olsen, A.J., Altin, D., Overrein, I., Storøy, W., Hansen, B.H. and De Laender, F., 2011. Oil droplets do not affect assimilation and survival probability of first feeding larvae of North-East Arctic cod. *Science of the Total Environment*, 412, pp.148–153.

Oil Spill Solutions 2015, 'Evaluation - The Theory of Oil Slick Appearances', viewed 6 January 2015, http://www.oilspillsolutions.org/evaluation.htm

Owen, A 1980, 'A three-dimensional model of the Bristol Channel', *Journal of Physical Oceanography*, vol. 10, pp. 1290–1302.

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

Redman AD 2015, 'Role of entrained droplet oil on the bioavailability of petroleum substances in aqueous exposures', *Marine Pollution Bulletin*, vol. 97, no. (1–2), pp. 342–348.

Saha, S, Moorthi, S, Pan, H-L, Wu, X, Wang, J & Nadiga, S 2010, 'The NCEP Climate Forecast System Reanalysis', *Bulletin of the American Meteorological Society*, vol. 91, no. 8, pp. 1015–1057.

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

Scholten, MCTh, Kaag, NHBM, Dokkum, HP van, Jak, R.G., Schobben, HPM & Slob, W 1996, *Toxische effecten van olie in het aquatische milieu*, TNO report TNO-MEP – R96/230, Den Helder.

Spaulding, MS, Mendelsohn, D, Crowley, D, Li, Z, & Bird A 2015, 'Technical Reports for Deepwater Horizon Water Column Injury Assessment- WC_TR.13: Application of OILMAP DEEP to the Deepwater Horizon Blowout', RPS APASA, 55 Village Square Drive, South Kingstown, RE 02879.

Suprayogi, B & Murray, F 1999, ‘A field experiment of the physical and chemical effects of two oils on mangroves’, *Environmental and Experimental Botany*, vol. 42, no. 3, pp. 221–229.

Swartz RC, Schults DW, Ozretich RJ, Lamberson JO, Cole FA, Ferraro SP, Dewitt TH & Redmond MS 1995, ‘ΣPAH: A Model to predict the toxicity of polynuclear aromatic hydrocarbon mixtures in field-collected sediments’, *Environmental Toxicology and Chemistry*, vol. 14, no. 11, pp. 1977–1187.

Verhaar, HJ, Van Leeuwen, CJ & Hermens, JL 1992, ‘Classifying environmental pollutants’, *Chemosphere*, vol. 25, no. 4, pp. 471-491.

Verhaar, HJ, de Wolf, W, Dyer, S, Legierse, KC, Seinen, W & Hermens, JL 1999, ‘An LC_{50} vs time model for the aquatic toxicity of reactive and receptor-mediated compounds. Consequences for bioconcentration kinetics and risk assessment’, *Environmental science & technology*, vol. 33, no. 5, pp.758-763.

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

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

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

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

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

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

Appendix C PMST Operational Area

EPBC Act Protected Matters Report

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

Report created: 24-Feb-2022

Summary

Matters of National Environment Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	38
Listed Migratory Species:	36

Other Matters Protected by the EPBC Act

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

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 Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	45
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	5
Key Ecological Features (Marine):	None
Biologically Important Areas:	15
Bioregional Assessments:	None
Geological and Bioregional Assessments:	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 a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
EEZ and Territorial Sea

Listed Threatened Species [Resource Information]

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

Scientific Name	Threatened Category	Presence Text
BIRD		
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	Species or species habitat likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
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 likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
FISH		
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
Thunnus maccoyii Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
MAMMAL		

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat may 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
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		

Scientific Name	Threatened Category	Presence Text
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
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	Species or species habitat likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Migratory Marine Species		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat may 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
Eubalaena australis as Balaena glacialis australis		
Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus		
Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus		
Dusky Dolphin [43]		Species or species habitat 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 known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
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]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]		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 overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Species or species habitat likely to occur within area
Diomedea antipodensis gibsoni as Diomedea gibsoni Gibson's Albatross [82270]	Vulnerable	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat 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 likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
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
Stercorarius skua as Catharacta skua Great Skua [823]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		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
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Solegnathus spinosissimus		
Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Vanacampus phillipi		
Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri		
Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus		
Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptile		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat may 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]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata		
Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Yolla Gas Field (TRL1) Development	2001/321	Controlled Action	Post-Approval
Not controlled action (particular manner)			
Aroo Chappell 3D seismic survey	2010/5701	Not Controlled Action (Particular Manner)	Post-Approval
Bass Basin 2D and 3D seismic surveys (T/38P & T/37P)	2007/3650	Not Controlled Action (Particular Manner)	Post-Approval
Shearwater 2D and 3D marine seismic survey	2005/2180	Not Controlled Action (Particular Manner)	Post-Approval
Tap Oil Ltd Molson 2D Seismic Survey T47P	2008/3967	Not Controlled Action (Particular Manner)	Post-Approval

Biologically Important Areas		
Scientific Name	Behaviour	Presence
Seabirds		
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Distribution	Known to occur
Carcharodon carcharias White Shark [64470]	Distribution (low density)	Likely to occur
Carcharodon carcharias White Shark [64470]	Known distribution	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Eubalaena australis Southern Right Whale [40]	Known core range	Known to occur

Caveat

1 PURPOSE

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

The report contains the mapped locations of:

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

2 DISCLAIMER

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

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

3 DATA SOURCES

Threatened ecological communities

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

Threatened, migratory and marine species

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

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

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

4 LIMITATIONS

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

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

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

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

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

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

Acknowledgements

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

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

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

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

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

Appendix D PMST EMBA

EPBC Act Protected Matters Report

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

Report created: 25-Feb-2022

Summary

Matters of National Environment Significance

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

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	3
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	11
Listed Threatened Species:	136
Listed Migratory Species:	78

Other Matters Protected by the EPBC Act

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

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 Lands:	16
Commonwealth Heritage Places:	5
Listed Marine Species:	123
Whales and Other Cetaceans:	32
Critical Habitats:	1
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	5
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

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

State and Territory Reserves:	169
Regional Forest Agreements:	4
Nationally Important Wetlands:	18
EPBC Act Referrals:	131
Key Ecological Features (Marine):	3
Biologically Important Areas:	42
Bioregional Assessments:	1
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Indigenous		
Western Tasmania Aboriginal Cultural Landscape	TAS	Listed place

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

Ramsar Site Name	Proximity
Corner inlet	Within Ramsar site
Gippsland lakes	Within Ramsar site
Lavinia	Within Ramsar site

Commonwealth Marine Area [Resource Information]

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

Feature Name
EEZ and Territorial Sea
EEZ and Territorial Sea

Listed Threatened Ecological Communities [Resource Information]

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

Community Name	Threatened Category	Presence Text
Alpine Sphagnum Bogs and Associated Fens	Endangered	Community may occur within area
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
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
Lowland Grassy Woodland in the South East Corner Bioregion	Critically Endangered	Community may occur within area

Community Name	Threatened Category	Presence Text
Lowland Native Grasslands of Tasmania	Critically Endangered	Community likely to occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community may occur within area
River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	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 likely to occur within area
Tasmanian white gum (Eucalyptus viminalis) wet forest	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

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

Scientific Name	Threatened Category	Presence Text
BIRD		
Acanthiza pusilla magnirostris listed as Acanthiza pusilla archibaldi		
King Island Brown Thornbill, Brown Thornbill (King Island) [91709]	Endangered	Species or species habitat known to occur within area
Acanthornis magna greeniana		
King Island Scrubtit, Scrubtit (King Island) [82329]	Critically Endangered	Species or species habitat known to occur within area
Anthochaera phrygia		
Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Aquila audax fleayi		
Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) [64435]	Endangered	Breeding 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

Scientific Name	Threatened Category	Presence Text
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
Ceyx azureus diemenensis Tasmanian Azure Kingfisher [25977]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	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 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

Scientific Name	Threatened Category	Presence Text
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat 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	Breeding 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	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pardalotus quadragintus Forty-spotted Pardalote [418]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Platycercus caledonicus brownii Green Rosella (King Island) [67041]	Vulnerable	Species or species habitat known to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat 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 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

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Breeding known to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tyto novaehollandiae castanops (Tasmanian population) Masked Owl (Tasmanian) [67051]	Vulnerable	Breeding known to occur within area
CRUSTACEAN		

Scientific Name	Threatened Category	Presence Text
Astacopsis gouldi		
Giant Freshwater Crayfish, Tasmanian Giant Freshwater Lobster [64415]	Vulnerable	Species or species habitat known to occur within area
Engaeus martigener		
Furneaux Burrowing Crayfish [67220]	Endangered	Species or species habitat known to occur within area
FISH		
Epinephelus daemelii		
Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat may occur within area
Galaxiella pusilla		
Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Vulnerable	Species or species habitat known to occur within area
Hoplostethus atlanticus		
Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area
Nannoperca obscura		
Yarra Pygmy Perch [26177]	Vulnerable	Species or species habitat may occur within area
Prototroctes maraena		
Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Rexea solandri (eastern Australian population)		
Eastern Gemfish [76339]	Conservation Dependent	Species or species habitat likely to occur within area
Seriolella brama		
Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
FROG		
Heleioporus australiacus		
Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Litoria aurea		
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
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
Litoria watsoni		
Watson's Tree Frog [91509]	Endangered	Species or species habitat likely to occur within area
Mixophyes balbus		
Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat may occur within area
INSECT		
Oreisplanus munionga larana		
Marrawah Skipper, Alpine Sedge Skipper, Alpine Skipper [77747]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus minimus maritimus		
Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	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
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

Scientific Name	Threatened Category	Presence Text
Dasyurus maculatus maculatus (Tasmanian population)		
Spotted-tail Quoll, Spot-tailed Quoll, Tiger Quoll (Tasmanian population) [75183]	Vulnerable	Species or species habitat known to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isoodon obesulus obesulus		
Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus		
Broad-toothed Rat (mainland), Tooarrana [87617]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Perameles gunnii gunnii		
Eastern Barred Bandicoot (Tasmania) [66651]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat likely to occur within area
Potorous longipes		
Long-footed Potoroo [217]	Endangered	Species or species habitat likely to 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

Scientific Name	Threatened Category	Presence Text
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sarcophilus harrisii Tasmanian Devil [299]	Endangered	Species or species habitat likely to occur within area
PLANT		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area
Caladenia campbellii Thick-stem Caladenia, Thick-stem Fairy Fingers [64857]	Critically Endangered	Species or species habitat known to occur within area
Caladenia caudata Tailed Spider-orchid [17067]	Vulnerable	Species or species habitat likely to occur within area
Caladenia dienema Windswept Spider-orchid [64858]	Endangered	Species or species habitat known to occur within area
Caladenia orientalis Eastern Spider Orchid [83410]	Endangered	Species or species habitat known to occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat known to occur within area
Caladenia tonellii Robust Fingers [64861]	Critically Endangered	Species or species habitat known to occur within area
Centrolepis pedderensis Pedder Centrolepis, Pedder Bristlewort [12647]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Commersonia prostrata Dwarf Kerrawang [87152]	Endangered	Species or species habitat likely to occur within area
Correa lawrenceana var. genoensis Genoa River Correa [66626]	Endangered	Species or species habitat may occur within area
Corunastylis brachystachya Short-spiked Midge-orchid [76410]	Endangered	Species or species habitat known to occur within area
Craspedia preminghana Preminghana Billybutton [77046]	Endangered	Species or species habitat likely to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat may occur within area
Diuris lanceolata Snake Orchid [10231]	Endangered	Species or species habitat known to occur within area
Dodonaea procumbens Trailing Hop-bush [12149]	Vulnerable	Species or species habitat likely to occur within area
Euphrasia collina subsp. muelleri Purple Eyebright, Mueller's Eyebright [16151]	Endangered	Species or species habitat may occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Hypolepis distans Scrambling Ground-fern [2148]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat likely to occur within area
Leucochrysum albicans subsp. tricolor Hoary Sunray, Grassland Paper-daisy [89104]	Endangered	Species or species habitat known to occur within area
Persicaria elatior Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat may occur within area
Pomaderris parrisiae Parris' Pomaderris [22119]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum atratum Three Hummock Leek-orchid [82677]	Critically Endangered	Species or species habitat known to occur within area
Prasophyllum favonium Western Leek-orchid [64949]	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 known to occur within area
Prasophyllum pulchellum Pretty Leek-orchid [64953]	Critically Endangered	Species or species habitat known to occur within area
Prasophyllum secutum Northern Leek-orchid [64954]	Endangered	Species or species habitat likely to occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Prostanthera galbraithiae Wellington Mintbush [64959]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
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 rubenachii Arthur River Greenhood [64536]	Endangered	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 likely to occur within area
Senecio macrocarpus Large-fruit Fireweed, Large-fruit Groundsel [16333]	Vulnerable	Species or species habitat may occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area
Thelymitra jonesii Sky-blue Sun-orchid [76352]	Endangered	Species or species habitat known to occur within area
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat likely to occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		

Scientific Name	Threatened Category	Presence Text
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
SHARK		
Carcharias taurus (east coast population)		
Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat may occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Centrophorus harrissoni		
Harrisson's Dogfish, Endeavour Dogfish, Dumb Gulper Shark, Harrison's Deepsea Dogfish [68444]	Conservation Dependent	Species or species habitat likely to occur within area
Centrophorus zeehaani		
Southern Dogfish, Endeavour Dogfish, Little Gulper Shark [82679]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus		
School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat likely to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Zearaja maugeana Maugean Skate, Port Davey Skate [83504]	Endangered	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat likely to occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	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 carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Breeding known to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaenoptera 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 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 likely to occur within area
Caperea marginata		
Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus		
Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Physeter macrocephalus		
Sperm Whale [59]		Species or species habitat may occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus		
White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat 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
Symposiachrus trivirgatus as Monarcha trivirgatus		
Spectacled Monarch [83946]		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

Scientific Name	Threatened Category	Presence Text
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 may 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	Species or species habitat likely 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]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
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
Philomachus pugnax Ruff (Reeve) [850]		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 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

Scientific Name	Threatened Category	Presence Text
Xenus cinereus		
Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

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

Commonwealth Land Name	State
Unknown	
Commonwealth Land - [21498]	VIC
Commonwealth Land - [21489]	VIC
Commonwealth Land - [21490]	VIC
Commonwealth Land - [21491]	VIC
Commonwealth Land - [60346]	TAS
Commonwealth Land - [21487]	VIC
Commonwealth Land - [21488]	VIC
Commonwealth Land - [60135]	TAS
Commonwealth Land - [60115]	TAS
Commonwealth Land - [60116]	TAS
Commonwealth Land - [21496]	VIC
Commonwealth Land - [60143]	TAS
Commonwealth Land - [22391]	VIC
Commonwealth Land - [60066]	TAS
Commonwealth Land - [21497]	VIC
Commonwealth Land - [60142]	TAS

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Cape Sorell Lighthouse	TAS	Listed place
Gabo Island Lighthouse	VIC	Listed place
Goose Island Lighthouse	TAS	Listed place
Table Cape Lighthouse	TAS	Listed place
Wilsons Promontory Lighthouse	VIC	Listed place

Listed Marine Species

[Resource Information]

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

Scientific Name	Threatened Category	Presence Text
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 overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni as Diomedea gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Breeding known to occur within area overfly marine 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 overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route known to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]		Species or species habitat known to occur within area overfly marine 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 overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Pelecanoides urinatrix Common Diving-Petrel [1018]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area overfly marine area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area overfly marine area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Stercorarius skua as Catharacta skua		
Great Skua [823]		Species or species habitat may occur within area
Sterna striata		
White-fronted Tern [799]		Breeding known to occur within area
Sternula albifrons as Sterna albifrons		
Little Tern [82849]		Breeding known to occur within area
Sternula nereis as Sterna nereis		
Fairy Tern [82949]		Breeding known to occur within area
Symposiachrus trivirgatus as Monarcha trivirgatus		
Spectacled Monarch [83946]		Species or species habitat known to occur within area overfly marine area
Thalassarche bulleri		
Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov.		
Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Breeding known to occur within area
Thalassarche chrysostoma		
Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita		
Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
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
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Dotterel, Hooded Plover [87735]		Species or species habitat known to occur within area overfly marine area
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area overfly marine area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area overfly marine area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
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

Scientific Name	Threatened Category	Presence Text
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Arctocephalus pusillus		
Australian Fur-seal, Australo-African Fur-seal [21]		Breeding known to occur within area
Reptile		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata		
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 likely to occur within area
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour 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 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	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
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Kogia sima as Kogia simus Dwarf Sperm Whale [85043]		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	Foraging, feeding or related behaviour 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

Current Scientific Name	Status	Type of Presence
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
Tasmacetus shepherdi Shepherd's Beaked Whale, Tasman Beaked Whale [55]		Species or species habitat may 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

Critical Habitats [Resource Information]

Name	Type of Presence
Thalassarche cauta (Shy Albatross) - Albatross Island, The Mewstone, Pedra Branca	Listed Critical Habitat

Australian Marine Parks [Resource Information]

Park Name	Zone & IUCN Categories
Apollo	Multiple Use Zone (IUCN VI)
Beagle	Multiple Use Zone (IUCN VI)
Boags	Multiple Use Zone (IUCN VI)
East Gippsland	Multiple Use Zone (IUCN VI)
Franklin	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves		[Resource Information]
Protected Area Name	Reserve Type	State
Albatross Island	Nature Reserve	TAS
Anser Island	Reference Area	VIC
Arthur Bay	Conservation Area	TAS
Arthur-Pieman	Conservation Area	TAS
Baawang	Reference Area	VIC
Babel Island	Indigenous Protected Area	TAS
Badger Island	Indigenous Protected Area	TAS
Badger River	Regional Reserve	TAS
Bass Pyramid	Nature Reserve	TAS
Bemm, Goolengook, Arte and Errinundra Rivers	Heritage River	VIC
Benedore River	Reference Area	VIC
Big Green Island	Nature Reserve	TAS
Bird Island	Game Reserve	TAS
Black Pyramid Rock	Nature Reserve	TAS
Black River	Conservation Covenant	TAS
Black River	Conservation Area	TAS
Black River Bridge	Conservation Area	TAS
Blyth Point	Conservation Area	TAS
Boat Harbour Road	Conservation Covenant	TAS
Boxen Island	Conservation Area	TAS
Brashton Dairies	Conservation Covenant	TAS
Bull Rock	Conservation Area	TAS
Bun Beetons Point	Conservation Area	TAS
Calm Bay	State Reserve	TAS

Protected Area Name	Reserve Type	State
Cape Conran Coastal Park	Conservation Park	VIC
Cape Howe	Wilderness Zone	VIC
Cape Howe	Marine National Park	VIC
Cape Liptrap Coastal Park	Conservation Park	VIC
Cape Sorell	Historic Site	TAS
Chalky Island	Conservation Area	TAS
Chappell Islands	Nature Reserve	TAS
City of Melbourne Bay	Conservation Area	TAS
Cone Islet	Conservation Area	TAS
Corner Inlet Marine and Coastal Park	National Parks Act Schedule 4 park or reserve	VIC
Councillor Island	Nature Reserve	TAS
Counsel Hill	Conservation Area	TAS
Craggy Island	Conservation Area	TAS
Crayfish Creek	Regional Reserve	TAS
Croajingolong	National Park	VIC
Curtis Island	Nature Reserve	TAS
Darling Range	Conservation Area	TAS
Devils Tower	Nature Reserve	TAS
Dip Range	Regional Reserve	TAS
East Gippsland Coastal streams	Natural Catchment Area	VIC
East Kangaroo Island	Nature Reserve	TAS
East Moncoeur Island	Conservation Area	TAS
Edgcumbe Beach	Conservation Area	TAS
Egg Beach	Conservation Area	TAS
Eldorado	Conservation Area	TAS

Protected Area Name	Reserve Type	State
Emita	Nature Recreation Area	TAS
Foochow	Conservation Area	TAS
Forwards Beach	Conservation Area	TAS
Fotheringate Bay	Conservation Area	TAS
Four Mile Beach	Regional Reserve	TAS
Gippsland Lakes Coastal Park	Conservation Park	VIC
Goose Island	Conservation Area	TAS
Harbour Islets	Conservation Area	TAS
Henderson Islets	Conservation Area	TAS
Highfield	Historic Site	TAS
Hogan Group	Conservation Area	TAS
Honeysuckle Avenue	Conservation Covenant	TAS
Hunter Island	Conservation Area	TAS
Isabella Island	Nature Reserve	TAS
Jacksons Cove	Conservation Area	TAS
Kangaroo Island	Conservation Area	TAS
Kent Group	National Park	TAS
Killiecrankie	Nature Recreation Area	TAS
King Island	Conservation Covenant	TAS
Kings Run	Private Nature Reserve	TAS
Kings Run #2	Conservation Covenant	TAS
Lake Coleman W.R	Natural Features Reserve	VIC
Lavinia	State Reserve	TAS
Little Chalky Island	Conservation Area	TAS
Little Island	Conservation Area	TAS
Little Peggs Beach	State Reserve	TAS

Protected Area Name	Reserve Type	State
Little Trefoil	Conservation Area	TAS
Long Island	Conservation Area	TAS
Low Point	Conservation Area	TAS
Lyons Cottage	Historic Site	TAS
Marrawah #1	Conservation Covenant	TAS
Marriott Reef	Conservation Area	TAS
Marshall Beach	Conservation Area	TAS
Mile Island	Conservation Area	TAS
Millwood Road	Conservation Covenant	TAS
Morley Swamp G.L.R.	Natural Features Reserve	VIC
Mornington Peninsula	National Park	VIC
Mount Chappell Island	Indigenous Protected Area	TAS
Mount Dundas	Regional Reserve	TAS
Mount Heemskirk	Regional Reserve	TAS
Mount Tanner	Nature Recreation Area	TAS
Mount Vereker Creek	Natural Catchment Area	VIC
Murkay Islets	Conservation Area	TAS
Nadgee	Nature Reserve	NSW
Nares Rocks	Conservation Area	TAS
North East Islet	Nature Reserve	TAS
North East River	Game Reserve	TAS
Ocean Beach	Conservation Area	TAS
Palana Beach	Nature Recreation Area	TAS
Pasco Group	Conservation Area	TAS
Patriarchs	Private Sanctuary	TAS

Protected Area Name	Reserve Type	State
Patriarchs	Conservation Area	TAS
Pegarah	Private Nature Reserve	TAS
Pegarah Forest	Conservation Covenant	TAS
Peggs Beach	Conservation Area	TAS
Penguin Islet	Nature Reserve	TAS
Petrel Islands	Game Reserve	TAS
Pieman River	State Reserve	TAS
Point Hicks	Marine National Park	VIC
Preminghana	Indigenous Protected Area	TAS
Prime Seal Island	Conservation Area	TAS
Rame Head	Remote and Natural Area - Schedule 6, National Parks Act	VIC
Redbanks Sisters Creek	Conservation Covenant	TAS
Reedy Lagoon	Private Nature Reserve	TAS
Reef Island	Conservation Area	TAS
Reid Rocks	Nature Reserve	TAS
Rocky Cape	National Park	TAS
Rodondo Island	Nature Reserve	TAS
Roydon Island	Conservation Area	TAS
Salt Lake - Backwater Morass G.L.R.	Natural Features Reserve	VIC
Sandpatch	Wilderness Zone	VIC
Sandridge	Conservation Covenant	TAS
Seacrow Islet	Conservation Area	TAS
Sea Elephant	Conservation Area	TAS
Sea Elephant River	Conservation Covenant	TAS
Seal Creek	Reference Area	VIC

Protected Area Name	Reserve Type	State
Seal Islands W.R.	Nature Conservation Reserve	VIC
Sellars Lagoon	Game Reserve	TAS
Sentinel Island	Conservation Area	TAS
Settlement Point	Conservation Area	TAS
Shell Islets	Conservation Area	TAS
Sister Islands	Conservation Area	TAS
Sisters Beach	Conservation Covenant	TAS
Sisters Island	Conservation Area	TAS
Slaves Bay	Conservation Area	TAS
Southern Wilsons Promontory	Remote and Natural Area - Schedule 6, National Parks Act	VIC
South Pats River	Conservation Area	TAS
Southwest	Conservation Area	TAS
Stack Island	Game Reserve	TAS
Stanley	Conservation Area	TAS
Strahan Customs House	Historic Site	TAS
Strzelecki	National Park	TAS
Sugarloaf Rock	Conservation Area	TAS
Table Cape	Conservation Area	TAS
Table Cape	State Reserve	TAS
Tatlows Beach	Conservation Area	TAS
Teepookana	Regional Reserve	TAS
The Dock	Conservation Covenant	TAS
The Doughboys	Nature Reserve	TAS
The Nut	State Reserve	TAS
Three Hummock Island	State Reserve	TAS

Protected Area Name	Reserve Type	State
Tikkawoppa Plateau	Regional Reserve	TAS
Trial Harbour	State Reserve	TAS
Trousers Point Beach	Conservation Area	TAS
Tully River	Conservation Area	TAS
Unnamed (Duck Bay)	Conservation Area	TAS
Vereker Creek	Reference Area	VIC
West Inlet	Conservation Area	TAS
West Moncoeur Island	Nature Reserve	TAS
West Point	State Reserve	TAS
Wilsons Promontory	National Park	VIC
Wilsons Promontory	Wilderness Zone	VIC
Wilsons Promontory	Marine National Park	VIC
Wilsons Promontory Islands	Remote and Natural Area - Schedule 6, National Parks Act	VIC
Wilsons Promontory Marine Park	National Parks Act Schedule 4 park or reserve	VIC
Wilsons Promontory Marine Reserve	National Parks Act Schedule 4 park or reserve	VIC
Wingaroo	Nature Reserve	TAS
Wright Rock	Nature Reserve	TAS
Wybalenna Island	Conservation Area	TAS
Yambacoona	Conservation Covenant	TAS

Regional Forest Agreements

[Resource Information]

Note that all areas with completed RFAs have been included.

RFA Name	State
East Gippsland RFA	Victoria
Eden RFA	New South Wales
Gippsland RFA	Victoria

RFA Name	State
Tasmania RFA	Tasmania

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Benedore River	VIC
Corner Inlet	VIC
Fergusons Lagoon	TAS
Lake Ashwood	TAS
Lake Bantick	TAS
Lake Garcia	TAS
Lake Victoria Wetlands	VIC
Lake Wellington Wetlands	VIC
Lavinia Nature Reserve	TAS
Mallacoota Inlet Wetlands	VIC
Nadgee Lake and tributary wetlands	NSW
Rocky Cape Marine Area	TAS
Sellars Lagoon	TAS
Stans Lagoon	TAS
Sydenham Inlet Wetlands	VIC
Tamboon Inlet Wetlands	VIC
Thurra River	VIC
Unnamed Wetland	TAS

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Dairy Farm expansion on the Woolnorth property	2013/6710	Controlled Action	Completed
DPIPWE - Arthur-Pieman Conservation Area - off-road vehicle mitigation actions	2017/8038	Controlled Action	Completed
Golden Beach Gas Project	2019/8513	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Heemskirk Windfarm Development	2002/678	Controlled Action	Completed
Marinus Link underground and subsea electricity interconnector cable	2021/9053	Controlled Action	Assessment Approach
Robbins Island Renewable Energy Park, Robbins Island, Tasmania	2017/8096	Controlled Action	Assessment Approach
Star of the South Offshore Wind Farm Project	2020/8650	Controlled Action	Guidelines Issued
Tasmania Natural Gas Project - Stage 2	2001/211	Controlled Action	Post-Approval
Western Plains wind farm	2010/5712	Controlled Action	Assessment Approach
White Rock Wind Farm	2003/986	Controlled Action	Completed
Wind Farm Construction	2000/12	Controlled Action	Post-Approval
Yolla Gas Field (TRL1) Development	2001/321	Controlled Action	Post-Approval
Not controlled action			
2004/2005 drilling program for exploration and production (VIC 01-06, 09-11, 16, 18 & 19 and VIC/RL 01 & 04	2003/1282	Not Controlled Action	Completed
2D seismic survey, Petroleum Exploration Permit Area T/36P	2004/1787	Not Controlled Action	Completed
2D seismic Survey in VIC/P55, VIC/RL2 and VIC/P41	2004/1876	Not Controlled Action	Completed
55m lattice tower & infrastructure	2003/1159	Not Controlled Action	Completed
Acquistion of 2D seismic data in State Waters adjacent to Ninety Mile Beach-VIC/P39(V)	2004/1889	Not Controlled Action	Completed
Angas and Galloway Exploration Wells VIC/P39(v)	2005/2330	Not Controlled Action	Completed
Basker-Manta-Gummy Oil Development	2011/6052	Not Controlled Action	Completed
Basker-Manta Oil Field Development	2005/2026	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Bass Basin - Pee Jay-1 - Drilling Program	2007/3908	Not Controlled Action	Completed
Bass Hwy upgrade - Sisters Hills midway between Wynyard and Smithton	2006/3007	Not Controlled Action	Completed
Beardie-1 Field wildcat oil well	2001/505	Not Controlled Action	Completed
Biodiversity Impacts Audit	2011/6191	Not Controlled Action	Completed
Capture of Juvenile Tasmanian Devils for Conservation Purposes	2007/3261	Not Controlled Action	Completed
Capture of Tasmanian Devils from Disease-Free Areas	2007/3883	Not Controlled Action	Completed
Communications tower extension	2003/1099	Not Controlled Action	Completed
Construction of an ocean access boat ramp at Bastion Point	2004/1407	Not Controlled Action	Completed
Development of Kipper gas field within Vic/L3, Vic/L4 Vic/RL2	2005/2484	Not Controlled Action	Completed
Development of Turrum Oil Field and associated infrastructure	2003/1204	Not Controlled Action	Completed
Drilling and side track completion at Baleen gas production well in Production Licence area VIC/L21	2004/1535	Not Controlled Action	Completed
Drilling of 'Culverin' oil exploration well, permit VIC/P56	2005/2279	Not Controlled Action	Completed
Drilling of Scallop-1 Exploration Well	2003/917	Not Controlled Action	Completed
Duck Irrigation System, north-west coast Tasmania	2016/7778	Not Controlled Action	Completed
East Pilchard exploration well	2001/137	Not Controlled Action	Completed
Exploration Drilling Well Trefoil-1	2003/1058	Not Controlled Action	Completed
Gippsland Basin Seismic Programme	2004/1866	Not Controlled Action	Completed
Hayes Hill Ridge Wind Farm	2007/3437	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Hemingway1/Oil Exploration	2001/177	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Installation of a 3.5kW Wind Turbine	2012/6604	Not Controlled Action	Completed
Installation of optic fibre cable from Inverloch, Victoria to Stanley, Tasmania	2002/906	Not Controlled Action	Completed
Longtom-3 Gas Appraisal Well, VIC/P54	2005/2494	Not Controlled Action	Completed
Longtom Gas Pipeline Development, VIC/P54	2006/3072	Not Controlled Action	Completed
Marlin-Snapper Gas Pipeline Project	2006/3197	Not Controlled Action	Completed
Melville 1 Oil Exploration Well	2001/167	Not Controlled Action	Completed
Millwood Road Gravel Quarry	2002/602	Not Controlled Action	Completed
Northright-1 Exploration Well	2001/209	Not Controlled Action	Completed
Offshore Petroleum Exploration	2001/289	Not Controlled Action	Completed
Offshore Seismic Survey	2001/498	Not Controlled Action	Completed
Port Latta Wind Farm, Tas	2018/8249	Not Controlled Action	Completed
Port Phillip Channel Deepening Project - Trial Dredge Program	2005/2164	Not Controlled Action	Completed
Sole-2 appraisal gas well, VIC/RL3	2002/636	Not Controlled Action	Completed
Sole gas field development	2003/937	Not Controlled Action	Completed
Spikey Beach 1, West Triton Drilling Program, Bass Basin Permit T/38P	2007/3914	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Telstra optic fibre cable across Bass Strait - Sub bottom profiler Surve	2002/779	Not Controlled Action	Completed
Turrum Phase 2 Development Project	2008/4191	Not Controlled Action	Completed
Venus Bay Outfall Extension	2004/1555	Not Controlled Action	Completed
West Triton Drilling Program - Gippsland Basin	2007/3915	Not Controlled Action	Completed
Not controlled action (particular manner)			
2D & 3D seismic survey T/39P	2005/2237	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey in Permit Areas T/32P and T/33P	2002/845	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Aquisition Survey	2008/4041	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2008/4066	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2008/3962	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2008/4131	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey in the Sole gas field and adjacent acreage in the Gippsland Basin (VIC RL/3 & VIC/P41)	2002/871	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
2D seismic survey Permit Area VIC/P49	2006/2943	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey Program in Bass Strait	2008/4040	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey within Torquay Sub-basin off sthn Victoria	2012/6256	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey	2008/4528	Not Controlled Action (Particular Manner)	Post-Approval
Apache 3D seismic exploration survey	2006/3146	Not Controlled Action (Particular Manner)	Post-Approval
Aroo Chappell 3D seismic survey	2010/5701	Not Controlled Action (Particular Manner)	Post-Approval
Bass Basin 2D and 3D seismic surveys (T/38P & T/37P)	2007/3650	Not Controlled Action (Particular Manner)	Post-Approval
Bream 3D seismic survey	2006/2556	Not Controlled Action (Particular Manner)	Post-Approval
Collection of cast bull kelp	2002/813	Not Controlled Action (Particular Manner)	Post-Approval
Controlled Burn, Understorey Clearance and Removal of UXO	2003/1030	Not Controlled Action (Particular Manner)	Post-Approval
Dalrymple 3D Seismic Survey	2010/5680	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Exploration drilling of the Craigow-1 and Tolpuddle-1 wells	2010/5725	Not Controlled Action (Particular Manner)	Post-Approval
Gas Pipeline	2000/20	Not Controlled Action (Particular Manner)	Post-Approval
Gippsland 2D Marine Seismic Survey - VIC/P-63, VIC/P-64 and T/46P	2009/5241	Not Controlled Action (Particular Manner)	Post-Approval
Golden Beach gas field development	2003/1031	Not Controlled Action (Particular Manner)	Post-Approval
Granville Wind Farm, TAS	2012/6585	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
Inspection of project vessels for presence of invasive marine pests in Commonwealth waters off Victoria coast	2012/6362	Not Controlled Action (Particular Manner)	Post-Approval
Labatt 3D Seismic Survey T/47P Bass Strait	2007/3759	Not Controlled Action (Particular Manner)	Post-Approval
Longtom-5 Offshore Production Drilling (Vic/L29), VIC	2012/6498	Not Controlled Action (Particular Manner)	Post-Approval
Longtom South -1 Exploration Drilling	2011/6217	Not Controlled Action (Particular Manner)	Post-Approval
Luxury Cruise on the Gordon River, Tasmanian Wilderness PT 2	2006/3044	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Luxury Cruise on the Gordon River, Tasmanian Wilderness WHA	2004/1846	Not Controlled Action (Particular Manner)	Post-Approval
Maintenance dredging of 150,000 cubic metres of sediment in Burnie Port and du	2004/1569	Not Controlled Action (Particular Manner)	Post-Approval
Marine Farming Expansion, Macquarie Harbour, TAS	2012/6406	Not Controlled Action (Particular Manner)	Post-Approval
Non-exclusive 3-D Marine Seismic Survey, Bass Strait	2002/775	Not Controlled Action (Particular Manner)	Post-Approval
Northern Fields 3D Seismic Survey	2001/140	Not Controlled Action (Particular Manner)	Post-Approval
Origin Energy Silvereye-1 Exploration Drilling Programme	2010/5702	Not Controlled Action (Particular Manner)	Post-Approval
OTE10 2D Marine Seismic Survey	2009/5223	Not Controlled Action (Particular Manner)	Post-Approval
Pelican 3D Marine Seismic Survey, Gippsland Basin, Vic	2017/8097	Not Controlled Action (Particular Manner)	Post-Approval
Removal of Tasmanian blue gums	2004/1356	Not Controlled Action (Particular Manner)	Post-Approval
Remove silt build up on existing swales around the perimeter of the Three Hummo	2010/5676	Not Controlled Action (Particular Manner)	Post-Approval
Rockhopper-1 and Trefoil-2 Exploration Drilling in Permit Area T/18P	2009/4776	Not Controlled Action (Particular Manner)	Post-Approval
Seismic Exploration in Permit VIC/P41	2001/267	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Seismic Survey	2001/206	Not Controlled Action (Particular Manner)	Post-Approval
Seismic survey, Gippsland Basin	2001/525	Not Controlled Action (Particular Manner)	Post-Approval
Shearwater 2D and 3D marine seismic survey	2005/2180	Not Controlled Action (Particular Manner)	Post-Approval
Silvereye 3D Seismic Survey	2007/3551	Not Controlled Action (Particular Manner)	Post-Approval
Soil and Organic Recycling Facility	2005/2216	Not Controlled Action (Particular Manner)	Post-Approval
Southern Flanks 2D Marine Seismic Survey	2010/5288	Not Controlled Action (Particular Manner)	Post-Approval
Southern Margins 3D Seismic Survey VIC/P55	2007/3780	Not Controlled Action (Particular Manner)	Post-Approval
Surface Geochemical Exploration Program, TAS	2010/5780	Not Controlled Action (Particular Manner)	Post-Approval
Tap Oil Ltd Molson 2D Seismic Survey T47P	2008/3967	Not Controlled Action (Particular Manner)	Post-Approval
Torquay Sub-basin (VIC/P62) OTE12-3D Seismic Survey	2012/6655	Not Controlled Action (Particular Manner)	Post-Approval
Tuskfish 3D Seismic Survey, Bass Strait	2002/864	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Upgrade of Arthur River Road	2003/930	Not Controlled Action (Particular Manner)	Post-Approval
West Seahorse Oil Development Project, Commonwealth waters offshore Victoria	2013/6973	Not Controlled Action (Particular Manner)	Post-Approval
Wilson's Creek Bridge Replacement, Bass Highway	2007/3892	Not Controlled Action (Particular Manner)	Post-Approval
Wolseley 3D seismic acquisition survey	2010/5703	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
3D Marine Seismic Survey	2011/6156	Referral Decision	Completed
All actions taken in response to the current severe bushfires in Victoria.	2009/4787	Referral Decision	Completed
Beardie-1 Field wildcat oil well	2001/469	Referral Decision	Completed
Darymple 3D Seismic Survey, Petroleum Exploration Permit T/41P	2010/5322	Referral Decision	Completed
Holloman 2010 Vic/P60 3D Seismic Acquisition Survey Program	2009/5251	Referral Decision	Completed
Kelly Channel Discharge, Macquarie Harbour, Tasmania	2017/8057	Referral Decision	Completed
Longtom 5 Offshore Production Drilling (VIC/L29)	2012/6404	Referral Decision	Completed
Longtom-5 Offshore Production Drilling (Vic/L29)	2012/6413	Referral Decision	Completed
Mineral Exploration Ringarooma Bay	2012/6508	Referral Decision	Completed
Shark 3D Seismic Survey	2007/3294	Referral Decision	Completed
Stanton 3D Marine Seismic Survey	2013/6764	Referral Decision	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Referral decision			
Wolseley 3D Seismic Acquisition Survey in Permit T/32P	2010/5291	Referral Decision	Completed

Key Ecological Features

[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
Big Horseshoe Canyon	South-east
Upwelling East of Eden	South-east
West Tasmania Canyons	South-east

Biologically Important Areas

Scientific Name	Behaviour	Presence
Dolphins		
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Breeding	Likely to occur
Seabirds		
Ardenna grisea Sooty Shearwater [82651]	Foraging	Likely to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging	Likely to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Eudyptula minor Little Penguin [1085]	Breeding	Known to occur

Scientific Name	Behaviour	Presence
Eudyptula minor Little Penguin [1085]	Foraging	Known to occur
Morus serrator Australasian Gannet [1020]	Aggregation	Known to occur
Morus serrator Australasian Gannet [1020]	Foraging	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Breeding	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Breeding	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Phalacrocorax fuscescens Black-faced Cormorant [59660]	Breeding	Known to occur
Phalacrocorax fuscescens Black-faced Cormorant [59660]	Foraging	Known to occur
Phalacrocorax fuscescens Black-faced Cormorant [59660]	Foraging	Likely to occur
Pterodroma mollis Soft-plumaged Petrel [1036]	Foraging	Known to occur
Sterna striata White-fronted Tern [799]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Breeding	Known to occur

Scientific Name	Behaviour	Presence
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Sharks		
Carcharias taurus Grey Nurse Shark [64469]	Migration	Known to occur
Carcharodon carcharias White Shark [64470]	Breeding (nursery area)	Known to occur
Carcharodon carcharias White Shark [64470]	Distribution	Known to occur
Carcharodon carcharias White Shark [64470]	Distribution	Likely to occur
Carcharodon carcharias White Shark [64470]	Distribution (low density)	Likely to occur
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur
Carcharodon carcharias White Shark [64470]	Known distribution	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Scientific Name	Behaviour	Presence
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Known Foraging Area	Known to occur
Eubalaena australis Southern Right Whale [40]	Connecting habitat	Known to occur
Eubalaena australis Southern Right Whale [40]	Known core range	Known to occur
Eubalaena australis Southern Right Whale [40]	Migration and resting on migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Foraging	Known to occur

Bioregional Assessments

SubRegion	BioRegion	Website
Gippsland	Gippsland Basin	BA website

Caveat

1 PURPOSE

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

The report contains the mapped locations of:

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

2 DISCLAIMER

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

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

3 DATA SOURCES

Threatened ecological communities

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

Threatened, migratory and marine species

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

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

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

4 LIMITATIONS

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

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

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

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

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

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

Acknowledgements

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

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

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

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

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

Appendix E Beach Energy Yolla Drilling Campaign - Acoustic Modelling for Assessing Marine Fauna Sound Exposures

Beach Energy Yolla Drilling Campaign

Acoustic Modelling for Assessing Marine Fauna Sound Exposures

JASCO Applied Sciences (Australia) Pty Ltd

17 June 2022

Submitted to:

Phil Wemyss
Beach Energy
Contract BE00054727

Authors:

Dion H. Stroot
Matthew W. Koessler
Craig R. McPherson

P001359-010
Document 02741
Version 4.0

JASCO
APPLIED SCIENCES

Suggested citation:

Stroot, D.H., M.W. Koessler, and C.R. McPherson. 2022. Beach Energy Yolla Drilling Campaign: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Document 02741, Version 4.0. Technical report by JASCO Applied Sciences for Beach Energy.

Contents

Figures

Tables

Executive Summary

JASCO Applied Sciences (JASCO) performed a modelling study of underwater sound levels associated with the Beach Energy Yolla Drilling Campaign. This study considers specific components of the program to take place at the Yolla well head platform (WHP), including the drilling of the Yolla-7 well.

In addition to the regular activities of the Yolla WHP, the modelling study considers the activities of a jack-up drill rig conducting drilling operations, and an associated Offshore Support Vessel (OSV) conducting re-supply operations under dynamic positioning (DP).

The study assessed distances from operations where underwater sound levels reached thresholds corresponding to various levels of potential impact to marine fauna. The animals considered here included marine mammals, turtles, and fish (including fish eggs and larvae). Due to the variety of species considered, there are several different thresholds for evaluating effects, including: mortality, injury, temporary reduction in hearing sensitivity, and behavioural disturbance. Of particular note, whilst the newly published Southall et al. (2021) provides recommendations and discusses the nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals.

The modelling methodology considered scenario specific source levels and range-dependent environmental properties. Estimated underwater acoustic levels for non-impulsive (continuous) noise sources presented as sound pressure levels (SPL, L_p), and as accumulated sound exposure levels (SEL, L_E). In this report, the duration of the SEL accumulation is defined as integrated over a 24 hour period.

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) would not stay in the same location for 24 hours. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with impairment if it remained in that location for 24 hours

Vessel and Drilling Noise

For the results below, the distances to isopleths/thresholds were reported from the most dominant source when a group of sources were present. Maps are provided in with the report to assist in with contextualising tabulated distances. The key results of this acoustic modelling study are summarised below. There are no thresholds for invertebrates for effects from non-impulsive noise, therefore no results are reported.

Marine mammals:

The maximum distances to the (NOAA) (2019) marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) are presented in Table 1. The results for the criteria from Southall et al. (2019) for marine mammal PTS and TTS for Jack-up rig and vessel operations are assessed for four scenarios. The maximum distances and total ensonified areas are presented in Table 2.

Table 1. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to the marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) from the most appropriate location for considered sources per scenario. WHP: Well Head Platform, JU: Jack-Up Drill Rig, OSV: Offshore Support Vessel

Applicable Scenario number	Description	R_{max} (km)	$R_{95\%}$ (km)
1	Yolla WHP	0.16	0.16
2	Yolla WHP + JU	2.14	2.06
3	Yolla WHP + JU + OSV under DP	6.20	5.85
4	Yolla WHP + OSV under DP	5.94	5.55

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 from the most appropriate location for the considered scenario. WHP: Well Head Platform, JU: Jack-Up Drill Rig, OSV: Offshore Supply Vessel

Scenario number	Description	R_{max} (km)	Area (km^2)
1	Yolla WHP	0.03	0.004
2	Yolla WHP + JU	0.17	0.08
3	Yolla WHP + JU + OSV under DP	0.49	0.58
4	Yolla WHP + OSV under DP	0.35	0.34

Fish:

Sound produced by the drilling activity operations at the Yolla WHP may reach the sound levels associated with physiological effects, recoverable injury, and TTS for some fish species in close proximity to the sound sources (within 30–110 m respectively), but in order for the thresholds to be exceeded, the fish must remain at those distances for either 12 or 48 h respectively.

1. Introduction

JASCO Applied Sciences (Australia) performed a modelling study of underwater acoustic noise emissions associated with the Beach Energy Yolla Drilling Campaign. This study considers specific components of the program to take place at the Yolla well head platform (WHP), including the drilling of the Yolla-7 well.

This study specifically assessed distances from the considered operations to where underwater sound levels reached thresholds corresponding to various levels of impact to marine fauna. The key fauna considered in this study included humpback whales, fish (including fish eggs and larvae) and benthic invertebrates; however, other marine mammals and sea turtles are also considered. Due to the variety of species considered, there are several different thresholds for evaluating effects, including: mortality, injury, temporary reduction in hearing sensitivity, and behavioural disturbance.

The modelling methodology considered source directivity and range-dependent environmental properties. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), and accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria for non-impulsive (vessels and drilling).

1.1. Acoustic Modelling Scenario Details

This study considered the following activities associated with the drilling campaign at the Yolla WHP:

- Operational noise from an offshore platform,
- Drilling noise from a stationary jack-up drill rig,
- Vessel noise from an Offshore Support Vessel (OSV) conducting resupply operations under dynamic positioning (DP).

Three modelled sites were considered to model the noise footprints from individual sources. Details of the modelled sites are presented Table 3 and displayed graphically in Figure 1. Each scenario may contain a single or multiple sites (to represent multiple sources) as indicated in Table 4. The modelled scenarios considered below and detailed in Table 4 and consider various combinations modelled sites and activity durations of the drilling campaign activities.

Table 3. Modelled site locations and source information.

Site	Source	Latitude (S)	Longitude (E)	MGA Zone 55 (GDA94)		Water Depth (m)
				X (m)	Y (m)	
1	Yolla Platform	39° 50' 37.98"	145° 49' 4.98"	398878	5588902	80.0
2	Jack-Up Drill Rig	39°50'40.65"	145° 49' 4.98"	398880	5588819	80.0
3	OSV	39° 50' 40.68"	145° 49' 7.85"	398948	5588819	80.0

Table 4. Description of modelled scenarios.

Scenario number	Site(s)	Source(s)	Description
1	1	Platform	Yolla Platform Operations
2	1,2	Platform Jack-Up Drill Rig	Yolla Platform Operations + Noble Tom Prosser Jack-Up Drilling
3	1,2,3	Platform Jack-Up Drill Rig OSV	Yolla Platform Operations + Tom Prosser Jack-Up Drilling + OSV under DP conducting Resupply Ops (4 h)
4	1,3	Platform OSV	Yolla Platform Operations + OSV under DP conducting Resupply Ops (4 h)

All scenarios include the continuous activity of the Yolla Well Head Platform (WHP) (Section 3.1), whose onboard systems are assumed to produce a constant source of noise operating 24 hrs a day. Specifically, Scenario 1 is solely this source. In Scenarios 2 and 3 a representative jack-up drill rig, proposed for this project is used to assess noise during regular drilling activities. The jack-up drill rig is considered to run parallel to the WHP operation.

Scenarios 3 and 4 include noise from the OSV, where scenario 3 is the combination of all three noise sources, and Scenario 4 is just the WHP and OSV. During a 24 h period, the OSV conducting resupply operations is considered to operate under DP for 4 h.

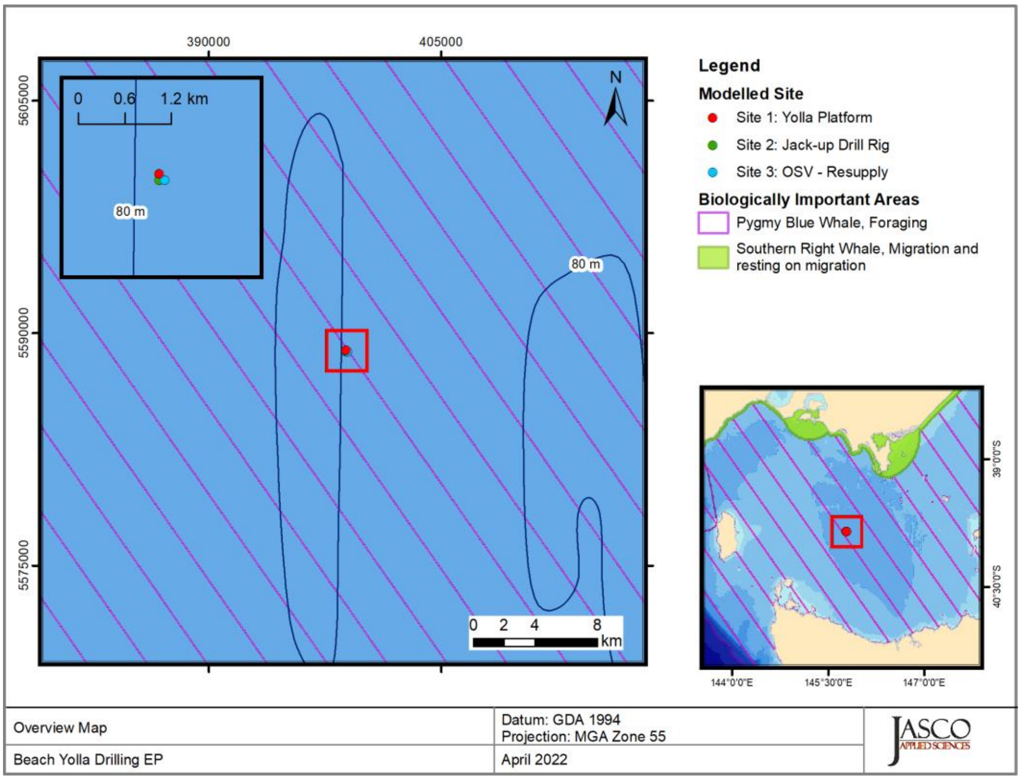


Figure 1. Overview map of the modelled extent and modelled sites.

2. Noise Effect Criteria

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

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

The following thresholds and guidelines for this study were chosen because they represent the best available science, and sound levels presented in literature for fauna with no defined thresholds:

1. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Southall et al. (2019) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals for non-impulsive sources.
2. Marine mammal behavioural threshold based on the current interim U.S. National Oceanic and Atmospheric Administration (NOAA) (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources.
3. Sound exposure guidelines for fish, fish eggs, and larvae (Popper et al. 2014).
4. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Finneran et al. (2017) for the onset of PTS and TTS in turtles for non-impulsive sound sources.

The following sections (Sections 2.1 and 2.2, along with Appendix A.3 and A.4), expand on the thresholds, guidelines and sound levels for marine mammals, fish, fish eggs, fish larvae, and sea turtles.

2.1. Marine Mammals

The criteria applied in this study to assess possible effects of non-impulsive and impulsive noise sources on marine mammals are summarised in Table 5. Cetaceans and otariid seals were identified as the hearing groups requiring assessment. Details on thresholds related to auditory threshold shifts or hearing loss and behavioural response are provided in Appendix A.3, with frequency weighting explained in detail in Appendix A.4. Of particular note, whilst the newly published Southall et al. (2021) provides recommendations and discusses the nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals.

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

Hearing group	NOAA (2019)	Southall et al. (2019)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (L_p; dB re 1 µPa)	Weighted SEL (L_E; dB re 1 µPa^2 s)	Weighted SEL (L_E; dB re 1 µPa^2 s)
Low-Frequency (LF) cetaceans	120	199	179
High-frequency (HF) cetaceans		198	178
Very High-frequency (VHF) cetaceans		173	153
Otariid seals		219	199

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

2.2. Fish, Sea turtles, Fish Eggs, and Fish Larvae

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

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

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

2.2.1. Sea Turtles

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. Popper et al. (2014) suggested thresholds for onset of mortal injury (including PTS) and mortality for sea turtles and, in absence of taxon-specific information, adopted the levels for fish that do not hear well (suggesting that this likely would be conservative for sea turtles).

Finneran et al. (2017) presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS). Their rationale is that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol and Ketten 2006, Dow Piniak et al. 2012). Accordingly, TTS and

PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al. 2014). Table 6 lists the relevant effects thresholds from Popper et al. (2014) for vessel and drilling noise. Some evidence suggests that fish sensitive to acoustic pressure show a recoverable loss in hearing sensitivity, or injury when exposed to high levels of noise (Scholik and Yan 2002, Amoser and Ladich 2003, Smith et al. 2006); this is reflected in the SPL thresholds for fish with a swim bladder involved in hearing. Finneran et al. (2017) presented revised thresholds for turtle injury, considering frequency weighted SEL, which have been applied in this study for drilling and vessel noise (Table 7).

Table 6. Criteria for non-impulsive (vessel and drilling) noise exposure for fish, adapted from Popper et al. (2014).

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

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

Table 7. Acoustic effects of non-impulsive noise on sea turtles, weighted SEL_{24h}, Finneran et al. (2017).

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

3. Methods

The following sections provide a high-level description of the inputs used for this underwater noise modelling study. The sections are divided into subsections within Section 3.1 detailing the source inputs for the Production Platform, Jack-up Drill Rig and OSV, with Section 3.2 providing the details on the applied modelling technique and model configuration information.

3.1. Sound Sources

For the Yolla platform, jack-up drill rig and OSV Figure 2 presents a summary plot of consider source spectra for comparison purposes; additional detail is provided in Sections 3.1.1–3.1.3.

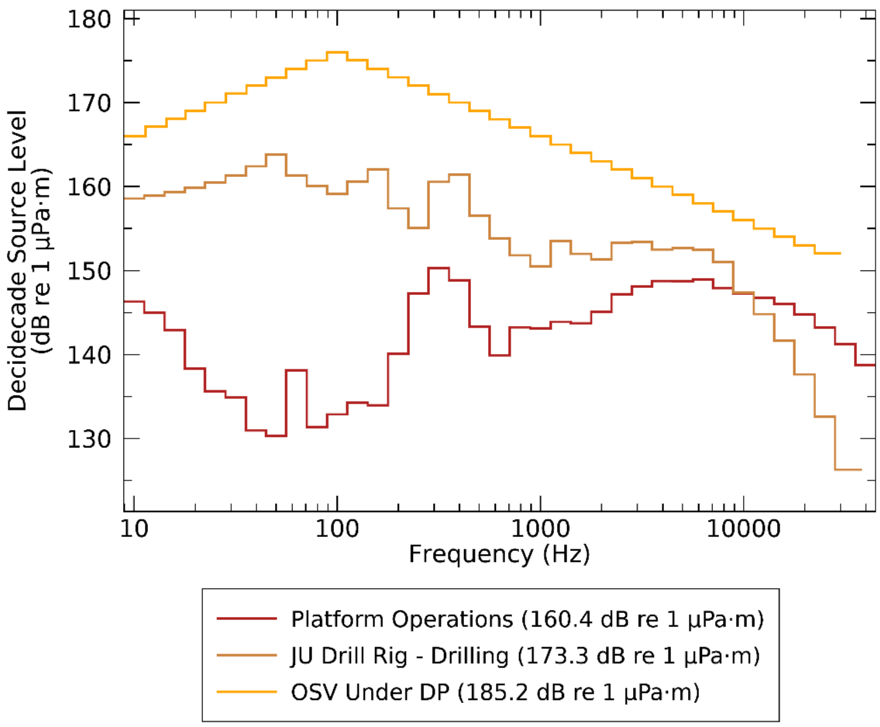


Figure 2. Energy source level (ESL) spectra (in decidecade frequency-band) for all three sound sources.

3.1.1. Production Platforms

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

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 platform, the decidecade band spectrum is shown in Figure 3 was used in modelling noise emissions from the Yolla platform.

Jack-up platforms extend from the sea-surface to the sea-floor, and the noise production is distributed along this range non-uniformly. Our propagation model does not support distributed sources and as a conservative estimate, the platform's sound is modelled as a point source at a depth of 40 m, the mid-water depth.

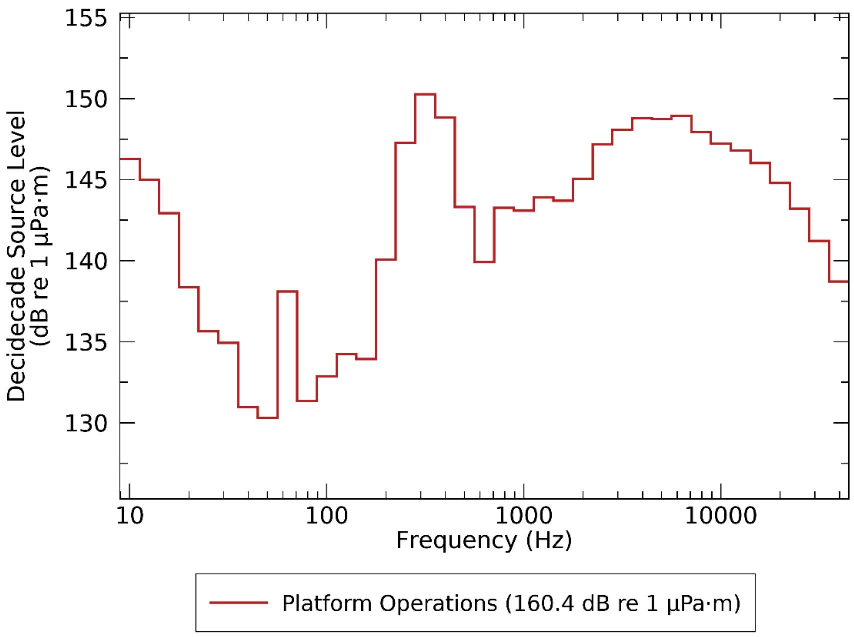


Figure 3. Energy source level (ESL) spectra (in decidecade frequency-band) for the Jack-up Rig considered as a proxy source for the Yolla Platform.

3.1.2. Jack-up Drill Rig

Jack-up rigs, such as the Noble Tom Prosser, are a type of mobile offshore drilling units; they are not fixed, and are usually less self-sufficient then fixed platforms. Therefore, they usually require a support vessel, standing-by within a certain distance from the rig.

Todd et al. (2020) reported on the near-field recordings of underwater noise from the sides of a jack-up rig during drilling operations in the North Sea (water depth of 40 m). Measurements were made of the *Noble Kolskaya*, a three-legged cantilever type jack-up rig, 69 m long and 80 m wide (Todd et al. 2020, Wikipedia 2022). The reported decidecade received levels for drilling operations (25 Hz to 12.5 kHz) were back propagated assuming spherical spreading over a distance of 60 m, to provide conservative estimates of the MSL. The spectrum was extrapolated by continuing the attenuation of the last decidecade, that is assuming a 10 dB per decade at frequencies below 25 Hz, and 25 dB per decade at frequencies above 12.5 kHz. Figure 4 presents the spectrum for the jack-up rig drilling.

The jack-up drill modelled source depth of 40 m is used again here, applying the same distributed source justification as the jack-up platform.

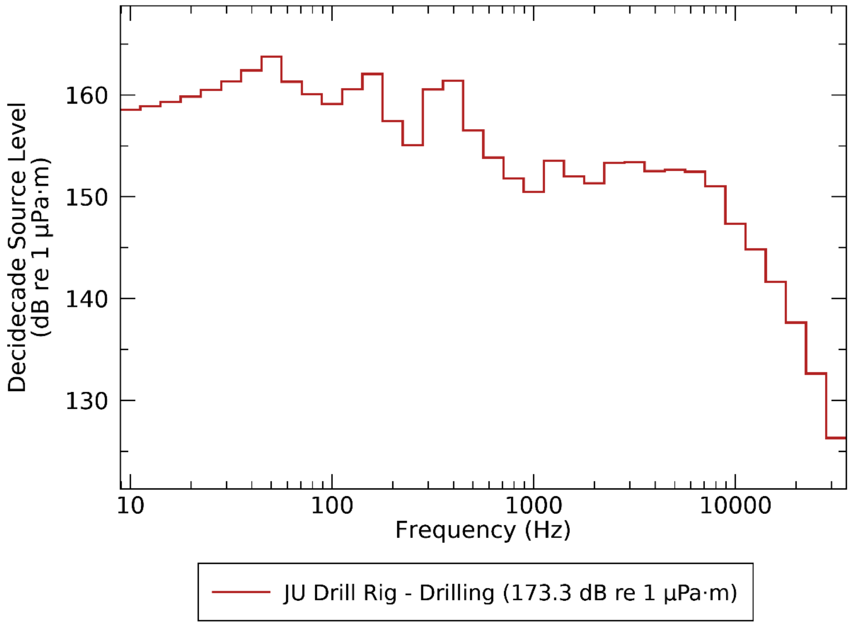


Figure 4. Monopole Source Level (MSL) spectra representing the jack-up rig during drilling operations.

3.1.3. Offshore Support Vessels

At the time of this study, the Offshore Support Vessel (OSV) to be used in the project was unconfirmed. A range of different vessels are being considered as potential choices of OSV, therefore the source level and spectrum used to represent any of these vessels was based potential nominal specifications of dimensions and power presented below.

The main propulsion system will have two aft propellers, with the following specifications likely:

- 3.2 m propeller diameter,
- 165 rpm nominal propeller speed, and
- 2200 kW maximum continuous power input.

Additional thruster modules active during DP operations include two bow tunnel thrusters and a single bow azimuth thruster. The two bow tunnel thrusters could have the following specifications:

- 2.0 m propeller diameter,
- 318 rpm nominal propeller speed, and
- 1000 kW maximum continuous power input.

The bow azimuth thruster could have the following specifications:

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

Source spectra for the main propellers and bow azimuth thruster were determined by the method described in Appendix B.3. Estimates of the acoustic source levels were based on the parameters of the propulsion system, and the percent of Maximum Continuous Rating (MCR) the vessel is expected to be operating at during typical DP operations, as provided by the potential vessel operators.

The source spectrum for full power operation was determined by summing the spectra for the individual thrusters and main propellers. The source spectrum used for modelling was determined by offsetting the full power spectrum by 10log10(%MCR), where the %MCR is represented as a fraction of full power, and where power levels were supplied by the potential vessel operators. The ESL spectra is shown in Figure 5, and an overall broadband source level of 185.2 dB re 1 µPa m was used for operations involving the OSV under typical DP. The vessel was modelled as a monopole sound source at a depth of 4.9 m.

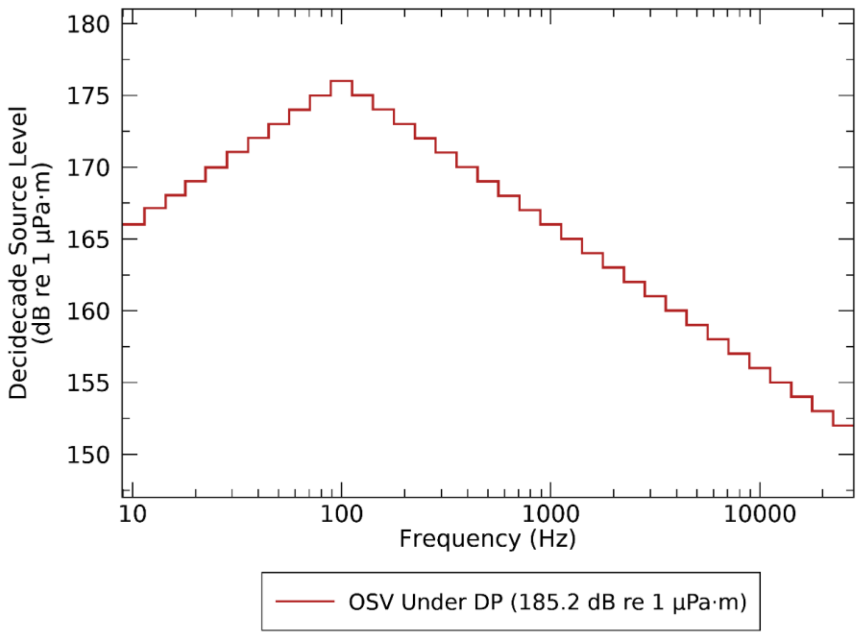


Figure 5. Decidecade energy source level (ESL) spectra of the support vessels. The support vessels have a broadband ESL (10 Hz to 25 kHz) of 185.2 dB re 1 uPa m.

3.2. Geometry and Modelled Regions

Several fit-for-purpose propagation models were used to model underwater noise emission from the scenarios considered for this study. Details on the model configuration is provided below.

JASCO's Marine Operations Noise Model (MONM-BELLHOP; Appendix B.1.2) was used to predict the acoustic field at frequencies of 10 Hz to 25 kHz for all vessels. To supplement the MONM results, high-frequency results for propagation loss were modelled using Bellhop for frequencies from 1.26 to 25 kHz. The sound field modelling calculated propagation losses up to 100 km from the source, with a horizontal separation of 20 m between receiver points along the modelled radials. A horizontal angular resolution of $\Delta\theta$ = 2.5° for a total of *N* = 144 radial planes were used. Receiver depths were chosen to span the entire water column over the modelled areas, from 2 m to a maximum of 85 m, with step sizes that increased with depth.

For all stationary vessels, the SPL modelling results were converted to SEL by the duration of the measurement, which is appropriate for a non-impulsive noise source. As SEL was assessed over 24 h and for a stationary vessel over a day, the conversion from SPL was obtained by increasing the levels by $10*\log_{10}(T)$, where T is 86,400 (the number of seconds in 24 h). In the case of the OSV which was considered as operating under DP for only 4 hours a day, it's 24 h SEL is calculated using a T value of 14,600 (seconds in 4 h).

4. Results

The maximum-over-depth sound fields for the modelled scenarios (described in Section 1.1) are presented below in two formats: as tables of distances to sound levels and, where the distances are long enough, and as contour maps showing the directivity and range to various sound levels.

4.1. Tabulated Results

Table 8 presents the maximum and 95% distances (defined in Appendix B.3) to SPL isopleths. Table 9 presents the maximum distances to frequency-weighted SEL_{24h} thresholds, as well as total ensonified area.

The SPL sound footprints presented here represent the instantaneous sound field and do not depend on accumulation time, whereas the unweighted and frequency-weighted SEL_{24h} thresholds do. For the results below, the distances to isopleths/thresholds were reported from the most dominant source if several sources were present. Maps are provided in Section 4.2 to assist in with contextualising tabulated distances.

Table 8. Vessel scenarios: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL). A dash indicates the threshold is not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 4. A slash indicates that $R_{95\%}$ is not reported when the R_{max} is greater than the maximum modelling extent.

SPL (L_p; dB re 1 µPa)	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	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	–	–	–	–	0.01	0.01	0.01	0.01
170[a]	–	–	–	–	0.03	0.03	0.03	0.03
160	–	–	0.02	0.02	0.11	0.11	0.11	0.11
158[b]	–	–	0.08	0.08	0.11	0.11	0.11	0.11
150	0.02	0.02	0.10	0.10	0.12	0.11	0.12	0.11
140	0.02	0.02	0.10	0.06	0.50	0.47	0.49	0.46
130	0.03	0.03	0.39	0.37	2.23	1.95	2.00	1.87
120[c]	0.16	0.16	2.14	2.06	6.20	5.85	5.94	5.55
110	0.81	0.77	8.08	7.67	17.8	16.9	15.5	14.6

[a] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[b] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[c] Threshold for marine mammal behavioural response to non-impulsive noise (NOAA 2019).

Table 9. *Vessel Scenarios:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on Southall et al. (2019) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km²). A dash indicates the level was not reached within the limits of the modelled resolution (20 m). A slash indicates that the area is less than an area associated with the modelled resolution (0.0013 km²). Scenario descriptions are given in Table 4.

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
PTS									
Low-Frequency (LF) cetaceans	199	–	–	0.08	/	0.11	/	0.11	/
High-frequency (HF) cetaceans	198	–	–	0.08	/	0.11	/	0.11	/
Very High-frequency (VHF) cetaceans	173	0.02	/	0.10	/	0.12	0.01	0.12	/
Otariid seals	219	–	–	–	–	–	/	–	/
Sea Turtles	220	–	–	–	–	0.01	/	0.01	/
TTS									
Low-Frequency (LF) cetaceans	179	0.03	/	0.17	0.08	0.49	0.58	0.35	0.34
High-frequency (HF) cetaceans	178	0.02	/	0.10	/	0.12	/	0.12	/
Very High-frequency (VHF) cetaceans	153	0.28	0.22	0.44	0.47	0.55	0.81	0.47	0.57
Otariid seals	199	–	–	0.08	/	0.11	/	0.11	/
Sea Turtles	200	–	–	0.08	/	0.11	/	0.11	/

4.2. Sound Field Maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for SPL and SEL_{24h} sound fields are presented for the four modelled vessel scenarios. The SPL maps are in Figures 6–9 and the SEL_{24h} maps are in Figures 10–13.

4.2.1. Maximum-over-depth SPL Sound Fields

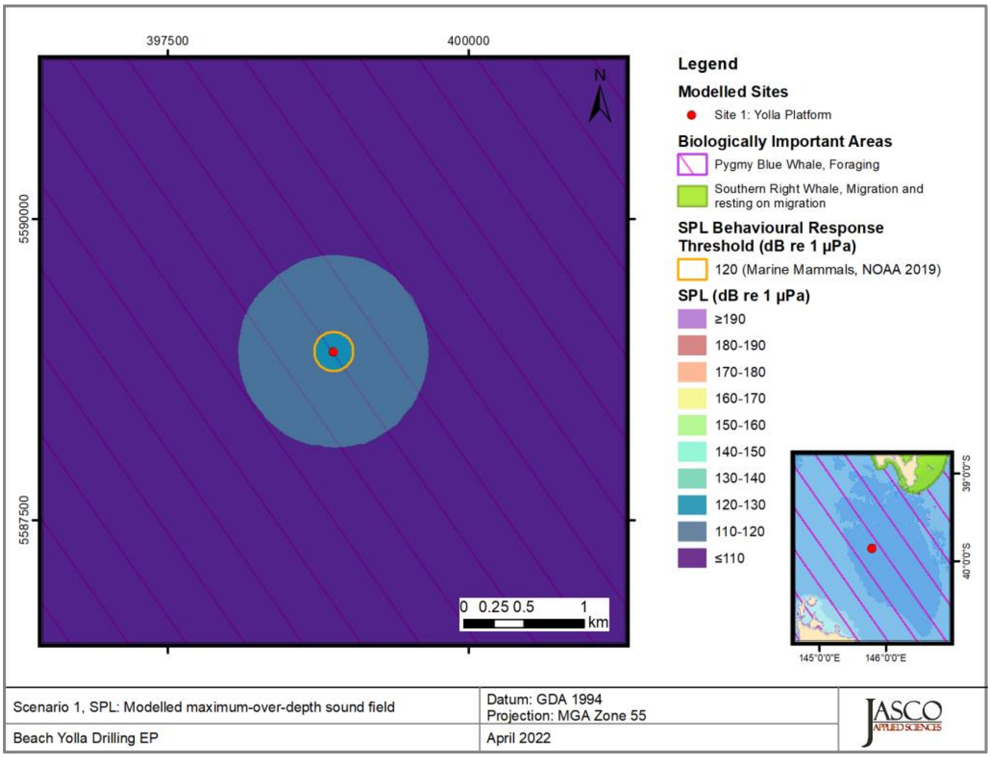


Figure 6. Scenario 1, Platform operations, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

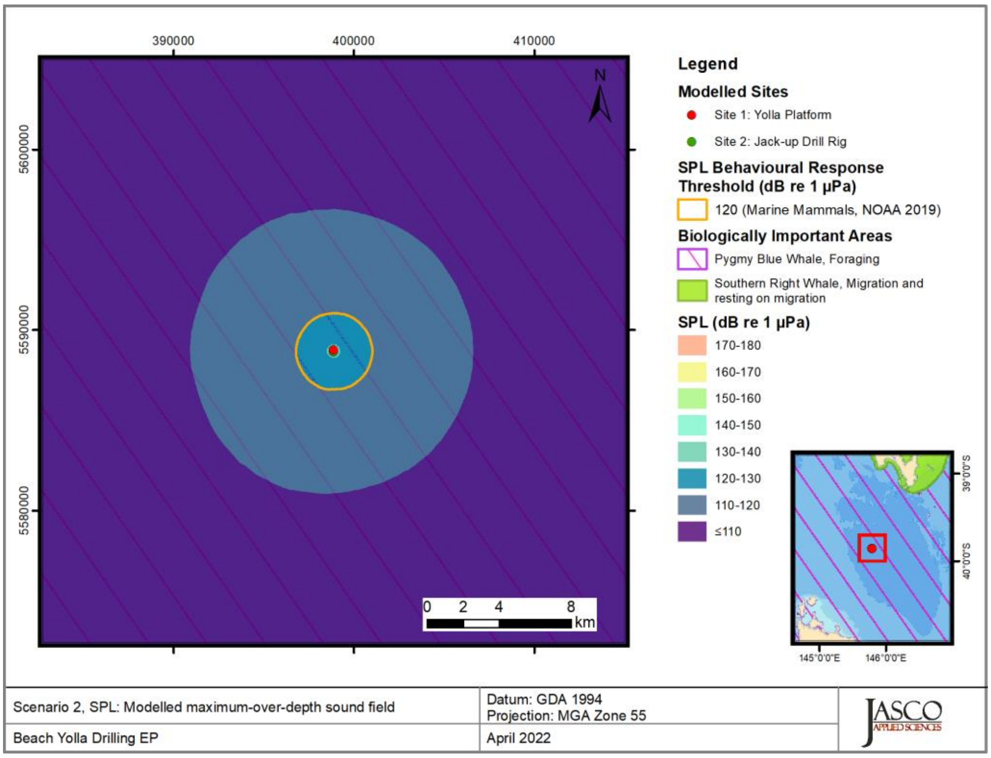


Figure 7. Scenario 2, Platform operations and jack-up drilling, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

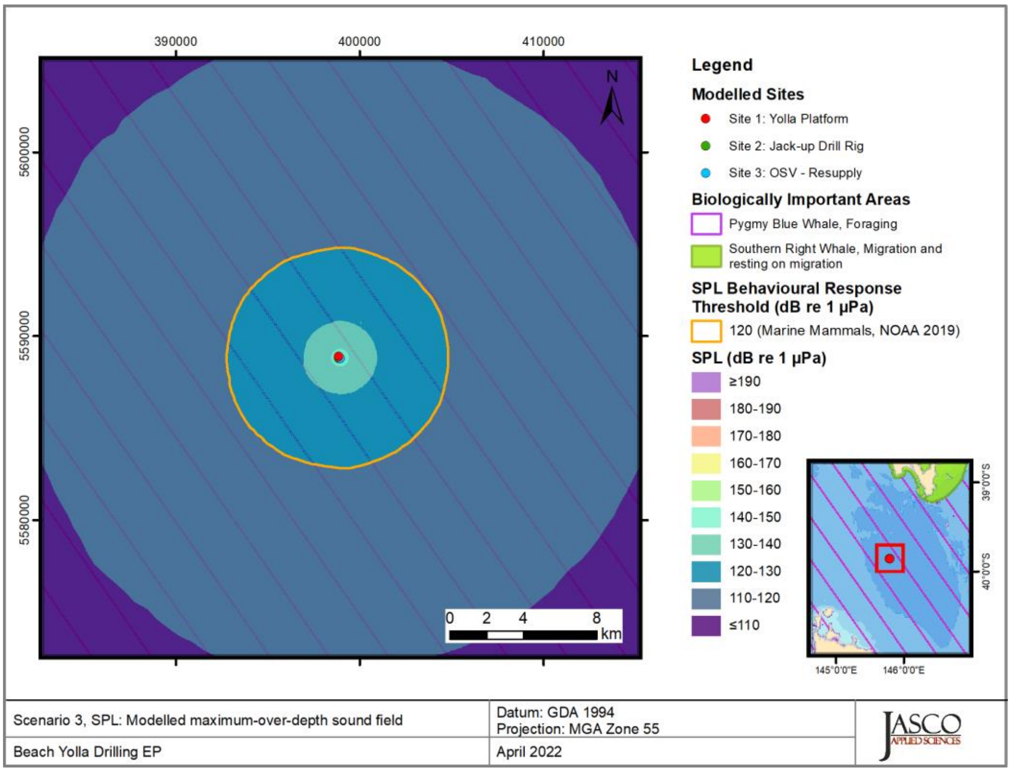


Figure 8. Scenario 3, Platform operations and jack-up drilling with OSV resupply, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

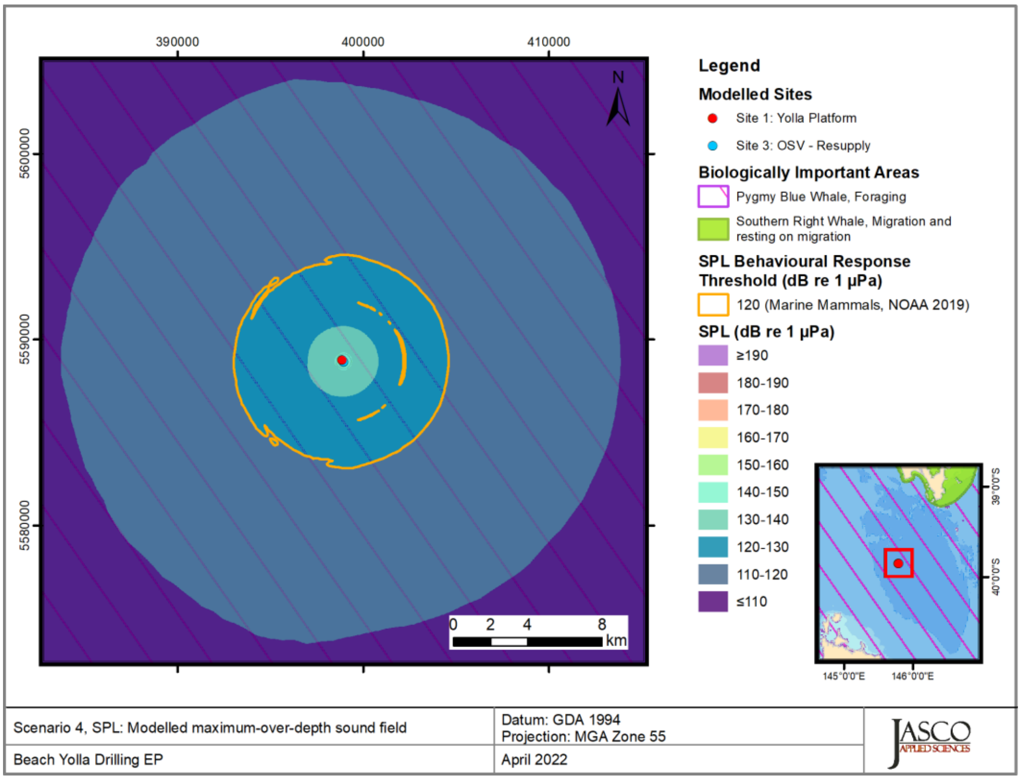


Figure 9. Scenario 4, Platform operations with OSV resupply, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

4.2.2. Accumulated 24-hour Sound Fields

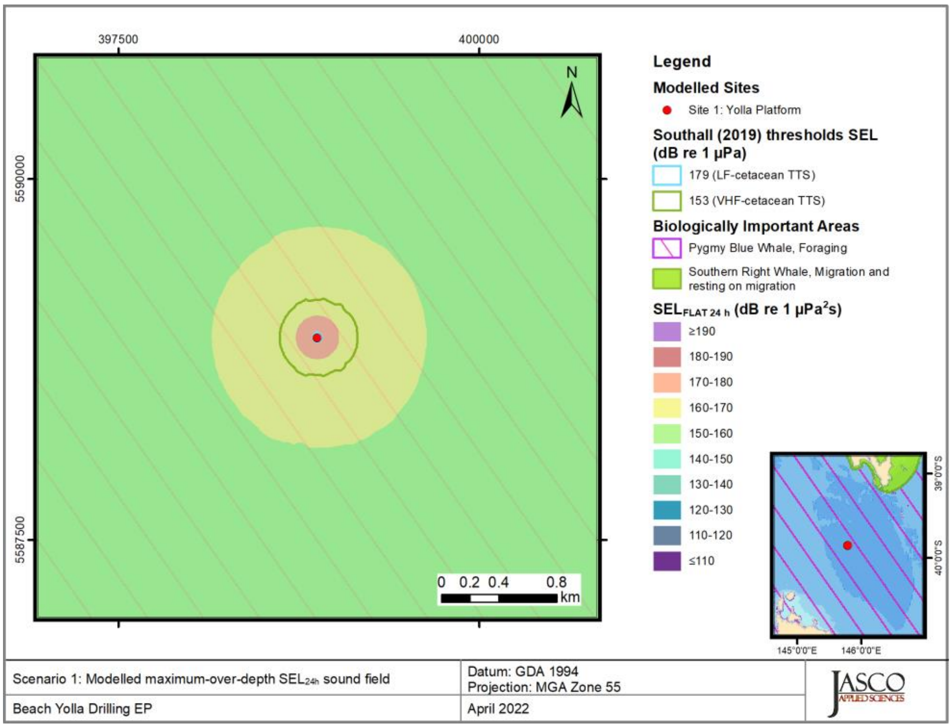


Figure 10. Scenario 1, Platform operations, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

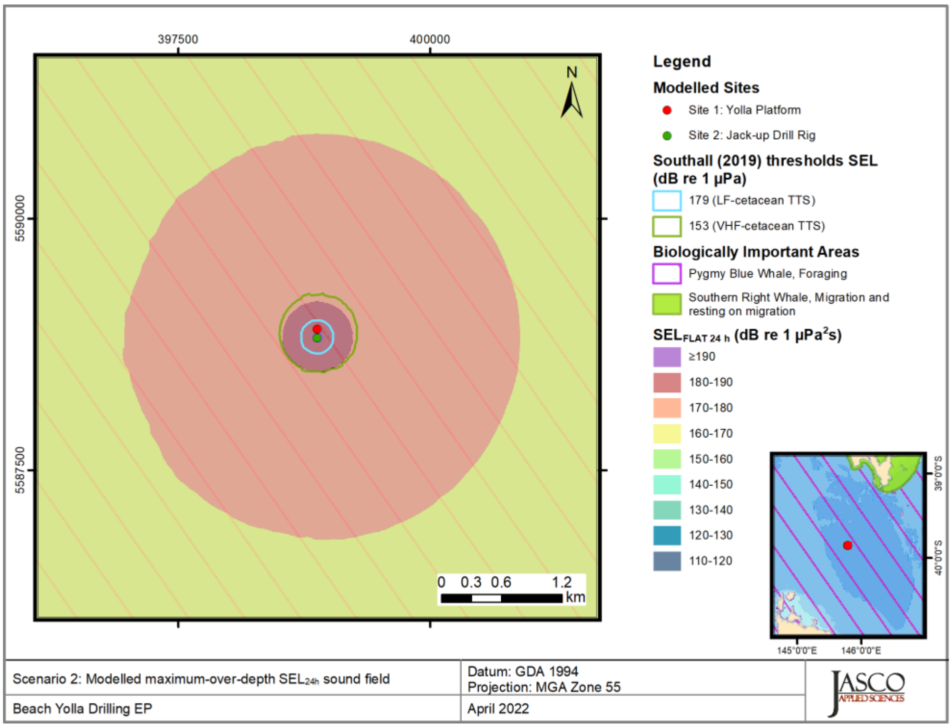


Figure 11. Scenario 2, Platform operations and jack-up drilling, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

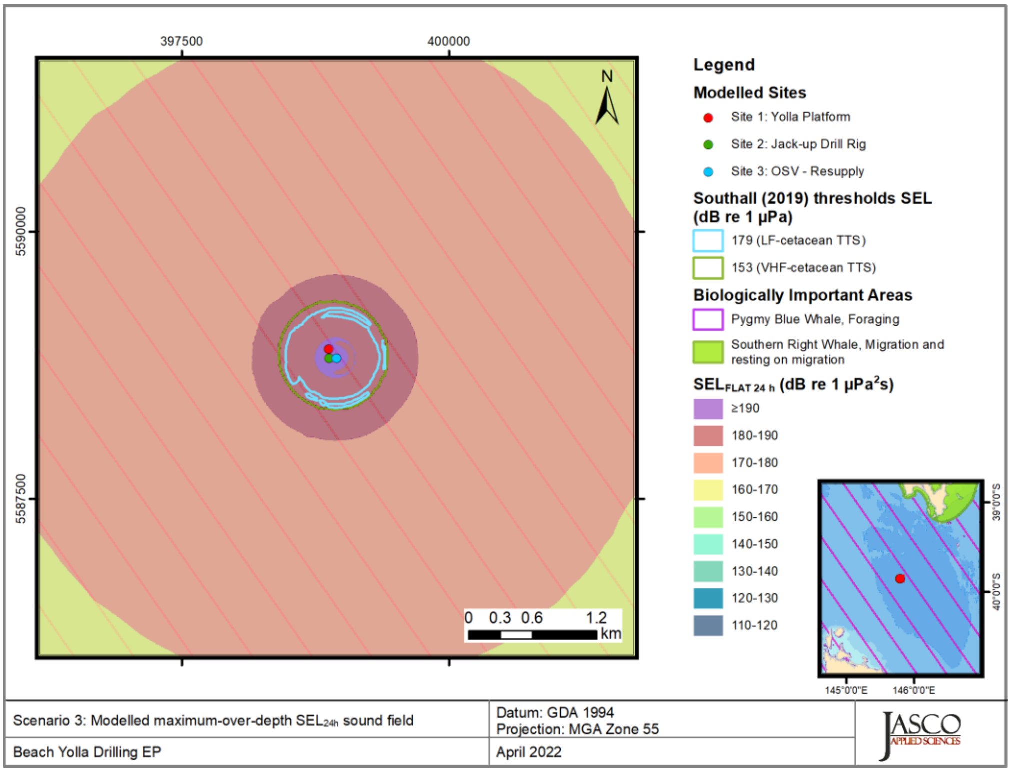


Figure 12. Scenario 3, Platform operations and jack-up drilling with OSV resupply (4 h), SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

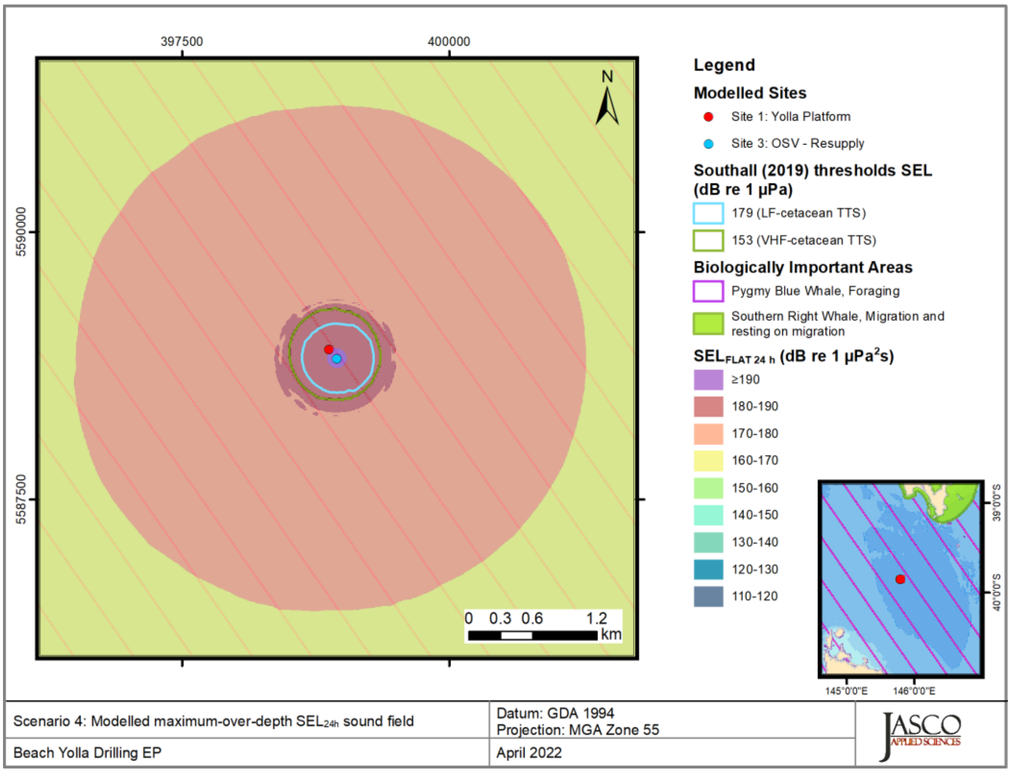


Figure 13. Scenario 4, Platform operations with OSV resupply (4 h), SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

5. Discussion and Conclusion

The Yolla platform location is located in central Bass Strait, and the modelled area had only gradual variation in bathymetry, with a slow decrease in depth towards the shores of Tasmania and Victoria. This bathymetry had little effect on the propagation model, as manifested in the generally symmetric sound field footprints. The modelled seabed composition is reflective at the sea-floor and increased the propagation distances for all scenarios.

The sound speed profile (Appendix B.2.2) was derived from data from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). The water conditions were chosen to provide the most conservative estimate. These correspond to the month of August, which was determined to result in the greatest sound propagation through a sensitivity analysis considering multiple months. The final sound speed profile consisted of a composite profile representative of the environmental conditions likely to occur within the modelled area to capture associated propagation effects.

The considered sound speed profile for August contained a small thermocline which resulted in an upward refracting layer extending from the sea-surface down to approximately 40 m depth. This layer has the potential to trap high frequency energy near the sea surface that would otherwise dissipate more rapidly in range due to propagation, absorption, and seabed losses. The slight upward refracting layer in the sound speed profile only has the potential to effectively trap frequencies above 741 Hz based on the thickness of the refracting layer (Jensen et al. 2011).

For the results tables presented in Section 4, thresholds may or may not have been reached for many scenarios, and in the results tables a dash is used in place of a horizontal distance. Due to the discretely sampled 20 m calculation grids of the modelled sound fields, distances to these thresholds could not be estimated for practicable computational purposes. It is likely that SPL isopleths could be reached at distances between the source and the modelled horizontal resolution (20 m); however, distances to injurious accumulated SEL thresholds may not be reached at any range greater than the point source representation of the platform, jack-up drill-rig and OSV, due to the species-specific frequency weighing functions. Additionally, if close-to-source radii are comparable to the dimensions of the modelled source then they may only be reached within close proximity to the source, if at all.

Glossary

Unless otherwise stated in an entry, these definitions are consistent with ISO 80000-3 (2017).

1/3-octave

One third of an octave. *Note*: A one-third octave is approximately equal to one decidecade (1/3 oct ≈ 1.003 ddec).

1/3-octave-band

Frequency band whose bandwidth is one one-third octave. *Note*: The bandwidth of a one-third octave-band increases with increasing centre frequency.

acoustic impedance

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

acoustic noise

Sound that interferes with an acoustic process.

ambient sound

Sound that would be present in the absence of a specified activity, usually a composite of sound from many sources near and far, e.g., shipping vessels, seismic activity, precipitation, sea ice movement, wave action, and biological activity.

attenuation

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

audiogram

A graph or table of hearing threshold as a function of frequency that describes the hearing sensitivity of an animal over its hearing range.

auditory frequency weighting

The process of applying an auditory frequency weighting function. In human audiometry, C-weighting is the most commonly used function, an example for marine mammals are the auditory frequency weighting functions published by Southall et al. (2007).

auditory frequency weighting function

Frequency weighting function describing a compensatory approach accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity. Example hearing groups are low-, mid-, and high-frequency cetaceans, phocid and otariid pinnipeds.

azimuth

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

bandwidth

The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI S1.13-2005 (R2010)).

broadband level

The total level measured over a specified frequency range.

cavitation

A rapid formation and collapse of vapor cavities (i.e., bubbles or voids) in water, most often caused by a rapid change in pressure. Fast-spinning vessel propellers typically cause cavitation, which creates a lot of noise.

cetacean

Any animal in the order Cetacea. These are aquatic species and include whales, dolphins, and porpoises.

compressional wave

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

conductivity-temperature-depth (CTD)

Measurement data of the ocean's conductivity, temperature, and depth; used to compute sound speed and salinity.

continuous sound

A sound whose sound pressure level remains above ambient sound during the observation period. A sound that gradually varies in intensity with time, for example, sound from a marine vessel.

decade

Logarithmic frequency interval whose upper bound is ten times larger than its lower bound (ISO 80000-3:2006).

decidecade

One tenth of a decade. *Note*: An alternative name for decidecade (symbol ddec) is “one-tenth decade”. A decidecade is approximately equal to one third of an octave (1 ddec ≈ 0.3322 oct) and for this reason is sometimes referred to as a “one-third octave”.

decidecade band

Frequency band whose bandwidth is one decidecade. *Note*: The bandwidth of a decidecade band increases with increasing centre frequency.

decibel (dB)

Unit of level used to express the ratio of one value of a power quantity to another on a logarithmic scale. Unit: dB.

energy source level

A property of a sound source obtained by adding to the sound exposure level measured in the far field the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 μPa²m²s.

energy spectral density

Ratio of energy (time-integrated square of a specified field variable) to bandwidth in a specified frequency band f_1 to f_2. In equation form, the energy spectral density E_f is given by:

$$E_f = \frac{2\int_{f_1}^{f_2} |X(f)|^2 \, \mathrm{d}f}{f_2 - f_1},$$

where $X(f)$ is the Fourier transform of the field variable $x(t)$

$$X(f) = \int_{-\infty}^{+\infty} x(t) \exp(-2\pi \mathrm{i} f t) \, \mathrm{d}t \, .$$

The field variable $x(t)$ is a scalar quantity, such as sound pressure. It can also be the magnitude or a specified component of a vector quantity such as sound particle displacement, sound particle velocity, or sound particle acceleration. The unit of energy spectral density depends on the nature of x, as follows:

- If x = sound pressure: Pa² s/Hz
- If x = sound particle displacement: m² s/Hz
- If x = sound particle velocity: (m/s)² s/Hz
- If x = sound particle acceleration: (m/s²)² s/Hz

The factor of two on the right-hand side of the equation for E_f is needed to express a spectrum that is symmetric about $f = 0$, in terms of positive frequencies only. See entry 3.1.3.9 of ISO 18405 (2017).

energy spectral density level

The level ($L_{E,f}$) of the **energy spectral density** (E_f). Unit: decibel (dB).

$$L_{E,f} := 10 \log_{10}\left(E_f / E_{f,0}\right) \mathrm{dB} \, .$$

The frequency band and integration time should be specified.

As with **energy spectral density**, energy spectral density level can be expressed in terms of various field variables (e.g., sound pressure, sound particle displacement). The reference value ($E_{f,0}$) for energy spectral density level depends on the nature of field variable.

energy spectral density source level

A property of a sound source obtained by adding to the energy spectral density level of the sound pressure measured in the far field the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 μPa²m²s/Hz.

ensonified

Exposed to sound.

far field

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

Fourier transform (or Fourier synthesis)

A mathematical technique which, although it has varied applications, is referenced in the context of this report as a method used in the process of deriving a spectrum estimate from time-series data (or the reverse process, termed the inverse Fourier transform). A computationally efficient numerical algorithm for computing the Fourier transform is known as fast Fourier transform (FFT).

flat weighting

Term indicating that no frequency weighting function is applied. Synonymous with unweighted.

frequency

The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: f. 1 Hz is equal to 1 cycle per second.

frequency weighting

The process of applying a frequency weighting function.

frequency-weighting function

The squared magnitude of the sound pressure transfer function. For sound of a given frequency, the frequency weighting function is the ratio of output power to input power of a specified filter, sometimes expressed in decibels. Examples include the following:

- *Auditory frequency weighting function*: compensatory frequency weighting function accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.
- *System frequency weighting function*: frequency weighting function describing the sensitivity of an acoustic acquisition system, typically consisting of a hydrophone, one or more amplifiers, and an analogue to digital converter.

geoacoustic

Relating to the acoustic properties of the seabed.

hearing group

Category of animal species when classified according to their hearing sensitivity and to the susceptibility to sound. Examples for marine mammals include very low-frequency (VLF) cetaceans, low-frequency (LF) cetaceans, mid-frequency (MF) cetaceans, high-frequency (HF) cetaceans, very high-frequency (VHF) cetaceans, otariid pinnipeds in water (OPW), phocid pinnipeds in water (PPW), sirenians (SI), other marine carnivores in air (OCA), and other marine carnivores in water (OCW) (NMFS 2018, Southall et al. 2019). See **auditory frequency weighting functions**, which are often applied to these groups. Examples for fish include species for which the swim bladder is involved in hearing, species for which the swim bladder is not involved in hearing, and species without a swim bladder (Popper et al. 2014).

hearing threshold

The sound pressure level for any frequency of the hearing group that is barely audible for a given individual for specified background noise during a specific percentage of experimental trials.

hertz (Hz)

A unit of frequency defined as one cycle per second.

high-frequency (HF) cetacean

See **hearing group**.

impulsive sound

Qualitative term meaning sounds that are typically transient, brief (less than 1 second), broadband, with rapid rise time and rapid decay. They can occur in repetition or as a single event. Examples of impulsive sound sources include explosives, seismic airguns, and impact pile drivers.

isopleth

A line drawn on a map through all points having the same value of some quantity.

knot

One nautical mile per hour. Symbol: kn.

level

A measure of a quantity expressed as the logarithm of the ratio of the quantity to a specified reference value of that quantity. Examples include sound pressure level, sound exposure level, and peak sound pressure level. For example, a value of sound exposure level with reference to 1 μPa^2 s can be written in the form *x* dB re 1 μPa^2 s.

low-frequency (LF) cetacean

See **hearing group**.

median

The 50th percentile of a statistical distribution.

mid-frequency (MF) cetacean

See **hearing group**.

monopole source level (MSL)

A source level that has been calculated using an acoustic model that accounts for the effect of the sea-surface and seabed on sound propagation, assuming a point-like (monopole) sound source. Also see **radiated noise level**.

M-weighting

See **auditory frequency weighting function** (as proposed by Southall et al. 2007).

mysticete

A suborder of cetaceans that use baleen plates to filter food from water. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

***N* percent exceedance level**

The sound level exceeded *N*% of the time during a specified time interval. Also see *Error! Reference source not found.*.

non-impulsive sound

Sound that is not an impulsive sound. A non-impulsive sound is not necessarily a continuous sound.

octave

The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete

The presence of teeth, rather than baleen, characterizes these whales. Members of the Odontoceti are a suborder of cetaceans, a group comprised of whales, dolphins, and porpoises. The skulls of toothed whales are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

otariid

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

otariid pinnipeds in water (OPW)

See **hearing group**.

other marine carnivores in water (OCW)

See **hearing group**.

permanent threshold shift (PTS)

An irreversible loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

phocid

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

phocid pinnipeds in water (PPW)

See **hearing group**.

pinniped

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

point source

A source that radiates sound as if from a single point.

power spectral density

Generic term, formally defined as power in a unit frequency band. Unit: watt per hertz (W/Hz). The term is sometimes loosely used to refer to the spectral density of other parameters such as squared sound pressure. ratio of **energy spectral density**, E_f, to time duration, Δt, in a specified temporal observation window. In equation form, the power spectral density P_f is given by:

$$P_f = \frac{E_f}{\Delta t}.$$

Power spectral density can be expressed in terms of various field variables (e.g., sound pressure, sound particle displacement).

power spectral density level

The level ($L_{P,f}$) of the **power spectral density** (P_f). Unit: decibel (dB).

$$L_{P,f} := 10 \log_{10}\left(P_f / P_{f,0}\right) \text{ dB} .$$

The frequency band and integration time should be specified.

As with **power spectral density**, power spectral density level can be expressed in terms of various field variables (e.g., sound pressure, sound particle displacement). The reference value ($P_{f,0}$) for power spectral density level depends on the nature of field variable.

power spectral density source level

A property of a sound source obtained by adding to the power spectral density level of the sound pressure measured in the far field the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 μPa^{2}m^2/Hz.

pressure, acoustic

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

pressure, hydrostatic

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

propagation loss (PL)

Difference between a source level (SL) and the level at a specified location, PL(x) = SL − L(x). Also see **transmission loss**.

radiated noise level (RNL)

A source level that has been calculated assuming sound pressure decays geometrically with distance from the source, with no influence of the sea-surface and seabed. Also see **monopole source level**.

received level

The level measured (or that would be measured) at a defined location. The type of level should be specified.

reference values

standard underwater references values used for calculating sound **levels**, e.g., the reference value for expressing sound pressure level in decibels is 1 μPa.

Quantity	Reference value
Sound pressure	1 μPa
Sound exposure	1 μPa^2 s
Sound particle displacement	1 pm
Sound particle velocity	1 nm/s
Sound particle acceleration	1 μm/s^2

rms

abbreviation for root-mean-square.

shear wave

A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called a secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sound

A time-varying disturbance in the pressure, stress, or material displacement of a medium propagated by local compression and expansion of the medium.

sound exposure

Time integral of squared sound pressure over a stated time interval. The time interval can be a specified time duration (e.g., 24 hours) or from start to end of a specified event (e.g., a pile strike, an airgun pulse, a construction operation). Unit: Pa^2 s.

sound exposure level

The level (L_E) of the sound exposure (E). Unit: decibel (dB). Reference value (E_0) for sound in water: 1 μPa^2 s.

$$L_E := 10 \log_{10}(E/E_0)\,\text{dB} \ = 20 \log_{10}\left(E^{1/2}/E_0^{1/2}\right)\,\text{dB}$$

The frequency band and integration time should be specified. Abbreviation: SEL.

sound exposure spectral density

Distribution as a function of frequency of the time-integrated squared sound pressure per unit bandwidth of a sound having a continuous spectrum. Unit: Pa^2 s/Hz.

sound field

Region containing sound waves.

sound intensity

Product of the sound pressure and the sound particle velocity. The magnitude of the sound intensity is the sound energy flowing through a unit area perpendicular to the direction of propagation per unit time.

sound pressure

The contribution to total pressure caused by the action of sound.

sound pressure level (rms sound pressure level)

The level ($L_{p,\text{rms}}$) of the time-mean-square sound pressure (p_{rms}^2). Unit: decibel (dB). Reference value (p_0^2) for sound in water: 1 μPa^2.

$$L_{p,\text{rms}} := 10 \log_{10}(p_{\text{rms}}^2/p_0^2)\,\text{dB} \ = 20 \log_{10}(p_{\text{rms}}/p_0)\,\text{dB}$$

The frequency band and averaging time should be specified. Abbreviation: SPL or Lrms.

sound speed profile

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

soundscape

The characterization of the ambient sound in terms of its spatial, temporal, and frequency attributes, and the types of sources contributing to the sound field.

source level (SL)

A property of a sound source obtained by adding to the sound pressure level measured in the far field the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 $\mu Pa^2 m^2$.

spectrogram

A visual representation of acoustic amplitude compared with time and frequency.

spectrum

An acoustic signal represented in terms of its power, energy, mean-square sound pressure, or sound exposure distribution with frequency.

surface duct

The upper portion of a water column within which the sound speed profile gradient causes sound to refract upward and therefore reflect off the surface resulting in relatively long-range sound propagation with little loss.

temporary threshold shift (TTS)

Reversible loss of hearing sensitivity. TTS can be caused by noise exposure.

thermocline

The depth interval near the ocean surface that experiences temperature gradients due to warming or cooling by heat conduction from the atmosphere and by warming from solar heating.

transmission loss (TL)

The difference between a specified level at one location and that at a different location, TL(x1,x2) = L(x1) − L(x2). Also see **propagation loss**.

unweighted

Term indicating that no frequency weighting function is applied. Synonymous with flat weighting.

very high-frequency (VHF) cetacean

See **hearing group**.

very low-frequency (VLF) cetacean

See **hearing group**.

wavelength

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

Literature Cited

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

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

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

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

[ISO] International Organization for Standardization. 2017. *ISO 18405:2017. Underwater acoustics – Terminology*. Geneva. https://www.iso.org/standard/62406.html.

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

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

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://media.fisheries.noaa.gov/dam-migration/tech_memo_acoustic_guidance_(20)_(pdf)_508.pdf.

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

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

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

[NOAA] National Oceanic and Atmospheric Administration (US). 2019. *ESA Section 7 Consultation Tools for Marine Mammals on the West Coast* (web page), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west.

[ONR] Office of Naval Research. 1998. *ONR Workshop on the Effect of Anthropogenic Noise in the Marine Environment*. Dr. R. Gisiner, Chair.

Aerts, L.A.M., M. Blees, S.B. Blackwell, C.R. Greene, Jr., K.H. Kim, D.E. Hannay, and M.E. Austin. 2008. *Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report*. Document P1011-1. Report by LGL Alaska Research Associates

Inc., LGL Ltd., Greeneridge Sciences Inc., and JASCO Applied Sciences for BP Exploration Alaska. 199 p. ftp://ftp.library.noaa.gov/noaa_documents.lib/NMFS/Auke%20Bay/AukeBayScans/Removable%20Disk/P1011-1.pdf.

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

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

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

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

Austin, M.E. 2014. Underwater noise emissions from drillships in the Arctic. *In*: Papadakis, J.S. and L. Bjørnø (eds.). *UA2014 - 2nd International Conference and Exhibition on Underwater Acoustics*. 22-27 Jun 2014, Rhodes, Greece. pp. 257-263.

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

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

Bartol, S.M. and D.R. Ketten. 2006. *Turtle and tuna hearing*. *In*: Swimmer, Y. and R. Brill (eds.). Sea turtle and pelagic fish sensory biology: Developing techniques to reduce sea turtle bycatch in longline fisheries. Volume December 2006. NOAA Technical Memorandum NMFS-PIFSC-7. 98-103 p. http://www.sefsc.noaa.gov/turtles/TM_NMFS_PIFSC_7_Swimmer_Brill.pdf#page=108.

Brown, N.A. 1977. Cavitation noise problems and solutions. *International Symposium on Shipboard Acoustics*. 6-10 Sep 1976, Noordwijkehout. p. 17.

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

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

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

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

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

Dow Piniak, W.E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. *Underwater hearing sensitivity of the leatherback sea turtle (Dermochelys coriacea): Assessing the potential effect of anthropogenic noise*. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2012-00156. 35 p.

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

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

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

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

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

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

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

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

Finneran, J.J., E.E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p. https://nwtteis.com/portals/nwtteis/files/technical_reports/Criteria_and_Thresholds_for_U.S._Navy_Acoustic_and_Explosive_Effects_Analysis_June2017.pdf.

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

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

Illingworth and Rodkin Inc. 2014. *Cook Inlet Exploratory Drilling Program – underwater sound source verification assessment, Cook Inlet, Alaska.* . Prepared for BlueCrest Energy, Inc. by Illingworth & Rodkin, Inc., Petaluma, California. https://www.federalregister.gov/documents/2014/09/11/2014-21662/takes-of-marine-mammals-incidental-to-specified-activities-taking-marine-mammals-incidental-to.

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

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

Leggat, L.J., H.M. Merklinger, and J.L. Kennedy. 1981. *LNG Carrier Underwater Noise Study for Baffin Bay*. Defence Research Establishment Atlantic, Dartmouth, NS, Canada. 32 p.

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

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

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

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

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

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

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

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

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

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

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

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

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

McPherson, C.R. and S.B. Martin. 2018. *Characterisation of Polarcus 2380 in^3 Airgun Array*. Document 001599, Version 1.0. Technical report by JASCO Applied Sciences for Polarcus Asia Pacific Pte Ltd.

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

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

O'Neill, C., D. Leary, and A. McCrodan. 2010. Sound Source Verification. (Chapter 3) *In* Blees, M.K., K.G. Hartin, D.S. Ireland, and D.E. Hannay (eds.). *Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report*. LGL Report P1119. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. pp. 1-34.

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

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

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

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

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

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

Ross, D. 1976. *Mechanics of Underwater Noise*. Pergamon Press, NY, USA.

Scholik, A.R. and H.Y. Yan. 2002. Effects of boat engine noise on the auditory sensitivity of the fathead minnow, *Pimephales promelas*. *Environmental Biology of Fishes* 63(2): 203-209. https://doi.org/10.1023/A:1014266531390.

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

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

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

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

Southall, B.L., D.P. Nowacek, A.E. Bowles, V. Senigaglia, L. Bejder, and P.L. Tyack. 2021. Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise. *Aquatic Mammals* 47(5): 421-464.

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

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

Todd, V.L.G., L.D. Williamson, J. Jiang, S.E. Cox, I.B. Todd, and M. Ruffert. 2020. Proximate underwater soundscape of a North Sea offshore petroleum exploration jack-up drilling rig in the Dogger Bank. *Journal of Acoustical Society of America* 148(6): 3971-3979. https://doi.org/10.1121/10.0002958.

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

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

Whiteway, T. 2009. *Australian Bathymetry and Topography Grid, June 2009*. GeoScience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/67703.

Wikipedia. 2022. *Kolskaya (jack-up rig)* (web page). https://en.wikipedia.org/wiki/Kolskaya_(jack-up_rig).

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

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

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

Appendix A. Acoustic Metrics

This section describes in detail the acoustic metrics, impact criteria, and frequency weighting relevant to the modelling study.

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially pulsed sound such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate sound and its effects on marine life. Here we provide specific definitions of relevant metrics used in the accompanying report. Where possible, we follow International Organization for Standardization definitions and symbols for sound metrics (e.g., ISO 2017, ANSI S1.1-2013).

The sound pressure level (SPL or L_p; dB re 1 μPa) is the root-mean-square (rms) pressure level in a stated frequency band over a specified time window (T; s). It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

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

where $g(t)$ is an optional time weighting function. In many cases, the start time of the integration is marched forward in small time steps to produce a time-varying SPL function.

The sound exposure level (SEL or LE; dB re 1 μPa2·s) is the time-integral of the squared acoustic pressure over a duration (T):

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

where T_0 is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to impact to the exposed recipients.

SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events. When applied to pulsed sounds, SEL can be calculated by summing the SEL of the N individual pulses. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right)\text{ dB}\,. \quad \text{(A-3)}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LFC,24h}$; Appendix A.4). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should also be specified.

A.2. Decidecade Band Analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analysing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. A decidecade is sometimes referred to as a "decidecade" because one tenth of a decade is approximately equal to one third of an octave. Each decade represents a factor 10 in sound frequency. Each octave represents a factor 2 in sound frequency. The centre frequency of the ith band, $f_c(i)$, is defined as:

$$f_c(i) = 10^{\frac{i}{10}} \text{ kHz} \quad \text{(A-4)}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decade band are defined as:

$$f_{lo,i} = 10^{\frac{-1}{20}} f_c(i) \quad \text{and} \quad f_{hi,i} = 10^{\frac{1}{20}} f_c(i) \quad \text{(A-5)}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure A-1). The acoustic modelling spans from band 10 (f_c (10) = 10 Hz) to band 44 ($f_c(44)$ = 25 kHz).

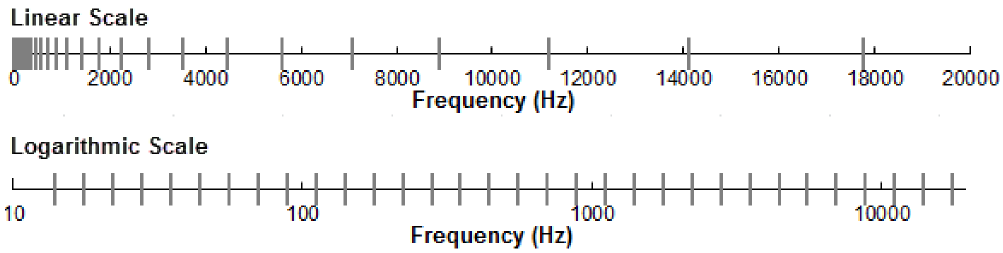


Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{lo,i}$ and $f_{hi,i}$:

$$L_{p,i} = 10\, log_{10} \int_{f_{lo,i}}^{f_{hi,i}} S(f)\, df \;\; \text{dB} \quad \text{(A-6)}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10 \log_{10} \sum_i 10^{\frac{L_{p,i}}{10}} \text{ dB} \quad \text{(A-7)}$$

Figure A-2 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient noise signal. Because the decidecade bands are wider than 1 Hz, the decidecade band SPL is higher than the spectral levels at higher frequencies. Acoustic modelling of decidecade bands requires less computation time than 1 Hz bands and still resolves the frequency-dependence of the sound source and the propagation environment.

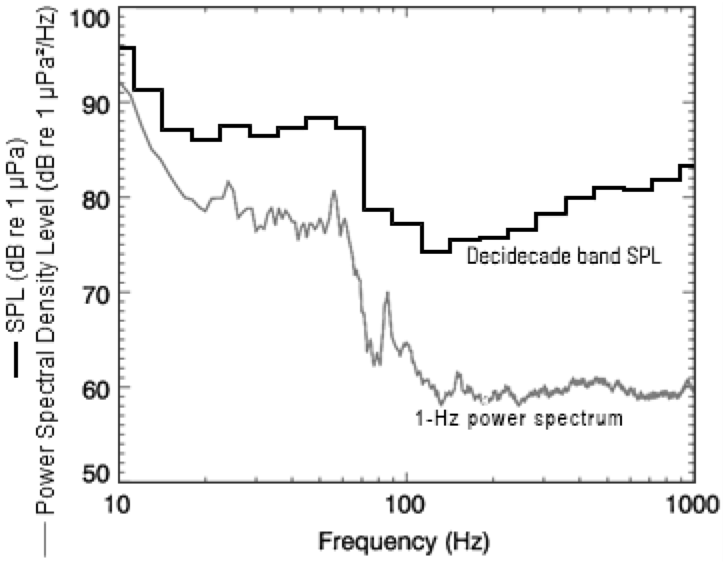


Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.Because the decidecade bands are wider with increasing frequency, the decidecade-octave-band SPL is higher than the power spectrum.

A.3. Marine Mammal Noise Effect Criteria

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

A.3.1. Injury and Hearing Sensitivity Changes

In recognition of shortcomings of the SPL-only based auditory injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual auditory injury criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for humans; see Appendix A.4). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

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

As of 2017, a definitive approach is still not apparent. There is consensus in the research community that an SEL-based method is preferable, either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2016). The guidance describes auditory injury criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). The latest revision to this work was published in 2018 (NMFS 2018). Southall et al. (2019) revisited the interim criteria published in 2007. All noise exposure criteria in NMFS (2018) and Southall et al. (2019) are identical (for impulsive and non-impulsive sounds); however, the mid-frequency cetaceans from NMFS (2018) are classified as high-frequency cetaceans in Southall et al. (2019), and high-frequency cetaceans from NMFS (2018) are classified as very-high-frequency cetaceans in Southall et al. (2019).

A.3.2. Behavioural Response

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016, Southall et al. 2021).

A.3.2.1. Non-Impulsive Noise

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

A.4. Marine Mammal Frequency Weighting

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

A.4.1. Marine Mammal Frequency Weighting Functions

In 2015, a US Navy technical report by Finneran (2015) recommended new auditory weighting functions. The auditory weighting functions for marine mammals are applied in a similar way as A-weighting for noise level assessments for humans. The new frequency-weighting functions are expressed as:

$$G(f) = K + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\} \quad \text{(A-8)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses acoustic impacts on marine mammals (NMFS 2018). The updates did not affect the content related to either the definitions of M-weighting functions or the threshold values. Table A-1 lists the frequency-weighting parameters for each hearing group; Figure A-3 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions as recommended by Southall et al. (2019).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
High-frequency cetaceans (dolphins, plus toothed, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
Very High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36
Phocid seals in water	1.0	2	1,900	30,000	0.75
Otariid seals in water	2.0	2	940	25,000	0.64

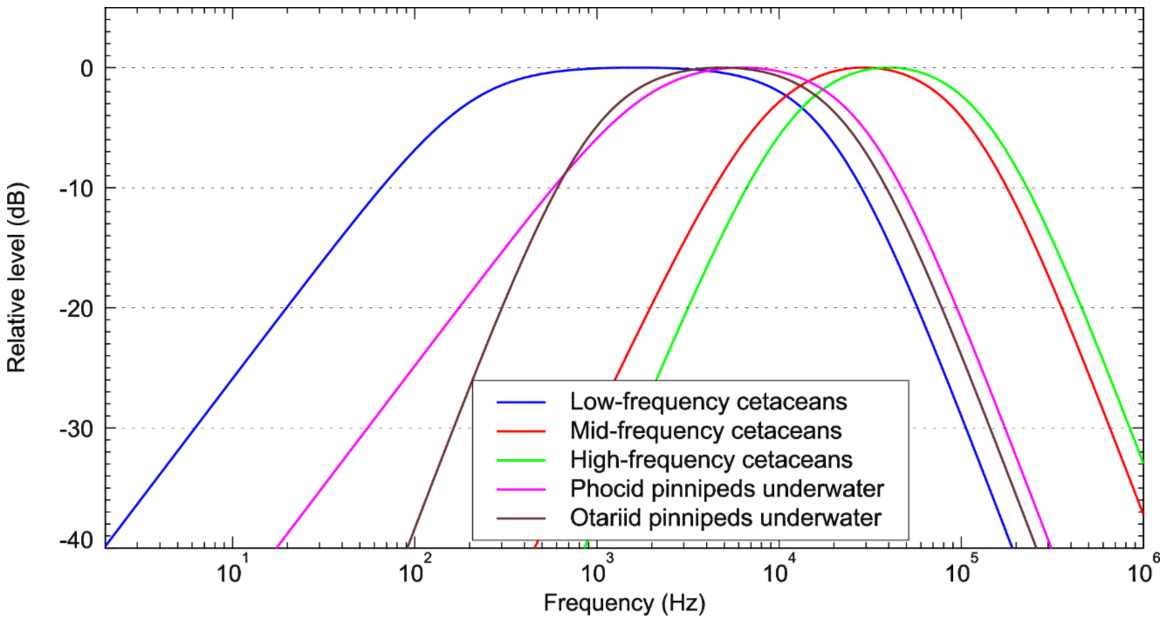


Figure A-3. Auditory weighting functions for functional marine mammal hearing groups as recommended by Southall et al. (2019).

Appendix B. Methods and Parameters

B.1. Sound Propagation Models

B.1.1. Propagation Loss

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

If the acoustic energy source level (ESL), expressed in dB re 1 $\mu Pa^2 \cdot s\ m^2$, and propagation loss (PL), in units of dB, at a given frequency are known, then the received level (RL) at a receiver location can be calculated in dB re 1 $\mu Pa^2 \cdot s$ by:

$$\mathrm{RL} = \mathrm{SL} - \mathrm{PL}. \tag{B-1}$$

B.1.2. MONM-BELLHOP

Long-range sound fields were computed using JASCO's Marine Operations Noise Model (MONM). While other models may be more accurate for steep-angle propagation in high-shear environment, MONM is well suited for effective longer-range estimation. This model computes sound propagation at frequencies of 10 Hz to 1.6 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies > 1.6 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

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

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

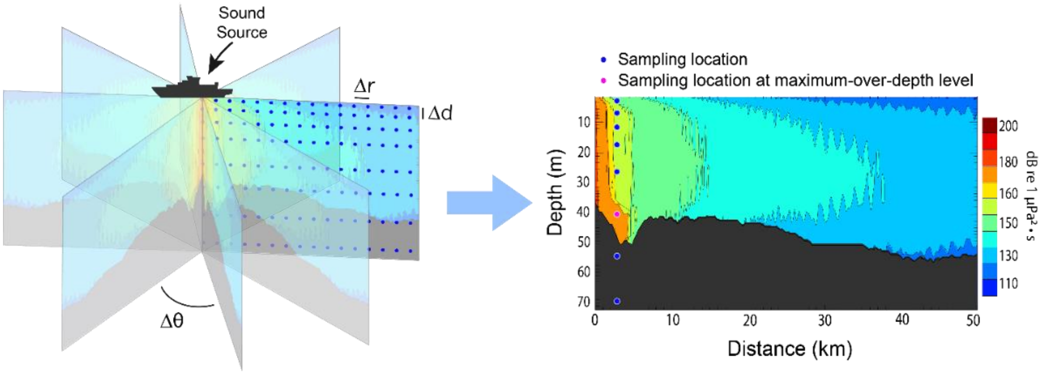


Figure B-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

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

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

B.2. Environmental Parameters

B.2.1. Bathymetry

Water depths throughout the modelled area 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 55) with a regular grid spacing of 200 × 200 m (Figure B-2).

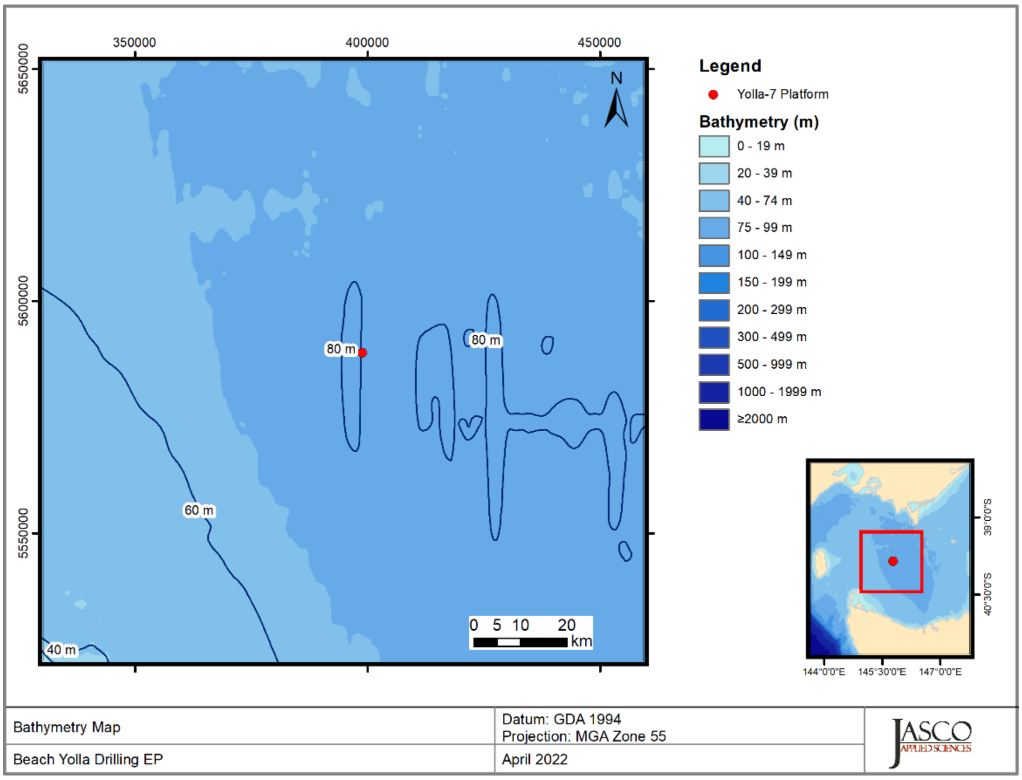


Figure B-2. Bathymetry in the modelled area.

B.2.2. Sound Speed Profile

The sound speed profile in the area was derived from temperature and salinity profiles from the US 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 US 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 within the modelled area. A small-scale sensitivity run was completed across all months of the year to test the which sound speed profile would provide the most conservative estimate for long range propagation. August was found to result in the furthest propagation, likely due to its favourable conditions for upward refraction and was thus chosen as the sound speed profile used for all further sound propagation modelling. Figure B-3 shows the resulting profile, which was used as input to the sound propagation modelling, as well as the other monthly profiles.

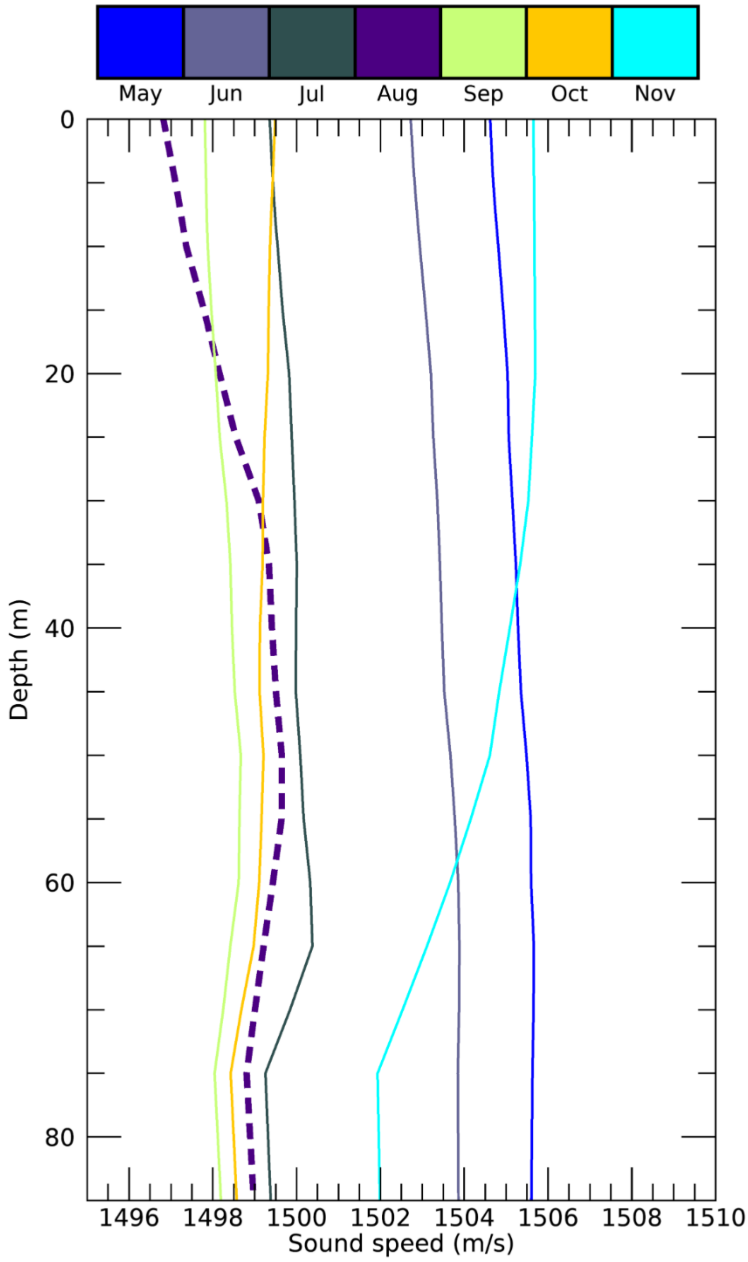


Figure B-3. The sound speed profile considered for acoustic modelling corresponding to August (dashed curve) and other considered monthly profiles Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

B.2.3. Geoacoustics

A single representative geoacoustic profile was used for all modelled sites based on geotechnical site investigations conducted at the Yolla WHP. The seabed composition at the seafloor was taken from the results of multiple grab samples provided by the client surrounding the Yolla WHP. These data indicated that the seafloor sediments consist predominantly of fine sand. Additionally, a geotechnical survey report including the results of a core sample was also provided by the client. This described the composition at a depth of 100 m as very fine sand or silt. These grain sizes were then linearly interpolated as a function of depth between the two sediment grainsize.

The geoacoustic properties were then calculated using the sediment grain-shearing model of Buckingham (2005). The grain sizes were used as input to the grain-shearing model to estimate the geoacoustic parameters required by the sound propagation models. Table B-1 presents the geoacoustic profile for all modelled sites.

Table B-1. Geoacoustic profile for all modelled sites. Each parameter varies linearly within the stated range.

<table>
<tr><th rowspan="2">Depth below seafloor (m)</th><th rowspan="2">Predicted lithology</th><th rowspan="2">Density (g/cm3)</th><th colspan="2">Compressional wave</th><th colspan="2">Shear wave</th></tr>
<tr><th>Speed (m/s)</th><th>Attenuation (dB/λ)</th><th>Speed (m/s)</th><th>Attenuation (dB/λ)</th></tr>
<tr><td>0–10</td><td>Very Fine Sand (unconsolidated)</td><td>2.07–2.06</td><td>1665–1873</td><td>0.22–0.95</td><td rowspan="8">390</td><td rowspan="8">3.65</td></tr>
<tr><td>10–20</td><td rowspan="2">Very Fine Sand (unconsolidated increasing in compaction)</td><td>2.06–2.06</td><td>1873–1938</td><td>0.95–1.13</td></tr>
<tr><td>20–50</td><td>2.06–2.05</td><td>1938–2009</td><td>1.13–1.34</td></tr>
<tr><td>50–75</td><td rowspan="2">Sandy Silt (unconsolidated increasing in compaction)</td><td>2.05–2.02</td><td>2009–1989</td><td>1.34–1.34</td></tr>
<tr><td>75–100</td><td>1.93</td><td>1989–1877</td><td>1.20–1.34</td></tr>
<tr><td>100–150</td><td rowspan="2">Silt (unconsolidated increasing in compaction)</td><td>1.93</td><td>1877–1933</td><td>1.34–1.45</td></tr>
<tr><td>150–200</td><td>1.93</td><td>1979–2053</td><td>1.34–1.60</td></tr>
<tr><td>≥300</td><td>Consolidated sandy silt/sedimentary rock</td><td>1.93</td><td>2035</td><td>1.60</td></tr>
</table>

B.3. Thruster Source Level Estimation

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

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

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

$$L_{100} = 155 + 60\log(u/25) + 10\log(B/4)\,, \qquad \text{(B-2)}$$

where L_{100} is the spectrum level at 100 Hz, u is the propeller tip speed (m/s), and B is the number of propeller blades. Equation B-2 gives the total energy produced by the propeller cavitation at frequencies between 100 Hz and 10 kHz. This equation is valid for a propeller tip speed between 15 and 50 m/s. The spectrum is assumed to be flat below 100 Hz. Its level is assumed to fall off at a rate of −6 dB per octave above 100 Hz (Figure B-4).

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

$$\mathrm{SL}_B = 163 + 40\log D + 30\log N + 10\log B + 20\log f + 10\log(A_c/A_D)\,, \qquad \text{(B-3)}$$

where D is the propeller diameter (m), N is the propeller revolution rate per second, B is the number of blades, A_C is the area of the blades covered by cavitation, and A_D is the total propeller disc area. Similarly to Ross's approach, the spectrum below 100 Hz is assumed to be flat. The tests with a naval propeller operating at off-design heavily loaded conditions showed that Equation B-3 should be used with a value of $(A_c/A_D) = 1$ (Leggat et al. 1981).

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

$$\mathrm{SL}_{\mathrm{total}} = 10\log_{10}\sum_i 10^{\frac{SL_i}{10}}, \qquad \text{(B-4)}$$

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

$$\mathrm{SL}_N = \mathrm{SL} + 10\log N \qquad \text{(B-5)}$$

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

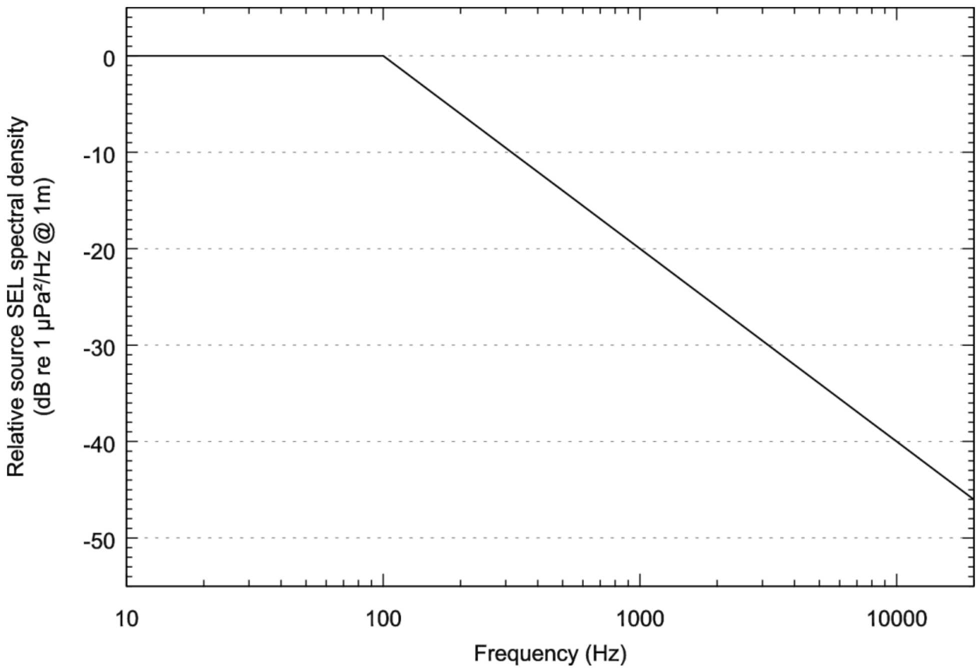


Figure B-4. Estimated sound spectrum from cavitating propeller. (Leggat et al. 1981).

B.4. 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-5).

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-5(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-5(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.

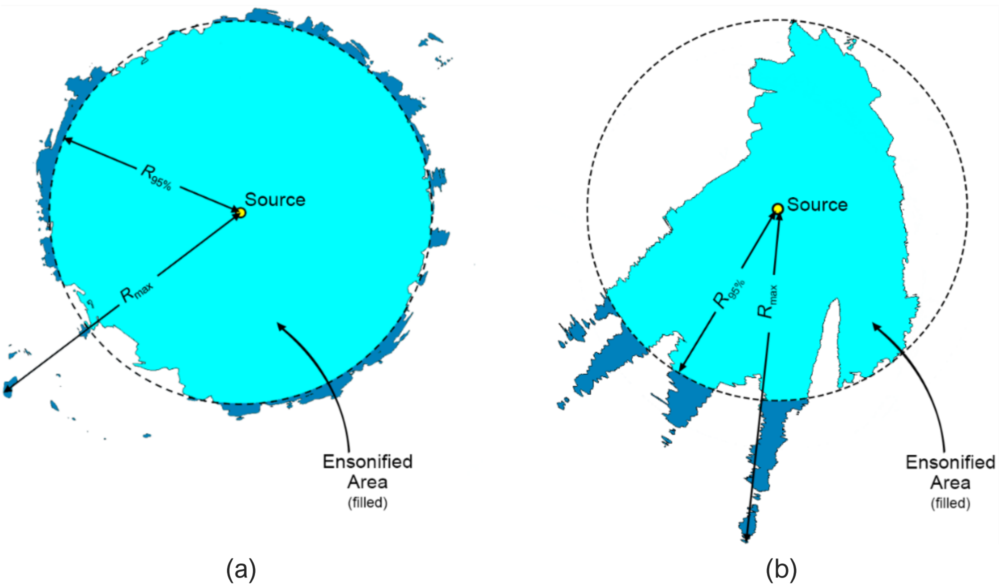


Figure B-5. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

Appendix C. Model Validation Information

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

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

Appendix F Whale Management Standard Operating Procedure

Whale Management Standard Operating Procedure

Yolla Infill Drilling

Document No.:

Date	2 June 2022
Document owner	Drilling Manager
Distribution	Drilling & Completions, HSE

Document status

Version	Date reviewed	Prepared by	Reviewed by	Endorsed by	Date of and final approval by
Rev A	2/06/2022	R Phillips	P Wemyss Dave Taylor Brad Muir	Brad Muir	

Amendment record

Version	Clause	Description of amendment
Rev A	[Enter text]	First draft.

Contents

Tables

Figures

Attachments

1 Purpose

1. The purpose of this Whale Management Standard Operating Procedure (SOP) is to detail noise mitigation measures Beach Energy (Operations) Ltd (Beach) will take when operating in the presence of whales during the drilling of the Yolla infill wells.

2. The desired Environmental Performance Outcome (EPO) detailed in the Yolla Infill Environment Plan (Ref. [1]) is.

   - *Noise emissions in BIAs will be managed such that all whales, including blue whales, continue to utilise the area without injury, and are not displaced from a foraging area.*

2 Reference Documents

[1] Yolla Infill Drilling Environment Plan. Document number: CDN/ID Sxxx Rev xx. xx June 2022.

[2] JASCO. 2022. Beach Energy Yolla Drilling Campaign: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. (Document 02741, Version 1.0 DRAFT). Technical report by JASCO Applied Sciences for Beach Energy, JASCO Applied Sciences..

3 Safety

1. At all times and without exception, safety to personnel and well integrity takes priority over the requirements described in this procedure.

4 Scope

1. This procedure applies to the Yolla infill drilling campaign (see Environment Plan (Ref. [1]) and covers noise mitigation for:

   - Entry of the MODU into the field;
   - Exit of the MODU into the field;
   - Drilling; and
   - Resupply.

2. No specific actions are required for activities which do not emit noise levels above mitigation thresholds for whales, including tripping, completions, testing and flow back, wait on weather, running and cementing casing.

3. Figure 1 shows the well location

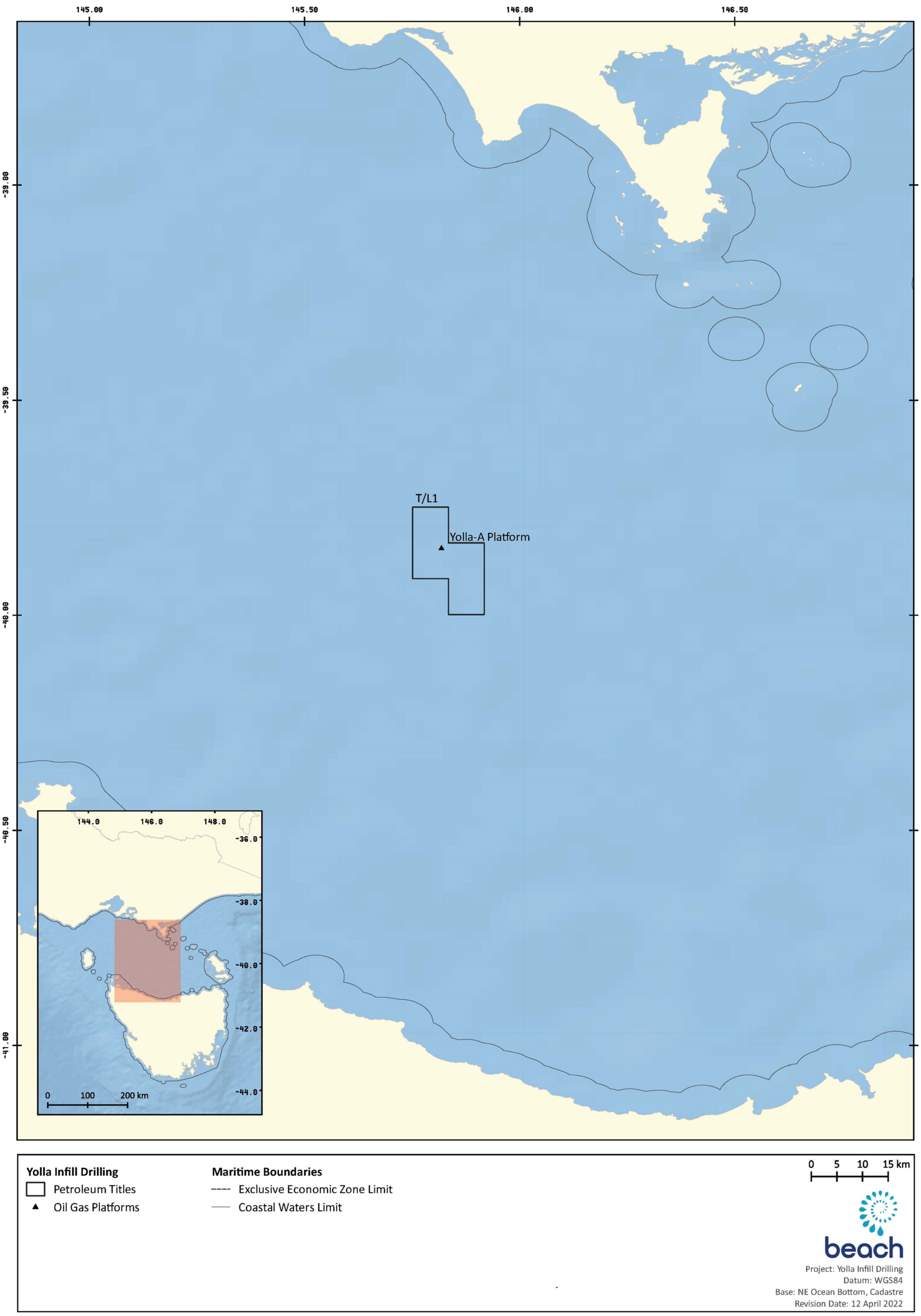


Figure 1: Yolla well location

5 Abbreviations

Term	Definition
MFO	Marine Fauna Observer (also referred to as Marine Mammal Observers (MMOs))
MODU	Mobile Offshore Drilling Unit
TTS	Temporary Threshold Shift
SDSV	Senior Drilling Supervisor
SOP	Standard Operating Procedure

6 Definitions

Term	Definition
Absence of whales	No whales observed for more than 30 minutes within the relevant mitigation zone or whales observed leaving the relevant mitigation zone.
Cetaceans	Whales, dolphins and porpoises.
Whale detection	An observation of 1 or more whales in a pod
Disturbance or displacement of whales	Guidance provided by DAWE (DAWE, 2021a) states a whale could be displaced from a foraging area if stopped or prevented from foraging, caused to move on when foraging, or stopped or prevented from entering a foraging area. Further, a whale is considered displaced from a foraging area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that foraging area.
Drilling	The drilling sub-activity refers **ONLY** to the drill bit rotating in the hole with mud pumps on, including back-reaming operations. Commencement of Drilling is defined as the time at which operations are set to proceed from the safe point to d*rilling* as defined above. Examples are commencing the drilling of a casing shoe, commencing drilling following a bit trip or other suspension of *drilling* as defined above.
Daylight hours	Sunrise to sunset time as per the Bureau of Meteorology
Foraging Whale	A whale searching for food and/or feeding (Refer **Table 2**)
Marine Fauna Observer (MFO) / Marine Mammal Observers (MMO)	Qualified and experienced personnel in marine fauna identification and distance calculation stationed onboard the vessels assigned for the project to observe, record, report and advise mitigation of applicable species.
Mitigation Zone	The area wherein the MFO advises of the presence of applicable species so that the SDSV can take appropriate action with either the drilling or resupply operations per the procedures described in this SOP.
Operational Area	Defined in the Environment Plan as 2km around the well centre.
Resupply	The transfer of goods to and from the MODU by the resupply vessel. The activity commences when the vessel is operating on thruster, within the 500 m rig safety zone.
Resupply Vessel	Vessel performing resupply of the MODU.
Safe Point	Delineates stages where the sub-activity (move-in / move-out, drilling or resupply) can proceed to before implementing further noise control actions, whilst maintaining well and platform integrity and personnel safety.

Temporary Threshold Shift	A temporary shift in the auditory threshold. May occur suddenly after exposure to a high level of noise
Whale	Includes baleen whales and larger toothed whales, such as, sperm whales, killer whales, false killer whales, pilot whales and beaked whales. Table 2 lists whales to which this procedure and mitigation applies.

7 Responsibilities

Role	Responsibility
Drilling Manager	• Review and endorse this procedure • Provide support in implementing whale management and noise mitigation actions
Drilling Superintendent	• Review and endorse this procedure • Provide support in implementing whale management and noise mitigation actions
Senior Drilling Supervisor (SDSV)	• Maintain open communication with MFOs. Communicate the status of the sub-activities to MFOs and vessel masters (i.e., time drilling is expected to commence, time drilling actually commences and time drilling stopped). • Receives communications regarding the activity of foraging whales within the mitigation zone and makes decisions on the actions to follow with reference to this procedure and considering the criticality and integrity of operations on the MODU. • Document the reasons for these decisions and communicate same to Lead MFO • Maintain time-stamped daily logs regarding activities and communications undertaken related to the implementation of this procedure.
Vessel Masters	• Maintain open communication with MFOs. • Decides, in consultation with the Senior Drilling Supervisor, whether actions within this procedure can safely be implemented and act accordingly. • Maintain time-stamped daily logs regarding activities and communications undertaken related to the implementation of this procedure. • Document reasons for decisions.
Marine Fauna Observers (MFOs)	• Attend morning meeting (or an equivalent information session) to be informed of activities for the day. • Undertake daily marine fauna observations to provide a record of marine fauna activity and to satisfy the requirements of this SOP. • Undertake, whale observations 30 minutes prior to darkness each day to satisfy the requirement for night-time activities. • Train vessel officers on watch (OOW) to cover watches for marine fauna during MFO break times or after a 12 hour shift is complete (only required when one MFO on the vessel). • Communicate foraging whale detections that may require mitigation and provides this information clearly and concisely in a timely manner to Beach Senior Drilling Supervisor so that the appropriate action decision can be taken.
Beach Environment Adviser	• Ensure this procedure is updated. Communicate any changes to all MFOs, Drilling Superintendent, Beach Senior Drilling Supervisor and Vessel Masters. • Accountable for ensuring that appropriately trained MFOs are available for all of the associated vessels • Audit compliance against this procedure • Report non-compliance to the regulator

8 Requirements

8.1 Whale Observations

1. At least one *Marine Fauna Observer* (MFO) shall be in the field to carry out whale observations.
2. If a vessel is used as the MMO platform it shall endeavour to provide full observation coverage around the MODU to minimise the blind spot behind the rig. When only one vessel in the field, this shall include sailing around the MODU approximately every 6 hours (daylight hours) to minimise the blind spot behind the MODU (Figure 2). When two vessels are in the field, the blind spot shall be minimised by stationing each vessel at opposing sides of the rig.

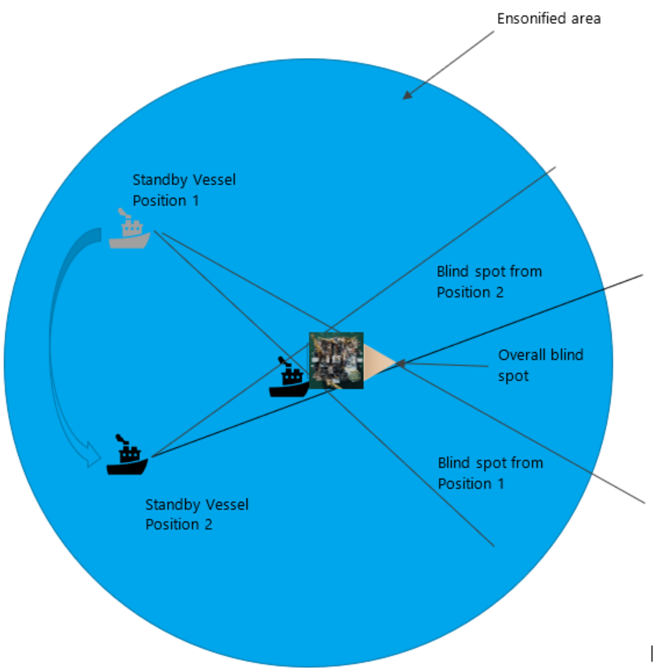


Figure 2: Illustration of standby vessel field of view

8.2 Foraging Whales

1. Noise mitigation actions are only required for *foraging whales* observed within mitigation zones [1]. Sizes of these mitigation zones are provided in Table 1.

[1] Mitigation zones were derived using sound transmission loss modelling (Ref. [4]) to ensure that behavioural disturbance thresholds are not reached.

Table 1: Sizes of mitigation zones for drilling and resupply.

Sub-activity	Radii of mitigation zone around the MODU
Presurvey zone[2]	6.20 km
Drilling [3]	0.17 km
Resupply [4]	0.49 km

2. Table 2 lists the whale species requiring mitigation and defines how *foraging* should be interpreted for different species[5] at different times of year.

Table 2: Definition of foraging for different whale species for different seasons[5]

Whale	Nov – June	July – Oct
Blue whale	If present, it must be assumed they are foraging	
Fin, pygmy right, sei, southern right and unidentified whales	Assume whales are foraging	If present, they must be positively identified as undertaking surface feeding behaviour
All other baleen whale species	Foraging only if positively observed undertaking surface feeding behaviour	

8.3 Communication

1. Primary communication between the MFO (both vessel and aerial based) and Senior Drilling Supervisor shall be agreed.
2. The Lead MFO shall attend the morning call (or equivalent meeting) to be appraised of activities for the day.
3. Communication drills shall be undertaken weekly to ensure all parties are familiar with communication protocols. These shall be logged in the MFO daily report and reported on the Daily Drilling Report.

[2] Based on predicted range to behavioural impact threshold derived from underwater sound modelling drilling with resupply vessel on DP scenario (Ref. [[2])

[3] Based on predicted range to temporary threshold shift (TTS) threshold derived from underwater sound modelling Yolla well head platform + drill rig scenario (Ref. [[2])

[4] Based on predicted range to temporary threshold shift (TTS) threshold derived from underwater sound modelling Yolla well head platform + drill rig + vessel under dynamic positioning scenario (Ref. [[2])

[5] Advice provided by Blue Whale Study in Whale Management Workshop held 30 June 2021

8.4 Mobilisation of MODU to the Yolla Field

1. Pre-watch shall be undertaken of the Pre-survey Zone immediately prior to entry to ensure *absence of foraging whales*.
2. If the area is absent of whales, the ALL CLEAR can be given to the SDSV for the MODU to enter the presurvey zone.
3. Once the tow commences it can continue to the next safe point, which, in the case of the MODU for Yolla infill drilling is, it can move-in to the Yolla Platform, carry out preload and jack-up to the required height.
4. The tow shall comply with EPBC regulations Part 8 Division 8.1 interacting with cetaceans, that is it must remain 500m from foraging whales. If whales or dolphins are observed within prescribed distances, tow speed shall be slowed to less than 6 knots to give time for cetaceans to move away.
5. Conditions for tow to enter pre-survey zone during night-time or poor visibility:
   - No foraging whales observed within the presurvey zone 30 minutes before darkness/poor visibility. If a foraging whale is observed during this time, the ALL CLEAR can only be given if it is observed to exit the zone before darkness/poor visibility.

     AND
   - No more than three foraging whales observed within the presurvey zone in daylight hours leading up to darkness/poor visibility.
6. Communication protocols are illustrated in Figure 3.

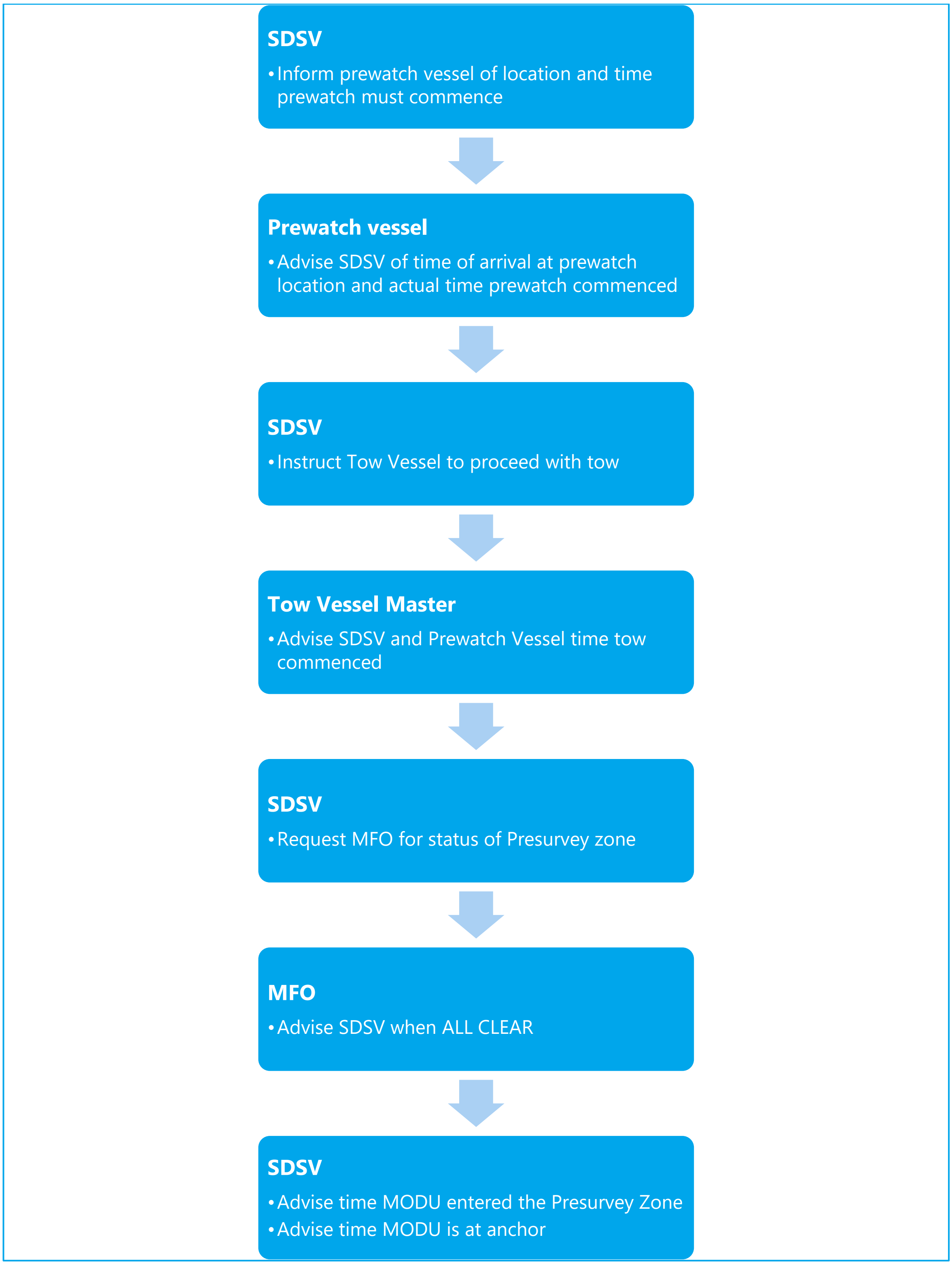


Figure 3: Communication for entry into the Thylacine Field

8.5 Demobilisation of MODU from the Yolla Field

7. Pre-watch shall be undertaken of the Pre-survey Zone immediately prior to commencing demobilisation to ensure *absence of foraging whales*.
8. If the area is absent of whales, the ALL CLEAR can be given to the SDSV for demobilisation to commence.
9. Once the bridles are connected to the MODU, demobilisation and the tow can continue until completion.
10. The tow shall comply with EPBC regulations Part 8 Division 8.1 interacting with cetaceans, that is it must remain 500m from foraging whales. If whales or dolphins are observed within prescribed distances, tow speed shall be slowed to less than 6 knots to give time for cetaceans to move away.
11. Conditions for decommissioning to commence during night-time or poor visibility:
    - No foraging whales observed within the presurvey zone 30 minutes before darkness/poor visibility. If a foraging whale is observed during this time, the ALL CLEAR can only be given if it is observed to exit the zone before darkness/poor visibility.

      AND
    - No more than three foraging whales observed within the presurvey zone in daylight hours leading up to darkness/poor visibility.

8.6 Drilling (see also Attachment 1, Flowchart 1 and specific definition of activity)

1. Whale observation shall be undertaken at least 30 minutes prior to drilling commencing (and 30 minutes prior to darkness for night-time activities).
2. Drilling may commence only when the MFO confirms *absence of foraging whales* (refer Table 2) within the drilling mitigation zone (Table 1).
3. Whale observations shall continue during drilling. Should foraging whales enter drilling mitigation zone, drilling may continue until next designated *Safe Point* to ensure safety of personnel and well integrity.
4. The *Safe Point* shall be determined by the SDSV.
5. Once *Safe Point* has been reached, drilling may only recommence once the MFO confirms the absence of foraging whales within drilling mitigation zone.
6. SDSV shall implement noise minimisation actions, as practicable, including but not limited to:
    - reducing load on mud pumps and rotary drilling equipment;
    - reducing loads on generators; and
    - stopping non-essential equipment or non-safety critical equipment /activities.
7. The SDSV shall document decisions with regards to *Safe Point* in the daily drilling report.

Night-time or poor visibility case

8. In the case that drilling is scheduled to commence during night-time or poor visibility, the following conditions must be met before drilling can commence.

- No foraging whales observed within the drilling zone 30 minutes before darkness/poor visibility. If a foraging whale is observed during this time, the ALL CLEAR can only be given if it is observed to exit the zone before darkness/poor visibility.

  AND

- No more than three foraging whales observed within the presurvey zone in daylight hours leading up to darkness/poor visibility.

9. A decision tree for the above logic is provided in Figure 4 below.

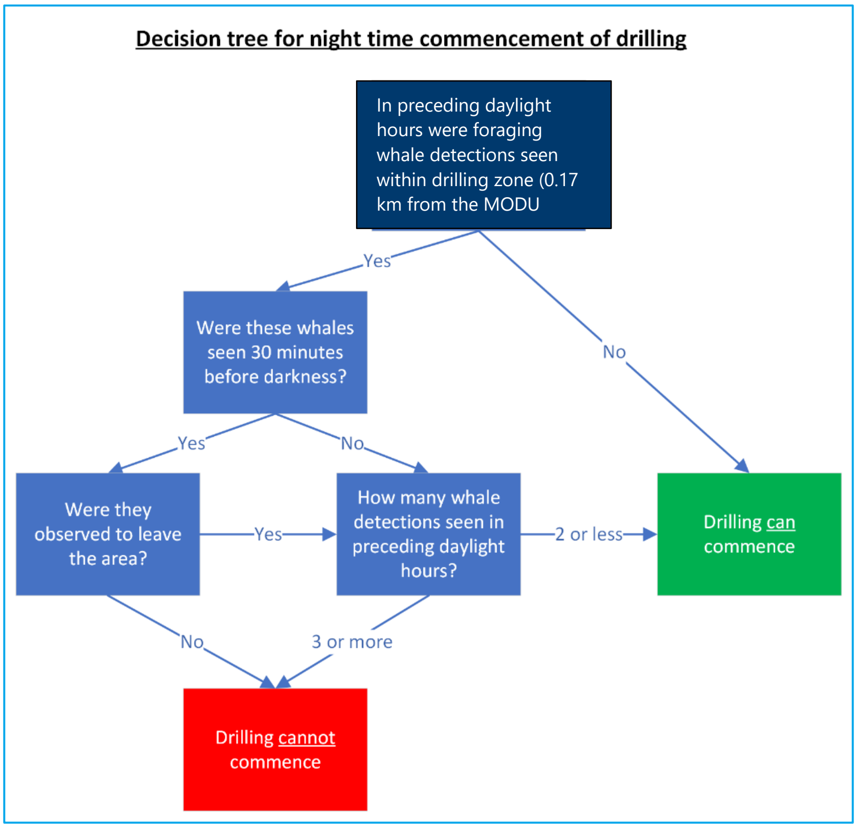


Figure 4: Decision tree for night-time drilling

8.7 MODU Resupply (see also Attachment 1, Flowchart 2)

1. Whale monitoring shall be undertaken at least 30 minutes prior to commencement of *resupply* operations (and 30 minutes prior to darkness for night-time activities).
2. When only a single vessel in the field, the Vessel Master shall position the vessel to ensure a near full field of view for whale observations (i.e., blind spot behind the rig is minimised).
3. *Resupply* may commence only when the MFO confirms to the SDSV the *absence of foraging whales* (refer Table 2) within resupply *mitigation zone*.
4. The SDSV shall direct the vessel master to enter the 500m zone to commence *resupply*.
5. Once the resupply vessel has entered the 500 m zone on thrusters, resupply may continue to completion.

Night-time or poor visibility case

6. In the case that resupply is scheduled for night-time or poor visibility, the following conditions must be met before resupply can commence.

- No foraging whales observed within the drilling zone 30 minutes before darkness/poor visibility. If a foraging whale is observed during this time, the ALL CLEAR can only be given if it is observed to exit the zone before darkness/poor visibility.

AND

- No more than three foraging whales observed within the presurvey zone in daylight hours leading up to darkness/poor visibility.

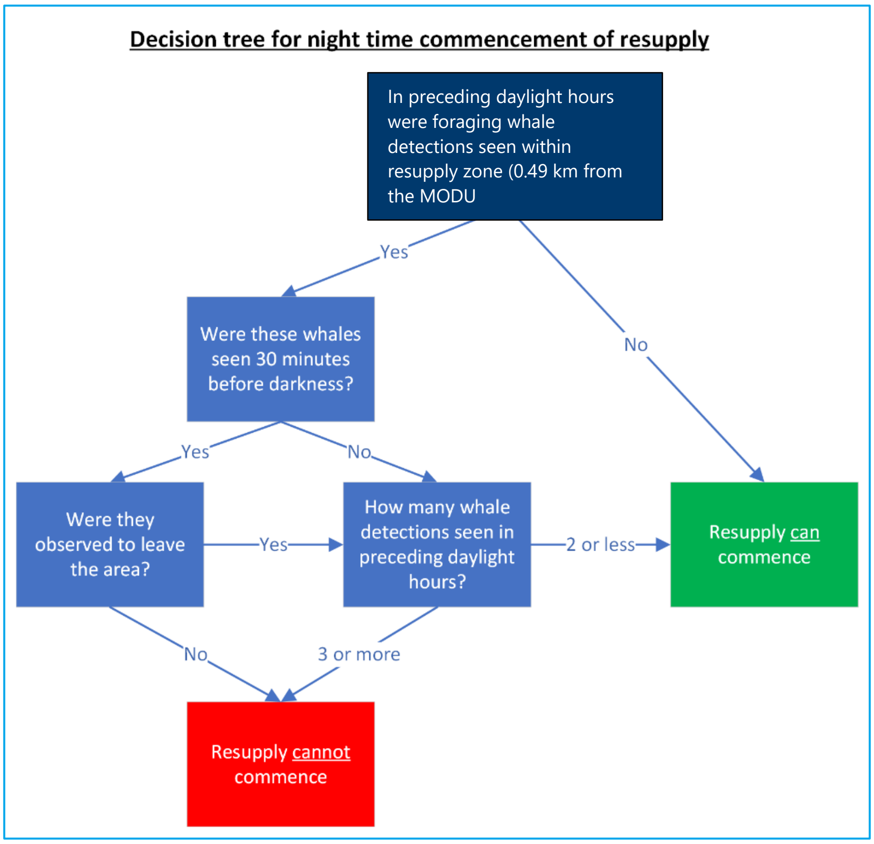


Figure 5: Decision tree for night-time resupply

8.8 Vessels on Standby

1. At all times, vessel operators shall adhere to the requirements of EPBC Regulations 8.1 Part 8 Division 8.1 – Interacting with cetaceans and report vessel interactions with dolphins and whales (in transit to and from the well location and at all times in the operational area), specifically:

- do not approach either whales or dolphins;
- maintain distances of 150 m from dolphins and 300 m from whales;

- try to maintain the separation distances without changing direction or moving into the path of the animals.
- This doesn't include bow-riding whales and dolphins

2. In addition to the above, when in the vicinity of the MODU, vessels shall maintain a minimum distance of 1.2 km from all foraging whales and reduce thruster operations to as low as reasonably practicable.

8.9 Helicopters

1. Helicopters shall not fly below 1650 ft when within 500 m horizontal distance of a cetacean except during landing or taking off and will not approach a cetacean from head on.

9 Records

9.1 Drilling Log

1. Activities and communications undertaken related to the implementation of this procedure shall be entered by the Beach Senior Drilling Supervisor in the Daily Drilling Report.

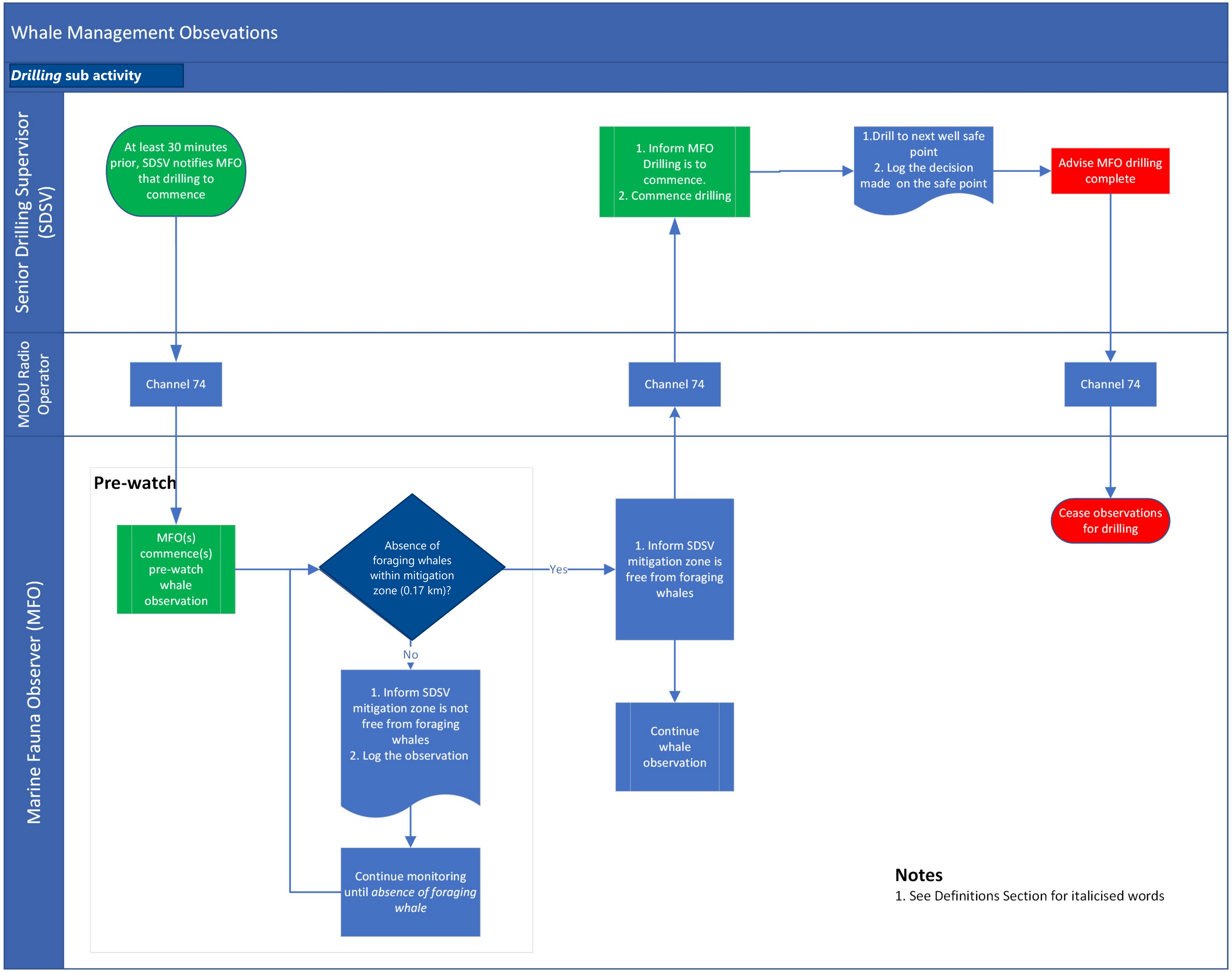
9.2 MFO Daily Log

1. MFOs shall record observations of marine fauna (specifically whales, dolphins, pinnipeds, sharks, turtles, flocks of birds and bait/krill balls) in their Daily Log.
2. At the end of the day, MFOs shall submit Daily Logs to the Lead MFO who will summarise in the daily report.

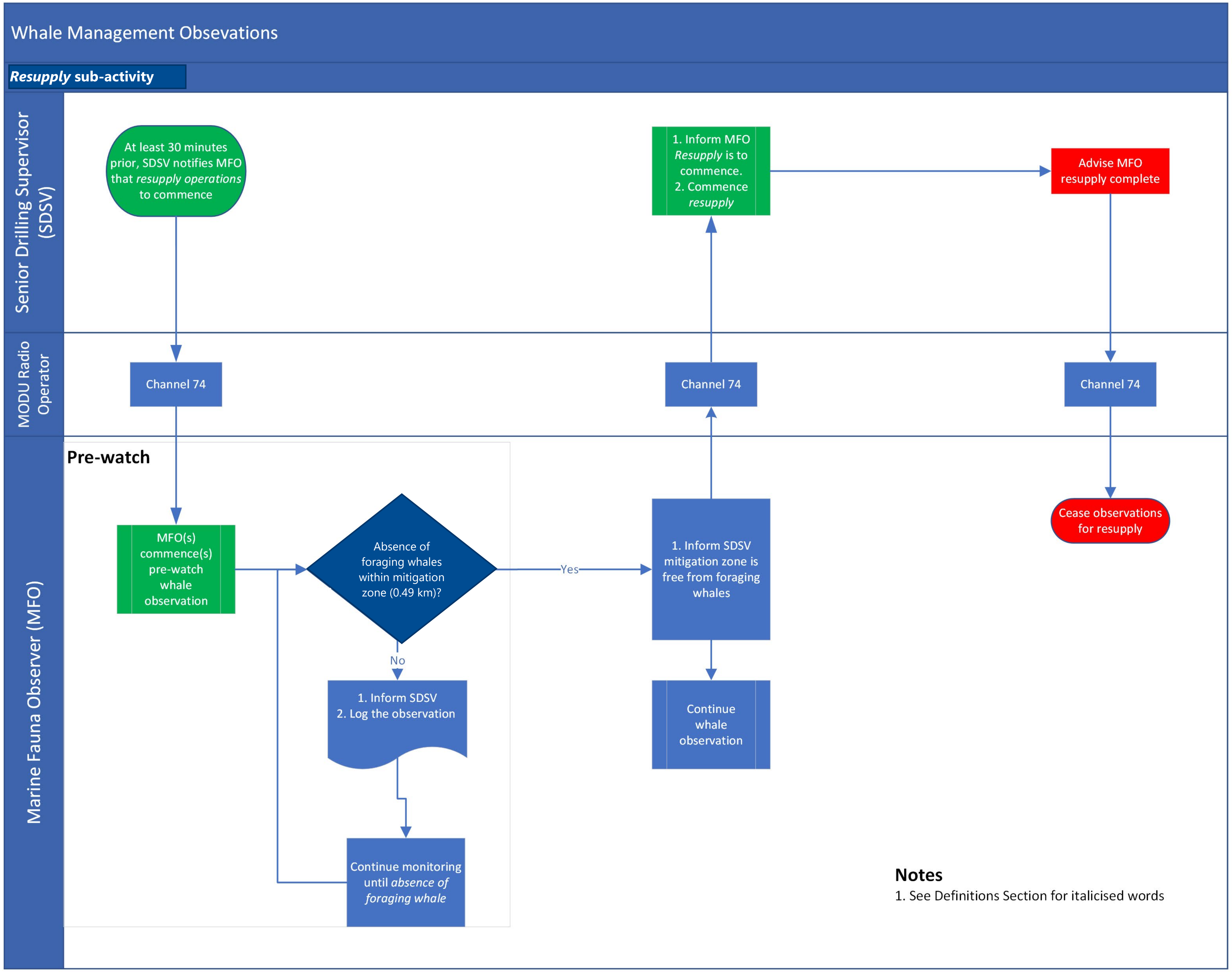
9.3 MFO Daily Report

1. Lead MFO compiles the MFO Daily Report and, as a minimum, submits to the distribution list (see below).
   - Senior Drilling Supervisor
   - HSE
   - Beach Energy Principal Environment Advisor
   - Environmental Advisor
   - Beach Drilling Superintendent
   - Beach Senior HSE Advisor (Offshore)

Attachment 1: FC1 – Whale Management actions for *drilling* sub-activity



Attachment 2: FC2 – Whale Management actions for *resupply* sub-activity



Appendix G Victorian OPEP (CDN/ID 18986979)

Plan

VIC 1000 SAF PLN
CDN/ID 18986979

Victorian Offshore Pollution Emergency Plan

Victorian - OPEP

IN THE EVENT OF AN OIL POLLUTION EMERGENCY REFER DIRECTLY TO SECTION 4

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	21/10/2021	Issued for use	FGR, GRA	SPA	TFL

Review due	Review frequency
21/10/2022	1 year

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

Table of contents

Table of figures

List of tables

List of appendices

1 Purpose

The purpose of this Victorian Offshore Oil Pollution Emergency Plan (OPEP or 'the Plan') is to:

- describe the arrangements regarding Beach Energy's access to resources and appropriately trained response personnel in order to effectively respond to and manage an emergency oil spill response in a timely manner;
- provide a timely implementation of the pre-determined response strategies as outlined in this OPEP, based on credible worst-case hydrocarbon spill risks as presented within activity-specific Environment Plan (EPs);
- ensure the processes and response structures are consistent with those used in applicable government and industry oil spill response plans, including:
    - the National Plan for Maritime Environmental Emergencies ('NatPlan') (AMSA, 2019);
    - State Maritime Emergencies (non-Search and Rescue) Plan ('VicPlan') (EMV, 2016);
    - Tasmanian Marine Oil Spill Contingency Plan ('TasPlan') (DPIPWE, 2011);
    - the AMOSPlan (AMOSC, 2017); and
    - National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) Guidance note GN1488 Rev 2 – Oil pollution risk management (NOPSEMA Feb 2018)
- ensure effective integration and use of industry and government response efforts and resources;
- meet the following regulatory requirements:
    - Commonwealth - Regulation 14(8) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (herein referred to as the OPGGS(E))
    - Victoria - Regulation 17 of the Offshore Petroleum and Greenhouse Gas Storage Regulations 2011 (herein referred to as the OPGGS Regulations)
    - Tasmania – Regulation 20 of the Petroleum (Submerged Lands) (Management of Environment) Regulations 2012 (herein referred to as the P(SL) (MoE) Regulations).

This OPEP supersedes the Oil Pollution Emergency Plan, Bass Gas Offshore Operations CDN/ID 3972816 and the Oil Pollution Emergency Plan, Otway Offshore (same CDN as this OPEP).

A list of external and internal supporting references and plans applicable to the OPEP is supplied in Appendix I.

2 The Proponent

Beach Energy (Operations) Limited (Beach), is the operator of the Otway and BassGas offshore fields.

The offshore facilities and infrastructure are presented in Figure 1 and located within the petroleum titles relevant to the scope of this OPEP (Table 3.1).

3 Scope

This OPEP covers potential oil pollution emergencies that may result from Beach petroleum activities within State and Commonwealth waters off Victoria, including the Otway and Bass Basins. Spills within the Bass or Otway Basins may impact Victorian and/or Tasmanian jurisdictions.

The plan recognises the divisions of responsibility as defined under the terms of the "NatPlan", which have been incorporated into this plan.

3.1 Interface with other Beach documents

This OPEP interfaces with the follow documents:

- Beach Crisis Management Plan (CMP) CDN 18024233.

The purpose of the CMP is to detail the required actions by Beach – to be executed by the Crisis Management Team (CMT) members in line with the principle of prioritising People, Environment, Asset, Reputation, and Livelihood (PEARL). The document provides detail on the process of notification, escalation and activation to provide a state of readiness for effective deployment and response.

The CMP addresses the response, ongoing strategic management and associated recovery responsibilities – including processes and tools to be considered – and the strategic activities required to be initiated and associated arrangements required to be in place to manage a crisis event and to support Beach activities and personnel.

The CMP details Beach's emergency hierarchy, the key responsibilities of the Beach CMT and its links to the Beach Emergency Management Team (EMT), where providing crisis event support and focus on response hierarchy and associated strategic support.

The CMP is designed to appropriately address all Beach activities, countries and/or Business Unit locations and associated operations. Activities of primary contractors, subcontractors and suppliers are also covered under the CMP and it is designed to be activated in the event of a Beach crisis event (or the potential thereof), primarily to support and emergency event originating from a site-based incident.

The CMP details the organisation of the CMT, and the key responsibilities held therein.

The key responsibilities of the CMT are:

- reaction – strategically supporting emergency management efforts to contain and control a crisis event;
- stakeholder communication – managing the demand for information and interface; and
- strategic planning – control, business continuity and recovery processes.

- Beach Emergency Management Plan (EMP) CDN 18025990

The purpose of the EMP is to provide guidance to the EMT on processes, roles and responsibilities during an event. The document provides detail on the process of notification, escalation and activation to provide a state of readiness for effective deployment and response.

The EMP comprises actions and guidelines to enable Beach to:

- support any response at any site, provide operational support and advice where the event may have an impact that cannot be handled through normal business processes;
- facilitate appropriate notifications and communication with relevant stakeholders, both internal and external;
- coordinate sourcing and deployment of additional resources as required, including corporate assistance, communications, specialist technical input and communications; and
- this is achieved through pre-planning, appropriate mitigation and recovery management, of any potential major emergency event that may be associated with Beach's operations.

The EMP describes the operational concepts, structures and Emergency Management (EM) arrangements for the management of response and recovery activities, by outlining the processes and interrelationships between Beach and various stakeholders. It is designed as a generic construct that can be adapted as required, recognising that each event will be unique and therefore it is not possible to be overly prescriptive.

Furthermore, the EMP is designed to provide overarching support of Beach activities at various sites, facilities, commercial locations and associated operations. The EMP is designed to be activated in the event of a Beach emergency or crisis, to either:

- support a serious specific site / facility emergency (drilling, exploration or production) event that requires ongoing corporate or business continuity management and involvement; or
- a Beach non-emergency related event that has the potential to significantly impact or destabilise the entire organisation.

The EMP details each level of its 3-tier Crisis and Emergency Management (CEM) Framework, the key responsibilities of each, the associated responsibilities of the EMT members and includes the required interface with each Beach Emergency Response Team (ERT), Plans, organisation and responsibilities.

The Asset and Wells Emergency Response Plans are found on the intranet and provide supporting information to this Plan.

- Beach Well Operations Management Plan (WOMP)

A NOPSEMA accepted WOMP is required prior to well activities being undertaken in accordance with Part 5 of the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011.

The purpose of the WOMP is to detail the controls in place to restore well integrity in the event of a LOWC incident.

The WOMP specifically addresses well integrity risks and controls in accordance with the requirements of Part 5 of the OPGGS (RMA) Compilation No.8 2011. Operational safety including hazard identification, risk assessment, and controls shall be described in the MODU Safety Case and a campaign specific Safety Case Revision (SCR).

A detailed description of available source control equipment and resources including deployment timeframes is provided within each Beach Offshore Source Control Contingency Plan (SCCP). For the avoidance of doubt, each offshore well has its own individual SCCP.

Well specific SCCPs detail the source control strategy to contain a LOWC event in an effective and timely manner and is submitted to NOPSEMA as part of the WOMP. These SCCPs are consistent with International Oil and Gas Producers (IOGP) Report 594 - Subsea Well Source Control Emergency Response Planning Guide for Subsea Wells (Jan 2019). The SCCPs specifically detail:

  - the structure, function and responsibilities of the Beach Emergency Management Team (EMT) and Source Control Incident Management Team (Source Control IMT) inclusive of external support services;
  - details of well control and emergency response procedures and processes to be applied by the EMT and SCIMT during a LOWC event;
  - an analysis of alternate MODUs capable of both being mobilised to the relief well location and of performing a dynamic well kill operation based upon identified selection criteria (including technical capability, current location, Australian Safety Case status and mutual aid arrangements);
  - a mobilisation and deployment plan (including logistical pathways, potential constraints, and schedule) for equipment and personnel for effective implementation of source control (dynamic well kill and/or well capping where feasible) in a timely manner.
  - a well-specific worst-case discharge (WCD) analysis and well kill simulation;
  - pre-identified relief well locations and relief well intersection targets; and
  - casing design, mud kill weight and pumping rate required to achieve a dynamic well kill based upon the intersection target.

- Activity-specific Environmental Plan (EP)

All petroleum activities in Commonwealth and State waters require an activity specific EP. Each EP includes:

  - activity specific WCD oil pollution emergency scenarios;
  - description of the environment that may be affected (EMBA) by an oil pollution emergency including key ecological and socio-economic receptors including matters protected under Part 3 of the EPBC Act;

- person(s) or organisations whose interests or activities may be affected by an oil pollution emergency;
- impact and risk evaluation for both planned operations and unplanned events inclusive of oil pollution;
- spill response needs analysis based upon activity spill risk profile; and
- response option feasibility assessment and ALARP (As Low As Reasonably Practicable) evaluation; and
- site specific Tactical Response Plans (TRP)

Site specific TRPs have been developed for priority protection areas along the Victorian coastline. The purpose of the TRPs is to pre-determine site and response information prior to an oil pollution incident to ensure an informed, timely and effective protection of priority areas as required. The TRPs detail:

Site Information: site location description and map, site access description and map, site specific logistical / access constraints, key ecological and socio-economic sensitivities within the area, nearby facilities and services.

Response Information: response strategies and tasks, site overview and maps, response checklists, site establishment information, local information including contact details of key stakeholders, detailed task checklists, resource requirements (personnel / vehicles / vessels / equipment / site support).

- Vessel-specific Shipboard Oil Pollution Emergency Plan (SOPEP) or Shipboard Marine Pollution Emergency Plan (SMPEP);
- SOPEP and SMPEP detail vessel specific spill response arrangements
- Beach Offshore Victoria Operational and Scientific Monitoring Program (OSMP).

The Offshore Victoria OSMP provides the framework for environmental monitoring response to Level 2 and Level 3 offshore oil spills from petroleum activities undertaken by Beach in the Otway and Bass Basins.

The OSMP is to be read in conjunction with the relevant EP, this OPEP, and the activity specific Addendum to the OSMP when considering the existing environment, values and sensitivities, credible oil spill risks and potential impacts, response activities and the decision processes that will apply if a spill occurs.

The OSMP is relevant to all Beach petroleum activities within the Otway and Bass Basins regulated under the Commonwealth OPGGS(E)R, Victorian OPGGSR and Tasmanian P(SL)(ME)R. This includes, but is not limited to the following activity types:

- operation of a facility or pipeline
- vessel activities

- drilling

Spill risks from the above activities that could result in a Level 2 or Level 3 spill event include two oil types:

- gas condensate
- marine diesel.

The OSMP is relevant to all oil types and states (i.e., fresh and weathered); and all distributions throughout the environment (e.g., surface, entrained, dissolved and shoreline).

3.2 Beach Offshore Facilities and Activities within the Otway and Bass Basins

This OPEP covers petroleum activities in Commonwealth waters, Victorian State waters and Tasmanian State waters, within the Otway and Bass Basins.

Beach facilities and activities covered by this OPEP are summarised in Table 1. A detailed description of offshore facilities and petroleum activities is available within activity-specific EPs.

The locations of facilities, infrastructure and petroleum titles covered by this OPEP are presented in Figure 1.

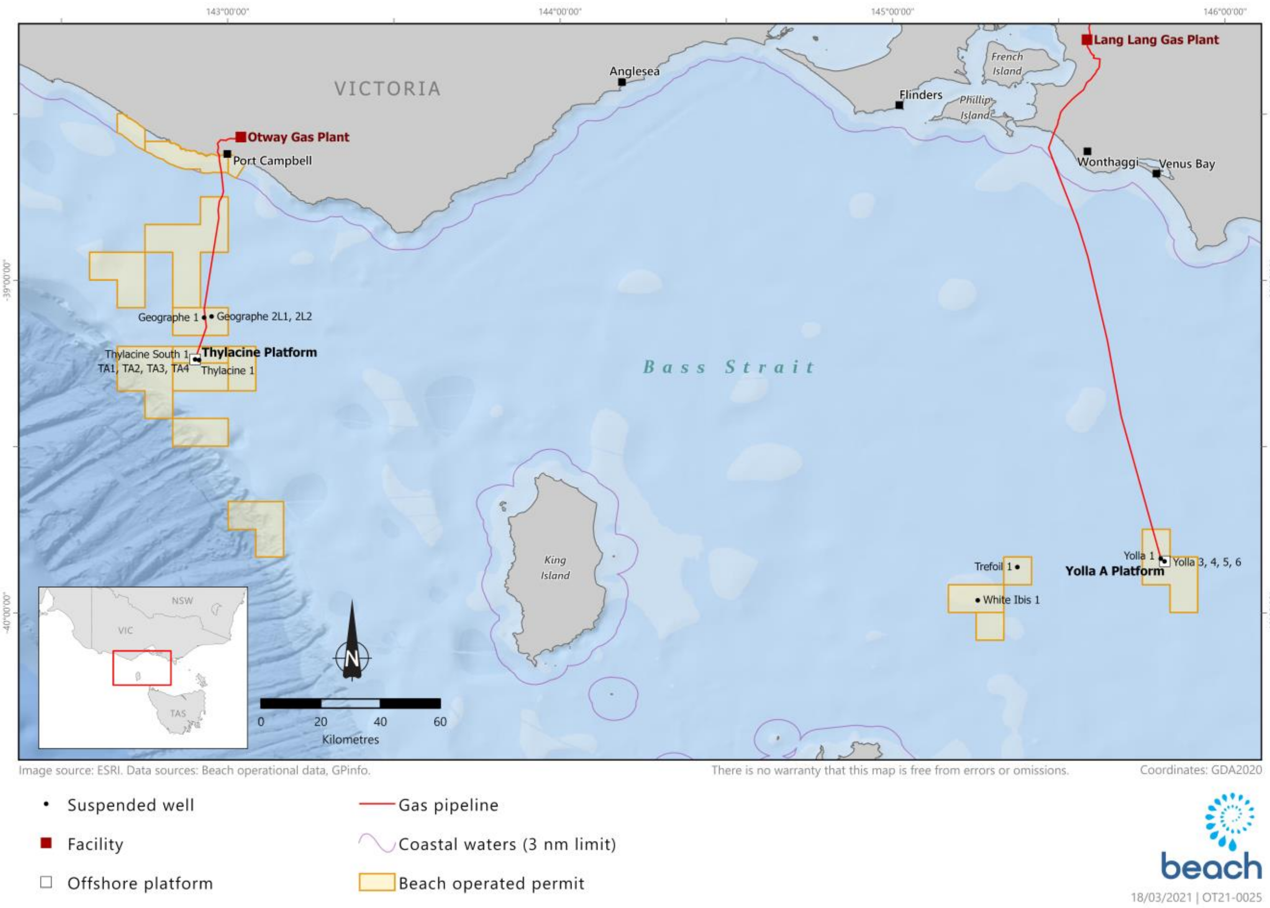


Figure 1: Beach Offshore Victoria Assets

Table 1: Summary of Beach facilities and activities within Victorian waters

Facility / Activity	Description	Title	Hydrocarbon type	Minimum distance from shore	Water Depth (approx.)	Flight Time (approx.)	Vessel Steaming Time (approx.)
Geographe production wells	Producing Geographe gas wells and two plugged and suspended Geographe wells (GEO-1 and GEO-3),	VIC/L23	Geographe gas condensate	45 km	80 m	20 min (Warrnambool)	16 hrs (Port Anthony)
Thylacine production wells	Producing Thylacine gas wells and the plugged and suspended Thylacine 1 exploration well.	TL/2 TL/3	Thylacine gas condensate	70 km	100 m	25 min (Warrnambool)	20 hrs (Port Anthony)
Thylacine Platform-A (unmanned)	Unmanned Thylacine-A production platform, supporting the wellheads and topsides facilities required for production metering from the combined Thylacine wells.	T/L2	Thylacine gas condensate	70 km	100 m	25 min (Warrnambool)	20 hrs (Port Anthony)
Otway Gas Pipeline	Offshore pipeline system consisting of a 500mm (20 inch) production pipeline and a 100mm mono ethylene glycol (MEG) piggyback service pipeline from the platform to the shore crossing at the Port Campbell Rifle Range, situated to the west of Port Campbell.	VIC/PL36(V) VIC/PL36 T/PL3	Co-mingled gas condensate	0-70 km	Shallow to 100 m	Varies	Varies
Offshore Drilling	Exploration and production drilling.	VIC/P43	Thylacine gas condensate	32 km	70 m	15 min (Warrnambool)	10 hrs (Port Anthony)
	La Bella production drilling.	VIC/P73	Gas condensate	45 km	90 m	20 min (Warrnambool)	16 hrs (Port Anthony)
	Geographe production drilling.	VIC/L23	Geographe gas condensate	45 km	80 m	20 min (Warrnambool)	16 hrs (Port Anthony)

Facility / Activity	Description	Title	Hydrocarbon type	Minimum distance from shore	Water Depth (approx.)	Flight Time (approx.)	Vessel Steaming Time (approx.)
	Thylacine production drilling.	T/L2 T/L3	Thylacine Gas condensate	70 km	100 m	25 min (Warrnambool)	20 hrs (Port Anthony)
Otway Basin Vessel-based activities	Site surveys & project support.	T/L1	Marine Diesel	0-70 km	Shallow to 100 m	Up to 25 min (Warrnambool)	Up to 20 hrs (Port Anthony)
Yolla production wells	Four producing Yolla gas wells and two plugged and suspended wells	T/L1	Gas and condensate	93 km	80 m		
Yolla-A Platform	Manned Yolla-A production platform, supporting the wellheads and topsides facilities	T/L1	Gas and condensate	93 km	80 m		
Yolla offshore Raw Gas Pipeline (RGP)	Offshore RGP system (350 mm diameter) from the platform to the shore crossing near Kilcunda	T/L1	Gas and condensate	0 - 93 km	Shallow to 80 m		
Bass Gas Vessel-based activities	Platform support, inspection and maintenance activities	T/L1	Marine Diesel	0 - 93 km	Shallow to 80 m		
Bass Strait Non-production wells	Suspended wells in the Bass Strait; Trefoil 1, White Ibis 1, and Yolla 1	T/RL2, T/RL4, T/L1	Gas condensate	83 km	60 – 80 m		
Otway Basin Non-production wells	Suspended wells in the Otway Basin; Aritsan 1, Geographe 1 and 3, Thylacine 1	VIC/P43, VIC/L23, T/L2	Gas condensate	32 km	70 – 100 m		

3.3 Hydrocarbon Types

There are two types of hydrocarbon covered in this OPEP that are associated with Beach's offshore activities;

- marine diesel
- gas condensate (Artisan, Geographe, Thylacine and Yolla).

3.3.1 Marine Diesel

Marine diesel (DMA blend) is a light petroleum distillate. At the environmental conditions experienced in Otway and Bass Basins, marine diesel is predicted to undergo rapid evaporative loss and slicks are expected to break up rapidly. Characteristics of the DMA blend diesel are detailed in Table 2 and Table 3.

Table 2: Marine diesel physical characteristics

Parameter	MDA Blend
Density (kg/m^3)	829 at 15°C
API	37.6
Dynamic viscosity (cP)	4.0 at 25°C
Pour point (°C)	-14
Oil category	Group II
Oil persistence classification	Light-persistent oil

Table 3: Marine diesel boiling point ranges

Parameter	Volatiles (%)	Semi-volatiles (%)	Low-volatiles (%)	Residual (%)
Boiling point (°C)	<180	180-265	265-380	>380
DMA Blend Diesel	6.0	34.6	54.4	5
	⇦	Non-Persistent ⇨		⇦ Persistent ⇨

3.3.2 Gas Condensate

The target reservoirs within the Otway and Bass Basins are gas condensate. As a result, no heavy oil will be present during extraction or drilling activities. The fields of the Otway and Bass Basins have slightly different condensate characteristics and potential flow rates (pressures). Characteristics of the gas condensate from the production wells are detailed in Table 4.

Condensate characteristics indicate that spills of these fluids are likely to spread rapidly, and residual hydrocarbons potentially distributed over a large area. Any slicks will break up readily as a result of weathering processes.

Table 4: Condensate Otway Basin

Parameter	Geographe	Thylacine	Yolla
Density (kg/m^3)	751 at 15°C	805 at 15°C	770.6 at 15°C
API	56.9	44.3	
Dynamic viscosity (cP)	0.500 at 25°C	0.875 at 20°C	0.14 at 25°C
Pour point (°C)	-50	-50	
Oil category	Group I	Group I	Group I
Oil persistence classification	Non-persistent oil	Non-persistent oil	Non-persistent oil
Volatiles %	78.4	64.0	80
Semi-volatiles %	13.4	19.0	12
Low-volatiles %	7.2	16.0	6.55

3.4 Potential Worst-Case Spill Scenarios

The potential worst-case hydrocarbon spill scenarios relating to the offshore activities are:

- for drilling an open-hole and unrestricted well release from the Artisan-1 location representing the overall worst-case loss of well control (LOWC) within the Otway or Bass Basins given their proximity to shore, noting other wells within the area may have similar flow rates and reservoir properties but are in deeper water and located further from shore
- an uncontrolled well release from the Geographe production well location
- an uncontrolled well release from the Thylacine production well location
- an uncontrolled well release from the Yolla production well location
- a pipeline rupture
- a release of marine diesel from a vessel involved in the Otway or Bass Basin offshore activities, either near-shore or in deep water.

These hypothetical WCD have been subject to modelling via an OILMAP stochastic module used to quantify the probability of sea surface exposure, contact to shorelines, largest shoreline loading, time to shoreline loading, in-water dissolved aromatic and entrained hydrocarbon concentrations. This involved simulating multiple spill trajectories with randomly varying metocean conditions to represent varying annual conditions.

An analysis of the modelling results for visual and actionable surface and shoreline exposure, minimum time to shoreline contact and maximum shoreline loading is presented in Table 5 and 3-7. Further detail relating to spill modelling results and potential environmental impacts can be found within activity-specific EPs.

3.5 Spill Modelling Analysis

Table 5: Analysis of spill modelling

Spill Scenario	Drilling 8-1/2" open hole	Producing Wells		Pipeline Rupture	Vessel Spill	
Location	Artisan-1	Thylacine	Geographe	3 nm from shore – State / Commonwealth boundary	Artisan-1	3 nm from shore – State / Commonwealth boundary
Product	Thylacine condensate		Geographe Condensate	Co-mingled Condensate	DMA Blend Diesel	
Release Volume	2,584 bbl/day	1,010 bbl/day	750 bbl/day	1,175 bbl	300 m^3	300 m^3
Duration	86 days	86 days	86 days	14.4 min	6 hours	6 hours
Sea Surface 0.5g/m^2 (Barely Visible)	Up to 52 km and 53 km from the release site under summer and winter conditions, respectively Dissipates in <2 days	Up to 15 km and 17 km from the release site under summer and winter conditions, respectively	Up to 6 km and 7 km from the release site under summer and winter conditions, respectively	Up to 14.1 km and 19.6 km from the release site under summer and winter conditions, respectively Dissipates in <2 days	Up to 68 km and 93 km from the release site under summer and winter conditions, respectively Dissipates in <2 days	Up to 31.5 km and 45.8 km from the release site under summer and winter conditions, respectively Dissipates in <2 days
Sea Surface >10 g/m^2 (Actionable)	Up to 4 km and 3 km from the release site under summer and winter conditions, respectively Dissipates in <1 day	Nil	Nil	Up to 4.9 km and 5.2 km from the release site under summer and winter conditions, respectively Dissipates in <1 day	Up to 12 km and 10 km from the release site under summer and winter conditions, respectively Dissipates in <2 days	Up to 26.1 km and 33.9 km from the release site under summer and winter conditions, respectively Dissipates in <2 days
Shoreline >100 g/m^2 (Actionable)	Up to 4 km summer & 8 km winter	Nil	Nil	Up to 3 km summer & 4 km winter	Nil	Up to 10 km summer & 9.5 km winter

Spill Scenario	Drilling 8-1/2" open hole	Producing Wells		Pipeline Rupture	Vessel Spill	
Shoreline >1000 g/m^2 (High loading)	Nil	Nil	Nil	Nil	Nil	Up to 4 km summer & 4.5 km winter
Shoreline Minimum Time to Contact	3 days summer & 5 days winter	N/A	N/A	7 hours summer & winter	N/A	5 hours summer & winter
Shoreline Maximum Loading m^3	15 m^3 summer and 33 m^3 winter	Nil	Nil	5.0 m^3 summer and 6.5 m^3 winter	Nil	142 m^3 summer and 110 m^3 winter

Table 6: Summary of BassGas sea surface and shoreline OSTM results

Spill Scenario	LoWC	Pipeline Rupture	Vessel Spill
Location	Yolla wells	3 nm from shore	3 nm from shore
Product	Condensate	Condensate	MDO
Release volume	204,250 bbl	3,144.9 bbl	300 m^3
Duration	86 days	57.6 minutes	6 hours
Sea Surface			
1 – 10 g/m^2 (barely visible)	Up to 17.3 km from release site	Up to 9.4 km from release site	Up to 26.6 km from release site
10 – 50 g/m^2 (Actionable)	Nil	Up to 3 km from release site	Up to 10.7 km from release site
≥ 50 g/m^2 (Actionable)	Nil	Up to 0.7 km from the release site	Up to 2.5 km from release site

Shoreline			
Maximum length of shoreline contacted >100 g/m² (Actionable)	No contact	4 km	7 km
Maximum length of shoreline contacted >1,000 g/m² (High loading)	No contact	No contact	4 km
Absolute minimum time before contact at or above the low threshold	No contact	12 hours	10 hours
Mean maximum volume on shoreline	No contact	6.8 m^3	24 m^3

3.6 Response Areas

Figure 2 and Figure 3, represent the Otway Basin areas, and Figure 4 provides the Bass Basin area where a spill response could be undertaken to; protect, deflect, or mount a shoreline clean-up operation.

To identify areas where a response may be actionable the following oil exposures were used from NP–GUI–025: National Plan response, assessment and termination of cleaning for oil contaminated foreshores (AMSA 2015):

- A sea surface oil exposure of 10 g/m^2 as this represents the practical limit for surface response options; below this thickness, oil containment, recovery and chemical treatment (dispersant) become ineffective
- A shoreline contact exposure of 100 g/m^2 as this represents the minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone.

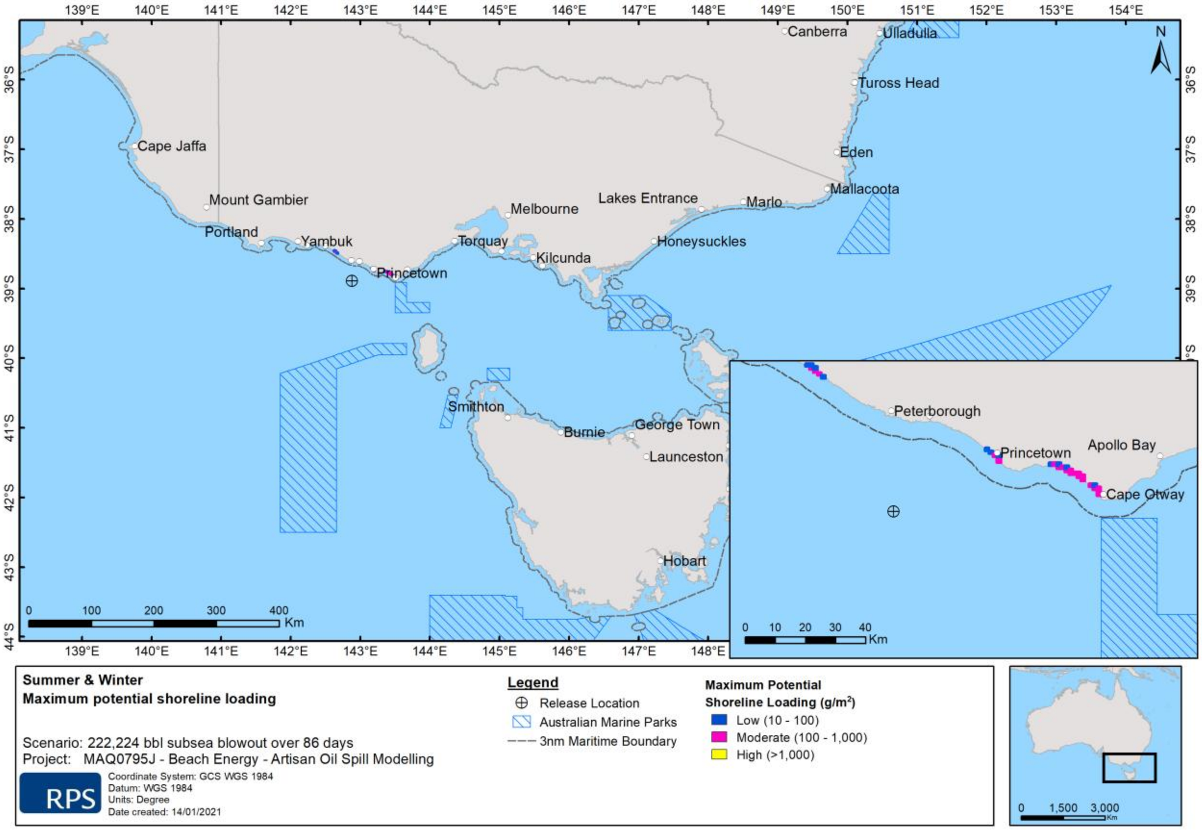


Figure 2: Condensate spill (LOWC) actionable response areas, Otway Basin – Summer & Winter (RPS APASA, 2019)

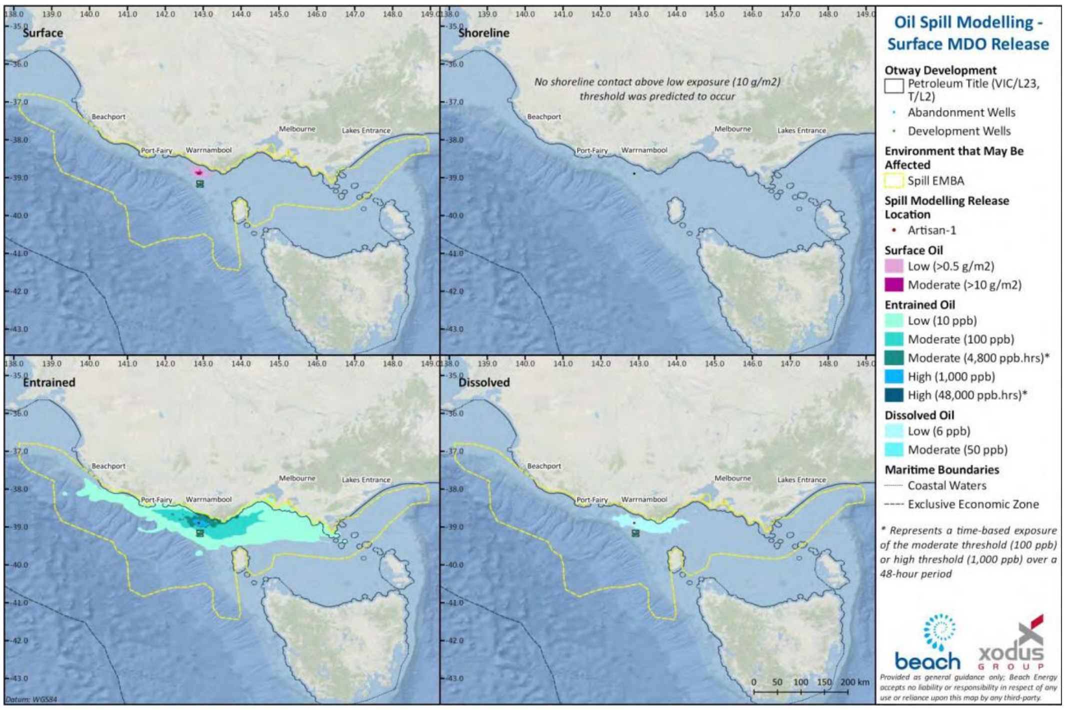


Figure 3: Marine diesel spill (300m^3), Otway Basin

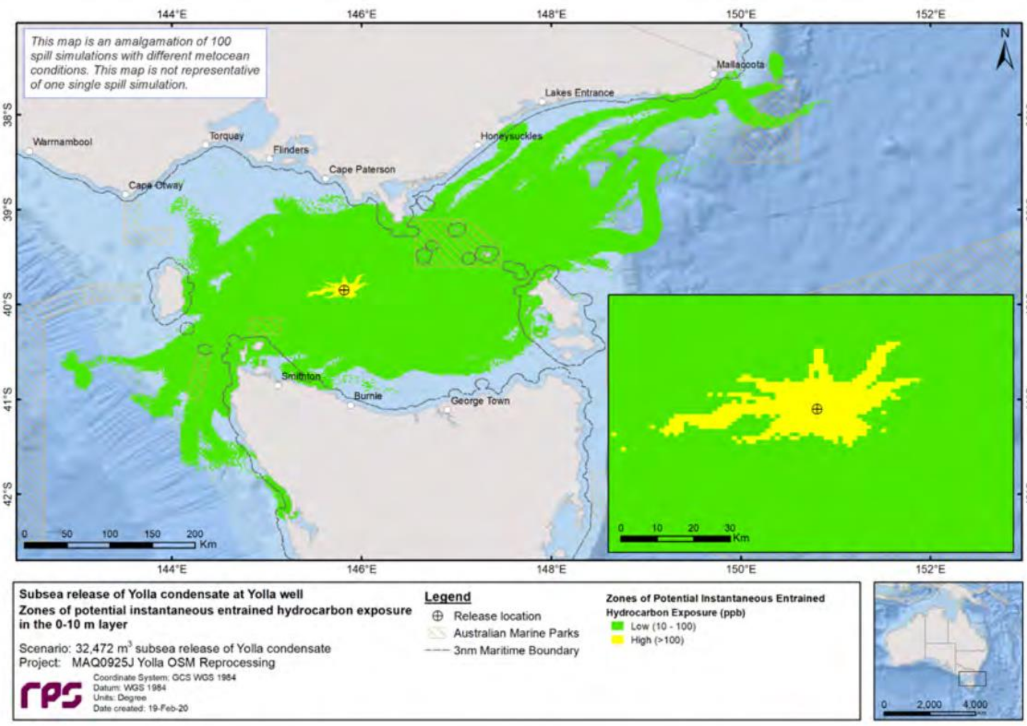


Figure 4: Condensate spill (LOWC), Bass Basin (RPS APASA, 2020)

4 Response Actions

4.1 Response Levels and Control Agencies

4.1.1 Level of Incident

The National Plan classifies incidents to provide direction on the potential consequence and impact of an incident. This assists in guiding agency readiness levels, incident notifications, response actions and potential response escalations. Beach's response plan is based on those identified by the National Plan and consists of three levels, which are based on the size and/or complexity of the incident.

Level 1 Incidents are generally able to be resolved through the application of local or initial resources only (first strike capability).

Level 2 Incidents are more complex in size, duration, resource management and risk and may require deployment of jurisdiction resources beyond the initial response.

Level 3 Incidents are generally characterised by a degree of complexity that requires the Incident Controller (EMT Leader) to delegate all incident management functions to focus on strategic leadership and response coordination and may be supported by national and international resources

4.1.2 Statutory and Control Agencies

Under existing Commonwealth and State Intergovernmental Agreements, authorities have been nominated with statutory and control responsibility for incidents within harbours, State waters and Commonwealth waters around Australia.

While Beach remains accountable for spills relating to its petroleum operations, the nominated Control Agency will vary depending on source, size and location of the spill as defined in Table 7.

State agencies such as the Victorian Department of Jobs, Precincts and Regions (DJPR) or the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE), may assume Incident Control in state waters under the following circumstances:

- the incident is greater than a Level 1 spill in state waters and requires immediate escalation
- the incident occurred in Commonwealth waters, but has impacted on State waters
- the Control Agency has requested State assistance
- the State believes that Beach is not implementing an appropriate response to the incident.

4.1.2.1 Victorian State Arrangements

If an incident occurs in Commonwealth waters and impacts Victorian State waters (spreading oil slick for example), DJPR will assume Incident Control over the impacted area in State Waters. The Control Agency in Commonwealth Waters will remain responsible for managing the spill outside Victorian coastal waters in consultation with the State.

Whilst DJPR is the Control Agency for marine pollution in Victorian State waters, Beach shall conduct initial necessary response actions in State waters, in accordance with this OPEP and continue to manage those operations until formal incident control can be established by DJPR.

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.

If an incident affecting wildlife occurs in Commonwealth waters close to Victorian State waters, the Control Agency may request support from Department of Environment, Land, Water and Planning (DELWP) to assess and lead a wildlife response.

Additional detail on the management of a cross-jurisdiction marine pollution incident that originates in Commonwealth waters and results in DJPR exercising its control agency obligations in State waters is provided in Section 5.7.

4.1.2.2 Tasmanian State Arrangements

The Tasmanian Environmental Protection Authority (EPA) Division (DPIPWE) is responsible for preparedness for and responding to oil and chemical spills in Tasmania. If an incident occurs in Commonwealth waters and has an impact on Tasmanian State waters, DPIPWE will assume Incident Control over the impacted area in State waters while the Commonwealth Waters Control Agency will remain responsible for managing the spill outside Tasmanian coastal waters in consultation with the State.

When under direction of DPIPWE, a Beach EMLO, shall be allocated to DPIPWE.

The Tasmanian Oiled Wildlife Response Plan (WildPlan) is administered by the Resource Management and Conservation Division of the DPIPWE and outlines priorities and procedures for the rescue and rehabilitation of oiled wildlife.

Table 7: Statutory and Control Agencies

Spill Source	Level of Spill	Impact to State Waters (<3nm)	Impact to Commonwealth Waters (>3nm)	Statutory Agency	Control Agency
Condensate release from platform, sub-sea wells / installation or pipeline	1	✓		Vic DJPR Tas DPIPWE	Beach
			✓	NOPSEMA	Beach
	2	✓		Vic DJPR Tas DPIPWE	Vic DJPR Tas DPIPWE
			✓	NOPSEMA	Beach
	3	✓		Vic DJPR Tas DPIPWE	Vic DJPR Tas DPIPWE
			✓	NOPSEMA	Beach
Diesel release from vessel	1	✓		Vic DJPR Tas DPIPWE	Vessel Owner / Operator
			✓	Australian Maritime Safety Authority (AMSA)	Vessel Owner / Operator

Spill Source	Level of Spill	Impact to State Waters (<3nm)	Impact to Commonwealth Waters (>3nm)	Statutory Agency	Control Agency
			✓ (within 500m platform exclusion zone)	NOPSEMA	Vessel Owner / Operator
	2 and 3	✓		Vic DJPR Tas DPIPWE	Vic DJPR Tas DPIPWE
			✓	AMSA	AMSA

4.2 Immediate Action Plans and Notification Requirements (Contacts correct as of 01 November 2019)

Confirmation of providing access to relevant monitoring and evaluation reports when available; and

4.2.1 Vessel Spill / Collision (L1 / L2 / L3)

Table 8: Immediate Action Plan – Vessel Spill / Collisions

Item	Action	Responsibility	Timing
1.	**Initial Emergency Actions**		
1.1	Implement the relevant emergency response procedures to protect human life and the environment in accordance with the vessel SOPEP / SMPEP	Vessel Master	Immediate
1.2	Identify any potential fire risks and attempt to isolate the supply of oil to the spillage	Vessel Master	Immediate
1.3	Identify the extent of spillage and the weather/sea conditions in the area using SITREP (Appendix C. 2)	Vessel Master	ASAP
1.4	Notify Production Manager / MODU OIM / Drill Site Manager and provide initial SITREP (Appendix C. 2)	Vessel Master	ASAP
1.5	Notify Production Manager / Drilling Manager	PM / MODU OIM / Drill Site Manager	ASAP
1.6	Notify EMT Leader via NRC (03) 9411 2147	Beach PIC	ASAP
2.	**Level 1 Notifications**		
2.1	Any vessel collision with a facility or MODU within Commonwealth waters (>3 nm) and / or any hydrocarbon spill >80 L AMSA: Ph: 1800 641 792 Email: mdo@amsa.gov.au NOPSEMA: Ph: 1300 674 472 Email: submissions@nopsema.gov.au	Vessel Master / Production Manager / Drilling Manager	ASAP but not later than 2 hours after collision / spill

Item	Action	Responsibility	Timing
2.2	Spill with potential to impact Australian Marine Park(s) or impact matters of national environmental significance (including potential for oiled wildlife) Director of National Parks via Marine Compliance Duty Officer (24-hr): 0419 293 465 Provide: • titleholder details • time and location of the incident (including name of marine park likely to be affected) • proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) • confirmation of providing access to relevant monitoring and evaluation reports when available; and • contact details for the response coordinator. Department of the Environment and Energy: Ph: (02) 6274 1111	Vessel Master / Production Manager / Drilling Manager	ASAP
2.3	Within or potential for moderate to significant environmental damage to Victorian State waters (<3 nm) – refer to activity-specific EP for clarification (Victorian) Department of Jobs, Precincts and Regions – Emergency Management Branch (DJPR EMB): Ph: 0409 858 715 (24/7) and Email: semdincidentroom@ecodev.vic.gov.au	Vessel Master / Production Manager / Drilling Manager	ASAP
2.4	Within or potential for release to cause, or may cause, environmental harm or environmental nuisance in Tasmanian State waters (<3 nm) – refer to activity-specific EP for clarification DPIPWE: Ph: +61 (0)3 6165 4599 or 1800 005 171 (within Tasmania only) Radio: TasPorts Vessel Traffic Services VHF radio channel 16/14/12 Call sign "relevant port name VTS" Email: incidentresponse@epa.tas.gov.au	Vessel Master / Production Manager / Drilling Manager	ASAP
2.5	Within port boundary or potential impact to Port boundary – notify relevant Port Authority	Vessel Master	Immediate
2.6	Complete Level 1 Incident Report (Appendix C. 3)	Vessel Master / Production Manager / Drilling Manager	ASAP
2.7	Notify and escalate to the EMT via the NRC (03) 9411 2147	Production Manager / Drilling Manager	Immediate
3.	**Level 2 / 3 Notifications**		
3.1	Notify EMT Leader for any spill or **any** vessel collision and provide initial SITREP (Appendix C. 2)	Production Manager / Drilling Manager	Immediate

Item	Action	Responsibility	Timing
3.2	Any vessel collision with a facility or MODU within Commonwealth waters and / or any Level 2 / 3 vessel spill AMSA: Ph: 1800 641 792 Email: mdo@amsa.gov.au NOPSEMA: Ph: 1300 674 472 Email: submissions@nopsema.gov.au	EMT HSE	ASAP but not later than 2 hours after becoming aware of spill
3.3	Within Commonwealth waters (> 3nm) – written report to NOPSEMA: Email: submissions@nopsema.gov.au and NOPTA: Email: info@nopta.gov.au	EMT HSE	Within 3 days of spill
3.4	Spill with potential to impact Australian Marine Park(s) or impact matters of national environmental significance (including potential for oiled wildlife) Director of National Parks via Marine Compliance Duty Officer (24-hr): 0419 293 465 Provide: ◦ titleholder details ◦ time and location of the incident (including name of marine park likely to be affected) ◦ proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) ◦ confirmation of providing access to relevant monitoring and evaluation reports when available; and ◦ contact details for the response coordinator. And Department of the Environment and Energy: Ph: (02) 6274 1111	EMT HSE	ASAP
3.5	Within or potential for moderate to significant environmental damage to Victorian State waters (<3 nm) – refer to activity-specific EP for clarification or the impact of wildlife (including cetaceans) DJPR EMB: Ph: 0409 858 715 (24/7) and Email: semdincidentroom@ecodev.vic.gov.au and DELWP: Ph: 1300 134 444 Email: sscviv.scmdr.delwp@scc.vic.gov.au	EMT HSE	ASAP but not later than 2 hours after becoming aware of spill
3.6	Within or potential for release to cause, or may cause, environmental harm or environmental nuisance in Tasmanian State waters (<3 nm) – refer to activity-specific EP for clarification DPIPWE: Ph: +61 (0)3 6165 4599 or 1800 005 171 (within Tasmania only) Radio: TasPorts Vessel Traffic Services VHF radio channel 16/14/12 Call sign "relevant port name VTS" Email: incidentresponse@epa.tas.gov.au	EMT HSE	ASAP (first instance of oil on/in water)

Item	Action	Responsibility	Timing
3.7	Within port boundary or potential impact to Port boundary – notify relevant Port Authority	Vessel Master	Immediate
3.8	Complete Level 2/3 Incident Report (Appendix C. 4)	EMT HSE	ASAP
3.9	Confirm takeover of incident control by AMSA (>3 nm) or State agency as the Control Agency (<3 nm)	EMT HSE	ASAP
4.	**Level 2 / 3 Monitoring, Evaluation & Surveillance**		
4.1	Request monitoring assistance from AMOSC via execution of Service Contract using Service Request for Mutual Aid (Appendix C. 6) as directed by Control Agency	EMT Leader	ASAP
4.2	Mobilise surveillance by aircraft via service provider (Appendix D, Appendix E, Appendix F) as directed by Control Agency	EMT Logistics	ASAP
4.3	Initiate Oil Pollution trajectory modelling via service provider (Appendix C. 5) as directed by Control Agency	EMT Logistics	ASAP
5.	**Level 2 / 3 Oil Pollution Response**		
5.1	Provide support and information to the Control Agency as directed	EMT Leader via EMLO	As directed
5.2	Determine offshore and onshore response options and request assistance from AMOSC via execution of Service Contract using Service Request for Mutual Aid (Appendix C. 6) and/or AMSA as directed by Control Agency AMSA: Ph: 1800 641 792 Email: mdo@amsa.gov.au AMOSC: 0438 379 328	EMT Leader	As directed
5.3	Assess and monitor shoreline and intertidal zones to identify areas affected by the Oil Pollution and to determine the nature of the impact (Appendix G) as directed by Control Agency	EMT Leader	As directed
5.4	Validate and agree implementation of relevant Tactical Response Plan(s) with Control Agency	EMT Leader / EMLO	ASAP
5.5	Implement Team Meeting and Operational Planning Cycle (Section 6.1)	EMT Leader	ASAP
5.6	Complete role-specific checklists as outlined in Appendix A. 3	All EMT	ASAP
6.	**Ongoing Monitoring**		
6.1	Implement Beach Offshore Victoria OSMP as directed by State Control Agency	EMT Leader / Monitoring Provider	As required

4.2.2 Loss of Integrity – Platform or Pipeline (L2 / L3)

Table 9: Immediate Action Plan – Loss of Integrity from Platform or Pipeline

Item	Action	Responsibility	Timing
1.	**Initial Emergency Actions**		
1.1	Implement the relevant emergency response procedures to protect human life and the environment and, those procedures focused at reducing the risk of fire or explosion	PIC	Immediate
1.2	Identify any potential fire risks and attempt to isolate the supply of oil to the spillage	PIC	Immediate
1.3	Identify the extent of spillage and the weather/sea conditions in the area using SITREP (Appendix C. 2)	PIC	ASAP
1.4	Notify Production Manager and provide initial SITREP (Appendix C. 2)	PIC	ASAP
1.5	Notify GM Vic Operations and provide initial SITREP (Appendix C. 2)	Production Manager	ASAP
1.6	Notify EMT Leader via NRC (03) 9411 2147	Production Manager	ASAP
2.	**Level 1 Notifications**		
2.1	Within Commonwealth waters (>3 nm) and / or any hydrocarbon spill >80 L NOPSEMA: Ph: 1300 674 472 Email: submissions@nopsema.gov.au	Production Manager (Production Manager may delegate the following actions to Beach Manager in charge of site)	ASAP but not later than 2 hours after spill
2.2	Spill with potential to impact Australian Marine Park(s) or impact matters of national environmental significance (including potential for oiled wildlife) Director of National Parks via Marine Compliance Duty Officer (24-hr): 0419 293 465 Provide: • titleholder details • time and location of the incident (including name of marine park likely to be affected) • proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) • confirmation of providing access to relevant monitoring and evaluation reports when available; and • contact details for the response coordinator. And Department of the Environment and Energy: Ph: (02) 6274 1111	Production Manager	ASAP
2.3	Within or potential for moderate to significant environmental damage to Victorian State waters (<3 nm) – refer to activity-specific EP for clarification DJPR EMB: Ph: 0409 858 715 (24/7) and Email: semdincidentroom@ecodev.vic.gov.au	Production Manager	ASAP

Item	Action	Responsibility	Timing
2.4	A release or potential release from pipeline within 3 nm (Victorian) Department of Jobs, Precincts and Regions – Earth Resources Regulation (DJPR ERR): Ph: 0419 597 010 (ERR Duty Officer) and Email: Compliance.Southwest@ecodev.vic.gov.au	Production Manager	ASAP
2.5	Complete Level 1 Incident Report (Appendix C. 3)	Production Manager	ASAP
2.6	Notify and escalate to the EMT if available response resources are inadequate	Production Manager	ASAP
3.	**Level 2 / 3 Notifications**		
3.1	Notify EMT Leader and provide initial SITREP (Appendix C. 2)	Production Manager	Immediate
3.2	Within Commonwealth waters (>3 nm) NOPSEMA: Ph: 1300 674 472 Email: submissions@nopsema.gov.au	EMT HSE	ASAP but not later than 2 hours after becoming aware of spill
3.3	Within Commonwealth waters (>3 nm) – written report to NOPSEMA: Email: submissions@nopsema.gov.au and NOPTA: Email: info@nopta.gov.au	EMT HSE	Within 3 days of spill
3.4	Spill with potential to impact Australian Marine Park(s) or impact matters of national environmental significance (including potential for oiled wildlife) Director of National Parks via Marine Compliance Duty Officer (24-hr): 0419 293 465 Provide: • titleholder details • time and location of the incident (including name of marine park likely to be affected) • proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) • confirmation of providing access to relevant monitoring and evaluation reports when available; and • contact details for the response coordinator. And Department of the Environment and Energy: Ph: (02) 6274 1111	EMT HSE	ASAP
3.5	Within or potential for moderate to significant environmental damage to Victorian State waters (<3 nm) – refer to activity-specific EP for clarification or the impact of wildlife (including cetaceans) DJPR EMB: Ph: 0409 858 715 (24/7) and Email: semdincidentroom@ecodev.vic.gov.au DELWP: Ph: 1300 134 444 Email: sscviv.scmdr.delwp@scc.vic.gov.au	EMT HSE	ASAP

Item	Action	Responsibility	Timing
3.6	Within or potential for release to cause, or may cause, environmental harm or environmental nuisance in Tasmanian State waters (<3 nm) – refer to activity-specific EP for clarification DPIPWE: Ph: +61 (0)3 6165 4599 or 1800 005 171 (within Tasmania only) Radio: TasPorts Vessel Traffic Services VHF radio channel 16/14/12 Call sign "relevant port name VTS" Email: incidentresponse@epa.tas.gov.au	EMT HSE	ASAP (first instance of oil on/in water)
3.7	Confirm takeover of incident by State agency (DJPR) as the Control Agency (<3 nm)	EMT HSE	ASAP
3.8	Notify AMSA and request 500 m exclusion zone from location of the spill. Request AMSA make a call to vessels to avoid the area. AMSA: Ph: 1800 641 792 Email: mdo@amsa.gov.au	EMT HSE	ASAP
3.9	Complete Level 2/3 Incident Report (Appendix C. 4)	EMT Leader	ASAP
3.10	Notify and escalate to CMT if Level 3 response required	EMT Leader	ASAP
4.	**Level 2 / 3 Monitoring, Evaluation & Surveillance**		
4.1	Request monitoring assistance from AMOSC via execution of Service Contract using Service Request for Mutual Aid (Appendix C. 6) as directed by Control Agency (inside 3nm)	EMT Leader	ASAP
4.2	Mobilise surveillance by aircraft via service provider (Appendix D, Appendix E, Appendix F) as directed by Control Agency (inside 3nm)	EMT Logistics	ASAP
4.3	Deploy oil spill tracking buoy	EMT Logistics	ASAP
4.4	Initiate Oil Pollution trajectory modelling via service provider (Appendix C. 5) as directed by Control Agency (inside 3nm)	EMT Logistics	ASAP
4.5	Request Oil Spill Trajectory Modelling from service provider (RPS APASA) RPS: Ph: 0408 477186 Email: rpsresponse@rpsgroup.com	EMT HSE	ASAP
5.	**Level 2 / 3 Oil Pollution Response**		
5.1	Assess the feasibility and safety risks to implement source control. Develop source control strategy and implement when safe to do so.	EMT Leader	ASAP
5.2	For loss of integrity from subsea wells, inform Source Control Incident Management Team (SCIMT) – see Table 10 below for immediate actions.	EMT Leader	ASAP
5.3	Determine offshore and onshore (if required) response options and request assistance from AMOSC via execution of Service Contract using Service Request for Mutual Aid (Appendix C. 6) and/or AMSA as directed by Control Agency AMSA: Ph: 1800 641 792	EMT Leader	As directed

Item	Action	Responsibility	Timing
	Email: mdo@amsa.gov.au AMOSC: 0438 379 328		
5.4	Assess and monitor shoreline and intertidal zones to identify areas affected by the oil spill and to determine the nature of the impact (Appendix G) as directed by Control Agency	EMT Leader	As directed
5.5	Validate and agree implementation of relevant Tactical Response Plan(s) with Control Agency (if required)	EMT Leader / EMLO	ASAP
5.6	Implement Team Meeting and Operational Planning Cycle (Section 6.1)	EMT Leader	ASAP
5.7	Complete role-specific checklists as outlined in Appendix A. 3	All EMT Members and specialist teams	ASAP
6.	**Ongoing Monitoring**		
6.1	Implement Beach Offshore Victoria OSMP as directed by State Control Agency	EMT Leader / Monitoring Provider	As required

4.2.3 Loss of Well Control (L2 / L3)

Table 10: Immediate Action Plan – LOWC

Item	Action	Responsibility	Timing
1.	**Initial Emergency Actions**		
1.1	Manage the safety of personnel on rig and in operational area – activate evacuation plans. Implement Otway Offshore Well Control Bridging document for Otway drilling campaign	MODU OIM	Immediate
1.2	Notify and escalate to Beach Drilling Superintendent / Offshore Drilling Manager. Call National Response Centre (NRC) and activate Beach Source Control Incident Management Team (SCIMT), Emergency Management Team (EMT) and CMT. NRC: 03 9411 2147	Beach Senior Wellsite Representative	Immediate
1.3	If possible / safe to do so, Identify the extent of spillage and the weather/sea conditions in the area and provide initial SITREP (Appendix C. 2) to EMT Leader	Beach Senior Wellsite Representative / Vessel Master	Within 1 hour
1.4	If possible / safe to do so, deploy oil spill tracking buoy from MODU / vessel	Beach Senior Wellsite Representative / Vessel Master	Within 1 hour
1.5	Prepare to control the source - activate the Offshore well-specific Source Control Contingency Plan (SCCP) inclusive of well-specific Relief Well Plan: • SCIMT Leader mobilises relief well planning group; • SCIMT Leader engage Well Control Specialists and prepare for mobilisation to Adelaide; • Rig / Vessel Broker contacted for procuring suitable rig and support vessels • initiate APPEA Memorandum of Understanding: Mutual Assistance to facilitate the transfer of alternate drilling unit and well site services from alternate Operator(s)	SCIMT Leader with SC IMT	Within 2 hours
1.6	Activate Emergency Management Liaison Officer (EMLO) (if necessary).	EMT Leader	Within 1 hour
1.7	Notify Production Manager	EMT Leader	Within 1 hour
1.8	Notify Operations Manager	EMT Leader	ASAP
1.9	Implement Team Meeting and Operational Planning Cycle (Section 6.1) and establish CMT / EMT / SCIMT personnel roster providing 24-hour coverage.	EMT Leader	Within 2hours
1.10	EMT Leader to activate and activate team	EMT Leader	Within 2 hours
1.11	Complete role-specific checklists as outlined in Appendix A. 3	All EMT	As activated
1.12	Manage the safety of all responders – activate the development of a Safety Management Plan	EMT Leader	Within 12 hours

Item	Action	Responsibility	Timing
1.13	BOP closure attempts with ROV initiated within 24 hrs	SCIMT Leader	Within 24 hours
1.14	Initiate AMOSC via execution of Service Contract using Service Request for Mutual Aid (Appendix C. 6) and engage AMSA to initiate National Response Team (NRT) and National Response Support Team (NRST). AMSA: Ph: 1800 641 792 Email: mdo@amsa.gov.au AMOSC: 0438 379 328	EMT Leader	Within 2 hours
2.	**Level 2 / 3 Notifications**		
2.1	For all LOWC incidents NOPSEMA: Ph: 1300 674 472 Email: submissions@nopsema.gov.au	EMT Leader	ASAP but not later than 2 hours after becoming aware of spill
2.2	Within Commonwealth waters (>3 nm) – written report to NOPSEMA: Email: submissions@nopsema.gov.au and NOPTA: Email: info@nopta.gov.au	EMT HSE	Within 3 days of spill
2.3	For all LOWC incidents given potential to impact Australian Marine Park(s) or impact matters of national environmental significance (including potential for oiled wildlife) Director of National Parks via Marine Compliance Duty Officer (24-hr): 0419 293 465 Provide: • titleholder details • time and location of the incident (including name of marine park likely to be affected) • proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) • confirmation of providing access to relevant monitoring and evaluation reports when available; and • contact details for the response coordinator. And Department of the Environment and Energy: Ph: (02) 6274 1111	EMT HSE	ASAP
2.4	For all LOWC incidents with potential for moderate to significant environmental damage to Victorian State waters (<3 nm) or the impact of wildlife (including cetaceans) DJPR EMB: Ph: 0409 858 715 (24/7) and Email: semdincidentroom@ecodev.vic.gov.au DELWP: Ph: 1300 134 444 Email: sscviv.scmdr.delwp@scc.vic.gov.au	EMT HSE	ASAP but not later than 2 hours after becoming aware of spill
2.5	For all LOWC incidents with potential to cause, or may cause, environmental harm or environmental nuisance in Tasmanian State waters (<3 nm) – refer to activity-specific EP for clarification DPIPWE: Ph: +61 (0)3 6165 4599 or 1800 005 171 (within Tasmania only)	EMT HSE	ASAP (first instance of oil on/in water)

Item	Action	Responsibility	Timing
	Radio: TasPorts Vessel Traffic Services VHF radio channel 16/14/12 Call sign "relevant port name VTS" Email: incidentresponse@epa.tas.gov.au		
2.6	Confirm takeover of incident by State agency as the Control Agency (<3 nm)	EMT HSE	ASAP
2.7	Notify AMSA and request 2 km exclusion zone from the well location. Request notification to marine traffic to avoid the area. AMSA: Ph: 1800 641 792 Email: mdo@amsa.gov.au	EMT HSE	ASAP
2.8	Complete Level 2/3 Incident Report (Appendix C. 4)	EMT Leader	ASAP
3.	**Level 2 / 3 Monitoring, Evaluation & Surveillance**		
3.1	Request monitoring assistance from AMOSC via execution of Service Contract using Service Request for Mutual Aid (Appendix C. 6) AMOSC: 0438 379 328	EMT Leader	Within 2 hours
3.2	Mobilise surveillance by aircraft via service provider (Appendix D, Appendix E, Appendix F)	EMT Logistics	ASAP
3.3	Initiate oil spill pollution trajectory modelling (Appendix C. 5). from service provider (RPS APASA) RPS: Ph: 0408 477186 Email: rpsresponse@rpsgroup.com	EMT Logistics	ASAP
3.4	Instruct project support vessels to perform support and surveillance function and engage Vessel Broker to source additional support / surveillance vessels.	EMT Logistics	ASAP
3.5	Deploy oil spill buoys from the MODU	EMT Logistics	ASAP
4.	**Level 2 / 3 Oil Spill Response**		
4.1	Provide support and information to the State Control Agency as directed	EMT Leader via EMT HSE	As directed
4.2	Determine offshore and onshore response options and request assistance from AMOSC via execution of Service Contract using Service Request for Mutual Aid (Appendix C. 6) and/or AMSA as directed by Control Agency AMSA: Ph: 1800 641 792 Email: mdo@amsa.gov.au AMOSC: 0438 379 328	EMT Leader	Within 2 hours / As directed
4.3	Validate and agree implementation of relevant Tactical Response Plan(s) with Control Agency	EMT HSE	ASAP
4.4	Deploy MODU and commence drilling relief well in accordance with Source Control Contingency Plan inclusive of Relief Well Plan	SCIMT Leader / SC IMT Operations	Within 8 weeks
5.	**Ongoing Monitoring**		

Item	Action	Responsibility	Timing
5.1	Implement Beach Offshore Victoria OSMP as directed by State Control Agency and in consultation with Director of National Parks and DotEE.	EMT Leader / Monitoring Provider	As required

5 Crisis and Emergency Management (CEM) Framework

The Beach emergency management structure consists of a three-tiered approach. With teams that have specific roles regarding response to and management of emergency and crisis events. This visual overview clearly depicts this framework and associated protocols for the effective management and coordination of all levels of emergency and crisis events impacting on the Beach organisation. The framework is depicted in Figure 5.

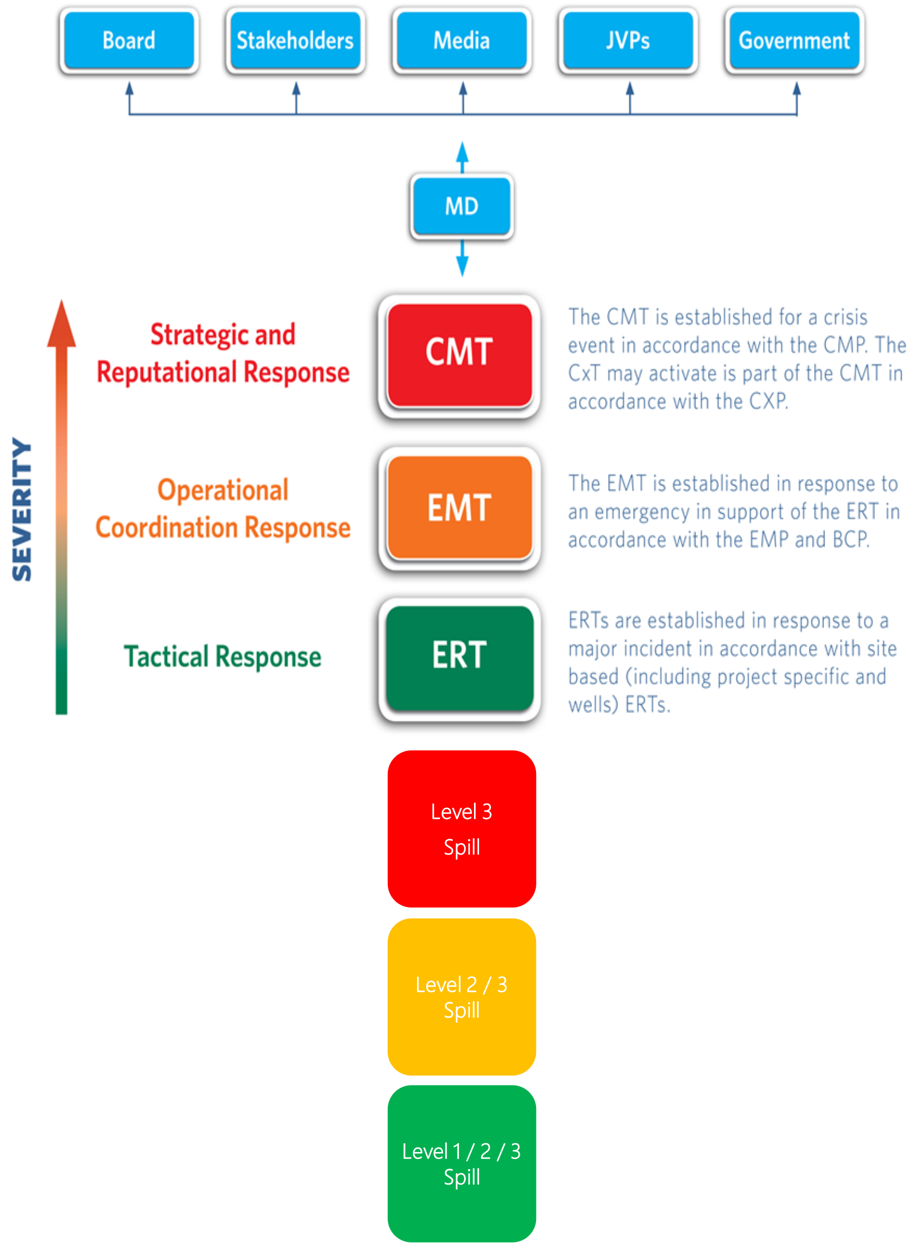


Figure 5: Beach Energy Crisis and Emergency Management Framework

In summary:

- site-based ERTs carry out emergency response activities at the site of the emergency.

- Adelaide and Melbourne based EMTs – provide operational management support to the site-based ERT, facilitate planning and liaise with external parties for all events, Australia wide.
- the oil spill/oil pollution response capability lives within the EMT (with IMO3 trained on-call representatives to ensure expedience of access to all company-wide resources required).
- during a spill event, the IMO3 becomes the EMT Leader and the on call EMT Leader becomes the Deputy.
- the Adelaide-based SCIMT interface with the MODU and implement Beach source control procedures in the event of a LOWC.
- the Adelaide-based CMT undertakes crisis management operations and direct strategic actions at the corporate level, addresses implications of the crisis on the employees, is concerned with the company's reputation, relationships with external parties and joint venture partners.
- the CMT is activated for a crisis event or as directed by the MD or the CMT Leader.

The extent of the response structure will be dictated by the size of the incident and the required response.

5.1 Alignment with National ICS

The structure of Beach's Crisis and Emergency Management system is aligned with the Australasian Inter-service Incident Management System (AIIMS) but modified enough to allow for established corporate processes and reporting during emergency events. The main nuance is the role change from the on-call EMT Leader to the IMO3 representative to become the EMT Leader in the event of an off-shore oil pollution event, with the on-call EMT Leader taking the role of Deputy and remaining the information conduit into the CMT. See Figures 5.2 and 5.3 for further detail.

5.2 The Managing Director

The Beach MD will be the critical interface between the CMT and senior external stakeholders, including, but not limited to the Beach Energy Board of Directors, the media and government.

The CMT Leader will keep the MD apprised of the incident and will discuss decisions of the CMT with the MD and render advice as required. However, the MD may assume the role of CMT Leader.

5.3 Crisis Management Team (CMT)

Leadership of the CMT (Figure 6) is empowered by the Beach MD to assume responsibility for providing strategic support to emergency or crisis events impacting Beach operations or commercial viability.

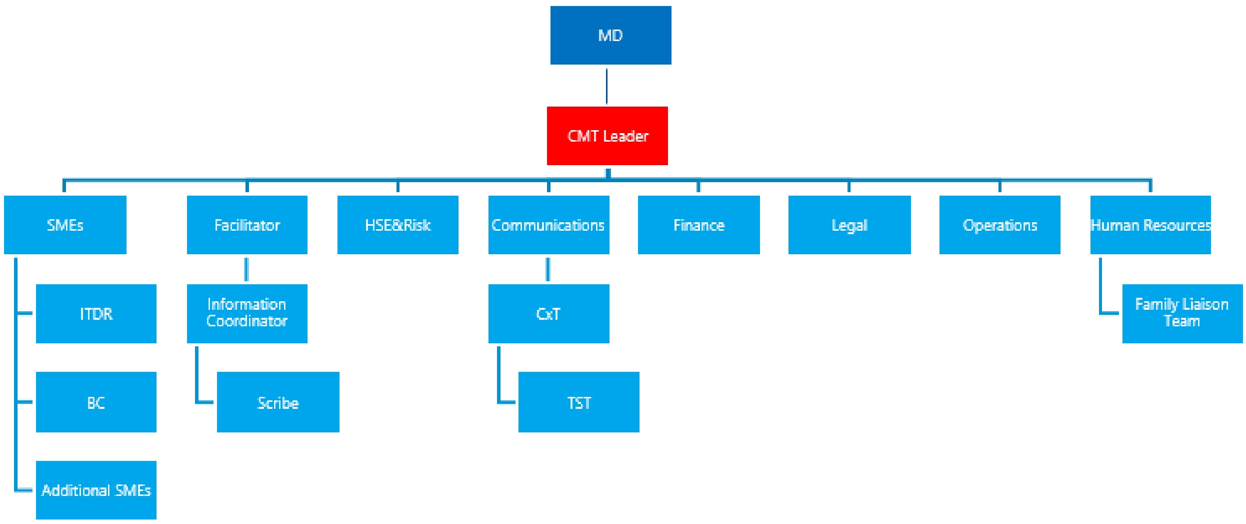


Figure 6: Composition of the Crisis Management Team

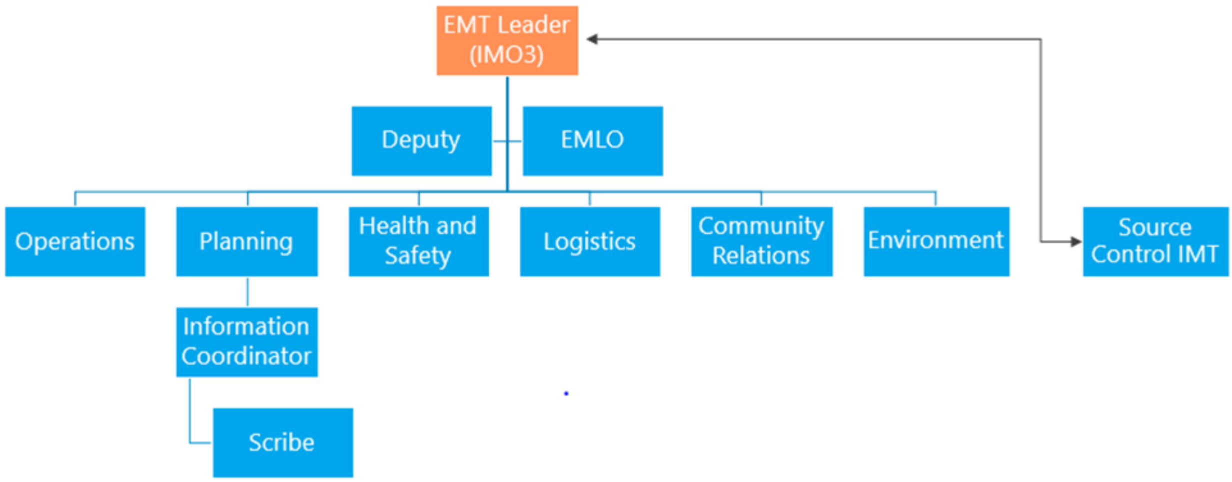


Figure 7: Composition of the Emergency Management Team

5.4 EMT composition for Off-shore Oil Spill/Oil Pollution response

The EMT for all level off-shore oil spill/oil pollution event (Figure) is led by the IMO Level 3-trained EMT Leader. Beach have an IMO3 qualified representative on-call 24/7. In the event of an offshore oil spill/pollution event, the EMT Leader assumes responsibility for implementing this OPEP and the OSMP (under the direction of State regulators within 3nm). The implementation of the Source Control Contingency Plan (SCCP) specific to the well, remains the responsibility of Operations. An Emergency Management Liaison Officer (EMLO) is embedded within the EMT and acts as the key interface between the EMT and State Control Agency Incident Management Teams (IMT).

The Deputy EMT Leader is the conduit of information from the EMT to the CMT (CMT Leader or CMT Operations).

The on-call roster is a 24hr / 7 days a week. There are four Australian based EMTs that are on a weekly roster from 10 am Friday morning to 10 am Friday morning. The on-call roster is a live document and is on the Beach Intranet.

5.5 Source Control Incident Management Team (SCIMT)

In the event of an offshore well control incident, the Operations – Wells function becomes the SCIMT Leader and activates the SCIMT. If the situation requires activation of the Source Control Contingency Plan, a Source Control IMT will be established (see SCCP references Section 10.1.1.3). The SCIMT Leader will lead the Source Control IMT but continues to report through to the EMT Leader. The primary function of the SCIMT is to bring the well under control, in compliance with ER priorities of PEARL.

The organisation structure and responsibilities of the SCIMT are detailed within the SCCPs and WOMPs that are produced and maintained by the asset or project owner for all wells. The structure of the SCIMT once activated for source control events is identical for all offshore incidents.

5.6 Emergency Response Team (ERT)

Each site has a site, project or area-specific Emergency Response Plan (ERP) and an ERT that is typically a Beach team led by the ERT Leader. or offshore vessels and rigs operating under contract to Beach, there are bridging ERPs to ensure adequacy of response and will respond to all Level 1 incidents. All plans and responses require notification to the Beach's EMT via the NRC.

All vessels and rigs are required to undertake emergency exercises prior to mobilising to Beach's permit area to ensure that communications work and that roles and responsibilities are clearly understood. These exercises are stored in Beach's incident and action reporting software (CMO) – Beach's Emergency incident and action management tracking software.

The ERT is responsible for managing all site / field incidents and coordinating a local response to any incident. The ERT are responsible for notification to the EMT for any ERT activation, regardless of level.

The National Response Team (NRT) and the National Response Support Team (NRST) provides support to control agencies in the event of a major marine oil pollution incident.

The NRT consists of personnel to fulfil the following Australian Interservice Incident Management System (AIIMS) positions (Table 5):

Table 11: NRT positions and numbers required

Role	Positions Required per State/NT	Totals
Planning Officer	1	7
Operations Officer	1	7
Logistics Officer	1	7
Aerial Observer	1	7
Response Team Leader	5	35
Total	9	63

Source: National Plan National Response Team Policy (NP-POL-002) 10 Nov 2014

The NRST has been developed to provide additional personnel to support an incident response. The following roles have been identified for a national capacity:

- Environmental Advisers
  - Environmental Adviser to Incident Controller
  - Technical Advisers in Planning and Operations (IMT)
  - Field Advisers
- Finance personnel
- Wildlife Coordinator
- Equipment Operators
  - Marco Operator
  - Offshore Containment/Recovery
  - Inshore Containment/Recovery
  - Vessel-based dispersant spraying
  - Dispersant Helicopter Spray Buckets
  - Shoreline Clean-up
- Shoreline assessment personnel

The Guideline on Accessing National Plan Support Arrangements sets out the initial notification of AMSA regarding the mobilisation of National Plan equipment and personnel. Once the initial notification has been given to AMSA via the Control Agency, the Incident Controller or one of the Incident Management Team will liaise with AMSA to request and manage personnel from the NRT, NRST and AMOSC Core Group (see below). Requests for personnel should be made to AMSA by telephone request or email to the AMSA Environment Protection Duty Officer or another nominated AMSA person. A verbal request must be confirmed within three (3) hours by an email.

Beach Energy has a Master Service contract with AMOSC. Under this contract:

- AMOSC will use its best endeavours to provide training and response services – generally (but not limited to) three AMOSC personnel or one third of AMOSC's store of equipment or consumables.
- AMOSC may request that an AMOSC Member provide equipment, consumables or personnel in response to a request for services made by another AMOSC member. As such, Beach has potential access to external resources from other AMOSC Members, both locally and regionally. The personnel available under this mutual aid arrangement form the AMOSC Core Group. The minimum number of AMOSC Core Group members is 84; normally there are more than 100 in the

group. AMOSC funds the training, revalidation and management for this number of Core Group members.

Whilst AMOSC provide a supporting role within the EMT, Beach Energy are responsible for the direction and control of all activity and matters during the Deployment Period and all activity and matters at the deployment locations in consultation and agreement with the relevant Control Agency.

5.7 Joint Strategic Coordination Committee (Victoria)

The following section has been adapted from DJPR guidance.

Transboundary arrangements from state to state is covered by the National Plan. Where Victorian State waters are impacted by cross-jurisdictional marine pollution incidents, DJPR will only assume the role of control agency for response activities occurring in Victorian State waters, in accordance with the State Maritime Emergencies (non-search and rescue) Plan. In this instance, Beach and DJPR shall work collaboratively, sharing response resources and providing qualified personnel to the DJPR IMT. To facilitate effective coordination between the two control agencies and their respective IMT, a Joint Strategic Coordination Committee (JSCC) shall be established. The control and coordination arrangements for cross-jurisdictional maritime emergencies is outlined in Figure 8.

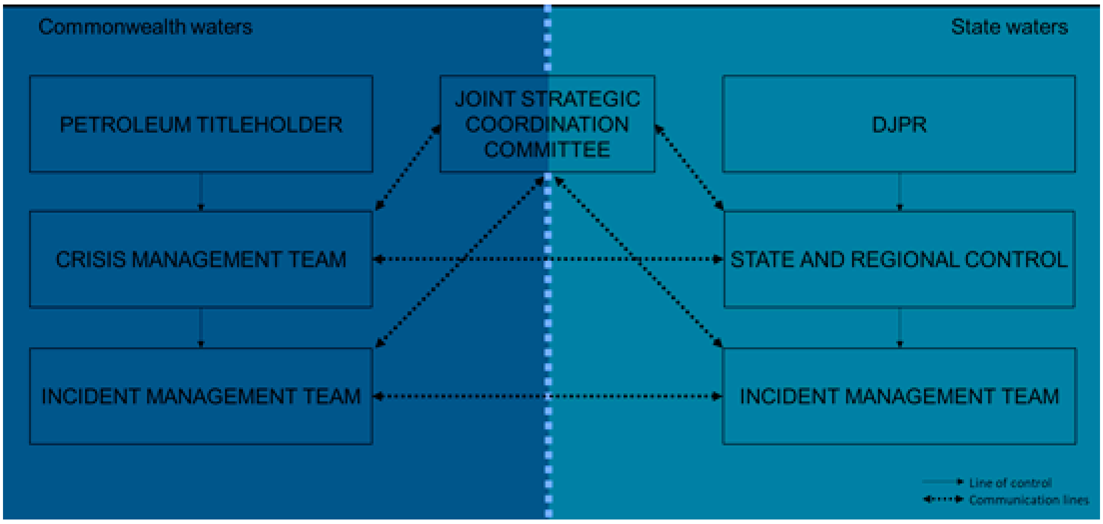


Figure 8: Joint Strategic Coordination Committee (Victoria) structure (DJPR, 2019).

The role of the JSCC is to ensure appropriate coordination between the respective IMTs established by multiple control agencies. The key functions of the JSCC include:

- ensuring key objectives set by multiple IMTs in relation to the marine pollution incident are consistent and focused on achieving an effective coordinated response
- resolving competing priorities between multiple IMTs
- resolving competing requests for resources between the multiple IMTs, including those managed by Australian Maritime Safety Authority (AMSA), such as national stockpile equipment, dispersant aircraft and the National Response Team
- resolution of significant strategic issues as they arise during the incident response

- ensuring that there is a shared understanding of the incident situation and its meaning amongst all key stakeholders
- ensuring there is agreement on how information is communicated to the public, particularly those issues that have actual or perceived public health implications
- ensuring adequate coordination and consistency is achieved in relation to access and interpretation of intelligence, information and spill modelling to promote a common operating picture.

The JSCC will be administered by DJPR and the inaugural JSCC meeting will be convened by the State Controller Maritime Emergencies (SCME) once both Beach and DJPR formally assume the role of control agency in respective jurisdictions.

The JSCC will be jointly chaired by the SCME and the Beach CMT/EMT Leader, who will determine whom will sit in the committee for a coordinated response. As the relevant jurisdictional authority in Commonwealth waters, NOPSEMA may opt to participate in the JSCC as they see fit.

In a cross-jurisdictional marine pollution incident, DJPR and Beach shall each deploy an EMLO to corresponding IMTs for effective communication between DJPR and Beach. The role of the DJPR EMLO includes, but is not limited to:

- represent DJPR and provide the primary contact for Beach, inter-agency and/or inter-State coordination
- facilitate effective communications between DJPR's SCME and Incident Controller and the Beach CMT / EMT Leader
- provide enhanced situational awareness to DJPR of the incident and the potential impact on State waters
- facilitate the delivery of technical advice from DJPR to the Beach EMT Leader as required.

The Beach EMLO will work under the direction of the DJPR and will be responsible for supplying additional resources to the Control Agency as required. This would be via internal Beach resources, AMSA (NRT & NRST), and/or AMOSC service contract.

5.8 Roster

A roster is maintained for CMT Leaders and for full EMTs as well as the SCIMT. The roster is promulgated each Friday morning for the next twelve weeks and is kept on the Beach Energy Intranet 'Umbrella' in the 'Emergency Management' site. See: Link

All CMT, EMT and SCIMT members will make themselves available when called. Primary members will advise their alternate when they will not be available to respond, and all rostered members are able to seek their counterpart as replacement and modify the roster to ensure 24/7 coverage.

Beach utilises the services of the National Response Centre (NRC) to be the conduit of information from the affected site to the on-call EMT Leader and EMT Leader to on call CMT Leader. The NRC will also activate the on-call teams, as directed.

6 Crisis and Emergency Management System (CEMs)

This section describes how to implement a response to an incident using the Beach Crisis and Emergency Management System (CEMS). Regardless of the size of the incident, the response process begins with incident detection, notification and activation of response personnel and other resources, and for L2 / L3 spills the establishment of the incident command, in the form of the EMT and Leader. The IMO3 EMT Leader is the 'Incident Commander' and as the response develops, the CEMs organisational structure and cyclical planning process are established.

For larger, more complex incidents (L2 / L3 spills), the EMT will expand in staffing (resourcing sought from within Beach or external SMEs) and the planning cycle becomes increasingly critical. All oil pollution response activities will include a written Incident Action Plan (IAP) which includes tactics and resource assignments to accomplish the response objectives established by the EMT Leader. The response is typically divided into operational periods, and the IAP is reviewed and revised during each operational period to reflect current objectives, strategies and response tactics to meet evolving incident conditions.

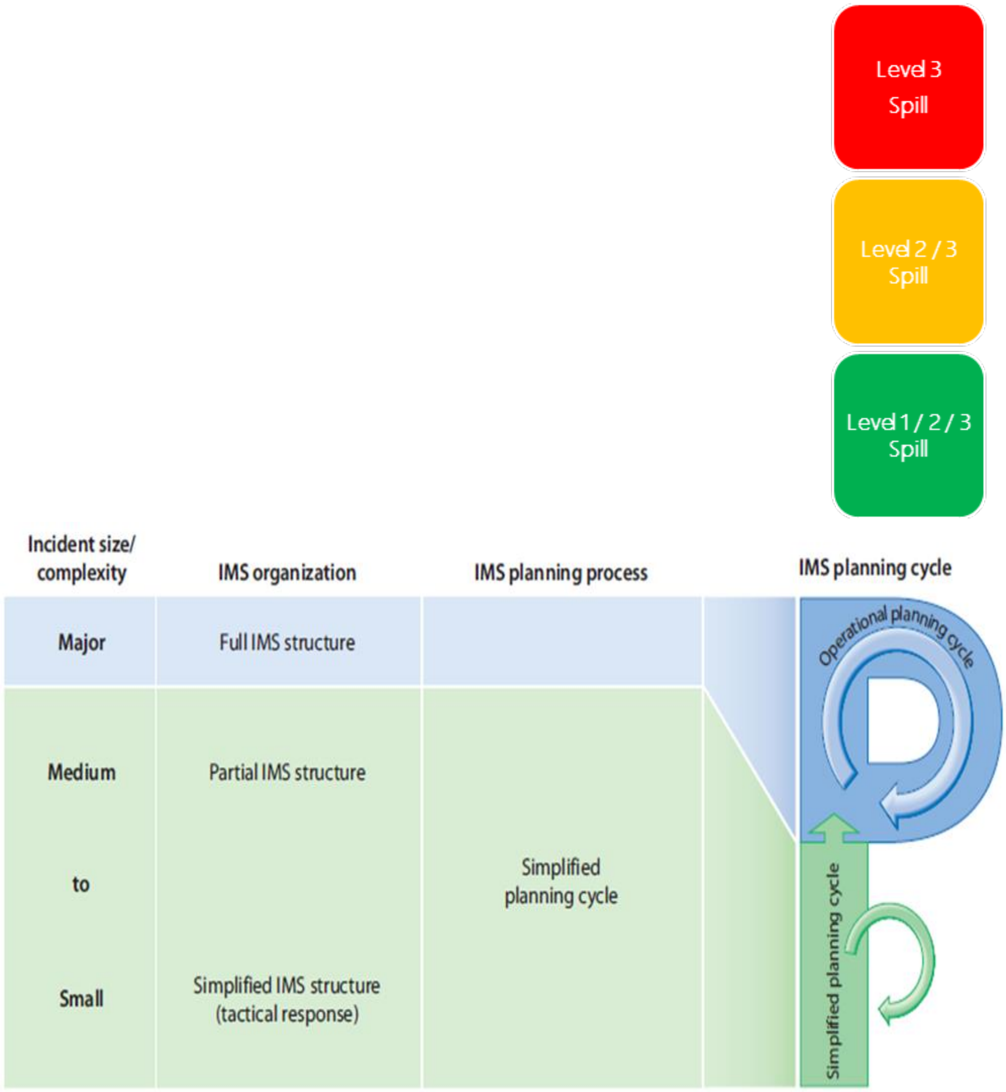


Figure 9: Application of the Beach Incident Management System for all events

6.1 Team Meeting and Operational Planning Cycle

Emergency Management (EM) is a 'team' orientated process: the EMT Leader, through the Deputy, will have reporting requirements to the CMT Leader and will need to receive updates from the site based ERT and/or the SCIMT Leader.

Once the team is activated and following an initial assessment of the specific circumstances of the oil spill/pollution emergency, the EMT Leader will lead and guide the EMT through a defined response process for emergency oil spill/oil pollution scenarios and responses, as outlined in Figure 6.2 and Table 6.1.

In order for this to occur with all participants receiving and giving information at the same briefing, the 'Team Process' has been adopted by Beach EMTs and the CMT. The team meeting and operational planning cycle is to be implemented until each of the strategy-specific termination criteria have been met. The structure of the EMT and frequency of the operational periods is relative to the scale and stage of the spill event.

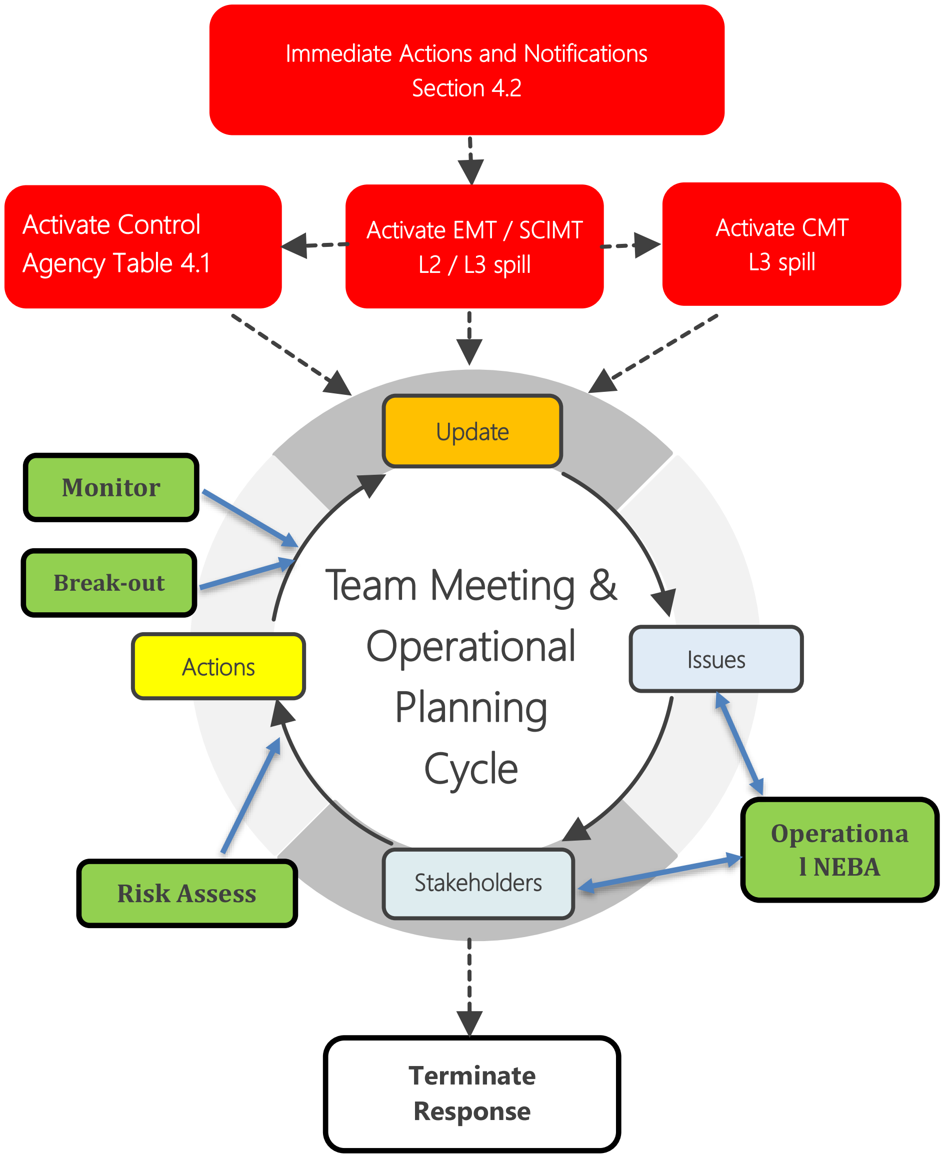


Figure 10: Team Meeting and Operational Planning Cycle

Table 12: Team Meeting and Operational Planning Cycle Components

Immediate Actions and Notifications	First Responders: Implement Immediate Action Plan and make notifications relevant to spill scenario as per Section 4.2 above: • Vessel spill / collision (L1 / L2 / L3): Table 4.2 • Loss of integrity – platform or pipeline (L2 / L3): Table 4.3 • LOWC (L2 / L3): Table 4.4 Provide EMT Leader with initial situation report (Appendix C. 2 SITREP).
Activate	• EMT Leader: Assess event against the initial site situation report from First Responders and Activate EMT Planning and team for **any** L2 or L3 spill. • EMT Leader: assessing event, clarify roles and tasks required, including communication protocols with CMT • Notify SCIMT Leader for **any** LOWC event (if notification did not come from SCIMT) • Notify the CMT Leader upon activation and immediately for **any** L3 spill. • Notify the State Control Agency for **any** spill impacting or potentially impacting State waters • Determine team composition and commence callout (through the NRC) (03 94112147) • Establish the Crisis Comms Network and reporting frequency with the ERT and CMT • **EMT Members and SCIMT Members:** Attend EM Room and access Role Boxes • Conduct initial assessment • Commence objective setting with Planning and Control Agency (when relevant) • Clarify issues and/or concerns • Develop initial plan of action based upon feasible response strategies (Section 10 below) • Prepare for team briefing
Update	• Conduct team briefing – Establish 'rules' and chain of command (see ERP) • Gather current event information, utilising SITREP (Appendix C.2) / team's knowledge / damage assessments • Assess current event status and severity / potential severity – informed by operational monitoring. • Establish response priorities • Identify response areas and onshore priority planning areas (Section 8 below) • List and agree outcomes and strategic objectives • Assign roles and responsibilities • Resolve issue / concerns • Review team objectives – display prominently in the EM Room • Establish operational periods based upon spill risk profile (6/12/24/48 hours)
Issues	• For each outcome and objective, identify and list response issues and potential limiters • Commence scenario planning based on feasible response strategies (Section 10) • Draft Operational NEBA (Section 6.2) in collaboration and to the agreement of relevant Control Agency • Confirm protection priorities and key protection outcomes in collaboration and to the agreement of relevant Control Agency • Team members should consider issues specific to their role
Stakeholders	• Identify stakeholders – internal and external based upon assessment of potential hydrocarbon exposure. Use issues list as a prompt • Consider prioritising stakeholder list • EMLO to undertake stakeholder liaison • Engage relevant stakeholders and validate draft Operational NEBA (where relevant to stakeholders) • Record stakeholder interactions and consider stakeholder objections or claims • Form and approve key messaging asap
Actions	• Undertake risk assessment considering, asset integrity / safety / health / quality / environment (considering outcomes of operational NEBA and relevant Stakeholder objections or claims) • Develop and agree strategy specific IAPs with Control Agency (inclusive of Tactical Response Plans and establish monitoring, evaluation and surveillance program. • Identify and allocate tasks – including who is responsible and when they are due • EMT members clearly briefed on strategy specific IAPs, roles and responsibilities defined, and tasks allocated • Record and track progress and completion in EMQNet

Break-out	• All team members as needed, can break out to execute actions in accordance with strategy specific IAPs. • Deputy to brief CMT (Leader or Operations, as decided) • All teams to monitor and record response effectiveness • All members are to return at the agreed operational period interval, ready to update on actions executed.
Terminate Response & Demobilise	• Strategy-specific termination criteria must be achieved prior to terminating response: • **Source Control:** controls successfully implemented to stop the source of the spill and no further risk from release from vessel, facility or infrastructure. • **Monitoring & Evaluation:** source control successfully implemented and released hydrocarbon no longer posing risk to receptors at actionable thresholds as agreed with State Control Agency. • **Protection and Deflection:** Monitoring evaluation and surveillance indicates shoreline(s) no longer at risk from actionable thresholds of hydrocarbon and no net benefit gained by continuing protection and deflection as agreed with State Control Agency. • **Shoreline Clean-up:** Shorelines affected by actionable thresholds of stranded oil cleaned until no net benefit gained by continuing clean-up operations as agreed with State Control Agency. N.B. shoreline monitoring continues following termination of clean-up operations as agreed with State Control Agency. • **Oiled Wildlife**: No affected wildlife detected and affected individuals that have been (where possible) captured, triaged and rehabilitated as agreed with State Control Agency and / or Commonwealth Department of the Environment and Energy.

6.2 Net Environmental Benefit Analysis (NEBA)

The NEBA process is used to compare the likely positive and negative outcomes of various oil spill response options with respect to environmental sensitivities at risk from the spill or response activities. NEBA recognises that certain clean-up options may cause a net negative environmental impact in comparison to the impact of leaving the spill to disperse and weather naturally or alternative response options. The key objective is to identify the response options that will result in minimal impacts and maximum recovery of the environment, considering the specific sensitivities of the resources that have been prioritised for protection. The NEBA will be undertaken by the Control Agency or under the direction of the EMT for spills in Commonwealth waters.

A NEBA may be either 'strategic' (pre-spill event) or 'operational' (post-spill event).

The following steps allow for an effective NEBA to be conducted:

Step 1

a. Identify potential spill impact area based on incident specifics, trajectory modelling and observations. Within the predicted impact area, identify the key characteristics of the habitats. This can be based on field observation, aerial photos and local knowledge.

Step 2

a. Identify resources (human, ecological, economic etc) at risk at each of the different habitats within the impact area. During the NEBA, specific consideration must be given to formally managed environment receptors and relevant formal management advice:

- south-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013)
- the following Conservation Advices / Recovery Plans that identify pollution as a key threat:
    - Conservation Advice *Balaenoptera borealis* (sei whale)
    - Conservation Advice *Balaenoptera physalus* (fin whale)
    - Recovery Plan for Marine Turtles in Australia (CoA, 2017), identified as acute chemical discharge (oil pollution)
    - Wildlife Conservation Plan for Migratory Shorebirds – 2015
    - Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion)
    - Recovery Plan for the *Neophoca cinerea* (Australian sea lion)
    - Conservation Advice *Calidris ferruginea* (Curlew Sandpiper) identified as Habitat degradation/ modification (oil pollution)
    - National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016
    - Conservation Advice for *Sterna nereis nereis* (Fairy Tern)

- the following Conservation Advices / Recovery Plans that identify habitats degradation/modification as threat, which may be consequence of accidental release of hydrocarbon:
  - Conservation Advice *Calidris canutus* (Red Knot)
  - Conservation Advice *Limosa lapponica baueri* (Bar-tailed Godwit (Western Alaskan))
  - Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed Godwit (Northern Siberian))
  - Conservation Advice for *Numenius madagascariensis* (Eastern Curlew)
  - Conservation Advice for *Charadrius leschenaultia* (greater sand plover)
- the following conservation advices and recovery plans that 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.
- response activities associated 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

Step 3

a. assess the potential impact from the spill on each of the resources at risk based on severity of impact and predicted recovery time. This is assuming no response to the spill.

b. a precautionary approach should be adopted, assuming that the entire site will be covered by oil and that this will persist at the site for at least 24 hours. However, in certain situations the behaviour of the spill may be more accurately predicted, and this information can be used when assessing potential impacts. The second assumption that must be agreed is whether the percentage of a species or resource impacted relates to the local (site), regional or even global (in the case of endangered species) population. This does not necessarily need to be consistently applied to all resources at the site. For example, it may be considered that if a resource is very abundant regionally then it is not significant enough at a particular site to warrant a high level of concern even though it may be seriously impacted at that site.

Step 4

a. review the site-specific advantages and disadvantages of the different response options available, using natural recovery as a baseline. The predicted effect, likely impact and recovery time of the various response options on each of the resources must be assessed.

b. in the case of a hydrocarbon spill from Beach activities or operations impacting Victorian State waters and/or lands, it is expected that the Control Agency (DJPR) would undertake an operational NEBA, with support from Beach as requested, in determining the most appropriate response actions in accordance with the NatPlan or the VicPlan as applicable. Under the NatPlan, Environmental Science Coordinators contribute advice on likely environmental outcomes of each response option to the spill planning team based on a NEBA approach.

c. as part of the response planning process, Beach has conducted strategic NEBA (Table 15). As part of the due diligence process, Beach shall also conduct an operational NEBA in consultation and agreement with the Control Agency regarding the results of that assessment and recommendations for response activities. Additionally, information from the NEBA may be used to help inform requirements for environmental monitoring relating to anticipated impacts from the spill and any response activities. Beach's operational NEBA assessment would be conducted by an environmental professional with experience in oil spill planning and response.

7 Responsibilities/Accountabilities

For Level 1 spills, the site ERT Leader has responsibility for oil spill/oil pollution response and implementation of this OPEP.

For Level 2/3 spills, the Beach EMT Leader has responsibility for oil spill/oil pollution response and implementation of this OPEP in parallel with the Emergency Management Plan (EMP) (INT 1000 SAF PLN, CDN/ID 18025990).

For any LOWC event, the SCIMT Leader has the responsibility for the implementation of the well-specific Source Control Contingency Plan (SCCP) inclusive of relief well planning. Roles and responsibilities for the SCIMT members (Section 5.5) are detailed within the well-specific SCCP.

Individual role checklists for the EMT can be found Appendix A.3.

Role-specific responsibilities for an offshore oil pollution emergency are detailed in the immediate actions and notifications (Section 4) of this OPEP.

For Level 3 spills, the CMT has responsibility for implementation of the CMP. CMT individual role checklists can be found in Appendix B of the CMP.

8 Response Areas and Onshore Priority Planning Areas

8.1 Response areas

To identify the response planning areas the following oil exposures were used (based on AMSA guidance):

- offshore: a sea surface oil exposure of >25 g/m^2 as this represents the practical limit for surface response options; below this thickness, oil containment, recovery and chemical treatment (dispersant) become ineffective
- onshore: a shoreline contact exposure of >100 g/m^2 as this represents the minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone.

It is noted that within NOPSEMA Bulletin #1 Oil spill modelling (A652993) (NOPSEMA 2019) refers to >50 g/m^2 as a level to inform response planning, and therefore the use of >25 g/m^2 from stochastic modelling results is considered conservative.

For the spill scenarios as identified in Section 3.4, the response areas have been defined based on the outcomes of oil spill modelling (Figure 11, and 8-2).

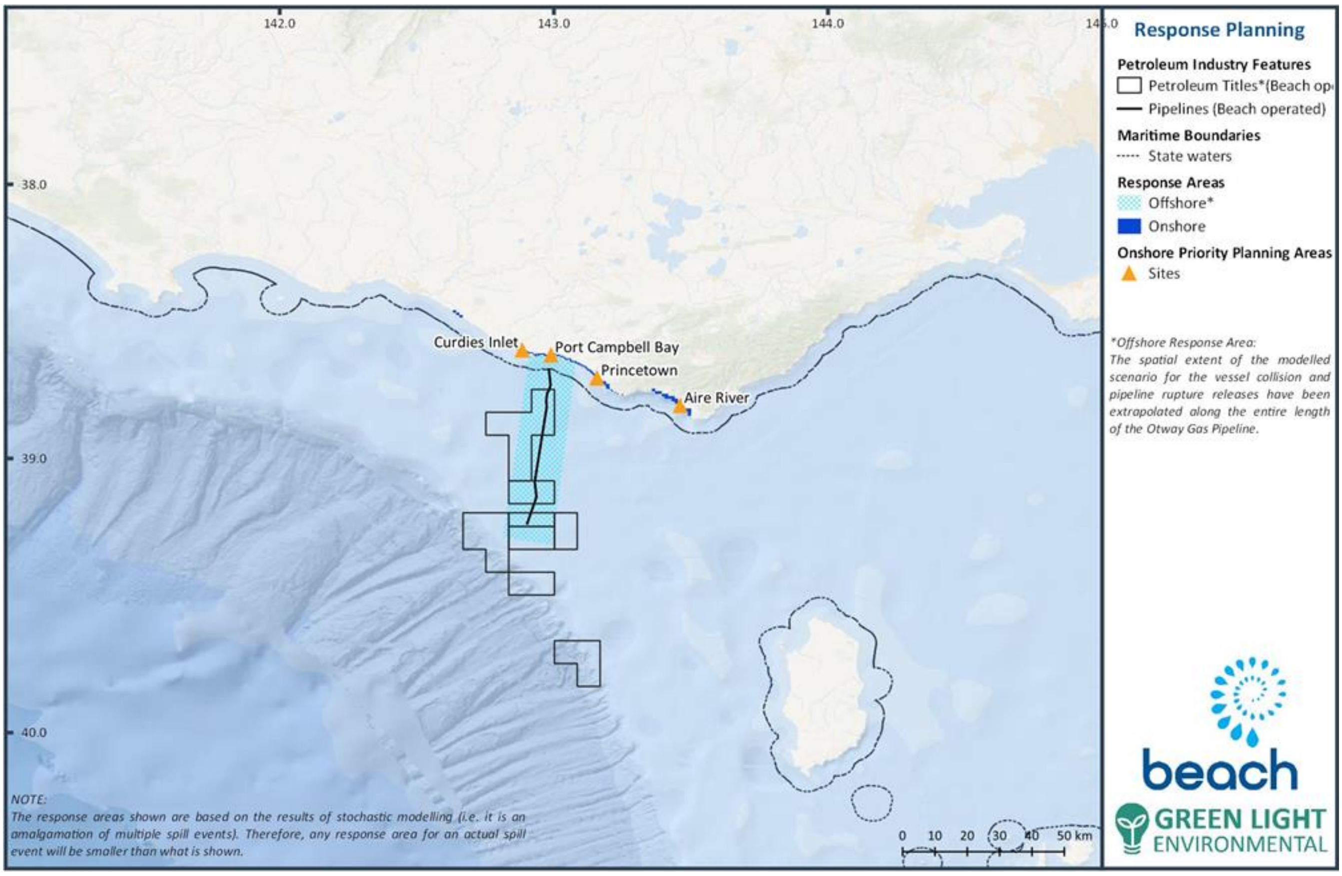


Figure 11: Otway Basin response areas and onshore priority planning areas

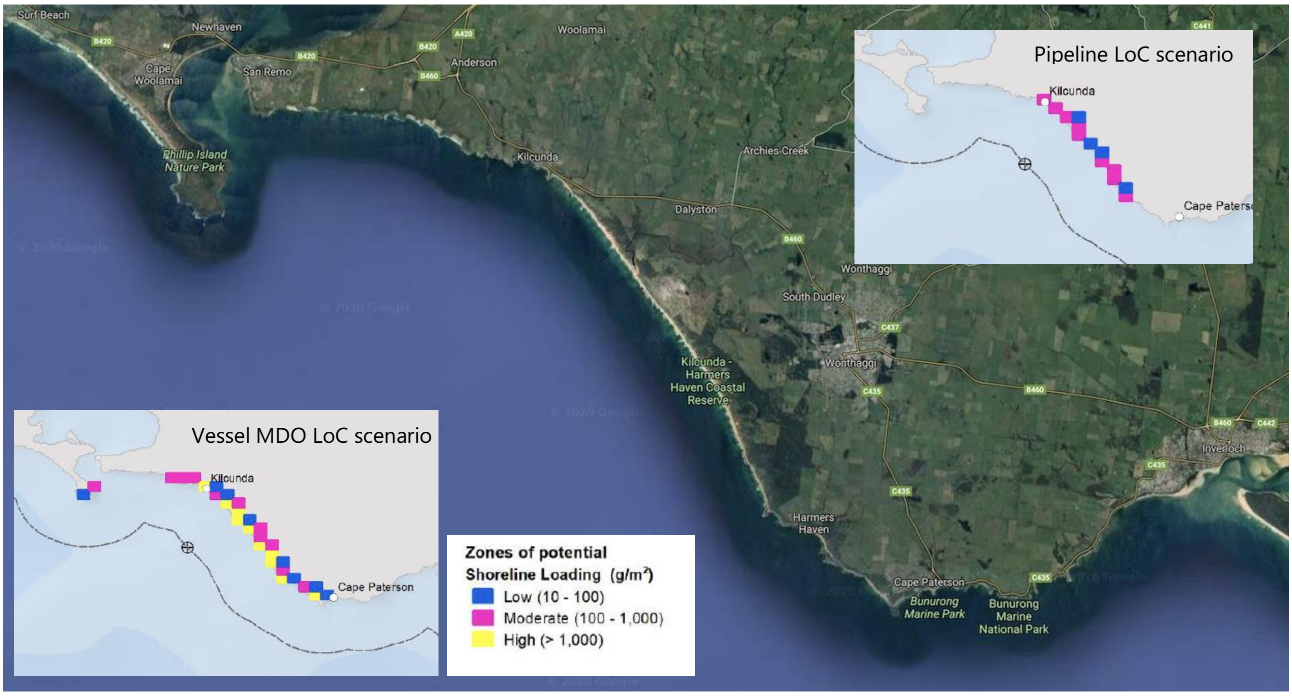


Figure 12: Bass Basin response areas and onshore priority planning areas

8.2 Onshore priority planning areas

Within the onshore response areas, priority planning areas have been identified where the following two criteria are met:

- predicted time to shoreline exposure is less than 7-days
- sensitive environmental receptors are present in the intertidal/coastal zone:
  - national or international important wetlands
  - sheltered tidal flats
  - mangrove or saltmarsh habitat
  - known breeding/calving/nesting aggregation areas for protected (threatened or migratory) fauna
  - known breeding/haul-out areas for pinnipeds
  - threatened ecological communities.

Note, the requirement for time to exposure is based upon the time required to plan and implement a response in this area, i.e. it is estimated to take approximately 5 days to develop and ground-truth a tactical response plan (TRP) and 24-48 hours to mobilise equipment and personnel to location.

The priority planning areas identified for spill scenarios that are relevant to the Otway and Basin assets and activities are detailed in Table 13. A series of TRPs have been developed for these priority protection areas to assist in implementing a rapid response.

Table 13: Otway and Bass Basin priority response planning areas

Priority response planning area Otway Basin	Sensitive environmental receptors
Aire River	• Wetland of national importance • Saltmarsh habitat • Coastal TEC's (Coastal Saltmarsh, Salt-wedge Estuary Communities)
Curdies Inlet	• Saltmarsh habitat • Coastal TEC's (Coastal Saltmarsh, Salt-wedge Estuary Communities
Princetown	• Wetland of national importance • Saltmarsh habitat • Coastal TEC's (Coastal Saltmarsh, Salt-wedge Estuary Communities)
Port Campbell Bay	• Coastal TEC's (Coastal Saltmarsh, Salt-wedge Estuary Communities
Priority response planning area Bass Basin	**Sensitive environmental receptors**
Powlett River	• Victorian Desalination Plant • Wetland of environmental significance • Saltmarsh habitat • Coastal TEC's (Coastal Saltmarsh, Salt-wedge Estuary Communities)
Shoreline San Remo to Cape Patterson	• Saltmarsh habitat • Coastal TEC's (Coastal Saltmarsh, Salt-wedge Estuary Communities)

9 Environmental Monitoring

The Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) provides a framework for Beach's environmental monitoring response for Level 2 and Level 3 offshore hydrocarbon spills from their petroleum activities undertaken in the Otway and Bass Basins.

Oil spill monitoring has been divided into two types:

- operational monitoring which collects information about the spill and associated response activities to aid planning and decision making during the response or clean-up operations. Operational monitoring typically finishes when the spill response is terminated.

- scientific monitoring (also known as Type II or recovery phase monitoring) which is focussed on non-response objectives and evaluating environmental impact and recovery from the spill and response activities. Scientific monitoring may continue for extended periods after a spill response is terminated.

Operational monitoring studies may be implemented in conjunction with relevant response strategies as described in this OPEP (e.g. Monitoring and Evaluation, Protection and Deflection, Shoreline Clean-up and Oiled Wildlife Response (OWR)).

10 Response Strategies

There are several response strategies which can be utilised in response to hydrocarbon spills, including:

- source control
- monitoring and evaluation
- assisted natural dispersion
- chemical dispersants
- containment and recovery
- protection and deflection
- shoreline assessment and clean-up
- oiled wildlife response.

Table 14 summarises the response options that are feasible and effective in response to the hydrocarbon types associated with the Otway and Bass Basin offshore activities.

Table 14: Response option feasibility and effectiveness by hydrocarbon type

Response Strategy	Hydrocarbon Type	Feasibility / Effectiveness	Implement	Justification
Source control	Gas Condensate & DMA	Feasible & effective	Yes	Always primary spill response strategy. Reduction in release volume has direct environmental benefit. N.B. Relief well is the primary strategy for responding to a LOWC event. Well capping is not technically feasible.
Monitor & evaluate	Gas Condensate & DMA	Feasible & effective	Yes	Both gas condensate and DMA will largely evaporate and disperse rapidly, a residual fraction of the hydrocarbon may spread to sensitive receptors. Monitoring and evaluation of the spill trajectory will provide information to inform other response strategies and monitoring requirements.
Assisted natural dispersion	Gas Condensate	Not feasible & not effective	No	Gas condensate will evaporate and disperse rapidly, therefore assisted natural dispersion will present no net environment benefit.
	DMA	Feasible but partially effective	Pending Operational NEBA	DMA will evaporate and disperse rapidly. Depending on weather conditions, thickness of surface slick proximity to sensitive receptors this response may present a net environmental benefit.
Chemical dispersants	Gas Condensate & DMA	Feasible but not effective	No / Separate risk assessment.	Not recommended for Group I oils such as condensate due to the very low viscosity and high volatility – generally no environmental benefit gained by the application of dispersant on Group I oils. Subsea dispersant injection (SSDI) may reduce volatile organic compounds (VOCs) at sea surface within the response area, therefore creating a safer work environment for responders. However, given capping stack system (CSS) are not feasible to deploy, SSDI is not considered for this application. If the SCIMT determine that is a benefit to safe offshore operations then it may be considered with a separate risk assessment. **Confirmation for emergency use must be obtained from NOPSEMA prior to use 1300 674 472**
	DMA	Feasible but not effective	No	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 spill/oil pollution).

Response Strategy	Hydrocarbon Type	Feasibility / Effectiveness	Implement	Justification
Containment & recovery	Gas Condensate	Not feasible & not effective	No	High volatility of condensate creates inherent safety risks when attempting to recover mechanically. Logistically, gas condensate will evaporate faster than the collection rate of a thin surface film present. To be of value, contain and recover techniques are dependent on adequate oil thickness (generally in excess of 10 g/m^2)
	DMA	Not feasible & not effective	No	Low viscosity property allows for efficient containment by boom and recovery by oleophilic skimmers (i.e. komara disc skimmer) with ~90% hydrocarbon to water recovery rate. To be of value, contain and recover techniques are dependent on adequate oil thickness (generally in excess of 10 g/m^2), The normal sea state of the Otway and Bass Basins do not provide significant opportunities to utilise this equipment.
Protection & deflection	Gas Condensate	Potentially feasible & partially effective	Pending Operational NEBA	High volatility of condensate creates inherent safety risks when attempting to deflect mechanically. The normal sea state of the Otway and Bass Basins do not provide significant opportunities to utilise this equipment efficiently.
	DMA	Potentially feasible & partially effective	Pending Operational NEBA	Low viscosity property allows for efficient protection and deflection with boom such as absorbent, zoom boom and beach guardian. The normal sea state of the Otway and Bass Basins do not provide significant opportunities to utilise this equipment efficiently.
Shoreline assessment & clean-up	Gas Condensate	Potentially feasible & partially effective	Pending Operational NEBA	Condensate is highly volatile and will evaporate naturally even if shoreline impact occurred. Potentially, more environmental impact would occur during clean-up operations depending on the shoreline type and sensitivities present. Shoreline assessment activities would occur if shoreline impact occurred.
	DMA	Potentially feasible & partially effective	Pending Operational NEBA	The normal sea state of the Otway and Bass Basins encourages natural processes with high energy wave action, wind and regular storm events. Potentially, more environmental impact would occur during clean-up operations depending on the shoreline type and sensitivities present. Shoreline assessment activities would occur if shoreline impact occurred.

Response Strategy	Hydrocarbon Type	Feasibility / Effectiveness	Implement	Justification
Oiled wildlife response	Gas Condensate	Potentially feasible & partially effective	Yes	If oiling occurs in areas above the conservative environmental exposure threshold of >10 g/m^2 for surface & >100 g/m^2 for shoreline, oiled wildlife response may be effective. At the direction of State Control Agency, impacts to wildlife shall be monitored and oiled wildlife response implemented to affected wildlife as appropriate. Effectiveness of response option depends on affected species and habitat type.
	DMA	Potentially feasible & partially effective	Yes	

10.1 Strategic NEBA and Response Strategy Implementation

Table 15 summarises the response strategies that are relevant (based upon the extent of hydrocarbon exposure) and feasible or potentially feasible to implement for hypothetical spill scenarios associated with Offshore activities and a strategic pre-spill NEBA.

Table 15 : Response feasibility and strategic NEBA

Scenario	Hydrocarbon Type	Response	Strategic NEBA	Key Operational Considerations
Vessel Spill	DMA	Source Control	Yes, source control always considered to provide net environmental benefit by virtue of reducing the overall spill volume.	Other marine users Other petroleum Operations / Titleholders
		Monitor & Evaluate	Indirect benefit by informing response strategies. Aerial and vessel surveillance to be mobilised to determine the extent and direction of L2/L3 spill.	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans Wildlife Marine Mammals Regulations 2009 (Vic) Relevant Conservation Advices, Conservation Plans, Conservation Management Plans and Recovery Plans for nearshore and shoreline MNES (refer Section 6.2). Include management for turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs. Consider breeding sites which are vulnerable to oil pollution. Implement measures to reduce adverse impacts of habitat degradation and/or modification. Other marine users and coastal communities Refer to Tactical Response Plans
		Assisted Natural Dispersion	Site-specific operational NEBA required prior to undertaking response option given variability in potential impact depending on location of spill in relation to marine ecology and habitats.	
		Protect & Deflect	Yes, potential net environmental benefit to coastal habitats, coastal ecology and socio-economic receptors. Site-specific operational NEBA required prior to undertaking response option.	
		Shoreline Clean-up	Yes, potential net environmental benefit to coastal habitats: sandy beaches & intertidal rocky platforms. Potential net benefit to shoreline birds and socio-economic receptors. Potential negative impact for coastal habitats: saltmarsh / seagrass & Wetlands. Site-specific operational NEBA required prior to undertaking response option.	
		Oiled Wildlife Response	Will occur (at the direction of State Control Agency) for all impacted species: cetaceans, pinnipeds, turtles & sea birds. Coastal ecology: shoreline birds, pinniped haul-out sites & penguin colonies.	

Scenario	Hydrocarbon Type	Response	Strategic NEBA	Key Operational Considerations
Loss of Integrity Platform or Pipeline	Gas Condensate	Source Control	Yes, source control always considered to provide net environmental benefit by virtue of reducing the overall spill volume.	
		Monitor & Evaluate	No direct net environmental benefit. Indirect benefit by informing response strategies.	
Loss of Well Control	Gas Condensate	Source Control	Yes. Source control always considered to provide net environmental benefit by virtue of reducing the overall spill volume. N.B. does not apply to CSS as this is not a feasible response option for well within the Otway and Bass Basins	Other marine users Other petroleum Operations / Titleholders
		Monitor & Evaluate	Indirect benefit by informing response strategies. Aerial and vessel surveillance to be mobilised to determine the extent and direction of L2/L3 spill.	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans Wildlife Marine Mammals Regulations 2009 (Vic) Relevant Conservation Advices, Conservation Plans, Conservation Management Plans and Recovery Plans for nearshore and shoreline MNES (refer Section 6.2). Include management for turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs. Consider breeding sites which are vulnerable to oil pollution. Implement measures to reduce adverse impacts of habitat degradation and/or modification. Other marine users and coastal communities Refer to Tactical Response Plans
		Protect & Deflect	Yes, potential net environmental benefit to coastal habitats, coastal ecology and socio-economic receptors. Site-specific operational NEBA required prior to undertaking response option.	
		Shoreline Clean-up	Yes, potential net environmental benefit to coastal habitats: sandy beaches & intertidal rocky platforms. Potential net benefit to shoreline birds and socio-economic receptors. Potential negative impact for coastal habitats: saltmarsh / seagrass & Wetlands. Site-specific operational NEBA required prior to undertaking response option.	
		Oiled Wildlife Response	Will occur (at the direction of State Control Agency) for all impacted species: cetaceans, pinnipeds, turtles & sea birds. Coastal ecology: shoreline birds, pinniped haul-out sites & penguin colonies.	

10.1.1 Source Control

Source control is the primary and most effective form of spill response. In the event of an offshore hydrocarbon spill, the feasibility of controlling the spill from the source should always be considered, giving due consideration to logistical constraints and safety implications.

Source control equipment and resources available to Beach in the event of a LOWC are detailed in Appendix B. 1.

10.1.1.1 Vessel

For a vessel spill at sea, the Vessel Master shall implement the Shipboard Marine Pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (SOPEP) (equivalent to class).

10.1.1.2 Pipeline / Platform

System pressures are monitored via the distributed control system (DCS) onshore, and the platform and pipeline can be shut down via the DCS or emergency shut down (ESD) can be implemented from the platform.

10.1.1.3 Well Control

Restoring well control is the primary objective under a LOWC scenario. The primary method of well control is via a dynamic well kill by intersecting the well bore below the release location via a relief well and circulating kill weight drilling fluid into the well bore, thus controlling the flow of hydrocarbons from the reservoir.

Recommended source control strategies are detailed within the well-specific Source Control Contingency Plans (SCCP):

- Artisan-1 Source Control Contingency Plan (SCCP) CDN/ID: S4810RD718250;
- Thylacine North-1 Source Control Contingency Plan (SCCP) CDN/ID: S4110AV718255;
- Thylacine West-1 Source Control Contingency Plan (SCCP) CDN/ID: S4110AD718258;
- Geographe-5 Source Control Contingency Plan (SCCP) CDN/ID: S4110AD718256
- Geographe-4 Source Control Contingency Plan (SCCP) CDN/ID: S4210AD718257
- Thylacine North-2 Source Control Contingency Plan (SCCP) CDN/ID: S4110AD718259
- Thylacine West-2 Source Control Contingency Plan (SCCP) CDN/ID: S4110AD718260
- Beach Offshore Source Control Contingency Plan (SCCP)
- Relief Well Plan Basic - Otway and Bass (T-5100-35-MP-005)

Relief Well

Drilling a relief well is the primary source control strategy for wells in the Otway and Bass Basins. Each well, or group of similar wells, has a Relief Well Plan detailing: the relief well strategy for each well or group of similar wells, anticipated timeframes to drill a relief well and resources available to implement the relief well strategy.

Beach anticipate the mobilisation of an alternate MODU to the Otway and Bass Basins and the successful intersection of a flowing well would take approximately 86 days. Details of the most suitable source control methods applicable to the specific wells will be detailed in well-specific Source Control Contingency Plan, inclusive of the relief well plan and dynamic kill modelling.

Well Kill Simulation

Blowout and relief well modelling shows a worst-case scenario of a 15 ppg (1.8 sg) kill mud pumped at approximately 64 bpm down the choke and kill lines of the relief well is sufficient to achieve a dynamic well kill based on intersecting the wells below the 9 5/8" casing shoe. The maximum pump pressure is less than 3,000 psi (4,600HP power requirement). It is important to highlight that the fracture strength of both the relief well and target well casing shoes are not exceeded in the simulated well kill modelling. The well kill can be achieved with one relief well.

Sensitivity of blowout scenarios has been done to demonstrate a lower bound of 11.3 ppg (1.35 sg) kill mud pumped at 33 bpm down the choke and kill lines of the relief well is sufficient to achieve a dynamic well kill. The maximum pump pressure is less than 3,000 psi (2,283 HP power requirement). The well kill can be achieved with one relief well.

Relief Well Locations

Two relief well sites have been identified for each location, even though modelling confirms only one relief well is required for the kill operation. This redundancy will give contingency in the event one of the relief well sites is deemed not accessible. Final sites will be chosen based on a risk assessment considering the actual conditions in the event of a LOWC.

Relief Well Targets

An intersection point as deep as possible, but above top of the reservoir, is preferable in order to achieve maximum frictional and hydrostatic pressure drop in the blowing wellbore. Steel is required in the blowout well in order to home in on the target using magnetic ranging techniques, hence the 9 5/8" casing shoe will be the deepest possible intersection point for an open hole blowout scenario.

The relief well may be drilled directly to the target, or alternatively a conventional strategy of approach and cross-by of the target well to facilitate detailed ranging and triangulation. Subsequently, the relief well should parallel the blowout well at close proximity. This section is used to align the relief well with the blowout well before intersecting at the planned kill point. The relief well designs are based on conservative directional drilling parameters.

MODU Selection

The Fields that Beach operates in Victoria are considered remote locations and therefore likely to have an impact on the time taken for a suitable rig to be mobilised to the relief well location. This timeframe has been built into the oil pollution modelling. rig broker reports are used to monitor the rig market on a monthly basis and, if required, assist in sourcing and contracting a suitable MODU, including whether the facility has a valid Australian Safety Case.

The rig broker can be contracted to identify and contract a suitably specified rig (including Australian Safety Case status) within 14 days. Note, a MODU mobilised from the NW Shelf or Singapore is likely to take 35 days. These periods have been factored into the relief well schedule within the well-specific relief well plans.

MODU selection for relief well drilling will be based on the following:

- rating of well control equipment: Rigs considered shall have equipment rated to at least 10,000 psi to perform the required well kill;
- water depth: Rig being considered for relief well drilling must be rated for a minimum water depth of 60 m-100 m;
- seabed conditions.
- rig with a valid Australian Safety Case;
- proximity to the Otway and Bass Basins; and
- ability to engage in a mutual aid agreement with the operator.

Capping Stack System (CSS) Deployment

Rough sea states, including high waves and longer wave periods, can affect the safe operating limits of CSS deployment. The sea state can negatively impact the ability to safety deploy capping stack using a deck crane or A-frame located on the stern of the deployment vessel. Furthermore, if the vessel is experiencing too much heave due to wave action, the CSS could unintentionally hit the subsea wellhead during deployment causing damage to the equipment itself and to the wellhead. Thus, operating limits of acceptable sea states are required for deployment of the equipment for successful deployed in adverse sea state environments such as the Otway and Bass Basins. However, the gas plume environment in shallow water conditions is manifestly different to a deeper water environment due to the exclusion zone above the wellhead preventing vertical installation of the equipment. The feasibility analysis has confirmed that due to the technical complexity of deploying a CSS in shallow waters with a gas plume environment and harsh metocean conditions the use of a capping stack is not operationally suitable for Beach wells within the Otway and Bass Basins.

10.1.2 Monitoring and Evaluation

Understanding the behaviour and trajectory of hydrocarbon slicks is required for L2 and L3 spill scenarios to confirm the potential for environmental harm from the spill. There are a number of methods that can be used to monitor and evaluate hydrocarbon spills including direct observation (surveillance by air, vessel or tracking buoys), manual calculations, or computer modelling. Each of these methods, including the triggers for their use, is discussed in the following sections.

10.1.2.1 Predicting spill trajectory

Manual calculations for estimation of spill trajectory will be used for an initial calculation in parallel with oil spill trajectory modelling to provide an accurate spill trajectory for the current weather conditions and type/volume of hydrocarbon spill.

For a L2 or L3 spill, trajectory modelling would be conducted based on real time spill and metocean data and this information would be used to refine the spill response planning and execution.

10.1.2.2 Aerial / Vessel surveillance

Estimation of hydrocarbon volume can be estimated using the Bonn Agreement Oil Appearance Code (BAOAC – Refer to Appendix D).

Aircraft provide a better platform than vessels for surveillance, and Beach would utilise this option in the event of a Level 2 or 3 spill to provide information on the location, extent, trajectory and spill volume estimate.

Fixed-wing aviation support available to Beach in the event of a L2/L3 spill is detailed in Appendix B. 3. Trained oil spill observers would be engaged from AMOSC to undertake the observations.

Aerial observations would be discontinued (with only shoreline surveillance remaining) once no areas of metallic sheen or true oil colour were observed as this would indicate that the slick thickness was less than 5 microns throughout and therefore poses little risk of environmental harm and is not amenable for any on-water or shoreline clean-up techniques.

10.1.2.3 Satellite Tracking Buoys

These units can be used to track the movement and extent of a spill. Beach own two satellite tracking buoys that are on the MODU. If additional buoys are required, Beach will obtain them from AMOSC and may be used in parallel with aerial surveillance to track the extent of a spill.

10.1.3 Protection and Deflection

Deflection equipment such as booms can be deployed to deflect slicks from encroaching on environmentally sensitive areas. Absorbent type booms are a suitable secondary protection measures at environmental sensitive sites. The feasibility and effectiveness of these measures is largely dependent on calm sea conditions allowing for the deployment of booms and this response option is only warranted where shoreline resources or offshore infrastructure are at risk.

Priority response areas are identified in Section 8.2.

Detailed Tactical Response Plans (TRPs) have been developed for priority protection areas.

All protection and deflection operations within State waters shall be under the direction of the state control agency. Beach will support protection and deflection operations as direct by state control agency.

10.1.4 Shoreline Clean-Up

Shoreline clean-up strategies must be developed in consideration of the shoreline character, resources at risk, and nature and degree of oiling. In general, other strategies are considered prior to shoreline clean-up due to the immediate environmental impact, heavy resource requirement, health and safety concerns (i.e. manual handling, heat stress, fatigue, etc), logistical complexities and waste management.

Shoreline clean-up of diesel or condensate is not generally feasible or beneficial in the high energy environments typical of the Victorian south coast, and any diesel would be highly weathered before it could make landfall and would be expected to have minimal environmental impacts.

The coastline of the Otway Basin is dominated by sheer sandstone cliffs, while the Bass Basin has sand dunes and rock formations. Both coastlines have small and remote beaches which experience frequent heavy surf and swell. These locations rarely have vehicles that would allow for the deployment of clean-up equipment and teams. Any hydrocarbons on these shorelines will likely weather rapidly and be broken down by natural processes.

In the event shoreline impact, DJPR would be the State Control Agency for the response within Sate waters or lands. Beach would support the response option as directed.

10.1.5 Oiled Wildlife Response (OWR)

10.1.5.1Victorian State waters

DELWP is the agency responsible for responding to wildlife affected by a marine pollution emergency in Victorian State waters. If an incident which affects or could potentially affect wildlife occurs in Commonwealth waters close to Victorian State waters, AMSA will request support from DELWP to assess and lead a response if required. DELWP’s response to oiled wildlife is undertaken in accordance with the Wildlife Response Plan for Marine Pollution Emergencies (draft).

Beach will provide support for the response through provision of resources as requested by DELWP utilising existing contracts such as AMOSC.

AMOSC maintains oiled fauna kits.

Both DELWP and AMSA have local and regional oiled wildlife response capability that may be activated under the direction of DELWP.

Personnel may also be deployed under the direction of DELWP to undertake wildlife response activities in State jurisdiction.

DELWP responds to oiled wildlife notifications and has identified the following steps which must be taken when reporting wildlife affected by an oil spill:

1. notify the DJPR State Duty Officer on 0409 858 715 and the DELWP State Agency Commander on 1300 13 4444 immediately.

2. notify AMSA (02 6230 6811) if the oil spill occurs in Commonwealth waters and wildlife is affected.

3. determine the exact location of the animal and provide accurate directions. Maintain observation until DELWP can deploy staff to the site.

4. take response actions only as advised by DELWP or AMSA:

- determine the exact location of the animal for accurate directions for appropriately trained wildlife response personnel. Maintain observation and keep people, dogs and wildlife scavengers away until trained rescuers have arrived.

- avoid handling or treating injured wildlife as this may cause further stress and poses a safety risk to untrained handlers.

10.1.5.2 Tasmanian State Waters

The Tasmanian Oiled Wildlife Response Plan (WildPlan) is administered by the Resource Management and Conservation Division of the DPIPWE and outlines priorities and procedures for the rescue and rehabilitation of oiled wildlife.

Wildlife rescue kits are held at the Hobart and Launceston DPIPWE offices.

To activate oiled wildlife response, contact Natural and Cultural Heritage Division (OWR) on (03) 6165 4396

10.1.5.3 Commonwealth Waters

Beach will activate AMOSC and AMSA in the event of a Level 2 / 3 spill. Part of this activation will be the standby of OWR teams. AMOSC and AMSA both have on call personnel and equipment who can be activated if necessary. The Oil Spill Trajectory Modelling (undertaken by RPS APASA via AMOSC contract) will determine the direction of the spill and the potential interaction of any wildlife. Fixed-wing aircraft would be mobilised via Babcock's and will be used to observe any slick. If it is safe to do so, vessels will be mobilised to the slick area.

To activate, contact:

AMSA: Ph: 1800 641 792

Email: mdo@amsa.gov.au

AMOSC: 0438 379 328

To notify the Department of the Environment and Energy of oiled or potentially oiled wildlife in Commonwealth waters, contact switchboard: Ph: (02) 6274 1111 and the director of national parks: Ph: (02) 6274 2220

10.2 Waste Management

10.2.1 Disposal of Waste

Of the modelled worst-case discharge scenarios, only a near-shore diesel spill from a vessel collision of a full LOWC from Artisan-1 well location is predicted to result in actionable thresholds of shoreline hydrocarbon exposure. Likewise, these scenarios also have the potential for waste generation from oiled wildlife response.

10.2.2 Waste Management Methodology

This section provides context for the potential scale of waste that may be generated during oil pollution response operations.

During clean-up and oil recovery operations, the type and amount of waste generated will depend on the location and recovery method (see Table 16).

Table 16: Waste volume calculation

Location	Hydrocarbon: Waste volume	Comments
Offshore recovery	1: 3	Inefficiency of recovery systems causing higher levels of water to oil ratio intake
Shoreline clean-up	1: 10-20	Significant increase in waste volume due to collection of surrounding environment

In the event of a clean-up operation, temporary waste handling bases will be set up at designated staging areas such as Port Welshpool. Beach in conjunction with its current waste management contractor will determine the suitability of temporary storage facilities for the collected hydrocarbons and oily debris. Table 17 summarises packing, storing and disposal of different types of waste that Beach's EPA licensed waste contractor, can support.

The transport of waste material may be required at sea, from sea to land and on land to on land, liquid transport trucks, flatbed trucks, dump trucks and gully suckers can be utilised to transport waste material through Beach's licensed waste contractor.

Table 17: Waste category, storage, disposal and treatment options

Waste category	Packing & temporary onsite storage	Disposal & treatment[5]
Oiled Liquids	Oil field tanks (fast tanks) IBC Tank trucks Livestock tanks Sealed oil drums Lined skips/pits[1]	Recovery and recycling Bioremediation/land farming[3] Incineration/land filling[2]
Oiled man-made materials	Lined skips Lined earthen pits or berms[1] Industrial waste bags Plastic trash bags Sealed-top drums	Recovery and recycling Incineration/land filling[2]
Oiled naturally occurring organic materials	Lined skips Lined earthen pits or berms[1] Industrial waste bags Plastic trash bags Sealed-Top drums	Recovery and recycling Bioremediation/land farming[3] Incineration/land filling[2]
Oiled dead wildlife/birds[4]	Industrial waste bags Plastic trash bags	Incineration/land filling[2]

1. lined pits for the storage of oiled wastes cannot be constructed within a National Park due to the sensitivity of the location. The potential impacts on subterranean fauna and aquifers must be considered at all other locations.
2. incineration and land filling will only occur at appropriately licensed waste disposal facilities
3. suitable areas to be identified in consultation with local and state authorities.
4. wildlife and birds are collected by those trained in wildlife recovery. All dead wildlife and birds must be segregated. Some wildlife carcasses may need to be retained for scientific purposes. DELWP and/or DPIPWE will provide direction if this is required.
5. sorted by most preferred to least preferred method

11 Spill Response Environmental Performance Outcomes, Standards & Measurement Criteria

Table 18: Spill Response Environmental Performance Outcomes, Standards and Measurement Criteria

Environmental Performance Outcome	Environmental Performance Standard	Responsible Person	Measurement Criteria
Response Capability			
Beach maintain trained and competent EMT and CMT personnel for the duration of the activity.	**Training and Competency** Beach maintain trained and competent EMT and CMT personnel as per Table 13.1 and Table 13.2.	Crisis, Emergency & Security Advisor	Training and competency records
Source Control			
Isolation of spill source & cessation of spill to sea from vessel spill	**SOPEP/SMPEP** All vessels contracted by Beach within the Otway and Bass Basins shall have an SOPEP / SMPEP (appropriate to class).	Vessel Owner / Operator	Pre-mobilisation inspection records demonstrate vessel SOPEP / SMPEP in place prior to vessel entering the field
Beach has appropriate source control plans in place prior to undertaking drilling activities	**Source Control Plans** Prior to undertaking drilling activities Beach shall have: • a NOPSEMA accepted WOMP for each well prior to drilling and throughout the production phase detailing the controls in place to restore well integrity in the event of a LOWC incident; • a well specific Source Control Contingency Plan (SCCP) inclusive of relief well plan demonstrating source control response arrangements are in place to: ◦ deploy an alternate MODU and commence drilling a relief well within 8 weeks of a LOWC incident; and ◦ successfully intersect a flowing well within 86 days.	Offshore Wells Manager	Documented NOPSEMA accepted WOMP prior to drilling Documented well specific SCCP inclusive of Relief Well Plan prior to drilling
Beach maintains capability to effectively implement well control	**Well Control Resources** Prior to undertaking drilling activities Beach shall; • be a signatory to the APPEA Memorandum of Understanding: Mutual Assistance; • maintain contractual agreements with well control specialists to supply specialist personnel and equipment to facilitate source control activities; • maintain agreements with Vessel / Rig Broker(s) to access suitable response support vessels and alternate MODU(s); • have enough and suitably qualified personnel, or knowing have access to enough personnel, to form and maintain the Source Control Incident Management Team (SCIMT) for the worst-case 86-day duration of a LOWC incident; and • have enough equipment and consumables, or knowingly have access to enough equipment and consumables, to effectively intersect a flowing well.	Offshore Wells Manager	Signed copy of APPEA Memorandum of Understanding: Mutual Assistance Well Control Specialist contract(s) in place Vessel / MODU Broker reports available Register of SCIMT members and roster in place
Beach validates source control capability is accessible and available in a timely manner	**Spill Response Exercises – Source Control** Prior to undertaking drilling activities within the Otway and Bass Basins, and annually thereafter, Beach shall undertake a source control exercise ensuring arrangements are in place to: • effectively apply the SCCP in a hypothetical LOWC event; • initiate the APPEA Memorandum of Understanding: Mutual Assistance via APPEA members and confirm a suitable alternate MODU could be engaged within 2 weeks of a hypothetical LOWC event; • mobilise Well Control Specialists to Adelaide within 3 days of a hypothetical LOWC event; • contract suitable support vessels within 2 weeks of a hypothetical LOWC event; • initiate the SCIMT within 2 hours of a hypothetical LOWC event and maintain the SCIMT (to the structure detailed within the well specific SCCP) for a worst-case 86-day LOWC event; and • access enough equipment and consumables to effectively intersect a flowing well based upon the relief well strategy detailed within the well specific relief well plan Prior to undertaking drilling activities in the Otway and Bass Basins, Beach shall test emergency communications protocols between: • the MODU and National Response Centre (NRC)	Offshore Wells Manager / Crisis, Emergency & Security Advisor	Exercise records confirm pre-drill and annual source control capability testing Exercise records confirm access to enough source control equipment and personnel within timeframes specified within well specific SCCPs and relief well plans Exercise records confirm emergency communications protocols in place and effective Rig and vessel exercise / drill records

Environmental Performance Outcome	Environmental Performance Standard	Responsible Person	Measurement Criteria
	• the EMT, CMT and SCIMT • the EMT and Regulatory authorities / Control Agencies • the EMT / SCIMT and source control response providers Beach shall validate that all contracted MODUs and vessels have undertaken exercises and spill drills in accordance with their approved SOPEP / SMPEP or equivalent.		
Monitoring and Evaluation			
Beach maintains capability to effectively implement monitoring & evaluation	**Monitoring & Evaluation Resources** Beach shall: • maintain a service contract with AMOSC to enable access to AMOSC personnel and equipment and other AMOSC Members personnel (AMOSC Core Group) and equipment under mutual aid arrangements; • validate AMOSC on call roster to ensure trained aerial observers can be available within 4 hours for deployment; • maintain a contract with an aircraft operator enabling mobilisation of aircraft for aerial monitoring within 90 min of initiation; • maintain contractual arrangements to access Oil Spill Trajectory Monitoring service providers, either directly or via AMOSC; • maintain arrangements with a Vessel Broker to gain access to surveillance vessels; • maintain an oil spill tracking buoy aboard the MODU during offshore drilling activities for ready deployment during a L2/L3 spill event.	Crisis, Emergency & Security Advisor	AMOSC service contract in place AMOSC equipment and personnel audited by Beach. Aviation contracts in place OSTM contract in place (with RPS APASA) Vessel / MODU Broker reports available Record of spill tracking buoy aboard MODU
Risks managed from monitoring & evaluation	**Risk Assessment** In consultation with State Control Agency and relevant stakeholders, and prior to undertaking monitoring & evaluation operations, Beach shall undertake an operational NEBA and risk assessment (Beach's Risk Assessment Process will be used unless otherwise directed) to mitigate potential impacts to: • Marine fauna including listed migratory species; • Commercial shipping; • Aviation; and • Socio-economic receptors	EMT Leader	Documented risk assessment Consultation records
Beach implements monitoring & evaluation to inform spill response for L2/3 spills	**Implement Monitoring & Evaluation** Beach shall implement monitoring and evaluation (as per s10.1.2 or as directed by the Control Agency) during a L2/L3 oil pollution emergency or as requested by State Control Agency where State waters are, or have the potential to be, impacted.	EMT Leader	Incident records confirm monitoring and evaluation undertaken during L2 / L3 spill event.
Monitoring undertaken	**Operational Monitoring** During monitoring and evaluation operations Beach shall implement operational monitoring in alignment with the Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) (CDN/ID S4100AH717908)	EMT Leader	Monitoring records maintained
Shoreline Clean-up			
Beach maintains capability to effectively assess shorelines and implement shoreline clean-up	**Shoreline Clean-up Resources** Beach shall: • maintain a service contract with AMOSC to enable access to AMOSC personnel and equipment and other AMOSC Members personnel (AMOSC Core Group) and equipment under mutual aid arrangements; • validate AMOSC on call roster to ensure trained in shoreline assessment can be available within 4 hours for deployment; • prior to drilling, engage with AMSA regarding potential access arrangements to the National Response Team (NRT) and National Response Support Team (NRST) in the event of an oil pollution emergency; • maintain a contract with licenced waste contractors and licenced waste facilities to enable appropriate disposal / treatment of oil contaminated waste.	Crisis, Emergency & Security Advisor	AMOSC service contract in place AMSA engagement records regarding access to NRT and NRST Waste Management contract in place

Environmental Performance Outcome	Environmental Performance Standard	Responsible Person	Measurement Criteria
Shoreline Assessment undertaken	**Shoreline Assessment** In consultation with State Control Agency, an assessment shall be undertaken of affected and potentially affected shorelines to establish response priorities and outcomes when developing Incident Action Plans (IAPs).	EMT Leader	Shoreline assessment records inform response priorities and outcomes within IAPs
Monitoring undertaken	**Operational Monitoring** During shoreline clean-up operations Beach shall implement operational monitoring in alignment with the Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) (CDN/ID S4100AH717908):	EMT Leader	Monitoring records indicate monitoring undertaken in accordance with NOPSEMA accepted OSMP.
Shoreline clean-up present net environmental benefit	**NEBA** Beach shall jointly undertake a NEBA with State Control Agency and only implement shoreline clean-up where a net environmental benefit is agreed with the Control Agency.	EMT Leader	Documented NEBA Communications records
Risks managed from shoreline clean-up operations	**Risk Assessment** In consultation with State Control Agency and relevant stakeholders, and prior to undertaking shoreline clean-up operations, Beach shall undertake a risk assessment (Beach's Risk Assessment Process will be used unless otherwise directed) to mitigate potential impacts to: • shoreline habitats; • shoreline communities; • oiled wildlife; • cultural heritage sites; and • socio-economic receptors	EMT Leader	Documented risk assessment
Relevant access authority obtained	**Site Access** In consultation with State Control Agency, access authority from relevant stakeholders shall be obtained prior to undertaking shoreline clean-up operations.	EMT Leader	Records of access authority
Tactical Response Plans developed	**Tactical Response Plans** Prior to undertaking drilling activities in the Otway or Bass Basin, Tactical Response Plans (TRPs) shall be developed for all priority protection areas where predicted shoreline hydrocarbon loading exceeds 100 g/m^2 within 7 days and include: • site Information: site location description and map, site access description and map, site specific logistical / access constraints, key ecological and socio-economic sensitivities within the area, nearby facilities and services. • response Information: response strategies and tasks, site overview and maps, response checklists, site establishment information, local information including contact details of key stakeholders, detailed task checklists, resource requirements (personnel / vehicles / vessels / equipment / site support).	Crisis, Emergency & Security Advisor	Documented TRPs for all priority protection areas
Oiled Wildlife Response			
Beach maintains capability to effectively implement oiled wildlife response	**Oiled Wildlife Resources** Beach shall: • maintain a service contract with AMOSC to enable access to AMOSC personnel and equipment and other AMOSC Members personnel (AMOSC Core Group) and oiled wildlife response equipment under mutual aid arrangements; • validate AMOSC on call roster to ensure trained oiled wildlife responders can be available within 4 hours for deployment; • prior to drilling, engage with AMSA regarding potential access arrangements to the National Response Team (NRT) and National Response Support Team (NRST) and addition oiled wildlife response equipment in the event of an oil pollution emergency; and • maintain a contract with licenced waste contractors and licenced waste facilities to enable appropriate disposal / treatment of oil contaminated waste.	Crisis, Emergency & Security Advisor	AMOSC contract in place AMSA engagement records regarding access to NRT and NRST Waste Management contract in place
Required notifications undertaken	**Notifications** Beach shall notify State Control Agency (DJPR), DELWP and the Department of Environment and Energy AMSA as soon as possible after a spill that has, or has the potential to, affect wildlife in either State or Commonwealth waters.	Emergency Management Liaison Officer	Communications records

Environmental Performance Outcome	Environmental Performance Standard	Responsible Person	Measurement Criteria
Operational monitoring undertaken	**Operational Monitoring** Beach will implement, via scientific monitoring consultants, the following operational monitoring in alignment with the Offshore Victoria Operational and Scientific Monitoring Plan: • Study O3: Oiled wildlife surveillance	EMT Leader	Monitoring records
Shoreline clean-up present net environmental benefit	**NEBA** Beach shall jointly undertake a NEBA with State Control Agency (DJPR) and DELWP and only implement oiled wildlife response where a net environmental benefit is agreed with the DELWP.	EMT Leader	Documented NEBA Communications records
Risks managed from shoreline clean-up operations	**Risk Assessment** In consultation with State Control Agency, DELWP and relevant stakeholders, and prior to undertaking oiled wildlife response, Beach will undertake site-specific risk assessment and mitigate potential impacts to: • shoreline habitats; • shoreline communities; • oiled wildlife; • cultural heritage sites; and • socio-economic receptors	EMT Leader	Documented risk assessment Consultation records
Authority to handle wildlife obtained	**Fauna Handling** In consultation with DELWP, only authorised responders shall handle and treat oiled wildlife.	EMT Leader	Consultation records Licencing records.
Monitoring undertaken	**Operational Monitoring** During oiled wildlife response Beach shall implement operational monitoring in alignment with the Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) (CDN/ID S4100AH717908)	EMT Leader	Monitoring records indicate monitoring undertaken in accordance with NOPSEMA accepted OSMP.
Waste Management			
Waste management appropriate	**Waste Management Plan** Site-specific waste management plans will be developed in consultation and agreement with the EPA, DJPR EMB and the land custodian / owner.	EMT Leader	Documented Waste Management Plan Consultation records
Waste storage appropriate	**Waste Storage** Waste storage arrangements will be agreed with the Beach Waste Management Contractor in consultation and agreement with the EPA, DJPR EMB and the custodian / owner and will be: • fully bunded; • secured; and • supervised	EMT Leader	Documented Waste Management Plan Consultation records
Waste disposal appropriate	**Waste Facility** Wastes will be segregated and manifested to ensure they are sent to an appropriately licenced waste facility as agreed with the EPA.	EMT Leader	Documented waste manifest Licenced waste Contractors & waste facilities. Consultation records
Waste transport appropriate	**Waste Transport** Wastes will be transported by correctly permitted vehicles to licenced waste facilities in accordance with Victorian EPA requirements.	EMT Leader	Documented waste manifest Licenced waste transporters Consultation records

12 On-Going Response Preparedness and Exercises

12.1 OPEP Review

The plan shall be reviewed and updated as necessary in response to one or more of the following:

- annually
- when major changes which may affect the oil spill/pollution response coordination or capabilities have occurred
- routine testing of the plan if gaps are identified within the plan
- after an actual emergency
- if Beach's spill risk profile changes significantly due to additional activities or operations.
- changes in COVID-19 measures or restrictions

The review of the plan shall consider external influences including:

- change in any relevant legislation
- COVID-19 measures or restrictions
- advice from the government relating to the conservation of listed species
- updates to State or Australian Marine Park management plans
- changes in fisheries management or other socio-economic features of the environment
- new knowledge about the receiving environment in bioregional profiles or published scientific literature that may contribute to environmental baselines or data collection methods
- change in State or Commonwealth oil spill response arrangements and resources.

12.2 Testing Arrangement

In accordance with Regulation 14 (8A) & (8C) of the OPGGS(E) Regulations the response arrangements within this OPEP including :

- when they are introduced
- when they are significantly amended
- in accordance with Appendix H of this document – Testing Schedule
- if a new location for the activity is added to the EP after the response arrangements have been tested, and before the next test is conducted – testing the response arrangement in relation to the new location as soon as practicable after it is added to the plan

- if a facility becomes operational after the response arrangements have been tested and before the next test is conducted – testing the response arrangements in relation to the facility when it becomes operational.

The effectiveness of response arrangements will be measured by the performance standards detailed in Table 18 for each exercise type and take into account any COVID-19 measures or restrictions. Exercises will be documented, and corrective actions/recommendations tracked to closure.

A log shall be maintained during all oil pollution response exercises including a record of the effectiveness and timeliness of the response against the objectives of the exercise.

Where objectives are not met, or potential improvements have been identified during an exercise, these learnings shall be recorded and retained for inclusion into the subsequent revision of this OPEP.

Where significant deficiencies are identified in the effectiveness or timeliness of response arrangements as identified within this OPEP, this OPEP shall be updated within one month of the exercise to address the identified issues.

As required by the Environment Regulation 14(8A), the testing must relate to the nature and scale of the risk of oil pollution relevant to the activity.

Testing arrangements appropriate to the nature and scale of each activity covered by this OPEP are included in Appendix H.

In accordance with Regulation 14 (8C) (d) and (e), these arrangements are also designed to provide for:

- the various locations of Beach facilities and activities in the Otway and Bass Basins.
- response arrangements in relation to each of the facilities and activities.

Not all spill preparedness and response testing environmental performance outcomes will be tested simultaneously. The frequency of testing will relate to the potential spill level, spill risk and complexity of response.

Table 19: Spill Preparedness and Response Testing Environmental Performance Outcome, Standards and Measurement Criteria

Environmental Performance Outcome	Environmental Performance Standard	Testing Timing / Frequency	Responsible Person	Participants	Measurement Criteria
Vessel Operations (Level 1 / 2 spill)					
Response systems functioning	Emergency communications between shore base, MODU and offshore vessels shall be tested when the vessel is new to field	Prior to arrival in field	Beach Contract Owner	Shore base MODU Vessel(s)	Exercise records confirm effective communications
Procedures in place and appropriate	Beach shall validate that each vessel within field has a SOPEP / SMPEP	Prior to arrival in field	Beach Contract Owner	Vessel(s)	Vessel inspection / audit records confirm SOPEP / SMPEP in place
	Beach EMT shall test the effectiveness of OPEP & OSMP in guiding spill response and remediation based upon: • notification timing and completeness; • timeliness of response according to predicted response timing; • availability of response personnel; • training and competency of response personnel	Approximately[1] one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	EMT on call roster AMOSC Monitoring Provider	Exercise records confirm OPEP / OSMP effective
	Beach shall test the effectiveness of Emergency Management Plan in guiding EMT to fulfil roles and responsibilities	Annually	Crisis, Emergency & Security Advisor	EMT	Exercise records conform all EMT able to fulfil allocated roles & responsibilities

[1] Timing of any testing will be determine based on the availability of the crew who will be involved in the activity with the time required to implement any changes.

Environmental Performance Outcome	Environmental Performance Standard	Testing Timing / Frequency	Responsible Person	Participants	Measurement Criteria
Contractual arrangements in place to obtain equipment & people	Beach shall validate contractual arrangements with external service providers the capability of each service provider to respond according to scope.	Approximately[1] one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	Contract Owner(s) Service Providers	All required contracts in place
Equipment available in a timely manner	Beach shall validate equipment stock levels and deployment times from AMOSC (desktop) based upon those presented within this OPEP	At least one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	Contract Owner AMOSC	Written confirmation of AMOSC capability
Appropriately trained people available	Beach shall validate the capability of environmental monitoring providers to ensure they continue to meet Beach requirements based upon company spill risk profile and potential monitoring scope of work (desktop)	Upon contract renewal	Crisis, Emergency & Security Advisor	Contract owner(s) Monitoring Providers	Written confirmation of Environmental Consultant capability to implement OSMP
	Internal and external training requirements for EMT validated (desktop)	Approximately[1] one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	Leaning & Development	Training records in place and meet capability requirements
Pipeline and Platform Operations (Level 1 / 2 spill) as above plus					
Response systems functioning	Emergency communications shall be tested between ERT and EMT	Annually	Crisis, Emergency & Security Advisor	ERT EMT	Exercise records confirm effective communications
	Emergency notifications between EMT and Regulator(s) tested (including regulatory timeframes)	Annually	Crisis, Emergency & Security Advisor	EMLO EMT Regulators	Exercise records confirm effective communications and notification timeframes met
Contractual arrangements in place to obtain equipment & people	Beach shall validate contractual arrangements with external service providers the capability of each service provider to respond according to scope.	Annually	Crisis, Emergency & Security Advisor	Contract Owner(s) Service Providers	All required contracts in place

Environmental Performance Outcome	Environmental Performance Standard	Testing Timing / Frequency	Responsible Person	Participants	Measurement Criteria
Drilling (Level 2 / 3 LOWC) as above plus					
Response systems functioning	Emergency communications between the MODU and EMT / SCIMT tested	At least one month prior to drilling in field and then 6-monthly	Crisis, Emergency & Security Advisor	MODU EMT / SCIMT	Exercise records confirm effective communications
	Emergency notifications between EMT and Regulator(s) tested (including regulatory timeframes)	At least one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	EMLO EMT / SCIMT Regulators	Exercise records confirm effective communications and notification timeframes met
	Communication systems and methods between CMT / EMT Leader / SCIMT Leader / EMT members tested	At least one month prior to drilling in field and then 6-monthly	Crisis, Emergency & Security Advisor	CMT / EMT/ SCIMT	Exercise records confirm effective communications
	OSTM arrangements tested	Approximately[1] one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	AMOSC OST Service Provider	Exercise records confirm ability to initiate OSTM
Procedures in place and appropriate	Beach shall test readiness or arrangements to implement the relief well plan under the APPEA MoU	Approximately[1] one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	SCIMT APPEA Well Control Specialists	Exercise records confirm relief well plan in place & tested
	Beach shall test the effectiveness of Source Control Contingency Plan guiding SCIMT to fulfil roles and responsibilities	Approximately[1] one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	SCIMT	Exercise records conform all EMT able to fulfil allocated roles & responsibilities
Equipment available in a timely manner to respond to a L2 / L3 LOWC	Beach shall test logistics pathways for mobilisation & deployment of L2 / L3 equipment, including support vessels and suitable MODUs validated (desktop)	Approximately[1] one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	MODU / Rig Broker SCIMT Other Operator(s) under MoU	Exercise records confirm logistics pathways open and likely to facilitate deployment within anticipated timeframes

Environmental Performance Outcome	Environmental Performance Standard	Testing Timing / Frequency	Responsible Person	Participants	Measurement Criteria
Appropriately trained people available to respond to a L2 / L3 LOWC	Validation Well Control Specialists capability continues to meet Beach requirements based upon company spill risk profile (desktop)	Approximately[1] one month prior to drilling in field and upon contract renewal	Crisis, Emergency & Security Advisor	Well Control Specialists Learning and Development	Written confirmation of Well Control Specialists capability
	Internal and external training requirements for the SCIMT validated (desktop)	Approximately[1] one month prior to drilling in field and then annually	Crisis, Emergency & Security Advisor	Learning and Development	Training records in place and meet capability requirements

13 Training and Competency

All personnel who have been assigned Beach EMT roles are required to be conversant with their roles and associated responsibilities as defined within the EMP and OPEP.

All personnel with specific roles or responsibilities within the Beach CEM Framework shall receive appropriate levels of training and ongoing development commensurate with the responsibility and associated accountabilities required of each position.

A Crisis and Emergency Management Team Capability Matrix is managed and updated by the Senior Capability Advisor. A summary of Oil Pollution related training and competency requirements for CMT and EMT personnel is provided in Table 20 and Table 21.

As detailed in Table 20 and Table 21 beach has identified the minimum number of personnel per position to appropriately respond to an oil spill/pollution event at the modelled requirement of 180 days. A minimum number of four trained personnel per position is based on that at any time one person may be on leave or not available at the time of activation of the event. This allows for three trained personnel to be available.

Beach maintain an on-call roster of a full EMT per shift (Friday to Friday) with four EMTs on rotation but have a redundancy of additional appropriately trained and qualified staff.

Table 20: **External** Training Requirements for CEM Capability

Course Name	Minimum personnel	PMAOMIR320 (Manage Incident Response Information)	Management (IMO L2)	Command & Control (IMO L3)	PMAOMIR418 (Coordinate Incident Response)
EMT					
Leader	4	✓		✓	✓
Operations	4	✓	✓		✓
Planning	4	✓	✓		✓
Information Coordinator	4	✓			
Scribe	4	✓			
HSE	4	✓	✓		
Logistics	4	✓			✓
EMLO	4	✓	✓		
Community Relations	4	✓			
CMT					
CMT Leader	4				✓
CMT Facilitator	2	✓	✓		
CMT Members					

Course Name	Minimum personnel	PMAOMIR320 (Manage Incident Response Information)	Management (IMO L2)	Command & Control (IMO L3)	PMAOMIR418 (Coordinate Incident Response)
Duration of Training / Course		4 days	4 days	4 days	4 days
Frequency of training/refresher		Lifetime validation, however, Beach require revalidation every 4 years	3 years, full course	3 years, full course	Lifetime validation, however, Beach require revalidation every 4 years
Current Provider		RTO	AMOSC	AMOSC	RTO

Table 21: **Internal** Training and Exercising Requirements for CEM Capability

Course Name	Minimum personnel	Individual OPEP / OSMP Awareness	Introduction/ Refresher to Beach CEM	Desktop Exercise	EMT 'Live' OPEP test (Australia and NZ)	'Live' Exercise (with SCIMT)
EMT						
Leader	4	✓	✓	✓	✓	✓
Deputy	4	✓	✓	✓	✓	✓
Operations	4	✓	✓	✓	✓	✓
Planning	4	✓	✓	✓	✓	✓
Information Coordinator	4	✓	✓	✓	✓	✓
Scribe	4	✓	✓	✓	✓	✓
Environment	4	✓	✓	✓	✓	✓
Health & Safety	4	✓	✓	✓	✓	✓
Logistics	4	✓	✓	✓	✓	✓
EMLO	4	✓	✓	✓	✓	✓
Community Relations	4	✓	✓	✓	✓	✓
CMT						
CMT Leader	4	✓	✓	✓	✓	✓
CMT Facilitator	2	✓	✓	✓		✓
CMT Members	As per CMT roster	✓	✓	✓		✓

Course Name	Minimum personnel	Individual OPEP / OSMP Awareness	Introduction/ Refresher to Beach CEM	Desktop Exercise	EMT 'Live' OPEP test (Australia and NZ)	'Live' Exercise (with SCIMT)
Duration of Training		2 hours	3 hours	3 hours	3 hours	3 – 6 hours
Frequency of training / exercise		Annually	Annually and for onboarding new members as required	Annually	Annually for Australia and NZ	Annually
Trainer		CES Advisor (TAEIV)	CES Advisor (TAEIV)	CES Advisor (TAEIV) and external facilitator	AMOSC with CES Advisor (TAEIV)	CES Advisor (TAEIV) and external facilitator

Note: additional SME training, Pre-Spud exercises, additionally requested role specific training, training on EMQNet occur as required throughout the year, CMT exercises for CMT only scenarios, Business Continuity and IT Disaster Recovery events occur and are captures in the relevant documents and recorded as part of Beach's Training and Capability requirements. All activities are recorded on CMO and recommendations are captured and actioned recorded via this means.

14 Record keeping

All consultation correspondence, written reports (including monitoring, audit, test and review reports such as emergency exercise logs used to record the effectiveness and timeliness of the response against the objectives of the exercise, or any other record relating to the environmental performance of this OPEP must be retained for a minimum of 5 years following the cessation of activities within the scope of this OPEP.

All records must be stored in a way that makes retrieval of the document or record reasonably practicable.

15 List of Abbreviations

Definitions of terms used in this document:

Abbreviation	Definition
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
CEM	Beach Emergency's Crisis and Emergency Management Framework
CMP	Crisis Management Plan
CMT	Crisis Management Team
CMO	Beach's incident and action reporting software
CSS	Capping Stack System
CxT	Crisis Communications Team
DCS	Distributed Control System

Abbreviation	Definition
DotEE	(Commonwealth) Department of the Environment and Energy
DELWP	(Victorian) Department of Environment, Land, Water and Planning
DJPR EMB	(Victorian) Department of Jobs, Precincts and Regions – Emergency Management Branch
DJPR ERR	(Victorian) Department of Jobs, Precincts and Regions – Earth Resources Regulation
DPIPWE	(Tasmanian) Department of Primary Industries, Parks, Waters and Environment
EMBA	Environment that May be Affected
EMLO	(Beach) Emergency Management Liaison Officer
EMT	Emergency Management Team
EP	Environment Plan
EPA	Environmental Protection Authority
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESD	Emergency Shut Down
HSE	Health, Safety, and Environment
IMT	Incident Management Team (Used at Beach for Source Control IMT)
IMO	International Maritime Organisation accreditation
JSCC	Joint Strategic Coordination Committee
LOWC	Loss of Well Control
MD	Managing Director
National Plan	National Plan for Maritime Environmental Emergencies
NEBA	Net Environmental Benefit Analysis
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NRC	National Response Centre
OIE	Offset Installation Equipment
OSMP	Operational & Scientific Monitoring Plan
OSMIP	Operational & Scientific Monitoring Implementation Plan
OSRL	Oil Spill Response Limited
OSTM	Oil Spill Trajectory Model
OWR	Oiled Wildlife Response
PIC	Person in Charge of site
POLREP	Marine Pollution Report
SCCP	Source Control Contingency Plan
SC IMT	Source Control Incident Management Team (activated under the SCIMT)
SCME	State Controller Maritime Emergencies

Abbreviation	Definition
SIRT	Subsea Incident Response Toolkit
SITREP	Marine Pollution Situation Report
SMPEP	Shipboard Marine Pollution Emergency Plan
SOPEP	Shipboard Oil Spill Pollution Emergency Plan
SSDI	Subsea Dispersant Injection
TAEIV	Training and Assessment Certificate 4
TST	Telephone Support team
VOC	Volatile Organic Compounds
SCIMT	Source Control Incident Management Team
WOMP	Well Operations Management Plan

16 Document information and history

Document custodian group

Title	Name/s
DocCust-HSER-Environment	Tm Flowers, Phil Wemyss

Document superseded

Rev	Date	Document number	Document name
5	26/06/2019	3972816	Oil Pollution Emergency Response Plan – OPEP – Yolla-A Platform
6	31/01/2020	3973983	Otway Offshore Oil Pollution Emergency Plan (OPEP)

Document history

Rev	Date	Changes made in document	Reviewer/s	Consolidator	Approver
A	15/05/2021	Yolla-A and Thylacine OPEPs merged	Frank Groen, Geoff Randall	Sam Payne	-
0	21/10/2021	Approved for use	-	-	Tim Flowers

Appendix A Emergency Contacts Directory (Current 1st November 2019)

A. 1. External Contacts

A. 1. 1 Regulatory Contacts

Regulator	Contact	Phone	E-Mail
AMSA	Marine oil pollution	1800 641 792	mdo@amsa.gov.au https://www.amsa.gov.au/about/contact-us
DotEE	Director of National Parks	02 6274 2220	marineparks@awe.gov.au
	Switchboard	02 6274 1111	
NOPSEMA	Emergency	1300 674 472	submissions@nopsema.gov.au
NOPTA	Titles		titles@nopta.gov.au & info@nopta.gov.au
Transport for NSW	Manager, Marine Pollution & Emergency Response	0419 484 446	Shayne.wilde@transport.nsw.gov.au
Port Authority of NSW	Harbour Master, Eden Operations	0438 374 034	pwebster@portauthoritynsw.com.au
	Whale Hotline	0427 942 537	
	Natural and Cultural Heritage (OWR) Division	(03) 6165 4396	Kathryn.Lambert@dpipwe.tas.gov.au
Vic DELWP	State Control Centre	1300 134 444	sscviv.scmdr.delwp@scc.vic.gov.au
	Customer Service Centre	136186	
Vic DJPR	General	13 61 86	customer.service@ecodev.vic.gov.au
	State Duty Officer	0409 858 715 (24/7)	sccvic.sdo.dedjtr@scc.vic.gov.au & semdincidentroom@ecodev.vic.gov.au
	West of Cape Otway – Portland Region	(03) 5525 0900	
	East of Cape Otway – Port Philip Region	(03) 9644 9777	
	Compliance South West Team	0419 597 010 ERR Duty Officer	Compliance.Southwest@ecodev.vic.gov.au
Vic Gippsland Ports	Duty Officer	(03) 5150 0500	
Vic Port of Portland	Duty Officer	(03) 5525 0999	

A. 1. 2 Responder Contacts

Responder	Function	Contact	Phone	E-Mail
Adagold Aviation Pty Ltd	Fixed-wing aviation support		1800 767 747	
AMOSC	Spill Response - all		0438 379 328	
AMSA	Spill Response - vessel		1 800 641 792	
Boots and Coots (Halliburton) (Australia, New Zealand, Papua New Guinea, Timor Leste)	Well Control Specialist	Level 27, 140 St. Georges Terrace Perth WA 6000 Australia	Perth: +61 8 9455 8300 or 24/7: +1-281-931-8884 or 1-800-BLOWOUT	
Babcock	Fixed-wing & helicopter support		0438 237 242	
Cudd Well Control (Houston)	Well Control Specialist	Headquarters: Cudd Well Control 2828 Technology Forest Blvd. The Woodlands, TX 77381	T: 713.849.2769 F: 713.849.3861	cwcinfo@cudd.com

A. 1. 3 Consultant Contact

Consultant	Service	Contact	Phone	E-Mail
BMT	OSMP implementation	Level 4 20 Parkland Rd Osborne Park Western Australia 6017	+61 8 6163 4900	
Cardno	OSMP implementation	Level 11 515 St Paul's Terrace Fortitude Valley QLD 4006	+61 (7) 3369 9822	
GHD	OSMP implementation	Level 10 999 Hay Street Perth, Western Australia 6000	+61 8 6222 8222	
RPS	OSMP Implementation PlanOSMP implementation	27 – 31 Troode Street, West Perth, WA, 6005Level 10 999 Hay Street Perth, Western Australia 6000	0427 933 944 / 0458 568 277	
RPS APASA	Oil Spill Modelling		0408 477 196	

A. 2. Internal Beach Contacts

A. 2. 1 Internal Beach Contacts

Contact / Function	Phone	E-Mail
Vic GM Operations	0436645483	
BassGas Production Manager	0419 890 559	
Otway Production Manager	0476 828 914	
EMT Leader	(03) 9411 2147 (via the NRC)	
Source Control Incident Management Team Leader	(03) 9411 2147 (via the NRC)	
Crisis, Emergency and Security Advisor	0447 718 481	ces@beachenergy.com.au

A. 3. Emergency Management Team Role Checklists for Oil Pollution Event

Role	Responsibility
EMT Leader	❑ Recognise and maintain response priorities (People, Environment, Assets, Reputation and Livelihood) ❑ Provide strategic direction and leadership to the whole EMT – this will include the OP IMT, the SCIMT and the SC IMT. ❑ Determine structure of response team, discuss with OP IMT Leader and activate EMT/OP IMT ❑ Develop and implement a coordinated range of support initiatives across the activated teams (SCIMT/SC IMT and OP IMT) to resolve the event, including being the conduit of information to the CMT Leader; and ❑ Communicate the format in which discussions will occur (e.g. utilising Team Process' or regular timing schedule for updates) ❑ Decide on communications method with CMT Leader (via EMT Leader or Deputy) **Activate/Update/Initial actions** ❑ Activate the OSMP/OPEP (possibly, in consultation with EMT Environment) ❑ Government and corporate communications ❑ Chair team meetings / briefing / debrief sessions – set and review response objectives ❑ Carry out incident assessment and escalation potential analysis: ◦ Are all people accounted for and safe? ◦ Is the sources isolated? ◦ What is the current size of the spill? ◦ What is it? (product name and properties) ◦ Where is it? (GPS reference, distance and bearing from, place name) ◦ How big is it? (Volume, area) ◦ Where is it going? (Current forecast, weather and tide) ◦ When will it get there? ◦ What is in the way? (Prioritise protection) ◦ What is happening to it? (Weathering) ◦ How could it escalate? ❑ Roles and responsibilities: ◦ Statutory agency ◦ Combat agency ❑ Notifications: ◦ Reports ◦ Crisis Management Team ◦ EPA ◦ Key Stakeholders ❑ Assess and declare the event level– consult with CMT to carry out organisational as required (through CMT Communications) ❑ Discuss with CMT Leader requirement for additional SMEs to be brought into the EMT (or specialist teams) or into the CMT ❑ Escalate / de-escalate event as appropriate and carry out associated activations / notifications ❑ Review and approve meeting minutes / actions on event status boards and task list ❑ Establish / review team objectives **Issues**

Role	Responsibility
	❑ Recognise and maintain response priorities (People, Environment, Assets, Reputation and Livelihood) and ensure response teams are doing the same ❑ Response strategy development / review and execution – refer to specific EMP Appendices for response and communications guidance, information, contingency plans and SOPs ❑ Identify other emergency or crisis management plans that are endorsed by regulators for the impacted asset and what thresholds these plans have regarding activation of and coordination with additional teams ❑ Alignment / consistency of EMT members' actions and activities – manage response continuity ❑ Align EMT actions and response with those of other activated response teams (e.g. ERT / CMT) ❑ Communications strategy and requirements (with relevant EMT members) ❑ Industry wide considerations (including notifications – joint response obligations) ❑ Industry / NOPSEMA communication obligations ❑ Impact minimisation – contain event and begin recovery ❑ Regulatory notification requirements (e.g. ESV, NOPSEMA etc) within timelines as defined in licenses **Stakeholders** ❑ Contribute to stakeholder identification and prioritisation ❑ Customers – review / assess ongoing impact to customers (liaise with EMT Logistics or Commercial)) ❑ Consider stakeholder needs and expectations – e.g. regulators, government agencies, emergency services, community groups, employees, media outlets, customers, retailers ❑ Other industry participants and communications / notification groups – as per Emergency Communications Protocol (if applicable) ❑ Industry partners – e.g. retail companies, contractors (per industry practices and contractual obligations) ❑ Industry meetings – attend meetings / arrange representation, contribute on behalf of Beach ❑ Regulators (e.g. ESV, NOPSEMA, UTR etc) – advise regulators of operating constraints (e.g. reduced pipeline operating pressures) ❑ EMT CMT Leader – provide SITREP / briefing as event changes and following EMT meetings **Actions** ❑ During any absences from the Emergency Management Room, delegate to Deputy or Planning to support team function ❑ Guide and advise EMT members on response requirements, identify and allocate tasks ❑ Activate support teams as necessary to assist the response (including subject matter experts, system technical / supply advisers, communications specialists) ❑ Establish team meeting / briefing schedule (including frequency and timing) – with EMT Planning ❑ Provide regular updates to CMT ❑ Identify and apply appropriate plans, procedures and work instructions ❑ Refer any media interest to EMT Communications ❑ Consider shift handover for extended responses – including for support staff / teams ❑ Log of events – maintain and record your decisions, actions, updates and contacts **Concluding Actions** ❑ Identify and complete all outstanding actions and obligations ❑ Ensure all relevant strategy specific termination criteria have been met in agreement with Control Agency ❑ Declare end of event and coordinate / chair EMT debriefing

Role	Responsibility
	❑ Formulate and implement a stand down plan with other activated response and support teams – manage consistency and coordination of actions ❑ Confirm notification of all operational resources / 3rd party responders of event conclusion ❑ Authorise and participate in the post-event investigations (by Legal representative) – assign actions, track and monitor progress and completion status ❑ Provide all log sheets and written records / correspondence to EMT Planning
EMT Deputy	❑ Act as 2IC of the EMT, and carry out tasks as requested by EMT Leader ❑ Provide advice on overall management of EMT, including H&S and HR aspects ❑ Act as conduit of information to the CMT, for update briefings and direct liaise with Finance ❑ Decide on communications method with CMT Leader and CMT Finance and if required, HR ❑ Recognise and maintain response priorities (People, Environment, Assets, Reputation and Livelihood) and ensure response teams are doing the same ❑ Response strategy development / review and execution – refer to specific EMP Appendices for response and communications guidance, information, contingency plans and SOPs ❑ Identify other emergency or crisis management plans that are endorsed by regulators for the impacted asset and what thresholds these plans have regarding activation of and coordination with additional teams ❑ Alignment / consistency of EMT members' actions and activities – manage response continuity ❑ Align EMT actions and response with those of other activated response teams (e.g. ERT / CMT) ❑ Communications strategy and requirements (with relevant CMT members) **Stakeholders** ❑ Contribute to stakeholder identification and prioritisation ❑ Customers – review / assess ongoing impact to customers (liaise with EMT Logistics or a commercial representative for advice) ❑ Consider stakeholder needs and expectations – e.g. regulators, government agencies, emergency services, community groups, employees, media outlets, customers, retailers ❑ Other industry participants and communications / notification groups – as per Emergency Communications Protocol (if applicable) ❑ Industry partners – e.g. retail companies, contractors (per industry practices and contractual obligations) ❑ Commercial – Liaise with commercial members for updates on operating production commitments ❑ Brief CMT Leader – provide SITREP / briefing as event changes and following EMT meetings **Actions** ❑ During any absences of EMT Leader from the Emergency Management Room, assume management functions to support ongoing team functions ❑ Guide and advise EMT members on response requirements, identify and allocate tasks ❑ Consider shift handover for extended responses – including for support staff / teams ❑ Log of events – maintain and record your decisions, actions, updates and contacts **Concluding Actions** ❑ Provide all log sheets and written records / correspondence to EMT Planning
EMT Planning	❑ This position is help by an IMO2 qualified EMT Member ❑ Provides support to the EMT Leader in delivering timely integrated crisis management actions ❑ May serve as a sounding board for the EMT Leader ❑ Will assist the EMT Leader in developing the objectives in the first hour of notification of an event;

Role	Responsibility
	❑ EMT Planning will manage the EM Room and team members within it. This includes moderating discussions and adherence to the rules of the room leading the 'Team Process' ❑ EMT Planning is the 2IC of the EMT and is the conduit of information from the Leader to the Information Coordinator and Scribe. EMT Planning will act as Leader when the EMT Leader steps out or is unavailable. **Activate/Update** ❑ Upon activation, attend the EMT as directed – obtain event briefing from EMT Leader ❑ Create and distribute POLREP within first 60 minutes of notification ❑ Commence a personal event log ❑ Determine level of response and staffing requirements – in consultation with EMT Leader ❑ Establish Emergency Management Room and notify EMT members of its location – verify that all equipment is present and functioning correctly (with EMT Information Coordinator) ❑ Advise EMT Leader of status of team members (available / unavailable / arrived / en-route) ❑ Confirm ERT / CMT contact information, distribute Emergency Management Room (EMR) / EMT contact information ❑ Consider the need to appoint separate role holders for the EMT Planning and Information Coordinator roles (with EMT Leader) **Activation** ❑ Assist EMT Leader to chair meetings / briefing sessions ❑ Contribute to overall event assessment based on current information ❑ Prompt EMT Leader to establish / review team objectives ❑ Advise EMT members on EMT process, their roles, responsibilities and any outstanding actions / commitments and ensure induction for new/incoming members ❑ Prepare SITREP (coordinate with Information Coordinators) – distribute to activated response team/s ❑ Initiate personal log of events **Phase 1:** ❑ Recognise and maintain response priorities (**P**eople, **E**nvironment, **A**ssets, **R**eputation and **L**ivelihood) ❑ Obtain and collate IAP documentation ❑ Identify immediate priority areas for protection ❑ Draft IAP, recording response: ◦ Aim ◦ Objectives ◦ Response Strategies ◦ Tasks ◦ Resourcing ❑ Present IAP to EMT Leader for approval and distribute ❑ Conduct NEBA ❑ Conduct Trajectory (ADIOS) ❑ Security and integrity of EMR and safety of EMT members – authorised entry for the EMR ❑ Administrative and logistical support required by the EMT (deploy support groups) ❑ Monitor and manage effectiveness, morale and fatigue levels of the EMT ❑ Extended operation – assist EMT Leader with EMT member shift changes, manage to minimise impact on response continuity and fatigue of team members

Role	Responsibility
	❑ Resourcing – identify and provide support resources to assist the EMT to function (e.g. facilities, administrative and logistical, current and future needs, establish a SAP work centre cost code for time writing purposes) **Phase 2:** ❑ Information Review ❑ Planning Preparations ❑ Response Strategies ❑ Supporting Plans ◦ Health and Safety ◦ Waste Management ◦ Oiled Wildlife Response ❑ Further develop IAP ❑ Implement response strategies **Ongoing Actions** ❑ Manage information flow and ensure information remains up-to-date ❑ Obtain regular updates from Operations, Logistics and CMT Finance, Information Coordinator and Scribe ❑ Report Key outcomes to the EMT Leader ❑ Monitor / manage the EMT membership (e.g. monitor fatigue and effectiveness, source alternates) ❑ Assist EMT Leader with EMT briefing schedule (preparation, execution, timing) ❑ Monitor team log – ensure that key event information is recorded (e.g. decisions, actions, updates and contacts) and confirm this is undertaken by the EMT Information Coordinators when activated ❑ Consider shift handover for extended responses – including for support personnel ❑ Log of events – maintain and record your decisions, actions, updates and contacts **Concluding Actions** ❑ Identify End Point Criteria ❑ Notify all staff ❑ Ensure completion of duties ❑ and identify and complete all outstanding actions and obligations ❑ Assist EMT Leader to coordinate / chair EMT debriefing and implement an EMT stand down plan ❑ Issue a notification to the business regarding stand down of the EMT ❑ Collect and collate log sheets written records / correspondence from all EMT members – compile a comprehensive master event log and provide to CMT Legal ❑ Review post-event reports and identify areas for improvement (with EMT Leader) – assign actions and track their progress and completion ❑ Review Emergency Management Plan and identify updates
EMT Information Coordinator	❑ The Information Coordinator is responsible for ensuring accurate and appropriate collection and recording of information ❑ The Information Coordination is responsible advising the EMT Scribe, as required, regarding room set up and populating the display charts **Activate/Update** ❑ Upon activation, attend the EMT as directed – report to EMT Planning for briefing and requirements ❑ Assist EMT Planning with EM Room setup – confirm all equipment is present and functioning

Role	Responsibility
	❑ Prepare recording devices for use e.g. whiteboards, laptops etc. ❑ Compile an initial Situation Report, collating all the key event information and data – provide to the EMT Leader for review and distribution ❑ On instruction from the EMT Planning, assist in initiating a team log of events – consult EMT members as necessary for clarification and details of response actions undertaken so far ❑ Maintain a record of the status on the Status Board as directed by the EMT Leader ❑ Record / document EMT briefing meetings – record decisions, actions and outcomes ❑ Update event records immediately following EMT briefings ❑ Assist EMT Planning with preparation of event SITREPs **Issues** ❑ Record / document EMT issues ❑ Information updates / current event statistics and data – gather, compile and provide to the EMT Leader ❑ Key event information – identify required information categories with EMT Leader (e.g. geographical area affected, number of customers impacted, resources deployed, response / recovery duration) **Stakeholders** ❑ Record stakeholder identification, prioritisation and notifications ❑ EMT Leader – provide information and statistics on the size and scale of the event, assist with their distribution to internal stakeholders **Actions** ❑ Maintain an accurate and chronological team log / record of events ❑ Your recording function is critical – DO NOT get involved in any other activities ❑ Record actions / tasks assigned to EMT members and track their status – inform EMT members of overdue tasks / unfulfilled commitments ❑ Notify EMT Planning if you are having trouble maintaining event records (e.g. unsure of what to record, volume of information is too great, too many discussions occurring simultaneously) ❑ Request additional Information Coordinators as required – assign tasks and responsibilities ❑ Clarify any confusion of events / actions as soon as apparent ❑ Prepare and populate an information template to capture key event information ❑ Display and maintain information hardcopies in EMR (e.g. media releases, contact lists, event details – maps, details of event scene) **Actions** ❑ Be prepared to compile and distribute minutes / status summaries during the event as required – liaise with EMT Planning for assistance ❑ Maintain a record of EMT members assigned to team roles / present in the EM Room ❑ Consider shift handover for extended responses – including for support personnel ❑ Log of Events – maintain / record TEAM decisions, actions and contacts **Concluding Actions** ❑ Enter any outstanding information into recording logs / devices ❑ Identify and complete any outstanding actions and obligations ❑ Participate in event debriefs as necessary – act as recording secretary ❑ Assist EMT Planning to collect and consolidate log sheets and written records / correspondence into a master event log

EMT Scribe	❑ The Scribe is responsible for commencing the event on EMQNet and ongoing updating of stakeholders and tasks ❑ The Scribe is responsible for populating the display charts, under the direction of the Information Coordinator ❑ The Scribe is responsible for maintaining the visual display of EMT and CMT members phone numbers, and the start and finish time of CMT Members (for fatigue management) ❑ Continuous management and updating of EMQNet, preparation of SITREPs as requested ❑ Maintains a record of the event and the activities of the EMT for reference during the event and following return to BAU ❑ Record of all stakeholder notification and engagement required ❑ Records all financial commitments, costs for informing the CMT Finance of costs (expended and anticipated). **Activate/Update/Initial Actions** ❑ Upon activation, attend the EMT as directed – report to Information Coordinator for briefing and requirements ❑ Assist EMT Information Coordinator with Emergency Management room setup – confirm all equipment is present and functioning ❑ Prepare recording devices for use e.g. whiteboards, laptops etc. ❑ Compile an initial Situation Report collating all the key event information and data – provide to the EMT information Coordinator for review and distribution ❑ On instruction from the EMT Planning, assist in initiating a team log of events– consult EMT members as necessary for clarification and details of response actions undertaken so far ❑ Maintain a record of the status on the Status Board as directed by the EMT Information Coordinator ❑ Record / document EMT briefing meetings – record decisions, actions and outcomes ❑ Update event records immediately following EMT briefings ❑ Assist EMT Information Coordinator with preparation of event SITREPs **Phase 1** ❑ Information updates / current event statistics and data – gather, compile and provide to the Leader ❑ Key event information – identify required information categories with EMT Leader (e.g. geographical area affected, number of customers impacted, resources deployed, response / recovery duration) **Phase 2:** ❑ Maintain an accurate and chronological team log / record of events ❑ Your recording function is critical – DO NOT get involved in any other activities ❑ Record actions / tasks assigned to EMT members and track their status – inform EMT members of overdue tasks / unfulfilled commitments ❑ Notify EMT Planning if you are having trouble maintaining event records (e.g. unsure of what to record, volume of information is too great, too many discussions occurring simultaneously) ❑ Request additional Information Coordinators as required – assign tasks and responsibilities ❑ Clarify any confusion of events / actions as soon as apparent ❑ Prepare and populate an information templates to capture key event information ❑ Display and maintain information hardcopies in EMR (e.g. media releases, contact lists, event details – maps, details of event scene) ❑ Be prepared to compile and distribute minutes / status summaries during the event as required – liaise with EMT Planning for assistance ❑ Maintain a record of EMT members assigned to team roles / present in the EMR

Role	Responsibility
	❑ Consider shift handover for extended responses – including for support personnel ❑ Log of Events – maintain / record TEAM decisions, actions and contacts **Concluding Actions** ❑ Enter any outstanding information into recording logs / devices ❑ Identify and complete any outstanding actions and obligations ❑ Participate in event debriefs as necessary – act as recording secretary ❑ Assist EMT Planning to collect and consolidate log sheets and written records / correspondence into a master event log
EMT Community Relations	EMT Community Relations will most likely go on to be part of the Crisis Communication Team (CxT), but will remain the conduit of information between the EMT and the CxT (in the CMT); **Activate/Update** ❑ Contribute to overall event assessment based on current information ❑ Provide input to a review of the severity classification ❑ Review response outcomes against external communications and community management objectives ❑ Advise the EMT on likely / expected reputational and community perspectives, interest and reactions ❑ Establish contact with any other activated external communications or community teams / representatives within Beach (including CxT) – agree on standard event communication protocols ❑ Initiate personal log of events ❑ Confirm the EMT Leader communications needs and expectations ❑ Identify any response-related communications already undertaken or received ❑ Refer to Crisis Communications Plan (If applicable) (Attachment 1 of CMP) **Issues** ❑ Recognise and maintain response priorities (People, Environment, Assets, Reputation and Livelihood) ❑ Communication priorities (establish in consultation with CxT Leader) ❑ Media / reputation exposures – communicate to the EMT any immediate, emerging and ongoing communications issues, interest and activity (e.g. traditional and social media, NGOs, other stakeholders) ❑ External scrutiny – monitor external (e.g. media) awareness / reporting of event ❑ Spokesperson considerations – Identify need early and discuss with CxT/CMT Communications ❑ Media attendance – arrange through any media attending event scene / Beach locations (including security, segregation from response, response to information requests, communication of key messages) ❑ Influential / aggressive media or community stakeholders – with CxT/CMT Communications, formulate specific response strategies, prepare spokesperson ❑ External contact – manage filtering, prioritisation and re-direction of incoming event related calls (e.g. media, next of kin, community) including resource requirements, information needs (e.g. approved / key messages) ❑ Call centre / switchboard, IVR messaging, SMS, websites – with CxT/CMT Communications, identify resource requirements, actions, information needs (including currency and accuracy of scripts / information) **Stakeholders** ❑ Identify key media, government and community contacts and develop briefing schedule / management strategy –assign responsibilities to individual CxT members

Role	Responsibility
	❑ Prompt direction from CxT/CMT Communications, Inform / notify relevant media, community groups and external agencies ❑ Provide updates on external and community related issues and actions/support, utilise for implementation of communications and media strategies at the event scene **Actions** ❑ Activate support personnel / groups and media / communication strategies as necessary – brief activated teams ❑ Consider stakeholder feedback during response strategy development, advise EMT on stakeholder perspectives, interest and reactions ❑ Develop media and community plans and materials and manage its distribution ❑ Coordinate prompt development, review and approval of communications material (e.g. event information, community / public safety information etc)– with EMT Emergency Manager, Legal, Commercial ❑ Develop key messages and materials for media and community – maintain consistency between messages from Communications and with other activated teams (e.g. ERT, CMT) ❑ Maintain EMT awareness and understanding of key messages ❑ Establish, maintain and distribute disclosure standards and communications protocols – clearly communicate which information is confidential and which may be released ❑ Prompt EMT members to maintain records of all stakeholder interactions ❑ Keep a communications log of all event related calls made / received ❑ Undertake notification and management of assigned stakeholders ❑ Consider shift handover for extended responses – including for support personnel ❑ Log of events – maintain and record your decisions, actions, updates and contacts **Concluding Actions** ❑ Advise EMT leader on the timing and reputational and community implications of stand down timing ❑ Identify and complete all outstanding actions and obligations ❑ Participate in event debriefs as necessary (including with CMT is required) ❑ Provide all log sheets and written records / correspondence to EMT Planning (including communications logs) ❑ Consider on-going media and community attention – develop suitable management strategies ❑ Confirm that all relevant stakeholders are notified of the event conclusion ❑ Review effectiveness of the CxP and identify areas for improvement Upon activation, attend or advise the EMT as directed – obtain event briefing from EMT Leader and assist (as requested) with classification on the Event Classification Matrix
EMT Logistics	Coordination of resources required to the affected site as well as required within the EMT. **Activate/Update/Initial Actions** ❑ Upon activation, attend or advise the EMT as directed – obtain event briefing from EMT Leader ❑ Initiate personal log of events ❑ Consider setting up a process to track, manage and collect costs and how to report to CMT Finance ❑ Provide an event update to the EMT on response resourcing (e.g. the availability of support services, equipment and materials and the status of outstanding resources requests) ❑ Ensure implementation of Procurement Strategy ❑ Ensure implementation of Staging Area Strategy ❑ Ensure implementation of Communications Strategy (working with CMT Communications)

Role	Responsibility
	❑ Ensure implementation of Medical Strategy (working with EMT H&S and Source Control IMT) ❑ If required, build support to include Procurement Coordinator, Staging Area Coordinator, Communications Coordinator and Medical Coordinator **Initial Response** ❑ Recognise and maintain response priorities (People, Environment, Assets, Reputation and Livelihood) ❑ Establish spill/pollution response equipment list for the required area(s) and place on standby or mobilise as required, including: ◦ Dispersant (Boat/Air) ◦ Oil Spill Response Equipment ◦ Transport ◦ Accommodation/Food ◦ PPE ◦ Waste Management Gear ◦ Vessels ◦ Crane ◦ Personnel ◦ Lay Down Area ❑ Establish other agencies and authorities available for support ❑ Organise air/vessels/locals to monitor and evaluate ❑ EMT response resource requirements – manage supply and deployment to site (in liaison with EMT Operations and ERT Resource Management) ❑ Response funding – activate management processes (e.g. fund tracking / transfer procedures) ❑ Resource usage, prioritisation and estimation of (and resource allocation to) future service and support requirements – develop a resource plan for the event ❑ Staging areas for coordination of operational dispatch and relief of resources ❑ Specialist response needs – source specialist personnel, services and equipment (manage ongoing resourcing) – liaise with EMT Operations for requirements ❑ Contractual requirements and implications related to emergency utilisation of contract staff currently allocated to undertaking scheduled / planned works **Ongoing Response** ❑ Activate support personnel / group as necessary – brief and allocate tasks ❑ Identify service and support requirements for planning operations ❑ Mobilise spill response gear as required ❑ Update team on ETA of resources ❑ Request support from other agencies/authorities such as: ◦ Fire ◦ Police ◦ SES ◦ Council ◦ Labour Hire ◦ Ports and Harbours ◦ Community Groups ◦ Local Companies

Role	Responsibility
	❑ Refer any media interest to EMT Communications ❑ Consider shift handover for extended responses – including for support personnel ❑ Log of events – maintain and record your decisions, actions, updates and contacts **Concluding Actions** ❑ Identify and complete all outstanding actions and obligations ❑ Participate in event debriefs as necessary ❑ Collect and collate records of all procurements relating to the event – produce a comprehensive record of ordering, delivery and invoicing of supplies and services for accounts processing ❑ Confirm payment of all external / third party suppliers, close all response-related purchase orders ❑ Formulate and manage implementation of an event demobilisation plan for response resources (liaise with ERT Logistics and EMT Operations) ❑ Ensure clean up and repair or assets if required ❑ Provide all log sheets and written records / correspondence to EMT Planning
EMT Health & Safety	The Health and Safety Response functions ensures that the resolution activities are in accordance with Beach's HSE directives and meet all the regulatory requirements. The HSE function will work closely with the CMT HSE & Risk representative. **Activate/Update** ❑ Upon activation, attend or advise the EMT as directed – obtain event briefing from EMT Leader and assist with set up as and notifications as required ❑ Initiate personal log of events ❑ Review any safety or environment related response, activity or contacts made prior to your arrival ❑ Contribute to overall event assessment based on current information ❑ Provide input to a review of the event classification ❑ Brief EMT on those people injured or at risk, as well as any environmental activities and issues **Issues** ❑ Recognise and maintain response priorities (People, Environment, Assets, Reputation and Livelihood) ❑ Status of people injured or at risk – source from affected site and update EMT (including head count, casualty numbers, locations and status), provide to EMT Operations ❑ Liability – identify any deviation between safety and environment procedural / policy requirements and any actions leading up to and during the event / response ❑ Common faults – identify any elements of the event that may impact other Beach assets (e.g. through use of similar equipment / processes or operating conditions / environments) **Stakeholders** ❑ Contribute to stakeholder identification and prioritisation ❑ Regulatory reporting – verify that appropriate HSE regulatory bodies have been contacted – including state Safe Work regulators ❑ ERT HSE – assist the affected ERT(s) with health and safety management at the scene ❑ Liaise with CMT Legal – discuss legal privilege requirements and impacts on response and investigations **Actions** ❑ Facilitate H&S risk assessments to inform development of IAPs ❑ Activate support personnel / group as necessary – brief and allocate tasks ❑ Assist and advise the EMT in development of an appropriate response strategy ❑ Provide the EMT with relevant company records or data (e.g. safety and environment policy records, training records, qualifications of affected personnel, company HSE statistics)

Role	Responsibility
	❑ Provide EMT with specialist H&S advice and support relevant to the response (including critical issues) ❑ Document injury / fatality details and advise EMT on legislative reporting ❑ Undertake notification and management of assigned stakeholders ❑ Refer any media interest to EMT Communications ❑ Consider shift handover for extended responses – including for support personnel ❑ Log of events – maintain and record your decisions, actions, updates and contacts **Concluding Actions** ❑ Identify and complete all outstanding actions and obligations ❑ Participate in event debriefs as necessary ❑ Provide all log sheets and written records / correspondence to EMT Planning ❑ Assist EMT Human Resources to organise counselling for affected personnel and monitor attendance ❑ Assist in final reporting to safety regulators – verify that requirements have been met ❑ Monitor any long-term health, environment or ecological effects related to the event or the response
EMT Environment	**Activate/Update** ❑ Consult with EMT Leader on activating the OSMP/OPEP ❑ Establish protection priorities and objectives in collaboration and agreement with Control Agency ❑ Develop Operational NEBA in collaboration and agreement with Control Agency ❑ Develop strategy specific incident action plans (IAPs) (excluding well control) in collaboration and agreement with Control Agency ❑ Feedback into the EMT about notifications and reporting requirements ❑ Monitor and evaluate – plane for visibility (AMOSC will supply trained aerial observer) ❑ Ongoing modelling (trajectory) APASA ❑ Work with EMT Logistics to deploy satellite tracking buoy ❑ GIS person is pulled in as part of the team, to provide mapping and visibility ❑ Implement Operational and Scientific Monitoring Plan (OSMP) ❑ Feedback monitoring and evaluation into the Team Meeting and Operational Planning Cycle ❑ Community information – work with EMT Communication for community liaison and stakeholder tracking. **Issues** ❑ Recognise and maintain response priorities (People, Environment, Assets, Reputation and Livelihood) **Stakeholders** ❑ Contribute to stakeholder identification and prioritisation ❑ Regulatory reporting – verify that appropriate HSE regulatory bodies have been contacted – including state Environmental protection Agencies **Actions** ❑ For any spill or release verify that appropriate surveillance and tracking is in place ❑ Consider the requirement to monitor possible environmental and ecological effects of any release ❑ If relevant, provide a profile of areas likely to be affected by any toxic release (produce maps if possible) – assist activated ERT(s) to prioritise areas for protection / special consideration ❑ Undertake actions as per any pre-prepared Environmental Plan or Oil Pollution Response Plans

Role	Responsibility
	❑ Provide the EMT with relevant environmental contaminants registers for affected systems (e.g. PFOS/PFAS) ❑ Consider shift handover for extended responses – including for support personnel ❑ Log of events – maintain and record your decisions, actions, updates and contacts ❑ Provide the EMT with relevant company records or data (e.g. environment policy records) **Concluding Actions** ❑ Identify and complete all outstanding actions and obligations ❑ Participate in event debriefs as necessary ❑ Provide all log sheets and written records / correspondence to EMT Planning ❑ Assist in final reporting to environmental regulators – verify that requirements have been met ❑ Monitor any long term environment or ecological effects related to the event or the response
Emergency Management Liaison Officer	This role is held by an IMO2 qualified EMT Member **Key Interfaces** ❑ EMT HSE: Provide updates, advise on HSE issues ❑ The Department of Jobs, Precincts and Regions (DJPR): is Victoria's State Government mining and resources regulator. Under the Emergency Management Act (EMA) 2013, DJTR is the control agency for marine pollution Oil Pollutions in Victorian coastal waters up to three nautical miles. ❑ NOPSEMA: According to the EMA 2013, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is the Statutory Agency for oil related spills greater than three nautical miles from the Victorian shoreline. ., While NOPSEMA maintains regulatory oversight of offshore petroleum incidents, offshore petroleum titleholders are required to control the response activities ❑ AMOSC: The oil industry established The Australian Marine Oil Pollution Centre (AMOSC) as a not-for-profit subsidiary company of the Australian Institute of Petroleum (AIP). To respond to oil related incidents **Activate/Update** ❑ Upon activation, attend or advise the EMT as directed – obtain event briefing from EMT Leader and assist (as requested) with event classification per the Event Classification Matrix ❑ Initiate personal log of events ❑ Review any safety or environment related response, activity or contacts made prior to your arrival ❑ Provide assessment of the stakeholders that require notification ❑ Gain approval EMT Leader to notify appropriate stakeholders ❑ Ensure AMOSC is notified and deployed **Issues** ❑ Coordinate Beach Energy and Emergency Services response for injured via the appropriate control agency ❑ Check legal position of notifications and messaging and gain approval to proceed ❑ Ensure the internal stakeholders are notified of the incident and the notification requirements of control agencies **Stakeholders** ❑ Prioritize safety of the public and employees ❑ Confirm liaison point of control agency under the EMA 2013 ❑ Confirm liaison point for AMOSC ❑ Set regular teleconferences and agendas ❑ Set location of meetings in control agency wishes to meet in person ❑ Appoint a scribe to note take and update the EMT after all meeting

Role	Responsibility
	❑ Receive sitreps from the EMT via EMQNet or dial in to update briefs **Actions** ❑ Regularly update EMT on control agency and AMOSC coordination ❑ Maintain meeting minutes and actions in the form of a sitrep which is shared amongst the EMT, control agency and AMOSC ❑ Refer any media interest to EMT Leader (to enable immediate referral to EMT) ❑ Consider shift handover for extended responses (greater than 8 hours)– including support personnel such as a scribe ❑ Log of events – maintain and record your decisions, actions, updates and contacts **Concluding actions** ❑ Identify and complete all outstanding actions and obligations ❑ Participate in event debrief/s as necessary ❑ Provide all log sheets and written records / correspondence to EMT Information Coordinator ❑ Assist EMT Human Resources to organise counselling for affected personnel and monitor attendance ❑ Assist in final reporting to safety and environment regulators – verify that requirements have been met ❑ Monitor any long-term health, environment or ecological effects related to the event or the response
EMT Operations	This function may be the conduit of information from the site/field, as directed by the EMT Leader. This function may activate as specialist teams but maintain the requirement to be part of the 'Team Process' and provide a representative to the EMT Monitor rosters and resources of the affected site during a declared event until the EMT Planning role is activated. Communicate with the affected ERT Incident Manager or Site Controller and assist with coordination of all activities undertaken directly to resolve an event. This includes oversight and application of company resources to the response and at the scene in support of the EMT response strategy. Provide technical advice on the affected system/assets that may involve alternate response strategies and overall assessment of impacts that the event and any planned response may have on production. **Activate/Update/Initial Actions** ❑ First Strike Response ❑ Report to EMT Room ❑ Initiate personal log of events ❑ Provide event updates to the EMT, including current situation, response progress, emergent risks ❑ Contribute to overall event assessment based on current information ❑ Provide input to a review of the event classification ❑ Actual operational outcomes Vs EMT response priorities / actions / objectives ❑ Ensure implementation of Marine Strategy ❑ Ensure implementation of Shoreline Strategy ❑ Ensure implementation of Waste Management Strategy ❑ Coordinate aerial operation ❑ Built Operations Group as required, with Marine Coordinator, Shoreline Coordinator, Waste Management Coordinator and possibly with Aviation Coordinator and Wildlife Coordinator) **Phase 1:** ❑ Recognise and maintain response priorities (People, Environment, Assets, Reputation and Livelihood)

Role	Responsibility
	❑ Attend first and subsequent EMT meetings ❑ Report on immediate response actions taken and outcomes including current status ❑ Ensure all field staff are briefed using SMEACS format ❑ Arial Surveillance Arrange with logistics for either a fixed wing aircraft or helicopter (as required) ❑ Have an aircraft perform Ariel Surveillance with an observer ❑ If aircraft is required for dispersant spraying, a separate aircraft will need to be sources – task logistics **Phase 2:** ❑ Obtain regular updates from personnel within the Operations group (if any) ❑ Oversee completion of tasks ❑ Report key outcomes reported to the EMT Leader ❑ Consider shift handover for extended responses – including for support personnel ❑ Log of events – maintain and record your decisions, actions, updates and contacts **Concluding Actions** ❑ When notified by EMT Leader of termination of response, inform all (if any) Operations staff ❑ Identify and complete all outstanding actions and obligations ❑ Participate in event debriefs as necessary ❑ Contribute to implementation of the event demobilisation plan (with EMT Logistics) ❑ Provide all log sheets and written records / correspondence to EMT Planning

Appendix B Spill Equipment and Resources (Current 1st November 2019)

B. 1. Source Control Equipment – Well Control

A detailed description of available source control equipment and resources including deployment timeframes is detailed within the Beach Offshore Source Control Contingency Plan (SCCP) and well-specific relief well plans. A summary of these resources is provided below.

B. 1. 1 Well Control Specialists

Access to a range of source control equipment including equipment and personnel is available through 3rd party contracts with:

- Boots and Coots (Halliburton): https://www.halliburton.com/en-US/ps/project-management/well-control-prevention/well-control-prevention-services.html
- Cudd Well Control: http://www.cuddwellcontrol.com/

Contact details for these well control specialists are provided in Appendix A.

B. 1. 2 MODU

The Otway and Bass Fields are considered remote locations and therefore likely to have an impact on the time taken for a suitable rig to be mobilised to the relief well location. This timeframe has been built into the Oil Pollution Modelling. Rig broker reports are used to monitor the rig market on a monthly basis and if required, assist in sourcing and contracting a suitable MODU. The rig broker can be contracted to identify and contract a suitably specified rig (including Australian Safety Case status) within 14 days. Note, a MODU mobilised from the NW Shelf or Singapore is likely to take 35 days. These periods have been factored into the relief well schedule within the well-specific relief well plans.

MODU selection for relief well drilling will be based on the following:

- Rating of well control equipment: Rigs considered shall have equipment rated to at least 10,000psi to perform the required well kill and pumping capacity to meet the well kill requirements.
- Water depth: Rig being considered for relief well drilling must be rated for the water depth of 60m-105m
- Seabed conditions.

B. 1. 3 Casing and Consumables

A detailed description of casing and consumable requirements based upon relief well design is detailed within the well-specific relief well plans.

B. 2. Maintenance Vessels & Vessels of Opportunity

Beach has existing contracts in place to support its maritime requirements including vessels to support relief well drilling operations.

The contracts for the Otway Basin currently reside with a number of service provides that have undertaken the Beach Contracts and procurement process.

Over time vessels and operating companies change in the region. Beach has a procurement process, contractor management process and contracting management system that is implemented prior to engagement of vessels.

Any vessels used on the project will carry a vessel SOPEP and Level 1 spill equipment on-board appropriate to the nature and scale of the vessel and vessel crew are fully trained and exercised in the application of the SOPEP.

Beach receives a monthly update of available vessels under an existing arrangement with a Vessel Broker. The availability and location of vessels capable of deploying the capping stack equipment, if suitable for the specific site, will be confirmed prior to spud of the wells.

Both operational and scientific monitoring program implementation requires vessel support, however these vessels do not need to meet the technical specifications of tug support vessel required for the MODU during relief well drilling operations, therefore alternate vessels can be used for these operations. Also, much of the monitoring program will likely be undertaken in near shore environments where larger vessels would be unsuitable.

B. 3. Fixed Wing Aviation Support

Beach may call upon fixed wing aircraft for aerial surveillance in the event of a Level 2 or Level 3 spill. The need for this service will be determined by the EMT Leader during the incident response and as per the OPEP Part 2 of this OPEP.

Beach have an existing contract with Babcock's to supply fixed-wing aerial support. Additionally, Adagold Aviation Pty Ltd can act as an aviation broker and engage the most appropriate aircraft available.

Beach will supply the aviation provider with the relevant flight pattern and log sheet for the surveillance and any additional trained oil spill observers via arrangements with AMOSC.

B. 4. Helicopter Support

During an incident response, Beach may call upon helicopter services to undertake aerial surveillance assistance or transport personnel in an event of a Level 2 or 3 spill, with the requirement determined by the EMT Leader at the time of the incident.

Babcock are the current contractor for the provision of helicopter services for Beach's Otway offshore activities. At least one helicopter will be available for use by Beach during a spill response. A helicopter will be located at either Warrnambool or Tooradin.

When drilling projects are in progress there may also be other Babcock helicopters located at Warrnambool or Essendon. Beach and Babcock have a working arrangement for this service and tests the call out process as part of its emergency response test plan and schedule.

A typical total mobilisation and flight time from:

- Essendon to site is about 1hr 45min (minimum)
- Tooradin to site is about 1hr 30min hours

- Warrnambool to site is about 50 min (20 min flight time)

Beach will supply the helicopter provider with the relevant flight pattern and log sheet for the surveillance and trained oil spill observers via arrangements with AMOSC.

B. 5. Oiled Wildlife Response

Under the National Plan, Maritime Emergencies Non-Search & Rescue (NSR) Plan and TasPlan, the response to oiled wildlife from a vessel spill where a government agency is the Control Agency is covered in terms of responsibilities and equipment.

In Victoria, DELWP is the lead agency for wildlife impacted by marine pollution. The response procedures are defined in the Wildlife Response Plan for Marine Pollution Emergencies. This plan is incorporated as part of State Maritime Emergencies (non-search and rescue) Plan where an oil spill has occurred.

The Tasmanian Oiled Wildlife Response Plan (WildPlan) is administered by the Resource Management and Conservation Division of the Department of Primary Industries, Parks, Water and Environment (DPIPWE) and outlines priorities and procedures for the rescue and rehabilitation of oiled wildlife.

Oiled wildlife kits are available through AMOSC, the national plan and state agencies. DELWP has a number of first strike kits as well as arrangements in place for triage and rehabilitation of small oiled seabirds. Wildlife rescue kits are held at the Hobart and Launceston DPIPWE offices.

AMOSC also has wildlife equipment which can be mobilised directly by Beach in the event of a spill where there is a likelihood of oiled wildlife requiring treatment. However, it is noted that the remoteness and typical sea conditions of the Otway offshore area and the logistic constraints associated with finding and collecting oiled wildlife at sea, will limit the feasibility of an offshore wildlife response effort.

Advice will be sought from AMOSC and regulatory agencies to guide any decisions regarding mounting a wildlife response will be based on the risks posed by the spill and safety and feasibility of a response.

B. 6. Government Resources

B. 6. 1 Australian Maritime Safety Authority

The Australian Maritime Safety Authority (AMSA) administers the National Plan which requires each State and Territory to produce its own contingency plans to support the national plan. If a spill occurs in Victorian or Tasmanian state waters the Maritime Emergencies (NSR) Plan or TasPlan is activated. If the spill is beyond the resources of the state agencies, then the additional resources can be sourced through agreements in the National plan for a marine pollution response.

B. 6. 2 Victorian Department of Jobs, Precincts and Regions (DJPR) Emergency Management Branch (EMB)

In the event of a diesel spill from a supply vessel near shore, the equipment within the respective port region will be utilised as per the Maritime Emergencies (NSR) Plan through Vic DJPR Emergency Management Branch (EMB).

In an event of a Level 2/3 incident, Vic DJPR, as per the Maritime Emergencies (NSR) Plan, may provide the following assistance as required:

- Provision of vessels and support to CFA/FRV for chemical spills in State Waters
- Coordinate the supply of State equipment and personnel resources in support of the Incident Management Team
- Coordinate provision of Victorian equipment and personnel for any interstate or Commonwealth response.

VIC DJPR EMB is updated with Beach's program changes as part of its consultation program and shall be provided a copy of the accepted OPEP.

B. 6. 3 Tasmanian Department of Primary Industry, Parks, Water and Environment (DPIPWE)

In the event of a spill from a vessel near shore, the equipment within the respective port will be utilised as per the TasPlan through Tas DPIPWE. This equipment may also be available to support a Level 2 or 3 spill where Beach is the Control Agency. Stockpiles of Level 1 equipment are located at Burnie, Devonport, Bell Bay and Hobart Ports and a current list of equipment is available from Tas DPIPWE.

B. 7. AMOSC Resources

AMOSC is supported by a core group of key personnel from oil industry members companies who are trained and regularly exercised in spill response. When called upon under arrangements established in AMOSPlan, Core Group Members are able to respond to an incident at short notice and provide a high level of expertise in leading teams on the ground responding to an incident. Actual timings and Core Group availability is updated monthly and can be obtained through AMOSC as required. AMOSC also holds large stockpiles of oil spill response equipment designed for both coastal and offshore use and has established contractual arrangements and processes for the mobilisation of equipment and personnel to assist with a spill anywhere in Australian waters. A list of the AMSOC available equipment can be obtained through the AMOSC or their website.

AMOSC assistance may be sought in the event of a Level 2 or 3 spill. Beach's EMT Leader shall determine when and whether AMOSC notification and assistance will be required.

Under AMOSPlan, should the spill response require equipment or personnel from another company, the request for assistance is made directly by Beach to that company. AMOSC can assist in this dialogue through the Mutual Aid Policy, and Beach will contact AMOSC to activate the relevant Principal & Agency Agreement (of the lending company) and Mutual Aid Policy if borrowing resources.

AMOSC headquarters and their major equipment base are located in Geelong, adjacent to the Port of Geelong Corio Quay Supply base.

Beach shall provide AMSOC a copy of the accepted OPEP.

B. 8. Environmental Monitoring Resources

Beach has a current Master Service Agreement in place with several recognised specialist environmental consultants capable of undertaking scientific monitoring. Beach will undertake audits /

desk top reviews of the capabilities of these consultants to ensure that they are capable of meeting the requirements of this OPEP.

Annual reviews of contracts and service providers are completed by Beach to confirm they still meet the required standards and are able to provide the contracted services. If any existing contractors are deemed unsuitable, a like service provider will be appointed. Should it be required (as determined by EMT Leader and the EMT Environment), the environmental consultant will undertake scientific sampling and analysis to fulfil the requirements of this monitoring program as detailed in Operational & Scientific Monitoring Plan (OSMP).

Appendix C Templates and Forms

Refer to the Australian Maritime Safety Authority website for the latest forms:

- https://www.amsa.gov.au/
- https://www.amsa.gov.au/forms-and-publications/environment/
- https://www.amsa.gov.au/forms-and-publications/environment/publications/NP-Reports/index.asp

Forms from AMSA include:

- Marine Pollution Report (POLREP)
  Marine Pollution Situation Report (SITREP)

C. 1. Marine Pollution Report (POLREP)

Online via https://amsa-forms.nogginoca.com/public/ or manual below:

Marine Pollution Report (POLREP)

NOTE: Incidents to be reported are outlined on page 3

Send completed form to: **AMSA Environment Protection**
Fax: **(02) 6230 6868** Email: **rccaus@amsa.gov.au**

C.C. ______

Date of incident ______

Time of incident ______

Location name / Description ______

Incident coordinates

Format of coordinates used (select one)	Latitude of spill	Longitude of spill
Degrees & decimal degrees	. °	. °
Degrees, minutes & decimal minutes	° ' . '	° ' . '
Degrees, minutes & seconds	° ' . "	° ' . "

Description of incident ______

POLLUTION SOURCE

☐ Vessel ☐ Land ☐ Other ☐ Unknown → Details ______

Vessel Details: Type (if known): ☐ Tanker ☐ Container ☐ Bulk Cargo ☐ Fishing ☐ Defence ☐ Recreational

☐ Other vessel type (specify): ______

Vessel name	Flag state / callsign	Australian vessel? ☐ Yes ☐ No

POLLUTANT

☐ **Oil** → ☐ Bilge ☐ Diesel bunker ☐ HFO Bunker ☐ Crude ☐ Unknown
☐ Other Specify ______

☐ **Chemical** →

Name	MARPOL Cat. / UN Nos

☐ **Garbage** →
☐ **Packaged** →
☐ **Sewage** →
☐ **Other** →
Details / description ______

EXTENT

Size of spill (length & width in metres) ______

Amount of pollutant, if known (litres) ______

ADDITIONAL INFORMATION

Has the discharged stopped? ☐ Yes ☐ No ☐ Unknown

Response action undertaken? ☐ Yes ☐ No If yes, provide details below, please include any environmental impact

Weather conditions at site

☐ Photos taken ▶	Details	Held by
☐ Video taken ▶	Details	Held by
☐ Samples taken ▶	Description	Held by
☐ Items retrieved ▶	Description	Held by

Original report source

Name	Position	Phone

Combat agency

Statutory agency

Equipment used

☐ AMSA ☐ State / NT

Possible further action

☐ Legal ☐ AMSA assistance ☐ Other

SENDER DETAILS

Name	Agency	Date
Phone	Fax	Email

PRIVACY STATEMENT

The Australian Maritime Safety Authority (AMSA) is collecting the information on this form to enable it to carry out its role as managing agency of the National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances.

AMSA may give some or all of this information to other government bodies, non-government organisations who have responsibilities under the National Plan, and law enforcement agencies.

SUMMARY OF INCIDENTS TO BE REPORTED

All slicks, including deck washings, that can be seen trailing a vessel should be reported. The type of substance contained in the slick may not be able to be determined until further investigation has been undertaken by enforcement agencies.

REPORTABLE	NON-REPORTABLE
Oil - All slicks trailing from a vessel. All spills in the marine environment (notwithstanding the size or amount of oil or sheen). All spills where National Plan equipment is used in a response. *Note: If oil or sheen is "visible" then it is an illegal discharge MARPOL permitted oily discharges are at 15 parts of oil to one million parts of water (15ppm). Oil discharges at sea cannot be visually observed until at least 50ppm and even that may not be readily discernable depending upon the observation platform, sea state, weather conditions etc.*	• Coral spawning. • Algal bloom. • Oil spills specifically known to be from land sources (eg drains, road tanker accidents) and where there is no response using National Plan equipment or resources used. • Exploration/production associated discharges where there is no response and National Plan equipment or resources used. (these are reportable to the relevant authority eg: Mines Department or Department of Science Industry and Resources).
Chemicals – All sightings of slicks/discolourations trailing vessels. All odorous discharges from a vessel.	
Harmful Packaged Substances - All packages associated with a vessel.	
Sewage – All slicks seen trailing from a vessel.	
Garbage – All sightings of garbage being disposed from a vessel. Any type of garbage found that can be specifically tied to a specific vessel such as garbage with printing showing a vessel name (eg Quarantine bonded plastic bags with identifier tag).	• Dumping at sea that requires a permit (EPA or EA) • Dumped dredge spoil. • Floating logs.

C. 2. Marine Pollution Situation Report (SITREP)

Marine Pollution Situation Report (SITREP)

Incident name / Description:

Date: Time: Sitrep No:

Priority ☐ Urgent ☐ Immediate

Final Sitrep? ☐ Yes ☐ No Next Sitrep on: ....

Description of incident and impact

Overall weather conditions

Summary of response actions to date

Current Strategies

Summary of Resources available/ deployed

Other information

SITREP prepared by

Name	Agency	Role
Phone	Fax	Email

Attachments No of pages attached

C. 3. Oil Spill Incident Report – Level 1 Spill

Date:

Spill observer:

Report time:

Reported to:

Location of the spill:

Material spilled:

Estimate of spill quantity and description of appearance of the slick:

Particulars of damage caused as a result:

Apparent source/cause of the spill:

Action taken to control spill:

Has spill been contained? (Tick✓) ❑ Yes❑ No

Comments:

Location	**Reported by**	**Reported to**
Time	**Date**	**Phone No**

Are additional resources required to disperse/contain spill:❑Yes❑No

C. 4. Oil Spill Incident Report – Level 2/3 Spill

Date:			**Report time**:		
Spill observer:			**Reported to**:		
Time spill occurred:			**Date spill occurred**:		
Material spilled:			**API gravity**:		
Apparent source/cause:					
Location of spill:	**Latitude:**		**Longitude:**		
Is spill continuing?	**Yes**		**No**		
If yes, estimated rate of release:	**cubic metres/day:**		**bbl/day:**		
Volume of discharge: a) estimated	**cubic metres:**		**bbls:**		
Volume of discharge: b) known	**cubic metres:**		**bbls:**		
Size of spill: (plot on chart)					
Rate and direction of slick movement:					
Oil slick type:	**Continuous:**		**Windows**:		
Estimated average thickness:					
Estimated time to nearest threatened resource:	(hrs)				
Meteorological and Ocean Data					
Temperature:	**Air:o C**		**Water:o C**		
Wind speed:	**knots**		**Direction:**		
Precipitation:					
Forecast:					
Oceanographic Data	**Tide state:**	**Direction:**			
	Currents:	**Speed:**			
Direction: Sea state:	1	2	3	4	5	6+
Average wave height:	metres				
Period:	seconds				
Comments:					

C. 5. Oil Spill Trajectory Modelling Request Form (RPS APASA)

INCIDENT ☐ EXERCISE ☐

MAKING COMPLEX EASY

PROCEDURE FOR INITIATING SPILL MODELLING

1. Complete the form for all details – provide estimates and detail uncertainties.
2. Call the RPS Response duty officer on (0408 477186) to alert them of the requirement for spill modelling, explaining the general details and seeking clarification as required.
3. Send the form to RPSresponse@rpsgroup.com

If new information becomes available, inform the duty officer by telephone then email updates

Date and time of this notification: ____

Type of trajectory modelling required

☐Oil	☐Chemical	☐Update request

Contact Details

Name of the Company	
Name of Contact Person	
Contact number (include country/area codes)	
Email address for return communications	

Details of spilled material (include assay or MSDS whenever available)

Oil or chemical name	
Type or Description	
CAS number, If a chemical	

Location, time of spill

Latitude of source	Degrees:	Minutes:	Seconds:
Longitude of source	Degrees:	Minutes:	Seconds:
If slicks have been observed from an unknown source, provide map information to define the bounds			
Do you want forecasting forward in time from this location or back-track to an unknown source?	Forward ☐ Back-track from an area ☐ Forward and Back-track ☐	**Geographic bounds of slick area(s) and time of observation must be supplied for back-track modelling**	
Date and time spill started			
Time zone (+ or - from UTC)			

Depth, type of discharge

Depth of release	☐ Surface ☐ Sub-surface. - If so, Specify the Depth (m)
If from sub-surface, describe the discharge energy	☐ Low turbulence e.g. Low-pressure leak ☐ Medium turbulence e.g. Intermediate-pressure leak ☐ High turbulence e.g. Well blow out, ruptured pipeline

Volume or rate of release

For spills that have ended	Volume:	Units:	Duration (hours):
For ongoing spills	Rate:	Units:	per hour

Documents attached

☐ Oil Assay sheet	☐ Safety data sheet	☐ Local wind measurements
☐ Spill site photos	☐ Aerial surveillance maps	☐ line drawings showing oil distribution
☐ Others (specify):		

Updated: 28/02/2020

PROCEDURE FOR REQUESTING UPDATED SPILL MODELLING

1. Revise the input form for any changes
2. If surveillance is available to define the observed location of slicks, this information should be provided to the duty officer in a form that can be translated to define the spatial distribution and relative thickness of the oil. Formats that would be useful include:
    - a GIS (shp) file defining the oil distribution (including the datum format)
    - satellite imagery that includes spatial references
    - photographs with location references
    - a line drawing marked with estimated centre and edge locations, length and width dimensions, and relative thickness contours (use the space below making sure to provide spatial references)
    - Location of tracking buoys (confirm first that these are marking the slick location)
3. Call the RPS Response duty officer on (**0408 477186**) to request an update to the spill modelling for changed details, explaining what has changed and seeking clarification as required.
4. Send the forms and any files to **RPSresponse@rpsgroup.com**

C. 6. AMOSC Service Request for Mutual Aid

Attachment 3
Available Services Request for Mutual Aid (clause 9)

Defined terms in this Available Services Request for Mutual Aid (**Services Request**) have the meaning given to them in the Master Service Contract (MSC) between AMOSC and you.

AMOSC has received a request for services from another AMOSC Member. AMOSC requests, in accordance with clause 9 of the MSC that you provide (or procure that an Affiliate provide) the following equipment, personnel or services as indicated below:

EQUIPMENT

☐ AMOSC requests Equipment

Type	Quantity	

CONSUMABLES

☐ AMOSC requests Consumables

Type	Quantity	

PERSONNEL

☐ AMOSC requests Personnel

Category or name of Personnel	Number	

Please state below:

- what equipment, consumables and/or personnel (as requested) (if any) can be provided by you or your Affiliate:

  [*Insert*]

  (being 'Available Resources'); and

- the timeframe for the provision of those Available Resources:

  [*Insert*]

Following completion please sign date and return this Request to AMOSC by email.

In returning this Request you acknowledge that the Available Resources will be provided to AMOSC on the terms of clause 9 of the MSC.

SIGNED by **[name of authorised representative]** as authorised representative for **[Member]** in the presence of: .... Signature of witness .... Name of witness (block letters)	)	.... By executing this Request the signatory warrants that the signatory is duly authorised to execute this Request on behalf of **[Member]**

Date [insert]

C. 7. Stand down of EMT Checklist

STAND DOWN CHECKLIST / ACTIONS

KEY ACTIONS:

The EMT Leader is responsible for assigning personnel to commence the collation of emergency data prior to the commencement of the investigation process.

On-going resources for incident control and post incident recovery (if required) should also be considered by the EMT Leader, including current/potential business continuity aspects (per Beach Energy's Business Continuity Plan).

Final information release and/or notification should occur to some, or all, of the following:

• All Site ERT and support personnel	• All relevant EMT and support personnel
• Contractor Management	• Regulatory authorities
• Emergency Services	• Employees (off and on duty)
• Employees families/NOK	• Third Parties
• Suppliers and/or contractors	• Joint Venture Partners and customers
• Media	• Government support agencies
• Mutual aid	• Environmental agencies
• Trade unions	• Local community and pressure groups

Initial 'hot' debrief of all personnel to include:

- A short report by all persons of the history of the incident and their responses;
- Outstanding problems with health, safety and environment;
- Recovery of production;
- Technical information regarding Beach's ongoing operations; and
- Emotional responses to what has happened.

Then:

- Close additional security arrangements
- Finalise additional catering and other services
- Continue counselling for those involved in the incident
- Compile and file all documents relating to the response
- Ensure that all log entries are signed and that all call records and Sit Rep's are signed off by the person who prepared the document
- Arrange for full incident investigation and analysis
- Approve/comment on incident debriefing reports and recommended actions

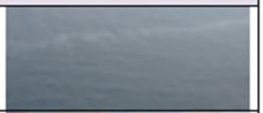
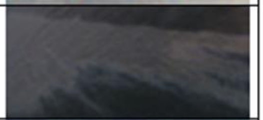
Carry out an After-Action Review to ascertain effectiveness of:

Incident callout	**Site ERT functions**
• Overall emergency response	• Interface with other EMT members

Recommend revision of Emergency Plans as required.

Schedule time for After-Action Review and if required, full debrief on the incident.

Appendix D Bonn Agreement Oil Appearance Code

Code	Description / Appearance	Layer Thickness Interval (Microns)	Litres per km^2	Typical Appearance
1	Sheen (silver / 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	

Appendix E Aerial Surveillance Observer Log – Oil Spill

Survey Details							
Date		Start time		End time		Observers	
Incident						Area of survey	
Aircraft Type		Call sign		Average altitude		Remote sensing used	

Weather Conditions			
Wind speed (knots)		Wind direction	
Cloud base (feet)		Visibility (Nm)	
Time high water		Current direction	
Time low water		Current speed (Nm)	

Slick Details							
Slick grid parameters by lat/long				Slick grid parameters by air speed		Slick grid dimensions	
Length Axis		Width Axis		Length Axis	Width Axis	Length	Nm
Start Latitude		Start Latitude		Time (seconds)	Time (seconds)	Width	Nm
Start Longitude		Start Longitude				Length	km
End Latitude		End Latitude		Air Speed (Knots)	Air Speed (Knots)	Width	km
End Longitude		End Longitude				Total Grid Area	km^2

Code	Colour	%age cover observed		Total Grid Area		Area per oil code		Factor	Oil volume	
1	Silver		%		km^2		km^2	40 – 300L/km^2		L
2	Rainbow		%		km^2		km^2	300 – 5,000L/km^2		L
3	Metallic		%		km^2		km^2	5,000 – 50,000L/km^2		L
4	Discontinuous true oil colour		%		km^2		km^2	50,000 – 200,000L/km^2		L
5	Continuous true oil colour		%		km^2		km^2	>200,000L/km^2		L
Non shaded areas to be completed on flight. Shaded areas completed on return.								TOTAL		L

Appendix F Aerial Surveillance Observer Log – Marine Mammals

Date:	Survey #
Aircraft/Pilot:	Observer:
Blue Whale Study Contact:	Enquest Contact:
Survey Start Time:	Survey Finish Time:

Event#	Waypoint #	Event time [hh:mm]	Event Position [dd.mmm]	Description of sighting and marine mammal	No. of Marine Mammal(s)	Sterling Position [dd.mmm]
			. °S			. °S
			. °E			. °E
			. °S			. °S
			. °E			. °E
			. °S			. °S
			. °E			. °E
			. °S			. °S
			. °E			. °E
			. °S			. °S
			. °E			. °E

Appendix G Shoreline Assessment

General Information			
Date	Dd/mm/yy:	Survey Time	From:To:
Weather	Sun / Cloud / Fog / Rain / Windy		
Location	Description:	LAT: LONG:	
Total Length	m		

Survey Team	
Name	Organisation

Shoreline Type

Legend: P = Primary S = Secondary

	Exposed Bedrock Cliff and Seawalls		Intertidal Mud/ Sand Flats
	Exposed Bedrock Platform or Reef		Mangroves
	Sheltered Bedrock Platform or Reef		Salt marshes
	Exposed Boulder/ Cobble and Rip rap		Seagrass (Shallow/Intertidal)
	Sheltered Boulder/ Cobble and Rip rap		Shallow/Intertidal Corals
	Pebble Beaches		Natural Inlets/ Channels
	Sand Beaches		Marinas/ Artificial Waterways

Operational Features	
Debris Present: Yes /No Amount: _____ m3	
Direct Backshore Access: Yes / No	Access Restrictions:
Backshore cliff: Yes / No Height ________m	Suitable Lay down Area: Yes / No

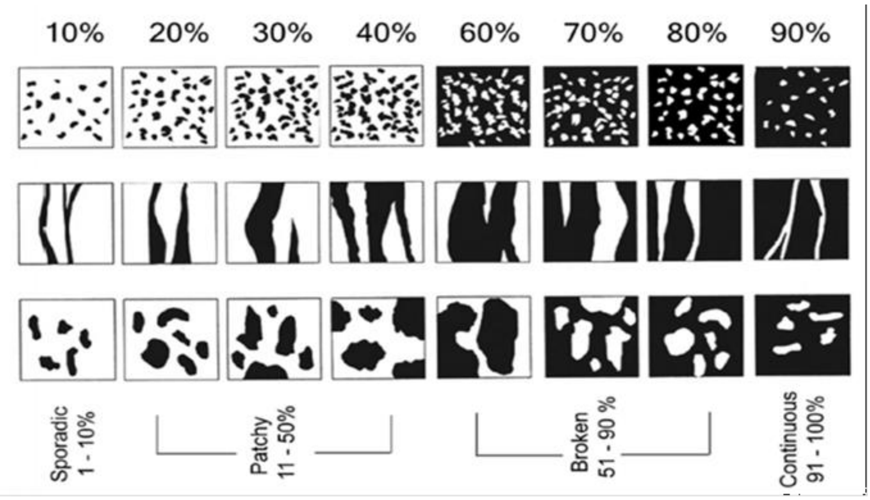
Surface Oiling Conditions

Place an X in the appropriate box

Zone #	Tidal Zone				Oil Cover			Oil Thickness					Oil Character					
	L	M	U	S	Length	Width	Cover (%)	PO	CV	CT	ST	FL	FR	MS	TB	TP	SR	AP

Legend:	
Tidal Zone L = Lower Tidal M = Middle Tidal U = Upper Tidal S = Super Tidal	
Surface Oiling Thickness PO = Pooled Oil (fresh oil or mousse > 1 cm thick) CV = Cover (oil or mousse from >0.1 cm to <1 cm on any surface) CT = Coat (visible oil <0.1 cm, which can be scraped off with fingernail) ST = Stain (visible oil, which cannot be scraped off with fingernail) FL = Film (transparent or iridescent sheen or oily film)	**Surface Oiling Character** FR = Fresh Oil (unweathered, liquid oil) MS = Mousse (emulsified oil occurring over broad areas) TB = Tar balls (discrete accumulations of oil <10 cm in diameter) TP = Tar Patties (highly weathered oil, of tarry, nearly solid consistency) SR = Surface Oil Residue (non-cohesive, oiled surface sediments) AP = Asphalt Pavements (cohesive, heavily oiled surface sediments)

Distribution Guide (% Oil Cover)



Sketch	**Date:**

Checklist: (Place an X once completed)			
Oiled Area		Local Features	
Orientation (North)		Access	
Scale		Survey Area (Width/Length)	

Appendix H – Testing Schedule

After pre-spud testing, the test schedule provides a 12-month program of testing. The test schedule is to be updated when testing the response arrangements when they are significantly amended. The tests are a guide, and tests may be carried out in other time periods, provided the tests are conducted within the calendar year. This table is taken from the CEM Training and Exercising Plan.

		Annual Scheduled Tests	Scheduled Jan - Mar Qtr.	Scheduled April to June Qtr.	Scheduled July to Sept Qtr	Scheduled October - Dec Qtr.
Protocol Testing **Beach to conduct a test . Announcing this is a test / exercise call only.**						
1	4.2.1 Vessel Spill / Collision	1		1		
2	4.2.2 Loss of integrity - Platform or Pipeline (L2/L3)	1			1	
3	4.2.3 Loss of Well Control (L2 / L3)	1				1
For the avoidance of doubt, all above protocols in their completeness, under all scenarios are to be tested. The above protocols can be tested in an exercise, or by individuals testing each separate action and protocol						
Notification testing - purpose ensure contact details are correct. To be titled, this is a test only.						
4	NRC	2	1		1	
5	AMSA	2		1		1
6	NOPSEMA	2	1		1	
7	Marine Duty Officer	2		1		1
8	Department of Environment & Energy	2	1		1	
9	Department of Jobs, Precincts and Regions	2		1		1
10	Radio TasPorts Vessel Traffic Services	2	1		1	
11	All relevant port authorities	2		1		1
12	DJPR EMB	2	1		1	
13	DELWP	2		1		1
14	DPIPWE	2	1		1	
15	Air surveillance	2		1		1
16	Director of National Parks via Marine Compliance Duty Officer (24-hr)	2	1		1	
17	Department of the Environment and Energy	2		1		1
18	(Victorian) Department of Jobs, Precincts and Regions – Earth Resources Regulation (DJPR ERR)	2	1		1	
19	NOPTA	2		1		1

Appendix I Internal and External Supporting Documents and Plans

Standard/CDN	Supporting Documents
Internal	
CDN 8189619	After Action Review Procedure
CDN S4810RD718250	Artisan-1 Source Control Contingency Plan (SCCP);
CDN 18386856	Business Continuity Plan
CDN 18985422	CEM Training and Exercising Plan
CDN 18331497	Crisis Communications Plan
CDN 18024233	Crisis Management Plan
CDN 18985346	Emergency and Security Management Standard
CDN 18025990	Emergency Management Plan (EMP)
CDN S4210AD718257	Geographe-4 Source Control Contingency Plan (SCCP)
CDN S4110AD718256	Geographe-5 Source Control Contingency Plan (SCCP)
CDN 4152175	Offshore Spill Response Plan (Kupe)
CDN 3972816	Oil Pollution Emergency Plan (BassGas)
CDN S4100AH717907	Oil Pollution Emergency Plan (Otway)
T-5100-35-MP-005	Otway and Bass RWP
CDN 18387076	Physical Security Manual
Element 8	Risk Management and Hazard Control
CDN S4110AD718259	Thylacine North-2 Source Control Contingency Plan (SCCP)
Matrix (via Boardwalk)	Training and Capability Matrix
CDN 8189619	After Action Review Procedure
CDN S4810RD718250	Artisan-1 Source Control Contingency Plan (SCCP);
CDN 18386856	Business Continuity Plan
CDN 18985422	CEM Training and Exercising Plan
CDN 18331497	Crisis Communications Plan
CDN 18024233	Crisis Management Plan
CDN 18985346	Emergency and Security Management Standard
CDN 18025990	Emergency Management Plan (EMP)
CDN S4210AD718257	Geographe-4 Source Control Contingency Plan (SCCP)
CDN S4110AD718256	Geographe-5 Source Control Contingency Plan (SCCP)
CDN 18630468	Health Emergency Plan
CDN 18330844	Human Resources Emergency Plan
CDN 16744575	Incident Management Directive
CDN 4152175	Offshore Spill Response Plan (Kupe)
CDN 3972816	Oil Pollution Emergency Plan (BassGas)
CDN S4100AH717907	Oil Pollution Emergency Plan (Otway)

External	
AMSA	Wildlife Response Plan for Marine Pollution Emergencies
AMSA	Bonn Agreement Oil Appearance Code
AMSA	NP–GUI–025: National Plan response, assessment and termination of cleaning for oil contaminated foreshores (AMSA 2015)
ASMA	National Response Team Policy (NP-POL-002) 10 Nov 2014
ASMA	Maritime Emergencies (NSR) Plan Wildlife Conservation Plan for Migratory Shorebirds – 2015Societal Security - Business Continuity Management systems - Requirements
ASMA	National Plan, Maritime Emergencies Non-Search & Rescue (NSR) Plan
ASMA	AMOSPlan (AMOSC, 2017); and
ASMA	National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) Guidance note GN1488 Rev 2 – Oil pollution risk management (NOPSEMA Feb 2018)
ASMA	National Plan for Maritime Environmental Emergencies ('NatPlan') (AMSA, 2019);
ASMA	State Maritime Emergencies (non-Search and Rescue) Plan ('VicPlan') (EMV, 2016);
ASMA	Tasmanian Marine Oil Spill Contingency Plan ('TasPlan') (DPIPWE, 2011);
Australian Marine Parks	South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013). Planning for Emergencies in Facilities
DELWP	Wildlife Marine Mammals Regulations 2009 (Vic)Security and Resilience – Emergency Management – Guidelines for Incident Response
Department Agriculture, Water & Environment	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans Wildlife Marine Mammals Regulations 2009 (Vic)Risk Management Guidelines
Department Agriculture, Water & Environment	Conservation Advice *Balaenoptera borealis* (sei whale)
Department Agriculture, Water & Environment	Conservation Advice *Balaenoptera physalus* (fin whale)
Department Agriculture, Water & Environment	Recovery Plan for Marine Turtles in Australia (CoA, 2017), identified as acute chemical discharge (oil pollution)
Department Agriculture, Water & Environment	Wildlife Conservation Plan for Migratory Shorebirds – 2015
Department Agriculture, Water & Environment	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016
Department Agriculture, Water & Environment	Conservation Listing Advice for the Neophoca cinerea (Australian sea lion)
Department Agriculture, Water & Environment	Conservation Advice *Calidris canutus* (Red Knot)
Department Agriculture, Water & Environment	Conservation Advice for *Charadrius leschenaultia* (greater sand plover)
Department Agriculture, Water & Environment	Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed Godwit (Northern Siberian))

Department Agriculture, Water & Environment	Conservation Advice for *Numenius madagascariensis* (Eastern Curlew)
Department Agriculture, Water & Environment	Conservation Advice *Limosa lapponica baueri* (Bar-tailed Godwit (Western Alaskan))
Department Agriculture, Water & Environment	Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed Godwit (Northern Siberian))
Department Agriculture, Water & Environment	Conservation Advice for *Numenius madagascariensis* (Eastern Curlew)
Department Agriculture, Water & Environment	Conservation Advice for *Charadrius leschenaultia* (greater sand plover)
DPIPWE	Tasmanian Oiled Wildlife Response Plan (WildPlan)
DPIPWE	Tasmanian Marine Oil Spill Contingency Plan ('TasPlan') (DPIPWE, 2011);
EMV	Emergency Management Act (Vic) EMA 2013
EMV	State Maritime Emergencies (non-Search and Rescue) Plan ('VicPlan') (EMV, 2016);
EPA Tasmania	Tasmania – Regulation 20 of the Petroleum (Submerged Lands) (Management of Environment) Regulations 2012 (herein referred to as the P(SL) (MoE) Regulations).
NOPSEMA	Australian Inter-Service Incident Management System (AIIMS) Bulletin #1 Oil spill modelling (A652993) (NOPSEMA 2019)
NOPSEMA	Offshore Victoria Operational and Scientific Monitoring Program (OSMP).
NOPSEMA	Offshore Source Control Contingency Plan (SCCP)
NOPSEMA	APPEA Memorandum of Understanding: Mutual Assistance to facilitate the transfer of alternate drilling unit and well site services from alternate Operator(s)
NOPSEMA	Offshore Victoria Operational and Scientific Monitoring Plan
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) Guidance note GN1488 Rev 2 – Oil pollution risk management (NOPSEMA Feb 2018)
NOPSEMA	Commonwealth - Regulation 14(8) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (herein referred to as the OPGGS(E))
NOPTA	Victoria - Regulation 17 of the Offshore Petroleum and Greenhouse Gas Storage Regulations 2011 ((herein referred to as the OPGGS Regulations)

Appendix J Testing protocols linked to Regulatory Commitments and Objectives

Protocol Testing including field deployment Beach to conduct a test. Announcing "this is a test / exercise call only".	Annual Scheduled Tests	Scheduled Mar Qtr.	Scheduled June Qtr.	Scheduled Sept Qtr.	Scheduled Dec Qtr.
1 4.2.1 Vessel Spill / Collision	**1**		1		
2 4.2.2 Loss of integrity - Platform or Pipeline (L2/L3)	**1**			1	
3 4.2.3 Loss of Well Control (L2 / L3)	**1**				1
For the avoidance of doubt, all above protocols in their completeness, under all scenarios are to be tested. The above protocols can be tested in an exercise, or by individuals testing each separate action and protocol					
Desktop testing schedule (note, Beach may test individually or in an exercise) Must be complete 1 Month prior to drilling and then 6-monthly (prior to drilling excluded from this test schedule)					
4 Effectiveness of OPEP & OSMP in guiding spill response and remediation based upon: · notification timing and completeness; · timeliness of response according to predicted response timing; · availability of response personnel; · training and competency of response personnel	2	1		1	
5 Test the effectiveness of Emergency Management Plan in guiding EMT to fulfil roles and responsibilities	2		1		1
6 Validate contractual arrangements with external service providers the capability of each service provider to respond according to scope of OPEP.	2	1		1	
7 Validate equipment stock levels and deployment times from AMOSC (desktop) based upon those presented within the OPEP	2		1	1	
8 Internal and external training requirements for EMT validated (desktop)	2	1			1
9 Test the effectiveness of Emergency Management Plan in guiding EMT to fulfil roles and responsibilities	2		1		1
10 Validate contractual arrangements with external service providers the capability of each service provider to respond according to scope.	2	1			1
11 Validate equipment stock levels and deployment times from AMOSC (desktop) based upon those presented within this OPEP	2		1		1

Protocol Testing including field deployment Beach to conduct a test. Announcing "this is a test / exercise call only".	Annual Scheduled Tests	Scheduled Mar Qtr.	Scheduled June Qtr.	Scheduled Sept Qtr.	Scheduled Dec Qtr.
12 Validate the capability of environmental monitoring providers to ensure they continue to meet Beach requirements based upon company spill risk profile and potential monitoring scope of work (desktop)	2	1		1	
13 Validate external and external training requirements for EMT validated (desktop)	2		1		1
14 Test Emergency communications shall be tested between ERT and EMT	2	1		1	
15 Validate Emergency notifications between EMT and Regulator(s) tested (including regulatory timeframes)	2	1	1		
16 Emergency communications between the MODU and EMT / SCIMT tested	2			1	1
17 Emergency notifications between EMT and Regulator(s) tested (including regulatory timeframes)	2	1		1	
18 Communication systems and methods between CMT / EMT Leader / SCIMT Leader / EMT members tested	2		1		1
19 OSTM arrangements tested	2			1	1
20 Beach shall test the effectiveness of Source Control Contingency Plan guiding SCIMT to fulfil roles and responsibilities	2		1		1
21 Beach shall test logistics pathways for mobilisation & deployment of L2 / L3 equipment, including support vessels and suitable MODUs validated (desktop)	2		1	1	
22 Validation Well Control Specialists capability continues to meet Beach requirements based upon company spill risk profile (desktop)	2			1	1
23 Internal and external training requirements for the SCIMT validated (desktop)	2	1		1	
24 Test readiness or arrangements to implement the relief well plan under the APPEA MoU	2		1		1
Totals	**45**	**9**	**11**	**12**	**13**

This table aligns with the schedule presented in the CEM Training and Exercising Plan.

Appendix H Victorian OSMP + BassGas Operations Addendum

Plan

CDN/ID S4100AH717908

Operational and Scientific Monitoring Plan

Offshore Victoria

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

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
2	19/12/2019	Issued for NOPSEMA assessment	PW	Xodus	PW
3	31/01/2020	Issued for NOPSEMA assessment	PW	Xodus	PW
4	26/02/2020	Issued for NOPSEMA assessment	PW	Xodus	PW

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

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

Table of contents

Table of figures

List of tables

List of appendices

1 Introduction

1.1 Purpose

This Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) provides the framework for environmental monitoring response to Level 2 and Level 3 offshore oil spills from petroleum activities undertaken by Beach Energy Ltd (Beach) in the Otway and Bass Basins.

The OSMP is a component of the environmental management framework, which also includes activity specific Environment Plans (EP), the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (OPEP) (CDN/ID S4100AH717907) and the BassGas Offshore OPEP (CDN/ID 3972816).

The OSMP has been developed to satisfy the requirements of Regulation 14(8AA) and 14(8D) of the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (OPGGS(E)R), Regulation 16 of the Victorian *Offshore Petroleum and Greenhouse Gas Storage Regulations 2011* (OPGGSR) and Regulation 19 of the Tasmanian *Petroleum (Submerged Lands) (Management of Environment) Regulations 2012* (P(SL)(ME)R).

The OSMP is to be read in conjunction with the relevant EP, OPEP and OSMP Addendum when considering the existing environment, values and sensitivities, credible oil spill risks and potential impacts, response activities and the decision processes that will apply in the event that a spill occurs. The relevant EP also describes any related performance standards, notification requirements and/or reporting compliance.

1.2 Scope

1.2.1 Activities

This OSMP is relevant to all Beach petroleum activities within the Otway and Bass Basins regulated under the Commonwealth OPGGS(E)R, Victorian OPGGSR and Tasmanian P(SL)(ME)R. This includes, but is not limited to the following activity types:

- Operation of a facility or pipeline
- Vessel activities
- Drilling.

1.2.2 Oil type

Spill risks from the above activities that could result in a Level 2 or Level 3 spill event include two oil types:

- Gas condensate
- Marine diesel.

This OSMP is relevant to all oil types and states (i.e. fresh and weathered); and all distributions throughout the environment (e.g. surface, entrained, dissolved and shoreline).

1.2.3 Geographic extent

This OSMP is relevant and applicable to all Commonwealth and State marine and coastal areas that are potentially at risk of exposure to oils in the event of a Level 2 or Level 3 spill resulting from Beach's petroleum activities within the Otway and Bass Basins.

The spatial extent of any particular operational or scientific monitoring study will depend on the actual and/or potential area exposed by an individual spill event. Therefore, monitoring extent would only be finalised once a spill event has occurred and be at a sufficient scale to meet monitoring objectives.

1.3 Definitions/Acronyms

Definitions of terms used in this plan:

Terms/acronym	Definition/expansion
AMSA	Australian Maritime Safety Authority
ANOVA	Analysis of variance
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Governments
API	American Petroleum Institute
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BACI	Before After Control Impact
Beach	Beach Energy Ltd
Control Agency	The Control Agency for an oil spill response is the government agency or company assigned by legislation, administrative arrangement or within the relevant contingency plan to control response activities to an oil spill
DJPR	(Victoria) Department of Jobs, Precincts and Regions
DPIPWE	(Tasmania) Department of Primary Industries, Parks, Water and Environment
EP	Environment Plan
EPBC Act	(Commonwealth) Environment Protection and Biodiversity Conservation Act 1999
EMBA	Environment that may be Affected
EMLO	Emergency Management Liaison Officer
EMT	Emergency Management Team
EUL	Environment Unit Lead
HSE	Heath, Safety and Environment
Incident Controller	The individual responsible for the management of all incident control activities across an incident (Note: for spill events where Beach is the Control Agency, this is the equivalent of the EMT Leader)
IMT	Incident Management Team
IvC	Impact versus Control
LCL	Lower control limit
LEL	Lower explosive limit

Terms/acronym	Definition/expansion
Level 2	Level 2 incidents are more complex in size, duration, resource management and risk and may require deployment of jurisdiction resources beyond the initial response (as per NatPlan)
Level 3	Level 3 incidents are generally characterised by a degree of complexity that requires the Incident Controller to delegate all incident management functions to focus on strategic leadership and response coordination and may be supported by national and international resources (as per NatPlan)
MBACI	Multiple Before After Control Impact
MNES	Matters of national environmental significance
Monitoring Provider	Service provider for environmental monitoring studies; may be one or multiple companies (as required)
NATA	National Association of Testing Authorities
NatPlan	National Plan for Maritime Environmental Emergencies
NOAA	(United States) National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
OPGGS(E)R	(Commonwealth) Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPGGSR	(Victoria) Offshore Petroleum and Greenhouse Gas Storage Regulations 2011
OSMP	Operational and Scientific Monitoring Plan
OSRL	Oil Spill Response Limited
OPEP	Oil Pollution Emergency Plan
PAH	Polycyclic aromatic hydrocarbons
PERMANOVA	Permutational multivariate analysis of variance
PSD	Particle size distribution
P(SL)(ME)R	(Tasmania) Petroleum (Submerged Lands) (Management of Environment) Regulations 2012
Ramsar	Convention on wetlands of international importance
SAP	Sampling and Analysis Plan
SD	Standard deviation
SMART	Special Monitoring of Applied Response Technologies
SME	Subject Matter Expert
SOP	Standard operating procedures
SQGV	Sediment quality guideline value
Statutory Authority	The Statutory Authority has the statutory responsibility for marine pollution incidents in their area of jurisdiction
TOC	Total organic carbon
TPH	Total petroleum hydrocarbon
UCL	Upper control limit
USEPA	United States Environment Protection Authority
VOC	Volatile organic compound

2 OSMP Framework

2.1 Overview

This OSMP provides the framework for Beach's environmental monitoring response to Level 2 and Level 3 offshore oil spills from their petroleum activities undertaken in the Otway and Bass Basins.

This OSMP lists a series of possible studies (with types of sampling techniques and parameters) that may be undertaken in the event of a spill. This OSMP is not intended to be prescriptive, but to provide a flexible framework such that the finalised monitoring studies are fit for purpose and tailored to the specific location, oil type, environmental sensitivities, and the nature and scale of the individual spill.

This OSMP incorporates regulatory guidance from the following documents:

- Guidance note – Oil pollution risk management (NOPSEMA 2018)
- Information paper – Operational and scientific monitoring programs (NOPSEMA 2016).

2.2 Objectives

The objectives of this OSMP are:

- Identify and describe the operational and scientific monitoring that may be implemented in the event of a Level 2 or Level 3 oil spill to the marine or coastal environment
- Demonstrate an appropriate degree of readiness to implement this monitoring in the event of an oil spill to the marine or coastal environment.

2.3 Types of monitoring

Oil spill monitoring has been divided into two types, operational and scientific, which are undertaken for two distinct, but closely related, purposes (NOPSEMA 2016).

Operational monitoring (also known as Type I or response phase monitoring) which collects information about the spill and associated response activities to aid planning and decision making during the response or clean-up operations. Operational monitoring may include both initial response phase monitoring (i.e. rapid qualitative and observational data gathering for situational awareness) and advanced response phase monitoring (i.e. quantitative measurement) (Hook et al. 2016). Operational monitoring typically finishes when the spill response is terminated.

Six operational monitoring studies have been identified (see Section 4):

- O1: Oil characterisation and behaviour
- O2: Water quality
- O3: Sediment quality
- O4: Marine fauna surveillance
- O5: Dispersant efficacy

- O6: Fish tainting.

Operational monitoring studies complement the Monitoring and Evaluate response strategy described in the relevant OPEP. This response strategy may include spatial surveillance techniques and spill trajectory predictions. Operational monitoring (e.g. Study O5) can also be directly related to a particular response strategy (i.e. Chemical Dispersants) (see Section 2.4).

Scientific monitoring (also known as Type II or recovery phase monitoring) which is focussed on non-response objectives and evaluating environmental impact and recovery from both the spill event itself as well as from any response activities. Results from scientific monitoring studies may also be used to identify and recommend remediation requirements where required. Scientific monitoring may continue for extended periods after a spill response is terminated.

Seven scientific monitoring studies have been identified (see Section 5):

- S1: Water quality impact assessment
- S2: Sediment quality impact assessment
- S3: Subtidal habitats impact assessment
- S4: Intertidal and coastal habitats impact assessment
- S5: Marine fauna impact assessment
- S6: Fisheries impact assessment
- S7: Heritage and socioeconomic impact assessment.

Operational and scientific monitoring studies may occur simultaneously (i.e. scientific monitoring can start before a response operation is completed). There may also be an information flow between studies, for example data from operational monitoring may be used to trigger the initiation of scientific studies.

Different oil types, spill locations, and volumes require different studies to form a fit–for–purpose operational and scientific monitoring program that is able to determine the extent, severity and persistence of environmental impacts from the oil spill.

2.4 Study design and standard operating procedures

Where appropriate, sampling design and procedures will be aligned with existing standards or guidance notes. These include, but are not limited to:

- Oil Spill Monitoring Handbook (Hook et al. 2016)
- Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018)
- Parks Victoria Standard Operating Procedure for Biological Monitoring of Subtidal Reefs (Edmunds and Hart 2005)
- Parks Victoria Standard Operating Procedure for Biological Monitoring of Intertidal Reefs (Hart and Edmunds 2005)
- Industry Recommended Subsea Dispersant Monitoring Plan (American Petroleum Institute 2013)

- Dispersant Application Monitoring Field Guide Tier I Visual Observation (OSRL 2011)
- Special Monitoring of Applied Response Technologies (NOAA 2006).

References to relevant standard operating procedures are provided within study tables in Section 4 and 5.

Consideration has also been given to the scopes and procedures within the Industry OSMP that is currently under preparation by APPEA (APPEA 2019).

2.5 Baseline environmental state

Baseline monitoring provides information on the condition of ecological receptors prior to or spatially independent (e.g. if used in control chart analyses) of a spill event. This is of importance for scientific monitoring where the ability to detect changes between pre-impact and post-impact conditions is necessary.

Given the large aerial extents of predicted oil exposure (or EMBA) from worst-case spill scenarios, and the inherent spatial and temporal variability in the environment, an ongoing or pre-impact baseline monitoring program is not planned.

However, Appendix B provides a database of known literature and studies relevant to environmental receptors within the Otway and Bass Basins that may provide suitable baseline data and/or contextual information in the event of a spill.

In addition, there are also operational and scientific monitoring studies that are suited to pre-impact baseline monitoring (Table 2-1). Therefore, in the event of a Level 2 or Level 3 oil spill, reactive pre-impact monitoring should, where practicable, be implemented to gather additional data on the current state of the environment.

Table 2-1: Study scopes appropriate for post-spill pre-impact sampling (reactive baseline)

Study	Pre-impact sampling	Post-impact sampling
Operational monitoring		
O1: Oil characterisation and behaviour		✓
O2: Water quality	✓	✓
O3: Sediment quality	✓	✓
O4: Marine fauna surveillance		✓
O5: Dispersant efficacy		✓
O6: Fish tainting		✓
Scientific monitoring		
S1: Water quality impact assessment	✓	✓
S2: Sediment quality impact assessment	✓	✓
S3: Subtidal habitats impact assessment	✓	✓
S4: Intertidal and coastal habitats impact assessment	✓	✓
S5: Marine fauna impact assessment	✓	✓
S6: Fisheries impact assessment		✓
S7: Heritage and socioeconomic impact assessment	✓	✓

2.6 Links to response options

The objectives of individual operational monitoring studies are typically associated with one or more specific response strategies (Table 2-2).

Table 2-2: Operational monitoring and response strategies

Response strategy	Study O1 Oil characterisation and behaviour	Study O2 Water quality	Study O3 Sediment quality	Study O4 Marine fauna surveillance	Study O5 Dispersant efficacy	Study O6 Fish tainting
Source control	✓	✓	✓			
Monitor and evaluate	✓	✓	✓	✓		✓
Assisted natural dispersion	✓	✓		✓		✓
Chemical dispersants	✓	✓	✓		✓	✓
Containment and recovery	✓			✓		
Protection and deflection	✓	✓	✓	✓		
Shoreline clean-up	✓		✓	✓		
Oiled wildlife response	✓			✓		

2.7 Links to environmental values and sensitivities

The types of environmental values and sensitivities (including matters of national environmental significance) known to occur in the Otway and Bass Basins and the related operational and scientific monitoring studies area shown in Table 2-3.

For the identification and descriptions of values and sensitivities present within an environment that may be affected (EMBA) for a particular activity, refer to the description in the relevant EP.

For an identification of key areas at risk, the associated environmental values and sensitivities and the links to relevant operational and scientific monitoring studies, refer to the relevant OSMP Addendum.

Table 2-3: Environmental values and sensitivities and related operational and scientific monitoring studies

Environmental value and sensitivities	Matters of national environmental significance	Value or sensitivity present in region		Operational Monitoring						Scientific Monitoring						
		Otway Basin	Bass Basin	Study O1	Study O2	Study O3	Study O4	Study O5	Study O6	Study S1	Study S2	Study S3	Study S4	Study S5	Study S6	Study S7
				Oil characterisation and behaviour	Water quality	Sediment quality	Marine fauna surveillance	Dispersant efficacy	Fish tainting	Water quality impact assessment	Sediment quality impact assessment	Subtidal habitats impact assessment	Intertidal and coastal habitats impact assessment	Marine fauna impact assessment	Fisheries impact assessment	Heritage and socioeconomic impact assessment
Protected areas																
Australian Marine Parks	✓[1]	✓	✓		✓	✓	✓			✓		✓		✓		✓
State marine protected areas		✓	✓		✓	✓	✓			✓	✓	✓	✓	✓		✓
State terrestrial protected areas		✓	✓			✓	✓				✓			✓		✓
Wetlands of international importance (Ramsar wetlands)	✓	✓	✓		✓	✓	✓				✓		✓	✓		✓
Ecological features																
Key ecological features	[2]	✓	×		✓					✓		✓				
Threatened ecological communities	✓	✓	✓		✓							✓	✓			

Environmental value and sensitivities	Matters of national environmental significance	Value or sensitivity present in region		Operational Monitoring						Scientific Monitoring						
		Otway Basin	Bass Basin	Study O1 Oil characterisation and behaviour	Study O2 Water quality	Study O3 Sediment quality	Study O4 Marine fauna surveillance	Study O5 Dispersant efficacy	Study O6 Fish tainting	Study S1 Water quality impact assessment	Study S2 Sediment quality impact assessment	Study S3 Subtidal habitats impact assessment	Study S4 Intertidal and coastal habitats impact assessment	Study S5 Marine fauna impact assessment	Study S6 Fisheries impact assessment	Study S7 Heritage and socioeconomic impact assessment
Threatened and migratory species	✓	✓	✓				✓							✓		
Invertebrates		✓	✓											✓	✓	
Fish		✓	✓											✓	✓	
Sharks		✓	✓				✓							✓		
Cetaceans		✓	✓				✓							✓		
Pinnipeds		✓	✓				✓							✓		
Turtles		✓	✓				✓							✓		
Birds		✓	✓				✓							✓		
Subtidal benthic habitats		✓	✓									✓				
Intertidal benthic habitats		✓	✓										✓			
Wetlands of national importance		✓	✓		✓	✓	✓						✓	✓		

Environmental value and sensitivities	Matters of national environmental significance	Value or sensitivity present in region		Operational Monitoring						Scientific Monitoring						
		Otway Basin	Bass Basin	Study O1	Study O2	Study O3	Study O4	Study O5	Study O6	Study S1	Study S2	Study S3	Study S4	Study S5	Study S6	Study S7
				Oil characterisation and behaviour	Water quality	Sediment quality	Marine fauna surveillance	Dispersant efficacy	Fish tainting	Water quality impact assessment	Sediment quality impact assessment	Subtidal habitats impact assessment	Intertidal and coastal habitats impact assessment	Marine fauna impact assessment	Fisheries impact assessment	Heritage and socioeconomic impact assessment
Cultural and heritage features																
World Heritage properties	✓	×	×													✓
Commonwealth Heritage places		×	✓		✓	✓	✓				✓		✓			✓
National Heritage places	✓	✓	✓		✓	✓	✓				✓		✓			✓
Indigenous Protected Areas		✓	✓			✓					✓		✓			✓
Areas of Aboriginal cultural heritage sensitivity		✓	✓			✓					✓		✓			✓
Shipwrecks		✓	✓		✓					✓		✓				✓
Socioeconomic features																
Commercial fisheries		✓	✓						✓						✓	

Environmental value and sensitivities	Matters of national environmental significance	Value or sensitivity present in region		Operational Monitoring						Scientific Monitoring						
		Otway Basin	Bass Basin	Study O1	Study O2	Study O3	Study O4	Study O5	Study O6	Study S1	Study S2	Study S3	Study S4	Study S5	Study S6	Study S7
				Oil characterisation and behaviour	Water quality	Sediment quality	Marine fauna surveillance	Dispersant efficacy	Fish tainting	Water quality impact assessment	Sediment quality impact assessment	Subtidal habitats impact assessment	Intertidal and coastal habitats impact assessment	Marine fauna impact assessment	Fisheries impact assessment	Heritage and socioeconomic impact assessment
Tourism and recreation		✓	✓		✓	✓	✓		✓		✓	✓	✓	✓		✓
Coastal settlements		✓	✓		✓	✓					✓		✓	✓		✓
Shipping		✓	✓		✓					✓						✓
Petroleum industry		✓	✓		✓					✓						✓

Notes:

1. Commonwealth marine areas are listed as a MNES under the EPBC Act. Marine protected areas are marine areas which are recognised to have high conservation value.
2. Key ecological features are not MNES and have no legal status in their own right; however, they may be considered as components of the Commonwealth marine area.

3 Implementation

3.1 Overview

This section outlines the following:

- roles and responsibilities for personnel involved in implementing operational and scientific monitoring
- communications and notification to key external stakeholders
- review and revision schedule for this OSMP
- environmental performance outcomes, standards and measurement criteria related to this OSMP.

3.2 Roles and responsibilities

Beach is responsible for the implementation and adherence to the requirements of this OSMP for events where they are the Control Agency. Key roles and responsibilities are identified in Table 3-1. Depending on the scale of the event, individual people may perform multiple roles; similarly, multiple people may share the same role. The Emergency Response Team (EMT) Leader (or delegate) is the key position responsible for overseeing the implementation of this OSMP (Table 3-1).

For oil spill events where the Control Agency is not Beach (e.g. vessel spills in Commonwealth waters), the relevant Control Agency would be responsible for the initiation and implementation of response phase (i.e. operational) monitoring requirements (AMSA 2019). It is noted that implementation may be delegated to another agency or company (including Beach) to provide services. Beach maintains the responsibility to initiate and implement the recovery phase (i.e. scientific) monitoring, in conjunction with support agencies, local government and statutory authorities where relevant.

Where the OSMP is activated the EMT Environment Leader will work in collaboration with the Monitoring Provider Program Manager. The Monitoring Provider Program Manager (over 20 years' experience and training) will manage the monitoring programs advised by Monitoring Provider Study Leads (a monthly log of the Monitoring Provider personnel is provided to Beach to ensure that they have the appropriate levels of training and experience). The Monitoring Provider Study Leads will direct any offshore monitoring that may be required in the event of an oil spill. Beach personnel will provide the resources to allow the monitoring to be undertaken in a safe manner.

Table 3-1: Roles and responsibilities for OSMP implementation

Role	Timing	Responsibilities
Emergency Management Team (EMT) Leader	Emergency response	• Overall responsibility for providing and coordinating operational emergency management activities • Equivalent to role of Incident Controller • Overall responsibility for implementation of this OSMP during an oil spill response • Overall responsibility for ensuring safe operations during OSMP implementation
EMT Environment Leader	Emergency response Ongoing	• Implementation of the OSMP • Initiation of operational and scientific monitoring studies • Termination of operational and scientific monitoring studies • Interface with EMT, Planning and Logistics Leaders and Monitoring Provider

Role	Timing	Responsibilities
		• Activation of Monitoring Provider/s • Day-to-day coordination of operational and scientific monitoring • Review and approval of operational and scientific monitoring plans and data reports • Interface with external agencies including NOPSEMA, DJPR and DPIPWE
EMT Planning Leader (or delegate)	Emergency response	• Interface with EMT Environment Leader for OSMP implementation (as required) • Provides operational monitoring data to EMT to support response planning
EMT Logistics Leader (or delegate)	Emergency response	• Interface with EMT Environment Leader for OSMP implementation (as required) • Support (as required) for implementing operational monitoring (e.g. site access etc.) • Support (as required) for mobilising plant and equipment (e.g. vessels, air support, vehicles etc.)
Emergency Management Liaison Officer (EMLO)	Emergency response	• Interface between Beach EMT and State Control Agency Incident Management Team (IMT)
Monitoring Provider – Program Manager	Emergency response Ongoing	• Work in collaboration with the EMT Environment Leader to implement the OSMP studies • Interface with Monitoring Provider Study Leads and EMT Environment Leader • Manage the monitoring programs advised by Monitoring Provider Study Leads • Provide Beach with a monthly log of the Monitoring Provider personnel available to implement the OSMP
Monitoring Provider – Study Lead	Emergency response Ongoing	• Interface with Monitoring Provider Program Manager and/or EMT Environment Leader • Implementation of individual monitoring studies (as required) • Prepare monitoring plans and sampling procedures • Review and approve data reports • Ensure compliance with requirements of this OSMP
Monitoring Provider – Field Personnel	Emergency response Ongoing	• Undertake field sampling and observations • Ensure compliance with requirements of this OSMP
Monitoring Provider – Office Personnel	Emergency response Ongoing	• Prepare data reports • Ensure compliance with requirements of this OSMP

3.3 Capability, training and competency

Personnel involved in implementing this OSMP may be sourced from both internal (i.e. Beach) and external (e.g. Monitoring Provider) resources. The number of personnel needed to fulfil roles for any given event depends on the event's circumstances. Depending on the scale of the event, individual people may perform multiple roles; similarly, multiple people may share the same role.

3.3.1 Capability

A capability needs assessment for the implementation of the OSMP studies is included in the OSMP Addendum specific to each EP's activities and relevant spill scenarios. The capability needs assessment identifies the minimum number of personnel to manage and implement the OSMP studies and the type of platforms (vessel, aircraft or vehicles) required to perform the studies. The studies have been group where appropriate to ensure effective use of resources.

3.3.2 Training and Competency

Training and competency for Beach EMT roles are described within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (OPEP) (CDN/ID S4100AH717907) and the BassGas Offshore OPEP (CDN/ID 3972816). This training matrix includes OSMP Awareness training for all relevant personnel.

Minimum competency requirements for individuals to fulfil OSMP-specific roles are identified within the operational and scientific monitoring study tables (Section 4 and 5). Minimum competencies can vary from degree qualified and experienced personnel (e.g. typical requirement for Study Leads) to an awareness level (e.g. typical for immediate response phase field sampling).

3.3.2.1 Internal resources

Internal capability within Beach includes offices and personnel based in Perth (Western Australia), Adelaide (South Australia), Melbourne (Victoria) and New Plymouth (New Zealand). Internal resources with appropriate environmental and/or oil spill response competencies will fulfil the OSMP-related roles of:

- EMT Leader
- EMT Environment Leader.

Internal Beach personnel may also perform Monitoring Provider (Study Lead, Field Personnel and Office Personnel) roles and responsibilities, particularly during first-response operational monitoring.

3.3.2.2 External resources

External personnel will primarily perform Monitoring Provider (Program Manager, Study Lead, Field Personnel and Office Personnel) roles and responsibilities, particularly during scientific monitoring.

External resources and capability are reviewed prior to an activity commencing to ensure appropriate agreements / activations are in place (see Section 3.7).

3.4 Monitoring

This OSMP lists a series of possible operational and scientific monitoring studies (with types of sampling techniques and parameters) that may be undertaken in the event of a spill; these studies are outlined in Sections 4 and 5. This OSMP is not intended to be prescriptive, but to provide a flexible framework such that the finalised monitoring studies are fit for purpose and tailored to the specific location, oil type, environmental sensitivities, and the nature and scale of the individual spill.

In the event of a Level 2 and Level 3 oil spill, a series of steps beginning with the preparation of an appropriate Sampling and Analysis Plan (SAP) is implemented (Figure 3-1). While the decision to initiate and terminate a particular study is the responsibility of Beach (EMT Environment Leader), the SAP, field survey and reporting is primarily undertaken by the

Monitoring Provider (Beach personnel may undertake or assist with operational monitoring, particularly during initial response phase).

Figure 3-1 also shows the flow of information (grey dashed lines) between the operational and scientific monitoring streams and associated OPEP processes.

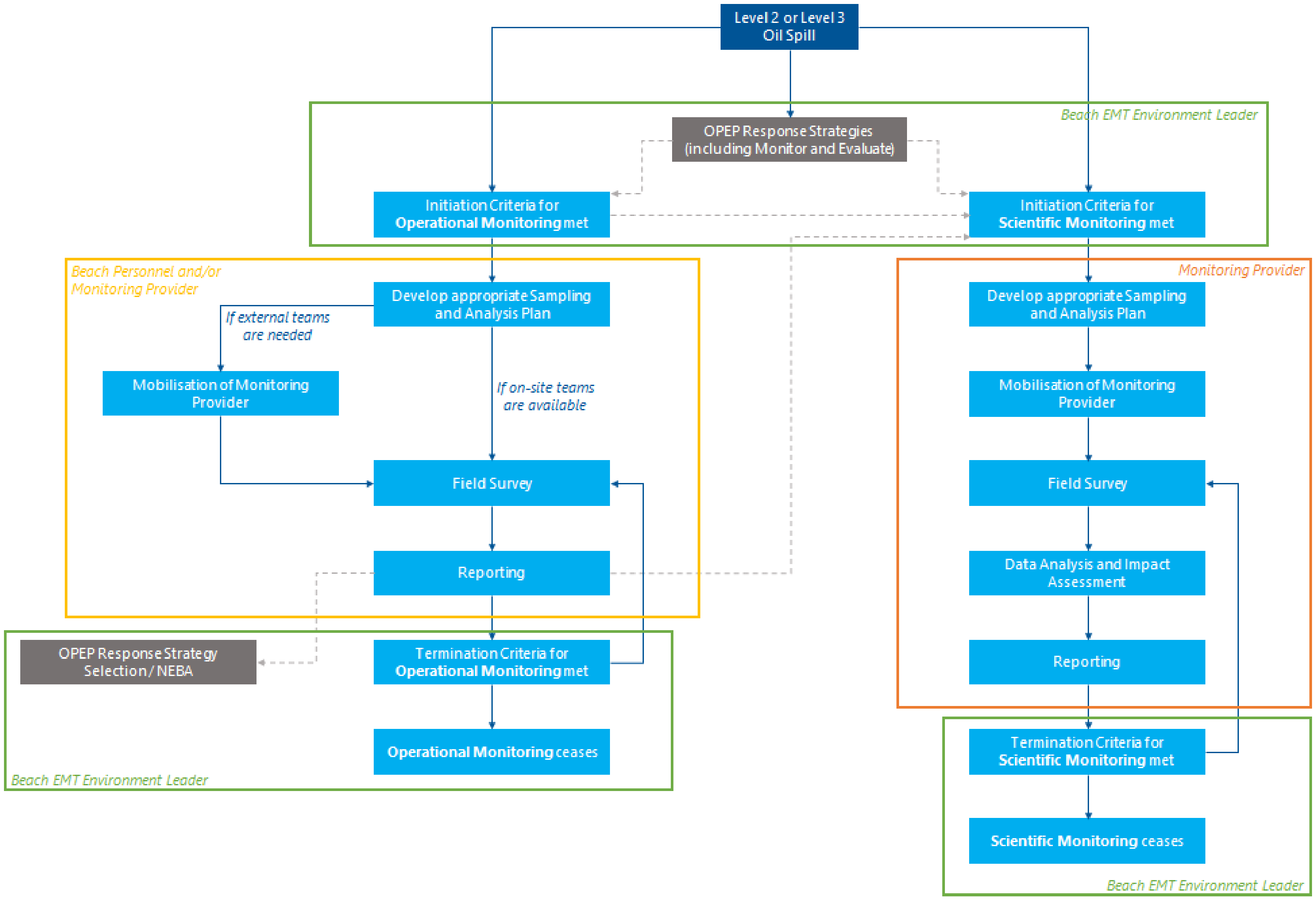


Figure 3-1: Implementation process for operational and scientific monitoring

3.5 Communication and notification

Stakeholder (including regulators) consultation and external notification requirements are described in the activity-specific EPs. This includes the requirement to consult with:

- Department of Jobs, Precincts and Regions (Victoria) and/or Department of Primary Industries, Parks, Water and Environment (Tasmania), in the event that an oil spill is likely to impact State waters
- Department of the Environment and Energy (DoEE), in the event that an oil spill is likely to impact matters of national environmental significance
- Director of National Parks, in the event that an oil spill and/or response activity are likely to impact an Australian Marine Park.

Consultation may also be undertaken with the above agencies or additional agencies (e.g. Heritage Victoria) in the event of a Level 2 or Level 3 oil spill with respect to input and/or review of a spill-specific Sampling and Analysis Plan (SAP) for scientific monitoring studies.

3.6 Review and revisions

This Offshore Victoria OSMP is subject to review, and revised if necessary, on an annual basis to incorporate the following:

- Significant change in the oil spills risks associated with Beach activities and/or facilities within offshore Victorian waters
- Significant environmentally relevant changes (e.g. changes to relevant legislation, stakeholder information, MNES, State/Commonwealth management plans, or availability of new literature)
- Findings from internal or external audits or exercises
- Lessons learned following any actual spill event.

Review records will be detailed in Beach Document Information and History tables (Section 7). Subsequent revisions to the OSMP (or supporting guides and procedures) will be actioned and closed-out as soon as practicable following the review.

As part an EP, Regulation 19 of the OPGGS(E)R also provides for the revision of the OSMP at least 14 days before the end of the period of five years from the most recent approval of an associated EP.

3.7 Environmental Performance Outcomes

Environmental performance outcomes, standards and measurement criteria related to this OSMP have been defined in Table 3-2.

Table 3-2: Environmental Performance Outcomes, Standards and Measurement Criteria

Environmental Performance Outcome	Control Measure	Environmental Performance Standard	Responsible Person	Measurement Criteria
Undertake oil spill response in a manner that will not result in additional impacts to marine environment, coastal habitat and oiled wildlife.	NOPSEMA accepted Operational and Scientific Monitoring Plan	Operational and scientific monitoring capability shall be maintained in accordance with the OSMP: • a month prior to the commencement of drilling a review of the contracted OSMP provider/s capability will be undertaken by Beach to ensure that the OSMP requirements can be met by the contracted OSMP provider/s. • during drilling the contracted OSMP provider/s will provide a monthly report to show that capability as detailed in the OSMP is maintained. • the contracted OSMP provider/s capability to meet the requirements detailed in the OSMP will be tested prior to commencing drilling.	Senior Crisis, Emergency & Security Advisor	Outcomes of internal audits and tests demonstrate preparedness

4 Operational Monitoring

4.1 Overview

The following sections outline the individual operational monitoring studies that may be implemented in the event of a Level 2 or Level 3 oil spill to the marine or coastal environment. The tables describe the objective, initiation and termination criteria, timing, monitoring (types of sampling techniques and parameters), reporting, resources and competencies.

The studies are presented separately below; however, in practice they may be undertaken simultaneously.

Six operational monitoring studies have been identified:

- O1: Oil characterisation and behaviour
- O2: Water quality
- O3: Sediment quality
- O4: Marine fauna surveillance
- O5: Dispersant efficacy
- O6: Fish tainting.

The operational monitoring studies described in this OSMP complement the Monitor and Evaluate response strategy described in the OPEP in providing information to support decision-making around response activity.

Note: due to the rapid weathering characteristics of gas condensate and marine diesel, operational monitoring studies O1, O2, O3 and O4 are not considered relevant for a pipeline rupture or vessel collision event where there is only a short period of oil release. The time that would elapse between a spill occurring and monitoring personnel being on site would render the data collected unnecessary in informing response strategies. Studies O1, O2, O3 and O4 are, therefore, only actioned (once initiation criteria are met) as a result of a loss of well control incident.

4.1.1 General design considerations

An event-specific sampling and analysis plan (SAP), appropriate to the nature and scale of the event, should be developed and in place before conducting field sampling. The following items should be considered when developing the SAP:

- Nature and scale of the spill (e.g. surface or subsea release, instantaneous or ongoing release, etc.)
- The environment which may be affected (e.g. subtidal or intertidal, depth, presence of other sensitive receptors, etc.)
- Program design aims, which may include but, not limited to the determination of the extent of oil, and the spatial and temporal distribution of the oil
- The sampling plan should have flexibility to be adjusted based on conditions in the field and as new information about the even becomes available

- The number of sites and samples to be collected should be spill-specific and take into account level of effort, potential logistical limitations, weather conditions, sample holding times, freight/transport options etc. that if not properly managed can compromise sample integrity
- Where time permits, appropriate QA/QC samples should be collected to allow assessment of local variability and ascertain potential for introduction of sample contamination throughout the collection and analysis process
- Appropriate QA/QC protocols for sample handling, storage and transport should be included to limit the potential for contamination and ensure sample integrity meets laboratory requirements.
- Monitoring frequency should consider weathering of the spilled oil, with frequency decreasing as the rate of change in the spilled oil decreases (i.e. monitoring effort is concentrated towards the beginning of a spill)
- Subsea sampling in the vicinity of project infrastructure should be designed to avoid damage to or entanglement with this infrastructure
- Health and safety factors associated with working in a range of environments with consideration of prevailing weather.

4.2 Study O1: Oil characterisation and behaviour

An overview of the key components of Study O1 are provided below:

Component	Description
Objective	To provide an assessment of the oil properties and visual observations of the behaviour and weathering of the spilled oil
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• Any related scientific monitoring studies have been initiated by the EMT Environment Leader (or delegate) **and** • The EMT Environment Leader (or delegate) considers that continuation of monitoring under Study O1 will not result in a change to the scale or location of active response options **or** • The EMT Environment Leader (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response **or** • The EMT Environment Leader (or delegate) has advised that continuation of monitoring under Study O1 may increase overall environmental impact
Timing	• Where required, the Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 4 hours of initiation criteria being met • Where required, an initial SAP to be available within 12 hours of initiation criteria being met • Field surveys to commence within 24 hours of initiation criteria being met Note: the initial SAP may be revised as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites
Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study O1: • Vessel or shore-based

Component	Description

	• Collection of an oil sample
	  ◦ Surface skimming (sampling pole with container)
	  ◦ Oleophilic absorbent pads
	• Behaviour and weathering
	  ◦ Visual observations

Standard Operating Procedures	The following references are provided as guides for standard operating procedures (SOP) that may be implemented under Study O1: • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the Sampling and Analysis Plan (SAP).
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study O1: • Physical properties (e.g. viscosity, pour point, density, wax content) • Chemical properties (e.g. hydrocarbon characterisation, volatile content) • Oil component concentrations (e.g. TRH, BTEX, PAH, MAH) • Visual records of extent and state (e.g. colour/optical effect on surface, form (slick, emulsion, mousse etc), presence waxy residue)
Guidelines	N/A
Reporting	• Results from laboratory sampling reported as available to EMT Environment Leader • Final report prepared within one-week of termination criteria being met and report provided to EMT Environment Leader
Key Resources	• Monitoring Provider or Responder Personnel • Vessels • Analytical laboratory services

Key Competencies	• Monitoring Provider – Study Lead
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 10 years experience in environmental practice
	  ◦ Familiarisation with relevant requirements of the OSMP and OPEP
	• Monitoring Provider – Field Personnel
	  ◦ Familiarisation with oil sampling and recording techniques
	• Vessel provider
	  ◦ Certificate of survey with appropriate service category
	• Analytical laboratory
	  ◦ NATA accredited

4.3 Study O2: Water quality

An overview of the key components of Study O2 are provided below:

Component	Description
Objective	To provide a rapid assessment of the presence, type and concentrations of oil (and dispersant chemicals where relevant) in offshore and intertidal waters

Component	Description
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• Any related scientific monitoring studies have been initiated by the EMT Environment Leader (or delegate) **and** • The EMT Environment Leader (or delegate) considers that continuation of monitoring under Study O2 will not result in a change to the scale or location of active response options **or** • The EMT Environment Leader (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response **or** • The EMT Environment Leader (or delegate) has advised that continuation of monitoring under Study O2 may increase overall environmental impact
Timing	• Where required, the Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 4 hours of initiation criteria being met • Where required, an initial SAP to be available within 12 hours of initiation criteria being met • Field surveys to commence within 24 hours of initiation criteria being met Note: the initial SAP may be revised as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites

Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study O2:
	• Surface water sample collection
	  ◦ Sampling pole with container
	  ◦ Hose with peristaltic pump
	• Sub-surface water sample collection
	  ◦ Niskin bottle (or similar)
	  ◦ Hose with peristaltic pump
	• In-situ profiles
	  ◦ Physio-chemical profiles
	  ◦ Fluorometer

Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study O2: • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the SAP.
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study O2: • Oil concentrations (e.g. TRH, BTEX, PAH, MAH) • Physical parameters (e.g. temperature, salinity, DO, pH) • Fluorescence • Dispersant chemicals (if applied)
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study O2: • Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018) • Oil spill modelling (NOPSEMA 2019)

Component	Description
Reporting	• Results from in-situ sampling reported daily to the EMT Environment Leader • Results from laboratory sampling reported as available to EMT Environment Leader • Final report prepared within one-week of termination criteria being met and report provided to EMT Environment Leader
Key Resources	• Monitoring Provider • Vessels • Analytical laboratory services
Key Competencies	• Monitoring Provider – Study Lead ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 10 years experience in environmental practice ◦ Familiarisation with relevant requirements of the OSMP and OPEP • Monitoring Provider – Field Personnel ◦ Familiarisation with oil and water sampling and recording techniques • Vessel provider ◦ Certificate of survey with appropriate service category • Analytical laboratory ◦ NATA accredited

4.4 Study O3: Sediment quality

An overview of the key components of Study O3 are provided below:

Component	Description
Objective	To provide a rapid assessment of the presence, type and concentrations of oil (and dispersant chemicals where relevant) in offshore, intertidal and shoreline sediments
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the OPEP Monitor and Evaluate response strategy indicates potential and/or actual sediment contact **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• Any related scientific monitoring studies have been initiated by the EMT Environment Leader (or delegate) **and** • The EMT Environment Leader (or delegate) considers that continuation of monitoring under Study O3 will not result in a change to the scale or location of active response options **or** • The EMT Environment Leader (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response **or** • The EMT Environment Leader (or delegate) has advised that continuation of monitoring under Study O3 may increase overall environmental impact
Timing	• Where required, the Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 4 hours of initiation criteria being met • Where required, an initial SAP to be available within 12 hours of initiation criteria being met • Field surveys to commence within 24 hours of initiation criteria being met Note: the initial SAP may be revised as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date

Component	Description
	Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites

Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study O3:
	• Subtidal sample collection
	  ◦ Grab or core sampler
	• Intertidal/shoreline sample collection
	  ◦ Cores or auger
	  ◦ Sediment box

Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study O3: • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the SAP.
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study O3: • Oil concentrations (e.g. TRH, BTEX, PAH, MAH) • Dispersant chemicals (if applied) • Total organic carbon • Physical parameters (e.g. PSD)
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study O3: • Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018) • Oil spill modelling (NOPSEMA 2019)
Reporting	• Results from in-situ observations reported daily to the EMT Environment Leader • Results from laboratory sampling reported as available to EMT Environment Leader • Final report prepared within one-week of termination criteria being met and report provided to EMT Environment Leader
Key Resources	• Monitoring Provider • Vessels (island access) • Vehicles (mainland access) • Analytical laboratory services

Key Competencies	• Monitoring Provider – Study Lead
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 10 years experience in environmental practice
	  ◦ Familiarisation with relevant requirements of the OSMP and OPEP
	• Monitoring Provider – Field Personnel
	  ◦ Familiarisation with sediment sampling and recording techniques
	• Vessel provider
	  ◦ Certificate of survey with appropriate service category
	• Analytical laboratory
	  ◦ NATA accredited

4.5 Study O4: Marine fauna surveillance

An overview of the key components of Study O4 are provided below:

Component	Description
Objective	To provide a rapid assessment of the presence, type and location of oiled marine fauna
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• Any related scientific monitoring studies have been initiated by the EMT Environment Leader (or delegate) **and** • The EMT Environment Leader (or delegate) considers that continuation of monitoring under Study O4 will not result in a change to the scale or location of active response options **or** • The EMT Environment Leader (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response **or** • The EMT Environment Leader (or delegate) has advised that continuation of monitoring under Study O4 may increase overall environmental impact
Timing	• Where required, the Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 4 hours of initiation criteria being met • Where required, an initial SAP to be available within 12 hours of initiation criteria being met • Field surveys to commence within 24 hours of initiation criteria being met Note: the initial SAP may be revised as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites

Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study O4:
	• Systematic surveillance
	  ◦ Aerial observations from fixed-wing or helicopter
	  ◦ Vessel-based observations
	  ◦ On-ground shoreline observations
	• Unmanned surveillance
	  ◦ UAV and/or satellite
	• Opportunistic / incidental observations
	• Carcass collection and tissue sampling

Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study O4: • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the SAP
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be recorded under Study O4 where possible: • Presence and identification (species group / species) of oiled fauna • State of oiled fauna • Presence and state of any carcass
Guidelines	N/A
Reporting	• Results from in-situ observations reported daily to the EMT Environment Leader

Component	Description
	• Final report prepared within one-week of termination criteria being met and report provided to EMT Environment Leader
Key Resources	• Monitoring Provider • Vessels • Aircraft • Vehicles
Key Competencies	• Monitoring Provider – Study Lead ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 10 years experience in environmental practice ◦ Familiarisation with relevant requirements of the OSMP and OPEP • Monitoring Provider – Field Personnel ◦ Familiarisation with the fauna observation and recording techniques ◦ Oiled, injured, and diseased fauna handling to be undertaken by trained personnel • Vessel provider ◦ Certificate of survey with appropriate service category • Aircraft ◦ Current registration with CASA • Analytical laboratory ◦ NATA accredited

4.6 Study O5: Dispersant efficacy

An overview of the key components of Study O5 are provided below:

Component	Description
Objective	Determine the effectiveness of dispersant application and reduce surface VOCs (where relevant)
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** the Chemical Dispersant response strategy from the OPEP has been selected for use
Termination trigger	• Any related scientific monitoring studies have been initiated by the EMT Environment Leader (or delegate) **and** • The EMT Environment Leader (or delegate) considers that continuation of monitoring under Study O5 will not result in a change to the scale or location of active response options **or** • The EMT Environment Leader (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response **or** • The EMT Environment Leader (or delegate) has advised that continuation of monitoring under Study O5 may increase overall environmental impact
Timing	Study O5 is to be undertaken at the same time as the Chemical Dispersant response strategy
Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling and surveillance may be implemented under Study O5: • Visual observations ◦ Aerial or vessel based • Oil and water sampling

Component	Description
	◦ Water sampling techniques as per Study O1 (e.g. niskin bottle, hose with peristaltic pump, etc.) ◦ Fluorometer ◦ Underwater video surveillance • Air quality monitoring ◦ In-situ detectors
Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study O5: • Oil Spill Monitoring Handbook (Hook et al 2016) • Industry Recommended Subsea Dispersant Monitoring Plan (American Petroleum Institute 2013) • Dispersant Application Monitoring Field Guide Tier I Visual Observation (OSRL 2011) • Special Monitoring of Applied Response Technologies (NOAA 2006) SOP will be confirmed by the Monitoring Provider during preparation of the SAP
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study O5: • Oil concentrations (e.g. TRH, BTEX, PAH, MAH) • Fluorescence • VOCs and %LELs
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study O5: • Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018) • Oil spill modelling (NOPSEMA 2019) • Workplace Exposure Standards for Airborne Contaminants (Safe Work Australia 2018)
Reporting	• Results from in-situ observations reported daily to the EMT Environment Leader • Final report prepared within one-week of termination criteria being met and report provided to EMT Environment Leader
Key Resources	• Monitoring Provider • Vessels • Aircraft
Key Competencies	• Monitoring Provider – Study Lead ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 10 years experience in environmental practice ◦ Familiarisation with relevant requirements of the OSMP and OPEP • Monitoring Provider – Field Personnel ◦ Familiarisation with vessel-based and/or aerial-based oil spill monitoring ◦ Familiarisation with relevant sampling techniques (e.g. sub-surface video surveillance, use of fluorometer, water sample collection, air quality monitoring) • Vessel provider ◦ Certificate of survey with appropriate service category • Aircraft ◦ Current registration with CASA • Analytical laboratory ◦ NATA accredited

4.7 Study O6: Fish tainting

An overview of the key components of Study O6 are provided below:

Component	Description
Objective	To provide an assessment of the potential of fish tainting in areas of recreational and/or commercial fisheries
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from Study O2 has confirmed exposure to offshore waters above the ANZG (2018) 99% species protection levels **and** this exposure occurred in waters that intersect with active fisheries **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• Any related scientific monitoring studies have been initiated by the EMT Environment Leader (or delegate) **and** • The EMT Environment Leader (or delegate) considers that continuation of monitoring under Study O6 will not result in a change to the scale or location of active response options **or** • The EMT Environment Leader (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response **or** • The EMT Environment Leader (or delegate) has advised that continuation of monitoring under Study O6 may increase overall environmental impact
Timing	• Where required, the Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 4 hours of initiation criteria being met • Where required, an initial SAP to be available within 12 hours of initiation criteria being met • Field surveys to commence within 24 hours of initiation criteria being met Note: the initial SAP may be revised as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites

Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study O6:
	• Systematic fish sample collection
	  ◦ Olfactory evaluation
	  ◦ Tissue collection
	• Opportunistic carcass collection and tissue sampling

Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study O6: • Oil Spill Monitoring Handbook (Hook et al 2016) • Managing Seafood Safety after an Oil Spill (Yender, Michel and Lord 2002) SOP will be confirmed by the Monitoring Provider during preparation of the SAP
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study O6: • Odour and appearance • Chemical analysis of tissue samples (e.g. TRH, BTEX, PAH, MAH)
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study O6:

Component	Description
	• Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018) • Australia New Zealand Food Standards Code
Reporting	• Results from laboratory sampling and sensory analysis reported as available to EMT Environment Leader • Final report prepared within one-week of termination criteria being met and report provided to EMT Environment Leader
Key Resources	• Monitoring Provider • Vessels • Analytical laboratory services
Key Competencies	• Monitoring Provider – Study Lead ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 10 years experience in environmental practice ◦ Familiarisation with relevant requirements of the OSMP and OPEP • Monitoring Provider – Field Personnel ◦ Familiarisation with oil and water sampling and recording techniques • Monitoring Provider – Olfactory Assessment ◦ Trained and/or experienced olfactory analysts • Vessel provider ◦ Certificate of survey with appropriate service category • Analytical laboratory ◦ NATA accredited

5 Scientific Monitoring

5.1 Overview

The following sections outline the individual scientific monitoring studies that may be implemented in the event of a Level 2 or Level 3 oil spill to the marine or coastal environment. The tables describe the objective, initiation and termination criteria, timing, monitoring (types of sampling techniques and parameters), reporting, resources and competencies.

The studies are presented separately below; however, in practice they may be undertaken simultaneously.

Seven scientific monitoring studies have been identified:

- S1: Water quality impact assessment
- S2: Sediment quality impact assessment
- S3: Subtidal habitats impact assessment
- S4: Intertidal and coastal habitats impact assessment
- S5: Marine fauna impact assessment
- S6: Fisheries impact assessment
- S7: Heritage and socioeconomic impact assessment.

Scientific monitoring generally has objectives relating to attributing cause-effect interactions of the spill or the spill-response activities with changes to the surrounding environment. Where impacts are identified, the studies also have the objective of identifying and recommending remediation activities and monitoring for recovery. Consequently, such studies are required to account for natural or sampling variation, and study designs must be robust and produce defensible data. Scientific monitoring is typically conducted over a wider study area, extending beyond the spill footprint, and a longer time period, extending beyond the spill response.

5.1.1 General design considerations

Guidance on various experimental monitoring approaches for scientific monitoring (e.g. use of baseline data in 'before versus after' analyses, and alternative approaches such as 'control versus impact' and 'gradient approach') is provided in Appendix A. .

Termination criteria for some of the scientific monitoring modules require the use of guidelines and/or benchmark values. Where available, Australian guidelines (e.g. ANZG 2018) or regionally relevant data is used. Where these are unavailable for a selected parameter, toxicity screening benchmarks developed by the USEPA in response to the Deepwater Horizon incident (e.g. USEPA 2015), or other international guidelines (e.g. USEPA 2017) may be adopted.

5.2 Study S1: Water quality impact assessment

An overview of the key components of Study S1 are provided below:

Component	Description	
Objective	Determine the impact to, and recovery of, offshore and intertidal water quality from oil exposure and/or any impacts associated with response activities	
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the Study O2 has confirmed exposure to offshore or intertidal waters **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence	
Termination trigger	• The EMT Environment Leader (or delegate) considers that: ◦ Hydrocarbon concentrations in offshore waters have returned to within the expected natural dynamics of baseline state and/or control sites **or** ◦ Hydrocarbon concentrations in offshore waters are below relevant ANZG (2018) 99% species protection levels or other applicable benchmark values **and** • The EMT Environment Leader (or delegate) considers that: ◦ Relevant water quality parameter (e.g. chemicals from dispersant) concentrations in offshore waters have returned to within the expected natural dynamics of baseline state and/or control sites **or** ◦ Relevant water quality parameter (e.g. chemicals from dispersant) concentrations in offshore waters are below relevant ANZG (2018) 99% species protection levels or other applicable benchmark values **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that water quality values within protected areas (i.e. Australian Marine Parks, Ramsar wetlands or State marine protected areas) have not been impacted or have returned to within the expected natural dynamics of baseline state **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring	
Timing	• Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 24 hours of initiation criteria being met An initial SAP, prepared by the Monitoring Provider, to be available within 48 hours of initiation criteria being met • Consultation with relevant agencies to commence as soon as practicable after initiation criteria are met • Field surveys to commence within 72 hours (3 days) of initiation criteria being met Note: the initial SAP may be revised following consultation with relevant agencies and/or as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites	
Monitoring Design	The following are monitoring designs recommended for different spill extents/behaviour; final design will be confirmed during preparation of the SAP by the Monitoring Provider.	
	Spill Extent / Behaviour	Monitoring Design
	• Spill plume concentrated around source, dissipating with distance	• Gradient approach
	• Spill plume has dissipated away from source	• Gradient approach • Lines of Evidence
	• Nearshore spill or spill reaches shoreline	• BACI (if appropriate baseline data available)

Component	Description	
		• IvC • Gradient approach
	• Spill interacts with area of biological importance (e.g. bay/shoal/island)	• BACI (if appropriate baseline data available) • IvC
Scope	All areas (intertidal, offshore) and water depths are included within the scope for Study S1. Note: where Management Plans for protected area (e.g. Australian Marine Parks, State marine protected areas, Ramsar wetlands) exist, the SAP will include consideration of any specific sampling and/or values that require monitoring	

Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study S1:
	• Surface water sample collection
	  ◦ Sampling pole with container
	  ◦ Hose with peristaltic pump
	• Sub-surface water sample collection
	  ◦ Niskin bottle (or similar)
	  ◦ Hose with peristaltic pump
	• In-situ profiles
	  ◦ Physio-chemical profiles
	  ◦ Fluorometer
	• Visual records of any damage or change due to response activities	

Sampling Frequency	• Initial sampling frequency will be determined by during preparation of the SAP by the Monitoring Provider • Ongoing sampling frequency will be determined by the Monitoring Provider in consultation with the EMT Environment Leader following each monitoring and reporting event until termination criteria are met.	
Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study S1: • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the SAP	
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study S1: • Oil concentrations (e.g. TRH, BTEX, PAH, MAH) • Physical parameters (e.g. temperature, salinity, DO, pH) • Fluorescence • Dispersant chemicals (if applied) and/or other water quality parameters as necessary to identify any impacts from response activities	
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study S1: • Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018) • Oil spill modelling (NOPSEMA 2019) • Acute and Chronic Screening Benchmarks for Water and Sediment Quality (USEPA 2015) • National Recommended Water Quality Criteria - Aquatic Life (USEPA 2017)	
Reporting	• Data report to be provided to EMT Environment Leader following the completion of each field survey	

Component	Description
	◦ The data report will also contain on-going trend analysis allowing for the tracking of impacts and recovery, identification/recommendations on any remediation works or active management (including changes to existing sampling or additional sampling required) that should be considered • Final impact assessment report (addressing impacts from spill event and any relevant response activities) to be provided to EMT Environment Leader following the termination criteria being met
Key Resources	• Monitoring Provider • Vessels • Analytical laboratory services
Key Competencies	• Monitoring Provider – Study Lead ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 10 years experience in environmental practice ◦ Familiarisation with relevant requirements of the OSMP and OPEP • Monitoring Provider – Field Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Experienced in the relevant sampling and/or recording techniques • Monitoring Provider – Office Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Experienced in water quality data analysis • Vessel provider ◦ Certificate of survey with appropriate service category • Analytical laboratory ◦ NATA accredited

5.3 Study S2: Sediment quality impact assessment

An overview of the key components of Study S2 are provided below:

Component	Description
Objective	Determine the impact to, and recovery of, offshore, intertidal and shoreline sediment quality from oil exposure and/or any impacts associated with response activities
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the Study O3 has confirmed exposure to shoreline sediments **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• The EMT Environment Leader (or delegate) considers that: ◦ Hydrocarbon concentrations in sediments have returned to within the expected natural dynamics of baseline state and/or control sites **or**

<table>
<tr><th>Component</th><th>Description</th></tr>
<tr><td></td><td>
Hydrocarbon concentrations in sediments are below relevant ANZECC/ARMCANZ SQGV (Simpson et al. 2013) other applicable benchmark values and
The EMT Environment Leader (or delegate) considers that:
Relevant sediment quality parameter (e.g. chemicals from dispersant) concentrations have returned to within the expected natural dynamics of baseline state and/or control sites or
Relevant sediment quality parameter (e.g. chemicals from dispersant) concentrations in are below relevant ANZECC/ARMCANZ SQGV (Simpson et al. 2013) other applicable benchmark values and
The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that sediment quality values within protected areas (i.e. Australian Marine Parks, Ramsar wetlands or State marine protected areas) have not been impacted or have returned to within the expected natural dynamics of baseline state and
Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring
</td></tr>
<tr><td>Timing</td><td>
Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 24 hours of initiation criteria being met
An initial SAP, prepared by the Monitoring Provider, to be available within 48 hours of initiation criteria being met
Consultation with relevant agencies to commence as soon as practicable after initiation criteria are met
Field surveys to commence within 72 hours (3 days) of initiation criteria being met
Note: the initial SAP may be revised following consultation with relevant agencies and/or as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date
Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites
</td></tr>
<tr><td>Monitoring Design</td><td>
The following are monitoring designs recommended for different spill extents/behaviour; final design will be confirmed during preparation of the SAP by the Monitoring Provider.
<table>
<tr><th>Spill Extent / Behaviour</th><th>Monitoring Design</th></tr>
<tr><td>Spill plume concentrated around source, dissipating with distance</td><td>Gradient approach</td></tr>
<tr><td>Spill plume has dissipated away from source</td><td>Gradient approach
Lines of Evidence</td></tr>
<tr><td>Nearshore spill or spill reaches shoreline</td><td>BACI (if appropriate baseline data available)
IvC
Gradient approach</td></tr>
<tr><td>Spill interacts with area of biological importance (e.g. bay/shoal/island)</td><td>BACI (if appropriate baseline data available)
IvC</td></tr>
</table>
</td></tr>
<tr><td>Scope</td><td>
All areas (shoreline, intertidal, offshore) are included within the scope for Study S2.
Note: where Management Plans for protected area (e.g. Australian Marine Parks, State marine protected areas, Ramsar wetlands) exist, the SAP will include consideration of any specific sampling and/or values that require monitoring
</td></tr>
<tr><td>Sampling Techniques</td><td>
Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study S2:
Subtidal sample collection
Grab or core sampler
Intertidal/shoreline sample collection
</td></tr>
</table>

Component	Description
	◦ Cores or auger ◦ Sediment box • Visual records of any damage or change due to response activities
Sampling Frequency	• Initial sampling frequency will be determined by during preparation of the SAP by the Monitoring Provider • Ongoing sampling frequency will be determined by the Monitoring Provider in consultation with the EMT Environment Leader following each monitoring and reporting event until termination criteria are met.
Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study S2: • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the SAP
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study S2: • Oil concentrations (e.g. TRH, BTEX, PAH, MAH) • Dispersant chemicals (if applied) • Total organic carbon • Physical parameters (e.g. PSD)
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study S2: • ANZECC/ARMCANZ SQGV (Simpson et al. 2013) • Oil spill modelling (NOPSEMA 2019) • Acute and Chronic Screening Benchmarks for Water and Sediment Quality (USEPA 2015)
Reporting	• Data report to be provided to EMT Environment Leader following the completion of each field survey ◦ The data report will also contain on-going trend analysis allowing for the tracking of impacts and recovery, identification/recommendations on any remediation works or active management (including changes to existing sampling or additional sampling required) that should be considered • Final impact assessment report (addressing impacts from spill event and any relevant response activities) to be provided to EMT Environment Leader following the termination criteria being met
Key Resources	• Monitoring Provider • Vessels (island access) • Vehicles (mainland access) • Analytical laboratory services
Key Competencies	• Monitoring Provider – Study Lead ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 10 years experience in environmental practice ◦ Familiarisation with relevant requirements of the OSMP and OPEP • Monitoring Provider – Field Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Experienced in the relevant sampling and/or recording techniques

Component	Description
	• Monitoring Provider – Office Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Experience in sediment quality data analysis • Vessel provider ◦ Certificate of survey with appropriate service category • Analytical laboratory ◦ NATA accredited

5.4 Study S3: Subtidal habitats impact assessment

An overview of the key components of Study S3 are provided below:

Component	Description
Objective	Determine the impact to, and recovery of, subtidal habitats from oil exposure and/or any impacts associated with response activities
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the OPEP Monitor and Evaluate response strategy or Study O2 or O3 indicates potential and/or actual exposure to near-bottom waters or sediments **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• The EMT Environment Leader (or delegate) considers that disturbance parameters (e.g. species composition, percent cover) and health parameters (e.g. leaf condition) have returned to within the expected natural dynamics of baseline state and/or control sites **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that subtidal habitat quality values within protected areas (i.e. Australian Marine Parks, Ramsar wetlands or State marine protected areas) have not been impacted or have returned to within the expected natural dynamics of baseline state **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring
Timing	• Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 24 hours of initiation criteria being met • An initial SAP, prepared by the Monitoring Provider, to be available within 72 hours of the initiation criteria being met • Consultation with relevant agencies to commence as soon as practicable after initiation criteria are met • Field surveys to commence within 120 hours (5 days) of initiation criteria being met Note: the initial SAP may be revised following consultation with relevant agencies and/or as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites
Monitoring Design	The following are monitoring designs recommended for different spill extents/behaviour; final design will be confirmed during preparation of the SAP by the Monitoring Provider. Spill Extent / Behaviour — Monitoring Design

Component	Description	
	• Spill plume concentrated around source, dissipating with distance	• Gradient approach
	• Spill plume has dissipated away from source	• Gradient approach • Lines of Evidence
	• Nearshore spill or spill reaches shoreline	• BACI (if appropriate baseline data available) • IvC • Gradient approach • Lines of Evidence
	• Spill interacts with area of biological importance (e.g. bay/shoal/island)	• BACI (if appropriate baseline data available) • IvC • Lines of Evidence
Scope	Soft and hard substrate subtidal benthic habitats and their associated organisms covered by Study S3 include: • Hard (scleractinian) corals, turf and coralline algae • Sponges and other filter feeders • Macroalgae (including turf and encrusting coralline algae) and seagrasses; • Kelp • Large and conspicuous (i.e. epifaunal) motile invertebrates (e.g. crustaceans and molluscs) Note: where Management Plans for protected area (e.g. Australian Marine Parks, State marine protected areas, Ramsar wetlands) exist, the SAP will include consideration of any specific sampling and/or values that require monitoring	

Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study S3:
	• Dive / towed video / drop camera / ROV surveys
	  ◦ Transects
	  ◦ Quadrats
	  ◦ Sediment grab (for soft-bottom habitat)
	• Remote sensing
	• Biological sample collection
	• Records of any damage or change due to response activities	

Sampling Frequency	• Survey timing should coincide with that appropriate for the habitat and/or community of interest • Initial sampling frequency will be determined by during preparation of the SAP by the Monitoring Provider • Ongoing sampling frequency will be determined by the Monitoring Provider in consultation with the EMT Environment Leader following each monitoring and reporting event until termination criteria are met	
Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study S3: • Parks Victoria Standard Operating Procedure for Biological Monitoring of Subtidal Reefs (Edmunds and Hart 2005) • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the SAP	
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study S3: • Habitat/substrate type	

Component	Description
	• Abundance and percent cover • Diversity • Distribution • State (e.g. evidence of stress, necrosis, leaf condition etc.) • Chemical analysis of tissue samples (e.g. TRH, BTEX, PAH, MAH)
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study S3: • Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018)
Reporting	• Data report to be provided to EMT Environment Leader following the completion of each field survey ◦ The data report will also contain on-going trend analysis allowing for the tracking of impacts and recovery, identification/recommendations on any remediation works or active management (including changes to existing sampling or additional sampling required) that should be considered • Final impact assessment report (addressing impacts from spill event and any relevant response activities) to be provided to EMT Environment Leader following the termination criteria being met
Key Resources	• Monitoring Provider • Vessels • ROV
Key Competencies	• Monitoring Provider – Study Lead ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 10 years experience in environmental practice ◦ Familiarisation with relevant requirements of the OSMP and OPEP • Monitoring Provider – Field Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Commercial dive qualifications ◦ Experienced in the relevant sampling and/or recording techniques ◦ Experienced in commercial ROV operations • Monitoring Provider – Office Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Experience in identification, analysis and interpretation of benthic habitat data • Vessel provider ◦ Certificate of survey with appropriate service category ◦ Suitable for commercial diving operations

5.5 Study S4: Intertidal and coastal habitats impact assessment

An overview of the key components of Study S4 are provided below:

<table>
<tr><th>Component</th><th>Description</th></tr>
<tr><td>Objective</td><td>Determine the impact to, and recovery of, intertidal and coastal habitats from oil exposure and/or any impacts associated with response activities</td></tr>
<tr><td>Initiation trigger</td><td>• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred and data from the OPEP Monitor and Evaluate response strategy or Study O2 or O3 indicates potential and/or actual exposure to near-bottom waters or sediments or
• The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence</td></tr>
<tr><td>Termination trigger</td><td>• The EMT Environment Leader (or delegate) considers that disturbance parameters (e.g. species composition, percent cover) and health parameters (e.g. leaf condition) have returned to within the expected natural dynamics of baseline state and/or control sites and
• The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that intertidal habitat quality values within protected areas (i.e. Ramsar wetlands or State marine protected areas) have not been impacted or have returned to within the expected natural dynamics of baseline state and
• Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring</td></tr>
<tr><td>Timing</td><td>• Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 24 hours of initiation criteria being met
• An initial SAP, prepared by the Monitoring Provider, to be available within 72 hours of the initiation criteria being met
• Consultation with relevant agencies to commence as soon as practicable after initiation criteria are met
• Field surveys to commence within 120 hours (5 days) of initiation criteria being met
Note: the initial SAP may be revised following consultation with relevant agencies and/or as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date
Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites</td></tr>
<tr><td>Monitoring Design</td><td>The following are monitoring designs recommended for different spill extents/behaviour; final design will be confirmed during preparation of the SAP by the Monitoring Provider.
<table>
<tr><th>Spill Extent / Behaviour</th><th>Monitoring Design</th></tr>
<tr><td>• Spill plume concentrated around source, dissipating with distance</td><td>• Gradient approach</td></tr>
<tr><td>• Spill plume has dissipated away from source</td><td>• Gradient approach
• Lines of Evidence</td></tr>
<tr><td>• Nearshore spill or spill reaches shoreline</td><td>• BACI (if appropriate baseline data available)
• IvC
• Gradient approach
• Lines of Evidence</td></tr>
<tr><td>• Spill interacts with area of biological importance (e.g. bay/shoal/island)</td><td>• BACI (if appropriate baseline data available)
• IvC
• Lines of Evidence</td></tr>
</table></td></tr>
</table>

Component	Description
Scope	Intertidal and coastal habitats covered by Study S4 include: • Mangroves • Saltmarsh • Macroalgae and seagrass (only those occurring in the intertidal zone) • Invertebrates (molluscs, crustaceans) and other rocky, muddy and sandy shore biota occurring in the intertidal zone • Shoreline/coastal areas Note: where Management Plans for protected area (e.g. Ramsar wetlands) exist, the SAP will include consideration of any specific sampling and/or values that require monitoring

Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study S4:
	• Ground / dive / snorkel / drop camera
	  ◦ Transects
	  ◦ Quadrats
	  ◦ Sediment grab (for soft-bottom habitat)
	• Remote sensing
	• Biological sample collection
	• Records of any damage or change due to response activities

Sampling Frequency	• Survey timing should coincide with that appropriate for the habitat and/or community of interest • Initial sampling frequency will be determined by during preparation of the SAP by the Monitoring Provider • Ongoing sampling frequency will be determined by the Monitoring Provider in consultation with the EMT Environment Leader following each monitoring and reporting event until termination criteria are met
Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study S4: • Parks Victoria Standard Operating Procedure for Biological Monitoring of Intertidal Reefs (Hart and Edmunds 2005) • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the SAP
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study S4: • Habitat/substrate type • Abundance and percent cover • Diversity • Distribution • State (e.g. evidence of stress, necrosis, leaf condition etc.) • Chemical analysis of tissue samples (e.g. TRH, BTEX, PAH, MAH) • Condition and quality of coastal environment (e.g. evidence of disturbance to sediment profile or environmental values from response [shoreline clean-up, oiled wildlife] activities)
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study S4: • Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018)
Reporting	• Data report to be provided to EMT Environment Leader following the completion of each field survey

Component	Description
	◦ The data report will also contain on-going trend analysis allowing for the tracking of impacts and recovery, identification/recommendations on any remediation works or active management (including changes to existing sampling or additional sampling required) that should be considered • Final impact assessment report (addressing impacts from spill event and any relevant response activities) to be provided to EMT Environment Leader following the termination criteria being met
Key Resources	• Monitoring Provider • Vessels (island access) • Vehicles (mainland access)
Key Competencies	• Monitoring Provider – Study Lead ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 10 years experience in environmental practice ◦ Familiarisation with relevant requirements of the OSMP and OPEP • Monitoring Provider – Field Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Experienced in the relevant sampling and/or recording techniques • Monitoring Provider – Office Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Experience in identification, analysis and interpretation of benthic habitat data • Vessel provider ◦ Certificate of survey with appropriate service category

5.6 Study S5: Marine fauna impact assessment

An overview of the key components of Study S5 are provided below:

Component	Description
Objective	Determine the impact to, and recovery of, marine fauna from oil exposure and/or any impacts associated with response activities
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the Study O4 has confirmed exposure to marine fauna **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• The EMT Environment Leader (or delegate) considers that disturbance parameters (e.g. population size, breeding success) have returned to within the expected natural dynamics of baseline state and/or control sites **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that protected marine fauna (i.e. threatened or migratory species) have not been impacted or have returned to within the expected natural dynamics of baseline state (including any assessment against management requirements in Conservation Advices and/or Recovery Plans) **and**

<table>
<tr><th>Component</th><th colspan="2">Description</th></tr>
<tr><td></td><td colspan="2">• Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring</td></tr>
<tr><td>Timing</td><td colspan="2">• Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 24 hours of initiation criteria being met
• An initial SAP, prepared by the Monitoring Provider, to be available within 72 hours of initiation criteria being met
• Consultation with relevant agencies to commence as soon as practicable after initiation criteria are met
• Field surveys to commence within 96 hours (4 days) of initiation criteria being met
Note: the initial SAP may be revised following consultation with relevant agencies and/or as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date
Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites</td></tr>
<tr><td rowspan="4">Monitoring Design</td><td colspan="2">The following are monitoring designs recommended for different spill extents/behaviour; final design will be confirmed during preparation of the SAP by the Monitoring Provider.</td></tr>
<tr><td>Spill Extent / Behaviour</td><td>Monitoring Design</td></tr>
<tr><td>• Spill reaches shoreline with known roosting/breeding/nesting/haul-out habitat</td><td>• BACI (if appropriate baseline data available)
• Control chart (if appropriate baseline data available)
• IvC
• Gradient approach
• Lines of Evidence</td></tr>
<tr><td>• Spill intersects with area of biological importance (e.g. foraging areas)</td><td>• BACI (if appropriate baseline data available)
• Control chart (if appropriate baseline data available)
• IvC
• Gradient approach
• Lines of Evidence</td></tr>
<tr><td>Scope</td><td colspan="2">Marine fauna covered by Study S5 include:
• Seabirds and shorebirds
• Marine megafauna (pinnipeds, reptiles, sharks, cetaceans)
Note: where Conservation Advice and/or Recovery Plans exist for protected marine fauna, the SAP will include consideration of any specific sampling and/or values that require monitoring</td></tr>
<tr><td>Sampling Technique</td><td colspan="2">Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study S5:
• Systematic surveillance (e.g. transects)
  ◦ Aerial observations from fixed-wing or helicopter
  ◦ Vessel-based observations
  ◦ On-ground shoreline observations
• Unmanned surveillance
  ◦ UAV and/or satellite
• Tissue sample collection and analysis
• Opportunistic / incidental observations
• Carcass collection and tissue sampling
• Records of any damage or change due to response activities</td></tr>
</table>

Component	Description
Sampling Frequency	• Survey timing should coincide with that appropriate for the marine fauna of interest • Initial sampling frequency will be determined by during preparation of the SAP by the Monitoring Provider • Ongoing sampling frequency will be determined by the Monitoring Provider in consultation with the EMT Environment Leader following each monitoring and reporting event until termination criteria are met
Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study S5: • Oil Spill Monitoring Handbook (Hook et al 2016) SOP will be confirmed by the Monitoring Provider during preparation of the SAP
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study S5: • Nest/burrow presence • Abundance (adults, juveniles, fledging/hatchling etc) • Density • Distribution • State (e.g. evidence of stress, oil cover, injured etc.) • Chemical analysis of tissue samples (e.g. TRH, BTEX, PAH, MAH) • Presence and state of any carcass
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study S4: • Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018)
Reporting	• Data report to be provided to EMT Environment Leader following the completion of each field survey ◦ The data report will also contain on-going trend analysis allowing for the tracking of impacts and recovery, identification/recommendations on any remediation works or active management (including changes to existing sampling or additional sampling required) that should be considered • Final impact assessment report (addressing impacts from spill event and any relevant response activities) to be provided to EMT Environment Leader following the termination criteria being met
Key Resources	• Monitoring Provider • Vessels • Aircraft • Vehicles • Analytical laboratory services

Key Competencies	• Monitoring Provider – Study Lead
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 10 years experience in environmental practice
	  ◦ Familiarisation with relevant requirements of the OSMP and OPEP
	• Monitoring Provider – Field Personnel
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 5 years experience in environmental practice
	  ◦ Experienced in the relevant sampling and/or recording techniques

Component	Description
	◦ Oiled, injured, and diseased fauna handling to be undertaken by trained personnel • Monitoring Provider – Office Personnel ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area ◦ Minimum 5 years experience in environmental practice ◦ Experience in identification, analysis and interpretation of biota data • Vessel provider ◦ Certificate of survey with appropriate service category • Analytical laboratory ◦ NATA accredited

5.7 Study S6: Fisheries impact assessment

An overview of the key components of Study S6 are provided below:

Component	Description
Objective	Determine the presence of, and recovery from, oil taint in commercially or recreationally important fish species and/or any impacts associated with response activities
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from Study O6 has confirmed the presence of fishing tainting **or** • Allegations of damage are received from commercial fisheries or government agencies **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• The EMT Environment Leader (or delegate) considers that: ◦ Fish or shellfish show no presence of tissue taint **or** ◦ PAH levels in fish and shellfish tissue have returned to within the expected natural dynamics of baseline state and/or control sites **or** ◦ PAH levels in fish and shellfish tissue are at or below regulatory levels of concern **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring
Timing	• Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 24 hours of initiation criteria being met • An initial SAP, prepared by the Monitoring Provider, to be available within 72 hours of initiation criteria being met • Consultation with relevant agencies to commence as soon as practicable after initiation criteria are met • Field surveys to commence within 120 hours (5 days) of initiation criteria being met Note: the initial SAP may be revised following consultation with relevant agencies and/or as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites
Monitoring Design	The following are monitoring designs recommended for different spill extents/behaviour; final design will be confirmed during preparation of the SAP by the Monitoring Provider. Spill Extent / Behaviour — Monitoring Design

Component	Description
	• Offshore spill — • Gradient approach • Lines of Evidence • Nearshore spill or spill reaches nearshore areas — • BACI (if appropriate baseline data available) • IvC • Gradient approach • Lines of Evidence
Sampling Techniques	Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study S6: • Systematic fish sample collection ◦ Olfactory evaluation ◦ Tissue collection • Opportunistic carcass collection and tissue sampling • Records of any damage or change due to response activities
Sampling Frequency	• Survey timing should coincide with that appropriate for the fish species of interest • Initial sampling frequency will be determined by during preparation of the SAP by the Monitoring Provider • Ongoing sampling frequency will be determined by the Monitoring Provider in consultation with the EMT Environment Leader following each monitoring and reporting event until termination criteria are met
Standard Operating Procedures	The following references are provided as guides for standard operating procedures that may be implemented under Study S5: • Oil Spill Monitoring Handbook (Hook et al 2016) • Managing Seafood Safety after an Oil Spill (Yender, Michel and Lord 2002) SOP will be confirmed by the Monitoring Provider during preparation of the SAP
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study S6: • Odour and appearance • Chemical analysis of tissue samples (e.g. TRH, BTEX, PAH, MAH) • Fish health indicators and biomarkers (e.g. liver enzymes, PAH metabolites)
Guidelines	The following references are provided as guidelines or thresholds that may be appropriate for comparison of results during Study O1: • Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters Quality (ANZG 2018) • Australia New Zealand Food Standards Code
Reporting	• Data report to be provided to EMT Environment Leader following the completion of each field survey ◦ The data report will also contain on-going trend analysis allowing for the tracking of impacts and recovery, identification/recommendations on any remediation works or active management (including changes to existing sampling or additional sampling required) that should be considered • Final impact assessment report (addressing impacts from spill event and any relevant response activities) to be provided to EMT Environment Leader following the termination criteria being met
Key Resources	• Monitoring Provider • Olfactory Analysis Panel • Vessels • Analytical laboratory services

Component	Description

Key Competencies	• Monitoring Provider – Study Lead
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 10 years experience in environmental practice
	  ◦ Familiarisation with relevant requirements of the OSMP and OPEP
	• Monitoring Provider – Field Personnel
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 5 years experience in environmental practice
	  ◦ Experienced in the relevant sampling and/or recording techniques
	• Monitoring Provider – Office Personnel
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 5 years experience in environmental practice
	  ◦ Experience in analysis and interpretation of biota data
	• Monitoring Provider – Olfactory Assessment Panel
	  ◦ Trained and/or experienced olfactory analysts
	• Vessel provider
	  ◦ Certificate of survey with appropriate service category
	• Analytical laboratory
	  ◦ NATA accredited

5.8 Study S7: Heritage and socioeconomic impact assessment

An overview of the key components of Study S7 are provided below:

Component	Description
Objective	Determine the impact to, and recovery of, heritage and socioeconomic features from oil exposure and/or any impacts associated with response activities
Initiation trigger	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the OPEP Monitor and Evaluate response strategy or Study O2 or O3 indicates potential and/or actual exposure to known areas of heritage or socioeconomic features **or** • Allegations of damage are received from other users (e.g. tourism operators, heritage groups) s or government agencies **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence
Termination trigger	• The EMT Environment Leader (or delegate) considers that considers that disturbance parameters (e.g. hydrocarbon visibility and concentration, condition/quality, area usage levels) have returned to within the expected natural dynamics of baseline state and/or control sites **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that heritage and/or socioeconomic features have not been impacted or have returned to within the expected natural dynamics of baseline state **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring

<table>
<tr><th>Component</th><th>Description</th></tr>
<tr><td>Timing</td><td>

Monitoring Provider/s will be activated (refer to the relevant OSMP Addendum for the petroleum activities) within 24 hours of initiation criteria being met
An initial SAP, prepared by the Monitoring Provider, to be available within 72 hours of initiation criteria being met
Consultation with relevant agencies to commence as soon as practicable after initiation criteria are met
Desktop and/or field surveys to commence within 96 hours (4 days) of initiation criteria being met

Note: the initial SAP may be revised following consultation with relevant agencies and/or as required due to the nature of an ongoing spill event, changing operational requirements and/or results from data collected to date
Note: timing of mobilisation and field surveys is dependent on safe operating conditions (e.g. weather, sea state, etc.) and operational access to sites
</td></tr>
<tr><td>Monitoring Design</td><td>
The following are monitoring designs recommended for different spill extents/behaviour; final design will be confirmed during preparation of the SAP by the Monitoring Provider.
<table>
<tr><th>Spill Extent / Behaviour</th><th>Monitoring Design</th></tr>
<tr><td>Offshore spill</td><td>Gradient approach
Lines of Evidence</td></tr>
<tr><td>Nearshore spill or spill reaches nearshore areas</td><td>IvC
Gradient approach
Lines of Evidence</td></tr>
</table>
</td></tr>
<tr><td>Scope</td><td>
Heritage and socioeconomic features covered by Study S7 include:

Cultural and heritage features (e.g. World, Commonwealth or National heritage listed places)
Indigenous heritage features (e.g. Indigenous Protected Areas, areas with artefacts or other cultural sensitivity)
Underwater cultural heritage features (e.g. shipwrecks, sunken artefacts)
Socioeconomic features (e.g. tourism and recreational activities, commercial shipping, other marine users)

Note: commercial fisheries are included within Study S6.
</td></tr>
<tr><td>Sampling Techniques</td><td>
Sampling techniques will vary depending on the individual event and final monitoring design. The following types of sampling may be implemented under Study S7:

Desktop assessment

Identification of heritage and/or socioeconomic features at risk based on direct or indirect change to ambient environmental conditions (e.g. water and sediment quality) or values
Notifications to any relevant government agencies (e.g. Heritage Victoria, Department of the Environment and Energy etc.) as required
Assessment of each affected feature and development of appropriate monitoring and management recommendations and develop appropriate

Field data collection

Visual inspection and records of any changes to condition, exposure to oil, changes in behaviour or use etc.
Systematic surveillance (e.g. transects) using aerial, vessel or on-ground observations as appropriate
Records of any damage or change due to response activities

</td></tr>
<tr><td>Sampling Frequency</td><td>

Initial sampling frequency will be determined by during preparation of the SAP by the Monitoring Provider

</td></tr>
</table>

Component	Description
	• Ongoing sampling frequency will be determined by the Monitoring Provider in consultation with the EMT Environment Leader following each monitoring and reporting event until termination criteria are met
Standard Operating Procedures	SOP for heritage and socioeconomic studies will be developed in consultation with the appropriate government agency with responsibility for protection of features
Parameters	Sampling parameters will vary depending on the individual event and final monitoring design. The following types of parameters may be analysed under Study S6: • Visual appearance • Condition (e.g. evidence of oil cover, damage etc.) • Use of parameters from other studies as required (e.g. water and sediment quality monitoring)
Guidelines	N/A
Reporting	• Data report to be provided to EMT Environment Leader following the completion of each desktop or field survey ◦ The data report will also contain on-going trend analysis allowing for the tracking of impacts and recovery, identification/recommendations on any remediation works or active management (including changes to existing sampling or additional sampling required) that should be considered • Final impact assessment report (addressing impacts from spill event and any relevant response activities) to be provided to EMT Environment Leader following the termination criteria being met
Key Resources	• Monitoring Provider • Vessels

Key Competencies	• Monitoring Provider – Study Lead
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 10 years experience in environmental practice
	  ◦ Familiarisation with relevant requirements of the OSMP and OPEP
	• Monitoring Provider – Socioeconomic and Heritage Specialist
	  ◦ Bachelor degree in environmental or social science from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 10 years experience in environmental/social practice
	  ◦ Experienced in interpretation and management of heritage, social and economic data
	• Monitoring Provider – Field Personnel
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 5 years experience in environmental practice
	  ◦ Experienced in the relevant sampling and/or recording techniques
	• Monitoring Provider – Office Personnel
	  ◦ Bachelor degree in environmental science/engineering from a recognised institution or equivalent tertiary study in technical area
	  ◦ Minimum 5 years experience in environmental practice
	  ◦ Experience in analysis and interpretation of heritage, social and economic data
	• Vessel provider
	  ◦ Certificate of survey with appropriate service category

6 References/Associated documents

1. AMSA. 2019. National Plan for Maritime Environmental Emergencies. Australian Maritime Safety Authority, Australian Government.

2. ANZG. 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments.

3. APPEA. 2019. (Draft) Joint Industry Operational and Scientific Monitoring Plan Framework. Australian Petroleum Production & Exploration Association.

4. API. 2013. Industry Recommended Subsea Dispersant Monitoring Plan. API Technical Report 1152. American Petroleum Institute, Washington, United States of America.

5. Beyers, D.W. 1998. Casual inference in environmental impact studies. Journal of the North American Benthological Society. 17: 367–373.

6. Downes, B.J., Barmuta, L.A., Fairweather, P.G., Faith, D.P., Keough, M.J., Lake, P.S., Mapstone, B.D., Quinn, G.P. 2002. Monitoring ecological impacts, concepts and practice in flowing waters. Cambridge University Press. Cambridge UK.

7. Edmunds, M. and Hart, P. 2005. Parks Victoria Standard Operating Procedure, Biological Monitoring of Subtidal Reefs. Parks Victoria Technical Series No. 9, Parks Victoria, Melbourne, Australia.

8. Fabricius, K.E., De'ath, G. 2004. Identifying ecological change and its causes: a case study on coral reefs. Ecological Applications. 14: 1448–1465.

9. Gotelli, N.J. and Ellison, A.M. 2004. A primer of Ecological Statistics. Sinauer Associates. Massachusetts, USA.

10. Hart, P. and Edmunds, M. 2005. Parks Victoria Standard Operating Procedure, Biological Monitoring of Intertidal Reefs. Parks Victoria Technical Series No. 21, Parks Victoria, Melbourne, Australia.

11. Hill, A.B. 1965. The environment and disease: association or causation? Proceedings of the Royal Society of Medicine. 58: 295–300.

12. Hook, S., Batley, G., Holloway, M., Irving, P. and Ross, A. (eds). 2016. Oil spill monitoring handbook. Commonwealth Scientific and Industrial Research Organisation (CSIRO) Publishing, Australia.

13. McArdle, B.H. 1996. Levels of evidence in studies of competition, predation and disease. New Zealand Journal of Ecology. 20: 7–15.

14. NOAA. 2006, Special Monitoring of Applied Response Technologies. National Oceanic and Atmospheric Administration, United States Department of Commerce. Accessed on 23 March 2018, https://response.restoration.noaa.gov/sites/default/files/SMART_protocol.pdf

15. NOPSEMA. 2016. Information Paper - Operational and scientific monitoring programs. Doc: N-04700-IP1349. National Offshore Petroleum Safety and Environmental Management Authority, Australian Government.

16. NOPSEMA. 2018. Guidance Note - Oil pollution risk management. Doc: GN1488. National Offshore Petroleum Safety and Environmental Management Authority, Australian Government.

17. NOPSEMA. 2019. Bulletin #1 – Oil Spill Modelling. Doc: A652993. National Offshore Petroleum Safety and Environmental Management Authority, Australian Government.

18. OSRL. 2015. Dispersant Application Monitoring Field Guide, Tier I Visual Observation. Oil Spill Response Limited, United Kingdom.

19. Safe Work Australia. 2018. Workplace Exposure Standards for Airborne Contaminants. Safe Work Australia, Canberra.

20. Simpson, S., Batley, G. and Chariton, A. 2013. Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO Land and Water Science Report 08/07. CSIRO Land and Water.

21. Suter, G.W., 1996. Abuse of hypothesis testing statistics in ecological risk assessment. Human and Ecological Risk Assessment: An International Journal 2: 331-347.

22. Underwood, A.J. 1991. Beyond BACI: experimental designs for detecting human environmental impacts on temporal variations in natural populations. Australian Journal of Marine and Freshwater Research 42: 569–587.

23. Underwood, A.J. 1994. On beyond BACI: sampling designs that might reliably detect environmental disturbances. Ecological Applications 4: 3–15.

24. US EPA. 2015. Acute and Chronic Screening Benchmarks for Water and Sediment Quality - EPA Response to BP Spill in the Gulf of Mexico. US Environmental Protection Agency. Available from: https://archive.epa.gov/emergency/bpspill/web/html/index.html. Accessed: June 2018.

25. US EPA. 2017. National Recommended Water Quality Criteria - Aquatic Life. US Environmental Protection Agency. Available from: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table. Accessed: June 2018.

26. Yender, R., J. Michel, and C. Lord. 2002. Managing Seafood Safety after an Oil Spill. Seattle: Hazardous Materials Response Division, Office of Response and Restoration, National Oceanic and Atmospheric Administration.

7 Document information and history

Revision History

Rev	Date	Changes made in document	Reviewer/s	Consolidator	Approver
0	19/06/2019	N/A	PW	GLE	TF
1	04/11/2019	Changes in response NOPSEMA RFFWI 5 September 2019	PW	Xodus	PW
2	19/12/2019	Changes in response NOPSEMA OMR 4 December 2019	PW	Xodus	PW
3	28/01/2020	Changes in response to NOPSEMA RFFWI 14 January 2020	PW	Xodus	PW
4	26/02/2020	Changes in response to NOPSEMA RFFWI 21 February 2020	PW	Xodus	PW

Appendix A Approaches for Scientific Monitoring Design

This appendix provides guidance (as provided in APPEA 2019) on survey design approaches that may be utilised for scientific monitoring:

- Impact versus Control (IvC)
- Gradient of Impacts
- Before-After-Control-Impact (BACI)
- Control Chart
- Lines of Evidence.

The design of monitoring studies should ensure, as far as possible, that the planned monitoring activities are practicable and that the objectives of the study will be met. The design must result in the collection of meaningful data and, where practicable, data that are sufficiently powerful to detect ecologically relevant changes.

The final survey design(s) can depend on a variety of factors, included but not limited to:

- Scale and pattern of potential effects of the spill
- Availability of baseline data and/or ability to rapidly obtain baseline data
- Time frame available to gather pre- and post-spill data
- Availability of operational monitoring data
- Availability of appropriate control sites
- Statistical approach proposed for data analysis
- Range of possible chronic and acute effects on the parameters of concern, based on the characteristics of the spill
- Monitoring frequency required to ensure short-and long-term impacts are detected
- Legislative requirements
- Available resources and equipment to conduct the work in terms of personnel, logistics, and access.

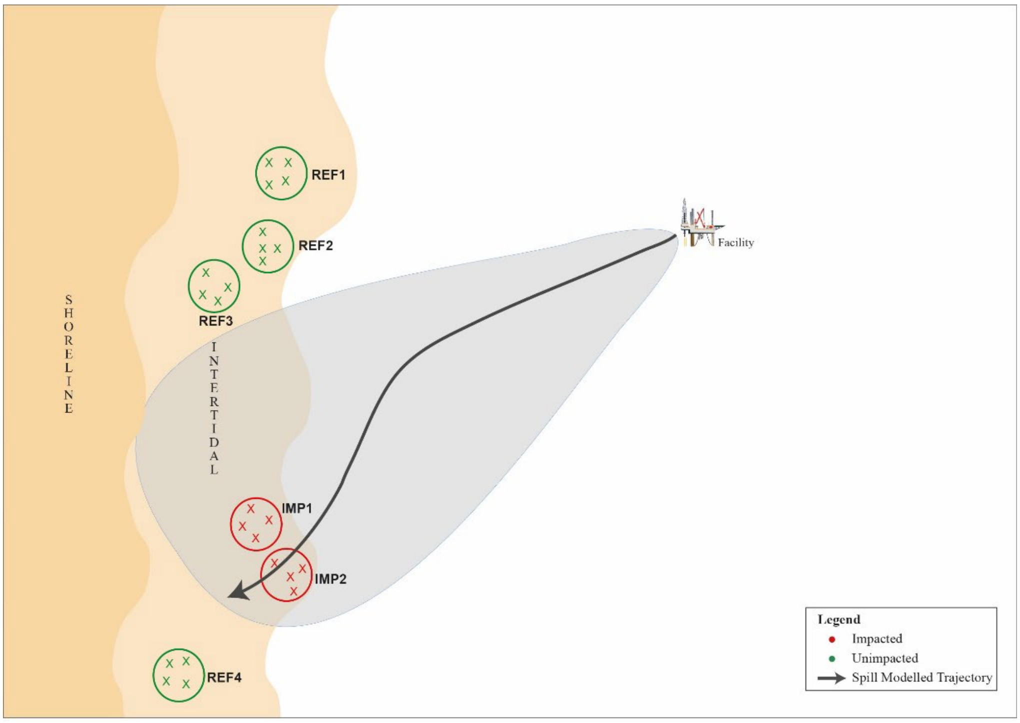
Note: data collection can depend on several constraints (as outlined above) and on access given logistical and safety constraints applicable to a spill event. Therefore, the survey designs recommended within the implementation guides for each scientific monitoring module, may not be able to be implemented exactly as intended. For example, there may be inadequate number of control sites because of the size of the spill and therefore data collected from an expected BACI design may need to be analysed as a gradient approach etc.

A. 1. Before-After-Control-Impact (BACI) approach

Where appropriate baseline data are available, consideration should be given to developing a beyond BACI monitoring program design (Underwood 1991; 1994) or similar extended BACI design (MBACI), which monitors a range of control and impact sites, and can do so over time (Figure A-1). Where robust, appropriate baseline data for exposure sites are not available, pre-exposure sampling of locations that lie within the hydrocarbon spill trajectory should be prioritised to obtain baseline data prior to hydrocarbon exposure.

Exposure sites should be selected first, encompassing a representative selection of locations within the area affected by hydrocarbons. Where practicable, the monitoring program design may consider stratified sampling along environmental gradients (e.g. level of hydrocarbon exposure etc.). Comparable control sites beyond the area affected by hydrocarbons should then be selected, with monitoring conducted at all sites. Clearly obtaining control sites pre-exposure can be challenging and is heavily reliant on predicting the extent of hydrocarbon movement.

The suggested statistical analysis of data collected using the BACI approach includes a univariate or multi-factorial analysis of variance (ANOVA) and equivalent non-parametric tests, all of which will compare between treatment (impact versus reference) and time (before versus after). Components of variation may help partition a sum of squares into different sources and describe the importance of factors within tests.



(Source: APPEA 2019)

Notes:

1. A modification to the beyond BACI design, is known as an MBACI design. MBACI designs incorporate multiple impact locations, whereas beyond BACI designs include only one impact location.
2. The above design consists of four reference/control locations and two impact locations, with four nested sites in each. The number of replicates (e.g. quadrats or transects) per site should be set based on resourcing, and /or the results of the power analysis (if applicable).
3. The area affected by the spill is indicated by the grey shaded area, or the area of influence.
4. Design assumes the area of influence has been affected equally.

Figure A-1: Example of an MBACI design for shoreline and/or intertidal communities

A. 2. Impact versus Control (IvC) approach

For some locations and receptors, baseline data may not exist, may not be recent and applicable, or was collected using methods that are unrepeatable in the current study. If there is a lack of baseline information that can feed into a BACI design, an IvC approach can be used to assess impacts. However, due to the unknown status of the parameter before impact, there is a higher likelihood of encountering Type I error (falsely concluding that an impact has occurred) with this approach. For example, if the status of the parameter to be measured was already naturally lower at impact sites than control sites before the impact occurred, but this was not measured, a conclusion may be reached using the IvC approach that an impact has occurred when it may be natural variation. For this reason, sampling designs should always try to collect or use baseline data (i.e. aim for a BACI design), and if an IvC design is used, it is important to ensure that the control sites are comparable to the impact sites in every way possible except for the presence or absence of the studied effect (hydrocarbon). This may include, but not be limited to, site physical aspect, substrate, current regimes, and community composition.

Because of the higher likelihood of Type I error, it is also useful to collect additional data on relevant physical environmental parameters that are likely to be different at impact and control sites and may affect the conclusion of the assessment. Biological information may also be relevant, such as degree of sub-lethal and lethal impacts to populations. These parameters can be examined later for any potential co-variance with the observed changes in the parameter of interest, to understand whether hydrocarbons or natural variation affected the outcome. The physical and biological information can therefore augment and act as additional evidence to help interpret conclusions from any IvC analyses. As with the BACI approach, when using the IvC approach it is important to understand the scale of natural variation that may affect the outcome of the assessment by replicating sites within sampling locations and replicating samples within each site.

The suggested statistical approach for analysing the data collected using the IvC approach is a multi-factorial ANOVA (to account for nested data), including PERMANOVA and non-parametric tests, to test whether the level of variation among treatments (IvC) is greater than the level of variation within treatments. Components of variation may help partition variance into different sources and help infer whether the effect of hydrocarbons or spatial variation was responsible for any detected change in the receptors.

A. 3. Gradient approach

The gradient approach can be used in some instances where a lack of suitable control sites prohibits using a BACI or IvC approach. Sampling should be established along a gradient of predicted effect (based on input of data from operational monitoring, surveillance or modelling), with sites established at various distances from the source of impact or along a gradient of magnitudes of concentrations of hydrocarbons. The gradient approach can also be used in combination with a BACI or IvC approach to help infer the cause of a detected impact and describe thresholds of impacts at which a response appears to have occurred. The gradient approach also provides a 'line of evidence' that the source of potential impact (hydrocarbons) was responsible for the observed effect, rather than natural variation. However, care should be taken to ensure awareness of any natural gradients in the parameter measured and take these into account when interpreting the data.

When designing a study using a gradient approach, relevant operational and scientific monitoring data (e.g. water and sediment quality), and modelling should be considered. Prior knowledge or prediction of the likely gradient of effect will greatly improve the efficiency of the sampling design by minimising the collection of data points that provide no additional information in the analysis (e.g. data points showing similar or no effects that do not help to characterise the gradient of effect), though noting these may aid in statistical power of gradient description so shouldn't necessarily be discouraged.

Typically, the level of observed impact will decline at distance from the source of a hydrocarbon release, with this decline likely to be exponential (i.e. large changes close to a release that quickly decrease in severity); therefore, sampling effort can be distributed along the gradient of effect in a way that best characterises the changes in the parameter measured.

If possible, multiple (> two) sites could be sampled at each distance along the gradient (if logistics and time permit) to provide an understanding of small-scale variation. Sites should also be sampled at distances where no environmental effect is predicted or observed, if possible, to characterise the full extent of the effect's gradient.

The suggested statistical analysis for the gradient approach includes correlation analysis between impact (measurements of hydrocarbon/stress; x-axis) and measurement parameter (biological response; y-axis), and associated regression analyses, may include least-squares regression line and hypotheses testing to determine if the trend is significantly different from zero.

A. 4. Control chart approach

The control chart approach is applicable in the following circumstances:

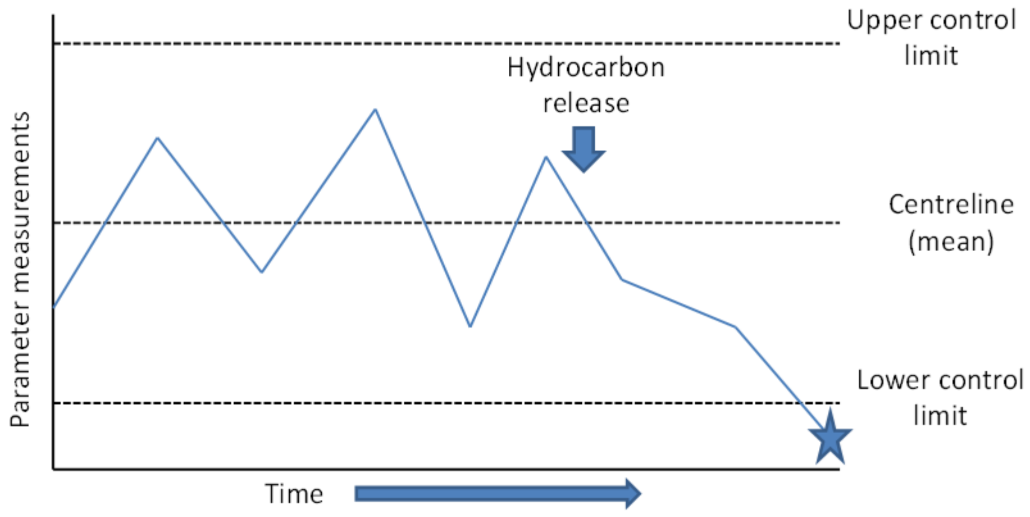
- When long-term (multi-year) datasets exist for the measured parameter;
- When a large amount of natural variation exists in the measured parameter;
- When predicting the expected range of outcomes from an impact.

One of the causal criteria described in the lines of evidence approach is 'strength of association' (Hill 1965), exemplified by a 'larger decline in individuals in areas affected by hydrocarbon than in control areas'. The control chart approach takes this causal criterion a step further and uses rules to establish whether a detected change in a parameter at impact sites is outside what would be expected to occur naturally. This technique requires tracking a parameter over time and determining whether an observed change is within the bounds of what has been observed to occur naturally at that impact site or at control sites.

A control chart has a central line for the mean, an upper control limit (UCL; e.g. typically 3 standard deviations [SD] above the mean), and a lower control limit (LCL; e.g. typically 3SD below the mean), which are typically all determined from historical data (Gotelli and Ellison 2004). The mean line can be constructed using data from i) historical data of an impact site prior to it being affected by hydrocarbons (i.e. what the mean used to be), or ii) control locations, whereby either historical or recent data is used for comparison to other sites (i.e. a control site historical data compared to impact site). The approach is then based on calculating the mean (ongoing) for an impact site to compare against the control chart. Any observations outside the UCL and LCL suggest that increased variation has been observed that are inconsistent with other data and may post a simple way to detect change in a system (Figure A-2).

In addition, if ongoing data collection is possible following a potential impact, the control chart approach can be used to examine the direction of change and whether this is consistent or inconsistent with other data. These data and interpretation may provide a weight of evidence of a directional change in a given parameter.

The control chart approach is only useful if there is an adequate knowledge of natural variability in a given parameter whether from historical sources or similar sites/locations. Control chart approaches can be a powerful tool for detecting impacts for systems that are naturally highly variable.



(Source: APPEA 2019)

Note: The star represents a measurement beyond the likely anticipated variation, which needs to be investigated.

Figure A-2: Example Control Chart showing Centreline (mean), Upper Control Limit (3 SD above mean), Lower Control Limit (3 SD below mean), and Measurements

A. 5. Lines of evidence approach

The lines of evidence approach is applicable in the following circumstances:

- Can be combined with any of the above monitoring designs to provide inferential evidence of an effect;
- Are useful to support evidence of effect if there are limited (or only one) impact locations;
- Are useful to support evidence of effect if the effect radiates outward from source;
- Are useful to infer cause of change if limited or no baseline data exist;
- Are useful to infer cause of change if limited or no control sites exist.

When a sampling design is suboptimal, or if conclusions from more formal tests are inconclusive, a lines of evidence approach can be used to help infer the cause of an observed change (i.e. attribute change to the hydrocarbon release or to other causes, such as natural variation). Within the lines of evidence approach, inference is developed based on carefully structured arguments. A weakness of this method is that the evidence may be largely circumstantial because it is based on correlations (Downes et al. 2002), which does not necessarily imply causation. Each causal argument may be weak when considered independently but combined they may provide strong circumstantial evidence and support for a conclusion (Downes et al. 2002).

This approach was originally developed in medicine (Hill 1965) but has been used more recently in ecological studies (e.g. Downes et al. 2002; McArdle 1996; Suter 1996; Beyers 1998; Fabricius 2004). Causal criteria have been developed for categorizing arguments from studies on disease on humans (Hill 1965), and these can be applied to ecological arguments (Hill 1965). With lines of evidence, there is a need to seek evidence not only to support the impact prediction, but evidence to rule out plausible alternative predictions, such as that the observed difference was due to natural processes (Downes et al. 2002; Beyers 1998).

In the lines of evidence approach, a set of descriptions should be developed for all or some of the causal criteria listed in Table A-1 before the survey is undertaken (see Downes et al. 2002 for further criteria and examples). Data would then be collected that allows each line of evidence to be tested or objectively questioned. The final assessment of whether an impact is likely to have occurred should be based on the 'weight of evidence' from examining multiple lines of evidence.

Example generalised lines of evidence descriptions are provided in Table A-2. These should be modified and tailored to individual scientific monitoring module, as required and each parameter investigated.

Table A-1: Causal criteria and description in the context of ecological impact Assessment

(Source: Hills 1965, in APPEA 2019)

Causal criterion	Description
Strength of association	A large proportion of individuals are affected in the impact area relative to control areas
Consistency of association	The association was observed by other investigators at other times and places
Specificity of association	The effect is diagnostic of exposure
Temporality	Exposure must precede the effect in time
Biological gradient	The risk of effect is a function of magnitude of exposure
Biological plausibility	A plausible mechanism of action links cause and effect
Experimental evidence	A valid experiment provides strong evidence of causation
Coherence	Similar stressors cause similar effects
Analogy	The causal hypothesis does not conflict with existing knowledge of natural history and biology

Table A-2: Causal criteria and example lines of evidence descriptions that could be used to assess whether a change in a measured parameter was due to the effects of a hydrocarbon release

(Source: APPEA 2019)

Causal criterion	Evidence supportive of a hydrocarbon release impact	Evidence unsupportive of a hydrocarbon release impact
Strength of association	Larger decline in individuals in areas affected by hydrocarbon than in control areas	Similar declines in individuals in areas affected by hydrocarbon and control areas
Consistency of association	Consistent finding of declines in a range of biota in areas affected by hydrocarbon	Inconsistent declines in biota in areas affected by hydrocarbon (e.g. declines in one species but not in other similar species)
Specificity of association	Number of individuals affected correlates with hydrocarbon concentrations	No correlation between number of individuals affected and hydrocarbon concentration
Temporality	Decline in individuals immediately preceded by contact with hydrocarbon	Decline in individuals occurred before or long after hydrocarbon contact

Causal criterion	Evidence supportive of a hydrocarbon release impact	Evidence unsupportive of a hydrocarbon release impact
Biological gradient	Changes in individuals aligned with exposure to hydrocarbon spills or concentrations	Decline in individuals occurs with increasing distance from a hydrocarbon spill or hydrocarbon concentrations
Biological plausibility	Evidence from literature of sensitivity to detected hydrocarbon concentration for species where declines are observed	Evidence from literature suggests lack of sensitivity to detected hydrocarbon concentration for species where declines are observed
Experimental evidence	A valid experiment provides strong evidence of causation	Not applicable (N/A)
Coherence	Evidence of a decline in species abundance, habitat, and food source with increasing hydrocarbon exposure	Evidence of a decline in species abundance, but no other evidence of expected declines associated with exposure
Analogy	Apparent declines in hatchling numbers despite no apparent decline in numbers of adults	Apparent declines in hatchling numbers associated with decreased numbers of adults

Appendix B Baseline Information

A database of known literature and studies relevant to environmental receptors within the Otway and Bass Basins that may provide suitable baseline data and/or contextual information in the event of a spill.

Source	Description	Relevant Scientific Monitoring Study
Group / Agency		
Birdlife Australia	Shorebirds 2020	S5: Marine fauna impact assessment
Parks Victoria	Signs of Healthy Parks program, including:	
	• Subtidal Reef Monitoring Program ◦ Popes Eye Component of the Port Phillip Heads MNP ◦ Reef Biota at Beware Reef Marine Sanctuary ◦ Reef Biota at Bunurong Marine National Park and Surrounding Coast ◦ Reef Biota at Eagle Rock Marine Sanctuary ◦ Reef Biota at Jawbone Marine Sanctuary ◦ Reef Biota at Marengo Reefs Marine Sanctuary ◦ Reef Biota at Marine Protected Areas in the Twofold Shelf region ◦ Reef Biota at Merri Marine Sanctuary ◦ Reef Biota at Phillip Island ◦ Reef Biota at Point Addis Marine National Park ◦ Reef Biota at Port Phillip Bay Marine Sanctuaries ◦ Reef Biota at Port Phillip Heads Marine National Park ◦ Reef Biota at Ricketts Point Marine Sanctuary ◦ Reef Biota at Wilsons Promontory Marine National Park ◦ Reef Biota on the Western Victorian Coast ◦ Reef Biota within the Twofold Shelf Bioregion ◦ Reef Surveys at Twelve Apostles Marine National Park and The Arches Marine Sanctuary ◦ The Reef Biota at Point Cooke Marine Sanctuary ◦ Western Victorian Coast	S3: Subtidal habitats impact assessment
	• Intertidal Reef Monitoring Program ◦ Intertidal Reef Biota of Central Victoria's Marine Protected Areas ◦ Intertidal Reef Biota of Northern Port Phillip Bay Marine Sanctuaries ◦ Reef biota in Central Victoria and Port Phillip Bay Marine Sanctuaries	S4: Intertidal and coastal habitats impact assessment
	• Shallow Water Habitat Mapping at Victorian Marine National Parks and Marine Sanctuaries ◦ Eastern Victoria ◦ Western Victoria	S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment

Source	Description	Relevant Scientific Monitoring Study
	• Mapping the Benthos in Victoria's Marine National Parks ◦ Cape Howe Marine National Park ◦ Discovery Bay Marine National Park ◦ Point Addis Marine National Park ◦ Point Hicks Marine National Park ◦ Twelve Apostles Marine National Park	S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment
	• Reef Life Survey	S3: Subtidal habitats impact assessment
	• Community-based monitoring programs, including: ◦ Intertidal Rocky Shore Monitoring ◦ Seagrass Monitoring ◦ Subtidal Reef Monitoring	S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment
	• Marine Natural Values Study, including: ◦ Marine Protected Areas of the Otway Bioregion ◦ Marine Protected Areas of the Central Victoria Bioregion ◦ Marine Protected Areas of the Victorian Embayments Bioregion ◦ Marine Protected Areas of the Victorian Embayments Bioregion ◦ Marine Protected Areas of the Flinders and Twofold Shelf Bioregions	S1: Water quality S2: Sediment quality S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment
	Other publications, including:	
	• Marine Habitat Mapping Project	S3: Subtidal habitats impact assessment
	• Species diversity and composition of benthic infaunal communities found in Marine National Parks along the outer Victorian coast	S4: Intertidal and coastal habitats impact assessment
	• Managing Hooded Plover in Victoria	S5: Marine fauna impact assessment
	• Birds as Environmental Indicators	S5: Marine fauna impact assessment
	• Rocky Shores of Marine National Parks and Sanctuaries on the Surf Coast Shire – Values, uses and impacts	S4: Intertidal and coastal habitats impact assessment
	• Identification of threats to natural values in Victoria's Marine National Parks and Marine Sanctuaries	S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment
	• Monitoring the macroinvertebrates and soft sediments in the Marine National Parks in Western Port	S4: Intertidal and coastal habitats impact assessment
	• Mud Islands Seagrass and Coastline Mapping 2011-12	S4: Intertidal and coastal habitats impact assessment
	• Yaringa and French Island MNP Habitat Mapping	S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment

Source	Description	Relevant Scientific Monitoring Study
Victorian National Parks Association	Reefwatch	S3: Subtidal habitats impact assessment
Journals		
Deep-Sea Research Part II: Topical Studies in Oceanography	McCauley, R. D., A. N. Gavrilov, C. D. Jolliffe, R. Ward, and P. C. Gill. (2018). Pygmy blue and Antarctic blue whale presence, distribution and population parameters in southern Australia based on passive acoustics. Deep-Sea Research Part II: Topical Studies in Oceanography 157-158: 154-168	S5: Marine fauna impact assessment
Marine Ecology Progress Series	Bruce, B. D., D. Harasti, K. Lee, C. Gallen & R. Bradford. (2019). Broad-scale movements of juvenile white sharks Carcharodon carcharias in eastern Australia from acoustic and satellite telemetry. *Marine Ecology Progress Series*, 619: 1-15	S5: Marine fauna impact assessment
	Gill, P.C., M.G. Morrice, B. Page, R. Pirzl, A.H. Levings and M. Coyne (2011). Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. Marine Ecology Progress Series, 421: 243–263.	S5: Marine fauna impact assessment
Marine Mammal Science	Kirkwood, R., Warneke, R.M., Arnould. J.P. (2009). Recolonization of Bass Strait, Australia, by the New Zealand fur seal, Arctocephalus forsteri. Marine Mammal Science 25(2): 441 –449	S5: Marine fauna impact assessment
The Journal of Wildlife Management	Gill, P.C., R. Pirzl, M.G. Morrice & K. Lawton (2015). Cetacean diversity of the continental shelf and slope off southern Australia. The Journal of Wildlife Management.	S5: Marine fauna impact assessment
Universities		
Curtin University Centre for Marine Science	Gavrilov, A. (2012). Seismic signal transmission, pygmy blue whale abundance and passage and ambient noise measurements during and after the Bellerive seismic survey in Bass Strait, 2011, Curtin University centre for Marine Science	S5: Marine fauna impact assessment

Addendum

CDN/ID 18985299

Operational and Scientific Monitoring Plan

Offshore Victoria

Addendum 2: BassGas Operations

Rev	Date	Reason for issue	Reviewer/s	Consolidator	Approver
1	30/09/2020	Issued for NOPSEMA assessment (based on Artisan-1 Rev 4)	PW	Aventus	PW
0	30/07/2020	Issued for internal review	PW	Aventus	PW

Review due	Review frequency
Annually from date of acceptance	1 year

THE THREE WHATS

What can go wrong?

What could cause it to go wrong?

What can I do to prevent it?

Table of Contents

Figures

Tables

Appendices

1 Introduction

1.1 Purpose

This document is an addendum to the Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) (CDN/ID S4100AH717908) relevant to BassGas operations and provides a description of the following:

- Worst-case hydrocarbon spill scenarios;
- Matters of national environmental significance (MNES) within the environment that may be affected (EMBA) and predicted oil exposure from stochastic spill modelling;
- Environmental values and sensitivities of key areas within the EMBA and the operational and scientific monitoring studies that may be relevant to these areas;
- Priority planning areas for scientific studies; and
- Environmental monitoring implementation plan.

1.2 Timing

BassGas operations (the extraction and processing of gas at the Yolla-A platform) have been ongoing since 2006.

1.3 Environment that May Be Affected

The EMBA has been defined as an area where a change to ambient environmental conditions may potentially occur as a result of an unplanned hydrocarbon spill. A thorough description of the environmental sensitivities and values of the EMBA is presented in Chapter 5 of the BassGas Operations Environment Plan (EP) (CDN/ID 3972814).

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. The EMBA for BassGas operations, as defined in the BassGas Operations EP, is shown in Figure 1.1.

1.4 Spill Scenarios

Three credible worst-case spill scenarios were modelled for BassGas operations:

- A loss of well control (LoWC) at Yolla-A of 204,250 bbl/day for 86 days;
- A loss of containment (LoC) from the offshore raw gas pipeline of 3,144.9 bbl of gas condensate over 57.6 minutes at the 3 nm State/Commonwealth waters boundary; and
- A release of marine diesel oil (MDO) from a vessel fuel tank (300 m^3) over 6 hours as a result of a vessel collision at the 3 nm State/Commonwealth waters boundary.

A summary of the predicted exposure of MNES to hydrocarbons within the EMBA is provided in Section 2.1. For a summary of all other stochastic modelling outcomes, refer to Chapter 7 of the BassGas Operations EP. The spatial extent of predicted exposure from the stochastic modelling for the spill scenarios is shown in Figure 1.2, Figure 1.3 and Figure 1.4.

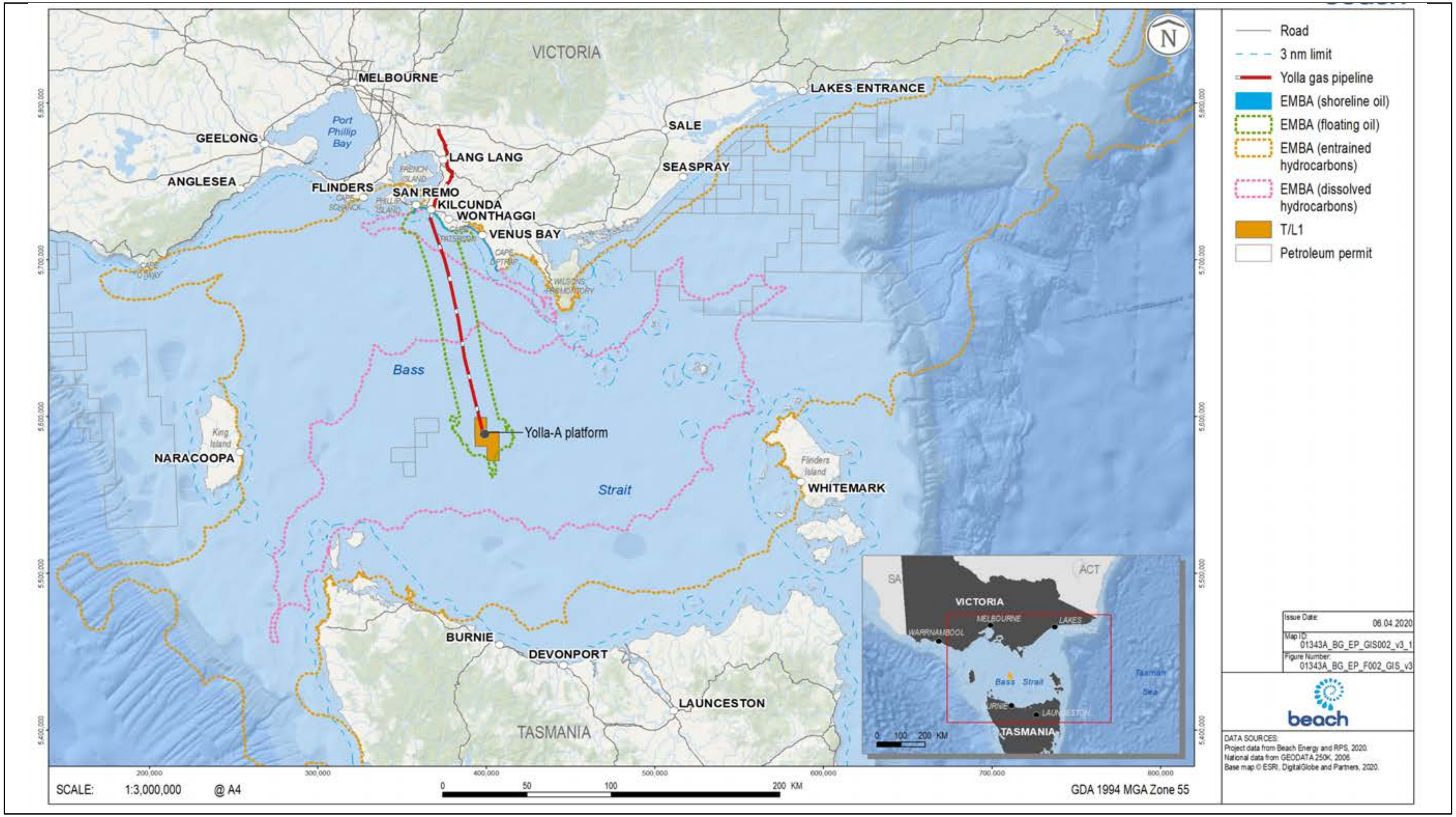


Figure 1.1. BassGas EMBA

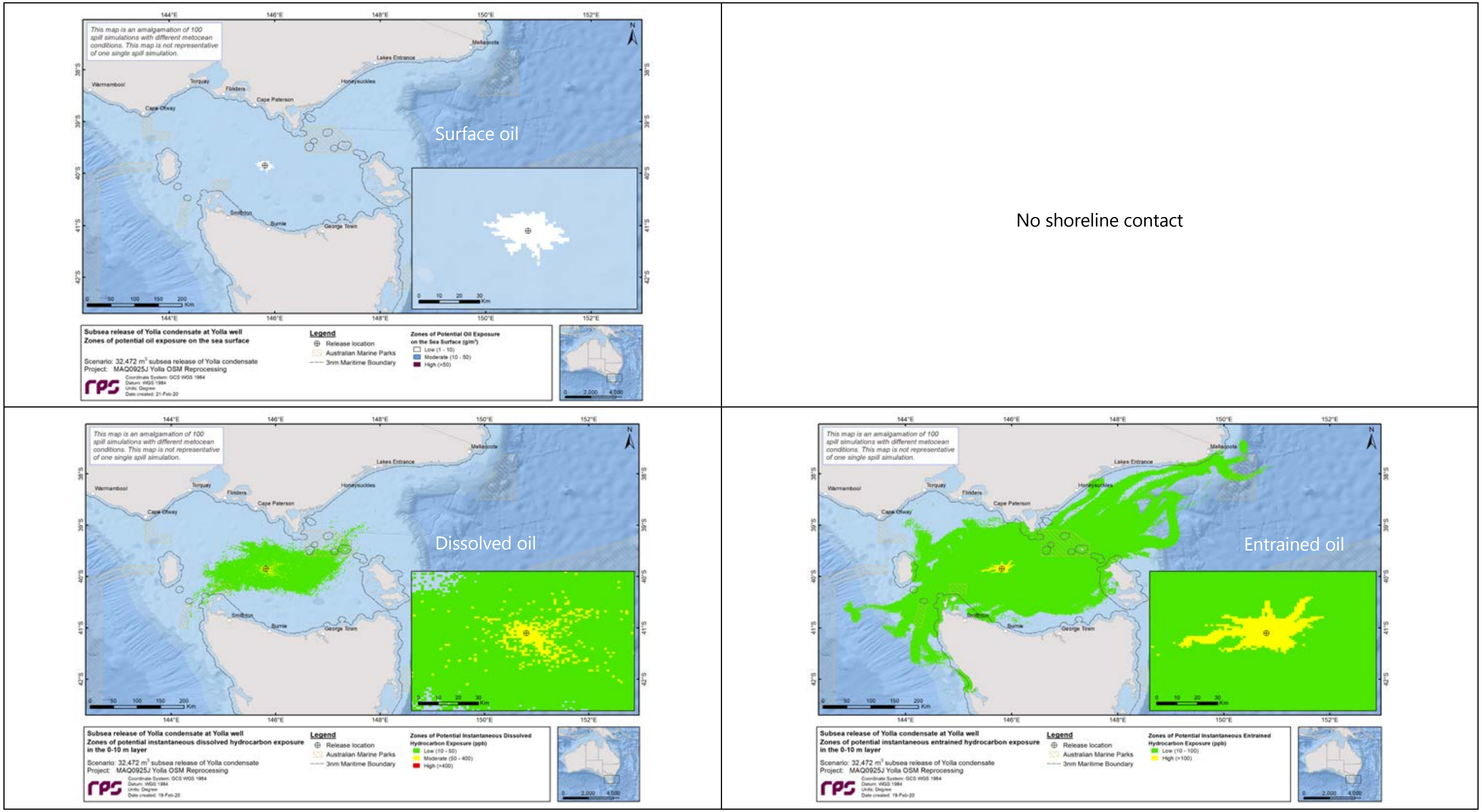


Figure 1.2. EMBA for LoWC

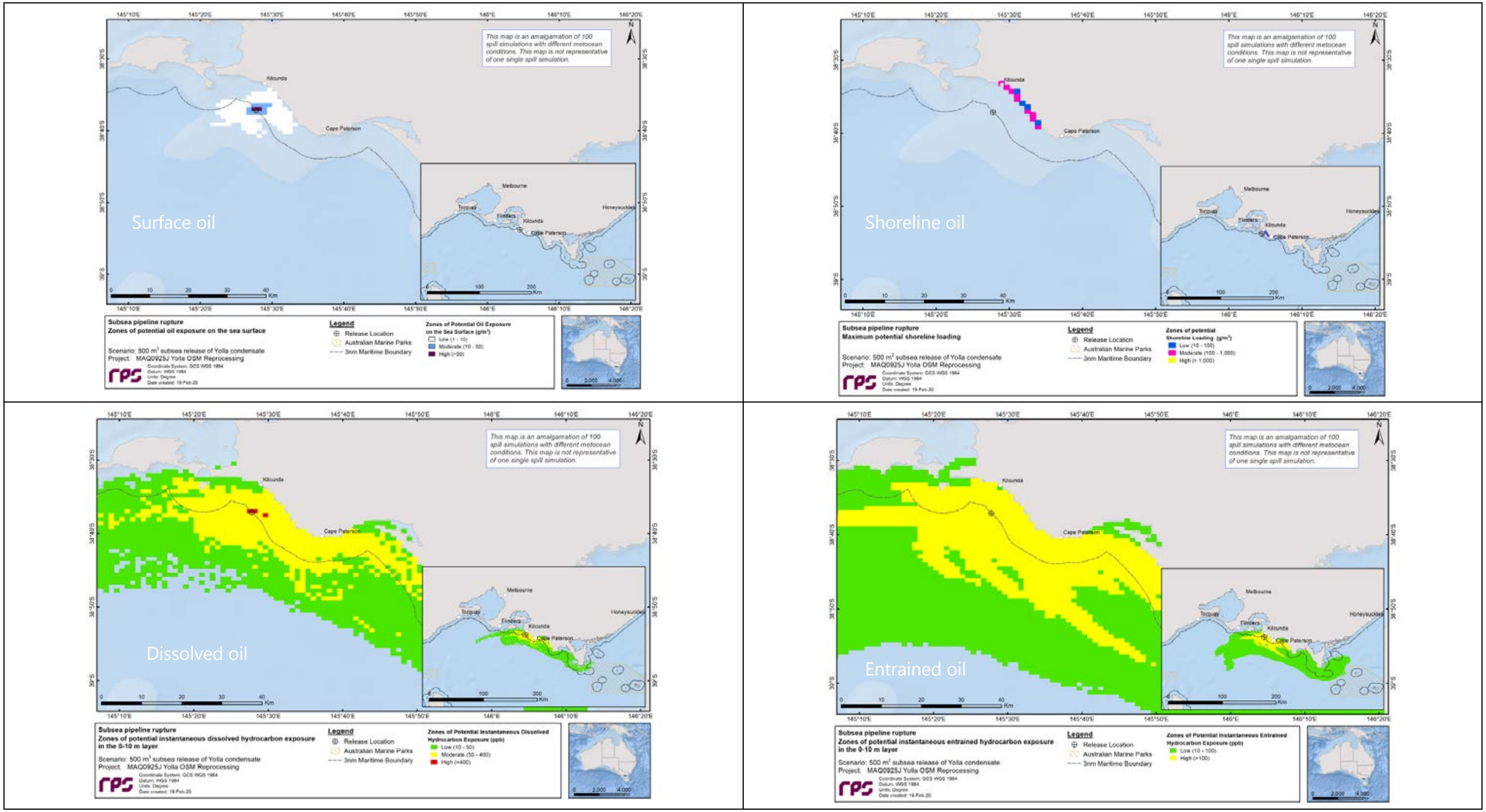


Figure 1.3. EMBA for LoC from the raw gas pipeline

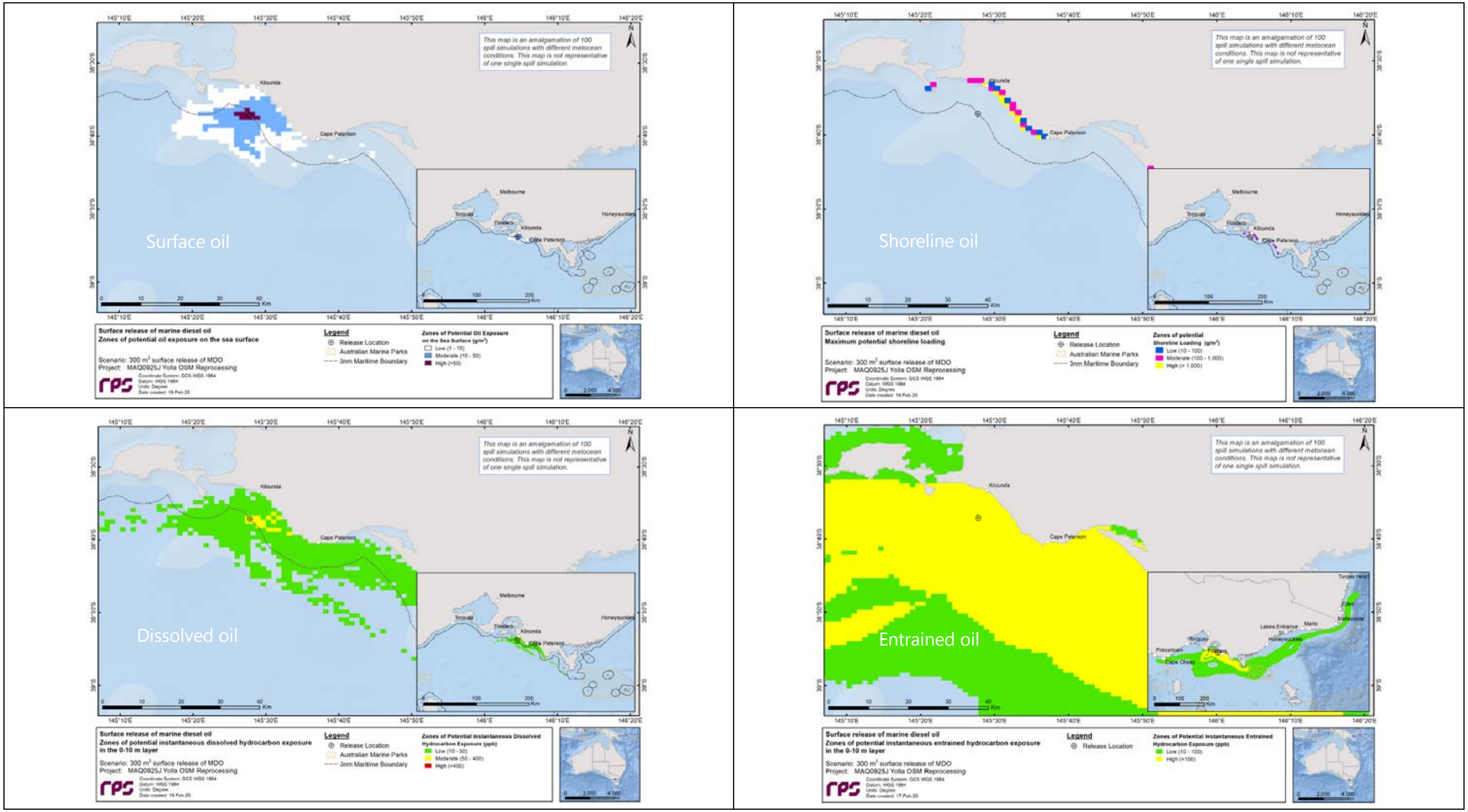


Figure 1.4. EMBA for MDO spill

2 Environmental Values and Sensitivities

The information presented in this section is based on spatial extents of stochastic spill modelling (Section 1.4) and/or the EMBA and the MNES and other environmental features identified within the BassGas Operations EP (Chapter 5). The information is presented here as context for spill monitoring awareness and planning. It does not restrict the implementation of any monitoring of MNES (or other) features that may be affected by an actual spill event that are beyond the area of predicted oil exposure (i.e., once the relevant initiation criteria are met for an operational and/or scientific study, these can be implemented irrespective of previous modelling outcomes).

2.1 Operational and Scientific Studies

Table 2.1 lists the operational and scientific studies that are described in detail in the Offshore Victoria OSMP.

Study	
Operational monitoring	
O1	Oil characterisation and behaviour
O2	Water quality
O3	Sediment quality
O4	Marine fauna surveillance
O5	Dispersant efficacy
O6	Fish tainting
Scientific monitoring	
S1	Water quality impact assessment
S2	Sediment quality impact assessment
S3	Subtidal habitats impact assessment
S4	Intertidal and coastal habitats impact assessment
S5	Marine fauna impact assessment
S6	Fisheries impact assessment
S7	Heritage and socioeconomic impact assessment

2.2 Predicted Hydrocarbon Exposure to MNES

Table 2.2 lists MNES that are known to occur within the EMBA and if there is predicted hydrocarbon exposure at or above low thresholds from the worst-case spill scenarios. It is noted that these low thresholds are not always relevant to levels associated with potential impacts, however, may represent a change in ambient environmental conditions.

Table 2.2. Matters of National Environmental Significance within the EMBA

MNES	Marine and/or coastal MNES features/species within the EMBA	Predicted MDO exposure				Predicted condensate exposure			
		Shoreline	Surface	Entrained	Dissolved	Shoreline	Surface	Entrained	Dissolved
World Heritage Properties	None present	–	–	–	–	–	–	–	–
National Heritage Places	The Western Tasmania Aboriginal Cultural Landscape	×	×	×	×	×	×	✓	×
Wetlands of International Importance (Ramsar wetlands)	Corner Inlet	×	×	✓	×	×	×	×	×
	Western Port	×	×	✓	×	×	×	✓	✓
	Gippsland Lakes	×	×	×	×	×	×	✓	×
	Lavinia (King Island)	×	×	×	×	×	×	✓	×
Threatened Ecological Communities (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	×	×	✓	×	×	×	✓	✓
	Subtropical and Temperate Coastal Saltmarsh	×	×	✓	×	×	×	✓	×
Threatened Species	Various	✓	✓	✓	✓	✓	✓	✓	✓
Migratory Species	Various	✓	✓	✓	✓	✓	✓	✓	✓
Commonwealth Marine Areas	Apollo Australian Marine Park (AMP)	×	×	✓	×	×	×	×	×
	Boags AMP	×	×	×	×	×	×	✓	✓
	Beagle AMP	×	×	✓	×	×	×	✓	✓
	Franklin AMP	×	×	×	×	×	×	✓	✓
	East Gippsland AMP	×	×	×	×	×	×	✓	×
	Upwelling East of Eden Key Ecological Feature (KEF)	×	×	×	×	×	×	✓	×
	West Tasmanian Canyons KEF	×	×	×	×	×	×	✓	×

MNES	Marine and/or coastal MNES features/species within the EMBA	Predicted MDO exposure				Predicted condensate exposure			
		Shoreline	Surface	Entrained	Dissolved	Shoreline	Surface	Entrained	Dissolved
	Big Horseshoe Canyon KEF	×	×	×	×	×	×	✓	×
	Canyons of the eastern continental slope KEF	×	×	×	×	×	×	✓	×
Great Barrier Reef Marine Park	None present	–	–	–	–	–	–	–	–
Nuclear Actions	None present	–	–	–	–	–	–	–	–
Water Resources	None present	–	–	–	–	–	–	–	–

2.3 Monitoring studies relevant to key areas within the EMBA

Table 2.3 provides a summary of environmental values and sensitivities of identified key areas within the EMBA. Key areas are determined to be:

- AMPs;
- Wetlands of International Importance (Ramsar wetlands);
- TECs;
- Threatened or migratory species with a spatially defined biologically important area (BIA;
- KEFs; and
- Other protected areas, including State protected marine and terrestrial areas, nationally important wetlands and heritage sites.

The description of values and sensitivities is summarised from the Existing Environment (Chapter 5) of the BassGas Operations EP.

Table 2.3. Environmental values and sensitivities of key areas within the EMBA that may be exposed to oil

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Australian Marine Parks			
Apollo AMP	• 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 crested tern. • Cultural and heritage site - wreck of the *MV City of Rayville.*	South-east Commonwealth Marine Reserves Network Management Plan 2013-2023	O2: Water quality S1: Water quality impact assessment S5: Marine fauna impact assessment
Beagle AMP	• 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.*	South-east Commonwealth Marine Reserves Network Management Plan 2013-2023	O2: Water quality O4: Marine fauna surveillance S1: Water quality impact assessment S5: Marine fauna impact assessment
Boags AMP	• Important foraging area for shy albatross, Australasian gannet, short-tailed shearwater, fairy prion, black-faced cormorant, common diving petrel and little penguins. • Located close to seabird breeding colonies on the nearby Hunter group of islands. • Ecosystems, habitats and communities associated with the IMCRA Bass Strait Shelf Province including sea floor plateau and tidal sandwave/sandbank.	South-east Commonwealth Marine Reserves Network Management Plan 2013-2023	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S5: Marine fauna impact assessment

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Franklin AMP	• Important feeding grounds for seabirds including species of albatross, petrel, shearwater and cormorant. • Located close to seabird breeding colonies on the nearby Hunter group of islands. • Great white sharks are known to forage in the reserve.	South-east Commonwealth Marine Reserves Network Management Plan 2013-2023	O2: Water quality S1: Water quality impact assessment S5: Marine fauna impact assessment
East Gippsland AMP	• Mixing of warm and temperate waters in the reserve creates habitat for phytoplankton. • Oceanic birds including albatrosses, petrels and shearwaters are known to foraging in the AMP. • Humpback whales pass through the reserve during their north and south migration.	South-east Commonwealth Marine Reserves Network Management Plan 2013-2023	O2: Water quality S1: Water quality impact assessment S5: Marine fauna impact assessment
State Marine Protected Areas			
Victoria (Marine National Parks)			
Bunurong Marine National Park (MNP)	• Extensive intertidal rock platforms and subtidal rocky reefs. • 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. • Highest diversity of intertidal and shallow subtidal invertebrate fauna recorded in Victoria on sandstone. • Important coastal habitat for several threatened species.	Bunurong MNP Management Plan	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Churchill Island MNP	• Within the park are numerous marine habitats including mangroves, sheltered intertidal mudflats, seagrass beds, subtidal soft sediments and rocky intertidal shores. • This MNPis part of the Western Port Ramsar site.	N/A (refer to Western Port Ramsar Site Management Plan)	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
	• 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.		S2: Sediment quality impact assessment S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Wilsons Promontory MNP	• 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. • 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. • Seascape, cultural places and objects of high traditional and cultural significance to Indigenous people. • Historic shipwrecks.	Wilsons Promontory MNP and Wilsons Promontory Marine Park Management Plan	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Point Hicks MNP	• A diversity of habitats, including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches. • A very high diversity of fauna, including intertidal and subtidal invertebrates. • Co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters. • Transient reptiles from northern waters, including turtles and sea snakes. • Threatened fauna, including whales and several bird species. • Outstanding landscapes, seascapes and underwater scenery. • Outstanding active coastal landforms, such as granite reefs and mobile sand dunes.	Point Hicks MNP Management Plan	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Cape Howe MNP	• Diversity of habitats including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches. • Co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters. • Marine mammals such as whales, dolphins, Australian fur-seals and New Zealand fur-seals. • Transient reptiles such as green turtles from northern waters. • Threatened fauna including whales and birds. • Foraging area for a significant breeding colony of Little Penguins from neighbouring Gabo Island. • Outstanding active coastal landforms within and adjoining the park, such as granite and sandstone reefs. • Victoria's most easterly MNP abutting one of only three wilderness zones on the Victorian coast. • Outstanding opportunities to build knowledge of marine protected areas and their management, and to further understand marine ecological function and changes over time.	Cape Howe MNP Management Plan	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Victoria (Marine Sanctuaries)			
Marengo Reefs Marine Sanctuary	• 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. • Historic shipwrecks. • Tourism and recreational activities including snorkelling and seal watching.	Marengo Reefs Marine Sanctuary Management Plan	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Mushroom Reef Marine Sanctuary	• Subtidal pools and boulders in the intertidal area that provide a high complexity of intertidal basalt substrates and a rich variety of microhabitats. • A range of reef habitats that support diverse and abundant flora including kelps, other brown, green and red algae; invertebrates including gorgonian fans, seastars, anemones, ascidians, barnacles and soft corals; and sedentary and migratory fish species.	Mushroom Reef Marine Sanctuary Management Plan	

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
	• Sandy bottoms habitats that support large beds of *Amphibolis* seagrass and patches of green algae. • Intertidal habitats that support resident and migratory shorebird species including threatened species. • Culturally important areas for the Boonwurrung people. • Recreational activities including diving and snorkelling.		
Tasmania (Marine Reserves)			
Arthur Bay Conservation Area	• Coastal and marine protected area on the west coast of Flinders Island. • Shallow marine area likely contains rocky reef sites and coastal interface used as habitat for marine fauna.	N/A	O2: Water quality S1: Water quality impact assessment S2: Sediment quality impact assessment S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Kent Group Marine Reserve	• Stronghold for fish species including violet roughy, mosaic leatherjacket, wilsons weedfish and maori wrasse. • Seagrass beds found at Murray Pass up to 20 m water depth. • Sponge gardens and stony coral found in 40 m water depths.	N/A	
State Terrestrial Protected Areas			
Victoria (National Parks)			
French Island National Park	• Land-based protected areas with a coastal interface that may be used as habitat for marine fauna (birds, pinnipeds, etc). • Where access is allowed, recreational activities may be present.	French Island National Park Management Plan	O3: Sediment quality O4: Marine fauna surveillance S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Great Otway National Park		Great Otway National Park and Otway Forest Park Management Plan	
Mornington Peninsula National Park		Mornington Peninsula National Park and Arthurs Seat State Park Management Plan	
Croajingolong National Park		Croajingolong National Park Management Plan	
Wilsons Promontory National Park		Wilsons Promontory National Park Management Plan	

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Victoria (Conservation, Nature, Wildlife Reserves)			
Cape Liptrap Conservation Park	• Mainland-based protected areas with a coastal interface that may be used as habitat for marine fauna (birds, pinnipeds etc) • Where access is allowed, recreational activities may be present	Cape Liptrap Coastal Park Management Plan	O3: Sediment quality O4: Marine fauna surveillance S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Flinders Foreshore Coastal Reserve		Flinders Foreshore Coastal Reserve Management Plan	
Western Port Intertidal Reserve		N/A (refer to Western Port Ramsar Site Management Plan)	
San Remo Coastal Reserve		San Remo Coastal Reserve Management Plan	
Punchbowl Coastal Reserve		N/A	
Phillip Island Nature Park		Phillip Island Nature Parks Management Plan	
Kilcunda – Harmers-Haven Coastal Reserve		N/A (refer to Bunurong Marine National Park, Bunurong Marine Park, Bunurong Coastal Reserve and Kilcunda-Harmers Haven Coastal Reserve Management Plan)	
Reef Island and Bass River Mouth Nature Conservation Reserve		N/A	
Shallow Inlet Marine and Coastal Park		N/A	
Gippsland Lakes Coastal Park		Lakes National Park & Gippsland Lakes Coastal Park Management Plan	
Cape Conran Coastal Park		Cape Conran Coastal Park Management Plan	

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Tasmania			
Councillor Island Nature Reserve	• Island-based protected areas with a coastal interface that may be used as habitat for marine fauna (birds, pinnipeds etc) • Where access is allowed, recreational activities may be present. However due to remoteness, recreation may be limited.	N/A	O3: Sediment quality O4: Marine fauna surveillance S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Albatross Island Nature Reserve		Small Bass Strait Islands Reserve Management Plan	
Petrel Islands Game Reserve		N/A	
Nares Rocks Conservation Area		N/A	
Three Hummock Island State Reserve		N/A	
Hunter Island Conservation Area		N/A	
Harbour Islets Conservation Area		N/A	
Henderson Islets Conservation Area		N/A	
Seacrow Islet Conservation Area		N/A	
Bird Island Game Reserve		N/A	
Stack Island Game Reserve		N/A	
The Doughboys Nature Reserve		N/A	
Bull Rock Conservation Area		N/A	

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Boxen Island Conservation Area		N/A	
Goose Island Conservation Area		N/A	
Badger Island Indigenous Protection Area		N/A	
Mount Chappell Island Indigenous Protected Area		N/A	
Big Green Island Nature Reserve		N/A	
East Kangaroo Island Nature Reserve		N/A	
Chalky Island Conservation Area		N/A	
Isabella Island Nature Reserve		N/A	
Prime Seal Island Conservation Area		N/A	
Pasco Group Conservation Area		N/A	
Roydon Island Conservation Area		N/A	
Sentinel Island Conservation Area		N/A	
Sister Islands Conservation Area		N/A	

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Curtis Island Nature Reserve		N/A	
Devils Tower Nature Reserve		N/A	
Craggy Island Conservation Area		N/A	
East Moncoeur Island Conservation Area		N/A	
West Moncoeur Island Nature Reserve		Small Bass Strait Islands Reserve Management Plan	
Hogan Group Conservation Area		N/A	
Cone Islet Conservation Area		N/A	
North East Islet Nature Reserve		N/A	
Rodondo Island Nature Reserve		Small Bass Strait Islands Reserve Management Plan	
Sugarloaf Rock Conservation Area		N/A	
Lavinia State Reserve	• Mainland-based (including King Island and Flinders Island) protected areas with a coastal interface that may be used as habitat for marine fauna (birds, pinnipeds etc) • Where access is allowed, recreational activities may be present	Lavinia State Reserve Management Plan	O3: Sediment quality O4: Marine fauna surveillance S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment
Sea Elephant Conservation Area		N/A	
City of Melbourne Bay Conservation Area		N/A	

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Calm Bay State Reserve		N/A	S7: Heritage and socioeconomic impact assessment
Slaves Bay Conservation Area		N/A	
West Point State Reserve		N/A	
Arthur-Pieman Conservation Area		Arthur-Pieman Conservation Area Management Plan	
Four Mile Beach Regional Reserve		N/A	
Mount Heemskirk Regional Reserve		N/A	
Ocean Beach Conservation Area		N/A	
The Nut State Reserve		The Nut State Reserve Management Plan	
Tatlows Beach Conservation Area		N/A	
Rocky Cape National Park		Rocky Cape National Park Management Plan	
Fotheringate Bay Conservation Area		N/A	
Settlement Point Conservation Area		N/A	
Emita Nature Recreation Area		N/A	
Marshall Beach Conservation Area		N/A	

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Mount Tanner Nature Recreation Area		N/A	
Bun Beetons Point Conservation Area		N/A	
Low Point Conservation Area		N/A	
Killiecrankie Nature Recreation Area		N/A	
Blyth Point Conservation Area		N/A	
Palana Beach Nature Recreation Area		N/A	
Jacksons Cove Conservation Area		N/A	
Internationally Important Wetlands (Ramsar Wetlands)			
Corner Inlet	• Represents the most southerly marine embayment and intertidal system of mainland Australia. • The site includes Corner Inlet and Nooramunga Marine and Coastal Parks, and the Corner Inlet MNP. • The major features of Corner Inlet 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.	Corner Inlet Ramsar Site Management Plan	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Gippsland Lakes	• Contains three main habitat types; permanent saline/brackish pools, coastal brackish/saline lagoons and permanent freshwater marshes. Threatened,	Gippsland Lakes Ramsar Site Management Plan	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
	endangered, vulnerable or rare native fish communities, and mammal, amphibian and plant species exist within these habitats. • The lakes and their associated swamps and morasses regularly support an estimated 40,000 to 50,000 ducks, swans, coots and other waterfowl. Lake Reeve (at the western end of the lake system) is a site of international zoological significance, attracting up to 12,000 migratory waders and is one of the five most important areas for waders in Victoria. • The lakes support the largest concentration (5,000) of red knot (*Calidris canutus*) recorded in Victoria, as well as up to 3,000 sharp-tailed sandpiper (*Calidris acuminata*) and up to 1,800 curlew sandpiper (*Calidris ferruginea*). Twenty-four (24) bird species listed under JAMBA and 26 species listed under CAMBA have been recorded at the lakes.		S1: Water quality impact assessment S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Lavinia	• The site is an important refuge for a collection of regional and nationally threatened species, including the nationally endangered orange-bellied parrot. • Other critical components of the site include wetland vegetation communities, regional and national rare plant species, regionally rare bird species, Kind Island scrubtit, water and sea birds, migratory birds, striped marsh frog and the green and gold frog • The site is currently used for conservation and recreation, including boating, fishing, camping and off-road driving. There are artefacts of Indigenous Australian occupation.	N/A (Plan is currently being revised)	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Western Port	• Western Port 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. • There are three marine parks within the Ramsar site (Yaringa, French Island and Churchill Island MNPs).	Western Port Ramsar Site Management Plan	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
			S7: Heritage and socioeconomic impact assessment
Nationally Important Wetlands			
Anderson Inlet	• Anderson Inlet is one of the largest estuaries on the Victorian coast. • The inlet is of high value for its fauna, including 23 waterbird species. • Popular for recreational fishing, camping, sailing, power-boating and water-skiing.	N/A	O2: Water quality O3: Sediment quality O4: Marine fauna surveillance S1: Water quality impact assessment S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment S5: Marine fauna impact assessment S7: Heritage and socioeconomic impact assessment
Lavinia Nature Reserve	• Lavinia Nature Reserve includes the Sea Elephant River Estuary and associated mudflats, areas of coastal swamp, lagoons and areas of drier marsh inland from the coast. • The wetland area supports species and communities which are threatened in both Tasmania and/or globally.	N/A (refer to Lavinia State Reserve Management Plan)	
Boullanger Bay – Robbins Passage	• Includes extensive area of tidal channels and intertidal mud and sand flats lying between the northwest channel coastline of Tasmania, and three offshore islands (Perkins, Robbins and Penguin Islands). • The site attracts the largest numbers of waders in Tasmania and represents significant habitat for non-migratory species.	N/A	
Rocky Cape Marine Area	• Area extends off the Rocky Cape National Park where the marine intertidal, tidal and deep waters, together with a range of wave exposures found in the area, result in particularly high biotic diversity. • Extensive fish fauna contains many warm and cool temperate species including cave dwelling species. • The area is commonly used for recreational activities such as scuba diving, snorkelling, fishing and boating.	N/A	
Thurra River	• Area of 2,920 ha and flows through State forest and Croajingolong National Park. • There are 29 threatened flora species and 37 threatened fauna species within the wetland.	N/A	

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Tamboon Inlet	• Located in east Gippsland and hosts a variety of wetland types that are affected by fresh and saline water, which supports a diversity of flora and fauna in estuarine habitat. • 96 plant taxa (including 38 introduced) have been recorded in the Tamboon Inlet area. The inlet is fringed by multiple vegetation classes including riparian scrub complex and coastal saltmarsh.	N/A	
Benedore River	• Occurs in east Gippsland in the Croajingolong National Park. The Benedore River has no introduced fish species and a natural assemblage of native species, which indicates pristine conditions. • There are 16 threatened flora species recorded in the wetland. There are 25 threatened fauna species including the little tern (*Sterna albifrons*).	N/A	
Powlett River Mouth	• The Powlett River Mouth provides valuable habitat for the endangered Orange-bellied Parrot. • The Powlett River Mouth area supports saltmarsh vegetation which is the required habitat of the Orange-bellied Parrot.	N/A	
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 under Ramsar Wetlands.	N/A (refer to Western Port Ramsar Site Management Plan)	
Threatened Ecological Communities			
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. • The Powlett River is a known site within the EMBA for this TEC.	Approved Conservation for the Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	O2: Water quality O3: Sediment quality S1: Water quality impact assessment S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment
Giant Kelp Marine Forests of South East Australia	• Giant kelp (*Macrocystis pyrifera*) is a large brown algae 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	Approved Conservation Advice for Giant Kelp Marine Forests of South East Australia	O2: Water quality O3: Sediment quality S1: Water quality impact assessment S2: Sediment quality impact assessment

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
	communities of closed or semi-closed giant kelp canopy at or below the sea surface that are protected. • The largest extent of the ecological community is in Tasmanian coastal waters; some patches may also be found in Victoria and South Australia.		S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment
Subtropical and Temperate Coastal Saltmarsh	• 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. • 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. • 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.	Conservation Advice for Subtropical and Coastal Saltmarsh	O2: Water quality O3: Sediment quality S1: Water quality impact assessment S2: Sediment quality impact assessment S4: Intertidal and coastal habitats impact assessment
Threatened or Migratory Fauna with BIAs			
White shark	• Vulnerable, migratory • Foraging, distribution and nursery BIAs	Recovery Plan for the White Shark (*Carcharodon carcharias*)	O4: Marine fauna surveillance S5: Marine fauna impact assessment
Southern right whale	• Endangered, migratory • Migration and distribution BIAs • Presence may occur from May to November	Conservation Management Plan for the Southern Right Whale, 2011-2021	O4: Marine fauna surveillance S5: Marine fauna impact assessment
Pygmy blue whale	• Endangered, migratory • Foraging and distribution BIAs • Typically forage in the Bass Strait region between January and April	Conservation Management Plan for the Blue Whale, 2015-2025	O4: Marine fauna surveillance S5: Marine fauna impact assessment
Antipodean albatross	• Vulnerable, migratory • Foraging BIA	National recovery plan for threatened albatrosses and giant petrels 2011-2016	O4: Marine fauna surveillance S5: Marine fauna impact assessment
Black-browed albatross	• Vulnerable, migratory • Foraging BIA		
Buller's albatross	• Vulnerable, migratory • Foraging BIA		

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Campbell albatross	• Vulnerable, migratory • Foraging BIA		
Shy albatross	• Vulnerable, migratory • Foraging BIA		
Wandering albatross	• Vulnerable, migratory • Foraging BIA		
Soft-plumaged petrel	• Vulnerable, migratory • Foraging BIA	Conservation Advice (*Pterodroma Mollis*) soft-plumaged petrel.	O4: Marine fauna surveillance S5: Marine fauna impact assessment
Short-tailed shearwater	• Migratory • Foraging BIA	N/A	O4: Marine fauna surveillance S5: Marine fauna impact assessment
Key Ecological Features			
Upwelling East of Eden	• An area of high productivity and aggregations of marine life. • Dynamic eddies of the East Australian Current cause episodic productivity events when they interact with the continental shelf and headlands. The episodic mixing and nutrient enrichment events drive phytoplankton blooms that are the basis of productive food chains including zooplankton, copepods, krill and small pelagic fish. • The upwelling supports regionally high primary productivity that supports fisheries and biodiversity, including top order predators, marine mammals and seabirds. This area is one of two feeding areas for blue whales and humpback whales, known to arrive when significant krill aggregations form. The area is also important for seals, other cetaceans, sharks and seabirds.	N/A	O2: Water quality O4: Marine fauna surveillance S1: Water quality impact assessment S5: Marine fauna impact assessment
West Tasmanian Canyons	• An area of high productivity and aggregations of marine life. • These canyons can influence currents, act as sinks for rich organic sediments and debris, and can trap waters or create upwellings that result in productivity and biodiversity hotspots. • Sponges are concentrated near the canyon heads, with the greatest diversity between 200-350 m depth. Sponges are associated with abundance of fishes and the canyons support a diversity of sponges comparable to that of seamounts.	N/A	O2: Water quality S1: Water quality impact assessment

Key Area Location / Feature	Summary of Environmental Values and Sensitivities	Relevant Management Plan / Conservation Advice / Recovery Plan	Relevant Operational and Scientific Monitoring Studies
Big Horseshoe Canyon	• The steep, rocky slopes provide hard substrate habitat for attached large megafauna. • Canyons have a marked influence on diversity and abundance of species through their combined effects of topography, geology and localised currents, all of which act to funnel nutrients and sediments into the canyon. • Sponges and other habitat forming species provide structural refuges for benthic fish, including the commercially important pink ling (*Genypterus blacodes*).	N/A	O2: Water quality S1: Water quality impact assessment
Canyons of the eastern continental slope	• The canyons provide a unique seafloor feature with enhanced ecological functioning, integrity and biodiversity, which apply to both its benthic and pelagic habitats. • These canyons affect the water column by interrupting the flow of water across the seafloor and creating turbulent conditions in the water column. • This turbulence transports bottom waters to the surface, creating localised upwellings of cold, nutrient-rich waters, which result in regions of enhanced biological productivity relative to the surrounding waters.	N/A	O2: Water quality S1: Water quality impact assessment
Heritage Features			
Western Tasmanian Aboriginal Cultural Landscape	• The Western Tasmania Aboriginal Cultural Landscape contains evidence of semi-sedentary villages that indicate a unique way of life for Tasmanian Aboriginals. • The Western Tasmania Aboriginal Cultural Landscape also contains other stone artefact scatters, stone arrangements, rock engravings and shelters and human burials that provide further insight into this unique way of life.	N/A	S7: Heritage and socioeconomic impact assessment

3 Priority Planning for Scientific Monitoring

Priority planning for scientific monitoring has been developed based on two elements:

1. Sensitive areas that may be exposed within a short period of time; and
2. Study scopes that have a short lead time for preparing an initial Sampling and Analysis Plan (SAP) for implementation.

Priority planning areas for potential scientific monitoring have been identified where the following criteria are met:

- Section of coastline between Kilcunda and Cape Paterson, where shoreline contact is predicted for the pipeline rupture and MDO release scenarios;
- Predicted time to exposure is ≤48 hours;
- Any of the following sensitive environmental receptors are present:
  - AMPs;
  - State marine protected areas;
  - National or internationally important wetlands;
  - Mangrove or saltmarsh habitat;
  - Known breeding/calving/nesting aggregation areas for protected (threatened or migratory) fauna;
  - Known breeding/haul-out areas for pinnipeds;
  - TECs; and
- Time given for preparation of an initial SAP for a particular scientific monitoring study is ≤48 hours.

Note, the time requirement is based upon the shortest time allowed (i.e., 48 hours) for the Monitoring Provider to prepare an initial SAP for a scientific monitoring study (as defined in the Offshore Victoria OSMP, which is for scientific monitoring studies 1 and 2).

The selection of sensitive environmental receptors is consistent with the receptors used in determining the onshore priority response planning areas within the OPEP, with the addition of marine protected areas (both Commonwealth and State).

The priority planning areas and relevant scientific monitoring scopes identified for spill scenarios that are relevant to the BassGas operations are detailed in Table 3.1. A series of checklists have been developed for these priority planning areas to assist in implementing scientific monitoring studies in these areas (**Appendix A**).

Table 3.1. Priority planning areas and scientific studies for BassGas operations

Sensitive Environmental Receptor	Priority Planning Area	Priority Scientific Studies
State protected areas	Punchbowl Coastal Reserve	S2: Sediment quality impact assessment
	Kilcunda Coastal Reserve	S2: Sediment quality impact assessment
	Kilcunda – Harmers-Haven Coastal Reserve Bunurong MNP Bunurong Marine and Coastal Park	S1: Water quality impact assessment S2: Sediment quality impact assessment
	Cape Liptrap Coastal Park	S2: Sediment quality impact assessment
Internationally important wetlands	Western Port	S1: Water quality impact assessment S2: Sediment quality impact assessment
Nationally important wetlands	Anderson Inlet Western Port Powlett River	S1: Water quality impact assessment S2: Sediment quality impact assessment
Sheltered tidal flats	Anderson Inlet	S1: Water quality impact assessment S2: Sediment quality impact assessment
Mangrove habitat	None	None
Saltmarsh habitat	Anderson Inlet Powlett River	S1: Water quality impact assessment S2: Sediment quality impact assessment
Known breeding/calving/nesting aggregation areas for protected fauna	Coastline from San Remo to Cape Paterson (shorebird roosting)	S5: Marine fauna impact assessment
Known breeding/haul-out areas for pinnipeds	Kanowna Island (seal breeding)	S5: Marine fauna impact assessment
TECs (Coastal Saltmarsh and/or Salt-wedge Assemblages)	Anderson Inlet (saltmarsh) Shallow Inlet (saltmarsh) Powlett River (salt-wedge assemblages)	S1: Water quality impact assessment S2: Sediment quality impact assessment
TECs (Giant Kelp)	None	None

4 Implementation Plan

4.1 Activation

In the unlikely event of a Level 2 or Level 3 offshore spill event, operational and scientific monitoring studies will be initiated once the relevant criteria have been met (as defined in the Offshore Victoria OSMP). The EMT Environment Leader (or delegate) will contact the Monitoring Provider Program Manager who will initiate their response.

4.1.1 Immediate response

Once notified, the Monitoring Provider Program Manager will confirm the availability of Study Leads, and specific sampling and analysis plans (SAPs) will be prepared based on the requirements of the individual spill event. Based on initiated studies and SAPs, personnel, equipment and mobilisation will commence.

4.2 Roles and responsibilities

The key roles and responsibilities for implementation of the OSMP are defined in Table 3.1 of the Offshore Victoria OSMP.

Key personnel within Beach with OSMP responsibilities are listed in Table 4.1.

Table 4.1. Key Beach personnel for OSMP implementation

Role	Name	Contact Details
Emergency Management Team (EMT) Leader	As per the on-call EMT Roster (refer to OPEP for details)	
EMT Environment Leader	As per the on-call EMT Roster (refer to OPEP for details)	

The Monitoring Provider and associated personnel will be identified and activated on a case-by-case basis. RPS has confirmed they have a pool of suitably trained and competent personnel to utilise in the event of a Level 2 or Level 3 hydrocarbon spill event and have confirmed their capacity and availability for the duration of BassGas operations. The key personnel for the monitoring scopes are listed in Table 4.2. The availability of these personnel is reviewed by RPS on a monthly basis and submitted to Beach.

Table 4.2. Key monitoring provider personnel for OSMP implementation

Role	Name	Contact Details
Program Manager	Jeremy Fitzpatrick	08 9211 1111 jeremy.fitzpatrick@rpsgroup.com.au
Study Lead/s	Jeremy Fitzpatrick	08 9211 1111 jeremy.fitzpatrick@rpsgroup.com.au
	Dr Garnet Hooper	
	Dr Mike Mackie	
	Dr Matthew Fraser	
	Peter Crockett	
	Tamara Al-Hashimi	

4.3 Capability, training and competency

Table 4.3 details the capability assessment for the implementation of the OSMP studies. It identifies the minimum number of personnel to manage and implement the OSMP studies and platforms (vessel, aircraft or vehicles) required to perform the studies. The studies have been group where appropriate to ensure effective use of resources.

The number of resources identified is based on:

- The fact that in the event of a spill, the full EMBA will not be impacted as it represents multiple spill simulations (e.g., 100 simulations per spill scenario);
- Shoreline contact is predicted from a surface MDO release and pipeline rupture scenario but not from the LoWC scenario, with the section of coast between Kilcunda and Cape Paterson most at risk;
- Higher concentrations of hydrocarbon are spatially limited to the vicinity of the release location (i.e., at the moderate and high exposure thresholds, the predicted surface exposure is up to 13.2 km for MDO and 3.7 km for condensate); however it is noted that lower concentrations that require monitoring do extend beyond these distances; and
- It is unlikely that wildlife would be oiled within the offshore environment, but some oiling of wildlife may occur along the maximum predicted 11 km length of coast exposed to moderate (100 g/m^2) to high (>1,000 g/m^2) MDO loading thresholds and 4 km for the same condensate loading thresholds.

RPS has confirmed they have a pool of suitably trained and competent personnel to fulfil the requirements of the OSMP. The availability of these personnel is reviewed by RPS on a monthly basis and submitted to Beach.

4.4 Sampling and Analysis Plans for Scientific Monitoring

Study S1 (water quality) and S2 (sediment quality) have implementation times of 72 hours once the study has been activated (refer to Offshore Victoria OSMP). Due to the short implementation time, draft standard operating procedures (SOP) have been prepared and are attached as **Appendix B**.

As the implementation times for the other scientific studies are longer (4–5 days), specific SAPs including SOP will be developed post-event by the Monitoring Provider. These will be based on the details provided in the Offshore Victoria OSMP and made fit-for-purpose to the nature and scale of the actual spill event.

4.5 Study Logistics

All field logistics in regard to survey timing, scheduling and scope are subject to safe operating conditions in accordance with Beach (and/or their Monitoring Providers) health, environment and safety policies. This includes the requirements for any additional qualifications and training for field personnel (e.g., medicals, BOSIET, HUET, ADAS Level 2, Coxswains etc.)

4.6 Survey Schedule

Survey scheduling (in terms of locations and sampling order) will be at the discretion of the Study Lead taking into account existing and predicted oil distributions, proximity to environmental sensitivities and forecasted weather/sea state conditions.

4.7 Permits

The worst-case spill scenarios for BassGas operations may cover Commonwealth, Victorian, Tasmanian and New South Wales (NSW) state waters (depending on scenario). The permits generally required by the governments are listed in Table 4.4.

Permit applications require details on the samples to be collected (including timing, species, numbers, methods to be used etc.), and can take up to approximately six weeks for approval. However, in the event of a hydrocarbon spill, this process is likely to be expedited and/or given exemptions.

The Monitoring Provider will confirm the need for any permits during the development of an initial SAP once a spill event has occurred.

Table 4.3. OSMP capability needs assessment for BassGas operations

Scope Description	Operational / Scientific Study	Study Lead	Field / Office Personnel	Platform
Program Manager	All	One Program Manager: • Bachelor degree in environmental science/engineering (or equivalent) • >20 years' experience in environmental practice • Familiarity with OSMP and OPEP, as relevant	N/A	N/A
Oil, water and sediment sampling	O1: Oil characterisation and behaviour O2: Water quality O3: Sediment quality (offshore and intertidal) S1: Water quality impact assessment S2: Sediment quality impact assessment	One Study Lead: • Bachelor degree in environmental science/engineering (or equivalent) • >10 years' experience in environmental practice • Familiar with OSMP and OPEP, as relevant	Two vessel-based personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experienced in the relevant sampling and/or recording techniques • Familiar with oil, water and sediment sampling and recording techniques including in situ profiling). One of the vessel personnel: • Familiar with oil visual observations. Two office personnel: • Bachelor degree in environmental science/engineering or equivalent • > 5 years' experience in environmental practice • Experienced in water and sediment quality data analysis	One vessel
Fish tainting, impact and recovery	O6: Fish tainting S6: Fisheries impact assessment	One Study Lead: • Bachelor degree in environmental science/engineering (or equivalent) • >10 years' experience in environmental practice • Familiar with OSMP and OPEP, as relevant	One vessel-based person: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experienced in the relevant sampling and/or recording techniques (biological tissue sampling, sensory analysis) One vessel-based person: • Familiar with oil and water sampling and recording techniques (hydrocarbon sensory assessment, field biological tissue sampling) • Trained and/or experienced olfactory analysts	One vessel

Scope Description	Operational / Scientific Study	Study Lead	Field / Office Personnel	Platform
			One office person: • Bachelor degree in environmental science/engineering or equivalent • > 5 years' experience in environmental practice • Experience in analysis and interpretation of biota data	
Intertidal and subtidal habitat impact and recovery	S3: Subtidal habitats impact assessment S4: Intertidal and coastal habitats impact assessment	One Study Lead: • Bachelor degree in environmental science/engineering (or equivalent) • >10 years' experience in environmental practice • Familiar with OSMP and OPEP, as relevant	Four vessel-base personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Commercial dive qualifications • Experienced in the relevant sampling and/or recording techniques One vessel person: • Experienced in commercial ROV operations Two mainland personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experienced in the relevant sampling and/or recording techniques Two office personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experienced in identification, analysis and interpretation of benthic habitat data and sediment quality data analysis	One vessel One vehicle
Coastal habitat impact and recovery	O3: Sediment quality (shoreline) S2: Sediment quality (shoreline) impact assessment S4: Intertidal and coastal habitats impact assessment	One Study Lead: • Bachelor degree in environmental science/engineering (or equivalent) • >10 years' experience in environmental practice Familiar with OSMP and OPEP, as relevant	Four mainland personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experienced in the relevant sampling and/or recording techniques Two of the mainland personnel: • Familiar with sediment sampling and recording techniques Two office personnel: • Bachelor degree in environmental science/engineering or equivalent	Two vehicles

Scope Description	Operational / Scientific Study	Study Lead	Field / Office Personnel	Platform
			• >5 years' experience in environmental practice Experienced in identification, analysis and interpretation of benthic habitat data and sediment quality data analysis	
Marine fauna surveillance, impact and recovery	O4: Marine fauna surveillance S5: Marine fauna impact assessment *Note:* *Aerial surveillance requirements are detailed within the 'Monitor and Evaluate' response within the OPEP* *Oiled, injured, and diseased fauna handling to be undertaken by trained personnel resources are detailed in 'Oiled Wildlife Response' within the OPEP*	Two Study Leads (one for seabirds/shorebirds and one for marine megafauna (marine mammals, sharks, reptiles)): • Bachelor degree in environmental science/engineering (or equivalent) • >10 years' experience in environmental practice • Familiar OSMP and OPEP, as relevant	Four vessel-based personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experienced in the relevant sampling and/or recording techniques • Familiar with fauna observation and recording techniques One of the vessel-based personnel: • Familiar with tissue sampling, storage and preservation One of the vessel-based personnel: • Experienced with ROV/UVA scopes Four field personnel for seabird/shorebirds: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experienced in the relevant sampling and/or recording techniques Two office personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experience in identification, analysis and interpretation of biota data Two office personnel: • Experienced with remote sensing scopes	One Vessel Two vehicles
Heritage and socioeconomic	S7: Heritage and socioeconomic impact assessment	One Study Lead: • Bachelor degree in environmental science/engineering (or equivalent) • >10 years' experience in environmental practice • Familiar OSMP and OPEP, as relevant	Desktop Assessment - One office person: • Bachelor degree in environmental or social science or equivalent • >10 years' experience in environmental/social practice • Experienced in interpretation and management of heritage, social and economic data	N/A

Scope Description	Operational / Scientific Study	Study Lead	Field / Office Personnel	Platform
			Four vessel-based personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Commercial dive qualifications • Experienced in the relevant sampling and/or recording techniques One vessel-based person: • Experienced in commercial ROV operations Two mainland personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice • Experienced in the relevant sampling and/or recording techniques One office person: • Bachelor degree in environmental or social science or equivalent • >10 years' experience in environmental practice • Experienced in interpretation and management of heritage, social and economic data Two office personnel: • Bachelor degree in environmental science/engineering or equivalent • >5 years' experience in environmental practice	One Vessel Two vehicles

Table 4.4. Permits that may be required for scientific monitoring

Permit	Relevance	Legislation	Government Agency
Commonwealth			
General Permit Application for: • threatened species and ecological communities • migratory species • whales and dolphins • listed marine species	Required for matters for scientific sampling for matters listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	EPBC Act	Department of Agriculture, Water and the Environment (DAWE)
Access to Biological Resources in a Commonwealth Area for Non-Commercial Purposes	An applicant must obtain written permission from each Access Provider. The Access Provider must state permission for the applicant to: • enter the Commonwealth area • take samples from the biological resources of the area • remove samples from the area	EPBC Act	DAWE
Victoria			
Application for a scientific permit to conduct research in areas managed under the *National Parks Act 1975*	Required for any research activity in marine and intertidal parks protected under Victorian legislation	*National Parks Act* 1975	Department of Environment, Land, Water and Planning (DELWP)
Application for a scientific permit	Required for any research involving fauna subject to the *Wildlife Act 1975*	*Wildlife Act* 1975	DELWP
Tasmania			
Application for a scientific permit to collect or disturb native fauna	A scientific permit is usually required for any research involving the collection or disturbance of protected wildlife, and the collection of protected wildlife products in Tasmania.	*Nature Conservation Act* 2002	Department of Primary Industries, Parks, Water and the Environment (DPIPWE)
Fishery Permit Application	A Fishery Permit Application is required for the taking of marine fish (including marine invertebrates) for scientific research.	*Living Marine Resources Management Act* 1995	DPIPWE
Animal Ethics Committee approval	If intending to take or disturb living vertebrate or higher invertebrate wildlife, then Animal Ethics Committee approval from a licensed institution is required.	*Animal Welfare Act* 1993	DPIPWE

Permit	Relevance	Legislation	Government Agency
New South Wales			
Scientific licence (biodiversity or species impact statement)	Several classes of scientific licences are required for activities ranging from research, surveying and education to collecting seeds, bush regeneration and ecological burns.	Biodiversity Conservation Act 2016	Department of Planning, Industry and Environment (DPIW)
Animal ethics approval	If the research involves animals, it may need to meet animal ethics obligations under the *Animal Research Act* 1985.	Animal Research Act 1985	DPIW

Appendix A Scientific Monitoring Priority Planning Area Summaries

A. 1. Punchbowl Coastal Reserve

Element	Description	
Potential oil exposure	Shoreline, Entrained, Dissolved	
Priority scientific studies	S2: Sediment quality impact assessment	Refer to Appendix B for SOP. Given location of the reserve in relation to the spill source, a linear / grid sampling design is considered appropriate, including samples from both within and external to the boundaries of the reserve. If shoreline sampling is required, cross-shore beach profiles from intertidal to above high-water mark. Sample design to be confirmed by Monitoring Provider prior to implementation.
Other scientific studies that may be implemented at the site	S5: Marine fauna impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S7: Heritage and socioeconomic impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
Management Plans	None.	N/A

A. 2. Kilcunda Coastal Reserve

Element	Description	
Potential oil exposure	Shoreline, Entrained, Dissolved	
Priority scientific studies	S2: Sediment quality impact assessment	Refer to Appendix B for SOP. Given location of the reserve in relation to the spill source, a linear / grid sampling design is considered appropriate, including samples from both within and external to the boundaries of the reserve. If shoreline sampling is required, cross-shore beach profiles from intertidal to above high-water mark. Sample design to be confirmed by Monitoring Provider prior to implementation.
Other scientific studies that may be implemented at the site	S7: Heritage and socioeconomic impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
Management Plans	Kilcunda Coastal Reserve Management Plan	No specific management actions

A. 3. Kilcunda – Harmers-Haven Coastal Reserve

Element	Description	
Potential oil exposure	Shoreline, Entrained, Dissolved	
Priority scientific studies	S1: Water quality impact assessment	Refer to Appendix B for SOP. Given location of the reserve in relation to the spill source, a linear / grid sampling design is considered appropriate, including samples from the coast and the adjacent waters. Sample design to be confirmed by Monitoring Provider prior to implementation.
	S2: Sediment quality impact assessment	Refer to Appendix B for SOP. Given location of the reserve in relation to the spill source, a linear / grid sampling design is considered appropriate, including samples from both within and external to the boundaries of the reserve. If shoreline sampling is required, cross-shore beach profiles from intertidal to above high-water mark. Sample design to be confirmed by Monitoring Provider prior to implementation.
Other scientific studies that may be implemented at the site	S5: Marine fauna impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S7: Heritage and socioeconomic impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
Management Plans	Bunurong MNP, Bunurong Marine Park, Bunurong Coastal Reserve and Kilcunda-Harmers Haven Coastal Reserve management plan	No specific management actions

A. 4. Bunurong MNP

Element	Description	
Potential oil exposure	Shoreline, Entrained, Dissolved	
Priority scientific studies	S1: Water quality impact assessment	Refer to Appendix B for SOP. Given location of MNP in relation to the spill source, a linear / grid sampling design is considered appropriate, including samples from both within and external to the boundaries of the MNP. Sample design to be confirmed by Monitoring Provider prior to implementation.
	S2: Sediment quality impact assessment	Refer to Appendix B for SOP. Given location of the MNP in relation to the spill source, a linear / grid sampling design is considered appropriate, including samples from both within and external to the boundaries of the MNP. Sample design to be confirmed by Monitoring Provider prior to implementation.
Other scientific studies that may be implemented at the site	S4: Intertidal and coastal habitats impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides

Element	Description	
	S3: Subtidal habitats impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S5: Marine fauna impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S7: Heritage and socioeconomic impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
Management Plans	Bunurong MNP, Bunurong Marine Park, Bunurong Coastal Reserve and Kilcunda-Harmers Haven Coastal Reserve management plan	No specific management actions

A. 5. Bunurong Marine and Coastal Park

Element	Description	
Potential oil exposure	Shoreline, Entrained, Dissolved	
Priority scientific studies	S1: Water quality impact assessment	Refer to Appendix B for SOP. Given location of the park in relation to the spill source, a linear sampling design is considered appropriate, with samples taken along an inshore-offshore gradient and including samples from both within and external to the boundaries of the park. Sample design to be confirmed by Monitoring Provider prior to implementation.
	S2: Sediment quality impact assessment	Refer to Appendix B for SOP. Given location of the park in relation to the spill source, a linear / grid sampling design is considered appropriate, including samples from both within and external to the boundaries of the park. If shoreline sampling is required, cross-shore beach profiles from intertidal to above high-water mark. Sample design to be confirmed by Monitoring Provider prior to implementation.
Other scientific studies that may be implemented at the site	S4: Intertidal and coastal habitats impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S5: Marine fauna impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S7: Heritage and socioeconomic impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
Management Plans	Bunurong MNP, Bunurong Marine Park, Bunurong Coastal Reserve and Kilcunda-Harmers Haven Coastal Reserve management plan	No specific management actions

A. 6. Powlett River Estuary

Element	Description	
Potential oil exposure	Shoreline, Entrained, Dissolved	
Priority scientific studies	S1: Water quality impact assessment	Refer to Appendix B for SOP. Given location of estuary in relation to the spill source, a linear sampling design is considered appropriate, with samples taken from both within and external to the boundaries of the estuary. Sample design to be confirmed by Monitoring Provider prior to implementation.
	S2: Sediment quality impact assessment	Refer to Appendix B for SOP. Given location of the estuary in relation to the spill source, a linear sampling design is considered appropriate, with samples taken from both within and external to the boundaries of the bay. If shoreline sampling is required, cross-shore profiles from intertidal to above high-water mark. Sample design to be confirmed by Monitoring Provider prior to implementation.
Other scientific studies that may be implemented at the site	S4: Intertidal and coastal habitats impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S5: Marine fauna impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S7: Heritage and socioeconomic impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
Management Plans	Powlett River Estuary Management Plan	Pollution events listed as specific threat to the estuary, no associated management actions relevant to spills
	Approved Conservation for the Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Change in water quality (although listed from other sources) is identified as a threat. No specific actions for a post-impact change in water quality listed. General activities to monitor changes in condition.
	Conservation Advice for Subtropical and Coastal Saltmarsh	Pollution from oil spill events are identified as a threat Actions for this TEC include identifying coastal saltmarsh as important habitat in all oil spill contingency planning and monitor the application of protocols on the management of spills involving saltmarshes

A. 7. Cape Liptrap Coastal Park

Element	Description	
Potential oil exposure	Shoreline, Entrained, Dissolved	
Priority scientific studies	S1: Water quality impact assessment	Refer to Appendix B for SOP. Given location of the park in relation to the spill source, a linear sampling design is considered appropriate, with samples taken from both within and external to the boundaries of the park. Sample design to be confirmed by Monitoring Provider prior to implementation.
	S2: Sediment quality impact assessment	Refer to Appendix B for SOP. Given location of the park in relation to the spill source, a linear sampling design is considered appropriate, with samples taken along an inshore-offshore gradient and including samples from both within and external to the boundaries of the park. If shoreline sampling is required, cross-shore profiles from intertidal to above high-water mark. Sample design to be confirmed by Monitoring Provider prior to implementation.
Other scientific studies that may be implemented at the site	S4: Intertidal and coastal habitats impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S5: Marine fauna impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
	S7: Heritage and socioeconomic impact assessment	SOP to be developed post-spill; refer to Offshore Victoria OSMP for relevant guides
Management Plans	Cape Liptrap Coastal Park Management Plan	No specific management actions

Appendix B Standard Operating Procedures for Water and Sediment Sampling

The Monitoring Provider will review and confirm/update these SOP to ensure they are fit for purpose for the nature and scale of the spill event prior to the SAP being finalised and sampling commencing.

B. 1. Water Sampling – Surface Waters

The number of water samples will be determined on an ad-hoc basis, depending on the nature of the spill, the distribution of the spill in relation to sensitive receivers, the availability of resources on site (i.e. vessel availability) and coordination with others responding to the spill (e.g., Australian Maritime Safety Authority, AMSA).

Triplicate seawater samples will be collected from impact and control sites. Surface water samples will be collected using a marine grade stainless steel bucket from an available support vessel. Subsurface water samples will be collected using Niskin bottles deployed to the appropriate sample depth. The appropriate sample depth should be determined on site in consultation with other agencies, with regard to the modelled distribution of entrained hydrocarbons and a consideration of potential sensitive receivers. Samples will be collected at a range of depths. As a minimum, samples will be collected from 0.5 m below the surface, 0.5 m above the seabed, and mid water column.

Surface water sampling should be conducted as per the following instructions:

1. Prior to deployment, liaise with the vessel crew to ensure that all personnel are familiar with the planned operation.
2. After reviewing the Decon 90 Material Safety Data Sheet (MSDS), clean the sampling bucket using Decon 90, ensuring you are wearing appropriate PPE, including:
    a. High visibility clothing
    b. Safety boots
    c. Personal Floatation Device (PFD) if working on the deck
    d. Hard hat (if working on the deck)
    e. Safety glasses
    f. Nitrile gloves.
3. Rinse the sample bucket thoroughly with deionised water once cleaned with Decon 90.
4. Confirm with the deck supervisor and vessel master that the vessel is on station and is prepared for sampling to proceed.
5. Ensure the sampling location is free of potential sources of contamination, including:
    a. Grease and oils
    b. Overhead wires
    c. Exhaust fumes (e.g., incinerators, engine exhaust, cigarette smoke, etc.)
    d. Vessel discharges (e.g., ballast water, grey water, sullage, etc.)
6. Ensure the sampling location is free of entanglement risks (e.g., propellers, thrusters, etc.).
7. Ensure the sampling location is safe (guard rails in place, life ring available), and that weather conditions are suitable for sampling.
8. Prepare the sample containers by labelling them appropriately and completing any required field documentation.
9. Ensure one end of the rope is securely attached to the sampling bucket and the other end to the vessel.
10. Lower the bucket into the water, let the bucket fill and haul it back on board.
11. Once the sample is on board, put on a clean pair of nitrile gloves and collect the water samples using the laboratory sample containers provided. Attempt to collect primarily water in the larger bottles and primarily oil in the smaller bottle. Do not sample rinse the bottles and cap them immediately upon collecting the sample.
12. Once collected, ensure that samples are clearly labelled and stored in the refrigerator.
13. Clean the sampling bucket using Decon 90 (see item 2 above for details) and rinse with deionised water.

B. 2. Water Sampling – Subsurface Waters

Subsurface water sampling will be conducted using Niskin bottles, deployed at appropriate depths. The three 10 L Niskin bottles have Teflon coating and external springs making them suitable for trace and heavy metals and hydrocarbons. The number of Niskin bottles casts and the amount of bulk water needed will depend on the sampling design. Ensure all staff review and sign the water quality sampling JHA.

Niskin samples will be collected in accordance with the following procedure:

1. Prior to deployment, liaise with the vessel crew to ensure that all personnel are familiar with the planned operation.
2. After reviewing the Decon 90 MSDS, clean the Niskin bottles using Decon 90, ensuring you are wearing appropriate PPE, including:
    a. High visibility clothing
    b. Safety boots
    c. PFD if working on the deck
    d. Hard hat (if working on the deck)
    e. Safety glasses
    f. Nitrile gloves
3. Rinse the Niskin bottles thoroughly with deionised water once cleaned with Decon 90. If possible, fill the Niskin bottles with uncontaminated seawater and allow then to sit prior to sampling.
4. Confirm with the deck supervisor and vessel master that the vessel is on station and is prepared for sampling to proceed.
5. Ensure the sampling location is free of potential sources of contamination, including:
    a. Grease and oils
    b. Overhead wires
    c. Exhaust fumes (e.g. incinerators, engine exhaust, cigarette smoke etc.)
    d. Vessel discharges (e.g. ballast water, grey water, sullage, etc.).
6. Ensure the sampling location is free of entanglement risks (e.g. propellers, thrusters, etc.).
7. Ensure the sampling location is safe (guard rails in place, life ring available), and that weather conditions are suitable for sampling.
8. Ensure one end of the rope is securely attached to the sampling bucket and the other end to the vessel.
9. Ensure the winch line is clean, smooth and has no broken wires or other things that could obstruct the messenger going down the line.
10. Attach the clump weight to the end of the winch line, approx. 10 – 20 kg (consider current at site).
11. Attach the bottom or deepest bottle 1.5–3 m above the weight.
12. Ensure top air bleed is closed, nozzle is pulled out and the bottle is open or set to sample.
13. Before firing the bottles at depth, allow the bottles to flush with sea water for 1–2 minutes at the sample depth.
14. Send the messenger down the line with enough force that it is going to travel directly down the line.
15. You can keep your hand on the line to feel each bottle close. You should be able to feel a tug on the line as the bottle fires.
16. Raise winch line slowly to retrieve bottles.
17. Take care when removing bottles from the winch line as they will be heavy and care should be taken not too accidently open the bottles.
18. Decant sea water from the Niskin bottle directly into sample containers.
19. When using carboys, carboys should be rinsed three times with a small amount of the sample water prior to filing with the sample.
20. Prepare the sample containers by labelling them appropriately and completing any required field documentation.
21. Lower the bucket into the water, let the bucket fill and haul it back onboard.

22. Once the sample is onboard, put on a clean pair of nitrile gloves and collect the water samples using the laboratory sample containers provided. Attempt to collect primarily water in the larger bottles and primarily oil in the smaller bottle. Do not sample rinse the bottles and cap them immediately upon collecting the sample.
23. Once collected, ensure samples are clearly labelled and stored in a refrigerator.
24. Clean the sampling bucket using Decon 90 (see item 2 for details) and rinse with deionised water.

B. 3. Sediment Sampling

Sediment samples will be collected using a van Veen sediment grab (or similar sediment sampling device). Prior to taking a grab sample, clean the grab using detergent and a scrubbing brush. Be sure to remove any material adhering to the grab. Ensure all staff review and sign the grab sampling JHA. Sediment samples will be collected in accordance with the following procedure:

Note that the vessel crew will operate the grab with assistance from RPS staff and the winch will be operated by vessel crew. Prior to taking a grab sample, clean the grab using detergent and a scrubbing brush. Be sure to remove any material adhering to the grab.

1. Prior to deployment, liaise with the vessel crew to ensure that all personnel are familiar with the planned operation and that clear lines of communication are available.
2. Prepare the grab on the deck, making sure it is securely attached to the vessel winch cable. Mouse any shackles to ensure pin does not come undone under load. Be VERY careful around the grab - always keep clear of the grab jaws. Assume that they may trigger at any time.
3. Take care when the grab is off the deck. NEVER stand under the grab. Check all shackles, etc. before lifting grab off deck. Use strops if required to stabilise the grab.
4. Lower the grab to the seabed, it will trigger when the cable goes slack.
5. Bring the grab to the surface and ensure the sample is sufficient. If the grab begins to swing, lower the grab into the sea to dampen the motion.
6. Open the jaws of the grab slightly to allow emptying of surplus water from the sediment sample but try not to let the fine sediments wash away.
7. Once drained of all free water, open grab completely and empty contents onto a tarpaulin on the deck. Note: due to the mechanics of the grab when opening, surface sediments may be concentrated towards the middle of the sample.
8. Collect a sample of the surface sediments by scraping the 250 ml sample jars through the sediments. Be mindful of contamination sources and ensure that all staff handling samples are wearing clean nitrile gloves.
9. Securely stow the grab onboard when not in use.

B. 4. Cleaning and Care

Niskin bottles should be cleaned with Decon 90 before the sampling trip. Once in the field the bottles should be soaked in sea water. This can be done by attaching the Niskin bottles to the winch line and lowering off the vessel. If time permits, allow the bottles to soak for at least one hour. Avoid touching the internal parts of the Niskin bottle or sampling bucket. Ideally Niskin bottles should be stored upright in racks on the vessel. Take care to store equipment away from potential sources of contamination.

B. 5. Chain of Custody

All samples submitted for analysis will be accompanied by a Chain of Custody (CoC) form. The CoC form will accompany samples during transport and delivery. The form will be signed with the time and date recorded by each individual responsible for the samples including RPS staff and laboratory personnel. Upon each exchange, the CoC form is countersigned and duplicated by the relinquisher. The recipient retains the original. When samples are received by the laboratory, a duplicate of the original will be issued to RPS confirming arrival. The CoC allows RPS to track the samples and ensure that samples arrive at the intended destinations on schedule.

B. 6. Sample Transport and Storage

Water and sediment samples should be transported as soon as practicable to a nominated laboratory (refer to the OSMP Implementation Plan) in appropriate containers (eskies) with ice bricks. The holding times for all samples are 7 days. Samples must be provided to the analytical laboratory within this time period. Liaise with RPS staff regarding sample transport, etc., as outlined in the personnel section of the OSMP Implementation Plan.

The proposed analyses to be undertaken by the primary analytical laboratory are total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH) for both sediments and water.

Appendix I Beach's Environmental Policy

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

Document status

Version	Date reviewed	Prepared by	Reviewed by	Endorsed by	Date of and final approval by
1.0	2015	HSE Manager	HSE Committee	Risk Management Committee	Board 1 March 2015
2.0	October 2017	HSE Manager	HSE Committee	Risk Management Committee	Board 26 October 2017
3.0	September 2019	Head of Environment	Risk Mgmt Committee	RCGS Commitee	Board 13 Dec 2019

Amendment record

Version	Clause	Description of amendment
October 2017	Multiple	Minor amendments to wording
September 2019	Multiple	Branding, and changes to obligations

Appendix J Summary of Stakeholder Engagement

The information sheet / project summary for the Yolla infill well that was used as the basis for stakeholder engagement is included below.

BassGas Project

Yolla Infield Well - Environment Plan

Project Summary | 21 February 2022

Project overview

Beach Energy is preparing to further develop the existing Yolla offshore gas field in Bass Strait to meet the ongoing demand for natural gas in Australian homes and industries.

Beach currently produces natural gas from the Yolla field via three wells on the existing Yolla offshore platform in Bass Strait. Raw gas is transported via a 147 km subsea pipeline to shore, and a 32 km gas buried pipeline across land to the Lang Lang Gas Plant where it is processed for local supply.

Beach is planning to drill an additional infield well into the existing Yolla field. A Jack-up Mobile Offshore Drilling Unit (MODU) will be towed into position adjacent the Yolla platform to drill the well. This is the same drilling method used for the last four wells in the Yolla field.

Yolla Platform, Bass Strait

Environmental assessment and approvals

Beach is preparing an Environment Plan (EP) for the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) to assess and accept before activities can commence.

The EP must include:

- definitions and descriptions of the activities required to drill the well
- a detailed description of the existing marine environment
- an assessment of relevant scientific studies
- the identification and evaluation of impacts and risks of the activities on the environment
- environmental performance outcomes and control measures to reduce any potential impacts
- an implementation strategy. and reporting requirements.

The EP must demonstrate to NOPSEMA that the impacts and risks will be managed to acceptable levels, and how activities will be conducted to ensure that potential impacts and any residual risks will be managed and reduced to "As Low As Reasonably Practicable" (ALARP). If NOPSEMA is satisifed that the EP meets the criteria set out in the Environment Regulations, it will accept the EP and publish it on its website.

Summary of activities

The infield well activities would include:

- towing a Jack-up MODU into position adjacent to the Yolla platform
- jacking down the legs of the MODU to the seabed once it is in position to stabilise it, and minimising seabed disturbance by placing inverted cones mounted at the base of the MODU legs (spud cans) into the existing seabed impressions from previous drilling campaigns
- the MODU will self-elevate out of the water to above maximum expected sea conditions, and drilling operations will begin from the existing well slot on the platform
- drilling an extended reach well from the existing Yolla platform slot to the targeted gas reservoir and completing the well if it is commercially viable
- workover of existing Yolla 3 and/or Yolla 5 wells for modification or replacement of production tubulars
- operations support activities to include support vessels and helicopters
- completing tie-in activities on the Yolla platform by connecting the well into the existing production piping, with no seabed disturbance. This will include fabricating and installing new flowline sections and pipe supports, modifying existing process pipework and instrumentation, and reusing and modifying as much of the existing piping, supports, instrumentation and instrument control as possible
- if the well is commercially unviable due to limited gas, multiple cement plugs will be installed within the well to permanently seal the well and isolate it from other geological formations. A cement plug will be installed at the seabed and all casings will be cut at least two metres below the mudline to ensure that the seabed is returned to the same condition prior to drilling.

Jack up MODU beside Yolla Platform, 2015

Location

The activities would take place on and alongside the Yolla platform in Bass Strait, approximately 100 km from Stanley on the Tasmanian coast and 139 km from Wonthaggi in Victoria. The coordinates below and map on the following page provide further details.

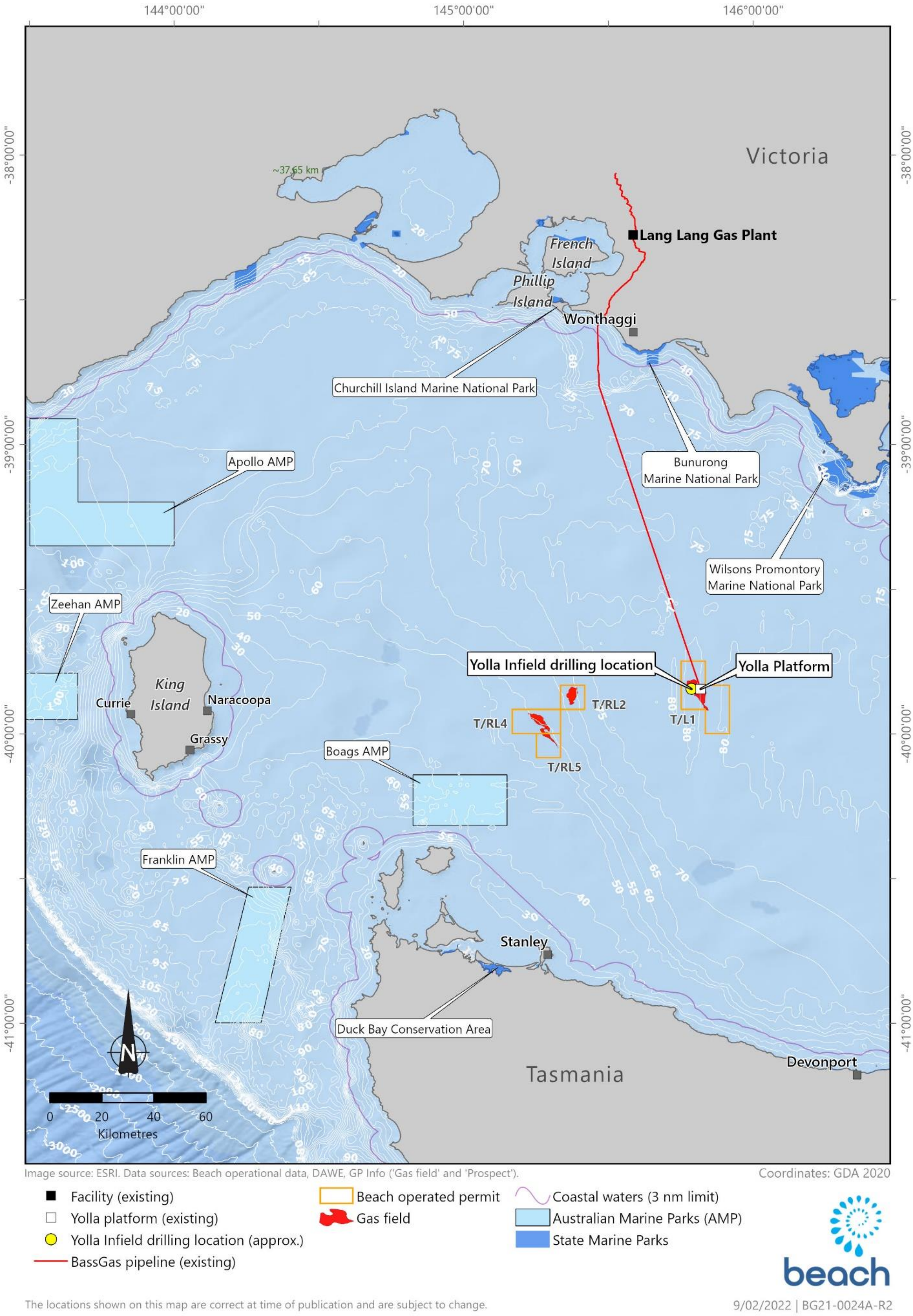
	Longitude	Latitude
Yolla Platform	145° 49.083'E	39° 50.633'S

Timing

Preliminary plans are for drilling to commence approximately late 2022 or early 2023. Activities will take approximately 130 days to complete.

Project plans will be finalised after Beach has received all regulatory and internal approvals, and exact timings will be subject to vessel and contractor availability and weather conditions. Stakeholders will be notified at least four weeks before drilling activities commence.

Yolla Infield project area map



Marine Environment

Beach has a proud track record for safety and environmental performance, adhering to performance measures set out in Environment Plans and Safety Cases accepted by regulators. We recognise the environmental, heritage, social and economic value in our operating areas.

The activities will be carried out in a water depth of approximately 80 metres where the seabed is primarily made up of muddy silts and sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and snails.

A variety of marine fauna occurs in the project area, including the potential presence of:

- blue, humpback and fin whales, particularly during the summer months
- southern right and minke whales, particularly during the winter months
- common dolphin and shark species throughout the year
- New Zealand and Australian fur seals throughout the year
- loggerhead, green and leatherback turtles throughout the year.

Economic values within the project area include commercial fishing and shipping activity.

The EP will address potential impacts to the marine environment, commercial fishing and shipping activity, and how they will be managed to acceptable levels.

Maritime safety protocols

At Beach, safety takes precedence in everything we do. The marine vessels and MODU contracted by Beach will have their specific Safety Cases reviewed and accepted by NOPSEMA, and will operate in accordance with Australian Maritime Standards, regulated by the Australian Maritime Safety Authority (AMSA) including:

- vessel masters issuing Notifications to the Australian Maritime Safety Authority before mobilising to the operational area and when demobilising
- providing advanced notice of activities and vessel contact details to stakeholders
- communicating with other vessels using standard maritime protocols
- maintaining safe operating distances around vessels and the MODU.

Safety exclusion and cautionary zones

Vessels in the area will be required to observe the existing Petroleum Safety Zone (PSZ) of 500m radius around the Yolla platform.

The Australia Hydrographic Office will issue a Notice to Mariners for safety exclusion and cautionary zones before activities commence and when complete.

Project emissions

As an oil and natural gas explorer and producer across Australia and New Zealand, Beach is committed to sustainably delivering energy for communities. Beach recognises that climate change is one of the global challenges of this century and understands the role we must play in managing our carbon emissions.

Should the Yolla Infield well prove viable, the BassGas Operations EP will be reviewed to assess whether additional standards and measures for greenhouse gas emissions mitigation are required. This review will be in accordance with the commitments set out in the Beach Environment Policy and the Beach Climate Change Policy, as well as NOPSEMA's requirement to demonstrate that any impacts will be made acceptable and reduced to ALARP. Beach has an aspiration to reach net zero Scope 1 and 2 emissions by 2050 and a target to reduce operational emissions by 25% by 2025. See further information in Beach's Sustainability Report.

Questions and Answers

Why is Beach drilling the Yolla Infield well?

Natural gas from the Bass Basin has been supplying Australia's east coast gas market for many years. Beach holds several permits in the area near its existing Yolla platform, which directs raw gas to the Lang Lang Gas Plant for processing and supply to Victorian homes and businesses. Beach is required to continue to search for recoverable hydrocarbons in the production license that contains Yolla platform in accordance with requirements set out by the National Offshore Petroleum Titles Administrator (NOPTA). Industry and regulators continue to see tight gas supply for south-east Australia. To positively impact declining production from existing fields as reservoirs deplete, new gas projects need to be undertaken.

Why do we still need natural gas?

Natural gas has a wide variety of uses in our daily lives. This includes generating electricity, residential heating, hot water and cooking. In the industrial sector, gas is a primary heat source for manufacturing glass, steel, cement, bricks, wood, ceramics, tiles, paper and in producing food. Gas is a common ingredient in the manufacturing of fertilisers, plastics, pharmaceuticals and fabrics. The Australian Competition and Consumer Commission's (ACCC) latest Gas Inquiry in July 2021 forecasts a potential shortfall across the east coast gas market from 2022 onwards, driven by a shortfall in the southern states (Victoria).

What role is natural gas playing as Australia transitions to renewable energy?

Carbon emissions of natural gas are 50% to 70% lower than coal. As old coal fired power stations are removed from Australia's energy mix, electricity powered from natural gas ensures a stable energy supply as our economy transitions to renewable energies. The The Australian Energy Market Operator's (AEMO) 2020 Integrated System Plan (ISP) has forecast more gas is required in all modelled scenarios. In the most ambitious "Step Change" scenario where a 90% reduction in carbon emissions from power generation is achieved by 2041-42, 33% more gas fired electricity generation is required, enabling generation from renewables to increase by 285%.

Is Beach exporting gas from Bass Strait?

No. The gas Beach produces from Bass Strait is processed at the Lang Lang Gas Plant in Victoria and directly supplied via an existing pipeline into the Australian east coast gas market to meet existing residential and commercial demands.

What about impacts to whales?

Based on the low intensity sound generated from the activities, any impacts to whales will be minor and temporary. Avoidance and disturbance of whales will be managed in accordance with the Environment Protection and Biodiversity Conservation (EPBC) Regulations (2000). This includes adhering to required speeds and distances from whales, and in accordance with mitigation measures set out in the EP.

What about impacts on commercial fishing?

As the Yolla Infield development project area is very small compared to the vast commercial fisheries areas, it is not expected to impact commercial fishing. Beach will consult commercial fishers to ensure each other's activities are understood, and develop mitigation plans if required.

What is an OPEP?

When conducting offshore activities, there is a highly unlikely risk of a release of hydrocarbons (which is primarily natural gas) or a spill from vessels in the event of an accident. Therefore, each EP must include an Oil Pollution Emergency Plan (OPEP) for managing any unlikely hydrocarbon release. Preparation of an OPEP includes modelling a release of hydrocarbons; calculating the spreading, entrainment and evaporation of hydrocarbons over time; assessing the likelihood and consequences of any hydrocarbon release; and detailing a range of control measures and response plans that reduce risks to ALARP.

We welcome your questions and feedback. Please contact us:

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

Please note that all records of stakeholder engagement will be provided to NOPSEMA in accordance with regulations.

Sensitive Information Report

The Stakeholder Engagement Log and consultation records have been withheld because they contain sensitive information.